SUPPLEMENT TO "THE ELECTRICIAN," OCTOBER 30, 1908.

THE ELECTRICIAN:

A WEEKLY ILLUSTRATED JOURNAL OF

ELECTRICAL ENGINEERING, INDUSTRY, SCIENCE AND FINANCE.

VOLUME LXI.

(Second Series.)

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"The Electrician"

INDUSTRIAL SUPPLEMENT.

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THE ELECTRICIAN:

THE OLDEST WEEKLY ILLUSTRATED JOURNAL OF

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CONTENTS OF THE CURRENT NUMBER.

NOTES.

Co-operative Electrical Exhibits.

EXHIBITIONS are now so frequent that it is often difficult to know whether money is well spent in taking space. Every exhibition cannot be essentially technical, and many are particularly popular. In the latter case the difficulty may be conveniently solved by a large number of exhibitors joining together to give a combined electrical exhibit. This course was to have been followed at the Franco-British Exhibition, but we very much regret to hear that the idea has now been abandoned. The electricity supply companies had promised financial support, and many prominent manufacturers and contractors had decided to take part. There appears, however, to have been a singular lack of business promptitude on the part of the exhibition authorities. Consequently the negotiations were so protracted that when details were finally arranged the manufacturers felt there was insufficient time left for them to do justice to the exhibit before the date of opening. Consequently, many of the most prominent exhibitors decided to withdraw, the result being that the scheme has been abandoned.

THIS is all the more regrettable because we understand that arrangements are being made to have an effective combined exhibit showing the advantages of gas. In popular exhibitions it may well be that a great deal of business cannot be attracted to heavy engineering, but it must not be forgotten that such exhibitions have their educational value. The advance of the electrical industry is very closely bound up with the proper education of the general public to the advantages of electrical applications generally. There is comparatively little use in having highly efficient lamps, convenient apparatus for heating and cooking, and handy little motors for domestic applications, if the public is left in ignorance of the many useful appliances ready at hand. Educational information of this kind can be given much more readily at an exhibition, such as the Franco-British Exhibition, and more effectively by a good combined electrical display than by any other means, and we think that the scheme should have been carried through even at the risk of the exhibit being incomplete—a most common occurrence—at the date of opening.

Technical Education in America.

THE Paper read by Sir WILLIAM PREECE before the Royal Society of Arts upon "Technical Education in America," of which a brief abstract will be found elsewhere, emphasises two points in which this country differs from America. In the first place, American technical institutions are founded and supported to a great extent by private individuals. Thus, the magnificent institute now being completed at Pittsburg is due to the munificence of Mr. CARNEGIE. Possibly this is natural enough, because America is the land of rapidly-made millionaires, men who frequently amass wealth by the industrial application of processes evolved by applied science. In this country, on the other hand, a good deal of municipal finan-

cial assistance is given, but private donations are not as frequent as might be desired. There are, however, some marked exceptions, as, for example, at Liverpool and Birmingham. But the older institutions, as often as not, do not benefit, because there is greater inducement to found some institution which is entirely new. Thus the oldest universities labour under difficulties. The same thing is evident in London where there is always greater difficulty in raising funds for our university colleges than for our polytechnics. Might not Mr. Carnegie help to set the fashion here as in America? Certainly the field is ample.

The other point emphasised by Sir William Preece in his Paper was the fact that employers in America usually require the production of diplomas by young engineers before accepting them for any position. Not only do employers assist the technical institutions in this way, but they help very liberally in the equipment. No doubt it is rather on this account that a fourth year of instruction has become very general in America. As Sir William Preece puts it, in the first three years the student should learn something of everything, and in the fourth year he should learn everything of something. Whether such a fourth year will eventually be adopted in this country is doubtful. In some respects it is preferable for the employer to obtain the raw material before it is too far crystalised by technical instruction along lines which may not be commercial. Moreover, there is a great probability that the student in his fourth year will not know what subject to choose in which "to learn everything," and he may eventually find that he is unable to take up that particular line, and that he must adopt some other work for which his specialised knowledge is of little value.

The Post Office Electrical Engineers.

We have this week received a new journal called the *Post Office Electrical Engineers' Journal*, devoted to the interests of the recently founded Institution of Post Office Engineers. In many respects our new contemporary, which is to be published quarterly, is a counterpart of the *National Telephone Journal*, except that it necessarily deals not merely with the subject of telegraphy, which is so essentially connected with the Post Office, but with the newer developments of telephony as well. A few words of welcome by Sir John Gavey show that the effect of specialisation has been rather to isolate the telegraph engineer and the telephone engineer from existing societies and publications, which have found it necessary to devote themselves increasingly to the wider and newer applications of electrical energy. It will, perhaps, be felt that the telegraph and telephone engineers have not availed themselves of existing facilities as much as they might have done during the past few years, for telegraphic and telephonic Papers have not been often read. However that may be the more specialised a branch of engineering becomes the more difficult it is for existing publications to meet the needs, and doubtless our new contemporary will fill a want. The present issue contains in its 80 pages a number of short articles on various telegraphic and telephonic subjects, and quite a number of pages are devoted to social topics. Every branch of engineering benefits by the discussion of new developments as they arise, and most engineers are the better for a little authorship. We, therefore, wish our newest contemporary every success.

Standardisation in Various Aspects.—We regret that in the abstract of Dr. Glazebrook's lecture on this subject, which appeared on p. 993 of our last issue, the electrochemical equivalent of silver was given as 0·0000111827, instead of 0·00111827 grammes per coulomb.

Batavia–Cocos Submarine Cable.—A new cable connecting Batavia with the Cocos Islands was recently laid by the Eastern Extension Telegraph Co.'s c.s. "Patrol," and was opened for traffic on Monday last. The cable is about 770 nautical miles in length.

Institution of Mechanical Engineers.—Under "Arrangements for the Week" in our last issue we announced that a Paper on "Mechanical Stokers" would be read by Mr. E. B. Ellington before the Graduates' Association of this Institution. We find that Mr. J. E. Barnes was in reality the author of this Paper, Mr. Ellington being the chairman.

Leeds Local Section of the Institution of Electrical Engineers.—At a meeting of this section held on Thursday, April 9th, the following officers were elected for the session 1908-9. Chairman: Mr. H. E. Yerbury; Vice-Chairman: Mr. W. M. Rogerson; Committee: Messrs. W. Emmott, W. B. Woodhouse, J. W. Hame and J. M. Smyth.

British Association.—The programme of the 78th annual meeting of this Association, to be held in Dublin from September 2nd to 9th, has been announced. Mr. Francis Darwin will deliver his presidential address on the former of these two dates, while special evening discourses will be given on "Halley's Comet," by Prof. H. H. Turner, and on "The Lessons of the Colorado Cañon," by Prof. W. M. Davis, of Harvard University. As regards the social side, garden parties will be given by the Lord Lieutenant and Lady Aberdeen, by Lord and Lady Ardilaun and by the Provost and Senior Fellows of Trinity College; evening parties will be held by Lord and Lady Ivagh and the Royal Dublin Society, and many excursions. The reception room at Trinity College will be opened on Monday, August 31st.

Electrical Development in Japan.—According to *L'Industrie Electrique*, the use of electricity in Japan is being extended in various directions. As a result of this, the Furukawa Company have established a new factory at Nikko for the manufacture of copper wire. During the last year the production from these works has greatly increased. It is principally used for cables in Tokio and Yokohama, though that employed on the municipal networks was made abroad. The Japanese Government has ordered for the port of Yokohama 61 electric cranes, varying in capacity from 1 to 75 tons. There are at present 100 hydro-electric stations at work, and several are in course of construction. Among the latter is one on the river Tamagawa, supplying Tokio; from this station 20,000 kw. are transmitted at 40,000 volts. There is also one of 32,000 kw. in course of erection. Japanese promoters are also studying the utilisation of the numerous waterfalls in Korea for this purpose.

The Tramways and Light Railways Association.—We have received the April issue of this Association's *Official Circular*, which states that, although no definite date has yet been fixed for the Annual Tramway Congress, to be held at the Franco British Exhibition in July, it will probably take place on either the 3rd or 10th of that month. Four Papers will be read, and a dinner of the members of the Association will follow. Full particulars will be given in the next issue of the *Circular*. The Association's Report on Brakes is nearing completion, and it is hoped that it will be found possible to publish it early in the summer. Nearly 18 months have been spent by the special committee appointed to consider this question, and their report will be found to be both full and comprehensive. The *Circular* also contains a copy of the Home Office amended draft regulations and a decision given recently on a tramway rating case.

Cable Interruptions.	Date of Interruption
Paramaribo–Cayenne	Mar. 15 1908

Personal.—On Friday last, the 10th inst., Lord Rayleigh, president of the Royal Society, was unanimously elected Chancellor of the University of Cambridge in succession to the late Duke of Devonshire.

Mr. Geo. Hinde Nisbett, M.I.E.E., engineer and manager of the British Insulated & Helsby Cables (Ltd.), of Huyton, Lancs., has been appointed to the Commission of the Peace for Lancashire.

Electric Lighting in Berlin.—According to L. J. Auerbacher, who gives some details on this subject in the *Electrical World*, practically all the commercial arc lighting in Berlin is accomplished by the flame arc. They are very liberally used, some shop fronts of moderate size having as many as 15 to 20 lamps, hung about 5 ft. apart. The lamps are installed over the windows, and heavy opal glass serves to screen and diffuse the light. A few open arcs, but no enclosed arcs, are used. A new kind of lamp named "Economy" is now being installed. These operate singly on 115 volts, and are made in 4, 6, 8 and 10 ampere sizes. They burn 30 to 50 hours and give a brilliant white light. A few carbon filament lamps are still in service, but whenever possible the "Osram" or tungsten lamp is used. The cost of current for lighting is about 6d. per unit.

The Institution of Mechanical Engineers.—The annual dinner was held at the Hotel Cecil on Thursday last, April 9th, the members and guests numbering over 200. The President (Mr. T. Hurry Riches) was in the chair, and among the guests were the Right Hon. Lord Tweedmouth, K.T., P.C., the Right Hon. Lord Justice Fletcher Moulton, and Hon. Sir Richard Solomon, K.C.B. Lord Tweedmouth, in replying to the toast of "Our National Defenders," mentioned that he spoke at a disadvantage, as he was no longer First Lord of the Admiralty. After referring to the necessity of possessing an unrivalled navy and also an efficient army, he remarked that as the world had progressed the engineer had become a necessity, and the first qualification of a naval officer now was that he should have a knowledge of engineering. Lord Justice Moulton, who replied, with Sir Richard Solomon, to the toast of "Our Guests," considered that invention was better organised in those countries which were taking the position in certain industries that Germany had already taken in the chemical industry.

Electricity in Mining.—The *Elektrische Kraftbetriebe und Bahnen* contains a very full account of the equipment at the Rombacher Hütte in Germany. The original power house supplied current at 220 volts on the three-wire system, but extensions have been made, and it now contains two 250 kw. steam and four 800 kw. gas-driven sets, supplying continuous current at 220 volts, and three 840 kw. gas-driven and one 1,000 kw. steam set generating three-phase current at 5,700 volts; there is, besides, a steam-driven 660 kw. set supplying three-phase current at 220 volts. Further extensions provide for the installation of four 840 kw. generators and four converter sets. These latter consist of synchronous motors driving continuous-current generators, and are connected to both networks, working as balancers. The output from this station is about 3,000,000 units per month. The aggregate horse-power of the continuous-current motors is 14,238, the terminal voltage being 220. There are four electric coal cutters and 12 centrifugal pumps, with a total horse power of 2,800, which are supplied with three-phase current at 5,200 volts. There is, besides, a 375 H.P. electric winding machine and seven three-phase direct-current converters for supplying the electrically-driven railway at 750 volts. There is a total length of 25 miles of line above ground and 22 miles underground, the trains being worked by 19 locomotives. The generating station at these works in connection with the Moselhütte supplies current at 17,000 volts through an overhead network to the town of Metz, a distance of 10 miles.

Occurrence and Uses of Tantalum.—The recent introduction of this metal into the manufacture of incandescent lamps, thus making a possible market for its ores, has caused a certain amount of interest to be shown in several British colonies. On account of a number of inquiries having been addressed to the Imperial Institute, the information available on the subject has been published in the current number of the *Bulletin*. The most abundant tantalum minerals are tantalite and columbite, consisting of tantalates, niobates and iron in varying proportions. The former is richer in the metal, containing about 84 per cent., while the latter is mostly useless niobic pentoxide. There are a number of other ores, but these are of minor importance. The tantalum-bearing minerals are found in the eastern part of the United States, columbite being the commonest; deposits also occur in the tin-bearing districts of North and Western Australia. The Australian ores appear to contain up to 80·61 per cent. of the tantalic oxide in the form of stibio-tantalite. The ore, in the process of extraction, is first converted into the alkaline fluoride, which, when treated with metallic sodium, yields the metal mixed with a small quantity of oxide. This mixture is then heated in a magnesia or thoria crucible in a closed electric furnace, the more volatile oxide being thus driven off. After the metal has been hammered it becomes extremely hard, and even a diamond drill has little effect on it. It is similar in chemical properties to gold and platinum. It is not acted upon by aqua regia, but is attacked by hydrofluoric acid. Besides being utilised for incandescent lamps, it has been used as a substitute for platinum in the manufacture of crucibles.

London County Council Tramways.—The development of these tramways was advanced another step on Friday last by the opening of the short length of subway from Aldwych terminus to the Victoria Embankment. The occasion was marked by very little ceremony, a reception being held at the London Day Training College, Southampton Row, and the guests then being taken by special cars from Holborn to Kennington through the subway, thence to Islington and back to the College. The chairman of the London County Council (Mr. R. A. Robinson) received the guests, who included a number of Board of Trade officials, representatives of the municipalities of Westminster, Holborn, Lambeth, Finsbury and Islington, Sir Alexander Kennedy, F.R.S., and Sir Clifton Robinson. The chairman of the Highways committee (Mr. W. W. Thompson) briefly explained the features of the work, and mentioned the difficulties which had been overcome in carrying it out. It has not been possible to design the subway for double-deck cars, but special "single deckers" have been provided, which will enable the inhabitants of the north to see the attractions of the south without change of car. The engineering work of the subway falls naturally into three parts: the alteration of Waterloo Bridge abutment, the under-pinning of the viaduct supporting Wellington-street and the construction of two tubes under the Strand. Of these, the most important is the second, for great care had to be taken to avoid any subsidence of Wellington-street. As regards track, the work is similar in all respects to that used in the older parts of the subway (see *The Electrician*, Vol. LVI., pp. 620, 805). The cars are of non-inflammable material, in accordance with the Board of Trade regulations for tube railways. The necessary energy is supplied from the Holborn sub-station. Signalling apparatus has been installed which will prevent one car leaving the Holborn station until its predecessor has passed the top of the incline, and *vice versa*. The signals are operated automatically by two switches through strikers fixed on the cars. The lighting installation of the subway can be supplied either from the mains of the Metropolitan Electric Supply Co. or from one of the phases of the Council's own supply from Greenwich. A change-over switchboard has been fixed at the Aldwych station. The supply voltage is 200 volts, the lamps being fixed at 40 ft. centres. The system is further divided into two separate circuits from the board, alternate lamps being on one or other of these. The electrically illuminated warning signs at the Embankment end of the subway are supplied from a similar change-over board.

ARRANGEMENTS FOR THE WEEK.

THURSDAY, April 23rd.

INSTITUTION OF ELECTRICAL ENGINEERS.

8 *p.m.* Meeting at the Institution of Mechanical Engineers, Storey's Gate. Paper on "Electric Supply Prospects and Charges, as affected by Metallic Filament Lamps and Electric Heating," by Messrs. H. W. Handcock and A. H. Dykes. Adjourned Discussion.

ELECTRIC CRANES.*

BY H. H. BROUGHTON.

(*Continued from page 983, Vol. LX.*)

Summary.—The author here deals with collectors, switchgear and wiring. Two typical diagrams of connections were given in our last issue, and simple rules deduced for determining the number of crosswires required to supply the various motors with current. In the next section of the article types of line insulators, supports, and current collectors were described, with examples covering the best practice. Installation material for revolving jib cranes is dealt with at some length, and collector-rings and cable-drums by The Electrical Company are described. In order to protect crane equipments against overloads and short circuits, and to facilitate testing, it is usual to provide a switchboard with double-pole main switch and double-pole fuse, and single-pole circuit fuses. For high-voltage and continuous-current equipments, circuit-breakers and magnetic blow-out fuses are recommended. "Association" cables, 600 meghoms grade, should be used for wiring, and the insulation resistance of each motor-circuit should be taken regularly. Ground and wall connecting boxes suitable for connecting up to the supply outdoor cranes, more particuarly dock cranes, are also described.

Collector Rings.—In slewing cranes current is, as already stated, supplied to the motors by means of brushes bearing against phosphor-bronze collector rings mounted upon the centre pin and insulated therefrom by stabilit or ambroin.

The collector rings as usually constructed are shown in Fig. 54.

The current-density in the rings must not exceed 800 to 1,000 amperes per square inch of cross-sectional area, and the brush bearing surface must be such as to limit the current to 120 amperes per square inch when copper-gauge brushes are used, and 60 amperes per square inch when carbon brushes are used. The minimum distance between two rings must not be less than 3 in. for 110 volts, 3½ in. for 220 volts, and 4 in. for 500 volts unless a cellular arrangement is decided upon.

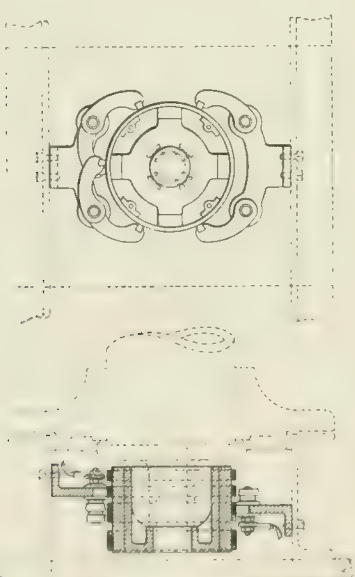


Fig. 54. Collector Rings by The Electrical Company.

Another design by the same firm is shown in Fig. 55. The contacts are attached to bronze or hard copper straps encircling the rings, the contact pressure being regulated by means of springs. The ends of the straps are attached to heavily insulated terminals mounted upon the crane framework in the manner shown. The collector rings may be mounted upon a similarly insulated cast iron spider attached to the centre pin or they may be threaded on insulated rods, as shown in Fig. 55. Some makers have used copper gauze straps in place of the renewable contacts on solid straps. In either case the large contact area effects an appreciable reduction in the size of the rings.

Travelling outdoor jib-cranes are usually fed from boxes in the ground, or on the walls of adjoining buildings, by means of flexible cables mounted upon a suitable drum fixed to the crane pedestal. Referring to Fig. 56 it will be seen that collector rings with brushes are fixed upon the axle of the drum, and the flexible cable is firmly connected to the brushes, which latter convey the current through the collector rings to the crane circuits. As made by the A. E. G. the drums are arranged to take up to about 80 yds. of cable having a section of $2 \times 0{\cdot}16$ sq. in.

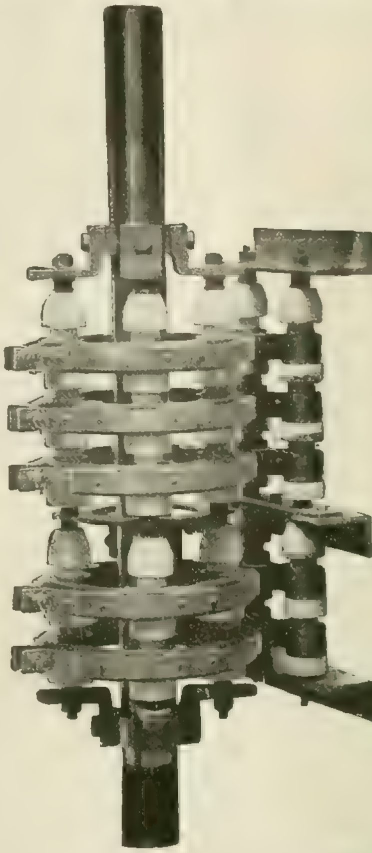


Fig. 55.—A. E. G. Collector Rings.

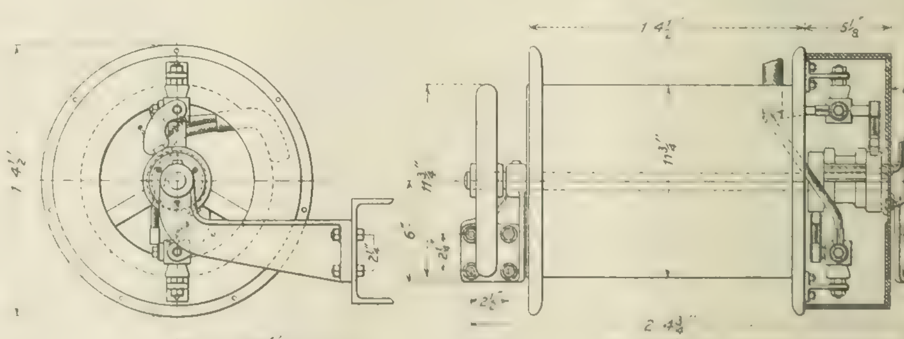


Fig. 56.—Cable Drum by The Electrical Company.

As usually constructed, the cranes have a slewing motion and hand travelling gear. In such cases it is only necessary to provide collector rings on the head of the centre pin to carry the current from the cable drum to the switchboard in the cab, the several motors being wired up permanently to the switchboard through the controllers.

When a travelling motor is fitted, it must be supplied with current from the main switchboard through collector rings mounted on the centre pin. A careful study of the diagrams already given will enable one to wire any crane correctly, no matter how many motors

there may be, and regardless of their positions with respect to the cab. A word of warning in connection with controllers arranged with electric braking positions on the "lowering" side; care must be taken that the controller "lowers" on the correct side.

The enamelled slate switchboard, with ebonite bushed holes for fixing, is mounted on wrought-iron supporting brackets to the side of the attendant's cabin, in order to allow of easy inspection of the wiring at the back of the board.

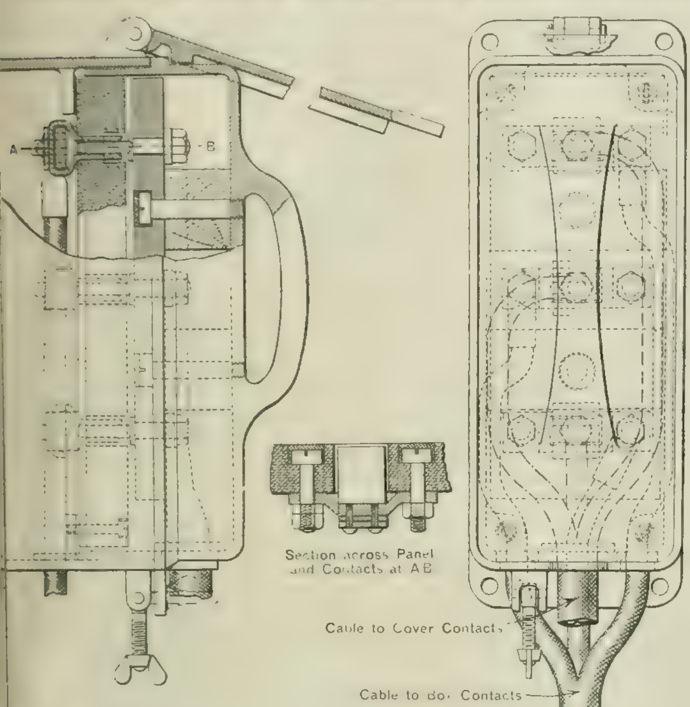


Fig. 57.—B.T.-H. Three-phase Wall Connecting Box.

For normal low-voltage continuous-current equipments a double-pole quick-break switch is required to make the crane dead. To protect the equipment two single-pole fuses are inserted in the main circuit, and in addition, each motor is protected by means of a single-pole fuse.

The fittings are proportioned on the assumption that at least two of the crane motors are running simultaneously at full-load, and the fuse links are adjusted to "blow" at 50 per cent. above their rated load.

Suitably situated fused plugs and a hand lamp attached to a length of protected workshop flexible allow of a thorough inspection of the crane at all times. It is advisable to so connect the portable lamp and the lamp on the switchboard that they can be lighted without closing the main switch.

For normal high-voltage continuous-current equipments it is usual to provide a single-pole quick-break switch in one main and a single-pole magnetic blow-out circuit breaker, having no-voltage and overload releases, in the other main. Each motor circuit is protected by a single-pole enclosed or magnetic blow-out fuse.

The whole of the wiring should be run in heavily galvanised steel tubing with screwed socket joints, and inspection boxes at all sharp bends. In cases where cables cannot be so enclosed they should be protected by flexible tubing or heavily taped and varnished.

The cable used should be of the quality known as "Association," having an insulation resistance of not less than 600 megohms per mile. The stranded conductors are insulated with pure and vulcanised rubber, rubber-covered tape, the whole being vulcanised together, cotton-braided and covered with preservative compound. The current-density in any conductor should not exceed the maximum laid down by the Institution of Electrical Engineers in their Wiring Rules.

The insulation resistance of the whole crane, and of each motor circuit from the switchboard, should be taken periodically, and, if found to be low, the circuits should be carefully overhauled.

The wall connecting box shown in Fig. 57 is one of the British Thomson-Houston Company's standard designs for three-phase 440 volt circuits.

In the interior of the cast-iron box A is mounted upon suitable lugs a paraffined slate panel B, which serves to hold in position the contacts connected to the main cables. The spring copper contacts C are sandwiched between heavy gun-metal contact plates, D, to which the main cables, coming up from behind, are attached, and gun-metal plates, E. The contact plates are secured to the slate panel by means of bolts, F, the heads of which are recessed and covered with hard wax insulation, G.

The method of mounting the contacts is, as shown in the figures, such that no "live" metal work projects beyond the face of the slate, and this is a most noteworthy feature in any switchgear intended to be operated by unskilled labour, and one to which crane users cannot attach too much importance.

The hinged cover H is held in position by means of a winged nut or padlock, and can be swung round to make room for the plug contacts J, mounted upon an ebonite slab, K, secured to the cast-iron handled cover L with recessed screws. Hardwood blocks inserted between the slab and the cover preserve the distance between the two, and enable the three-core cable, which passes through a hardwood insulating bush in the underside of the cover, to be connected to the plug contacts without the danger of accidental contact between the cover and the cables.

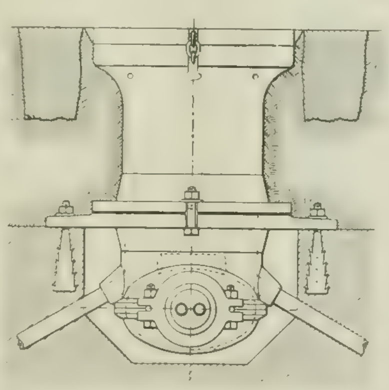
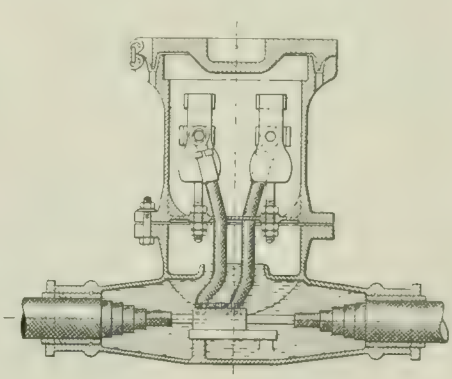
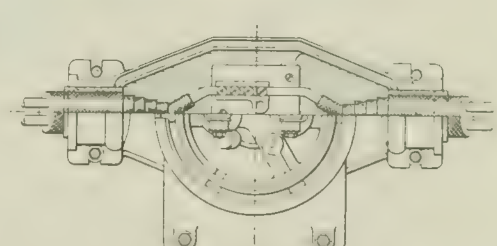


Fig. 58.—"Through" Type Ground Connecting Box by the Electrical Company.





Figs. 58 to 61 relate to the standard ground and wall

connecting boxes of the Allgemeine Elektricitäts Gesellschaft.

Referring to Figs. 58, 59 and 60, it will be seen that the ground connecting boxes consist of three parts: the sleeve, the box proper with cover, and the contact plug. The branch or end connecting boxes are used according to whether it is desired to tap the current from an inter-

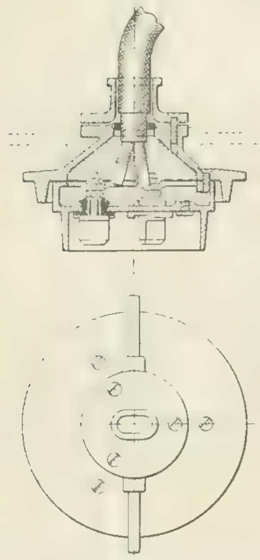


FIG. 59.—PLUG FOR CONNECTING BOX.

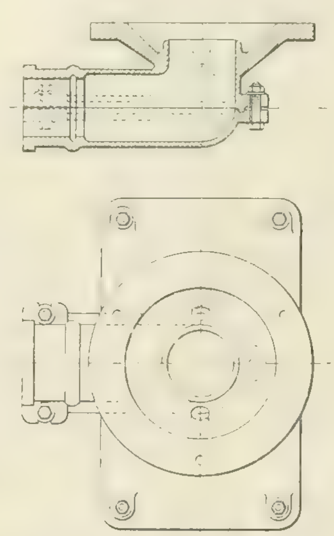


FIG. 60.—END SLEEVE FOR GROUND CONNECTIONS.

mediate position, or to make the connection from the end of the cable. The main cables are connected to suitable terminals mounted on a heavy slab of insulating material fixed to the lower half of the sleeve casting. Insulating compound poured hot into the finished sleeve ensures a thoroughly watertight joint. Drain pipes connected to the main drainage system are provided in the upper part of the

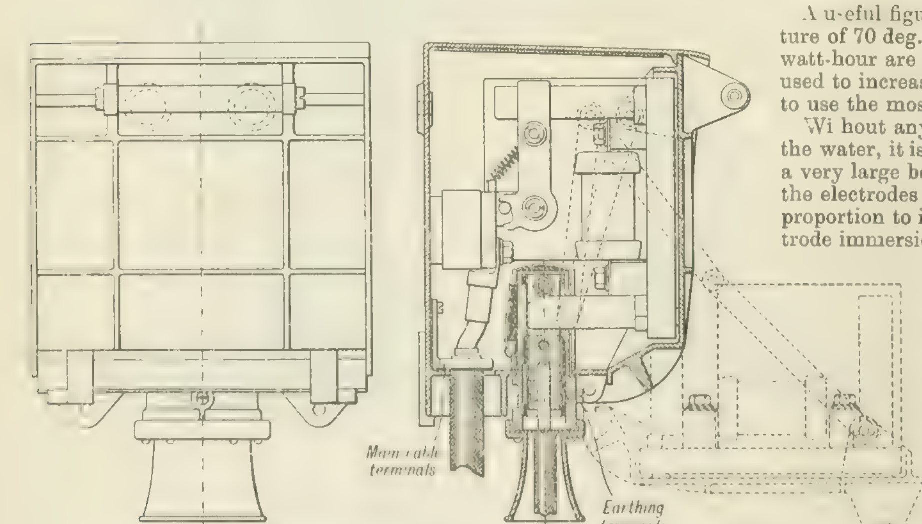


FIG. 61.—WALL CONNECTING BOX BY THE ELECTRICAL COMPANY.

sleeve casting to carry away any accumulation of water in the connecting boxes. The box is bolted to a concrete or brickwork foundation, the cover being flush with the ground.

The wall connecting box shown in Fig 61 has several advantageous features. It will be seen that the arrangement is such as to render it necessary to open the cover of the box every time the contact plug is inserted or withdrawn. The quick-break switch is connected to the cover in such a way that the connection to the contact plug is interrupted when the cover is opened, and that, on the other hand, the contact plug is held mechanically by the switch when the cover is closed. In this manner the circuit is only interrupted by opening the cover; in other words, by a suitable switch, and not by pulling out the contact plug.

(To be continued.)

ARTIFICIAL LOAD FOR TESTING ELECTRICAL GENERATORS.*

BY R. K. MORCOM AND D. K. MORRIS.

Summary. The authors first deal with the use of water resistances as artificial loads, and give details of a tank for high-tension testing which has proved very satisfactory. They then describe an easily adjustable apparatus for obtaining varying power factors, and describe its use, together with an account of experiments made with it.

Water resistances have probably been most used for obtaining an artificial load for testing purposes. The theory of the flow of current requires checking by experiment. It is necessary to know the specific conductivity, and also the correction for temperature. The resistance-temperature curve is not a straight line (*see* Fig. 1). For practical purposes it is useful to consider the correction as a percentage reduction from the resistance at 60°F. for the intended rise of temperature, say 70°F. The following table gives some approximate characteristic figures:—

Source.	Degree of hardness.	Mineral matter in solution.	Spec. resist per cm³ at 60 F.	Factor for 70 F. rise.
	Degrees.	(Parts in 100,000.)	Ohms.	p.c.
Distilled	...	.	600,000	
Conden. from an engine	...	About 2	66,000	.
Birmingham tap water	3·2	6·2	13,200	50
50 Birmingham tap & 50 Birmingham canal ...	...	..	965	...
Birmingham canal	52	143	435	50
Blackburn water..	...	..	17,000†	...
Glasgow water...			17,500†	...
West London water......	...	...	2,800†	...
Rugby water	.	...	2,400†	

A useful figure given by Mr. Kemp‡ is that for a rise of temperature of 70 deg., approximately, 50 gallons of cooling water per kilowatt-hour are required. Where possible, salt or soda should not be used to increase the conductivity, but the plant should be designed to use the most abundant local supply.

Without any special treatment of the problem of current flow in the water, it is useful to make one or two simple deductions. First, a very large body of water cannot give a high resistance even when the electrodes are very far apart. Secondly, if the tank be long in proportion to its cross-sectional dimensions the extent of the electrode immersion makes very little difference to the resistance, provided that the area of the electrode is not very small compared with the cross-sectional dimensions of the water. If, however, the distance between the plates be small then their area of opposition has a great influence on the resistance. In this connection it should be noted that proximity to the side of the tank has a great effect with narrow plates in large tanks.

Another convenient method of reducing the load from a given tank is by dropping diaphragms between the plates. Thus, with 8 in. wide plates 12 in. apart in a tank 12 in. wide, a ½ in. thick diaphragm with 2 in. hole reduced the current to 26.5 per cent of its value. Various modifications of the baffle method will suggest themselves by which the resistance of the path may be increased without upsetting the cooling arrangements or complicating the tank, but the possibility of charring by excessive voltage drop in a short length must be kept in mind. The proximity of the plates to the side of the tank is also a factor in the permissible volt drop per foot of water. It is found that where the line of flow from the electrode along the tank side differs but little in length from the shortest line, the voltage drop per foot should not exceed 600 volts, and should be lower than that unless the walls are well insulated

* Abstract of a Paper read before the Birmingham Local Section of the Institution of Electrical Engineers.

† Particulars supplied by Mr. Digby.

‡ *Electrical Magazine*, Vol. I., p. 86, 1904.

and free from metal. This point must be watched with high-tension work, and also in low-tension work where plates that are close together are carried near the side of the tank. A further limiting condition indicated by experience is the maximum permissible current-density per square inch of iron electrode. This should not be greater than 1 ampere per square inch. Trouble from bubbling and rapid corrosion is likely to occur if this be exceeded.

As regards materials, mention has already been made of iron electrodes and wooden tanks, and the reasons in their favour are strong ones. Wooden tanks are cheap and easy to obtain; they can, with proper precautions, be made durable and water-tight, and as the sides can be rendered practically non-conducting, there is no difficulty in obtaining light loads. Metal tanks, on the other hand, are either expensive or perishable, and light loads are hard to obtain owing to the low resistance path afforded by the walls, unless unduly large tanks are used. Cast-iron electrodes are cheap and satisfactory, though scrap metal of various sorts may in certain cases be substituted for sake of convenience.

The success of wooden tanks depends largely on the method of construction and the proper attention to details. Fig. 2 shows a

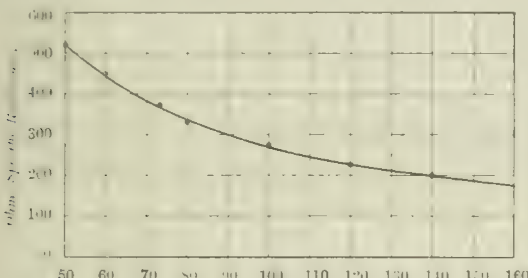


Fig 1.—Temperature Variation of Resistance of Canal Water.

tank for high-tension work, which has done excellent service. The sides and bottom are constructed of good spruce, tongued and grooved; all joints are tarred and caulked. Sides, ends and bottom are made double of $1\frac{1}{2}$ in. timber, the two layers being built up at right angles. The whole is screwed together in such a way that no screw comes within $\frac{3}{4}$ in of the water, and all timber is tarred all over. The water inlet is through a canvas hose brought over at the outlet end, and carried along the bottom of the tank for its full length. The outlet is over a sectional wire 6 in. from the end of the tank, and then through a hole in the bottom of the tank. One trouble thus avoided is the charring of the wood, which usually occurs along seams to which water has access; proper caulking prevents this. Also, any metal in the wood to which water has access corrodes and causes charring. This is prevented by using hidden screws, a hose pipe inlet and a plain hole outlet. The hose pipe inlet obviates troublesome short-circuits to earth, and the weir also provides for adjustment of water level. The double sides prevent

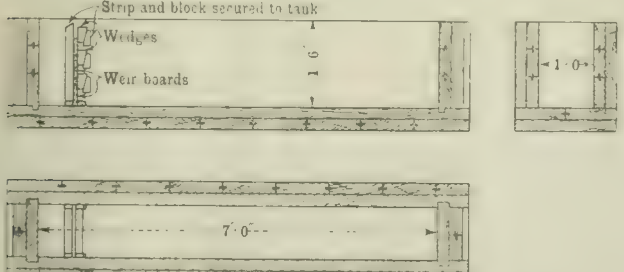


Fig. 2.—Construction of Wooden Tank for Water Load.

leaking and undue bulging. For tanks of larger dimensions iron stays may be used, but these should be carried outside the tank, an obvious but often neglected precaution. As this tank is for high-tension work it is supported on insulating pedestals. These can conveniently be constructed of Doulton's glazed earthenware "acid tiles," built about 3 ft. high, with a rubber pad between each horizontal face to prevent slipping. The water from the outlet hole is carried to a funnel or tray just above the floor level. A lead-lined save-all is provided. The operator has a wooden platform supported on earthenware blocks, and covered by a rubber mat. The electrodes are of iron, and are well insulated from their supports, which take the form of stout wooden cross-bars which can be slid along the tank top. The plates are clipped to 'bus bars carried at a considerable height, and the connections are so guided as to be neat and safe. Such an arrangement can be cheaply made, and gives satisfaction up to 6,000 volts.

A low-voltage tank construction can easily be deduced from the above, but probably the area will have to be obtained by using a number of electrodes in parallel, in which case, for variable loads, a suitably-arranged switchboard is a great convenience. Iron electrodes should not be placed less than 2 in. apart, as there is danger of an unsteady load, and a considerable splutter from short-circuiting by rust flakes; in fact, 3 in. should be aimed at as a minimum. Sometimes, for very low-voltage work, the size of the tank available is insufficient. A useful form of load can then be constructed from metal strip submerged in water. Strip iron $\frac{1}{2}$ in. wide × 19 S.W.G. supplied in 40 ft. lengths and doubled into zigzag shape will make very convenient units for low-voltage loads. With a current-density of about 25,000 amperes per square inch (the unit being immersed in moderately high resistance water) an average life of 100 hours may be expected. If, however, the cooling water is of relatively low resistance, such as canal or river water, the life is very much reduced. It is very convenient, when using these units, to have a small water load in parallel for fine adjustments. Obviously the relatively short life and lack of facility of adjustment are the chief disadvantages of this form of load.

The convenience of the water resistance for absorbing a test load can be enhanced by providing a suitable apparatus for producing inductive load. Transformers and inductive motors are, of course, ideal, but in their absence choking coils of cumbersome and expensive design have been constructed. A cheap, reliable, and easily adjustable apparatus for obtaining varying power factors is next described.

In the choking coils to be described below no air-gap at all is used, but the iron is instead worked at a flux density so high that its permeability is quite low, and the magnetising current is correspondingly large. There is, in fact, an equivalent air-gap all round the magnetic circuit, and the design is exceedingly compact.

Energy Loss in the Iron.—On account of the high flux density it is important, in order to avoid eddy currents, to use the thinnest laminations and to reduce hysteresis by employing the best iron. Also cooling is an essential condition. The object of cooling the core is not that the iron itself may be rendered cool, but that it shall not impart too much heat to the windings which surround it.

Two methods, beyond those ordinarily used for transformers, suggest themselves for working such high flux-density choking coils continuously without overheating. (1) The whole coil and winding may be immersed in water kept in circulation and slowly flowing to waste. (2) The limbs of the iron core may be surrounded by coils of flat copper tube, closely fitting, in which water is continually flowing, such coils being coupled by rubber pipes, so that no current shall be induced in them

Coils have been worked out by the authors using both these methods. Where the voltage permits it, there is great advantage in the first method. Not only does it provide a satisfactory means of getting rid of the heat in the core, but it allows of the use of very high flux densities in the winding. Copper for the windings may even be dispensed with altogether, and the coil wound with iron strip worked at current densities which would be high even for copper if not specially cooled. Such coils are in the highest degree economical to construct, and prove perfectly satisfactory if the voltage of the generator to be tested does not exceed 1,000-2,000. For higher voltages, or where a more durable apparatus is necessary, it is preferable to use water-cooled cores of the type described above.

Comparison between a Transformer and a Choking Coil wound on the same core and worked at the same flux current densities.—Consider a low-voltage 10 kw. transformer of standard design. Replace the primary and secondary windings by a single winding of double the carrying capacity, and increase the primary terminal pressure to four times its former amount; the kilovolt-amperes of the apparatus now are eight times as great as those for which the transformer was built, and this with the same current densities as before. To test a 1,000 kw. set at 0·8 power factor requires approximately 1,250 k.v.a., and 750 k.v a. of idle current, or three 250 k.v.a. choking coils. With the special cooling described above, these inductive coils can be constructed on cores not exceeding in size those which would be used for three 25 kw. transformers.

Continuous rating with special cooling of the core if necessary.	Minimum power factor.
0·25 kilovolt-amperes.	0·090
0·80 ,,	0·060
2·00 ,,	0·035
10·00 ,,	0·030
40·00 ,,	0·020
120·00 ,,	0·015
340·00 ,,	0·012

Power Factor.—The minimum power factors obtainable with different sizes of these coils are found by the makers to be as in the accompanying table. The lower the power factor the less the energy to be got rid of in the inductive coils, and consequently the higher the figure at which these may be rated. The manner in which power factor varies with the voltage or flux density is shown in Fig. 3, the data relating to the condition of working giving the least power factor.

Regulation of Voltage and Current.—It is of the greatest importance to provide means whereby the voltage as well as the current of an inductive load may be regulated while the power factor is maintained at a specified value of, say, 0·8. The most satisfactory method of arranging for such regulation is by means of a water resistance arranged in such a manner that the inductive coil current is shunted by an in-phase component of current in a water load, while, at the same time, resistance may be put in series with the choking coil (*see* Fig. 4). By shifting the plate B towards A or C, the double adjustment may be conveniently effected at one time. Adjustment is also obtained by raising or lowering one or more of the plates. The inductive coil may be either immersed in the tank, or may be

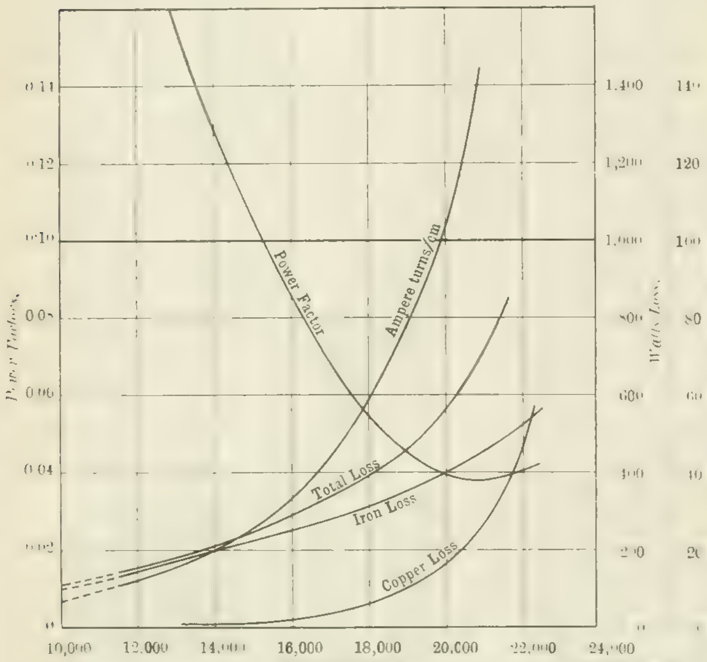


Fig. 3. Characteristics of Three-Phase 18 k.v.a. Choking Coil at 50~.

in a separate place according to the method used. Further variations of voltage and current may be obtained by the well-known methods of paralleling the coils, or changing from star to mesh.

For economy in design it is best to use choking coils wound for the lowest voltage which will satisfy the purpose for which the coils are required. If they are wanted for testing three-phase generators at a moderate power factor it will be found that the necessary coil-voltage is not more than one-third to one-half of the terminal voltage of the machine under test. Generally, if E_g = terminal volts of three-phase generator, W = output in kilowatts, and $\cos\phi$ = required power factor during test, then the three choking coils needed should be wound each for a current of $I = W/(\sqrt{3} \cdot E_g \cdot \cos\phi)$, and a voltage of $E_c = E_g \cdot \sin\phi/\sqrt{3}$. The maximum combined kilovolt-

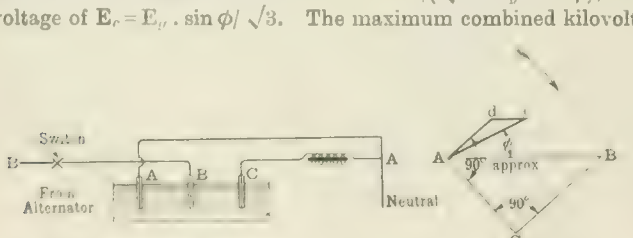


Fig. 4.—Combined Water Load and Inductive Load.

AB Total Voltage to Neutral. AC Voltage across Choking Coil. BC Voltage across Series Resistance. A[illegible] Current in Choking Coil and Series Resistance. [illegible] Current in Shunt Resistance. A[illegible] Total Current.

amperes of the three coils is, therefore, = W tan ϕ. Thus, the combination of inductive coils and water resistances described is capable of dealing with a given number of kilowatts at a specified power factor over a range of voltage extending from $E_g/\sqrt{3}$ down to $\sin\phi$ times this amount. The range of current is correspondingly as $\sin\phi : 1$.

To deal with yet lower voltages and higher currents, it is convenient to subdivide the windings on the coils each into three sections as described above. These, when paralleled and star-coupled, give a set of volt-ranges one-third of those first available, and consequently reduced as $\sqrt{3} : 1$ from the second arrangement in which the apparatus was delta connected and all the windings on each core were in series. Lower voltages still can, of course, be obtained by delta-coupling the third arrangement; and, if advisable, by further sub-division of the coils into nine sections each.

The use of these coils worked at such high flux densities gives rise to a current-wave whose peak is about 10 per cent. higher than that of an equivalent sine-wave of current. That is, in calculating the ampere-turns available for producing the maximum flux density the root mean square ampere-turns must be multiplied by about 1·56; so that the value of H is about 1·96 × the root mean square ampere-turns.

The authors conclude with a suggested design for artificial load, inductive and non-inductive, suitable for 1,000 kw. at 1,000 to 6,000 volts, and the corresponding diagram of connections.

DISCUSSION.

Mr. J. P. Kemp had found after considerable experience that a water load was the only suitable form where large amounts of energy had to be dissipated at high pressures. With wooden tanks, however, he had experienced trouble; the troughs had caught on fire and the water leaked out. In Manchester, at the Stuart-street station, he had used for three-phase 6,500 volt work a circular iron tank 6 ft. diameter and 4 ft. deep. Fig. 5 showed this arrangement. The outer electrodes were symmetrically spaced at 120 deg. about 7 in. away from the neutral, and the water, which was introduced in the centre at the bottom of the tank, flowed away over a weir at the top. With this particular tank 4,000 kw. had been successfully absorbed for over six hours. The outer body of the tank also formed part of the neutral element, and as this was substantially earthed there was no possible danger from shock. With wooden tanks, however, there was considerable risk of men receiving a shock from the body of the tank or even from the

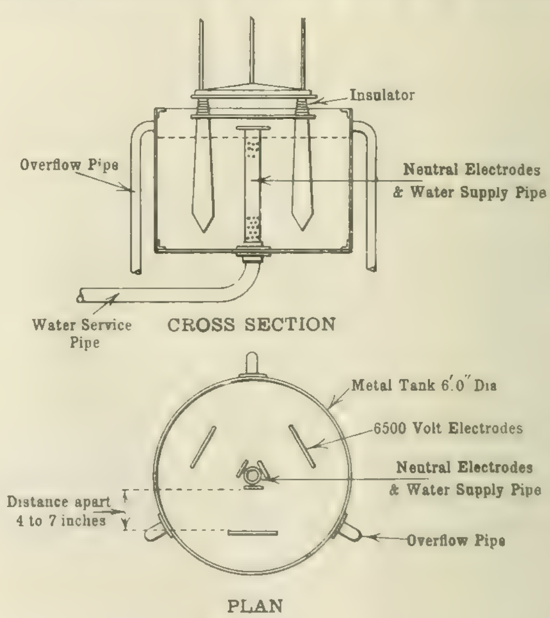


Fig. 5.

water. In giving the specific resistance of condensed or canal water it was more convenient to give this as so much per feet cube and not per centimetre cube as in the Paper. Even better, it might be given as the resistance between opposing plates 1 ft. square and 1 ft. apart, which was not quite the same thing as the resistance per foot cube. As a permanent adjunct to a central station a suitable water load was very desirable. The main point of interest in connection with the Paper was the very ingenious and simple method devised for obtaining loads of varied power factor. Although many inductive load tests had been called for in specifications, he did not know a case where they had been able to be carried out.

Mr. J. M. Walshe, referring to Mr. Kemp's description of the circular metal tank, said that it would be quite impossible to use this with Birmingham canal water at 6,000 volts as the maximum load would be too great. The best design of tank was one which would allow of the greatest range of loads and with a circular tank and Birmingham canal water it would be quite impossible to get small loads at high voltages. With low resistance water it was necessary to have a long narrow tank. Three tanks each 6 ft. long, 1 ft. deep and 6 in. wide had been found large enough for 950 kw. at 7,500 volts, and the load could be reduced to 40 kw. at the same voltage.

Mr. Kemp here explained that he quite agreed with Mr. Walshe that it was impossible to use canal water in small metal tanks for 6,000 volt tests. In the tests to which he had referred he had used town water.

Mr. E. A. Chattock thought that the stated voltage drop of 600 per foot of water was too low if it applied to low-tension currents. Also the limit of current density of 1 ampere per square inch of plate was too high. He recalled some tests in which he had used two plates placed in a canal. The conditions were 100 kw. single phase load at 1,000 volts, the electrodes were 15 ft. apart, the immersed area of each being

10 sq. ft. One could feel the effect of the electric current at least 50 ft. away, and fish were killed within a radius of 20 ft. He had had leakage and charring troubles with wooden tanks owing to deterioration of the wood.

Mr. F. FORREST remarked that the figure given, 5 galls. of cooling water per kilowatt-hour, for 70 deg. rise was practically that obtained by calculation using Joule's equivalent. The authors, in describing a 6,000 volt tank, had said that the position of the electrodes could be adjusted by sliding the supports along the top of the tank. Personally he would not like to do the sliding. Some mechanical means of adjustment was necessary, such as a right and left hand screw or a pulley arrangement. He wondered that no serious attempt had yet been made to utilise the power wasted in works test rooms. He suggested that it might be possible by using a system of storage cells and a wide range booster. Also, would it not be possible to feed the hot water from the testing tank direct into the boilers?

Mr. J. D COALES called attention to the peak in the wave form of the current in a choking coil worked at high flux density, and showed an oscillograph diagram, and gave particulars of the no-load current wave form of two 7½ kw. transformers. the primaries of which were connected in parallel to 208 volt mains, instead of being supplied at their rated pressure of 116 volts. The frequency was 50 per sec., the effective current 9·3 amps., the maximum value as shown by an oscillogram, being about 18·7 amps., and the maximum flux density about 10,600 lines per square centimetre. He pointed out that the duration of the peak was confined to a comparatively small portion of the cycle with its middle point roughly coincident with the instant of zero pressure, and suggested that when an alternator was tested on such an inductive load, the "drop" might be exaggerated unfairly, owing to the concentration of the demagnetising reaction in a small part of the cycle where it was most effective

Mr. W. SHAW had experienced the wasting away of iron-wire resistances, more particularly when working with canal water.

Dr. W. E SUMPNER said that Mr. Coales had drawn attention to a fact he (Dr. Sumpner) had pointed out many years ago, that the current wave in a transformer having a closed magnetic circuit consisted of a shoulder and a peak. At very high flux densities the peak would certainly be increased, while the shoulder would be less pronounced. This would result in a zig-zag wave of current very like a series of triangles. A sine wave was approximately a triangle with the peak rounded off, so that the resulting wave would essentially differ only very slightly from a sine curve. The use of these choking coils would thus have no unusual effect on the alternator. The authors' method seemed to him to be the best solution to the problem of obtaining an alternating-current load of adjustable power factor.

Mr. N. B. ROSHER asked if the authors had fully considered the use of wire resistances. He had had experience of these years ago and had found them to work well.

Mr. A. E. GOTT, as an illustration of the high resistance of pure country water, mentioned an experiment with an oil barrel filled with water. Lead plates were used each with 2 sq. ft. immersion. When these were brought to within ¾ in. of each other, 100 volts only gave 2 to 3 amperes. The addition of 2 oz. or 3 oz. of acid enabled 60 H.P. to be dissipated with the plates a safer distance apart. The capacity of a barrel was 20 H.P. for one hour before boiling. In his opinion insulated water tanks would not be tolerated as permanent plant under the new Home Office Regulations, a point which seemed to have been overlooked in the Paper. He advocated the use of wire coils immersed in oil and surrounded by circulating water. It was possible in this way to continuously dissipate 10 kw. with a unit which could be carried in one's pocket.

Prof. G. KAPP said that the tank should be not only earthed, but surrounded by a platform supported on insulators and covered with a rubber mat. He asked whether the authors had had any experience with earthenware tanks, which appeared to possess the advantages of both wood and metal with the drawbacks of neither. He had used earthenware tanks for small loads and found them to work very well. He also asked the authors if they had observed the actual power factor of a resistance consisting of iron plates in water. He believed that this was not quite unity, but that the water load took a leading current. Electrolysis was continually going on and producing a film of gas on the plates and thus forming a condenser.

Mr. O. T. DAVIS, in a written communication, said that, as the authors pointed out, hot well water had a very high specific resisiance at 60°F, and was, therefore, unsuitable; nevertheless, he had used the hot-well for a water resistance on one occasion for a 150 kw. 230 volt machine, sufficient current being obtained with a fairly small battery of resistance plates by reason of the high temperature of the water (about 150°F.). As a general rule, the circulating water discharge from a surface-condensing plant was suitable for use in an artificial load. For a permanent resistance he was distinctly in favour of a brick-built cement-lined tank. For a low voltage resistance, the plates (⅛ in. sheet iron for lightness) should be fixed in frames and the load controlled by raising or dropping the whole frame into the water. It was good practice to have a light fuse in series with each individual positive plate, and to group the plates, controlling each group by a switch. The load might then be prepared by lowering the resistance frame into the water, switching on a certain number of groups of plates and finally securing fine adjustment by further raising or lowering, or preferably by manipulating a weir on the outlet. Using water with a specific resistance of 725 ohms per centimetre³ at 650°F. the writer had found a convenient distance between positive and negative plates to be 2 in. at 100 volts, 3 in. at 200–300 volts, 5 in. at 400-600 volts, and 7 in. at 1,000 volts, which values gave much lower current densities than the limit of 1 ampere per square inch given by the authors. The positive plates got covered in time with a rust scale. This, however, could be easily scraped off or released by tapping the plates with a hammer. When corroded to a certain extent it was convenient to alter the connection so as to reverse the polarity. Iron wire resistances immersed in water were not permanent enough for standard use, but were useful in exceptional cases. They were best arranged in a box and should be well swept with water flowing through. If run at a density of about 10,000 amperes per square inch, their life was fairly long. For extra high voltage work it was necessary to well insulate the source of the entering water, and the writer had found a small erection resembling a cooling tower useful for breaking up the water into drops. As regards the use of choking coils, it must be remembered that ordinary commercial work only called for power factors of 0·75 and above, and this should be considered when designing chokers. The authors had not touched on the question of capacity effects due to the use of water resistances with alternating-current machines. Quite recently, when testing a large generator on a water load with very small electrodes, a curious momentary rise in terminal voltage was noticed when full load was suddenly switched on by dropping the electrodes into the water.

Mr. R. K. KEER (communicated) gave some particulars of a liquid resistance in one of the electrical laboratories of the Municipal School of Technology, Manchester, and intended primarily as a load for a 25 H.P. 500 volt traction motor used as a generator. The tank was built of glazed Staffordshire blue bricks, in cement, the wall being 9½ in. thick. A ½ in. layer of mastic asphalte was put between the two thicknesses to make it watertight. The internal dimensions of the tank were 6 ft 9 in. by 2 ft. 6 in. by 2 ft. It was placed in a pit, the bottom of which was 4 ft. 4 in. below the level of the floor. This pit was partly roofed over with steel girders, to which machines could be bolted for testing. The space between the girders was fitted with trap doors. The electrolyte used was a 2 per cent. solution of aluminimum sulphate, the electrode being lead plates. This made a very clean arrangement, as there was practically no sediment or fumes. The arrangement of the plates was as follows: At one end of the tank were four fixed plates, each 12 in. square and ½ in. thick, placed parallel to the length of the tank and 7½ in. from each other. The movable electrode consisted of three plates, each 1 sq. ft. in area, but all shaped at the bottom. These were fixed to a simple carriage, fitted with wheels, running on two lengths of gas pipe placed on an incline, sloping down towards the fixed plates. The plates were moved from above by means of a handwheel actuating a winch through bevel gearing. A brake was provided to prevent the plates running back. This arrangement of the plates gave a very large variation of resistance. Thus with a 1 per cent. solution the resistance could be varied from about 50 ohms with the plates just touching the liquid to about 0·75 ohm. when they were completely immersed. The lowest resistance required was less than this, so the amount of aluminum sulphate was doubled, bringing the resistance down to about 0·5 ohm. The resistance varied considerably with current density. With 2 per cent. solution, and with the plates completely immersed, the resistance with 10 amperes was 0·8 ohm, with 20 amperes 0·65 ohm, gradually becoming less until with 100 amperes it was only 0·48 ohm. The "resistance" measured included a certain amount of back E.M.F. which was constant and helped to account for the variations obtained, which were not caused by temperature rise.

Mr. R. K. MORCOM, in reply, said that there were objections to using the hot testing water in boilers; by the time it had passed through the water-softeners it would have lost a great deal of heat, and if it were softened previously it would not be so suitable for testing, and any lost waste would be expensive on account of the chemicals used. He had carefully considered the question of utilising the power usually wasted in the test room, but there would be considerable expense involved in the upkeep of the special plant. The system, and particularly the connections, would be most complicated to work out and to use. Mr. Chattock had had trouble owing to the liability of wooden tanks to fire, also he had expressed the opinion that a drop of 600 volts per foot was not so much as might be employed. In his (the speaker's) experience, it was only by using a moderate drop per foot of water that it was possible to avoid charring the wood of the tank. The objection to porcelain tanks was mainly that of expense. They had noticed the capacity effect of a water resistance. He did not believe that the factory inspectors would take exception to the insulated tank. They really had a very good earth in the overflow water flowing into the canal.

Mr. D. K. MORRIS said it was of great importance that the inductive load did not produce a different kind of load from that occurring in practice. Considering that only 3 or 4 per cent. of the current wave was sufficient to bring the flux over the knee of the saturation curve, it would be seen that practically the whole of the current wave corresponded to the region of low permeability. Thus the current wave was not far from being such that its rate of change was a copy of the volt wave, and the reactions in the generator for which the test was being carried out were, therefore, entirely normal.

Telephony in San Francisco.—According to the *Zeitschrift für Schwachstromtechnik*, the American telephone girls at times find it difficult to understand the "pigeon English" of John Chinaman. As there are over 700 subscribers of this nationality in San Francisco, a small exchange has been erected in "China Town," and will be served by attendants of appropriate colour.

THE MERCEDES PETROL-ELECTRIC SYSTEM FOR VEHICLES.

The principal object of the combination of a petrol engine with a dynamo and motor for vehicle propulsion would appear to be the entire abolition of gearing between the power system and road wheels. The majority of petrol electric vehicles up to the present constructed employ gearing of some description, either chain, or worm drive on to a differential shaft.

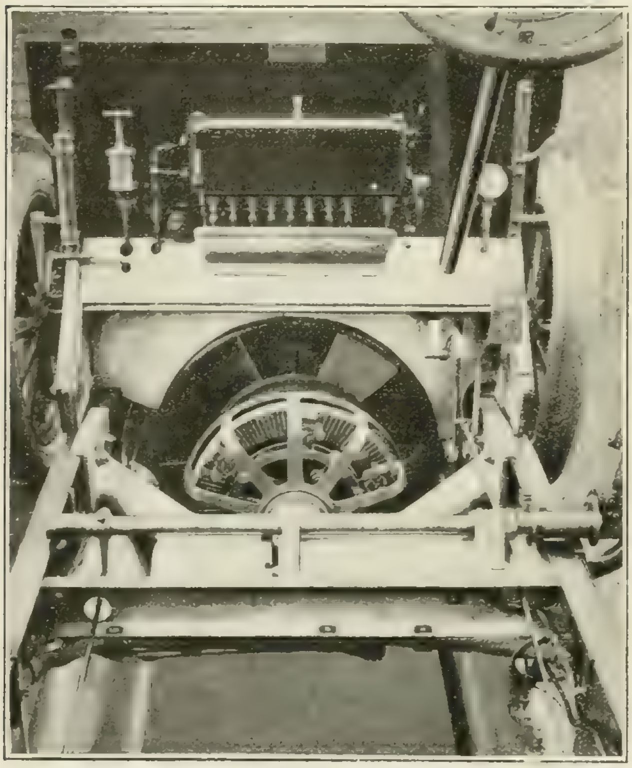


Fig. 1.—Mercedes Petrol-Electric System. View of Dynamo at Commutator End, showing Brush Gear, End Support for Armature and Fan Blades on Engine Flywheel.

The use of gearing is commonly put forward as a disadvantage in the driving of any vehicle from a petrol engine. The petrol motor itself is, of course, the chief cause for the introduction of gearing, and it is between the clutch and the road wheels that the principal losses in petrol driven vehicles are incurred.

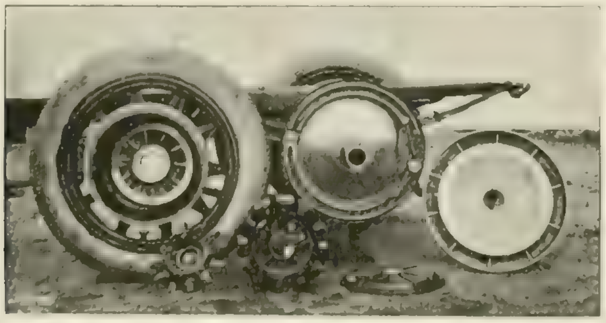


Fig. 2.—Mercedes Petrol Electric System. View of One of Driving Wheels Dissembled.

The field may be seen in the foreground, the commutator is on the far side of the wheel in which the armature is fixed

Until quite recently there has been no petrol-electric system for vehicles which dispensed entirely with gearing, and at the same time remained within the limits of weight of petrol vehicles of a certain class. The Mercedes system, which introduces electric motor wheels, removes at once gearing of any description between the power unit and the driving wheels. The electrical system adopted contains a number of features which are both novel and interesting. In the design and construction of the dynamo and motors a radical departure has been made from ordinary methods. In both machines the usual stationary field is retained, but the armature is built to rotate outside the field system instead of inside it.

An end view of the dynamo is shown in Fig. 1 looking towards the commutator and brush gear. The armature windings which rotate around the internal field are laid in slots in a core which is built up cone-shaped and fixed in a light steel cone, having a similar taper to that of the core. The armature is specially fixed to the engine shaft in a long bearing at the engine end and a shorter bearing at the commutator end. A

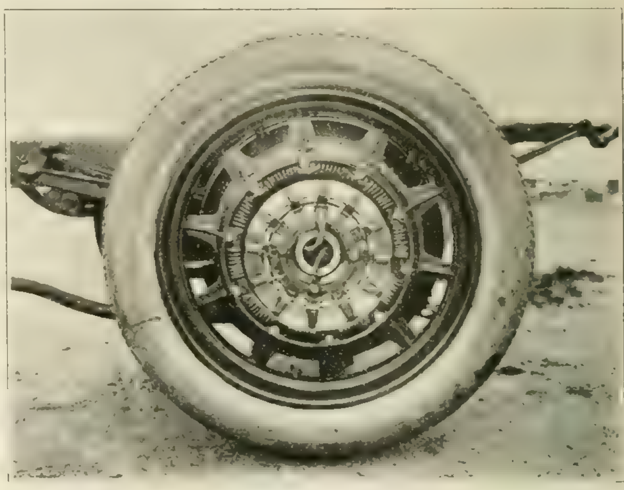


Fig. 3.—Mercedes Motor Wheel with Dust Cover Removed to Expose Commutator, Brush Gear and Leads through Fixed Axle.

light spider serves to support this end of the armature and commutator, as will be noticed in the illustration, Fig. 1. The field poles are built up on a sleeve sliding on a fixed shaft, in which a coarse thread has been cut. This construction has been adopted to allow the field flux to be varied automatically, according to the load on the generator. From the particulars supplied, and in the absence of drawings, we gather that the

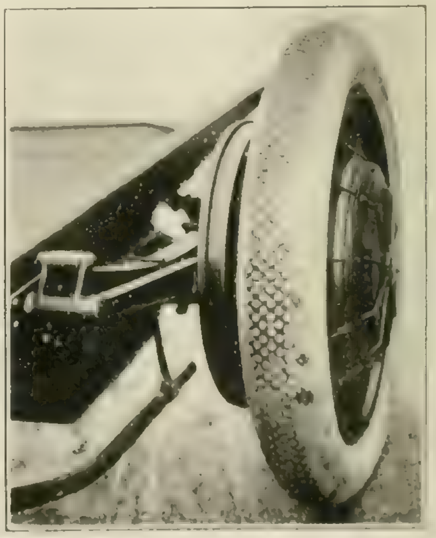


Fig. 4.—Mercedes Motor Wheel, showing Compact Nature of Complete Motor when Built up in the Wheel.

field is either attracted to or repelled from the armature, as the load is heavy or light, and in moving laterally it turns slightly by reason of the thread cut in the shaft supporting it. This adjustment either weakens or strengthens the field by varying the air-gap. At the same time the field, in thus turning, takes up a position in respect to the armature which

corresponds to that required for good commutation, and generally given by altering the brushes. The movement, as far as we can gather, is, in fact, equivalent to the automatic shifting of the brushes. The commutator bars are spaced radially around one end of the armature windings, and the brushes, which are held in a horizontal position, press against the vertical face of the commutator. This construction is clearly brought out in the illustration Fig. 1. The brushes themselves are fixed. It is claimed for this construction of the dynamo that the energy supplied is kept constant quite irrespective of the torque demanded by the road wheels.

Fig. 5.—40 h.p. Mercedes Petrol-Electric Omnibus.

The motors themselves are peculiar in that they are built to form an integral part of the road wheels. The method of construction can be best understood by reference to Fig. 2, which illustrates one of the wheels dissembled and the main parts exposed to view. As with the dynamo, the field is rigid and the armature moves externally round it. The shape of the field poles is well brought out in the illustration. The arrangement of the armature and field is identical with that of the dynamo, with the exception that the field system is rigidly fixed and has no adjustment similar to that of the generator. The armature casing and the spokes are built up in one piece, and revolve together with the rim and tyre. The construction of the commutator is similar to that of the dynamo, and the leads to the brushes and field are carried through the fixed axle, a portion of which is hollowed out specially for the purpose. Figs. 3 and 4 depict the main details of the motor and wheel construction very clearly.

Both wheels are identical, and the cables, which supply the energy from the generator, are run in the channelling of the chassis girders. The controller is placed immediately behind the commutator end of the dynamo, being carried on a girder in the frame. The motors, which are series machines, are regulated entirely from this controller. It is constructed after the drum type, and is operated from a lever at the side of the driver's seat. The various notches give four forward speeds, the connections of the motors and the fields being changed from series to parallel without the use of resistances. A reversing notch is also provided.

The system is at present adopted for touring cars fitted with 45 h.p. and 75 h.p. engines. These are of the Mercedes Standard four-cylinder pattern and do not call for any special comment. We give illustrations in Figs. 5 and 6 of the complete vehicle and chassis of a 40 h.p. two-deck omnibus, which is also fitted with the system. This has been doing trial runs in the London district for a considerable time past, and we are informed that the company are making arrangements for putting a standard British pattern vehicle on the London streets.

The system of operation provides for the constant running of the engine at a practically fixed speed, about 800 revs. per min. The driver has, however, control over the speed and power of the engine, throttle and ignition levers being fitted to a steering wheel. The use of a governor has not been found necessary.

Compared with other petrol-electric systems which we have described in these columns, the foregoing is a striking departure from conventional methods, and if all the claims of the makers are substantiated by further experiments the system has a very promising future before it.

Fig. 6.—Complete Chassis of 40 h.p. Mercedes Petrol-Electric Omnibus.

A STUDY OF THE PROPAGATION AND INTERCEPTION OF ENERGY IN WIRELESS TELEGRAPHY.*

by C. A. Culver.

(*Concluded from page 1005, Vol. LX.*)

Summary.—The author deals with the relative efficiency of several different types of receiving systems when used under various conditions. Wherever aerials or antennæ, however, are referred to, the reference is only to the receiving station.

Helix.—To test the effects of orientation upon an open-circuited coil of large diameter when utilised as a receiving system, a helix was constructed by winding two complete turns of wire about a wooden frame 1·5 metres square. This helix had an inductance of 0·040982 millihenry (Fleming-Anderson method). The helix thus made was supported and insulated as in the case of the small capacity area, the free ends of the wire being at the middle of the lower edge of the coil. 1·7 metres of wire connected one end of the helix

* Abstracted from the *Physical Review*.

to the lead H. The helix was so arranged as to permit of rotation about a central vertical axis. When resonance was secured in the usual manner energy readings were noted for various planes of orientation. It was found that such an open-circuited helix collected an equal amount of energy in all positions.

The experiment was next tried of breaking the ground connection at the receiving station and in its place making a connection to the remaining free end of the helix above described, thus making a closed oscillating system without earth connections. In the case last outlined the galvanometer showed a deflection of 87·5 mm. With the closed helix just described placed tangential to the wave front the deflection was only 5 mm., and when the helix was turned through 90 deg., so as to have its plane normal to the wave front, the deflection was so small as to be scarcely readable. The energy received by a closed helix apparently does not follow the same law as that of the open coil. These results are somewhat surprising, for if we assume the presence of a free Hertzian wave we would expect the open-circuited helix to show a difference on orientation as well as the closed circuited coil.

Screened Vertical Antenna.—The foregoing experiments gave rise in the mind of the writer to the thought that possibly the greater portion, if not all, of the energy transmitted in wireless telegraph operations is propagated by means of electric oscillations through the surface of the earth and not by means of the free ether surrounding the same. The following experiment was therefore devised. Two vertical antennæ, each consisting of a single wire 6·2 metres in length, were erected 17 cm. apart, and were so arranged at the base that either could be quickly coupled to the lead H. One of these vertical antennæ was then shielded from the free Hertzian waves by placing about it a metal cylinder made of tin, the cylinder being 10 cm. in diameter and 6·2 metres long. The enclosed wire hung

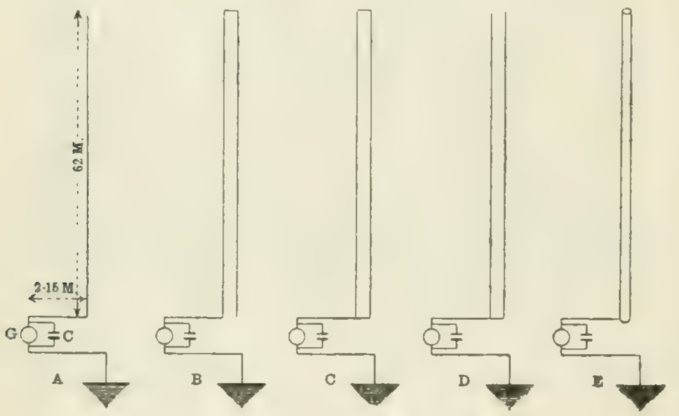


FIG. 5.

freely within the metal tube, which was insulated from the earth. Resonance was separately effected for both open and enclosed antennæ. On two different occasions several series of readings were taken in alternate groups, the results for the two tests agreeing within less than 0·1 of 1 per cent. The shielded antenna produced a mean galvanometer deflection 9·3 per cent. less than the unscreened system. This is equivalent to a difference of 4·9 per cent. in the value of the current in the two cases. The results of this experiment will be discussed elsewhere.

Relative Efficiency of Various Energy-collecting Systems.—We were now in a position to carry out a series of experiments designed to determine the relative efficiency as energy-gathering devices of the several types of antennæ now in commercial use. One or two original systems were also devised and tested. The two vertical single-wire antennæ described in the last experiment were so arranged as to permit of being connected at both the top and bottom, thus four different modifications of one system were possible. The metal cylinder used to enclose the vertical antenna of the last experiment was also suitably arranged to be used as a receiving system. The several cases are illustrated diagrammatically in Fig. 5 and will be referred to hereafter as systems A, B, C, D and E.

After the capacity* of the vertical portions of these systems was measured the systems were each in turn compared as energy-gathering devices with the simple vertical wire A taken as a standard. In these tests the readings for any given comparison were made by taking several alternate groups of observations consisting of three or five readings each, thus eliminating the effects from any possible change at the sending station. (This method of taking readings was followed in all experiments constituting this investigation unless otherwise specified.) The mean ratios of the galvanometer deflection due to the energy received are given in Table I., as are also the ratios of the current values in each case.

Table I.

System.	Capacity in microfarads.	Ratio of gal. deflections produced by various systems to that caused by standard system A.	Ratio of current values. (Square root of gal. deflection.)
A	0·000032	1·000	1·000
B	0·000056	2·220	1·483
C	0·000068	2·045	1·450
D	0·000080	2·225	1·490
E	0·000060	3·520	1·880

It is apparent from an examination of Table I. that systems B and D are of practically equal efficiency. C, though very close to both B and D in value, showed a persistently lower efficiency. The difference is, however, only slight. It would appear that in erecting multiple-wired antennæ it is practically immaterial whether the component parts are connected at the lower, upper or both ends. Though the metal cylinder shows an apparently greater efficiency than the double-wire type, yet, when other obvious factors are considered, it is doubtful if such a system possesses any material advantage over the multiple wire arrangement. The results would also seem to indicate that capacity is not as important a factor in determining the amount of energy received by a given system as is commonly supposed.

In the concluding series of experiments the relative efficiency of several systems already described, together with one or two original arrangements, were tested. The standard of comparison being a single vertical antenna 9·8 metres in length. The systems investigated in these tests were: A large capacity area 4·2 by 0·7 metre; a small capacity area; a large helix, 1·5 metres square, having 12 metres length of wire; a small helix, 15 cm. square, having

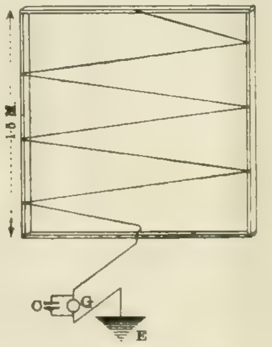


FIG. 6.

12 metres length of wire; a horizontal antenna 9·8 metres in length; a wire screen, 1 metre square, and a special system consisting of 9·8 metres of wire fastened to a light wooden rectangular frame, in the manner indicated in Fig. 6.

The results are recorded in Table II., which shows that all of the receiving systems tested fell far short in efficiency in the matter of intercepting energy when compared with a single vertical wire.

Table II.

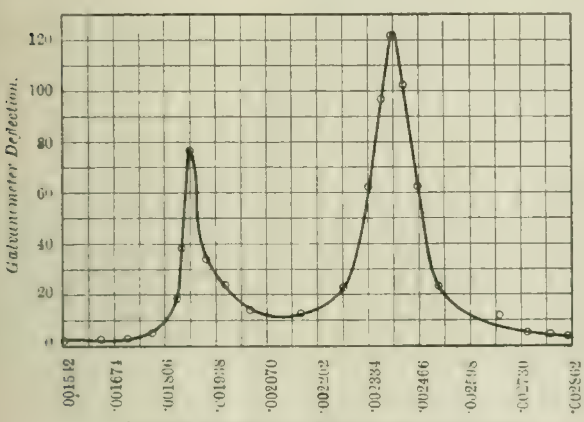
System.	Inductance in millihenrys.	Capacity in microfarads.	Ratio of gal. def. produced by various systems to that caused by standard	Ratio of current values.
Standard vertical antenna	—	0·000049	1·0000	1·0000
Large capacity-area	—	0·000106	0·4060	0·6360
Small capacity area		0·000008 ?	0·1750	0·4190
Large helix ..	0 041	0 000044	0·2520	0·5020
Small helix	0·056	0·000034	0·1060	0·3260
Horizontal antenna	-	0·000340	0·1730	0·4160
Wire screen	—	0·000044	0·1970	0·4440
Special system .	—	0·000030	0·2290	0·4790

The resonance curve shown in Fig. 7 is given to show the general properties of the two waves sent out by the sending station. The data for this curve were taken when using the capacity area 1 metre square as a receiving system. Capacity shunted about the galvanometer is plotted against galvanometer deflections. The smaller maximum probably corresponds to the shorter of the two wave-lengths radiated by the transmitting station and the greater maximum to the longer wave-length. However, this relation is somewhat difficult to determine, because of the fact that these maxima would frequently interchange places. The reason for this rather unusual phenomenon we have as yet been unable to determine.

* These and all other antenna capacity values were measured by the resonance substitution method suggested in the paragraph on wave length measurements.

Conclusion.—The comparative closeness of our stations afforded us a special opportunity to study the effects due to the free Hertzian waves as differentiated from the effects due to the propagation of energy in other possible ways. Stone maintains that the greater portion of the energy transmitted resides in that part of the wave which is immediately adjacent to the surface of the earth. It will be remembered in this connection that our capacity areas were placed very close to the surface of the earth. If the free wave ever enters as an important factor it should, according to the commonly accepted view, have produced marked effects in our experiments, but, on the contrary, we find in the cases where the capacity-areas, helixes, &c., were rotated about a horizontal axis variation in the plane of orientation produced but slight changes in the amount of energy received, and in some instances resulted in no change whatever.

In the experiments having to do with earth resistances the increase in the quantity of energy received was probably not wholly due to the decrease in the resistance between the two stations, but it is reasonable to suppose that the greater part of the increase may be ascribed to this cause. In view of the above facts, and since a fixed wave-length and constant supply of energy was radiated from the transmitting station, it would seem that the conclusion is not wholly unwarranted that practically all the energy taking part in wireless telegraph operations is propagated through the surface of the earth by means of electrical oscillations, and not by means of free Hertzian waves. The experience of those engaged in practical wireless work bears out the conclusion of the author in this respect. Again, if the theory of a free ether wave is correct the law of inverse squares should hold, approximately at least. That this law does not hold has been shown by several investigators, among



Capacity shunted about Galvanometer (Micro farads).

FIG. 7.

whom may be mentioned Duddell and Taylor,† who found that the product of the distance by the intensity was a constant, and Chant,‡ who also found that the energy fell off inversely as the simple distance.

In considering the possible processes by which energy is propagated in wireless telegraphy it is to be remembered that the beginning of wireless telegraphy as a practical commercial project dates from the time when Marconi first connected his transmitting apparatus to earth. The distances over which communication was effected prior to this were insignificant. We do not dispute the existence of the free ether wave, but maintain that its effect is nil beyond comparatively short distances from the radiating system.

May we not think of a wireless transmitting apparatus when in operation as impressing upon the earth, at the point where the system is earthed, a high frequency alternating potential, these waves of potential spreading out through the surface of the earth in all directions?

We are aware that the effect of intervening land is difficult of explanation on the basis of the theory which we advance. We believe, however, that the sudden decrease in energy when passing behind elevated bodies of land can be accounted for on other grounds than that of the electrical shadow in the commonly accepted sense of the term. The author is at present designing a series of experiments by which he hopes to prove this contention.

The phenomenon of the effects of light and darkness upon the propagation of energy we admit is also not readily explicable on the assumptions which we advance. However, a number of important facts which are difficult to account for upon the idea of a free Hertzian wave become easy of explanation on the basis of the oscillation theory, one notable example being the case of Marconi's trans-Atlantic communication. This is difficult to explain on the basis of a free ether wave, as is cited by Poincare,* but presents no particular difficulty when viewed in the light of the theory outlined above. Notwithstanding the failure of the proposed theory to account for several phenomena encountered in practical wireless work, we believe such a theory accounts for more of the facts now known than the conventional idea of a free energy wave.

* Stone, *Transactions* International Electrical Congress, St. Louis, 1904, p. 558.

† Institution of Electrical Engineers *Journal*, Vol. XXXV., p. 321.

‡ *American Journal of Science*, Vol. XVIII., p. 403.

* H. Poincaré, *Proc.* Roy. Soc., Vol. LXXII., July 8, 1903.

THE DEVELOPMENT OF PETROL-ELECTRIC SYSTEMS AND THEIR APPLICATION TO HEAVY ROAD VEHICLES.†

BY P. FROST-SMITH AND W. A. STEVENS.

Summary. The authors give some interesting figures showing the cost of running the existing motor 'buses on the London streets. They are in favour of the petrol electric type, and look unfavourably upon vehicles driven by accumulators. A new type of petrol electric 'bus is then described. One of these vehicles has been running very satisfactorily on the streets for several weeks, and the authors hope to effect great economies in the cost of maintenance, in comparison with the present types of motor 'buses.

Early types of petrol-electric systems have already been described by Messrs. Hart and Durtnall,‡ and are, therefore, not considered to any extent in the present Paper. The authors' experience in the operation of the present and generally accepted types of motor omnibuses—viz., those having gear-driven systems—shows that an entirely different type of vehicle must be introduced, since the general cost of running is much too high. This high cost of operation is due to: (*a*) The abuse to which the vehicle can be subjected by reason of bad driving and carelessness on the part of the drivers, which the authors believe is inevitable. (*b*) Bad driving by drivers, which now results in undue wear and tear on clutch gear, much damage to gear boxes and to transmission gear. (*c*) The present vehicle demands a very heavy night staff—about 1·5 men per vehicle, excluding washers—to prepare the mechanism for the following day's work. Night staffs are, and always will be, unsatisfactory, and the wretched circumstances under which they have to work does not permit of the best class of fitting being produced; therefore it only remains to reduce night labour to a minimum. This point we wish to urge as one of our most serious objections to the present systems. (*d*) Maintenance should, perhaps, come first under the several heads, as it is governed by the efficiency of the drivers, the work of the night staff, by the attitude taken by the licensing authorities, and by fair wear and tear.

The only items in which economy can be effected in motor-'bus operation are: depreciation, running costs, maintenance costs, oil and grease. The authors are enabled to publish the following figures in connection with a leading London motor-'bus company, and these figures may be taken as typical of vehicles three years old:—

Working Costs.	Pence.	
Day running	0·265	
Night running	0·750	
Maintenance	2·443	
Lubricants	0·241	
Grease	0·080	
Paraffin	0·040	
Vehicle lighting	0·105	
Body upkeep	0·250	
Drivers	1·308	
Tyres	1·750	
Conductors	0·945	
Petrol	1·325	
Traffic expenses	0·255	
Depreciation, insurance, rents, rates, taxes, water, gas, garage lighting, supervision and establishment charges	2·180	11·937

These figures, which extend over a period of three years, clearly show the hopelessness of going on as we are now doing. "Steamers" do not appeal to us; they are extremely clever, and will, no doubt, be successful where slow moving and heavy vehicles are concerned, but not for London traffic and motor 'bus work. We are of opinion that boilers, liquid fuel burners, thermostats, automatic fuel and water pumps, "red-hot" steam, with its consequent lubricating difficulties, and the necessity of a whole lot of funny little gadgets, will not allow of them ultimately proving practical or commercial. Hydraulic systems of transmission have not yet been made practicable.

The authors are in favour of the petrol-electric type, and deal briefly with the various systems proposed.

The prospects, we think, are of the worst for those interested in the accumulator system—*i.e.*, where a motor, or motors, are driven

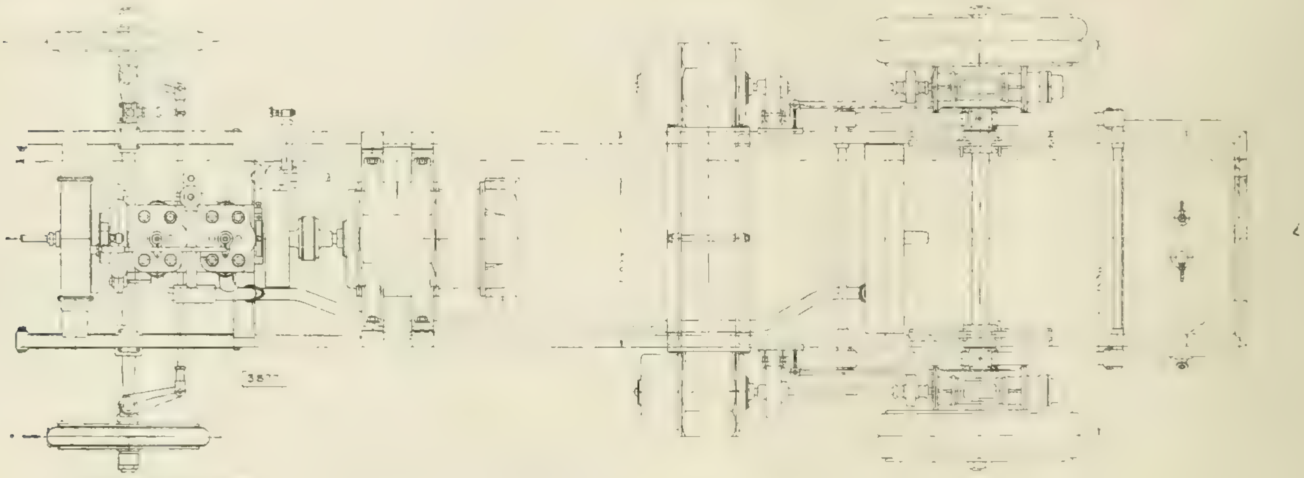
† Abstract of a Paper read before the Society of Road Traction Engineers.

‡ *The Electrician*, Vol. LVIII., p. 614.

from a storage battery carried upon the vehicle. As regards the purely petrol-electric combination, we are of opinion that the electric unit applied heretofore—by a double reduction gear, or by single motor on to a live axle, or to replace only the gear box and used only as a starter—does not warrant its existence. The Mercédès Simplex system, which is a direct application of electric motors, built into the road wheels, appears to us to be entirely wrong, owing to the very low speed, the limited size of the motors and the necessarily low efficiency. We have mentioned the Mercédès Simplex system last, as the object they aim at is, in our opinion, the correct one—viz., the direct application of the electric motors to the road wheels; but, still, this must be done in a manner that shall be mechanical and efficient. This we have endeavoured to do, and we hope successfully.

road wheel. The worm which drives the worm wheel is really a continuation of the motor armature spindle. This application of electric motors is, we believe, unique: It is direct, and has the further advantage of throwing the motors and transmission gear outside the frame, thus rendering them particulary accessible in common with the universal joints and brake gear. A single worm drive, as above quoted, has in the reader's experience, run 20,000 miles without being appreciably worn.

A plan of the vehicle is shown in Fig 1. The engine is directly coupled by means of a flexible coupling to a continuous current dynamo of the interpolar type; this dynamo is capable of generating a current of 0 to 250 amperes at a voltage varying from zero to 200 according to the speed of the engine, the maximum output in kilowatts being 18 when the engine is running at 900 revs. per min.



[From the "Commercial Motor."] FIG. 1.—PLAN OF CHASSIS.

A frame, front axle, steering gear, springs, &c., is not difficult to-day to arrange for, but the prime mover—the engine—requires careful selection. Unlike other manufacturers, we have employed a comparatively small engine developing 30 H.P. according to the R.A.C. rating, and this has a bore of 110 mm. and a stroke of 140 mm. This engine is of the Saurer design, modified and manufactured by J. & E. Hall (Ltd.), of Dartford. We determined to apply the motors direct to the road wheels, so as to avoid double reduction gears, and hit upon the design of back axle now known as the S.B. and S., which, after 6,000 miles' running, has realised our optimistic anticipations regarding it. This axle controls the position of the electric motors, and allows of them being heavy, robust and efficient, and to run at a normal speed of 1,200 revs. per min.; they are directly coupled to our patented worm-driven road wheels by a 12 : 1 ratio worm gear. On each end of a dead axle are forged two flanges, and these lie immediately outside the springs. Secured to the flanges are the worm casings, inside of which the worm wheels are bolted to housings, mounted on ball bearings. The housings extend through the worm casings, and are cut out in the form of a circular dog clutch, engaging into the road wheel centre, forming a part, though an easily separated portion, of the

FIG. 2. DIAGRAM OF CONNECTIONS.

The dynamo has a falling characteristic in common with other shunt wound dynamos, and, as a consequence, the voltage increases as the current required by the electric motors decreases. The current from the dynamo is carried through a main switch, which is controlled by the foot pedal, to the controller operated by a lever corresponding to the ordinary gear-changing device, and this speed-changing lever is interlocked with the foot pedal, so that it is impossible to move the controller, unless the main switch between the dynamo and the controller is broken. The controller under these conditions must be absolutely sparkless. From the controller, the current is carried to the electric motors, which are bolted to the side members of the chassis, and braced by two bridge pieces. These motors are series wound, and the armatures are capable of being connected up in series or parallel corresponding to the first or second speeds by the action of the controller, the reverse being effected by reversing the current exciting the motor field magnets. Brake drums are fixed to the motor shafts, which also carry universal joints connected to the cardan shafts that drive the worms in the worm wheel cases already described. A diagram of the electrical connections is given in Fig. 2.

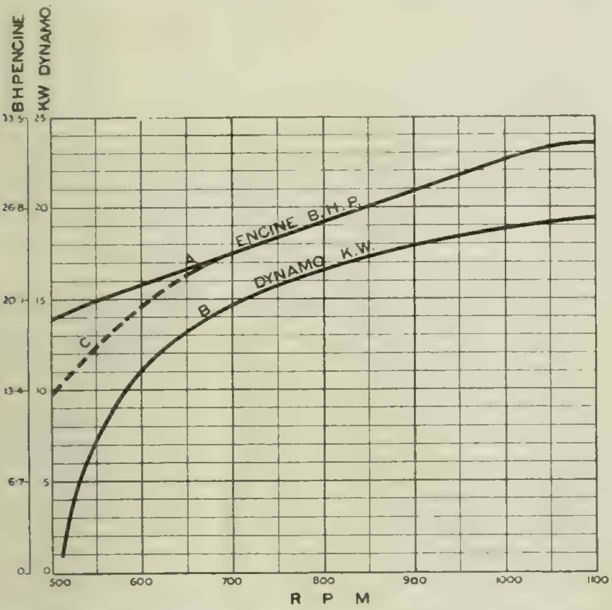
The speed of the engine is controlled by a small throttle pedal operated by the right foot, and this pedal in its normal or top position throttles the engine down below the speed required to excite the dynamo, the latter only exciting when the speed of the engine is increased by opening the throttle. This throttle pedal, and the brake pedal operated by the left foot, are the only pedals used in driving. In series with the shunt field of the generator is a small shunt resistance operated from a small lever on the steering wheel; this resistance by controlling the voltage of the generator enables the driver to get the most efficient results at any speed of engine or car. On level roads and very slight gradients the car will run with a strong field on the dynamo and a slow engine speed. For fast running and hill climbing, however, a weaker field is necessary to enable the engine to get away with the load and give its maximum horse-power, thus providing the electrical equivalent of a universal gear.

The conditions under which the petrol-electric drive will produce the greatest efficiency are then discussed. In Fig. 3 the characteristic of the Hallford petrol engine is compared with the characteristic of the interpolar dynamo which it drives by means of a flexible coupling. The distance between the two curves as compared with the total engine power at any speed above 650 shows the

efficiency of the conversion. A dotted line (C) on engine characteristic indicates that the engine must be throttled down below the speed of 500 to allow the dynamo to lose its excitation, thereby obviating the necessity of breaking the main switch in stopping the vehicle in traffic. The dynamo characteristic must be such that it will generate, approximately, constant watts, the volts and amperes varying in inverse ratio according to the requirements of the series-wound motors, which demand current in almost direct ratio to the torque demanded by them by the road conditions. As the power of the petrol engine is limited, the volts must necessarily fall to keep the load on the engine constant. To this end the dynamo must have a falling characteristic, but, owing to its special duties, a simple shunt-field winding would be unsuitable, as the armature reaction, with a heavy main current, and a weak field—conditions occurring when the vehicle is negotiating a steep hill—would cause heavy sparking, and, as a result of the armature reaction, the machine would lose its excitation at a time when its power is most required. The dynamo we have adopted is of the inter-polar type.

For London omnibus work and ordinary gradients all the driving is effected on the top speed with motor armatures in parallel, and the main circuit between motors and dynamos is not broken, the control being entirely by engine speed.

As the conditions of efficiency in continuous current petrol-electric systems are entirely different to those obtaining in tramway practice, owing to the total energy available for the electric motors being



CHARACTERISTIC CURVES OF ENGINE AND DYNAMO.

From the "Commercial Motor."

Fig. 3.

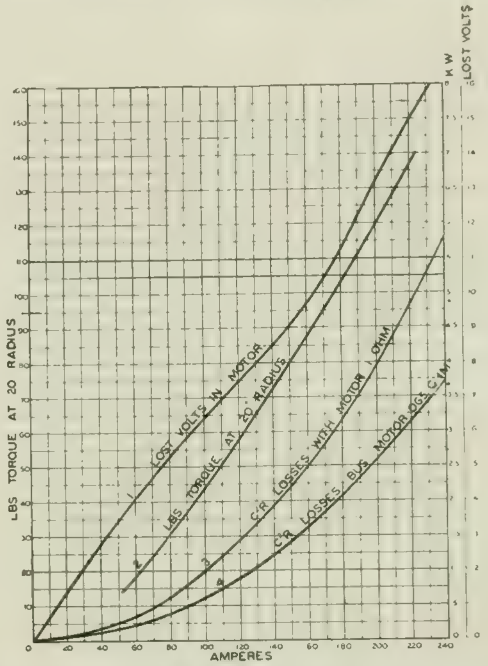
limited by the power of the petrol engine to produce that energy, a consideration of the curves in Fig. 4 may be of interest, as they have a most important bearing on the efficiency, hill-climbing powers and gear ratio for special conditions of work. The curves are taken from the motors of our petrol-electric omnibus.

An example is given to show the effect on the efficiency of a wrongly calculated gear ratio. In our experience the best gear ratio for electric motors of the dimensions that we are employing is from 12 : 1 to 16 : 1, the former for town work and the latter for mail van and country work generally, owing to its high efficiency on hills. With the 16 : 1 gear ratio the efficiency of transmission in a petrol-electric vehicle, weighing loaded 7 tons on a hill of 1 in 12, including all electrical losses, and allowing 10 per cent. for gear losses, will work out at 70 per cent. from the engine to the road wheels. The efficiency of a 12 : 1 gear ratio under these conditions is 67 per cent. On ordinary "give-and-take" roads the total efficiency from the engine to the road wheels averages over 70 per cent.

In the matter of durability of electrical equipment, the petrol-electric omnibus possesses the important advantage over the tramcar, in that the total electrical load on the dynamo and motors is limited by the power of the engine, and to "burn out" through an overload is impossible.

In concluding the account of the electrical equipment of our own vehicle, we wish to dissociate ourselves from any attempt to monopolise all the virtues appertaining to the petrol-electric system. A few brief comparisons between gear driven systems and the system herein described are given. This vehicle exists, and though it has only been in actual work and on a regular London service for eight weeks—covering 6,000 miles—yet, in comparison with the recent much-talked of R.A.C. trials, it shows up very well. Our vehicle cannot be started from a stationary position with a jerk, it simply glides away with a gentle, steady movement: this fact alone has a great bearing on the question of abnormal wear and tear. The night staff on a fleet of such vehicles can be very greatly reduced, and it is confidently estimated that only 0·5 to 0·75 man per vehicle would be required. The labour required would be: engine adjusters, brakesmen, greasers, cleaners and washers. Electrical labour has been clearly demonstrated to us to be unnecessary on night shifts, as the ordinary cleaning of the commutators would be done at the most suitable point on the vehicle's route during the day, as the operation only takes a few minutes to do.

With regard to maintenance, we have the strongest hopes of effecting a most substantial saving from the results already obtained. An engine, such as we have employed, may be safely taken to cost no more than $\frac{1}{4}$d. per mile on the very low basis of 30,000 miles run per annum. On the same basis the frame is estimated to cost $\frac{1}{4}$d. and the back axle the same sum. This latter unit was stripped after the 6,000 mile run for examination, and there was no visible signs of wear. The electrical unit has shown us that with a suitably designed dynamo and motors the maintenance cost would be extremely low, and certainly not more than $\frac{1}{4}$d. per mile, though we



CURVE 1 LOST VOLTS IN MOTOR AT VARYING CURRENT DENSITIES
CURVE 2 TORQUE OF MOTOR AT 20" RADIUS AT VARYING CURRENT DENSITIES
CURVE 3 C²R LOSSES IN MOTOR 1 RES AT VARYING CURRENT DENSITIES
CURVE 4 C²R LOSSES IN BUS MOTOR OGS RES AT VARYING CURRENT DENSITIES

From the "Commercial Motor."

Fig. 4.

really think that this figure, low as it is, would eventually be considerably reduced. A comparison with the working cost figures given earlier and relating to the gear-driven types is as follows:—

	Gear-driven.	Petrol-electric.
Depreciation, insurance, &c.	2·180d.	1·805d.
Day and night running charges	1·015d.	0·338d.
Maintenance	2·443d.	1·000d.
Lubricating oil	0·241d.	0·060d.
Grease	0·080d.	0·020d.
Paraffin	0·040d.	0·020d.
Other items (same as now)	5·938d.	5·938d.
Total	11·937d.	9·181d.

In the above table we have taken the petrol consumption to be the same as on our gear-driven vehicles, but, as a matter of fact, the petrol consumption has averaged $\frac{3}{4}$ mile per gallon more.

BOOKS RECEIVED.

(Copies of the undermentioned works can be had from *The Electrician* office, post free, on receipt of published price. Add 5 per cent. for abroad or for foreign books.)

"The Standard Handbook for Electrical Engineers." (New York: McGraw Publishing Co.) 17s. net.

"Principles of Direct-Current Electrical Engineering." By Jas. R. Barr. (London: Whittaker & Co.) 10s.

"Power Gas Producers." By Philip W. Robson. (London: Edward Arnold.) 10s. 6d. net.

"Science Abstracts." March, 1908, Vol. XI. Part 3. Section A—Physics; Section B—Electrical Engineering. (London: E. & F. N. Spon.) 1s. 6d. each.

ELECTRIC DISCHARGES THROUGH GASES.—VI.

In his sixth and last Royal Institution lecture of April 11th Prof. J. J. Th mson, F.R.S., first applied the principles laid down to the explanations of the appearance of a vacuum discharge tube. The kathode was the power station where the conductivity of the gas was manufactured. The positive particles were drawn into the intense field of the kathode, and their bombardment caused the kathode to emit negative particles, which, repelled at great velocity, produced more negative (and simultaneously also positive) particles by their collision with the gas molecules. In the tube the current must be the same for every cross section, and the current intensity could be maintained both by a large number of particles at low velocity and by a small number of particles at high velocity. In the kathode glow we had many particles and needed only a small velocity. But as we moved further away from the kathode, particles were diffused and sent to the walls of the vessel, and if the current were to be maintained, the electric force must rise again. At such spots the particles would again attain a sufficiently high velocity to render the gas luminous; the increased number of collisions would then once more give more particles, the electric force would diminish, and in this way we obtained the bright and dark patches of the striations.

If that explanation were true in its general features, anything tending to increase the rate of loss of negative particles should bring the luminous patches nearer up to the kathode. This was demonstrated in two ways. A vertical discharge tube showed only a faint luminosity and hardly any striations. When the negative particles were deflected by a magnet, the striations appeared and travelled up as the magnet approached the kathode at the top. Then a double ring tube consisting of bulbs alternating with narrow tubular portions was taken; the striations were more marked and were closer together in the narrow than in the wider portions, in which the particles were more apt to move to the sides. Measurements conducted by many phycisists moreover proved that the potential curve was actually a wave line, a crest corresponding to a luminous patch. The variety of effects observed in discharge tubes could be accounted for on these lines; there was at any rate nothing to contradict the explanation. It was, therefore, the stream of negative particles from the kathode which carried the current. If we had only these, however, the free electricity would produce a strong field, and the current would not flow with the small P.D. applied. But we had the neutralising effect of a stream of positive particles from the anode, produced by the anode fall of potential which—though to a certain degree dependent upon the gas pressure and the nature of the anode—was practically about 20 volts. This fall took place so close to the anode that we could not subdivide it—which we could easily do at the kathode—by bringing an exploring electrode more or less close to the anode.

The peculiarity of the gas discharge, that it was apt suddenly to stop without warning or apparent reason, was partly a resistance phenomenon. As there was, in the lecture theatre, a leak from the main to the lecture table the intended demonstration could not be given with a vacuum bulb, but only with an arc lamp which went out, as the resistance was gradually increased. For an ordinary circuit Ohm's law told us what current a certain battery would produce. But in gas discharge that law failed. The connection between E.M.F. and current was very complicated; each discharge bulb had its own characteristic, and we could only find the current by a graphical method. Prof. Thomson drew the type of curve; it rose steeply at first and fell off rapidly again, finally running near the current abscissa. We could draw a straight line from the ordinate to represent the current so far as it depended on the resistance of the wire leads. That line might cut the characteristic in three points, or be tangential to part of it, or cut in one point only. Those points indicated possible current values for the gas discharge. If a point fell on a part where the curve was sloping backward, the conditions would be unstable, because a slight rise in the E.M.F. would result in a diminution of the current intensity. The point of contact would be highly unstable. The intersection point nearest the ordinate would correspond to the dark portion of the discharge.

Prof. Thomson then passed to arc discharges. While in gas discharge tubes we had to deal with currents of milliamperes at very high potentials, we had in the arcs currents of several amperes at comparatively low potentials. In the former case the chief fall of potential was at the kathode, in the latter at the anode. In the arc the gas played only a secondary part, and the phenomenon was practically discharge of electricity from incandescent solids. Any solid raised to red heat seemed to give out negative electricity even in a vacuum. This was demonstrated with the aid of a Wehnelt tube in which a stirrup of platinum, to which a speck of lime was attached, was heated from the outside by the current of an auxiliary battery. When we made that stirrup the kathode, a stream of blue particles was seen to issue from it; there was no such effect when the platinum was made the anode. If we kept the current through the gas sufficiently intense to maintain the kathode at incandescence —without the aid of a special battery—we should obtain an arc discharge. The essential thing in the arc was the emission of negative particles from the kathode; to maintain this the kathode had to be incandescent; the anode was a matter of little importance.

To prove this, the lecturer repeated J. A. Fleming's experiment, in which a circuit was branched off from the kathode. This circuit comprised a battery of a few cells, a galvanometer and an exploring carbon electrode brought up to the kathode again. A current would flow through the galvanometer when the arc kathode was connected to the negative terminal of the battery—not when the kathode was joined to the positive battery terminal. The ordinary arc had to rely upon itself for keeping the kathode hot by its being bombarded by particles furnished by the anode; but as long as we kept the kathode hot, the anode mattered little. That was the essence of the different beha iour of different arc electrodes, metals or carbon. We could maintain an arc between a negative carbon and a positive iron electrode (not with reversed poles), because the carbon was not a good conductor for heat and would not melt. The hotter the kathode, the better the supply of negative particles, and for this reason a rise of 50°C. or 60°C. made a great difference in the arc intensity. We could raise the temperature by chemical combination. The arc was more easily maintained in air, where combustion resulted, than in hydrogen and nitrogen; in the latter case nitrides might be formed, but the arc was also difficult to keep up in nitrogen with metallic electrodes, and we were yet far from understanding this influence of chemical combination.

In concluding this most instructive series of lectures, Prof. Thomson regretted that he had not been able to refer to brush and point discharges. But these cases were covered by the general principles of the discharge through gases, and that depended upon the motion of electrified particles, which, when travelling at velocities above a certain limit, produced a fresh supply of negative particles by their collision with the molecules.

Throughout the series of lectures the experiments were in charge of Mr. E. Everett, Prof. Thomson's assistant in the Cavendish Laboratory.

ELECTRIC SUPPLY PROSPECTS AND CHARGES AS AFFECTED BY METALLIC FILAMENT LAMPS AND ELECTRIC HEATING.

The following is an abstract of the discussion which took place at the meeting of the Institution of Electrical Engineers last week when Messrs. Handcock and Dykes read their Paper on the above subject. An abstract of this Paper appeared in our last issue. The final proof of the Paper submitted by the authors contained a few corrections which were not included in the proofs previously circulated. In the case of the small auto-transformer mentioned, the no-load loss should be 12 to 15 watts instead of 15 to 20 watts, as first stated. A note was also added to the Paper, in which the authors comment on the great development in the few months since the Paper was written. Actual results show that the effect of metallic filament lamps is on no two stations the same, and, the authors say, the results confirm their views. They expect the demand for new plant to be small until matters have readjusted themselves. The lamp makers will reap a well-earned harvest, and installation contractors will also benefit. Any dislocation suffered by the investor will be of a temporary nature, and if the situation is properly dealt with, as it doubtless will be, there need be no fear for the future.

Mr. A. H. Dykes desired to bring out clearly two points. The advisability of alteration in the present methods of charging had been apparent to them for some time, and the advent of metallic filament lamps had only accentuated the need. The whole conditions of the business had been altered, and business men would have to see how best to meet those altered conditions. When a manufacturer found that he could no longer supply his goods at the old prices, what courses were open to him? One was to raise his prices all round, the other, and sounder way, to re-arrange his prices so that the greater part of the increase was borne by his most unremunerative customers, thus avoiding upsetting as far as possible his best ones. At the same time he should try to open up new avenues for the sale of his goods. That was sound business, and was what the "contract demand" system endeavoured to carry out. Put the increase on the short hour consumer, and encourage the use of current for other purposes besides lighting. The second point he wished to make clear was that they were not pessimistic as regards the future of the electric supply business if the new conditions were properly grappled with. Taking the case of a consumer now getting current at 5d. per unit and paying 1s. each for his 8 c.p. carbon lamps, if that customer replaced such lamps with osram 8 c.p. lamps at a cost of 3s., the amount he could afford to pay per unit for current, without increasing the total cost of lighting,

was no less than 11·8d., and if he used Osram 14 c.p. lamps 14·6d. It was quite clear, therefore, that there was ample margin for the total cost of electric lighting to be considerably cheapened, and for the stations still to get a satisfactory price for their current. That fact must, in the long run, be in favour of the stations.

Mr. A. Wright was certain that electrical engineers were in a serious position unless they tackled the metallic filament lamp problem. How that lamp would affect the stations of this country depended, in his opinion, entirely on the wiring contractors. He thought that during the next two or three years electricity suppliers would have a bad time unless the central station people took the matter up and insisted on consumers having more light at the same cost instead of the same light at a saving in cost. They ought to say "three times more light for the same cost," and unless they did that they would, he thought, suffer considerably. The gas companies had a great advantage over electric light companies, as they had no strict rules or fire regulations to conform to. The electrical folk had done themselves a great deal of harm in being too ready to make the service absolutely safe. They ought to have gone on in the same way as the gas companies—in the broad and easy way—leaving the insurance companies to insist on certain precautions. Station engineers should not, however, overlook the enormously increased field which the discovery of metallic filament lamps brought. It brought into their field a type of con-consumer, and a very numerous type of consumer, who had hitherto been beyond their reach. That new field was so large that he did not think the metallic filament lamp would in the long run do any harm to the industry; in fact, the consumption of current would be largely increased by the discovery of such lamps. Most of their stations could supply additional electrical energy at a much lower cost than the present average cost. Taking the case of Marylebone, the average cost there was 4½d., but they could double their output at an increase of 8 per cent. on their capital, and if the output were doubled the average cost would come down to 2½d. It was obvious, therefore, that they should do everything they could to increase the output, and nothing to increase the difficulties of business should be allowed. Most of them felt justified in charging less for power supply than for lighting, principally because of the great diversity factor. He thought Mr. Tapper had found that the diversity factor for motors was something like 4, whereas for lighting it was never more than 1½. It was obvious, therefore, that a lower rate could be charged for power. With a tramway motor load the diversity factor was very large compared with lighting. A disadvantage they were all suffering from was the high cost of connecting consumers at the present time; it cost nearly as much per kilowatt to connect a house as to build a power station. While they were taking all the trouble to reduce the cost of power stations nothing had been done to reduce the equally important cost of house connections. He hoped some day to have one service for several houses, and either overhead supply, or outside tubes, or something to avoid the £9 or £10 per house per service.

Mr. H. Hirst said that he had listened with great interest to the authors' figures and data, but it had made him feel somewhat uncomfortable. He had sent in a Paper to the Institution that day, in which he dealt rather exhaustively with the evolution of the metal filament lamp, and with transformers, &c. He thought that to state that a 40 watt tungsten lamp gave 30 c.p. was somewhat unjust; it gave at least 32 c.p. and up to 35 c.p. The life of the metallic filament lamp was considerably higher than that of the carbon lamp, and the remarks concerning series running with tungsten lamps were certainly not true to day. The loss of candle-power in the Osram lamp after a long run was exceedingly small, and if a new lamp were put in series with a lamp that had been burning for many hours the life of either would not be shortened, and they would run together perfectly well. There appeared to be a grievance against the makers of metallic filament lamps that they were making too much money out of the lamps. He thought the metallic filament lamp was such a tremendous asset to the electric lighting industry that it ought to be welcomed by everybody. The greatest losers in the first instance were the lamp makers, who had at once to depreciate their existing carbon lamp works, and it would take many years of good prices before the makers' risks would be covered. They were only taking £6,000,000 for electric lighting in this country, while the gas companies took £27,000,000, and there was plenty of room for securing a further six or seven millions with the metallic filament lamp. Some 12 months back, when he took over the control of the metallic filament lamp department of his firm, he had asked 15 central station engineers in London whether it would not be a good idea if they were to supply metallic filament lamps to the contractors, and the contractors under their instructions could introduce them to the consumers, and in that way the engineers would to some extent direct the policy with regard to the lamps. He personally thought the idea was a good one, but the station engineers thought it was an idea for his, the speaker's, own benefit, and it fell to the ground.

Mr. C. Bottomley Smith said he had considerable experience of the maximum demand system and knew the benefit of doing away with it. It had a very detrimental effect on the industry. He thought the system of charging proposed by the authors would be very unpopular from the consumer's point of view. He could hardly agree with Mr. Wright's figure of £10 per house for a service; but that was one of the principal points with which they had to deal in the future, as it was evident that they would have to double or treble the number of consumers.

Mr. W. R. Rawlings, from the contractor's point of view, thought he had heard more bad language expressed over the Wright maximum demand system than any other. He had never found a consumer who could understand the Wright indicator. A good many systems of charging had been introduced. That by Mr. Erskine, of the Kensington & Knightsbridge Co., was a good one, but there again the consumer had a great deal of difficulty in understanding it. It failed somewhat from the point of view of obtaining business. Most of the systems of charging in use did not do that which was necessary, and which had been referred to by the authors—the bringing about of the full use of the energy and the full use of the wires which were installed in any particular house. There were a number of installations in Kensington where no less than three meters, three main switches, three double-pole switches, and three sets of wires were installed, whereas one should be sufficient. The triplication of the wires and apparatus was a point that showed the absurdity of the system of charging, and brought about from the contractor's point of view a check on the industry. The author's system was designed to encourage the use of small apparatus, and he considered it was based on a sound financial basis. The authors had, he thought, overlooked the point of making provision for special illumination, such as for parties, when every lamp in the house might be in use, and there ought to be some method of charging a fee for any excessive demand made upon the lighting company.

Mr. F. M. Long (Norwich) gave some particulars of the system of charging at Norwich referred to in the Paper. About 18 months ago they had to consider the question of making a reduction of less than ½d. in the charge for current. They also wished to encourage the use of radiators and such like apparatus in houses, and it occurred to him that a fixed charge per house and a low price for current would have many advantages. He went into the matter, and made a record of the number of units consumed per house and put beside that the rateable value. At first it appeared that there was very little connection between the two, but by grouping the rateable values from £10 to £20, £20 to £30, and so on, it was found that the number of units consumed, divided by the rateable value, gave practically the same figure for each group. They found that if they were to get 10 per cent. on the rateable value and 1d. per unit the revenue would be the same as before; but they fixed it at 12 per cent. and 1d. per unit. That system of charging was started at the beginning of 1907. The advantage of that system was that only one set of wires was required throughout the house for all purposes. About 400 consumers started on the system, and they had now over 800. For the purpose of comparison he had taken 150 consumers who had been on the system for 12 months, and found that they had increased their consumption 20 per cent.; at the same time the amount of revenue from them was £388, equal to 3·1d. per unit, instead of 4½d. per unit previously. That was from consumers who came on at first, and were given some advantage, but with the others the reduction would not be so much. He had found that the system gave very great satisfaction, no one suggested that it was not fair and people understood it easily as they were accustomed to rateable values. The result had been that in a great many cases people had used electric light all over the house instead of in about two rooms. Since the system had been started they had supplied over 100 radiators. It was rather difficult to know how much the maximum load was affected by the system as they had no maximum demand indicators on that system. He had compared the readings on Sunday evenings and found that there was only 1½ per cent. increase in the maximum load, so that with about 8 per cent. increase in the consumption it looked as if they were getting a better load factor than before. He did not think that the suggestion for a contract demand was so suitable for a private house, and a special charge for parties, &c., would be a decided drawback. Further, there was no necessity for such a special charge, for if a man gave a party the likelihood was that his guests would be using less light in their own houses. Business premises had to be treated in a different way. The assessment could not be taken in that case, and at Norwich they had adopted for business premises the system suggested by the authors, taking the maximum demand of the place and charging at the rate of £10 per kilowatt and 1d. per unit. There was, of course, still the question where the consumer increased his load after he had settled on it. That, however, was got over to some extent by the suppliers undertaking the maintenance of lamps. The fixed charge of 1d. per unit gave considerable scope and encouraged the use of the current for various purposes. A charge of £10 per kilowatt was reasonable, but was probably too high for signs and advertisements, and perhaps £5 per kilowatt would meet such cases.

Prof. David Robertson (communicated) suggested the following as a simple and equitable way of charging for electricity supply: A nominal load would be fixed by the consumer, as a rule with the assistance of the official of the supply authority, and the consumer would contract to pay a minimum sum proportional to that load each quarter or year. The meter would be adjusted so that it registered at the nominal rate when the consumer was taking his nominal load, but at a higher rate with a larger load and at a lower rate with a smaller load. The standing charges might be taken as proportional to the demand. The revolutions per unit should therefore follow a linear law with the load instead of being constant; the constant part would represent the running charges and the remainder the standing charges, profit being included in one or both. With many types of meter there would be no difficulty in making the required adjustment; in fact, they had naturally a law something like it, and had to be compensated for ordinary use. The guaranteed sum, which should include meter charges, as should also the charge made for energy, should be that which would be brought in by the nominal load for the number of hours per year or per quarter, estimated when fixing the nominal rate of charging. That method would take some cognisance of diversity factor, for no account would be taken of occasional heavy loads, whose diversity factor would probably be high when determining the nominal load proper to any particular case. The correct nominal load should make the consumer's bill a minimum; the guaranteed sum would pre-

vent the consumer getting energy too cheaply if his load factor was less than he expected, while his energy would have to be paid for at a higher rate than necessary if he kept the guarantee too low. On the other hand, the consumer would not be deterred by increased annual charges from installing lamps in places where they would be little used, and whose diversity factor was generally very high; he would not have to instal an illogical and expensive double system of wiring if he wished power as well as light, and he would not be penalised for occasionally having all his lights on, beyond paying at a higher rate for the energy then actually used. The supply authority's load factor would probably be improved, for when the consumer understood that the more lamps he had on at a time the more he had to pay for each, and vice versa, the more likely would he be to keep his peak down and the less likely to economise when his load was light.

PHYSICAL SOCIETY.

At the meeting held at the Northampton Institute on March 27th, Dr. C. Chree, F.R.S., president, in the chair, Dr. C. V. Drysdale exhibited

"A Vacuum Tube Apparatus for Demonstrating the Propagation of Alternate Current Waves in Cables."

The propagation of alternate current waves in conductors has been frequently exhibited by the aid of a helix, notably by Prof. Fleming and Dr. G. Seibt, and the former has proposed the use of vacuum tubes to show the distribution of potential. The author had noticed that in a tube laid parallel to the helix the brightness was proportional to the slope of potential and hence to the current. The apparatus, therefore, consisted of a wooden stand which supported a helix about 6 ft. long, a vacuum tube just above it and a series of 18 vertical tubes below it. On feeding the helix from a high frequency resonance circuit nodes and loops of potential and current were simultaneously visible in the two sets of tubes, and these were approximately in quadrature with one another. Experiments were shown in which the frequency of the supply was varied, and the capacity of the helix was altered by introducing an earthed wire inside it. Resistance, capacity and inductance were also connected successively to the receiving end, and the effects were approximately in agreement with theory.

Mr. W. Duddell expressed his interest in the experiments, and asked why the points of zero potential were not more clearly marked. Was it due to absorption of energy by the tubes or to the superposition of oscillations with higher frequencies? Had the author used a single long tube with a strip of tinfoil on the outside? He also asked what gas the author used in the vertical tubes, and whether he had tried helium.

Dr. Drysdale, in reply, said that the tubes were filled with CO_2. It was somewhat difficult to ensure their equality, and no attempt had, therefore, been made to use rare gases. Doubtless still better results could be obtained, but the CO_2 tubes were sufficiently bright for most purposes. He believed that the energy taken by so many tubes was the cause of the absence of complete darkness at the nodes, as with a single tube sharper results had been obtained. For this reason the single tube with a strip of tinfoil on the side had not been used.

Dr. C. V. Drysdale read a Paper entitled

"Notes on the Plug Permeameter."

The author briefly described the instrument, in which a drill is employed to cut a conical hole in a casting or forging, at the same time leaving a pin $\frac{1}{10}$ in. diameter standing in the middle. A wrought iron plug carrying a bobbin with magnetising and search coils completes the magnetic circuit, forming a miniature permeameter. The readings are taken by means of an ammeter and ballistic galvanometer in the ordinary way, or by the aid of a portable direct-reading test set. When this instrument was first described it was found, as would be expected, that the values of the induction given by it were too low, and it had been supposed by some that this was due to imperfection in the magnetic joint. The author, on the other hand, had attributed it to end effects and to the shortness of the specimen. Investigations had been made confirming this view, and showing that the amount of this end effect could be fairly closely compensated by correcting the value of H in the same ratio for all specimens. These investigations had been carried out by obtaining some rings of cast and wrought iron and steel, testing them by the ring method, and afterwards cutting them into quadrants which were drilled and tested with the plug. Curves were given showing the results obtained by the plug permeameter when the instrument had been empirically calibrated from the foregoing tests. These showed that the instrument was accurate within 2 or 3 per cent., which was as satisfactory as most other permeameters.

Prof. S. P. Thompson said the author's instrument commended itself for its usefulness and ingenuity. He would like to know how far the results were comparable with those obtained from ring and double yoke methods. He was not sure that the author's explanation that the discrepancies were due to end effects was the correct one. In drilling the hole in the casting the magnetic properties of the iron were altered and the hysteresis increased?

Mr. A. Campbell remarked that from his experience of several varieties of permeameters he was not at all surprised to find that Dr. Drysdale had had to calibrate his permeameter by the purely experimental method of comparison with the trustworthy ring method. By averaging the different calibrations given by various types of material he appeared to be able to obtain fairly good results, but there were other permeameters which gave as satisfactory results without any empirical calibration.

Mr. A. Russell said he appreciated the ingenuity displayed in the Drysdale permeameter. He suggested the following as the probable cause of part of the discrepancy between the magnetisation curves got by the ring method and by the permeameter. In the former method the mean flux and the mean magnetising force over the cross-section of the ring were measured. The ring experimented on was of appreciable radial depth, so that the magnetic force on the inner circumference of the ring was about 50 per cent. greater than that on the outer circumference. The permeability of the iron at the greater force would probably be very different from that at the smaller force. The mean value, therefore, of the flux-density over the cross-sectional area of the ring might possibly be something quite different from the value it would have if the magnetic force were constant and equal to the mean magnetic force. The errors due to this cause in the ring method, even when the ring was narrow, were sometimes very appreciable. The criticism also applied to many cases in which electricians apply what they call the fundamental magnetic equation.

Mr. W. Duddell asked if it was assumed that all the pins had the same diameter.

Dr. C. V. Drysdale, in reply to Prof. Thompson, said that the end effect was not of the same nature as an air-gap or it would have had a more marked influence at high permeabilities. When the instrument was first introduced, a few tests had been made by drilling a specimen and testing it, and afterwards annealing and re-testing. No change had been observed, but possibly a greater number of tests would have shown variations. The size of the pin seemed not to vary by more than a mil whatever metal was drilled. As to Mr. Campbell's remarks, he quite agreed that other permeameters were equally or more accurate, but this was the only one that could be used on the actual forging or casting, and it was surprising and gratifying to find that it was as accurate as it seemed to be. The thickness of the ring mentioned by Mr. Russell was an important point. It was necessary in order to permit of drilling, but he was inclined to think that there would be litter error from this cause except at low inductions.

Dr. C. V. Drysdale read a Paper on

"The Use of Shunts and Transformers with Alternate-Current Measuring Instruments."

Owing to the limited range of most alternate-current instruments shunts and transformers have come into considerable use, but they are liable to cause errors both in the magnitude and phase of the current. The Paper deals with these errors mathematically and experimentally. In the case of shunts, the condition for accuracy at all frequencies is that the time constants of the instrument and shunt should be equal, but formulæ are given for the multiplying power and phase displacement in other cases. For current transformers the best results are obtained by keeping the magnetising and core-loss currents as small as possible. The best uniformity of ratio for different loads is obtained with a non-inductive or leading load; but the lowest phase displacement with a lagging load. P.D. transformers are much more satisfactory than current transformers, both for ratio and phase displacement. Experimental tests using a wattmeter as indicator approximately confirmed the theory.

Mr. A. Campbell expressed his interest in the thorough manner in which Dr. Drysdale had gone into the question of the use of transformers with measuring instruments. With regard to the author's criticism of his (Mr. Campbell's) work on the subject (which was carried out 12 years ago), he should like to mention several points. The main object of the first quoted Paper was to show that with air-core transformers the transformation ratio becomes more and more constant (for various frequencies) the higher we make the time-constant of the secondary circuit; thus, high inductance and low resistance are wanted. Mr. Campbell stated that in his Paper he also gave several experiments to show that iron ring transformers "may in many cases be used in a similar way," care being taken to have the resistance of the secondary circuit small enough. In a later paper he stated that to make the ratio sufficiently constant and independent of frequency we require relatively low resistance and high inductance in the secondary circuit. Dr. Drysdale showed that for the special case of constant frequency, relatively high inductance does not give the most constant ratio. His Mr. Campbell's experiments were not complete enough to settle this point and he was careful not to dogmatise on the matter. He was glad that Dr. Drysdale had elucidated it.

Mr. A. Russell expressed his interest in the Paper. He suggested that the author should take the mutual inductance between the shunt and the instrument into account. If L_1, R_1 be the constants of the instrument and L_2, R_2 those of the shunt, and if M be the mutual inductance between them, the multiplying factor for the reading will be the same whatever the frequency provided that $\frac{L_1 - M}{R_1} = \frac{L_2 - M}{R_2}$.

Mr. Kenelm Edgcumbe referred to the fact that the author recommended small core losses, and pointed out that he had seen it stated that in special cases it was possible to improve the ratio and phase errors by increasing the core losses.

Dr. Drysdale, in reply to Mr. Campbell, said his praise of the air-core transformer was justified, but in practice instrument makers were forced to use iron for commercial reasons. Similarly, the ring form of transformer was generally impossible, as in practice instrument transformers were used to insulate the observing instrument from high pressure mains, and considerable insulation between the windings was necessary. The reason why an iron-cored transformer behaved differently to one with an air core chiefly resided in the core-loss current which was not proportional to the magnetising current. The method of testing the transformers would be shown in operation in the laboratories.

A Paper on

"Dynamometer Wattmeters"

was read by Dr. C. V. Drysdale. The author gives a somewhat complete investigation of the theory of the wattmeter, including the effects of shunt inductance and capacity, mutual inductance, eddy currents, wave-form and of iron. It is pointed out that the theory of the wattmeter is much obscured by the use of the correction factor. On sine wave forms the true power $\omega = W \cos \phi$, while the reading of the wattmeter

$$\omega' = \frac{R}{I} W \cos(\phi - a) = W \cos a \cos(\phi - a),$$

where W is the apparent power, R and I the resistance and inductance of the shunt respectively, and a the angle of lag in the shunt. This leads to the simple relation

$$\omega = \frac{\omega'}{1 + T^2 p^2} - TpW \sin \phi,$$

where T is the time constant of the shunt and $p = 2\pi \times$ frequency. In practice T^2p^2 can be neglected in comparison with unity and hence $d\omega = \omega' - \omega = TpW \sin \phi$, which is perfectly determinate at all power factors. This shows that the correction of a wattmeter should always be applied as a difference and not as a ratio. It is practically as absurd to apply a correction factor to a wattmeter as to an instrument with a zero displacement. The Paper also contains a description of some single and double forms of standard wattmeter and of deflectional wattmeters containing iron. Also of the method of testing wattmeters for various errors and of a phase-shifting transformer for facilitating these tests. Various forms of wattmeters and phase-shifters were shown in operation.

Mr. W. Duddell expressed his interest in the Paper, referring especially to the author's remarks upon the application of a correction factor. In some ways he thought a correction factor was preferable to the addition of a zero correction. He was interested in the wattmeters exhibited, which resembled in many features an instrument he had designed some years ago.

Mr. Rayner, referring to the accuracy of the instruments, asked if Hooke's law held to 1 part in 500 over a whole turn of the torsion head.

Mr. Tinsley remarked that the instrument shown resembled those of Mr. Duddell in the mechanical details because the design adopted was the only practical one.

Dr. Drysdale, in reply, said he still maintained that the only rational way of correcting wattmeter readings was by adding a correcting term instead of applying a correction factor. Mr. Beattie's device was unnecessary and of little use, as the inductive coil would not give any indication of the error due to capacity in the shunt, which might be considerable. He had not troubled about astaticism in his instruments, as they were for use as standards, and it was easy to eliminate the effect of stray fields. He was surprised and gratified to find that Mr. Duddell recognised the strong resemblance between the wattmeter described in the Paper and his own. The author's first Paper on the subject appeared in *The Electrician* in March, 1901, and was available to anyone interested in the matter.

TORSION METERS AS APPLIED TO THE MEASUREMENT OF THE HORSE-POWER OF MARINE STEAM TURBINES.*

BY J. H. GIBSON.

The rapidly growing adoption of steam turbines for ship propulsion has created a demand for some means of ascertaining their horse-power, and as the ordinary indicators are not suitable for this purpose, some form of torsion meter is necessary. It is possible to obtain a measure of the power from the amount of water passed by the feed pumps, but, in ship propulsion, "revolutions" are the criterion, and this method would be very unsatisfactory. It is, therefore, very necessary that the power which is being transmitted to the shaft under varying conditions should be known; this power is called "shaft-horse-power," in contradistinction to "indicated-horse-power."

A small propeller working deeply immersed in smooth water is a fairly uniform brake, and the turning moment of a steam turbine is also very even. If, therefore the revolutions are known and the torque can be obtained, all the data required for calculating the work done are given. In the case of a reciprocating engine, however, there is a point of maximum and minimum torque, the latter being often negative—*i.e.*, the propeller exerts a flywheel effect on the engine. It, therefore, becomes necessary to find the torque at several points in a revolution, the mean of the readings being taken in calculating the horse-power.

Before using any torsion meter on a shaft, the latter's modulus of rigidity must be determined. This is done by applying a given static load at the end of a lever of known length, the shaft being meanwhile kept "alive" by jarring with a mallet. The power diagrams may then be built up from the formula $H = \theta D^4 N C L$, where H is the shaft-horse-power, θ the torque expressed as degrees, D the diameter of the shaft in inches, C a constant depending on the modulus of rigidity, and L the length of the shaft in inches. All the data except θ can be determined in advance, and θ is obtained by some form of torsion meter.

Among the better known forms of purely mechanical meter are those due to Fottinger & Collie, which consist essentially of connecting two points some distance apart on the shaft to discs, or a screw arrangement. The amount of torque is then given by the difference in twist between the two points on the shaft, and this can be measured by the relative movement of the discs circumferentially or the screwed shaft longitudinally.

The best known electrical torsion meter is the Denny-Johnson. This is made up of two armatures revolving with the shaft, and placed as far apart as possible. Each armature carries a small pointed magnet, which moves over a finely wound coil. The two coils are connected in series through a Wheatstone bridge arrangement to a telephone receiver. When the shaft twists the armature get out of step, and a clicking sound is heard in the receiver. The resistances are then adjusted until no sound is obtained, and the amount of resistance necessary for this purpose is a measure of the angle of twist.

Gardner has based his electrical torsion meter upon the varying current flowing through a wire connected to an ammeter. At two distant points on a shaft notched discs are placed and the notches filled with insulating material. A brush, whose width is equal to that of the notch, presses lightly on each disc. When there is no torque one brush is in contact on one disc, and the other just out of contact on the other disc. The circuit is, therefore, broken, and the ammeter reading is zero. When there is a twist on the shaft the relative positions of brushes and discs are altered and current passes through the ammeter, its amount depending on the relative displacement.

All the above methods, however, labour under the disadvantage that an exceedingly small error may lead to a comparatively large inaccuracy in the net result. Other meters which depend on the action of a beam of light are not so handicapped, and a description of an apparatus evolved independently by Frahm and Hopkinson is given in the Paper.

Starting with a similar arrangement to that used in Fottinger's apparatus, a small plane mirror is pivoted to the edge of one disc and oscillated by a projection on the other disc. As the relative movement between the discs increases, so is the plane of the mirror altered. A beam of light from a fixed lamp is projected on to the edge of the discs, and at each revolution of the shaft it is caught on the mirror and reflected on to a graduated scale. In a dark chamber, such as a shaft tunnel, the pencil of light is almost continuous, and the deflection can be easily read off, though the spreading of the light affects the accuracy.

Another arrangement due to Amsler consists in fixing a concentric sleeve on the shaft and bringing its free end up to a fixed collar. A short scale is engraved on the collar, and a pointer or vernier is fixed on the free end of the sleeve. As the shaft twists, the pointer moves along the scale, and by means of an electric spark, which throws a light on the scale once per revolution, the torque can be read off directly in degrees.

A method invented by Bevis Gibson is also founded on optical principles. It consists essentially of two blank discs mounted on the shaft some distance apart. These discs are pierced by radial slots, and when there is no torque the slots are in line. Behind one slot is placed a shaded electric lamp, and behind the other is a "torque finder," an instrument fitted with an eye-piece and capable of circumferential adjustment. When no power is being transmitted, the lamp, two slots and torque finder are in line, and a flash can be seen through the last revolution. When, however, power is being transmitted, one disc lags behind the other and the movement which it is necessary to give the torque finder to again pick up the lamp is a measure of the power. By modifying the apparatus slightly it may be applied to reciprocating engines, and from the readings very accurate torque diagrams may be built up.

The Paper concludes with the results of a steaming trial carried out with this meter.

* Abstract of a Paper read before the North-East Coast Institution of Engineers and Shipbuilders.

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With the number of "THE ELECTRICIAN" for Sept. 14, 1906, was issued the first of a series of "Industrial Supplements," to be published from time to time with "THE ELECTRICIAN." The twenty-first issue of the Supplement was issued (Gratis) with "THE ELECTRICIAN." for April 3.

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THE METALLIC FILAMENT LAMP AND ELECTRICITY SUPPLY.

The Paper read by Messrs. H. W. HANDCOCK and A. H. DYKES before the Institution of Electrical Engineers last week raised many important points in connection with the supply of electrical energy, as influenced by metallic filament lamps, and the discussion which took place after the reading of the Paper was of more than usual interest. We regret to note, however, that there was a slight tendency to regard the position in a spirit of panic, and Mr. ARTHUR WRIGHT went so far as to suggest that consumers should not be permitted to reduce their consumption by taking advantage of more economical lamps, but that they should only be permitted to have more light for the same current. We merely trust that, whatever else may be done no suggestion of this sort will be followed. Restrictions of any kind on the free development of electric lighting, equally

from the consumers' and from the suppliers' points of view, would be most short-sighted. Any such restrictions would certainly only be temporary, because they would be met by much opposition and they could not fail to do harm.

Lighting-consumers, from one point of view, may be divided into two broad classes—namely, (1) those who desire more light for the same money, and (2) those who desire the same light for less money. No doubt there are many consumers belonging to the first class who do not object to paying as much as they do at present for their light, but who would like something more for it. On the other hand, there are consumers, more particularly private-house consumers, who are stimulated by the desire for economy, more particularly during the present time when there is a good deal of depression. Such consumers will undoubtedly economise if they have the opportunity.

In considering these classes of consumer it is well to bear in mind that the position differs essentially according to whether the supply is continuous or alternating. Continuous-current networks are practically all supplying at 200 volts and upwards. In such cases it is necessary to deal with the metallic filament lamp for 200 volts, or with two lower pressure lamps in series. If 8 c.p. lamps are displaced in favour of such metallic filament lamps the consumption is increased, and the cost of lamps becomes more expensive; or if 16 c.p. lamps are similarly displaced there is not very much difference in the consumption, assuming, of course, that a single metallic filament lamp does not take the place of two or more carbon lamps. Generally speaking, therefore, on continuous-current systems the supply station is not likely to suffer much from a reduction of current. The consumer will sometimes gain by a slight economy, but, generally speaking, the gain would be in light. This statement, of course, involves an assumption that the present state of things will continue. It is always dangerous to prophesy, but certainly at the present time a strong and highly efficient 8 c.p. metallic filament lamp for high pressures does not appear probable. If such a lamp were to come, our views would necessarily have to be modified.

The Electrician Tables of Electric Lighting at once show a great preponderance of continuous-current supply over alternating current supply, but there are nevertheless a great many alternating-current systems which would be affected by the new lamps, and here the position is more difficult from the supply point of view, and better from the consumers' standpoint. Transformation is easy on such systems, and will, no doubt, be adopted by consumers who wish to economise. Even transformation down to 100 volts is beneficial, and if so low a pressure as 25 volts is adopted the results are still better, because the lamps are not only cheaper, but stronger and more efficient. For private-house lighting such a method gives all that is desired. For general use, however, it may be felt that there is a disadvantage in being limited to the smaller candle-powers at present available at 25 volts. Lamps of greater candle-power than 16 are often desired, and, therefore, it is not unlikely that a pressure of, say, 50 volts may come into favour with further developments, so as to permit of greater elasticity in the lighting. In any case transformation allows a very substantial saving on the part of the consumer. Every carbon lamp can thus be replaced by a metallic filament lamp of much the same candle-power; the efficiency is extremely high, and the only disadvantage is that the lamps are more expensive.

Undoubtedly there will be some loss by this innovation to stations supplying alternating current, but it must not be forgotten that all consumers are not essentially economical, and that fresh fields are opening to the central station engineer. Apart from street lighting, the possibilities of which are at once greatly extended by the advent of the metallic filament lamp, the field of the small shopkeeper alone is enormous. Small shops must necessarily be run economically, and so far they have largely patronised gas; but transformation on alternate-current networks, and the use of low voltage metallic filament lamps, brings them within reach of electric lighting on a competitive basis, and, since the hours of business are frequently long, this class of consumer will form a most desirable acquisition for the central station engineer.

REVIEWS.

Copies of the undermentioned works can be had from *The Electrician* Office, post free, on receipt of published price. Add 5 per cent. for abroad or for foreign books.)

Electric Wiring and Fitting for Plumbers and Gasfitters. By S. F. WALKER. (London: Scott, Greenwood & Son.) 5s. net.

The author believes that skilled plumbers and gasfitters with a little knowledge of electricity will do more trustworthy wiring than the average wireman, and this book has been written, in the words of the author, by a practical man for practical men, to provide such plumbers and gasfitters with the necessary information. We can only say that we would not care to trust such men, even full of such book knowledge, to carry out any important work in which we were interested. The book consists of five chapters. In the first of these the author attempts his customary explanation of electrical terms and units, perhaps with sufficient accuracy for his intended readers. We notice, however, that the ampere is compared with cubic feet of gas, and the watt to the foot-pound, though he afterwards gives the correct value of the latter as 44·2 ft.-lb. per minute. He mentions that the 6 ampere enclosed arc lamp gives the same amount of light as the 10 ampere open type, giving an altogether misleading idea regarding the efficiencies of the two types. "A table of currents that different sized wires will accommodate" is given, stated to be based upon the Institution of Electrical Engineers' rules, though the currents are worked out for both small and large wires at 1,000 amperes per square inch. It is also interesting to observe that the author tells his readers that the Institution rule forbidding the use of a smaller conductor than the equivalent of a No. 18 gauge wire is unnecessary if reasonable care is taken. His explanation of kilowatt-hours will scarcely prove of advantage, since it reads: "The number of kilowatt-hours is the number of kilowatts expended in one hour, or the equivalent. Two kilowatts expended in half an hour equal one kilowatt-hour, and twenty kilowatts expended in twenty hours equals twenty kilowatt-hours." Areas expressed as 0·1 in. and 0·5 in. are doubtless printers' errors.

Wiring systems are then described, the author evidently regarding expense as of secondary consequence, since he does not favour the looping-in system, but prefers that each lamp should have its own pair of wires from the distribution board. This, of course, would enable his intended readers to carry out the work with less difficulty. In pointing out the advantages of increased pressures in allowing distribution over greater distances, the author says the distance depends on the square of the pressure, thus doubling the pressure quadruples the area, an obvious confusion of length and area. Chapters II. and III. deal with the insulation of wires, fixing wires, jointing, &c., and cannot be considered at all satisfactory. Chapters IV. and V. give many

illustrations and brief remarks concerning lamps and fittings. Wiring diagrams are conspicuous by their absence, but on p. 150 a diagram is given showing the connections between the public supply mains and the house wiring; in this the consumer's main fuses are shown between the main switch and the undertaker's fuses, so that it is impossible to make the terminals dead whilst replacing a fuse. This is the more remarkable as throughout the book the author has emphasised the dangers of alternating current at 200 volts (this he proves is as deadly as continuous current at 560; thus, $200 \times 1{\cdot}44 \times (2)$).

Minute details are given for testing the insulating properties of the enamel on steel tubing, by connecting wires from the supply mains and wrapping them round the tube, a switch and fuse of course being inserted. This, obviously, is a very risky test to place in the hands of those who have presumably little electrical knowledge, and would be liable to lead to much tampering with the supply authority's fuse boxes.

Mueller-Pouillet's Lehrbuch der Physik und Meteorologie. By L. Pfaundler. 10th edition. Vol. II., Part 1. (Brunswick: F. Vieweg & Sohn.) Pp. xxii.-880. M. 15.

The 10th edition of this old and trusty guide is quite in keeping with its predecessors as far as range and finish are concerned. It caters, as before, for those to whom optics is a side issue, but who wish to remain generally acquainted with its experimental advances. The present book includes geometrical optics, spectrum analysis, interference, double refraction and polarisation; while total and metallic reflection, crystalline optics and electromagnetic theory are reserved for Part 2. Among its commendable features may be mentioned the increased substitution of waves for rays, the descriptions of new instruments like the stereocomparator, the echelon spectroscope and the ultra-microscope, and the very up-to-date treatment of radiation pressure, spectrum series and interferometer work. As regards spectroscopy, it is a pity that the date of publication precluded a mention of the fourth series of alkaline spectra recently discovered. The bolometer is described in detail, and Boys' radio-micrometer is just mentioned. The use of an elastic radiometer for radiation measurements might have been dealt with more fully, especially since it has been successfully applied to the measurement of radiation pressure. The spectrum distribution of radiant heat is dealt with in an exceptionally satisfactory manner, and the historical summary is provided with copious references, which are only sparingly used elsewhere in the book. Kirchhoff's ideal black body—a hollow space enclosed by opaque bodies at a uniform temperature—and Stefan and Boltzmann's radiation law, which makes the total radiation of a black body proportional to the fourth power of its absolute temperature, are two items in recent achievement which are here for the first time adequately embodied in a semi-popular physical treatise. But though some special subjects can be singled out in this manner, it must be acknowledged that the whole work bears the mark of careful revision and cannot fail to be of great value to all students of physics. E. E. F.

L'Année Electrique Electrothérapique et Radiographique. By Dr. Foveau de Courmelles. (Paris: Ch. Beranger.) Pp. 368. Fr. 3.50.

This book, which now makes its eighth appearance, is a sign that so-called medical electricity is in a flourishing condition. With a view, no doubt, to interesting its readers in other branches of the subject, chapters on Wireless Telegraphy and Electric Traction are also included. Under the heading "Applications Diverses de l'Electricité," we notice that M. Georges Knap's "electric" house at Troyes finds a place, while the use of electricity in horticulture also receives attention. The book should be of great use to "medical electricians," though an extension of the index would be a distinct advantage.

The Practical Electrician's Pocket-book and Diary for 1908 Edited by H. T. Crewe. (London: S. Rentell & Co.) Pp. lxxx. + 312. 1s. 6d. net.

A certain person having read steadily through a dictionary from cover to cover had only one complaint to make, namely, the frequent change of subject. We fear that anybody reading this pocket-book will be troubled in the same way, as the matters touched upon within a small space are very numerous, though as a book of reference, this, no doubt, adds to its value. Each section is treated by a specialist in the subject, and great use is made of catalogue illustrations. We have not so far "spotted" any misprints. The price of the book is 1s. net or 1s. 6d. net, and for the latter price, besides the better binding, the purchaser obtains an accident insurance policy for £25.

English Prices with French Equivalents. By H. P. McCartney. (London: E. & F. N. Spon.) Pp. 95. 1s. net.

This book simply consists of tables giving for various rates per lb., from $\frac{1}{16}$d. to 20s., the appropriate exchange values in francs gold per 100 kilos for six rates of exchange—viz., 25.0frs. 25.05frs., 25.10frs., 25.15frs., 25.20frs., 25.25frs., and 25.30frs. per English pound gold. The calculations have been worked out on the basis that the English ton is equal to 1016·4075 kilogrammes. The accuracy of the values given is often too great, the results at the lower rates being worked to four or five places of decimals. There is no coin in France of lower value than the centime or 0·01fr., therefore carrying the calculation much beyond two places of decimals is generally a needless refinement.

Annuaire pour l'An 1908 du Bureau des Longitudes. (Paris: Gauthier Villars. Pp. vi.—760 and Appendices. Fr. 1.50.

This volume, though primarily intended as a handbook for astronomers, also contains many tables relating to physics, chemistry and engineering. A feature of the book is its special articles, which this year include dissertations on astronomical subjects by MM. Bigourdau and Guyon.

TECHNICAL EDUCATION IN AMERICA.

At a meeting of the Royal Society of Arts, held on Wednesday, April 8th, Sir William Preece, K.C.B., F.R.S., read a Paper on this subject, in which he gave a general description of his visit last year to the Carnegie Institute in Pittsburg, drawing from it several interesting deductions as to the comparative state of technical education in America and in this country. The Paper was illustrated with numerous slides showing views of both the exterior and interior of the new building.

The formation of these schools is due to the munificence of Mr. Carnegie, who has from time to time subscribed sums amounting in all to £4,000,000. The Institute consists of the following departments: (1) Library, (2) Fine Arts, (3) Museum of National History, (4) School of Music and (5) School of Technology. The last is divided into (1) School of Applied Science, (2) School for Apprentices and Journeymen, (3) School of Applied Design, (4) School for Women. Their inception is due to a visit made by Mr. Carnegie to Keighley in Yorkshire, and it is gratifying that Great Britain has at least had some influence on the advance of technology in America.

There is no reason to lament the progress of technology at home. Contributions have not been so liberal as in America, but Government and municipal authorities have been by no means niggardly all over the country. The complaint is that the wealth of our fortunate citizens does not flow freely in the direction of educational endowments. Notwithstanding persistent, and sometimes undignified begging, our ancient universities themselves are sadly checked in modern progress by the want of funds and of patriotism in their *alumni*. It is extremely difficult, if not impossible, to obtain accurate statistics of the sums bequeathed and contributed to religion, charity, hospitals and education in the United Kingdom. In London alone it was over £10,000,000 in 1906, but of this only £123,778 was allocated to education. The total amount over the whole country must have exceeded £70,000,000, and of this probably only 1 per cent. was devoted to education! Distribution of wealth is much a matter of fashion, and for some unaccountable reason education is tabooed.

At Pittsburg the education provided is designed to meet local needs. The Institute is at present more a trade school than a college of technology, but will probably grow into a well co-ordinated system embracing all branches of preparation. In considering the most suitable kind of education all questions of general education and sex must be brushed aside and the assumption must be made that only those who have a fair primary education are being dealt with. They must then be prepared to grasp the meaning of the facts and principles which lie at the root of the business in life that is going to enable them to earn a living and to make them experts. The people to be provided for are workmen, workwomen, apprentices and journeymen, assistants and helpers, foremen and supervisors, designers and draughtsmen, engineers and managers

and, above all, masters, for more depends on the qualifications of the master than on those of the staff.

In the new schools provision has been made for 4,000 students, while up to the spring of last year 1,374 had entered themselves. 610 of these attended the school of applied science and 80 that of applied design. 485 attended the school for apprentices and journeymen and 199 the school for women. The great library with its 50,000 volumes on technical subjects and all the galleries are open at all times to the students, and every facility is given for pursuing their studies in the arts and sciences. The class rooms are purposely small, so as to bring teacher and student into such close contact as to insure easy and effective instruction. Technical education is more the result of self-acquisition than of professional impartation, and the true secret of success is to place within easy access of the student every possible means for enabling him to acquire facts for himself. It is for this reason so important that he should be instructed by the very tools and processes he uses in his own work, and that technical schools should be fitted up with actual machines in use and not with mere models. It is for this reason, also, that the instructors should be practical men, and that in all engineering colleges they should keep in touch with practice. The academical professor, who has lived a secluded life in some university town, is, in the language of our American friends, the worst teacher on earth. His knowledge of life is limited, but his value of his own qualifications is excessive. The knowledge he has imparted has often to be unlearned. On the other hand, the university trained teacher who has had practical training in the world makes an ideal professor.

The system of apprenticeship in the United States, as in the United Kingdom, is now virtually a function of the past, and one of the chief endeavours of the primary technical schools is to replace apprenticeship by technical training. Another important object is to make the various industries less dependent on imported skilled labour. It is remarkable that in 1902 a careful inquiry showed that in New York the percentage of skilled foreign labour was 70 per cent, in Chicago 60 per cent. and in Brooklyn 75 per cent. The type of student in Pittsburg is quite equal to that of our provincial universities, and nothing was more surprising than the character of the apprentice and journeyman who study and practice with all that wonderful energy that is such a marked feature in American life. This imbibed energy is not a question of race, but one of climate, for it affects all those who go there, whatever their nationality.

Turning to the question of State control of education, each State deals with its own domain, and politics do not enter into the matter. A course of action, more or less intuitive, has been prescribed, and all are working together towards a final goal of culture and skill. Even in the older Universities the study of the arts is decreasing in popularity, while the practical and utilitarian faculties are increasing with giant strides. Numerous scholarships are provided, for the majority of students are not of the well-to do class. The professors are not so well paid as in this country, though the recent institution by Mr. Carnegie of a pension fund has lately made their position more secure.

It is difficult, if not impossible, to make any just comparison between the methods of technical education in America and in this country. The conditions are totally different. While we are hampered by the traditions of the past and swayed by the precedents of our grandfathers, they have all the advantages of a new race, and enjoy a corresponding freedom of action. Teachers and pupils are affected alike by these conditions. Many of the former are imported from abroad, and the reverse process would doubtless have a salutary effect.

It is in the behaviour of the employers that even a greater characteristic is evident. In America they assist the acquisition of scientific attainments in their employés. There is no premium system, and only those who can submit diplomas are accepted. They encourage research and help to equip laboratories, thus accounting for the lavish display of apparatus met with in these institutions.

The lecturer then discussed the help that had been given by the State to the cause of education by means of grants of land and money. Education is recognised as the greatest national asset; every citizen regards it as his duty to contribute to its promotion.

In conclusion, a consideration of American practice shows some serious defects in our general education. (1) Children are removed too early from school. The limit here is 11 years, while in France and America it is 13, and in Switzerland 14. (2) Science as a brain trainer is not encouraged enough, and no effort is made to introduce it in our primary schools. (3) There are too many academic traditions at home. Our ancient seats of learning want to be thoroughly shaken up, and a new race of teachers introduced. Exclusive cliqueism has had its day. (4) Our technical schools are not sufficiently supported by our employers, and trained graduates are not welcomed in our works. (5) We want the fourth year for technical training and for specialisation. At the end of the third year the student should know something of everything, but in his fourth he should learn everything of something that is essential to his life work. (6) The premium system is very restrictive.

INCONSISTENCIES IN THE PRESENT INTERNATIONAL TERMINOLOGY RELATING TO ILLUMINATION.*

BY DR. B. MONASCH.

Investigations, having for their object the selection of an international unit of candle-power, date back as far as the first electrical congress at Paris in 1881. These efforts were followed by the work of the International Conference for the consideration of electrical quantities in Paris in 1882, 1884 and 1889. The International Electric Congress of Chicago of 1893, and the similar Congress at Geneva in 1896, and, finally, the formation of the International Photometrical Commission in Paris in the year 1900, also failed to bring about general agreement as regards the desired standard. The Hefner lamp of Germany, the Carcel lamp of France, and the English candle refused to be displaced.

Eventually the International Photometrical Commission of 1903, meeting for the second time at Zurich, realising that an international unit of light was for the moment impracticable, decided to endeavour to establish the connection between the standards at present in use. Investigations in this direction were subsequently undertaken by the National Physical Laboratory in England, the Reichsanstalt in Germany, and the Laboratoire d'Essais du Conservatoire des Arts et Métiers and the Laboratoire Central d'Electricité in France. The result of these investigations formed the subject of a report by the International Photometrical Commission in 1907, and the figures given by the Commission must now be regarded as the officially recognised relations existing between the present standards of light.

The Congress of 1896 had recommended the international adoption of the word "lux" to denote the unit of intensity of illumination, and this word was previously suggested by Preece at the congress of 1889. But in the official communication of 1897 we find the word "Meterkerze" (candle-metre) put forward as an alternative and apparently synonymous term for 1 lux.

The word "lux" has found its way into general acceptance with unusual celerity, and appears in almost all the works which have been published in France and Germany since the year 1900. It has the merit of containing neither a unit of light nor a unit of length. A word used to denote a unit is preferably a name pure and simple rather than an attempt at definition. For instance, we call the unit of force a "dyne" and not a "gramme-centimetre (second)^2," or, more strictly, a "gramme-centimetre (second)$^{-2}$."

On the other hand, the word "Meterkerze" (candle-metre) is undesirable on several grounds, and it is becoming obsolete among those who are concerned with accurate methods of terminology. For one thing, the term really denotes the intensity of illumination, measured in terms of the old German "Vereinskerze" = 1·2 H.K. Consequently, the older determinations of photometrical values ought by rights to be multiplied by 1·2 when expressed in lux. Yet we often find them quoted unaltered. For instance, the oculist Cohn, in 1885, specified the smallest illumination necessary in order to read with comfort as 10 "Meterkerzen," and the highest permissible value as about 50 "Meterkerzen." Yet to-day one almost invariably finds these values quoted not as 12 and 60, but as 10 and 50 lux respectively. The circumstance that the official unit of candle-power in Germany has been changed since 1897 is frequently ignored, and therefore, when one finds the older works quoted, one is always uncertain whether we are presented with actual values or whether they are merely quoted historically.

Therefore, the author contends, it is time that the word "Meterkerze" was struck out of the list of officially recognised quantities and replaced by "lux."

The confusion becomes worse confounded when we turn to the various terms and standards in use among different nations. We have already existing in—Germany, the Hefner lamp; in England, the Pentane lamp; in France, the Carcel lamp; while in the United States of America glow lamps, standardised by the Bureau of Standards, are also in use.

Corresponding to these standards we have the following units:—In Germany, the "Hefnerkerze"; in England, the candle; in France, the "Carcel" and the "bougie."

Even more various are the existing terms used to denote the unit of intensity of illumination, for here the different nations have often preferred to form an attempt at definition, instead of acquiescing in the word lux. Hence we find many compound words in existence in which the units of light and length in use in the different countries find expression. This is rendered worse still by the fact that in some countries the metric and other systems exist simultaneously.

Thus we find in use: (1) candle-foot, England, U.S.A.; (2) candle-meter, Am. Inst. of Elec. Eng.; (3) Carcel-metre, France; (4) bougie-metre, France; (5) Hefner-foot, U.S.A.; (6) Hefner-meter, U.S.A.; (7) lux, Germany, France, U.S.A.; (8) Meterkerze, Germany (replaceable by lux).

* Abstracted from the *Journal für Gasbeleuchtung*, &c.

These compound words are the result of applying national taste to the nomenclature of illumination; naturally those nations which became civilised first and so had greatest need for light were also the first to create such terms. It is possible, however, that as other nationalities become accustomed to the study of illumination, the eight terms specified above may be considerably added to.

Another difficulty occurs when it is proposed to form the plural of such terms as these. We find, for instance, that the English term foot-candle becomes, when used by competent authorities, both "candle-feet" and "foot-candles." Clayton Sharp* has already demonstrated that these compound words are essentially unscientific. "Candle-foot," for instance, does not actually mean "1 candle multiplied by 1 ft.," not even "1 candle divided by 1 ft.," but "1 candle divided by (1 ft.)^2."

Moreover, this multiplication of units is clearly unsatisfactory because it leads to confusion. As it is, one cannot help becoming sensible how little meaning is really attached to many photometrical terms really when applied to describe conditions existing in practice. The different types of lamps in use are rapidly increasing. We have now different types of arc lamps, lamps with upright and inclined carbons, lamps with long and short arc length, upright and inverted gas lamps, glow lamps with very varied forms of filaments, &c., and the polar curve of distribution of all these sources can be altered still further by the use of modern shades and reflectors. Hence a mere knowledge of the mean spherical candle-power of a source no longer suffices. Then, again, there are the tube lamps, such as the Moore and mercury vapour lamps, to which the photometrical laws depending upon the theoretical "point source" are of doubtful application.

"Illumination" is a conception which is not easily expressed with accuracy. From childhood we learn to recognise how great is a length of 1 metre, and to express other lengths in terms of this unit. But we cannot readily form a similarly precise idea of the magnitude of an illumination; cannot, for instance, tell by looking at it whether the illumination of a given surface is 1,000 or 1,500 lux. Yet we do learn to create certain reference points in our scale of illumination. We recollect that the strength of bright moonshine is about 0·1 to 0·16 lux, that about 12 lux is a sufficient illumination to read by, and that an illumination up to 50 lux does not unduly fatigue the eye.

By this means when we read about an illumination of so many lux we are enabled to form a mental picture of the illumination referred to. But when the value is expressed in unfamiliar units we are at once in difficulties. Thus, the German engineer, accustomed to think in lux, is perplexed when the illumination due to bright moonshine of 0·1 to 0·16 lux becomes, according to the American method of expression, of 0·015 c.p. to 0·03 c.p. Even so, one might get accustomed to the existence of two units, but, unfortunately, the matter does not rest there. One often finds in one and the same number of a periodical candle-feet, candle-metres, Hefner-feet and lux.

Yet the physiological sensation is always the same, however it be expressed. When we read of a certain value of intensity of illumination we are only anxious to form an impression as to the physiological impression specified, and it does not interest us in the least to discover the particular method chosen by the author in order to convey this impression.

In order that the variety in the possible numbers used to convey the same impression may be adequately realised, the following table has been worked out:—

Results expressed in	Factor for conversion into desired unit.					
	1. Lux.	2. Hefner-foot.	3 Candle foot.	4. Candle metre.	5. Carcel-metre.	6. Bougie-metre.
1. Lux (Hefner metre)	1	0·0929	0·0848	0·9132	0·093	0·8849
2. Hefner foot	10·76	1	0·9132	9·84	1·001	9 52
3 Candle foot	11·78	1 095	1	10·76	1 097	10·43
4. Candle metre	1·095	0·1016	0·0929	1	0·1018	0·969
5 Carcel metre	10 75	0·9986	0 9115	9·817	1	9·513
6 Bougie metre	1·13	0·105	0·0958	1·031	0·1051	1

Finally, to all these variations we must add the uncertainties which may easily arise from a mistaken conception as to the magnitude of the light units themselves. According to the findings of the latest International Photometrical Commission the ratio of the German to the English candle is 0·915. Yet this number was until recently accepted as 0·88, though Hyde had found it to be 0·893. In the figures given by the Commission it is assumed that the English candle is the tenth part of the light yielded by the 10 c.p. pentane standard, as has been customary in England since 1898.

Paterson has also found that the candle specified by the decisions of the Commission differs by 5 per cent. from the old spermaceti British candle; the latter, in fact, has become 5 per cent. smaller if expressed in terms of the 10 c.p. standard pentane lamp. Thus

* The [illegible] New York, 1907, pp. [illegible]

two distinct values of the British candle, and, consequently, also for the candle-foot, are liable to be introduced.

In conclusion, the author claims to have shown how desirable it is that one definite unit of intensity of illumination, denoted by a term containing neither the unit of length nor a unit of light as a component, should receive international recognition, and favours the universal adoption of the word "lux" for this purpose. Different nations would then be at liberty to utilise the units which they individually preferred in measurement and calculation, but the ultimate results should be converted into lux by multiplication by a suitable factor. In Germany the word "Meterkerze" (or candle-metre) ought now to be deleted from the list of photometrical quantities and replaced by the word "lux."

THE CARRIERS OF POSITIVE ELECTRICITY.

In introducing his discourse on the "Carriers of Positive Electricity," delivered at the Royal Institution on Friday evening, April 10th, Prof. J. J. Thomson, F.R.S., first referred to the carriers of the negative charges. These charges were made up, like matter, of great numbers of small charges; the isolated individual lived, as a rule, in the atom, but could be driven out of it, and then moved about with a velocity which might almost equal that of light. The atom, deprived of its negative corpuscle, was left positively charged; its mass hardly suffered by this loss. Such positive particles were sent out from tubular anodes when they contained salts of sodium, lithium, &c., and the masses of these particles were of atomic values, that is to say, the weights of the particles of different salts were proportional to the atomic weights of the metals (Gehrcke). In this case, however, we did not know whether we were studying the individual, the hermit without his cell, or the hermit in his cell.

Simpler conditions were given by the arrangement originally used by Goldstein in his discovery of the canal (or positive) rays. A vertical tube charged with neon at very low pressure was fitted with a perforated cap kathode; the lower part of the tube shone with the beautiful ruddy light of the rays passing through the perforations, while the upper portions of the tube phosphoresced in green light. More convenient still for study was the arrangement shown by Prof. Thomson in his series of lectures a year ago, in which a narrow beam of rays passed through a fine tube. The beam was exposed to the influence of two metallic electrodes kept at different potentials, and also to the action of a strong magnetic field, and fell finally on the flat wall of the glass vessel, coated on the inside with willemite.* When the fields were united, the bright spot produced by the beam was drawn out into bands, and we could, with fields of sufficient intensity, finally separate the bands into two patches. The carriers of the positive charge in these two patches had, respectively, the mass of the atom and the molecule of hydrogen, no matter what gas we were working in. This remarkable fact was concluded from the velocities of the particles, calculated from their deflections. J. Stark, of Hanover, had determined the velocities on the Doppler principle,† and his researches promised most important consequences as to the nature of the spectra. According to Doppler, a sound would appear to increase in pitch and a light ray in colour (being shifted towards the violet) when the source of sound or light approached us in the line of sight. By Doppler's principle, Huggins had found, some 45 years ago, that Sirius moved at that time towards us at the rate of 40 miles per second. Now those positive particles travelled at 600 miles per second, and using only an ordinary spectroscope, Stark could see the hydrogen lines changed into bands some distance from their original position; one of Stark's photographs was reproduced.

The different colours of the positive and negative streams of particles was very marked when we experimented in helium. An experiment by Goldstein showed this strikingly. A spherical bulb was provided with a lateral tube, through which the kathode wire was passed. This wire ended in the centre of the bulb in a small equilateral triangle, about 1·5 cm. on each side. There were really two such triangular pieces of aluminium, about 2 mm. apart and held together by a few aluminium pins; both the triangles were in a vertical plane through the centre of the bulb. From the points of the triangles—and thus at 120 deg. from one another—issued three positive red rays; from the middle of the sides, again at 120 deg., three blue negative rays, thus forming a regular star alternating of red and blue rays; only the latter were deflected by a magnet.

Going back to the tube of last year, just referred to, Prof. Thomson then demonstrated that the positive particles were somewhat violent and peculiar in their behaviour. When the poles of the tube were reversed, a few positive particles still, against expectation, found their way through the narrow passage to the willemite screen. He first thought that there might be a sort of explosive effect, apart from the electric field, and some experiments seemed to support

* Compare Figs. 4 and 5, p. 1,017, of The Electrician of April 12, 1907.

† Christian Doppler, of Prague, [illegible], 1842.

this assumption. Placing a wire gauze close behind the kathode perforated by a hole), and joining the gauze to the anode, he found that many positive particles were stopped, but a few got through, apparently at unimpaired speed. In the actual demonstration he gave to the kathode of a cylindrical glass tube the shape of a wedge disc, perforated by a hole, and placed the gauze parallel to the sloping face of the wedge. But a further study convinced him that the explanation was different. The original positive particle struck the kathode, became thereby negatively electrified, and was then repelled from the kathode at high velocity, thus appearing where it ought not to be.

As regards the fact that the mass of the positive particle always seemed to be that of hydrogen, either of the hydrogen atom or of the hydrogen molecule, we had to remember that it was almost impossible to get rid of hydrogen in bulbs, and he had, therefore, in the last few weeks attempted to investigate his point in another way. He had tried to ascertain the number of positive particles in discharges through hydrogen and in discharges through air and other gases. The argument was explained by reference to golf. Supposing a player had some light and some heavy balls; as long as the wind was not blowing, he could send them all over to the green. But as the wind increased, the balls were deflected and separated, and finally the light ones would no longer reach the green. In the experimental apparatus the electric field gave the energy of the blow; the magnetic field corresponded to the powerful wind. The electric field was not strong, but the arrangement was such that particles passing through the perforations of the one electrode could be exposed to a second stronger field, and then entered through a fine hole in a disc of soft iron under intense magnetisation into a box, where they would strike either a central plate connected to one electroscope, or, if more strongly deflected, another lateral electroscope plate. The charges on the different particles could thus be measured quantitatively. The magnetic field intensity was raised in four steps. The experiments were first carried out in air; the vessel was then exhausted and flushed with hydrogen. The following results were obtained in two series with potentials of 450 and 230 volts respectively.

Magnetic field: Potential 450 volts.	Charge on particles in	
	Air.	Hydrogen.
1	5	7
2	8	12
3	36	40
4	47	47
Potential 230 volts.		
1	3	12
2	28	30
3	63	60
4	66	68

We recognised that, as long as the magnetic fields were not strong, the charges on the particles were small. As field 3 was put on, the charge jumped from 8 up to 36 and then to 47. But the charges of the particles were the same for air and for hydrogen, in both series, especially when the magnetic intensity was high. The experiments had so far only been made with the two gases, air and hydrogen. Lilienfeld had last year described positive carriers of very small mass, resembling the negative particles in that respect. But Prof. Thomson found no indication of these light carriers of positive charges, and Lilienfeld's observations might perhaps be interpreted in a different way.

Mr. E. Everett conducted the experiments.

CORRESPONDENCE.

THE COMMUTATION PROBLEM.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: Dr. Goldschmidt in his reply in your last issue (p. 960) has not given any answer to my challenge put forth in *The Electrician*, March 20th, p. 884. The obvious conclusion is that Dr. Goldschmidt abandons his original Fig. 1, p. 720, and admits that my Fig. 2 on the same page is substantially correct.

This being settled, I will not follow Dr. Goldschmidt's evasive manner, but I will give a plain answer to his clear question. In relation to this, I beg to observe that Dr. Goldschmidt seems to make his "facts" to suit his arguments. For in his original Paper (*The Electrician*, February 7th, p. 635) he said: "The commutation is not affected by the presence of the iron at the top of the slots if the bridges are not thicker than $\frac{1}{32}$ in. or $\frac{3}{64}$ in." On p. 800, however, he asserts that "an increase of the thickness to $\frac{3}{64}$ in. reduces the commutation limit about 20 per cent." Now, apart from the inconsistency and contradiction about the $\frac{3}{64}$ in., this sudden reduction of the commutation limit by 20 per cent. is remarkable, the more so because nothing of the kind was indicated in Dr. Goldschmidt's original article. Therefore, I think it is quite within the meaning of his article when I correct his assertion on p. 960 of your last issue in the sense that there is an unfavourable influence by the iron bridges, which, however, increases only very gradually with their thickness, as it is practically of no importance with a thickness of $\frac{3}{64}$ in.

In reply to Dr. Goldschmidt's question: "Does this agree with Mr. Menges' theory?" my answer is: *certainly!* For the iron bridges form a bypath for the main magnetic flux, a part of which is deviated by that bypath, and so reduce the number of useful lines in the armature core, see my Fig. 2, p. 720. Thereby the armature comes under the same unfavourable conditions as when the magnetic flux is too weak. We return to all the bad effects we had in former days, when the field magnets were too small.

Dr. Goldschmidt alters his explanation, in so far that he puts "the fringe lines" as the main cause. *These fringe lines were not indicated in his original* Fig. 1, p. 720, but are shown in my Fig. 2. If Dr. Goldschmidt will consider the action on the field by the electric currents of the field magnet and the armature slot conductors, he will see that these fringe lines are *increased* at the left side and *reduced* at the right side of my Fig. 2 by the armature currents. It is precisely for these reasons that the neutral zone (I mean the real neutral zone, of course) is displaced, thereby necessitating a displacement of the brushes. But Dr. Goldschmidt's explanation is founded upon his assumption that the fringe lines remain the same, with or without current in the armature. *I challenge Dr. Goldschmidt to prove this.* To induce Dr. Goldschmidt not to evade my challenge, I offer to pay all the costs of the experimental proof of his assumption if he succeeds in proving that it is right, the conditions of the experiment to be settled publicly by mutual agreement.—I am, &c.,

C. L. R. E. MENGES.

Villa Mar, Scheveningen, Holland, April 6.

NEW ALTERNATE CURRENT INSTRUMENTS.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: I must first thank Dr. Sumpner for his kindly reference to my Paper, and next acknowledge an oversight in my reference to Mr. Russell's communication to the *Jour.* Inst. Elec. Eng. I must confess that for myself it was the first analysis of the case in point that I had seen, hence my oversight of the footnote acknowledging Dr. Sumpner's work. I trust he will accept my apology.

With regard to Steinmetz and the method of analysis which has come to be associated with his name, I feel that I must stick to my point. While acknowledging that the method is quite old, yet under the circumstances it seems to me that we are quite just in giving to Steinmetz what credit there is. Dr. Sumpner tells us that he taught the method 20 years ago, and that Oliver Heaviside has used it freely, but it must be allowed that the method of analysis has been virtually discarded, or, at any rate, is unused in England while enjoying a wide popularity in the United States. Surely, under these conditions it is to the American stepfather of the method that credit is due. Of course, I am aware that the whole affair is more a matter for personal opinion than for controversy, but I have ventured to defend my attitude.—I am, &c.,

Putney, April 13. D. W. RENNIE.

THE MEASUREMENT OF RESISTANCE.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: Will you kindly allow me to reply as briefly as possible to Mr. Fisher's letter in to-day's *Electrician.* Mr. Fisher does not give a single figure to substantiate his statements. To reply in the same way would be useless, but, if he will enter the lists with figures or formulæ, I am quite ready to defend my cause to the extent of at least five, or possibly six, decimal places, without using a Crompton potentiometer or its later developments

I have no wish to continue the discussion of this matter except on these lines, but, before closing, should like to mention that I inadvertently quoted the accuracy obtained by Dr. Drysdale's apparatus as 1 in 20 millions, whereas I should have said 2 in a million; the error, however, does not affect the principle at stake.—I am, &c.,

Beckenham, April 10. HENRY TINSLEY.

THE L.C.C. TRAMWAY AUDIT.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: Seeing that you continue to avoid giving any direct answer to my question as to "what you consider is the goodwill value of tramways which make a large annual loss," I am content to leave the controversy between us as it now stands.—I am, &c.,

A. A. CAMPBELL SWINTON.

66, Victoria-street, S.W., April 13.

[In our opinion goodwill has a value quite independent of the plant and other material assets of a business, and its value, from the point of view of acquiring a business, is not affected by questions of profit and loss. The mere fact of selling an article at a loss does not affect the value of the goodwill, but reduces the value of the management. Otherwise, supposing goodwill to remain the same in extent, the mere addition of 10 per cent. to the selling price of an article to make it profitable would alter the value of the goodwill enormously, which would scarcely be logical. As to whether a business running at a loss is worth acquiring is another question, and necessarily depends upon circumstances, but that is no reason for saying that goodwill is ever a minus quantity; we do not agree that it is. As to the actual value in any particular case, this must, of course, depend upon the conditions. It is scarcely within our province to give numerical values, even if the other data were available.—ED. *E.*]

THE FUTURE OF THE TELEPHONE SERVICE.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: I have troubled you once or twice lately on this subject in order to point out that the measured rate principle of telephone tariff makes for the best development and the highest efficiency of the telephone service. The application to the telephone business of the ordinary business principle of payment in proportion to service rendered is opposed only by those large users of the telephone who desire unlimited service at a flat rate, and disregard the injury to the interests of the great majority of small and moderate users which such special treatment of large users necessarily involves.

I have previously pointed out that the measured rate principle of telephone tariff, long ago in general use throughout the United States, has recently been adopted by Germany and Austria and is under consideration by other Continental telephone administrations. The latest official convert to the measured rate principle is the Government of the French Republic, which, in a bill authorising expenditure on the reconstruction of the Paris telephone system with central battery plant, speaks as follows on the general question of telephone rates:—

"It should be stated that the flat rate telephone tariff is most inequitable, as it requires all subscribers to pay the same price whatever the number of calls made by each of them. The most rational system of tariff is that in which the price is proportionate to the service rendered—that is to say, that which requires each subscriber to pay in proportion to the number of calls he makes. There is no technical reason why such a tariff as this should not be adopted in the Paris system, and efforts should be made to satisfy public opinion, which for a long time past has emphatically demanded the adoption of this measure."

It is stated in the bill that measured rates for telephone service are already in force in France in towns of less than 50,000 inhabitants with good results, and it is recommended that the measured rate tariff should be adopted not only in Paris, but in the other 16 French cities of over 50,000 inhabitants.—I am, &c.,

Westminster, April 10. HERBERT LAWS WEBB.

THE "ROBROW" SURFACE-CONTACT SYSTEM.

The supposed æsthetic drawbacks to the adoption of the "overhead" system have led inventors for some time past to concentrate their efforts upon evolving some arrangement which shall possess all the advantages, and as few as possible of the electrical disadvantages, of this method of traction. The "conduit" system is a solution which is often proscribed on account of its high initial cost, while the danger of "live" studs has rather militated against the introduction of "surface contacts" into crowded streets.

Most surface-contact systems have, moreover, up to the present, been dependent upon electromagnetic switch control, which has not always shown that certainty in action that is essential for gaining public confidence in a system when working in public streets. The heavy collecting equipment which must be fitted to every car in such systems does not make for economy in operation, while the energy which is necessarily absorbed in working the electromagnetic switches must also be considered in this connection. The ideal surface-contact system should be free from any danger of live studs, have light and simple collecting arrangements and absorb no more power than is necessary for the actual operation of the car. It is claimed that these conditions are to a large extent fulfilled in the "Robrow" surface-contact system, a short description of which we give below.

The construction of the track is similar to that employed when overhead equipment is used, and though a shallow conduit is necessary this need not exceed 6 in. or 7 in. in depth. This shallow conduit may either be placed at the side of the track, in which case the conduit slot also forms the groove in which the car wheels run, or two ordinary girder rails may be used, and the conduit and groove be formed of two additional light rails brazed together in the centre of the track. Fig. 1 is a cross-section of the track, and shows the relative positions of the stud, its seating, terminal box, street box, operating switch and lever, together with the application of the invention to an existing cable conduit system, which it is intended to convert gradually to electric traction. The operating switch is set back out of the line of the conduit, and is provided with a long arm, which allows the electric cars to collect the current. The cable cars also operate this arm, but this is immaterial in their case.

The distribution cable in the case of a single track is placed along the outside of the track in a shallow trench formed in the concrete, and is tapped into the street boxes at each switch. This is shown in Fig. 2, which is a plan and side elevation of the track; the distributor being placed above the drain pipe. In the case of a double-tracked section a single cable would be placed between the tracks and would be tapped off into both sets of street boxes. By arranging that the boxes on each track come opposite each other the jointing may be reduced to a minimum, and need not exceed that required on a single-track section.

A view of the street box is also given in Fig. 2. It not only serves as a receptacle for the operating switch, but also acts as a draining box for the conduit. As each box contains a draining arrangement the conduit can be kept dry while the operating bar of the car passing along sweeps all solid refuse into the box, from which it can be removed or flushed out easily and without danger. The depth of the box from the road surface is 17 in., though this can be reduced should it be necessary. The size of the hatchway communicating with the box is 10 in. by 12 in. Through this hatchway the switch is quite accessible, and owing to the special connecting arrangements mentioned below a defective one can be replaced in a few minutes.

Two terminal boxes are placed in each street box, by which the switch is connected respectively to the stud and the main cable. The two connecting cables are coupled to a special plug arrangement, which, when fitted in the box, ensures a watertight joint.

The stud is a mushroom-shaped steel casting, which can either be fixed on a hard wood block or direct in the concrete foundation. When the necessary connections have been made bitumen is poured in round the cable and under the stud, which is then dropped into position. The stud is of oval shape, measuring 5 in. by 3 in., and the highest part does not project more than ½ in. above the paving. The number of studs per mile on straight track is governed by the length of car used, but with an ordinary 6 ft. fixed wheel base truck the studs may be about 14 ft. apart, and this can be extended up to 24 ft. if double bogie cars are used. It is claimed that this system requires about 200 studs less per mile than any other surface contact system.

In any surface contact system the switch by which the studs are made alive is the most vital part of the installation. On its successful operation depends the efficient working of the cars, and if from any cause it does not work properly the attendant live studs are a constant menace to the ordinary traffic. It must, therefore, be constructed in such a manner that it is watertight and capable of withstanding the wear and tear of constant operation; also it must carry heavy currents without the risk of burning out. It is claimed that with the switch used on the "Robrow" system these conditions are fulfilled, and that its sure and certain operation are important factors in the successful working of the system.

Fig. 3 shows a plan and section of this switch. A bar suspended from the car and running in the shallow conduit throws the switch-lever through about 90 deg., and simultaneously causes the spindle to which it is attached to revolve. To the other end of this spindle is fixed a double-armed copper brush which serves as a switch, and when the spindle is revolved the ends of this brush engage with two terminal jaws at opposite sides of the box, thus placing the stud in connection with the main and supplying current to the car. The immediate return of the switch to the off position directly the car has passed is not so easy a matter, but provision is made for it in the upper part of the switch-box. It is done in the following manner by a mechanism comprising a pair of angular surfaced sleeves which are mounted on the switch spindle with their angular surfaces in contact. The lower sleeve is fixed on the spindle and turns with it, while the upper sleeve is loose on the spindle and is prevented from revolving by means of a feather working in a channel in the switch case. This upper part can, however, slide longitudinally on the spindle. When the fixed sleeve turns with the spindle its angular surface acts against that of the sliding sleeve and tends to cause the latter also to turn. As it is unable to do so it is forced to rise, thereby putting still greater compression on the buffer spring which is bearing on its upper surface. This compression, when the operating bar releases the lever, ensures the return of the parts to their normal position by reason of the inverse action of the co-acting angular surfaces.

As far as the life of the switch is concerned it is claimed this is 20 years and upward. Tests that have been actually made on the switches show that they are capable of withstanding more than two and a-half million blows and no part has been fractured or shown any signs of wear. As will be seen from the above description, the working parts are simple and easily renewable, and the upkeep and maintenance costs should not, therefore, be serious items.

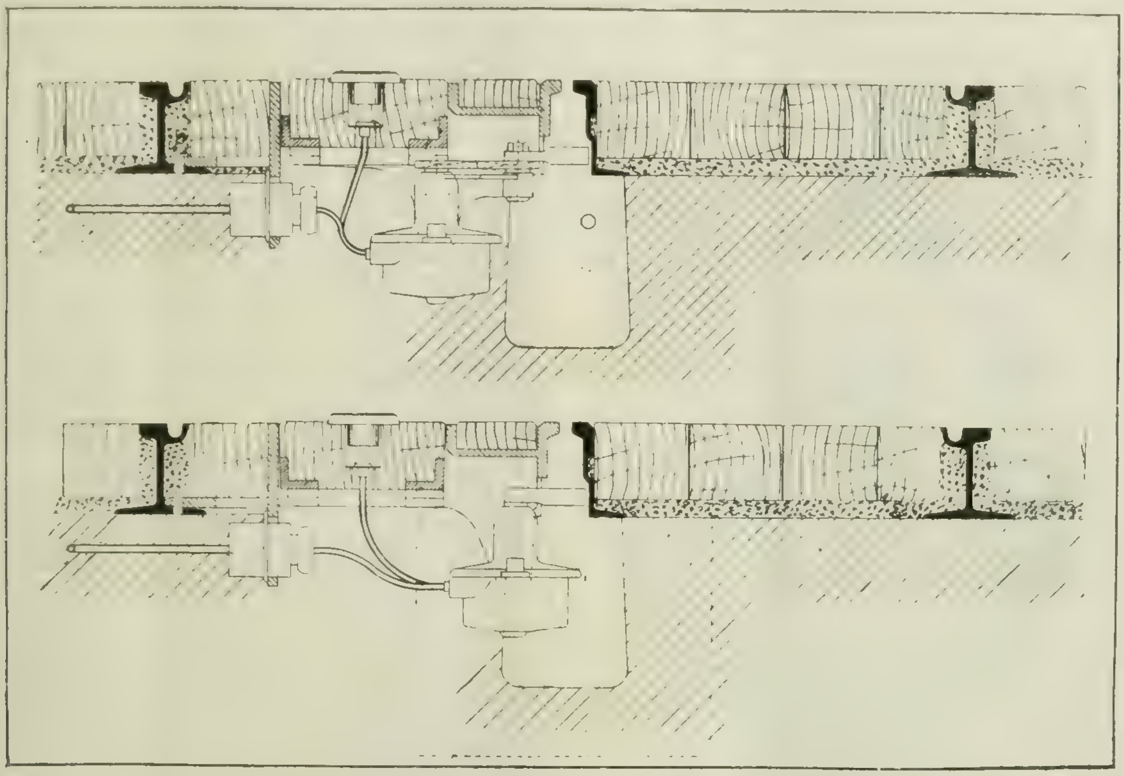


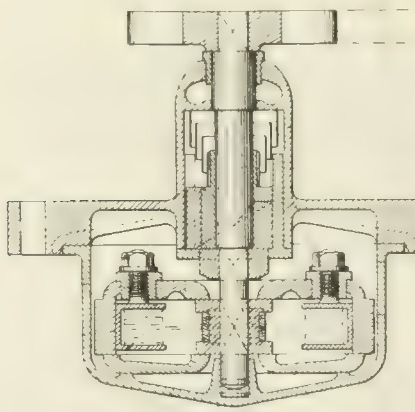
Fig. 1.—Sketch showing the Robrow System applied to existing Cable Conduit and giving Simultaneous Running for both Types of Cars.

The remarks that have been made regarding the simplicity of the switch are also applicable to the switch-operating device and current-collecting equipment on the car. The collector consists of a single bar of T steel suspended longitudinally under the centre of the car either from the axles or from a special bracket attached to the framework. It is hung on slides which enable it to rub lightly on the stud in the centre of the track, and while it is impossible for it to drop below a certain fixed, though adjustable, point, the slides permit it to rise in accordance with the available clearance under the car. The height being easily adjustable the skate can be regulated to any convenient height to compensate for the wear in the rail treads.

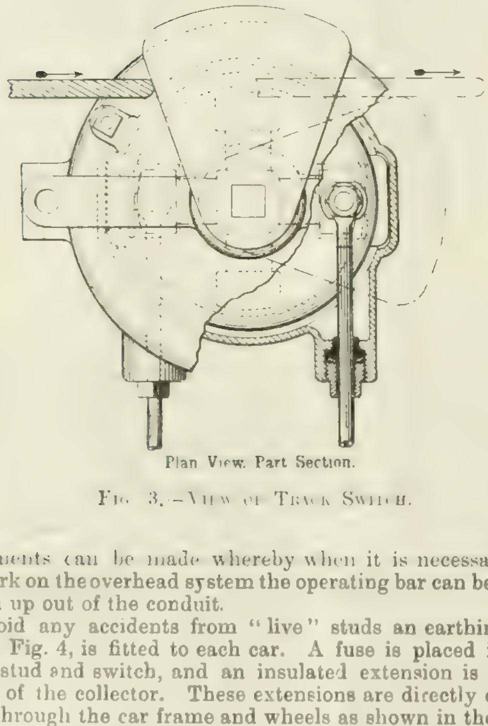
Fig 2.—Plan and Side Elevation of Track, showing Working Cable.

The other piece of special equipment on the car is the operating bar hung either from the side frames or the axle boxes, and which travels in the shallow conduit for the purpose of operating the switches. This bar is slightly longer than the collector, while the latter is also slightly longer than the distance between the studs on the track. The collector is always on one stud, which is made

alive before the collector reaches it and is not cut out of circuit until the collector has passed. This positive action prevents any sparking, as the collector is always under current. The weight of the whole of this special car equipment is about 300 lb., while it is claimed that the first cost is considerably cheaper than that of the conduit system and compares favourably with both overhead and other surface-contact systems. The operating bar is made in two more sections, and is suspended in such a manner that it accommodates itself to the curves in the track.



Vertical Section



Plan View. Part Section.

FIG. 3.—VIEW OF TRACK SWITCH.

Arrangements can be made whereby when it is necessary for the car to work on the overhead system the operating bar can be removed or drawn up out of the conduit.

To avoid any accidents from "live" studs an earthing device, shown in Fig. 4, is fitted to each car. A fuse is placed in circuit with the stud and switch, and an insulated extension is placed at each end of the collector. These extensions are directly connected to earth through the car frame and wheels as shown in the diagram (Fig. 4), where X is the fuse in circuit between the switch S and

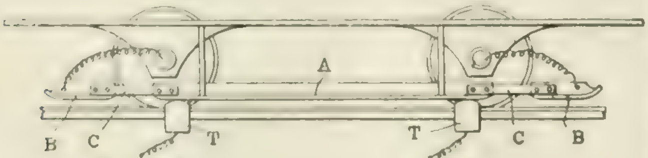


FIG. 4.—DIAGRAM OF EARTHING DEVICE ON THE CAR.

stud T. A is the collector. B is the insulated extension and C is the insulated material carrying this extension. If the stud is "live" when the earthed bar comes in contact with the stud the fuse X will be blown.

We are indebted for the above information to the Traction Corporation, Ltd., who are carrying out the equipment of the Benares Tramways on this system.

THE INTERNAL STRUCTURE OF METALS.*

BY W. ROSENHAIN, B.A., B.C.E.

The lecturer first explained the way in which materials are examined under the microscope, briefly describing the methods of grinding, polishing and etching specimens, and the modes of illumination which are used for the study of these opaque objects. Some special forms of microscope, designed for this purpose, were described with special reference to the manner in which the "vertical illumination" of metal specimens is obtained. The typical crystalline structure of a pure metal was then described, also the manner in which a molten metal solidifies, and how largely the mechanical properties of a metal depend upon the manner in which mutually interlocking crystals grow, thereby explaining the influence of such factors as casting temperature and the presence of minute quantities of foreign bodies. The typical structure of binary alloys was then discussed, and illustrated by a series of slides showing the structure of lead-tin alloys. The lecturer then described the observations made by Prof. Ewing and himself some nine years ago, which resulted in the discovery of "slip-bands" and the deformation by the slipping or sliding of the elements of each crystal over one another, each of the crystals of the metal thus accommodating itself to the new shape imposed upon it. In connection with slip bands, Mr. Rosenhain referred to the semi-plastic condition which in iron or steel follows upon plastic deformation; Muir's work on the recovery from this state produced by exposure to the temperature of boiling water was referred to, and from these facts an explanation was advanced of the causes which lead to the well-known phenomena of fatigue in edge tools and the recovery of their cutting power after prolonged rest.

In the last part of the lecture, the various modes of fracture of iron and steel under tension, shock, bending and alternating stresses were described and the microscopic features of the fractures illustrated by a series of sections of actual fractures, also obtained by the aid of the electro-embedding process. Special reference was made to the manner in which metals fail under the effect of alternating stresses; the crystalline appearances of the fractures produced in this way was explained on the basis of deformation by slip, and the view that vibration or alternating stresses could cause metal to "become crystalline" was characterised as an entirely groundless and most improbable assumption. In conclusion, the lecturer mentioned that the microscopic study of metals might find some direct electrical applications; the connection between the micro-structure of alloys and their electrical resistance and resistance temperature coefficient was given as one instance, while there was also certainly some connection between the magnetic properties of iron and its micro-structure.

Mr. S. L. PEARCE, in proposing a vote of thanks, mentioned that everyone would be impressed by the great amount of research work carried out in metallurgy. This was instanced by the gradual change which had come over the practice of large engineering works in substituting other metals in place of those in vogue a few years ago, particularly the more extended use of steel for heavy engine work, and of phosphor and manganese bronze.

Mr. C. D. TAITE seconded the vote of thanks, and Mr. W. ROSENHAIN briefly responded.

HIGH-SPEED ELECTRICAL MACHINERY.

We give below an abstract of the discussion which took place on April 6th at the Newcastle Local Section of the Institution of Electrical Engineers, when Messrs. Stoney and Law read their Paper on this subject. This Paper had previously been read and discussed in London, an abstract of the Paper appearing in our issue of April 3rd and of the discussion in our last issue.

Mr. J. HOLMES said that, with regard to Mr. Parsons' early patents on spiral end windings, he did not think that Mr. Parsons got his due. This was the first type of balanced winding, and had since come into almost universal use. It was very interesting to note the experiments which were made in 1885 with compensating winding. He was not sure if the want of success was entirely due to an insufficient number of ampere turns. He did not think the winding was applied in the right place. In 1889 he personally went into the same question, and constructed and sold a machine with compensating windings which met with some success. The compensating windings were applied so as to increase the lines of force in the halves of the two pole tips where the magnetism was weakest. Morganite brushes had lately come into use, and were more or less a success. He understood they were used by the Westinghouse Co. on a commutator, sideways on. It seemed to him that this arrangement might give good results. He also understood that the Morganite Co. had brought out a pneumatic arrangement† for regulating the pressure on the brush. With regard to the

* Abstract of a lecture delivered before the Manchester Local Section of the Institution of Electrical Engineers.

† See *The Electrician*, March 6, 1908, p. 792.

staying of end conductors, he did not think that this was only necessary on high-speed machines; he had come across some slow speed machines where this would have been an advantage. He had been through some works lately where the so-called knife edges for balancing tests were 6 in. wide. This was found to be necessary owing to the heavy weights sinking in.

Mr. TURNBULL thought compounding the exciter with alternating current extraordinary. It would be interesting to know the effect on the brushes. He had used some of the earliest types of Morganite brushes, but not successfully. He understood, however, that they were much better now.

Mr. DAVIDSON said that Messrs. Parsons had, up to the present, turned out seven machines with the exciters fitted with alternating-current leakage winding. The sizes varied from 250 kw. to 750 kw., and so far no trouble had been experienced with the commutation of the exciters. The curves shown in the Paper were taken from some of the first machines. The results were somewhat better now. The machine, 500 kw., 500 volt, was put on test, lamps were run across the terminals and full-load was thrown off and on without any rheostat adjustment. No flicker was observed. He thought that this arrangement was quite an epoch in alternator design.

Mr. LONGMAN thought it was well worth while going to some expense in brush gear if it was to save wear and tear on brushes, as this came to be a very heavy item in the course of a year on machines which were continually in commission. Regarding the alternating-current leakage path on the exciter he asked if a path was provided for each phase of the machine on top. He had come across some Parsons alternators where the bearing at one end of the shaft was insulated from the frame, and there was a P.D. of several volts between the bearing and frame. What was this due to?

Mr. BARBOUR asked what amount of wear there was on the brass brushes and if they cut the commutator at all. The trouble of flashing over when commutating poles were used could be got over by using inductive resistances in circuit with the commutating winding.

Mr. HUNT asked if manganese steel had ever been tried for binding wire. It was equally strong and non-magnetic. He also asked if the knife-edge method was relied on solely for balancing. In America they ran the armatures up to full speed and found by experiment where the balance weights were required.

Mr. LAW, in reply to Mr. Holmes' remarks with reference to the compensating winding, thought the results obtained were the same. Mr. Holmes' method added to the lines of force, whereas Parsons' method diverted the lines of force. The winding was now run through several holes in the pole-piece, instead of one, as shown. Carbon brushes, no doubt, in some cases gave good results; but the high surface speed of the commutators was responsible for excessive heating, and the commutators were liable to become rough. Messrs. Parsons had sent out about six machines fitted with carbon brushes, but until better success was got they did not intend adopting them. Most of their commutators, however, were made to suit carbon brushes. Were these afterwards found to be a success? They considered it better to produce a machine to run well with copper brushes rather than take risks with carbon brushes. The two oldest firms manufacturing high speed electrical machinery, Messrs. Brown, Boveri & Parsons, used some form of metal brush. Knife edges for balancing purposes were always made a reasonable width to give fair bearing surface. Machines were always balanced by running up. The rotor was run up in an armour-plated building, and could be operated by a man in a separate house to ensure safety. Mr. Parsons had always shown great consideration for making experimental work safe. They had no trouble with commutating in the exciter, either with or without the alternating-current leakage path. There was a leakage path for each phase of the machine, and these were mounted on top. It would be possible to make a transformer to give single-phase current from a three-phase machine; only one leakage path need then be provided. As to the P.D. between the bearing and bed plate, a test was to be made shortly at Carville power station with an oscillograph to determine the nature of the pressure generated. He thought it was due to the out of balance armature reaction. They had no difficulty in keeping the commutators true; they required very little attention, and the steel rings were entirely satisfactory. They made a test on one of the old 1,800 kw. Manchester sets, the commutators of which were guaranteed for two years, and estimated that they would last 10 to 12 years. Since then they had applied compensating winding and they would now probably last longer. Manganese steel could not very well be used for binding wire, as it would be difficult to make. Flashing over, in his experience, was completely overcome in two-pole machines. In the older four-pole machines, where the number of commutator segments was small, there was sometimes trouble.

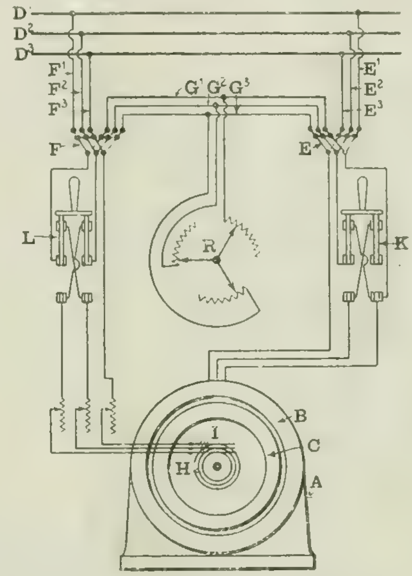
A NEW ALTERNATING-CURRENT MOTOR.*

A patent has recently been issued to C. A. Lohr, of Schenectady, N.Y., for the invention of an alternating-current motor, in which a simple means is provided for changing the speed of the motor without altering the number of poles or using different stators or rotors. The diagram indicates the electrical connections used for changing the speed. The motor is represented by A, and B shows the stator and C the rotor. D^1, D^2 and D^3 are main conductors connected with a three-phase, alternating-current supply, and E^1, E^2 and E^3, when in contact with a double-throw, triple-pole switch E, energise the stator. Three other conductors, F^1, F^2 and F^3, through switch F, energise the rotor. Auxiliary conductors G^1, G^2 and G^3 have interposed therein a regulating resistance, R.

*Abstracted from the *Electrical Review* (New York).

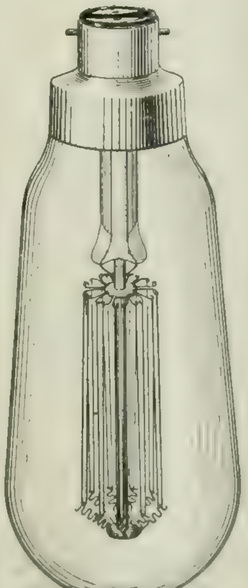
The arrangement differs from the usual construction, in that both parts of the motor generate rotary fields when supplied from an alternating-current source. The speed of these rotary fields may be the same or may differ, if a different number of poles are used in the stator and rotor, or if these are connected each with a source of electricity having a different periodicity. Also, the direction of rotation of the rotary fields in the stator and rotor may be the same or different. Two other cases also are possible: either to generate a rotary field in the stator and connect the rotor with the variable resistance, R; or connect the stator with the variable resistance R, and connect the rotor with the current supply.

Thus employing a different number of poles in the rotor and stator, we obtain: two asynchronous speeds obtainable under load by alternately connecting only one member with the alternating-current line, and closing the other member upon itself; two asynchronous and two synchronous speeds by alternately connecting only one member with alternating current line and closing the other member upon itself, and by simultaneously connecting both members with the alternating-current line, and changing the direction of rotation in the rotary field in one member; a low synchronous speed equal to the difference of the rotary field speeds in stator and rotor.



A BRITISH METALLIC FILAMENT LAMP.

The preponderance of metallic filament electric lamps developed and manufactured outside this country naturally adds interest to the announcement of an "all-British" lamp which we have now to record. The Bryant Trading Syndicate, who are well known as makers of carbon filament lamps, have been conducting experiments for some time past with a lamp which is the invention of Mr. F. Harrison, the manager of the company, and which, we understand, will shortly be available for commercial use. The process of producing the filament is at present kept secret, but we are informed that it results in a fine, smooth wire which can be laid up into the now familiar "cage" common to metal filament lamps, and made to burn on 200 210 volt circuits. An interesting feature of the lamp is the use of small springs at the lower loops of the filament, these springs keeping it taut in burning, while also serving to absorb shocks. We have seen a 200 volt lamp burning and were able to shake it about freely without damaging the filament. The adjoining illustration shows the general appearance of the lamp. The efficiency is stated as 1 watt per candle. We were shown through some of the new shops which the company has recently fitted up at Highbury, London, for the manufacture of these lamps, and shall probably give further details of these and the lamp in question at a later date.



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LEGAL INTELLIGENCE.

Ernest Scott & Mountain (Ltd.) v. Kent Collieries (Ltd.).

On Thursday last week Mr. Muir Mackenzie, official referee, resumed the hearing of the action brought by plaintiffs to recover £3,249, balance of account for electrical machinery and plant supplied to defendant company. There was a further claim for about £1,500 in respect of a pump supplied, wages paid on behalf of defendants, goods delivered and repairs to a pump. Defendants declared that the plant was not in accordance with contract, owing to the fact that it broke down, and counterclaimed for £48,000. The previous proceedings were reported in our last issue.

Mr. BOUSFIELD, K.C., continued his cross-examination of Mr. Hodgkin, assistant managing director of plaintiff company. Having put various questions to the witness as to the results of certain tests and the rise of temperature, Mr. Bousfield submitted the results of a test which showed that, while the engines were running at below their full power, the temperature rose in two hours to 60 deg., and at the end of 5½ hours to nearly 120 deg. Did not that show (asked counsel) that it was impossible to run the motor for more than five or six hours? Witness failed to agree on that point, nor did he think that a temperature of 120 deg. would be fatal to the working. The pumps started on July 30, and witness claimed that that was the date upon which defendants took over the plant. The specifications said clearly that plaintiffs should have nothing to do with the pumps after they were in the shaft without any previous tests as to efficiency, temperature, &c.

Re-examined by Mr. Russell, K.C., Witness said he believed a 120 deg. rise in temperature was quite good practice for enclosed motors which were generally insulated with cotton: The motor in question, which was of this type, was insulated with asbestos. When one of the pumps was returned to plaintiffs it was found to be in a very bad condition. Its efficiency had been reduced from 75 to 25 per cent. This loss of efficiency, of course, would mean that the machinery would have had to sustain an unduly heavy load if the quantity of water raised per minute were sustained. He should think that the increased output required by the motor would amount to about one-third. He produced portions of the pump, and pointed out the damage done to the guide blades, &c., which he said could only have been caused by the use of considerable force.

Mr. WM. CHAS. MOUNTAIN, managing director of plaintiff company, said he was quite satisfied that the plant his firm supplied was capable of doing the work specified, if the condition of defendants' power house &c., had not been adverse to the working of the machinery. He pointed out to defendants the necessity of having another pump. On Sept. 12 he received a communication from his firm's representative in charge of the work with regard to the pumping, and he again impressed upon defendants the necessity of lowering another pump into the shaft. It was absolutely necessary, in work of such a character, that there should be a relief pump, because such machinery doing that class of work required overhauling and careful attention. Care had to be taken to see that the electrical part of the motor was not unduly heating from any mechanical cause, and that the bearings in the motor, which were of the ball type, were in order so as to prevent any damage to the ball races. Constant examination of the machinery was necessary to prevent the oil from the bearings being flung by force into the windings of the motor. The machinery should be examined every shift, that was not more than every 12 hours. There was a clause in the Mines Regulations Act which stated that all machinery in the mines should be examined every 24 hours. He prepared and sent to defendants a list of instructions for the running of the machinery. The instructions were absolutely necessary, and it was quite impossible to carry them out with one pump. Eventually it was agreed that another pump should be laid in the shaft to work in series with the set already there.

Cross-examined by Mr. Hutchinson, Witness said that in contracting for an electric motor one had to consider the duty the motor was required to do. If it was to be run continuously, say a week at a stretch, the motor had to be of certain dimensions capable of sustaining that long duty. If, however, the machine was to be run for short periods, say up to six or eight hours, it did not require to be so large, and if, as was frequently the case, the motor was required for driving an intermittent piece of machinery, it might only be required to give its full power for half an hour at a time. Therefore, the bald statement that a 300 B.H.P. motor meant a standard article of that power was incorrect. A motor varied according to the duty it had to perform.

In answer to the Official Referee, Witness said it was the practice to supply motors slightly larger than the power required, and that was done in the case of the motor in question.

Mr. HUTCHINSON: Is it the practice to specify when supplying electric motors the duty they will perform and also the overload, or additional duty, they are capable of doing for a certain period?

Witness: Only when you have no specification. You do so in the ordinary trade way without knowing the work the machine is required to do.

Mr. HUTCHINSON: For instance, in the case of electric pumping plant. If the motor was specified at 300 B.H.P. and and an all over load of 25 per cent. for half an hour, should I be right in expecting to get a motor which would turn out 375 H.P. during that half hour?—If you specified it, yes.

Do you suggest the specification in this contract does not deal with overload?—Only as regards generation. He did not agree that there was nothing in the drawings he had prepared to show that two pumps would be necessary in the shaft. He certainly did not tell defendants that if another pump were laid down another compensating arrangement would be necessary because he thought it was quite obvious. With regard to the testing, it was the duty of defendants to fix a date and call upon plaintiffs to make a test of the plant before their expert. Such a test was arranged, but it was never held; if it had been litigation would have been avoided. Defendants took over the plant before it had been properly tested. There was no proper repair shop to do electrical repairs. Winding and re-winding of the motor coils were incidental repairs. It was not the duty of the contractor to go down and examine the strata through which the shaft passed, and usually he took the opinion of the purchaser upon the matter. The class of pump selected was generally determined after a close inspection of the material through which the pump was to work. The defendants decided for themselves as to the kind of pumps to be used in the contract, and in witness's opinion the centrifugal electric pump was entirely unsuitable. With regard to the moisture in the coils causing the breakdown in August, 1906, witness said he warned his representative in charge of the plant of possible dampness in the coils, but defendants' directors were so impatient to get the plant started that witness eventually allowed the machinery to be started up before current had first been put through the coils to dry them. He did not think any of them realised that there was so much dampness in the machines. He admitted that if the coils of a machine were wound with damp insulating cotton it would be a great deal more difficult to get rid of than dampness in the outside circuits caused by atmospheric conditions. He denied the suggestion that the whole cause of the breakdown was the fact that the coils of the machine had been wound with damp cotton. Before the motor left plaintiffs' works every coil was tested with 10,000 volts alternating current. If a wire insulated with varnished cotton were exposed to atmospheric dampness it would be possible for the enclosed wire to show some signs of it. He denied that if verdigris were found on the surface of such enclosed wire it was proof that the wire had been insulated in the first place with damp cotton. He considered that electric sinking pumps were more efficient than steam pumps, but they require more looking after. Asked by Counsel if it were not an ordinary thing to impregnate the windings of a motor with something which would prevent the absorption of damp, Witness replied that it was not done in the case of machines of the large size as the motor in question, but only with smaller machines. He was one of those who introduced the impregnation process.

In re-examination, Witness said the verdigris found upon the wires of the motor which were enclosed in varnished cotton might have been caused by the action of the damp of the varnish upon the wire. Varnished cotton insulation was not absolutely impervious to damp.

Mr. JOHN MORLEY, foreman engineer to plaintiffs, gave corroborative evidence.

The hearing was again adjourned.

Islington (London) Borough Council v. London Road Car Co. and Hill.

Last week, at the Clerkenwell County Court, plaintiffs sought to recover £30. 5s., damage caused by the alleged negligence of one of defendants' drivers (defendant Hull) to an arc lamp column and lamp.

Mr. A. M. BRAMALL, for the Council, said that on May 31 last one of defendants' motor 'buses was proceeding through Highbury-grove when it skidded, and in slewing round the rear part collided with an electric light standard on the footway. Not only were the column and lamp broken, but the cable was fractured. The Council alleged, alternatively to the charge of negligence, that the motor omnibus was a nuisance to the highway.

Evidence in support of plaintiffs' case was given by Mr. J. Hargreaves, mains engineer, and by Mr. J, P. Barber, borough engineer and surveyor.

For the defence, the driver, GEORGE HULL, said that at the time of the accident his speed was about 7 miles an hour. The road was not sanded, and its greasy condition caused the 'bus to skid. Within two seconds, and without any warning whatever, he was against the standard.

Mr. HOPE DUFF, assistant engineer to defendant company, said the 'bus was fitted with notched tyres and the best improvements known. They had tried five different devices to prevent skidding. The company had 230 Union Jacks on the road, and in six months the number of passengers carried was 40,000,000.

Mr. DRAKE, for defendant company, urged that the loss of the standard was due to the Council not having properly sanded the road. If the motor 'buses were a nuisance, as alleged, then the company could be indicted for putting a nuisance on the streets.

Mr. BRAMALL asked the jury to say that a machine that would spin round like a top was a dangerous one to put upon the highway. The case was of considerable importance.

Judge EDGE said that the duty of a borough council was to keep the highway in such a state as was reasonably safe for ordinary use. There was no duty upon the Council to sand roads, especially for motor traffic, and if dangerous machines were put upon the highway no duty was cast upon the Council to minimise that danger by taking extraordinary steps with regard to the roads. In submitting a number of questions to the jury, his Honour remarked that there was no evidence of negligence against the driver.

The jury found that the use of the motor omnibus was dangerous to the public using the highway and a nuisance. They also found that the damage was not caused by any defect in the road. Judgment was entered against the company for the full amount claimed.

MUNICIPAL, FOREIGN & GENERAL NOTES.

APPOINTMENTS VACANT AND FILLED.

An improver is wanted to act as switchboard attendant with a view to becoming a shift engineer at Coventry Corporation electricity works. Applications to the manager, Mr. Joseph Jeckell. See advertisement.

Watford Council require a chief electrical engineer. Commencing salary £250, rising by biennial increments of £25 to £400 per annum. Applications by 25th inst.

A telegraph inspector is wanted for service on the Federated Malay States Railways, age not to exceed 30 and preferably unmarried. Candidates must have been employed on an English railway and be competent to take charge of the erection and maintenance of telegraph and telephone lines, single-needle and Morse telegraph instruments, electric block signalling instruments, electric signal repeaters and electric train tablet apparatus. Salary £300, rising by annual increments of £10 to £350 per annum. Second class passage out and home. Applications to the Crown Agents for the Colonies, Whitehall-gardens, S.W., by 21st inst.

Applications are invited for the chair of Civil Engineering at the University of Liverpool, which has recently been established in the Faculty of Engineering. Particulars from the Registrar, to whom applications, with 12 copies of testimonials and references, should be sent before May 15.

Shoreditch (London) Lighting Committee require a mechanical engineer to take charge of destructor and steam plant at their electricity works. Applications to the Borough Electrical Engineer by April 18.

Mr. H. G. Thompson, of Swansea, has been appointed electrical engineer at Neath at £200 per annum.

Mr. J. A. Sykes, of the Heston and Isleworth electricity works, has been appointed chief electrician at the Parkhead works of Messrs. W. Beardmore & Co.

Mr. Chas. Lill, of East Ham, has been appointed sales engineer at a commencing salary of £120, rising by annual increments of £10 to £150 per annum.

Mr. Chas. Burgess, of Kirkcaldy, has been appointed (out of 113 applicants) tramway traffic manager at Wigan, at £200 per annum.

Mr. A. H. Whipple, M.A., B.Sc., director and secretary of education at Walsall, has been appointed director of Blackburn Technical School at £500, rising to £600 per annum.

Alleged Failure to Maintain Pressure of Electricity Supply.—At the North London Police Court on Monday, Islington Borough Council appeared by their solicitor (Mr. A. M. Bramall), to answer 10 summonses, taken out by Mr. A. W. Boreham, on behalf of the Consolidated Supply Co., for failing to supply to the company's works electrical energy at the declared constant pressure of 200 volts, contrary to statute and to Board of Trade Regulations.

There was no one present for the company, but Mr. Bramall pointed out that the Council had a summons against the company for £25. 11s., balance of account for electricity supplied. He had received letters suggesting that if the Council gave up their claim the company would withdraw their summonses. Such a suggestion could not be acted upon. That morning he had received a letter from the company which intimated that in consequence of proceedings in the High Court with reference to the future of the company, the Council's claim would not be contested or evidence offered on the other summonses.

Mr. Fordham dismissed the summonses against the Council with £5. 5s. costs, and made an order on the company to pay the Council's claim of £25. 11s., with 6s. costs.

Australasia.—Mr. Benjamin Deakin, manager in Australia of the Electric Supply Co. of Victoria, has been appointed by the Governor of Victoria, with two others, to inquire into the management, working and maintenance of the St. Kilda and Brighton electric street railway.

Melbourne City Council have recently installed two 750 kw. Westinghouse-Parsons steam turbo-alternator sets, with exciters and condensing plant, for supplying current in the suburban districts. Single-phase current is transmitted at 4,000—4,400 volts 50 cycles to transformer sub stations, where the current is transformed down for distribution. The condensing plant was supplied by Messrs. W. H. Allen, Son & Co.

Mr. Justice Cussen recently granted an order authorising the Leongatha Butter Factory Co. to supply electrical energy for lighting the town of Leongatha.

The committee appointed to inquire into the use of electricity in mines in New South Wales have issued their final report, which states that 25 collieries in the State have low-pressure electrical plant, seven medium pressure and one high pressure.

The committee report that there should be little, if any, danger in the use of a well-designed electrical plant, if good material be used and the plant be in charge of a capable man, even though high voltage current be employed. Cases have been known where fine coal dust has settled on incandescent lamps and become red hot. Coal is holed much more quickly by machines than by hand, and, therefore, a larger quantity of gas is likely to be liberated in a given time, and the air should be tested for gas during the progress of the holing. Mine electricians should be required to pass an examination as to competency. There are mines in which the conditions with regard to fire damp are such that a qualified manager would hesitate to introduce electricity at the working face, and in any case sufficient notice should be given to the district inspector to enable him to take steps to prevent the erection of electrical plant where he is of opinion that the use of such plant would be dangerous. To forbid the use of a power the dangers of which can be almost eliminated by conformity to rules would deprive the individual of means of lessening the more arduous portion of his work. The committee have drawn up rules which they think will meet the requirements of the industry.

Sydney City Council have entrusted the work of overhauling the electricity generating plant to Messrs. Dick, Kerr & Co.

The "Australian Mining Standard" says the prospectus has been issued of the Electric Light & Power Supply Corpn., Balmain (N.S.W.) with a nominal capital of £100,000. Mr. A. J. Arnot, manager in Australia for Messrs. Babcock & Wilcox, is one of the provisional directors of the new company.

Menzies (W.A.) Municipality is contemplating the adoption of electric lighting.

Messrs. Noyes Bros. have completed the new electric power plant for the New Moon Gold Mining Co., Bendigo (Victoria). The plant includes a Westinghouse-Belliss 150 kw. d.c. generating set and motors for driving, crushing and haulage plant, &c.; but the most interesting feature of the new plant is the double-drum reversible winding gear built by Harkness & Co. of Bendigo. This is driven by two Westinghouse motors worked on the series parallel system.

The report of the Launceston (Tasmania) city electrical engineer (Mr. R. J. Strike) for 1907 states that the total capital expenditure is £164,497, an increase of £3,354. Revenue was £16,287 (against £14,935) of which £2,435 was from street lighting. Gross profit is £8,771 (increase £375), and after payment of interest, sinking fund, &c., the net profit is £1,557. The units generated were 1,722,380. The maximum load was 680 kw. (increase 86 kw.). There are 3,175 private consumers.

Boston.—The Council have asked the Board of Trade to revoke the electric lighting order (1898) of the National Provincial Electricity Corpn.

Brighton.—At the next meeting of the Council the Lighting committee will recommend that a revised scale of charges be introduced for electricity for lighting and power.

The electrical engineer and manager (Mr. John Christie) states that some revision of the present tariff has become necessary, owing to the effect of the increased price of coal on the cost of production. The suggested new rates are estimated to produce the requisite addition to the revenue, but will not operate harshly on the consumer, who is now able to use electricity more economically and to better advantage by employing the high efficiency lamps obtainable, while the revision will have the effect of making the quarterly bills more equal. The proposed tariff is as follows; For hotels, clubs, public-houses, churches and places of worship, 3d. per unit for lighting; shops, private houses and other premises, 4d.; arc lamps arranged on independent circuits and wired through a separate meter direct to the Corporation terminal boxes, 3d.; for supply by prepayment meter, ½d. per unit, in lieu of meter rental, in addition to above rates. Consumers taking more than 20,000 units per annum for lighting may be supplied on special terms by arrangement, as follows: Hotels, clubs, public-houses and piers, up to 10,000 units per annum 4d., each additional unit up to 20,000 3d., each additional unit in excess of 20,000 up to 40,000 2d., each additional unit above 40,000 1d. Other premises will be supplied at 4d. per unit up to 20,000 units per annum, 3d. each additional unit up to 30,000, and 2½d. a unit in excess of 30,000 units. For power and heating, 1½d. per unit, or (with separate meters) 1d. per unit between 5:30 and 8 p.m. On the maximum demand system the charge will be 6d. per unit for the first hour's average daily use of the maximum demand and 2d. per unit for all consumption in excess. Outside the county borough current will be supplied at 4½d. per unit for lighting and 2d. for power and heating. For street lighting it is recommended that the charge be increased from an average of 1·565d. per unit to a flat rate of 1·75d. Mr. Christie also recommends that 16 c.p. tantalum lamps be installed on the 1,548 posts which at present have two 8 c.p. carbon filament lamps. The extra cost of tantalum lamps will amount approximately to £606. A 2×16 c.p. tantalum post under revised tariff will cost £3. 1s. 4d. per annum.

Burnley.—A reduced scale of charges for electrical energy for power and heating has been adopted by the electricity department.

Burslem.—At the meeting of the Council last week it was reported for the year ended Dec. 31 that the revenue of the electricity department was £3,261. 2s., including £2,858. 9s. 11d. from sale of current, £300 from public lighting and £42. 12s. 1d. meter rents.

Expenses were £1,223. 8s. 4d., leaving a gross profit of £2,037. 13s. 8d. Interest required £1,002. 5s. 4d., and sinking fund £800. 3s. 3d., leaving a net profit of £235. 5s. 1d., compared with a loss of £658. 1s. 11d. in 1906. The total capital outlay, including £5,917. 19s. 8d. expended during 1907 is £32,396. 14s.

Carlisle.—An unopposed inquiry was held last week into the Council's application for a loan of £5,000 for mains, services, &c.

Chichester.—The local electric light company have selected a site for the generating station at Stockbridge, and the work of erecting the station will be commenced forthwith.

Crystal Palace Engineering School.—The "Wilson Premium" for the best Paper read before the Crystal Palace Engineering Society during the present session has been awarded by the Council to A. N. Lucey for his Paper on "Macadam Roads." The "Premium" was presented to Mr. Lucey by Sir George Livesey on the occasion of the 106th distribution of certificates of the above school on Tuesday.

Dundee.—The Free Library committee are to take electric current for lighting the picture galleries from the Corporation mains.

Electrical Standardising, Testing and Training Institution.—As a result of the recent scholarship examination the governors of Faraday House have awarded an exhibition of 20 guineas per annum, tenable for three years, to Cyril Launcelot Underwood, of the Grammar School, Bedford.

Electric Power in Steel Works.—Messrs. Marples, Leach & Co have obtained the order for supply, delivery and erection of a high-tension two phase alternating-current induction motor for driving two 10 in. and one 8 in. mills at the works of Messrs. Samuel Osborn & Co., Sheffield.

This motor is being wound for the high pressure distributing mains of Sheffield Corporation electric supply department at 2,000 volts two-phase 50 cycles. The motor is normally rated at 350 B.H.P., but is capable of sustaining considerable overloads for short periods without injury. It is being provided with wound rotor, brush lifting and short-circuiting device, by means of which the wear and tear on the brushes and slip rings is reduced to a minimum. In order to enable the fly wheels to take their proper share of the work, the rotor is being provided with a bank of resistances which rotate with the machine, allowing a considerable percentage of slip when the load exceeds the normal. This motor is (it is stated) the largest motor yet placed upon these mains, and it is anticipated that great economy will result in the working of the mill.

Electricity in Co operative Stores.—The Great Harwood Co-operative Society are erecting new central premises, and propose to put down independent electric lighting and power plant.

Electricity in Mining.—The Seghill Colliery Co. propose to put down generating plant for supplying current for power and lighting at the colliery, and for the lighting the roads in the district.

The first sod of the New Winning East Pit, Lumley Colliery, near Chester-le-street, was cut on 9th inst. The pit is owned by the Lambton Collieries Co., and it is claimed by the agent (Mr. Kirkup) to be the only great coal mine in the world which will be worked entirely by electricity. The winding, pumping, hauling, screening, coal cutting and lighting are to be done electrically.

Erith.—Mr. F. Thompson, mains superintendent in the Electricity department, has resigned. Negotiations are proceeding with regard to the proposed increased supply of electrical energy to Callenders' Cable & Construction Co., and also the proposed supply to the works of Vickers, Sons & Maxim.

Exhibition.—An International Exhibition will be held at Brussels from April to November, 1910. M. Francis Wiener, 34, Rue des Douze Apôtres, Brussels, is Secretary. There will be science, art, industry, commerce and colonial sections, and special groups dealing with electricity, metallurgy, mechanics, mechanical traction, mines, &c.

Guisborough.—Mr. Cecil Lugard is to submit a report, with estimates of cost, on electricity supply.

Hammersmith (London).—The Electricity and Lighting committee propose to convert the system of lighting in 66 streets along which low-tension mains are laid by substituting a 44 c.p. electric lamp for a 30 c p. gas lamp. The charge for electricity will be the same as for the present gas supply (£3. 1s. per lamp per annum).

Hanwell.—The Metropolitan Electric Supply Co. have offered to take over the Council's provisional Electric Lighting Order, 1904.

Incorporated Municipal Electrical Association.—The 13th annual convention will be held at Nottingham from June 30 to July 3.

Infirmary Lighting.—Edmonton Guardians have decided to engage Messrs. May & Hawes to report on the electric lighting at their new infirmary.

Lectures.—An instructive lecture was given on Saturday evening by Mr. Alfred W. Bennis, M.I.Mech.E., A.I.E.E., before the members of the National Engineers' Association (Bolton Branch), on "Improvements in Modern Mechanical Stoking." Mr. David Catterall, president of the Association, occupied the chair.

The lecturer gave a short description of the method of working of each of the types of mechanical stokers invented and put on the market since the time of James Watt, the probable inventor of the first machine for firing. The stokers invented had been of various types, for example, chain grate and sprinkler, the first stoker of the latter type having been put upon the market in 1770. On the black smoke question the lecturer demonstrated that black smoke could be obviated if only a high enough temperature were maintained in the furnaces. Figures were offered for consideration as to the percentage of CO_2 that it was desirable to find in the flue gases as a testimony of efficient combustion. Mr. Bennis insisted on the advisability of having tests taken periodically of the quality of coal used on boilers. Coal merchants were sometimes tempted to lower the quality of the fuel supplied to their customers, but if tests were taken regularly by means of a standard calorimeter, such as the "Darling," any alteration in the heat value of the fuel supplied would be detected. By means of such an apparatus the number of British thermal units, together with the amount of ash and clinker contained in any given coal, could be precisely ascertained, and the behaviour of the fuel under high temperature conditions observed. Some interesting experiments bearing on the subject were carried out by one of Messrs. Bennis's chemists. The "Bennis" patent gold medal machine stoker and self-cleaning compressed air furnace was described, and figures obtained from actual operations were quoted to prove the high thermal efficiencies given by the stoker in the boiler houses of Sheffield Corporation electricity works, Coventry, where the thermal efficiencies are exceptionally high. Dealing with the objections to mechanical stokers on the ground of upkeep costs, the lecturer stated that that cost depended, to a large extent, on the way in which the machines were looked after by the firemen. He cited instances where the cost of upkeep did not exceed £1 per machine per annum.

At the conclusion of the lecture a discussion ensued, when some interesting facts bearing on machine firing were disclosed by the fireman of a well-known Northern firm, who were summoned on a charge of having caused a nuisance by the emission of black smoke. In the interval afforded by an adjournment this firm had arranged with Messrs. Bennis to install one of their stokers and compressed air furnaces on an undertaking to prevent the issue of black smoke. The magistrates, on being informed of the steps taken by the mill-owners to abolish the smoke, and the outlay undertaken with that object in view, dismissed the summons. Prior to the fitting of the stoker the mills were using 36 tons of coal per week on two boilers, but after its erection the firm were able to dispense with the services of the second boiler. The same quality of coal was used in both cases. After questions had been answered a vote of thanks to Mr. Bennis was carried unanimously.

The first of a series of lectures to the employés of the General Electric Co., Manchester, was given on the 9th inst. by Mr. A. Angold on "Arc Lamps."

The lecturer introduced his subject with an elementary explanation of the principles of the electric arc, and gave demonstrations of the different chemical and lighting effects secured by the use of long and short arcs in open and enclosed globes. The various conditions of the flame arc were also examined by means of a projector lens and screen. Having dealt concisely with the principles involved in the design of modern arc lamps, the various mechanisms were examined and discussed, chief amongst these being the ingenious magazine flame arc lamp to which Mr. Angold has given his name. At the conclusion of the lecture a number of questions were asked, which led to an interesting discussion.

London County Council.—On Tuesday it was reported by the Finance committee that during the financial year £272,518 was lent for electric lighting, against £282,760 in 1906-7, £319,119 in 1905-6 and £749,109 in 1904-5, the 1904 5 figures being exclusive of the £1,415,000 loaned to St. Marylebone for the purchase of the local undertaking of the Metropolitan Electric Supply Co. It was agreed to loan £31,306 to Marylebone and £330 to Woolwich for electric lighting.

Highgate Hill Tramways.—The Highways committee brought forward their adjourned recommendation for the purchase of the undertaking of the Highgate Hill Tramway Co.'s undertaking. The Finance committee stated that the total ultimate expenditure on capital account in connection with the reconstruction for electric traction was roughly estimated at £53,200, although if the overhead system were adopted the figures would be reduced by £6,045. A motion to refer the matter back was lost.

Metropolitan Electric Tramways.—The adjourned report of the Parliamentary committee was submitted with reference to the proposed extension of the company's tramways from Harrow-road to Edgware road. It was proposed that the company be allowed to proceed with their bill subject to the Council purchasing the tramways six months from the date of completion at the actual expenditure incurred, and that a further agreement be entered into for giving the company running powers over the line.—Referred back.

Queen's-road Battersea Tramways.—It was agreed to authorise the Works committee to execute the road work and plate-laying for the reconstruction on the conduit system of the tramways from Lavender-hill via Queen's-road, to Chelsea Bridge, at a cost estimated at £31,000.

Lea Bridge, Leyton and Walthamstow Tramways Co.'s Undertaking.—The Highways committee reported that as a result of negotiations there was every probability that satisfactory arrangements for the purchase of the tramways and the electrification of the lines on the overhead system.

Hammersmith to Putney Tramways.—The Standing Orders were suspended to consider the proposal of the Highways committee to expend £34,700 in the construction of authorised tramways from Hammersmith to Putney. The recommendation was carried.

London County Council Tramways.—Fulham Council have assented to the use of the overhead system on the tramway from a point near Hammersmith Broadway across Putney Bridge to Lower Richmond road. This will permit of through cars being run from Putney to Harlesden.

Lowestoft.—A special meeting of the Council in committee is to be summoned to consider the advisability of acquiring the East Anglian Light Railways Order.

The L. G. Board have sanctioned a loan of £940 for free wiring, repayable in 12 years. In view of the popularity of free wiring in the district, it has been decided to apply for sanction to a further loan of £1,000.

Manchester.—On Tuesday the Tramways committee considered their estimate of expenses and receipts for the current year. The committee anticipate an income of £813,662, compared with £769,188 (approximate) this year, and expect to hand over £60,000 for relief of rates, or £5,000 more than last year. Last year the income of the parcels department was £1,240, and the committee expect to receive £1,500 this year from this source. Capital expenditure for next year on new cars, sheds, &c., is estimated at £78,000, against £44,453.

Middlesbrough.—An arrangement was recently arrived at by which the Cleveland & Durham County Electric Power Co. has been supplying power in bulk to Middlesbrough Corporation. Supply was started three or four weeks ago and has been continued without interruption. The company supply power in bulk at a low cost to the Corporation, and are free to directly supply several of the large iron and steel works in the town.

Newport (Mon.).—On Tuesday the Council had before them reports by the borough engineer and tramways manager upon the question of depreciation of rolling stock, permanent way, &c., and it was resolved that before any surplus of tramways revenue be applied to relief of rates, a sum averaging £3,000 per annum be paid to the reserve fund.

Penzance.—The question of revoking the Penzance Electric Lighting Order 1904 has been deferred until Oct. 31.

Presentations.—The tramway staff at Northampton have presented a revolving dish and tray and a gold albert and medallion to Mr. McMahon, electrical engineer, who is leaving for Dumbarton.

On the occasion of his marriage the Batley borough electrical engineer (Mr. S. Derwen Jones) has been presented with an elastic bookcase by the staff of the electricity works.

Provisional Order Revocation.—The Board of Trade have revoked the Yeovil Corporation Electric Lighting Order, 1903.

Rome.—The Municipal Council propose to erect electricity generating works of 7,000 H P. capacity.

St. Pancras (London).—The Finance committee, reporting on the district auditor's report on the electricity accounts for the year ended March, 1906, states that the old practice of dealing with the proportions of interest at the close of each financial year was departed from by the desire of the district auditor, and was a reversion to the old method that the auditor now advocated.

The committee were prepared to agree to the adoption of his suggestions, but such dealings therewith should be final. They were in agreement with the suggestion of the auditor that the accrued portions of loan instalments, interest, rents, taxes, insurance premiums, &c., should be included in the accounts of the electricity undertaking for each financial year, and had given instructions accordingly. The report of the Government Departmental committee on the keeping of municipal accounts had been received, and the committee had approved the proposed method of dealing with running charges in connection with municipal trading undertakings.

The Electricity and Public Lighting committee have accepted the offer of Messrs. Bromhead & Co. to make a thorough and detailed schedule of the stores in hand for balance-sheet purposes and to check and price same, and supply inventory as required for 35 guineas, on the understanding that if engaged for more than one year they will only charge 25 guineas next year, so as to bring their fee to 30 guineas per annum, at which rate they are prepared to do the work in subsequent years.

The Electricity committee strongly disapprove of the proposed alteration of centre lighting to side lighting in Tottenham Court-road, on the ground that experience proves that the centre lighting is more advantageous from an illumination point of view.

Sowerby Bridge.—The Council's Provisional Order (1900) is to be transferred to the Electrical Distribution of Yorkshire (Ltd).

Telegraph Clerks' Conference—At the 28th annual conference of the Telegraph Clerks' Association last week at Glasgow, the following resolutions were passed:—

Telegraphists' Remuneration.—That telegraphists employed upon the cable room staff shall be entitled to an extra £10 per annum as compensatory remuneration for required knowledge of foreign languages; and that the same principle be also applied in all offices in direct telegraphic communication with foreign stations.

Remuneration of Telephonists.—That female telephonists be placed on the same scale of remuneration as female telegraphists.

Theft of Electricity.—At Alnwick Petty Sessions last week William Renwick, John Edgell and John Dunlop were each charged with abstracting electricity to the value of 1s., the property of the Northern Counties Electricity Supply Co., on Feb. 10. Electricity was supplied to each of the tenants through prepayment meters, but as the collections from the meters were extremely small in comparison with the number of lights, a watch was kept, with the result that the electric light was seen to be burning in the different tenements. One night the officials of the company visited each of the tenements to find that the wires in each place were connected with a pin, which prevented the current passing through the meter. The Bench inflicted a penalty of 40s. in each case, and a similar penalty on Adam Wakenshaw, who lived on the same property and who had tampered with his meter by taking off the front and shifting back the registering pointer.

Walsall.—The Electricity committee have decided to supply current through prepayment meters at 5d. per unit for lighting and 2½d. for power and heating.

Warrington.—In the course of a discussion on the estimates at the Council meeting on Tuesday, the chairman of the Electricity committee promised a grant of £2,000 out of the profits of the department in relief of rates.

West Ham.—A writ was recently issued against the Corporation by Mr. F. Osman, contractor for the construction of the tramways, for the recovery of £615 under an agreement for laying and bonding copper bands, and also for damages for breach of contract, &c. The Electricity and Tramways committee have settled the claim, subject to the Council's confirmation, at £2,000, and a sum not exceeding £50 for costs.

Whitehaven.—Sanction to a loan of £1,700 for additional plant at the electricity works has been applied for by the Council.

Willesden.—The electrical engineer (Mr. J. G. Bruce) is preparing specifications, and will advertise for tenders, for additional plant, estimated to cost £1,500, for the Salusbury-road sub-station. An additional feeder cable is to be laid from the sub-station at a cost of £2,070. Various extensions of mains have been authorised.

Wolverhampton.—The Chillington Tool Co. have agreed to take a supply of electrical energy for power and lighting at their workshops in the Willenhall-road.

York.—An inquiry was opened on Tuesday into the application of the Corporation for sanction to borrow £25,285 for excess expenditure on and for extensions of the electricity undertaking.

The Town Clerk submitted a statement of the requirements of the department for the next two years, and the Inspector (Mr. H. Ross Hooper) remarked that there must be a stop put to the practice of loans for money spent in excess of powers. The department had not differentiated their capital expenditure on public lighting, and unless they did that it was impossible to know in a trading concern what things were costing. Ultimately he adjourned the inquiry until June 2 for fuller accounts to be prepared.

Dinner.—The annual dinner and presentation of prizes of the Croydon Tramways Athletic Club took place last week. The tramways manager (Mr. T. B. Goodyer), president of the club, was in the chair, and among others present were the mayor, the chairman of the Tramways committee (Ald. J. Tremble, J.P.), and several councillors and municipal officials. After dinner the prizes were presented by the mayor. The club has sections devoted to cricket, football, swimming, &c., each of which had to record a most successful season.

TRADE NOTES AND NOTICES.

TENDERS INVITED.

Rawtenstall Corporation invite tenders for supply, delivery and erection of steel poles, overhead line equipment and accessories. Copies of general conditions, specification, &c., may be seen at the offices of the consulting engineers (Messrs. Lacey, Sillar & Leigh), 2, Queen Anne's gate, Westminster, and 78, King-street, Manchester, and may be obtained from the former offices only. Tenders to the town clerk (Mr. James Whalley), Municipal Offices, Rawtenstall, by Monday, May 4th. See also an advertisement.

Glasgow Corporation invite tenders for supply of (1) main cables, (2) small cables and wires, (3) electricity meters and (4) arc lamp carbons for 12 months from May 31. Copies of specification and forms of tender from the engineer (Mr. W. W. Lackie) and tenders to the town clerk (Mr. A. W. Myles) by 27th inst. See also an advertisement.

The Electricity committee of *Dundee* Corporation invite tenders for supply and erection complete of the following:—Section A: Complete steam, exhaust, feed-water and drain piping systems, with two steam-driven feed-pumps, and two hot-well tanks for main generating station; Section B: Complete equipment of circulating water pump room, including two electrically-driven vertical spindle centrifugal pumps in connection with the main generating station; Section C: Complete circulating water pipe system (about 1,500 ft.) in connection with the main generating station; Section D: Overhead travelling cranes for main generating station and two substations. Tenders to the town clerk (Mr. W. H. Blyth Martin), City Chambers, Dundee, by first post April 27.

London County Council invite tenders for wiring and fitting for electric lighting of the tramway car shed at Mare street, Hackney. Tenders, upon official forms, to the clerk to the Council (Mr. G. L. Gomme), County Hall, Spring gardens, S.W., by 11 a.m. May 12.

London County Council want tenders by 11 a.m. May 9 for supply of 175 double deck roof covered car bodies and maximum traction swing bolster trucks and complete electrical equipments for same. Forms of tender from the Clerk, Spring-gardens, S.W.

The Electricity committee of *Poplar* (London) Council invite tenders for supply and erection of various switchboards and gear at their electricity works and sub-stations. Drawing and specification from the borough electrical engineer, Mr. J. H. Bowden, Glaucus-street, Bromley-by-Bow, E. Tenders to the town clerk (Mr. Leonard Potts) Council Offices, High-street, Poplar, by noon April 29.

West Bromwich Corporation want tenders by noon, May 9, for the installation of modern destructor plant at the electricity works. Particulars from the Borough Engineer and Surveyor, Town Hall, West Bromwich.

Poplar (London) Council want tenders by noon April 29 for erection of brick, ferro-concrete or corrugated iron sub-station at Millwall. Conditions from Borough Electrical Engineer, Glaucus-street, Bromley-by-Bow, E.

Tonbridge Council invite tenders for 150 kw. high speed steam generating set with ejector condenser; steam feed pump (700 gallons per hour), centrifugal motor-driven pump (20,000 gallons per hour), steam, exhaust, feed and water piping; and two switchboard panels, milking booster and switchgear, cables and connections. Tenders to the Clerk by the 22nd inst.

Manchester Electricity committee require tenders by 10 a.m. 22nd inst. for supply of 10 ton locomotive tipping crane for Stuart-street generating station. Specification from Mr. F. E. Hughes, Town Hall, Manchester.

Manchester Tramways committee want tenders by 10 a.m. 21st inst for supply of steel tee girder rails and fishplates. Specifications from Mr. J. M. McElroy, 55, Piccadilly, Manchester.

Antwerp Municipal Authorities invite tenders for the supply and erection of two electric lifts in the municipal premises in the Palace de Meir. Tenders to M. le Bourgmestre de la Ville, Hotel de Ville, Antwerp, by April 30. A deposit of Fr.1,000 (about £40) will be required. A copy of the specification may be inspected by British contractors at the Board of Trade, 73, Basinghall-street, London, E.C.

TENDERS RECEIVED AND ACCEPTED.

The British Thomson Houston Co. have received an order from the Tyneside Electrical Development Co. for an exhaust steam turbine having an output of 1,500 k.v.a. at 2,875 volts 40 cycles when running at a speed of 2,400 revs. per min.

The turbine will be a standard Curtis type, containing two stages, direct coupled to a three-phase 40 cycle alternator. The steam for the turbine will be supplied from the works of the Teesbridge Iron Co. at atmospheric pressure, and will be condensed by surface condensing plant of the Mirrlees Watson Co. The condensed steam will be returned to the Teesbridge Co. Provision has been made so that should the turbine not be running at any time it can be isolated from the condensing plant and the condensed steam be still utilised for the boiler feed of the Teesbridge Iron Co. The turbine and the generator will be capable of an overload of 1,800 k.v.a. The plant has been so arranged that the necessity for the usual foundations is avoided, the condenser being on the same floor level as the turbine itself. The air and circulating pumps will be driven by three phase 440 volt 40 cycle B.T.-H. motors. The sluice valve between condensing plant and turbine will also be motor-operated.

The Gemeente Electriciteitswerken, Hoogte-Kadijk, 200, Hoek-Sarphatistraat, Amsterdam, have placed an order with Ed. Bennis & Co., Little Hulton, Bolton, for supply of 16 Bennis stokers and new patent self-cleaning compressed air furnaces for Lancashire-type boilers. This order is consequent on the excellent results obtained since the installation 10 months ago of 16 Bennis stokers. The former contract was obtained in competition with German manufacturers.

Lancaster Council have accepted the following tenders for the equipment of the electrical laboratories at the Technical Institute:—

Phœnix Dynamo Mfg. Co., two motors, £92; Veritys Limited, switchboard gear, £33. 6s. 3d.; Tudor Accumulator Co., 65 storage cells, £47. 5s.; General Electric Co., cables, £25. 16s. 6d.; Everett, Edgcumbe & Co., instruments, £65. 4s. 5d.; Clark Fisher, instruments, £39. 17s. 6d.

Beckenham Council have accepted the tender of the National Telephone Co. for fixing and maintaining the Stuart & Moore pendulum fire alarm system in the district at £180 per annum. The General Post Office offered to instal the Buzzer system, with street posts and overhead wires, at £152 per annum, plus cost of testing, which was estimated at a further £36.

Fulham (London) Council has accepted the following tenders for annual supplies:—General Electric Co., fuse wire. &c.; G. A. Pestalozzi & Co., carbons; W. Lucy & Co., house cutouts; A. Duckham & Co., cylinder oil; W. H. Willcox & Co., crank-chamber oil; H. Edmonds & Co., packings, &c.

Erith Council have accepted the following tenders for the electricity department: W. H. Willcox & Co., oils, gauge glasses, &c.; Veritys Limited, carbons and incandescent lamps; General Electric Co., meters; British Insulated & Helsby Cables, cutouts; Callender's Co., joint boxes; Owen's Ironmongery Stores, packings, &c.

London County Council received 16 tenders for the electric lighting of the secondary schools in Dawes-road, Fulham, and Hortensia-road, Chelsea, and the amounts varied from £665 to £1,542 in the case of Dawes-road school and from £685 to £1,142 for Hortensia road school. The lowest tender in each case (by G. H. Haden & Sons) was accepted.

London County Council have also accepted the tender of the Forced Lubrication Co. for shafting, brackets, &c., at £400. 3s. 2d., and for pulleys at £100, for the first portion of the central car repair depot in Woolwich-road. Eight tenders were received from five firms, the amounts varying from that of the accepted tender to £572. 1s. 3d.

London County Council have also entered into the following contracts: Hurst, Nelson & Co. for furniture for 50 tramcars at £369. 0s 9d. per set, sanding gear at £8. 2s. 6d. per set, movable steps £3. 12s. 6d. per set, lifeguards £4. 5s. per set, window operating gear £12. 10s. per set, and sunblinds 14s. each; United Electric Car Co. for brake gear £4. 19s. per set; Hoskins & Sewell, for ventilator operating gear at £3 per set.

For the supply and delivery of a battery booster, Whitehaven Council received 13 tenders, varying from £123. 16s. to £203, and the lowest (that of the Phœnix Dynamo Mfg. Co.) was accepted. The Council also received 16 tenders for the supply and delivery of a switchboard, and the lowest (that of Whipp & Bourne, at £86. 5s. was accepted. The highest tender was £164. 16s. 4d. The tender of the Tudor Accumulator Co. for a milking booster has also been accepted by the Council. The estimate of the electrical engineer (Mr. Bernard Sankey) for the switchboard and booster, erected and connected complete with battery meters (£30), was £300.

At a recent meeting of the Stalybridge, Hyde, Mossley and Dukinfield Tramways and Electricity Board the Generating Station committee were authorised to accept the tender of Willans & Robinson for supply of a third turbine and that of Ferranti Limited) for a switchboard.

Hammersmith Electricity and Lighting committee have accepted the tender of the Main Colliery Co. for the supply of Graigola and Victoria coal for three months at 15s. 10d., with option to continue contract for nine months further.

Bristol Electrical committee have accepted the tender of W. Cowlin & Son for a storage tank at the Avonbank electricity works at £645, and that of the Bedminster Collieries for 12 months' supply of coal.

The G.E. Railway Co. have placed an order with the Sandycroft Foundry Co., of Sandycroft, near Chester, for 10 "Cascade" induction motors for driving printing presses.

Bradford Corporation have accepted the tender of Hadfield's Steel Foundry Co. for tramway points and that of J. & T. Clark for malleable iron castings.

For repairs to the lighting battery at Victoria Embankment, London County Council have accepted the offer of the Electrical Power Storage Co. at £150.

Belfast Tramways and Electricity committee have accepted the tender of J. & S. Scott & Co. for the supply of 170 gunmetal keyhole covers for the tramway feeder pillars.

Burslem Council have accepted the tender of Babcock & Wilcox for a boiler at £1,500.

Liverpool Corporation have placed an order with the British Westinghouse Co. for a 500 kw. and two 200 kw. motor generators.

Mansfield Guardians have accepted the tender of J. Woolley for a year's maintenance of telephones, &c., at the workhouse.

Brierfield Council have accepted the tender of Carter & Co. for maintenance of the fire alarms in the district for a year.

Burslem Council have accepted the tender of Babcock & Wilcox for a boiler at £1,500.

Cheltenham Corporation have accepted the tender of G. & J. Weir for a steam-driven pump for £92.

Yarmouth Corporation have accepted the tender of Cory & Sons for 500 tons of Pleasley hard coal at 15s. 3d. per ton.

The Postmaster-General's Department, Adelaide (South Australia) have accepted the tender of British Insulated & Helsby Cables for supply of lead-covered cable of various sizes, the total amount of the contract being £4,832. 4s. 9d.

University College of South Wales and Monmouthshire.—The contract for the electric lighting of this college, which is close to the law courts and town hall in Cathays Park, Cardiff, has been let to Messrs. R. Alger & Sons, Newport, Mon.

Owing to the character of the building, a very wide scheme of corridor or leading light has been adopted, and every department is so arranged that when the main lighting is turned off by the attendant a leading light is left, which is double corridor switched everywhere, enabling a professor or other official to pass about the building. The installation throughout will be carried out in heavy gauge screwed steel conduit which will be buried. Provision is made for 1,300 lights. The special feature of the fittings will be that in all demonstration lecture rooms and diagram rooms the lighting will be by means of long reflected fittings, protecting the eyes of the worker. The fans to be used for ventilating will be driven by electric motors. Osram metallic filament lamps will be used throughout the building.

Messrs. Alger & Sons have also a number of important installations in hand, including a considerable amount of colliery work.

Generating Plant Sale.—Birmingham Corporation has accepted the tender of Mr. E. J. Jennings, West Walls, Westgate, Newcastle-on-Tyne, for the purchase of the whole of the generating sets, d.c. transformers, balancers, &c., which until recently formed their generating plant at the Dale End station.

BUSINESS NOTICES.

Messrs. L. J. Healing & Co., of Yokohama, Kobe and Tokio, Japan, have converted their business into a limited company with a capital of £100,000, under the style of L. J. Healing & Co. (Ltd.). Messrs. Tozer, Kemsley & Fisher, of 84, Fenchurch-street, E.C., will continue to act as commercial agents in this country, and there will be no public issue of shares.

Jas. St. J. Smith and Albt. A. Barron (trading as J. J. Smith & Co.), electrical fittings merchants, &c., 46A, Holborn-viaduct, and 48 and 49, Farringdon street, London, E.C., have dissolved partnership. Debts by Mr. Smith, who continues under same style.

Personal.—Mr. R. Ley Alkin, A.M.I.E.E., of the firm of L. J. Healing & Co., of Yokohama, Kobe and Tokyo, will shortly arrive in England on a business and pleasure trip. His address will be care of Messrs. Tozer, Kemsley & Fisher, Ltd., 84, Fenchurch-street, London, E.C.

BANKRUPTCIES, LIQUIDATIONS, &c.

The St. Albans & District Electric Supply Co. (Ltd.) is being wound up voluntarily. Mr. J. McLeod, 101, Finsbury-pavement, London, E.C., is liquidator.

The Monobloc Accumulator Synd. (Ltd.) is being wound voluntarily. Mr. H. Newson-Smith, 37, Walbrook, London, E.C., is liquidator.

A meeting to receive an account of the winding up of R. W. Vicarey (Ltd.) will be held on May 12 at County Chambers, High-street, Shrewsbury.

A meeting to receive an account of the winding-up of Siemens Electric Appliances Co. (Ltd.) will be held at 12, Queen Anne's-gate, London, S.W., on May 20.

A first and final dividend of 9s. 7d. will be payable on April 23, at 6, Bond-street, Wakefield, in the bankruptcy of Hy. Wainwright, electrical engineer, George-yard, Barnsley.

Plant, &c., for Sale.—A 40 B.H.P. Crossley gas engine (in first-class condition) is advertised for sale; also dynamo capable of supplying 450 16 c.p. lights. Plant can be seen running.

An advertiser wishes to dispose of two 12 in. Blackman fans, with starters, for 220 volt d.c. circuit.

Process for Insulating Cables.—The proprietor of Patent No. 8,991 (1905) for an improved process for insulating electric wires and cables, advertises that he is desirous of entering into arrangements, by way of licence and otherwise, for exploiting same and insuring its full development and practical working in this country. Communications to Messrs. Haseltine, Lake & Co., chartered patent agents and consulting engineers, 7 & 8, Southampton-buildings, Chancery lane, London, W.C.

Partnership Wanted.—An electro-metallurgical engineer, having valuable patents and with large contracts pending, advertises for a partner who could take up foreign travel.

Australasian Representation Wanted.—An experienced engineer, who is shortly leaving for Australia, advertises that he is open to negotiate with firms requiring a representative.

"Export Merchant Shippers and Manufacturers."—We have received a copy of the 1908 edition of the "Export Merchant Shippers and Manufacturers of Great Britain and Ireland" from the Carter Publishing Co., 15, Great Turnstile, High Holborn, London, W.C. The work is divided in two volumes. Vol. I. contains lists of exporters, places of shipment and classes of goods shipped, and an alphabetical index of classes of goods shipped, with the names and addresses of exporters and merchants shipping such goods, and other useful commercial information. Vol. II. gives similar particulars in regard to the provinces, and also trade marks sections and a manufacturers' trade directory ("Buyers' Guide"). Both volumes have been enlarged, and several new trade headings and over 300 names of manufacturing export firms have been added. It is claimed that every portion of the work has been thoroughly revised, and special care has been taken to avoid errors in addresses and in the information given. The published price of the book, which should prove very useful to those engaged in oversea trade, is 15s. 6d. net.

CATALOGUES, &c.

Colliery Card.—The British Westinghouse Co. are to be complimented upon the style and arrangement of their special wall card illustrating types of electrical machinery and apparatus for collieries and mines. The centre of the card is occupied by a sectional view of a coal pit. On the ground level are shown the power house, main winding engine and conveying and screening plant. Below these are sectional illustrations of underground haulage gear, pumping plant and motor-driven air compressors. A view is also shown of an underground sub-station. Immediately to the left and right of this diagram are panels containing cable formulæ, and the approximate rules for finding cable sections. The remainder of the card is filled with illustrations of typical Westinghouse switchgear, motors, motor installations, engine type and turbine generators, locomotives and ventilating plant. The card should form a useful reminder to colliery managers of the standardisation of electrical machinery and apparatus for mining work, particularly as the illustrations represent actual instances of the use of electric power in British collieries and mines. The card has been prepared from a thoroughly practical standpoint, so that its main features will naturally appeal to colliery men.

Arc Lamp Couplings.—The wide and varied experience of the Union Electric Co. with arc lamps of every description adds considerable interest to their designs of strain releases and arc lamp couplings. These are fully described in a list (No. 1,401) which has just reached us.

Enclosed Lamps.—A further addition to the B.T.-H. Co.'s pamphlet No. 207 dealing with enclosed arc lamps has come to hand. This has been prepared in the standard size of the company's publications, and among the illustrations is an interesting view of the railway goods yard at Newcastle-on-Tyne, where over 900 B.T.-H. lamps are in use.

Die Castings.—The perfection of processes for the accurate production of castings of both large and small size has been the means of saving a large amount of machining work for castings of every description. The Gratze Patents & Engineering Synd., Whitfield-street, London, W., make a speciality of die-finished castings of every description. Pieces can be cast any size from ½ in. square to 3 ft. square with great accuracy. The process is suitable for aluminium or alloys, and we understand that only a portion of the cost of the dies is debited to customers.

More Complex "Simplexities."—If the Simplex Co. continue their present policy it will be necessary for us to employ a professor of languages to translate their pamphlets. Last week we received a catalogue in French, and this week we are presented with a leaflet containing a copy of the speech delivered recently by Mr. A. Lester Taylor at the official opening of the company's new London pre-

mises in French, German and, we believe, Russian! In thus providing technical literature in other languages than our own Simplex Conduits (Ltd.) will, at any rate, help the spread of education

Ignition Specialities.—John C. Fuller & Son, Wick lane, Bow, London, E., have issued a complete catalogue of their wide and varied range of specialities for ignition purposes. These include the well-known Fuller magneto, of which a complete description with sectional diagrams is given in the list. The interesting feature of this speciality is the Fuller patent self-starting arrangement by which the car can be started from the driver's seat.

Imports.—The following are official values of electrical machinery, material and apparatus imported into this country (*a*) during March, 1908, and (*b*) during the current year from Jan. 1 to March 31, with the increases or decreases compared with the corresponding periods of 1907:—

Electrical machinery (*a*) £67,707 (increase £4,088); (*b*) £181,013 (increase £36,820); telegraph and telephone cables (*a*) £9,851 (decrease £14,502); (*b*) £34,699 (decrease £42,023); telegraph and telephone apparatus (*a*) £18,438 (decrease £3,303), (*b*) £59,995 (decrease £1,813); other electrical wires and cables, rubber insulated (*a*) £5,808 (decrease £3,058), (*b*) £18,829 (decrease £4,425); with other insulations (*a*) £8,324 (decrease £2,446), (*b*) £27,713 (decrease £158). The following were not separately enumerated last year: Carbons (*a*) £17,445; (*b*) £48,033; glow lamps (*a*) £15,855, (*b*) £59,957; arc lamps and electric searchlights (*a*) £311, (*b*) £1,136; parts of arc lamps and search lights (other than carbons) (*a*) £4,337, (*b*) £14,367; primary and secondary batteries (*a*) £5,239, (*b*) £10,374. Total of electrical goods and apparatus, other than machinery and telegraph and telephone wire (*a*) £97,855 (decrease £12,633), (*b*) £302,065 (decrease £22,740).

Exports.—The exports of electrical machinery, material, &c. (*a*) during March, 1908, and (*b*) during the current year from Jan. 1 to March 31, and the increases or decreases compared with the corresponding periods of 1907, are as follows:—

Electrical machinery (*a*) £114,599 (increase £43,517), (*b*) £355,971 (increase £150,358); telegraph and telephone cables (*a*) £49,673 (decrease £32,881), (*b*) £166,850 (decrease £60,497); telegraph and telephone apparatus (*a*) £10,379 (decrease £801), (*b*) £40,133 (increase £4,006); other electrical wires and cables, rubber insulated (*a*) £22,950 (decrease £69), (*b*) £75,347 (decrease £145); with other insulations (*a*) £18,004 (increase £2,483), (*b*) £59,625 (increase £19,926). The following were not separately enumerated last year: Carbons (*a*) £1,048, (*b*) £1,621; glow lamps (*a*) £3,469, (*b*) £9,872; arc lamps and searchlights (*a*) £1,347, (*b*) £3,530; parts of arc lamps and searchlights (other than carbons) (*a*) £1,042, (*b*) £3,702; primary and secondary batteries (*a*) £6,596, (*b*) £8,601. Total of electrical goods and apparatus, other than machinery and telegraph and telephone wire (*a*) £142,588 (decrease £41,219), (*b*) £459,606 (decrease £56,131).

PATENT RECORD.

APPLICATIONS FOR PATENTS.

NOTE. *The undermentioned Applications (except those marked †) are not open to public inspection until after acceptance of Complete Specifications. Those marked † are open for inspection 12 months after the date attached to them, if they have not been published previously in the ordinary course. Names within parentheses are those of communicators of inventions. When Complete Specification accompanies application, an asterisk is affixed.*

January 7, 1908.

372 JACOBS. Composite telegraph-telephone circuits.
391 STOTT. Incandescent lamps.
401 EDISON. Electrolytes for alkaline storage batteries. (Date applied for, 10/5/07.)*†
425 HYTTEN. Telegraphone apparatus.*
434 B.T.-H. Co. (G.E. Co., U.S.) Electric measuring instruments.

January 8, 1908.

440 EDISON & SWAN UNITED ELECTRIC LIGHT CO. & GIMMINGHAM. Incandescent electric lamps.
445 SOMER & CROWLEY. Storage batteries.
461 STEARS & TOPHAM. Incandescent lamps.
468 SIEMENS BROS. DYNAMO WORKS. (Siemens Schuckertwerke G.m.b.H., Germany.) Electricity meters.*
479 SMITH. Switches.
496 EISENSTEIN. Multiple and harmonic telegraphy with undamped oscillations.*
4[illegible] SAMATA. Setting the points of a railway or tramway by the driver of an approaching vehicle.*
505 BURT. Electric alarm apparatus.

January 9, 1908.

549 TRUMPLER. Electrical heating apparatus. (Date applied for, 1/2/07.)*†
551 DRAGER & DRAGER. Electric lamps for miners' helmets and the like.*
560 AMALGAMATED RADIO TELEGRAPH CO. (Poulsen, Denmark.) Radio-telegraphy.*
[illegible]A B.T.-H. CO. & WEDMORE. Switches. (Date applied for, 9/1/07.)

January 10, 1908.

[illegible] KOTT. Electrically driven vehicles.
[illegible] [illegible]. Electric motors and generators.
608 GARFORTH & BOUSFIELD. Switch and fuse boxes.*
613 GIRDLESTONE & JONES. Fluid contacts for electrical purposes.
620 FAIRWEATHER. (Benjamin Electric Mfg. Co., U.S.). Lamp clusters.*
658 AMALGAMATED RADIO TELEGRAPH CO. & MASKELYNE. Pictorial telegraphy.
660 ALLGEMEINE ELEKTRICITÄTS-GES. Multiple-rate electricity meters. (Date applied for, 11/1/07.)*†
661 ALEXANDERSON. Dynamo-electric machine. (Date applied for, 12/1/07.)*†

January 11, 1908.

665 STROHMENGER. New material for separating or enclosing plates of secondary batteries.*
700 AGRELL. Electric type-printing apparatus. (Date applied for, 12/1/07.)*†
726 JACOB. Electro-chemical process for the manufacture of acetates.
732 B.T.-H. CO. & NEEDHAM. Incandescent lamps.

January 13, 1908.

27,412A/07 BEVIS & ANGOLD. Arc lamps. (Date applied for, 13/12/07.)
784 SHELDON. Trolley pole contacts.
786 TIMBRELL & GABRIEL. Lifeguard for tramcars.
795 BROUGHAM. (Moore Electrical Co., U.S.) Rotary vacuum pumps.*
796 AUBERT & AUBERT. Electric apparatus for igniting and extinguishing lamps.*
811 GLENISTER & GLENISTER. Insulating wires, cables and the like.

January 14, 1908.

865 THORPE. Electrolytic meters.
871 PILKINGTON. Electric bells, induction-coils, &c.
873 JACOBY. Controlling electric motors.
877 SIEMENS BROS. DYNAMO WORKS & CLIFT. Automatic stopping devices for electric hoists.*
878 SIEMENS BROS. DYNAMO WORKS. (Elektrizitäts-Akt.-Ges. vorm. Schuckert & Co., Germany.) Arrangement on electricity meters for determining maximum consumption.*
880 BOULT. (Benjamin Electric Mfg. Co., U.S.) Electric lamp sockets or holding devices.*
889 SEIBT & AMALGAMATED RADIO-TELEGRAPH CO. Radio-telephony. (Date applied for, 14/1/07.)*†
892 CROMPTON & CO., MACFARLANE & BURGE. Alternating-current motors of the induction type.
893 FYNN. Alternate-current motors.
897 BOSCH. Testing installation for electromagnetic sparking plugs. (Date applied for, 22/3/07.)*†
898 BOSCH. Electromagnetic sparking machines. (Date applied for, 23/9/07.)*†
899 SIEMENS-SCHUCKERTWERKE G.M.B.H. Electric cable boxes or troughs. (Date applied for, 16/9/07.)*†

January 15, 1908.

5,506A/07 LAMME. Connection system for dynamo-electric machines. (Date applied for, 15/3/06).*
936 MUNRO. Preserving and fixing telegraph, telephone or other wires to insulators.
949 RICHMOND. Batteries. (Application for Patent of Addition to No. 3,962/07.)
951 GREENE. Electrical connector for lamps and other apparatus.
956 STOTT. Electrical controlling mechanism, chiefly for use with ships' steering gear.
977 ALLATT. Gas governor (electrically fitted).
980 RANSFORD. (Manson, Natal.) Apparatus for straining telegraph, telephone and like wires.
996 LEWIS. Dynamo-electric machinery.
997 COWPER-COLES. Electro-deposition of metals.
1,003 MARTIN. Electrical release devices for the control of electrical energy.
1,005 LAKE. (Clare, U.S.) Storage batteries.*

January 16, 1908.

1,019 GOLDSTONE, WARD & GOLDSTONE. Electric cycle lamps.
1,034 SUMMERS, WOOTON, HILL & GREEN, trading as RELIABLE LOCK & BRASSFOUNDRY CO. Electrically controlled locks and latches.
1,100 VALLAT. Electrical ignition for explosion engines.
1,109 CHAMBERS. Rails more particularly for use with tramways.

January 17, 1908.

5,508A/07 LAMME. Connection system for dynamo-electric machines. (Date applied for, 2/8/06.)
1,118 PATTERSON. Lighting miners' safety lamps by electricity.
1,131 CAMPBELL & WILLIAMS. Magnetic stands or holding appliances for tools.*
1,159 THOMPSON. Regulating apparatus for alternating-current circuits. (Date applied for, 2/3/07.)*†
1,178 SIMPSON. Brake blocks, electrical collector slippers and the like.

January 18, 1908.

1,187 THOMSON. (Kempt, Argentine Republic.) Conductors and collectors for electric railways and tramways.
1,209 PEARSON. Electric transmission and reproduction of pictorial representations.
1,221 TOMPKINS. Trolleys for electric railways and tramways.
1,239 HOFFMAN. Suspending devices for electric conductors. (Date applied for, 8/10/07.)*†
1,240 GUILLOT. Suspension devices for electric conductors. (Date applied for, 10/10/07.)*†
1,250 JENSEN. (Jeffrey, U.S.) Electrically driven mining machines.*

SPECIFICATIONS PUBLISHED.

1907 Specifications.

18,319 Girdlestone & Jones. Automatically limiting a current to a predetermined value.

18,921 British Insulated & Helsby Cables & Harrison. Telegraph apparatus.

18,955 Artom. Transmitters for electromagnetic waves Date applied for, 2/2 07.)

19,800 Lake. (Fabrik Elektrischer Zunder.) Dynamos for exploding electric igniters

19,829 Gilmore. Manufacturing reflector incandescent lamps

20,650 Hartenstein. Electric furnaces.

20,651 Hartenstein. Carbon holders for electric furnaces.

20,948 Siemens Bros. Dynamo Works. (Siemens Schuckertwerke Ges.) Reducing disturbances in telephone and telegraph wires.

21,030 Märkische Maschinenbauanstalt Ludwig Stuckenholz A.-G. Magnets for lifting. (Date applied for, 21/3/07.)

21,862 Rickmann. Armature for magneto-electric igniting apparatuses.

22,301 Noeggerath. Current-collecting devices for dynamo electric machines. (Date applied for, 10/10/06).

22,322 Jones. Brakes for tramway and railway vehicles.

23,497 Siemens-Schuckertwerke Ges. Spring support for motor on the axle of a vehicle. (Date applied for, 25 10 06.)

24,028 Wolfram Lampen A.-G. Process for decarbonising tungsten filaments containing carbon or carbide. (Date applied for, 31 8/06.

26,130 Brewer. (Taylor.) Electric furnaces.

26,846 Allgemeine Elektricitäts Ges. Arc lamps. (Date applied for, 5/12 06.)

COMPANIES' MEETINGS AND REPORTS.

Cuba Submarine Telegraph Co. (Ltd.)

The seventy-third ordinary general meeting was held on Wednesday, Mr Charles W. Parish, presiding.

The SECRETARY (Mr. James Scott) read the notice calling the meeting, and also the auditors' report.

The CHAIRMAN said: In looking back to the records of our two last meetings, one of which was held this time last year and the other last October, I find in each case I had to explain that our profits had been influenced by some unexpected occurrence. In the first case, our traffics had been increased by the political rising in the Island of Cuba, which led to American intervention, and in the following half-year came the earthquake in Jamaica, which brought a heavy addition to the Press and private messages from the West Indies. But during the half-year from July to December, with which we are now dealing, nothing unusual has happened of any importance. The cables have worked well, and we have had a satisfactory traffic which we have been easily able to deal with quickly and accurately. I must point out that in making comparisons between this half and the same period last year the exceptional traffic resulting from the political rising must be remembered. In 1906 we had as revenue £18,458 of traffic and £1,549 of interest, making together a total of £20,007; now we have £15,521 of traffic and £1,957 of interest, giving together £17,478, or a reduction of £2,529. You will notice our traffic is less, while the amount we received for interest is greater, owing to the high rate we earned on our cash balances. Our expenses in 1906 were £6,513, while in the present half-year they were £6,177, or £336 less. This reduction chiefly results from the maintenance and repairs of the cables having been less, and also there was a reduction in the overtime worked by our local staff; but, as I have mentioned on previous occasions, we find very little variation in our expenses. Every item thereof is carefully watched and adjusted, and I can safely assure you there is neither waste nor extravagance. Deducting our expenses of £6,178 from our gross receipts of £17,478, we have £11,300 to deal with. We have placed £3,000 to the reserve, and we are able to propose to you the usual dividend at the rate of 10 per cent. per annum on the £60,000 of preference shares and 6 per cent. per annum on our £160,000 of ordinary share capital, thus maintaining the same rate as we paid last October—a result which, I am sure, will be satisfactory to you, especially as the balance carried forward is slightly increased. So far as we have progressed in the present half, everything has gone along quietly, much on the same lines as heretofore, but I ought to mention that there has been rather a set back in the Island. Unfortunately the sugar crop has been a very short one, and this, as you know, is a most important point in the prosperity of Cuba.

In reference to our claims against the United States Government, and against the Spanish Government, I can only report that we are still pursuing them, and we hope that we may yet be successful in obtaining that compensation that is clearly due to us. It is not a very amusing part of our work to have to pursue these claims against the American and Spanish Governments, but I can assure you that the board keep them clearly before their minds, and we mean to push on with them. I now move the adoption of the report and accounts.

Mr. GEORGE KEITH seconded the motion, which was carried unanimously.

A resolution approving the dividends was then carried unanimously and a hearty vote of thanks to the chairman and directors brought the proceedings to a close.

BATH ELECTRIC TRAMWAYS (LTD.)—Sir Vincent Caillard stated at the meeting on Tuesday that the receipts were £1,270 less than in 1906, due entirely to bad weather. Expenses had increased by £256. They had applied to the Board of Trade to allow them to increase their rates on a portion of the Weston route, and the Bath Rural Council had decided that they would not oppose the application. After paying debenture interest and preference dividend, the balance (£2,489) has been carried forward. That sum would enable them to pay a 3 per cent. dividend, but the directors did not believe in dividing up to the hilt.

CALCUTTA TRAMWAYS CO. (LTD.)—At the meeting on Tuesday, Mr. E. C. Morgan said that £145,408 had been expended on extension works, which had been in progress during the year. About six miles of line were actually completed, and only required a few formalities to become immediately operative and revenue earning. In spite of difficulties they had obtained receipts amounting to £167,578, or £8,521 more than in 1906. But their increased receipts were more than counterbalanced by heavy expenditure. Power expenses were higher by £2,024, partly due to fuel; but the main increase had been owing to maintenance and repairs to plant. Traffic expenses were higher by £1,710, and maintenance and repairs by £7,164. The latter increase was mainly due to cars and their electrical equipment. General expenses also showed an increase of £6,418.

CITY OF BIRMINGHAM TRAMWAYS CO. (LTD.)—After providing £12,000 for debenture interest and £12,083. 6s. 8d. for preference dividend to Dec. 31, the surplus for 1907 was £35,772. 12s. 11d., from which is deducted interim dividend at rate of 5 per cent. on the ordinary shares for the half-year ended June 30, leaving £33,667. 18s. 11d. The directors recommend payment of a further dividend on the ordinary shares at the rate of 5 per cent for the six months to Dec. 31, together with a bonus of 5 per cent. (making 10 per cent. for the year) and the transference of £27,353. 16s. 11d. to reserve. Capital expenditure during the year was £8,696. 3s. 6d. The traffic receipts compared with 1906 show a reduction of £131,000, due to termination of the leases of the steam tramways in Birmingham and the sale of certain of the tramways in King's Norton and Handsworth. The shrinkage in the receipts has been slightly less than was anticipated. Expenses have been proportionately reduced and £12,200 less was paid for rental of lines Negotiations have been carried on during the year with the City of Birmingham and with other local authorities in regard to the disposal of the company's remaining interest in the tramways. Notice has been received from Handsworth Council of their intention to purchase a portion of the company's tramways, the price to be settled by arbitration, failing agreement. The working of the company's undertaking by the Birmingham and Midland Tramways joint committee continues to show satisfactory results, and the arrangement has been further continued. Owing to the competition of the Corporation tramways, and the excessively heavy cost of repairs and maintenance of the motor omnibuses and the prevalence of bad weather, the result of the past year's working of the Birmingham & Midland motor omnibuses has been very unsatisfactory, and the vehicles have been withdrawn from service.

CORK ELECTRIC TRAMWAYS & LIGHTING CO, (LTD.)—The receipts during 1907 were £51,513. 8s. 3d., and expenses £31,797. 1s. 3d. With £702. 16s. 2d. from 1906, the balance is £20,419. 3s. 2d. After paying interest and preference dividend, adding £2,500 to reserve, writing off £2,990. 8s., the directors recommend payment of 3 per cent. dividend on the ordinary shares, leaving £735. 13s. 9d. to be carried forward. The lighting and power business shows increased receipts of £2,870, or over 12 per cent. compared with the previous year, and now exceed the traction receipts. Owing to bad weather and trade depression the tramway traffic revenue shows a decrease of £792 compared with 1906. During 1906 and 1907 it became necessary to replace certain cables laid under the bed of the river at a cost of £1,742, and this amount has been written off. During the past year a considerable length of overhead line has been renewed out of revenue, and larger percentages have been written off certain items than in former years. Capital expenditure has been mainly on house services and additional plant for the power station.

DUDLEY, STOURBRIDGE & DISTRICT ELECTRIC TRACTION CO. (LTD.)—The gross receipts for 1907 were £46,254. 7s. 6d. After deducting all expenses, there remains £11,893. 16s. Deducting preference dividend to Dec. 31 and adding £1,050 brought forward, £7,948. 16s. 6d. is available for allocation. £1,000 is to be placed to sinking fund, £1,000 to depreciation and reserve and the directors recommend a dividend of 5 per cent. on the ordinary shares. It is proposed to enter into an agreement with the Birmingham & Midland Co. and the Shropshire, Worcestershire & Staffordshire Electric Power Co. to sell to the Power Co. the generating stations at Hart's Hill, Amblecote and Lye. As a condition of the sale, arrangements will be made for obtaining a supply of power from the Shropshire Co. at favourable prices. The arrangement for the management of all the tramways in the Black Country by the Birmingham & Midland Tramways Joint Committee has continued to work satisfactorily, and the agreement with the other companies has been continued for a further period. The parcels and goods service has been further developed during the year with good results. The gross receipts amounted to £607. 14s. 1d. and the expenses £511. 2s. 1d.

GRAND TRUNK RAILWAY CO. OF CANADA.—At the meeting last week the chairman (Sir Chas. Rivers Wilson) said that the work in connection with operating the traffic through the St. Clare Tunnel by electricity was now completed, and the reports were to the effect that the trains were running most successfully.

INDO-EUROPEAN TELEGRAPH CO. (LTD.)—The directors report for the year ended Dec. 31 last states that the lines of the company continue to work efficiently, and the direct Wheatstone working enables the heavy traffics to be dealt with continually, diminishing delay and with a minimum of errors. The company's revenue from message account and other sources amounted to £136,579 2s. 2d., compared with £124,610. 4s. 7d. for 1906, an increase of £11,968. 17s. 7d. The expenses are: On commercial and general account £47,618. 4s. 1d., and on maintenance account £25,434. 15s. 7d., total £73,052. 19s. 8d., against £73,643. 12s. 10d. for 1906, a decrease of £590. 13s. 2d. The revenue account, therefore, shows a balance of £63,526. 2s, 6d, which is carried to profit and loss account, 1907, and, after deduction of income tax paid, is reduced to £60,228. 6s. 2d. To this is added £8,974.15s.5d. brought forward, making £69,203. 1s. 7d. £18,144.13s.9d. has been provided to meet further depreciation to date on the company's investments and a small loss in connection with the redemption of certain of the same. Deducting this sum and the interim dividend of £10,625, there is a balance available for distribution of £40,433.7s.10d., and the directors propose a dividend for the six months ended Dec. 31 of 17s. 6d. per share (making with the interim 6 per cent. for the year and a bonus of 20s. per share (both tax free), carrying forward £8,558. 7s. 10d. It is also proposed to make a special distribution to the shareholders of £12,750, equivalent to 15s. per share, out of interest upon certain investments. This distribution will also be tax free.

OLDHAM, ASHTON & HYDE ELECTRIC TRAMWAY (LTD.)—The directors' report for 1907 states that the directors have had under consideration the question of making provision for the cost of renewals other than those ordinarily charged against the year's revenue, and have debited profit and loss with £1,716. 5s. 7d. to be placed to a provision for renewals. The total revenue for 1907 was £33,296. 2s. 2d. and the expenditure (including interest and the above £1,716. 5s. 7d.) £26,547. 3s. 8d., leaving £6,748. 18s. 6d. The directors propose to apply £500 to form a cumulative sinking fund for redemption of outstanding debentures, £1,000 to depreciation and reserve, £2,500 as preference dividend, and £3,000 as an ordinary dividend at the rate of 7 per cent. for the six months to Dec. 31 (making 6 per cent. for the year).

RIVER PLATE ELECTRICITY CO. (LTD.)—For the year 1907 the net revenue, after providing for debenture interest and depreciations, was £17,290, against £12,018 for 1906. The directors propose to pay 6 per cent. on the preference shares for the year, 6 per cent. on the ordinary shares (against 2½ per cent. last year), to put £4,000 to general reserve (against £2,000), and to increase the carry forward to £5,410. The demand for lighting and power at La Plata has necessitated further machinery and cables. The supply of further machinery for 1909 and 1910 is under consideration.

SLOUGH & ETON ELECTRICITY SUPPLY CO. (LTD.)—At the meeting last week the directors' report stated that during 1907 the equivalent of 1,746 8 c.p. lamps had been connected to the mains, making the total 13,072 8 c.p. The net profit was £2,756. 6s. 5d. A dividend of 3½ per cent. (less tax) was declared.

WINDSOR ELECTRICAL INSTALLATION CO. (LTD.)—The directors' report states that during 1907 the equivalent of 2,909 8 c.p. lamps were connected to the mains, bringing the total to 42,171 8 c.p., of which 3,498 c.p. represented power. The profit was £4,929. 11s. 6d., to which £250 was added from the dividend equalisation fund, making £5,179. 11s. 6d. After paying interest, preference dividend, and placing £1,000 to depreciation, renewal and reserve fund, the balance was £2,094. 11s. 6d. The directors recommended a dividend of 4 per cent. (less tax) on the ordinary shares. At the meeting, Sir Wm. Shipley said they had spent last year £1,427 on mechanical stokers, mains and meters. There had been an increase in the units sold of 18,000, but the average price obtained was somewhat lower. The metallic filament lamps now largely used in Windsor and Eton had made a difference to the revenue, but they anticipated they would have an increased number of customers. Since the beginning of the year the equivalent of 1,100 8 c.p. lamps had been connected.

WOLVERHAMPTON DISTRICT ELECTRIC TRAMWAYS (LTD.)—The total revenue for 1907 was £25,125. 5s. 11d. After deducting expenses (including debenture interest, repairs and maintenance, and £1,000 for renewals fund) there is a profit of £2,622. 6s. 7d. The directors recommend that £500 be placed to depreciation and reserve and a dividend of 1½ per cent. paid on the ordinary shares. £9,086 will be received from Dudley Corporation as the purchase price of the tramways in Dudley (hereafter to be leased to the company) and the directors have not considered it necessary to set aside any amount to sinking fund. During the year £1,135. 15s. 11d. was expended on capital account.

STATUTORY RETURNS AND MORTGAGES AND CHARGES.

STATUTORY RETURNS.

ANGLO SPANISH ELECTRICITY CO. (LTD.)—Return to Dec. 31 gives capital as [illegible] in £1 shares, of which 7 have been taken up. Nothing has been called up. Mortgages and charges, nil.

CHARING CROSS, WEST END & CITY ELECTRICITY SUPPLY CO. (LTD.)—Return to March 17 gives capital as £2,100,000 in 150,000 preference, 150,000 ordinary, 80,000 city undertaking preference and [illegible] city undertaking ordinary shares of £5 each, of which 80,000 preference, 80,000 ordinary 80,000 city undertaking preference and 70,000 city undertaking ordinary have been taken up. £5 per share has been called up on the preference, ordinary and city undertaking preference, and £1,200,000 has been received. £350,000 is considered as paid on the city undertaking ordinary. Mortgages and charges, £445,736 4 per cent. debenture stock and £472,000 city undertaking 5 per cent. debenture bonds.

KEIGHLEY ELECTRICAL ENGINEERING CO. (LTD.)—In return to Sept. 27 last (filed Jan. 29) capital is £10,000 in 7,000 ordinary and 3,000 preference shares of £1 each, of which 4,100 ordinary and 1,600 preference have been taken up. £1 per share has been called up on 2,488 ordinary and 1,200 preference, and £3,688 has been received. £2,012 is considered as paid on £1,612 ordinary and 400 preference. Mortgages and charges, £3,000.

THOMPSON, RITCHIE & CO. (LTD.)—In return to Dec. 31 capital is £5,000 in 200 preference and 300 ordinary shares of £10 each, of which 200 preference and 190 ordinary have been taken up. £2,200 has been paid on 220 shares and £1,700 is considered as paid on 170. Mortgages and charges, £2,500.

UNITED ELECTRIC CAR CO. (LTD.)—Capital, in return to Oct. 3, is £300,000 in 150,000 ordinary and 150,000 preference shares of £1 each, of which 150,000 ordinary and 100,000 preference have been taken up £250,000 has been received. Mortgages and charges, £50,000.

MORTGAGES AND CHARGES.

LEICESTERSHIRE & WARWICKSHIRE ELECTRIC POWER SYND. (LTD.—Issue on March 16 of £100 6 per cent. debentures, part of series created March 9, 1907, to secure £5,000, charged on company's undertaking and property, present and future, including uncalled capital. No trustees. Previously issued of same series, £850.

CITY NOTES.

MEMORANDA (April 16).—Bank rate 3 per cent. (since March 19, 1908). Price of silver $25\frac{3}{8}$—$25\frac{1}{2}$d. per oz. Consols $86\frac{15}{16}$—$87\frac{1}{16}$ for money, and $87\frac{1}{16}$—$87\frac{3}{16}$ for account. Consols Pay Day, May 6; Stocks and Shares Continuation Days, April 27 and May 6; Ticket Days, April 28 and May 7; Pay Days, April 29 and May 8; Mining Share carry-over Day, April 24.

Prices of Metals (London). *Copper*, cash, $58\frac{1}{2}$—$58\frac{3}{4}$; three months 59—$59\frac{1}{4}$. *Lead*, English, $13\frac{7}{8}$—$14\frac{1}{8}$; foreign, $13\frac{5}{8}$—$13\frac{7}{8}$. *Spelter*, foreign 21—$21\frac{1}{4}$. *Tin*, English, 144—145; foreign, cash, $144\frac{1}{2}$—145, three months, $143\frac{1}{2}$—144. *Iron*, Cleveland, cash, 52/$0\frac{1}{2}$; three months, 49/0 49/3.

CITY OF SANTOS IMPROVEMENTS CO. (LTD.)—The directors report states that the profit for the past year was £45,363. After providing for interest, preference dividend and interim ordinary dividend there remains £18,124. After placing £4,000 to reserve and £2,000 to tramway renewals account, a final dividend (tax free) of 4½ per cent. on the ordinary shares (making 7 per cent. for the year) is declared.

COUNTY OF LONDON ELECTRIC SUPPLY CO. (LTD.)—The transfer books and register of holders of the second debenture stock will be closed from the 22nd to the 30th inst., preparatory to payment of interest due May 1.

GESELLSCHAFT FUR ELEKTRISCHE UNTERNEHMUNGEN, BERLIN.—A dividend of 8 per cent. is recommended for the past year.

MARCONI'S WIRELESS TELEGRAPH CO. (LTD.)—The directors announce that the report will be issued to the shareholders immediately after Easter, and that the annual meeting will be held on April 30.

MEXICO TRAMWAYS CO.—The directors have declared a dividend at the rate of 4 per cent. per annum for the quarter ended March 31.

MONTE VIDEO TELEPHONE CO. (LTD.)—The directors recommend a dividend of 6 per cent. (less tax) on the ordinary shares for the past half year.

STOCK EXCHANGE NOTICES.—The Stock Exchange committee have appointed April 23 a special settling day in and have granted a quotation to £175,000 first debenture stock of the *Provincial Tramways Co. (Ltd.)* divided into £10 shares, and have also ordered a further issue of £383,575 deferred stock of the *National Telephone Co. (Ltd.)* to be quoted.

UNDERGROUND ELECTRIC RAILWAYS CO. OF LONDON (LTD.)—Particulars have been published of a scheme by the directors for providing for the redemption of the profit sharing secured notes which mature on June 1 next. There are 5 per cent. profit sharing notes outstanding to the amount of £[illegible],599,300 and $16,550,000, and it is proposed to exchange them for £3,000,000 4½ per cent. bonds and £5,200,000 6 per cent. income bonds. The terms are 40 per cent. nominal value of the notes for 4½ per cent. bonds and 70 per cent. nominal value for income bonds at par. In addition £1,600,000 of prior lien 5 per cent. bonds are also to be created, which will be underwritten by Messrs. Speyer, and will be offered to the noteholders and shareholders at 95. To enable the scheme to be effectively carried out, the company will have to be put into liquidation and steps have been taken to have a receiver and manager appointed.

On Wednesday, Mr. Justice Warrington appointed, with the consent of all parties, Sir G. S. Gibb receiver and manager of the company.

ELECTRIC TRAMWAY AND RAILWAY TRAFFIC RECEIPTS.

Line	Week ended	Amount	Inc. or Dec. (a)	Aggregate. No. of weeks	Aggregate. Amount	Aggregate. Inc. or Dec. (a)
		£	£		£	£
Aberdeen Corporation	April 8	1,223	- 27	45	60,995	- 1,367
Airdrie	,, 3	214	25	13	2,940	+ 62
Anglo-Argentine	,, 8	20,[illegible]	+ 1,628	14	258,162	+ 32,370
Ayr Corporation	,, 11	211	- 26	48	13,500	- 149
Baker St. & Waterloo Ry....	,, 11	2,980	+ 601	15	46,240	+ 11,374
Barnsley....................	,, 3	177	- 48	13	2,164	+ 87
Barrow	,, 3	225	- 78	13	2,832	- 76
Bath Electric Trams, Ltd..	,, 8	652	- 638	14	8,069	- 1,30[illegible]
Birkenhead Corporation ..	,, 12	1,0[illegible]	+ 1·1		...	
Birmingham Corporation .	,, 11	[illegible]	+ 676	2	11,934	+ 1,215
Birmingham & Mid.	March 27	775	+ 5	1[illegible]	9,557	+ 694
Blackburn Corporation	April 8	1,060	+ 45	2	2,073	- 801
Blackpool Corporation	...					..
Blackpool and Fleetwood ...	,, 13	262	- 14	..	..	..
Bolton Corporation...........	,, 12	2,244	+ 208	2	3,893	- 386
Bombay	March 19	2,300	+ 346	11	26,669	+ 5,318
Bournemouth Corporation.	April 8	1,189	- 133	1	1,480	- 133
Bradford Corporation.......					...	...
Brighton Corporation	,, 2	758	- 30	2	1,261	- 110
Bristol Trams & Carriage..	,, 10	4,583	- 118	14	63,201	- 3,455
Buenos Ayres & Belgrano...	,, 8	4,153	+ 13	14	52,836	+ 712
Burnley Corporation	,, 11	1,177	+ 59	2	2,501	+ 48
Burton Corporation	,, 12	211	- 18	2	431	- 20
Bury Corporation	,, 5	834		‡1	834	
Calcutta Tramways Co.......	,, 4	R45,625	+ R4,119	13	R742,052	- R15,183
Camborne-Redruth	,, 1	150	+ 30	15	1,774	+ 146
Cardiff Corporation	,, 4	2,012	- 438	1	2,012	+ 438
Cavehill	,, 3	54	- 236	13	759	186
Central London Railway ...	,, 11	5,914	- 213	15	91,352	- 2,003
Charing C.,Euston & H'stead	,, 11	3,100	...	15	47,210	...
Chatham & Dist. Lt. Rys. ..	,, 9	642	- 24	§14	8,585	- 886
City & South London Rly...	,, 12	3,140	+ 152	15	50,177	+ 5,596
City of Birmingham	,, 3	2,753	- 701	13	35,402	- 109
Colchester Corporation......	,, 8	164	- 20	14	2,178	- 225
Cork Electric Trams Co. ...	,, 9	139	- 6	§14	5,514	- 474
Croydon Corporation	,, 10	1,269	+ 22	2	1,802	- 832
Devonport & Dist. Trams...	,, 3	431	- 134	13	5,476	- 289
Dover Corporation	,, 11	162	- 33	2	279	- 192
Dublin & Lucan Railway ...	,, 10	108	+ 6	15	1,377	- 48
Dublin United	,, 10	4,311	- 148	15	68,123	+ 587
Dudley-Stourbridge	,, 3	792	- 615	13	9,540	- 1,240
Dundee Corporation	,, 8	1,144	- 51	47	53,562	+ 2,149
East Ham Council	,, 11	810	- 1	2	1,306	- 225
Exeter Corporation...........	,, 10	262	- 16	2	379	+ 232
Falkirk and District	,, 8	295	+ 29	1	296	+ 29
Gateshead & Dist. Trams...	,, 3	1,003	- 135	13	13,015	+ 130
Glasgow Corporation.........	,, 11	17,450	+ 400	45	781,264	+ 16,562
Glossop	,, 11	111	- 10	15	1,726	- 151
Gravesend – Northfleet......	,, 3	201	- 167	13	2,461	- 442
Great Northern & City Rly..	,, 11	1,648	- 198	15	26,697	- 1,181
Gt. Northern, Piccadilly,&c	,, 11	5,385	+ 1,475	15	81,275	+ 24,946
Greenock & Port Glasgow...	,, 3	469	- 315	13	6,132	- 1,743
Hartlepool Tramways	,, 3	194	- 160	13	2,800	- 524
Hastings Elec. Trams Co....	,, 9	812	- 131	15	11,105	- 768
Hong Kong	,, 4	8,177	+ 116	1	8,177	+ 116
Hull Corporation..	,, 11	2,375	+ 180	2	3,951	- 630
Ilford District Council	...	...	...	...	..	..
Ilkeston District Council ...	,, 8	129	+ 13	2	253	- 61
Ipswich Corporation	...	...	...	...	.	..
Isle of Thanet Co.	,, 11	258	- 82	28	7,302	- 637
Jarrow	,, 3	95	- 90	13	1,259	- 167
Keighley Corporation	,, 9	150	+ 13	41	6,401	+ 251
Kidderminster & District...	,, 3	87	- 124	13	1,103	- 170
Kilmarnock Corporation ...	.	...	...		.	...
Lanarkshire Trams Co. ...	,, 0	1,275	+ 108	14	17,514	+ 2,354
Lancashire United...........	,, 8	1,222	+ 172	14	16,258	- 185
Leamington	,, 3	125	- 121	13	1,689	+ 27
Leeds Corporation	.	...	...	...	...	.
Leicester Corporation	,, 11	2,129	+ 4	15	30,809	- 640
Leith Corporation	...	...	...	...	...	...
Lincoln Corporation	,, 13	102	+ 5	2	208	- 12
Liverpool Overhead Rly. ...	,, 12	1,352	- 5	15	20,692	- 169
Liverpool Corporation	,, 4	10,801	- 196	14	140,616	- 2,944
*London County Council ...	,, 4	31,879	+ 1,971	52	1,624,895	+ 247,915
London United	,, 11	5,579	+ 179	15	76,299	- 4,880
Lowestoft	,, 11	136	- 4	28	4,316	+ 38
Maidstone Corporation......	,, 11	157	...	2	268	...
Manchester Corporation ...	,, 11	14,161	- 1,164	2	23,079	- 32
Mersey Railway	,, 11	2,084	+ 105	15	28,738	+ 1,145
Merthyr	,, 3	199	- 117	13	2,550	- 125
Metropolitan Dist. Railway	,, 11	8,702	+ 805	15	134,195	+ 15,787
Metropolitan Elec. Trams..	,, 3	5,179	- 1,114	13	62,688	+ 9,857
Middleton	,, 3	333	- 315	13	4,000	- 2[illegible]
Nelson Corporation	,, 11	130	+ 7	1	130	+ 7
Newcastle-on-Tyne Corp. ...	,, 11	3,672	- 114	2	6,072	- 2,[illegible]
Newport (Mon.)	,, 11	630	+ 32	2	1,235	- 167
Northampton Corporation .	,, 10	398	+ 22	¶1	556	+ 9
Oldham, Ashton & Hyde ...	,, 3	558	- 274	13	7,399	- 329
Oldham Corporation	,, 12	1,861	+ 134	3	5,208	+ 1,014
Perth (N.B.) Corporation ...	,, 8	112	- 19	47	7,309	+ 17
Perth (W.A.) Elec. Trams...	,, 10	1,403	- 79	¶15	21,170	- 1,052
Peterborough	,, 3	110	- 115	13	1,361	- 100
Portsmouth Corporation ...	,, 11	1,566	+ 7	2	2,680	- 1,316
Potteries	,, 3	1,850	- 170	13	23,820	+ 193
Preston Corporation	,, 8	687	+ 22	15	9,935	- 393
Rotherham Corporation ...	,, 9	586	+ 71	‡1	701	- 316
Rothesay	,, 3	50	- 308	13	638	+ 239
Sheerness	,, 1	47	- 33	13	621	- 24
Sheffield Corporation........	,, 12	5,448	+ 394	†3	13,935	- 2,227
Singapore Trams	,, 4	$9,690	+ $1,104	1	$9,690	+ $1,104
Southampton Corpn.	,, 8	921	+ 2	1	921	+ 2
Southend Corporation	,, 8	296	- 3	2	335	- 230
South Metropolitan	,, 3	718	- 488	13	8,580	- 747
Southport Tramways.........	,, 3	225	- 291	13	2,603	- 498
South Staffs	,, 3	855	- 550	13	11,241	- 389
Sunderland Corporation ...	,, 12	1,087	- 126	2	1,893	+ 871
Sunderland and District ...	,, 8	453	+ 47	23	10,201	+ 909
Swansea Trams	,, 3	870	- 225	13	10,978	+ 117
Swindon Corporation	,, 8	138	- 12	1	138	- 12
Taunton	,, 3	1[illegible]	- [illegible]9	13	488	- 30
Tynemouth and District ...	,, 3	14	- 201	13	1,848	- 513
Tyneside Trams Co.	,, 8	339	- 32	15	4,909	- 1,077
Victoria Elec. Supply Co. of	March 8	559	+ 12	.	...	...
Wallasey District Council	April 13	755	+ 25	¶1	1,551	- 411
West Ham Corporation......	,, 9	2,650	- 23	2	4,215	- 21
Weston-super-Mare	,, 1	27	- 195	13	319	- 108
Wolverhampton Co.	,, 3	449	- 290	13	5,668	+ 277
Wolverhampton Corpn......	,, 8	769	+ 17	44	31,012	...
Worcester	,, 3	239	- 159	13	3,050	- 163
Wrexham	,, 3	93	- 38	13	1,162	- 82
Yorkshire W.R. Trams	,, 12	1,103	+ 150	15	15,953	
Yorkshire Woollen District.	,, 3	355	- 439	13	11,318	- 817

(a) These comparisons are with the corresponding period last year. § Plus 2 days. ¶ Plus 3 days. * Partly electrical. † Minus 3 days. ‡ Minus 2 days.

ELECTRICAL COMPANIES' SHARE LIST.

Share	Last Dividend	Name	Price Tues., April 14	Rate % Yielded £ s. d.	Dividend Due	Business 6 Days to April 14. Highest	Lowest
		ELECTRICITY SUPPLY.					
10	9 0	Bournemouth & Poole Elec. Sup. Ord. .	1[illegible] - 11[illegible]	5 10 0	Mar, Sept	..	
10	4 6	Do. 4½ per Cent. Cum. Pref.	10 - 11	4 2 0	Feb, Aug		..
10	6 0	Do. 6 per Cent. Cum. Second Pref. ..	10½ - 11	5 9 [illegible]	Feb, Aug	10[illegible]	..
St.	4½	Do. 4½ per Cent. Deb. Stock (red.)	102 - 105	4 5 6	Jan, July	[illegible]	.
5	3 6	†Bromley (Kent) El. Lt. & Power Shares	4 - 5	5 10 0	April, Oct	..	..
St.	4½	Do. Do. 1st Debs.	96 - 99	4 11 0	May, Nov	..	
5	5 6	Brompton & Kensington Elec. Sup. Ord.	7¾ - 8¼	6 1 0	March....		..
5	3 6	Do. 7 per Cent. Pref.	6¾ - 7¾	4 10 0	Mar, Sept	..	.
St.	4%	Central Elec. Sup. Co. 4% Guar. Db. Stock	98 - 101	3 19 0	June, Dec	..	..
5	2 6	Charing Cross (W. End & City) El. Sup. Co.	3⅝ - 4⅛	[illegible] 1 6	Feb, Aug	..	..
5	2 3	Do. 4½ per Cent. Pref.	4⅝ - 4⅞	4 17 0	Feb, Aug	4[illegible]	..
St.	4%	Do. 4 per Cent. Deb. Stock (red.)	96 - 99	4 1 0	Jan, July	95	..
5	2 3	Do. City Undertaking 4½% Cm. Pref.	4 - 4½	5 9 0	Jan, July	..	..
5	2/6	Chelsea Electric Supply Ord.	3⅛ - 3⅜	6 4 0	March ..	..	..
St.	4½%	* Do. 4½ per Cent. Deb. Stock (red.) ...	101 - 104	4 6 9	June, Dec		
10	7/0	City of London Electric Lighting Ord...	9¾ - 10⅝	5 13 0	Feb, Aug	..	
10	6/0	Do. 6 per Cent. Cum. Pref.	11¾ - 12¼	4 14 0	Jan, July	12¼	12[illegible]
St.	5%	Do. 5 per Cent. Deb. Stock (red.).....	123 - 126	3 19 6	June, Dec	..	
St.	4½%	Do. 4½ per Cent. 2nd Deb. Stock (red.)	101 - 104	4 6 6	Jan, July	104	..
5	1 10	County of Durham Elec. P.D. Ord.........	3 - 3¾	5 6 0	April, Oct	.	..
5	5%	Do. 5 per Cent. non Cum. Pref.	4¼ - 4[illegible]	5 5 0	April, Oct	.	..
10	6 0	County of London Elec. Supply Ord......	7¾ - 8¼	6 1 3	Feb, Aug	8	..
10	6 0	Do. 6 per Cent. Cum. Pref.	10¾ - 11¼	4 1 3	Mar, Sept	..	..
St.	4½%	Do. 4½% Deb. Stock (all paid) (red.)...	107 - 110	4 2 6	Jan, July	..	..
St.	4½%	Do. Second Deb. Stock Prov. Certs....	98 - 101	4 9 0	May, Nov		..
5	3 6	Folkestone Electricity Supply Co. Ord.	4½ - 5	5 10 0	April, Oct	..	..
5	2 6	Do. 5 per Cent. Cum. Pref.	4¾ - 5¼	4 12 6	Mar, Sept	..	..
St.	4½%	Do. 4½ 1st Deb. Stock (red)................	94 - 97	4 13 0	Feb, Aug	..	..
5	4 6	Hove Electric Lighting Ord.	6½ - 6¾	6 7 0	April, Oct	..	..
5	5/0	Kensington & Knightsbridge Ord..........	7¾ - 8¼	5 11 0	Feb, Aug	..	..
5	6%	Do. 6 per Cent. 1st Pref.	6¾ - 7	4 5 9	Jan, July	..	..
St.	4%	Do. 4 per Cent. Deb. Stock (red.)......	96 - 99	4 1 0	..	..	—
St.	4%	Kensingtn. & Kngtbg. Co. & Notting Hill Co. (Joint Station) 4% Deb. Stock (red.)	97 - 101	3 19 0	April, Oct	99½	99½
St.	4½%	Kent Elec. Power Co..........................	88 - 92	4 18 3	Jan, July	..	..
3	1/6	London Electric Supply Ord.	1 - 1½	5 0 0	Mar, Sept	..	..
5	3 0	Do. 6 per Cent. Pref.	4½ - 5	6 0 0	Mar, Sept		..
St.	4%	Do. 4 per Cent. 1st Mort. Deb.	90 - 93	4 8 0	Jan, July	9[illegible]	90
5	3 6	Metropolitan Electric Sup. Ord.	4¾ - 5¼	6 4 0	April, Oct	5[illegible]	4[illegible]
5	2 3	Do. 4½ per Cent. Cum. Pref.	4¾ - 5¼	4 6 0	Jan, July	5	..
St.	4½%	Do. 4½ per Cent. Deb. Stock 1st Mort.	107 - 111	4 1 0	June, Dec	..	..
St.	3½%	Do. 3½ per Cent. Mrt. Deb. Stock (red.)	85 - 90	3 18 0	Jan, July	..	..
100	4½%	Midland Elec. Corp. for P.D. 1st Mort. Db.	96 - 99	4 11 0	June, Dec	..	..
10	3 7½	Newcastle & Dist. Elec. Ltg. Ord.	9¾ - 10¼	3 18 9	Feb, Aug	..	—
100	4½%	Do. 4½ per Cent. Deb.	93 - 99	4 11 0	Jan, July	..	..
5	5/6	Newcastle Elec. Supply Ord.	5¾ - 6¼	6 12 0	Feb, Aug	..	..
5	5%	Do. 5 per Cent. non Cum. Pref.	5⅛ - 5⅜	4 15 3	Feb, Aug	5⅛	5[illegible]
100	4%	Do. 4 per Cent. Mort. Deb. red. 1907.	95 - 97	4 3 4	Jan, July	..	..
1	3%	Northern Counties Elec. Sup.	—	..	Mar, Aug	..	..
100	4½%	Do. 4½ per Cent. Deb.	95 - 97	4 13 9	Jan, July	..	..
10	8/0	Notting Hill Electric Ord......................	11¼ - 12¼	5 14 0	March ..	..	..
5	4 6	Oxford Electric Ord.	5⅞ - 6⅜	5 10 0	March ..	6[illegible]	6[illegible]
St.	4%	Do. 4 per Cent. Deb. Stock	93 - 95	4 4 6	Jan, July	..	..
5	5 0	St. James' & Pall Mall Elec. Ord.	7½ - 8¼	6 1 3	Feb, Aug	7¾	..
5	3 6	Do. 7 per Cent. Pref.	6¾ - 7	5 0 0	Feb, Aug	..	..
St.	3½%	Do. 3½ per Cent. Deb. Stock (red.) ...	85 - 90	3 17 9	Jan, July	..	..
5	..	Smithfield Markets Electric Sup. Ord...	½ - 1½	..	Feb	..	..
St.	4%	Do. 4 per Cent. Deb. Stock..............	70 - 74	5 5 0	Feb, Aug	..	..
5	4/0	†South London Electric Supply Ord.......	2⅞ - 3⅜	6 13 0	April ...	..	..
1	0/6	South Metrop'n Elec. Lt. & Power Ord.	⅝ - ⅞	4 0 0	..	.	..
1	0 8⅖	Do. 7 per Cent. Cum. Pref...............	1⅛ - 1⅜	5 2 0	Feb, Aug	..	..
St.	4½%	Do. 4½ 1st Db. Stk. Red..................	99 - 102	4 8 0	April, Oct	100½	..
5	2/6	Urban Electric Supply Ord.	1⅞ - 2⅛	10 18 0	April, Oct	..	..
5	2/6	Do. 5 per Cent. Cum. Pref.	1⅞ - 2⅛	11 14 0	April, Oct	..	..
St.	4½%	Do. 4½ per Cent. 1st Mort. Deb.......	87 - 90	5 0 0	April, Oct	.	..
5	5/0	Westminster Elec. Sup. Ord.	7½ - 8	6 5 0	Mar, Sept	7⅞	7[illegible]
5	2/3	Do. 4½ per Cent. Cum. Pref.	4¾ - 5¼	4 5 6	Jan, July	..	..
		ELECTRIC RAILWAYS, TRAMWAYS, &c.					
St.	4%	Baker St. & Waterloo 4% Perp. Db. St.	89 - 92	4 7 0	Jan, July	91¼	90¾
1	.	Bath Elec. Trams Pref. Ord.	⅜ - ⅝	8 0 0	April....	..	..
1	0/6	Do. 5 per Cent. Cum. Pref.................	[illegible] - ⅞	5 14 0	Jan, July	..	..
St.	4½%	Do. 4½ 1st Mort. Deb. Stock (red.) ...	89 - 94	4 16 0	April, Oct	..	..
St.	4½%	B'ham & Midland Trams 4½ 1st Db. Stk.	93 - 96	4 15 0	Jan, July	93¾	..
10	9%	Bristol Tramways & Carriage Ord.	10 - 10½	8 11 9	Feb, Aug	..	..
10	4%	Do. Cum. Pref. (fully paid)...............	8½ - 9	4 9 0	..	..	..
St.	4%	Do. 4 per Cent. Debs.	100 - 102	3 18 0	Feb, Aug	..	..
10	..	British Electric Traction Ord..............	1⅛ - 1⅜	..	June, Dec	1[illegible]	..
10	6/0	Do. 6 per Cent. Cum. Pref..................	4 - 4½	12 12 0	Feb, Aug	4½	..
St.	5%	Do. 5 per Cent. Perpetual Debs.	92 - 95	5 5 0	April, Oct	95½	..
St.	4½%	Do. 4½ per Cent. 2nd Deb. Stock	72 - 76	6 0 0	May, Nov	74½	..
St.	3%	Central London Ordinary Stock	75 - 78	3 17 0	Feb, Aug	77¾	78¼
St.	4%	Do. 4 per Cent. Pref. Stock	83 - 85	4 14 6	Feb, Aug	85	84
St.	2%	Do. Deferred Stock	54 - 57	3 10 0	Feb	53	54½
100	4%	Do. 4 per Cent. Debs.	100 - 103	3 18 0	Jan, July	102	100½
St.	4%	Charing X. Euston & Hmpstd Per. Db. Stk.	81 - 84	4 15 3	Jan, July	83¼	..
5	2/6	City of Birmingham Trams. 5% Cm. Pref.	4½ - 5	5 0 0	April, Oct	..	..
100	4%	Do. 4 per Cent. 1st Mort. Debs.... ...	98 - 101	3 19 0	April, Oct	..	..
St.	1¾%	City & South London Rly. Con. Ord. ..	38 - 40	4 7 0	Feb, Aug	40	39
St.	5%	Do. 5 per Cent. Perp. Pref. (1891) ...	113 - 116	4 6 0	Feb, Aug	..	..
St.	5%	Do. (1896)	112 - 115	4 7 0	Feb, Aug	..	..
St.	5%	Do. (1901)	110 - 113	4 8 6	Feb, Aug	..	..
St.	5	Do. (1903)	106 - 109	4 11 6	Feb, Aug	107⅜	..
St.	4%	Do. 4 per Cent. Perpetual Debs.	101 - 104	3 17 0	May, Nov	.	..
10	7/0	Dublin United Trams. Ord	12¾ - 13¾	4 10 6	Feb, Aug	..	..
10	6/0	Do. 6 per Cent. Pref.........................	12½ - 13½	4 9 0	Feb, Aug	..	..
10	..	Gt. Northern & City Rly. Pref. Ord. (1[illegible]	¾ - 1¼	..	Feb, Aug	..	..
10	4/0	G. Northern, Piccadilly & Brompton Ord.	6 - 7	5 14 0	Feb, Aug	.	..
St.	4%	Do. 4 per Cent. Deb. Stock	87 - 90	4 9 0	Jan, July	89¼	87½
5	4/0	Hastings & Dist. Elec. Trams 6% Cm. Pf.	4 - 4¼	7 5 0	Mar, Sept	..	..
St.	4½%	Do. 4½ Db. St. .	95 - 98	4 12 0	April, Oct	..	..
10	9%	‡ Imperial Tramways Ord..........	10½ - 11½	7 17 0	Mar, Sept	..	..
10	6%	‡ Do. 6 per Cent. Pref.	9½ - 10	9 5 6	Mar, Sept	..	..
St.	4½%	‡ Do. 4½ per Cent. Debs.	93 - 94	4 15 9	Jan, July	..	..
5	..	I. of Thanet E. T. & Lt. 5 per Cent. Pref.	⅞ - 1⅜	..	Mar, Sept	..	..
St.	4%	Do. 4 per Cent. Deb. Stock..............	58 - 63	6 7 0	Jan, July	..	—
10	6/0	Lanarkshire Tramways	9¾ - 10¼	5 13 0	Feb, Aug	..	..
St.	5%	Lancs. Utd. Trams 5% Prior Lien Db. St.	91 - 94	5 6 0	Jan, July	..	..
10	..	Liverpool Overhead Railway Ord.	1⅜ - 1½	..	Feb, Aug	..	..
10	5%	Do. 5 per Cent. Pref.	6½ - 6¾	7 10 0	Feb, Aug	..	..
St.	4%	Do. 4 per Cent. Deb.	8[illegible] - 8[illegible]	4 11 0	Jan, July	..	..
10	5/0	London United Trams 5% Cum. Pref.	6½ - 7[illegible]	6 18 0	Jan, July	,	..
St.	4%	Do. 4 per Cent. 1st Mort. Deb. Stock	8[illegible] - [illegible]	4 11 0	Jan, July	.	.
St.	..	Mersey Con. Ord. Stock .	2 - 4	—	Feb, Aug	..	..
St.	..	Do. 3 per Cent. Perp. Pref. ..	3 - 6	—	..	..	..
1	..	Metropolitan Elec. Tramways Def.	[illegible] - [illegible]	..	April.. .	[illegible]	..
1	0/6	Do. 5 per Cent. Cum. Pref.	¾ - [illegible]	5 14 0	Feb, Aug		[illegible]
St.	4½%	Do. 4½ per Cent. Deb. Stock	95 - 95	4 12 0	Jan, July	..	..
St.	[illegible]	Metropolitan Railway Consolidated	42½ - 43½	1 [illegible] [illegible]	Feb, Aug	44[illegible]	42[illegible]
St.	2½%	Do. Surplus Lands Stock	63 - 68	4 1 [illegible]	Feb, Aug	67¼	..
St.	3½	Do. 3½ per Cent. Preference .	8[illegible] - [illegible]	3 19 9	Feb, Aug	[illegible]	..
St.	3½	Do. 3½ per Cent. "A" Preference	76 - 79	4 [illegible] [illegible]	Feb, Aug	77¼	..
St.	3½%	Do. 3½ per Cent. Convertible Pref. . .	7[illegible] - 7[illegible]	4 12 0	Feb, Aug	7[illegible]	..
St.	3½	Do. 3½ per Cent. Debenture Stock	92 - 95	3 13 6	Jan, July	.	..
St.	3½	Do. 3½ per Cent. "A" Ditto . .	[illegible] - [illegible]	3 16 [illegible]	Jan, July	6[illegible]	69¾

* In calculating the yield, allowance has been made for accrued interest but *not* for redemption.

† Ex Dividend

ELECTRICAL COMPANIES' SHARE LIST.—*Continued.*

ELECTRIC RAILWAYS & TRAMWAYS (*Continued*)

Share	Last Dividend	Name	Price Tues., April 14	Rate Yielded £ s. d.	Dividend Due	Business 6 Days to April 14 Highest	Lowest
St.	..	Me[illegible] Ord.	11½—12½	..	Feb, Aug	12	11½
St	..	[illegible]	20—25	..	Feb, Aug	23	22⅞
St	3½	[illegible] Guar. by [illegible] of London, Ltd.	44—48	7 6 0	Feb, Aug	45	..
St	3%	[illegible] Rent-charge	78—7[illegible]	3 17 [illegible]	Jan, July	..	..
St.	4%	[illegible] Rent-charge	[illegible]—1[illegible]4	3 17 0	Jan, July	..	..
St	[illegible]	[illegible] Stock [illegible] per Cent.	30—4[illegible]	3 16 0	Mar, Sept	45	44
St.	[illegible]	[illegible] per Cent. Perp. Deb. Stock	1[illegible]8—113	5 6 3	Jan, July	..	..
St.	4%	[illegible] per Cent. Ditto	..	5 7 5	Jan, July	..	..
5	..	New Gen. Tract. 6 per Cent. Cum. Pref.	[illegible]—1	..	May	..	—
1	[illegible]	P[illegible] Electric Traction Ord.	[illegible]	8 0 0	April, Oct	..	—
1	0 6	Do. 5 per Cent. Cum. Pref.	[illegible]	6 13 0	Feb, Aug	[illegible]	..
St.	4½%	Do. 4½ per Cent. Deb. Stock	95—96	4 13 9	May, Nov	..	..
1	0 7½	S. Met. Elec. Trams. & Ltg. 6% Cm. Pref.	⅞—1⅛	5 7 0	Feb, Aug	..	..
St.	4%	Do. 4 per Cent. Deb. Stock	78—82	4 17 0	Jan, July	..	..
100	5%	Sunderland Dist. Elec. Trms. 5% 1st Mt. Db	7[illegible]—7[illegible]	6 8 [illegible]	Jan, July	—	..
..	5%	Underground Elec. Rys. Co. of London ...	39—43	11 12 0	June, Dec	..	..
5	..	Yorkshire (W.R.) Elec. Trams. Ord.	1—1¼	—	March ..	..	..
5	..	Do. 6 per Cent. Cum. Pref.	3—3½	—	..	..	..
St	4½	Do. 4½ per Cent. 1st Debs.	84—87	5 3 6	Jan, July	..	..

ELECTRIC MANUFACTURING, &c.

Share	Last Dividend	Name	Price Tues., April 14	Rate Yielded £ s. d.	Dividend Due	Business Highest	Lowest
1	..	Aron Electricity Meter Ord.	[illegible]	..	..	..	..
1	1 [illegible]	Do. 6% Cum. Pf.	[illegible]	7 7 6	April, Oct	..	..
1	1 7½	Babcock & Wilcox Ord.	3⅞—3⅜	6 12 6	April, Oct	3⅜	3[illegible]
1	0 7½	Do. Pref.	1 7/16—1 9/16	3 16 9	..	..	..
5	[illegible]	British Insulated & Helsby Cables Ord.	6⅛—6[illegible]	7 10 6	July, Feb	6[illegible]	6¼
5	3 0	Do. 6 per Cent. Pref.	5⅝—6⅛	4 18 0	Jan, July	..	..
St.	4½%	Do. 4½ per Cent. 1st Mort. Deb. (red.)	102—105	4 5 6	Jan, July	..	..
St.	4½%	British Thoms'n-Houst'n 4½% 1st Mt. Db.	94—99	4 11 0	Mar, Sept	94½	94
5	..	British Westinghouse 6 per Cent. Pref.	½—⅝	..	Feb, Aug	..	..
St.	4%	Do. 4 per Cent. Mort. Deb. Stock	45—50	8 0 0	Jan, July	46	..
2	..	Brush Electrical Engineering	½	—	March ..	—	..
2	..	Do. 6 per Cent. Pref. non-Cum.	[illegible]	..	Mar, Sept	..	..
St.	4½%	Do. 4½ per Cent. Perp. 1st Deb. Stock	74—79	5 11 0	Mar, Sept	..	..
St.	4½%	Do. Perpetual 2nd Deb. Stock	59—64	7 0 0	Jan, July	..	..
5	7 0	Callender's Cable Con. Ord.	10¾—11[illegible]	6 10 0	Jan, July	..	..
5	2 6	Do. 5 per Cent. Cum. Pref.	5¼—5¾	4 7 0	Jan, July	5[illegible]	..
St.	4½%	Do. 4½ per Cent. 1st Mort Debs. (red.)	106½—108½	4 2 6	Nov, May	108	107¼
1	1,7½	Castner-Kellner Alkali Co.	1[illegible]—1[illegible]	8 11 0	May, Nov	1⅝	1[illegible]
St.	4½%	Do. 4½ per Cent. 1st Mort. Deb. (red.)	100—103	4 7 6	Feb, Aug	101[illegible]	100¾
1	0 9[illegible]	Chadburn's (Ship) Telegraph Ord.	1[illegible]—1 1/16	8 8 0	March ..	..	..
1	0,7[illegible]	Do. 6 per Cent. Cum. Pref.	1—1⅛	5 6 6	April, Oct	..	..
1	[illegible]	Consolidated Electrical Co.	[illegible]	6 4 6	August ...	..	..
1	1 0	†Consolidated Signal Co.	1½—1¾	4 5 6	April, Oct	..	..
1	[illegible] 7½	Do. 6 per Cent. Cum. Pref.	[illegible]	6 4 0	April, Oct	..	..
3	[illegible]	* Crompton & Co. Nos. 1 to 85,000)	1[illegible]—1 5/16	7 15 0	Jan, July	..	..
100	[illegible]	Do. 5 per Cent. 1st Mort. Debs. (red.)	92—96	5 5 0	Jan, July	..	..
1	[illegible] 7½	Davey & Timmins	⅞—1⅛	.	Mar, Sept	..	..
5	2 0	Dick, Kerr & Co. Ord.	1⅛—1[illegible]	7 5 6	Sept	..	..
5	[illegible] 7½	Do. 6 per Cent. Cum. Pref.	1—1¼	4 16 0	Sept	1⅛	..
St	4½	Do. 4½ per Cent. Deb. Stock	100—103	4 7 3	Jan, July	..	—
5	2 6	Edison & Swan United ("A" Sh.) £3 pd.	¾—1	2 0 0	Feb, Aug	..	..
5	1 2	Do. (£5 paid)	1½—2½	5 0 0	Feb, Aug	..	—
St	4%	Do. 4 per Cent. Mort. Deb. Stock (rd.)	78—81	4 19 3	June, Dec	..	..
St	5%	Do. 5 per Cent. 2nd Deb. Stock	85—87	5 15 0	Mar, Sept	—	..
5	..	Edmundson's Elec. Corp. Ord.	¼—[illegible]	..	Jan, July	..	..
5	..	Do. 6 per Cent. Cum. Pref.	¾—1¼	..	May, Nov	—	..
St	4½%	Do. 4½ per cent. 1st Mort. Deb. (red.)	58—63	7 2 0	Jan, July	..	..
2	..	Electric Construction Co.	½—⅝	..	Jan, July	..	..
2	..	Do. 7 per Cent. Cum. Pref.	1¼—1¾	..	July	1[illegible]	1[illegible]
St	[illegible]	Do. 4 per Cent. Perp. 1st Mort. Debs.	61—68	5 17 0	Jan, July	..	..
1	[illegible] 0	General Electric 1900 5% Cum. Pref.	7¾—8½	6 1 8	June, Dec	—	..
St	4%	Do. 4 per Cent. 1st Mort. Debs.	87—90	4 9 0	Mar, Sept	..	—
[illegible]	10/0	Henley's Telegraph Works Ord.	10½—11½	6 10 0	Feb, Aug	11½	..
[illegible]	[illegible]	Do. 4½ per Cent. Pref.	[illegible]—5⅝	4 3 0	Feb, Aug	..	..
St	4½%	Do. 4½ per Cent. 1st Mort. Deb. Stock	106—108	4 3 0	Mar, Sept	..	..
10	[illegible] 0	India Rubber, Gutta Percha, &c., Wrks	16[illegible]—16½	6 2 0	Feb, Aug	16[illegible]	..
100	4%	Do. 4 per Cent. Debs. (red.)	98—100	4 0 0	April, Oct	..	..
1	[illegible]	[illegible]	[illegible]	..	April	..	..
1	[illegible] 9	[illegible] Westgarth & Co., Ltd. Ord	½—[illegible]	6 8 0	Nov	..	..
1	[illegible] 7½	Do. 6 per Cent. Cum. Pref.	[illegible]	6 8 0	May, Nov	..	..
St	4½%	Do. 4½ per Cent. Perp. Deb. Stock	87—91	4 19 0	Jan, July	—	..
1	..	[illegible] Ord.	1½	..	..	—	—
5	..	Do. 6 per Cent. Cum. Pref.	6¼	..	..	..	..
12	[illegible]	Telegraph Construction & Maintenance	31—33	6 7 0	Mar, July	32	31[illegible]
100	4%	Do. 4 per Cent. Deb. Bonds (1909)	100—103	3 17 6	Jan, July	..	..
1	2/0	Vickers, Sons & Maxim, Ltd., Ord.	1[illegible]—1[illegible]	8 8 0	..	1[illegible]	1
1	[illegible]	Do. 5 per Cent. Non-Cum. Preference	1[illegible]—1[illegible]	4 14 6	..	1	1
St	5%	Do. 5 per Cent. [illegible] Cum. Preferred	1[illegible]—1[illegible]	4 15 6	..	..	..
St	4%	Do. 4 per Cent. 1st Mort. Db. Sk. (red)	102—104	3 16 6	June, Dec	102½	..
100	4½%	Do. 4½ per Cent. 2nd Mort. Deb. (red.)	102—104	4 6 6	June, Dec	103⅛	102⅞
10	6,0	J. G. White & Co. 6 per Cent. Cum. Prf.	8—9	6 13 0	Jan, July	..	..
5	1/0	†Willans & Robinson Ord.	1—1½	.. 6 8	Apr, Oct	..	..
5	[illegible] 0	† Do. 6 per Cent. Cum. Pref.	8⅝—8⅞	7 15 0	Apr, Oct	..	..
100	4	Do. 4 per Cent. 1st Mort. Debs.	72—77	5 4 0	May, Nov	73	7[illegible]

TELEGRAPHS.

Share	Last Dividend	Name	Price Tues., April 14	Rate Yielded £ s. d.	Dividend Due	Business Highest	Lowest
10		Amazon Telegraph	2—3	—	June, Dec	..	—
100	5%	Do. 5 per Cent. Debs. (red.)	84—87	5 15 0	June, Dec	..	..
St	15/0	†Anglo-American	15—58	6 [illegible] 0	F,My,Ag,N	..	..
St	[illegible] 0	Do. Preferred	[illegible]—10[illegible]	5 19 6	F,My,Ag,N	100¼	99¼
St.	[illegible]	Do. Deferred	13½—14	7 3 0	F,My,Ag,N	14[illegible]	1[illegible]
St.	4%	[illegible] 4 per Cent. Deb. Stk	84—87	4 12 0	Jn,Ap,Jy,O	8[illegible]	85⅝
10	[illegible]	[illegible] Ord.	7[illegible]—[illegible]	6 9 0	Feb, Aug	8[illegible]	..
10	[illegible]	Do. [illegible] 10 per Cent.	16—1[illegible]	5 17 9	Feb, Aug	..	..
5	[illegible] 0	[illegible] Ord.	[illegible]—3½	5 13 0	April, Oct	..	..
[illegible]	[illegible] 0	Do. [illegible] per Cent. Cum. Pref.	[illegible]	5 8 0	April, Oct	8¼	..
St	[illegible]	Do. 4½ per Cent. Deb.	[illegible]—102½	4 8 0	Jan, July	..	..
St	[illegible] 0	[illegible] United States Cable	[illegible]—11	6 11 6	Ja,Ap,Jy,O	13¾	13[illegible]
100	4½%	[illegible] Cable 4½% Rg. Db. (rd.	[illegible]—101	4 9 0	June, Dec	..	..
St	[illegible] 0	[illegible]	[illegible]—135	5 3 6	Ja,Ap,Jy,O	[illegible]	131¾
St	17 6	Do. [illegible] per Cent. Pref. Stock	[illegible]—87	4 0 6	Ja,Ap,Jy,O	[illegible]	8[illegible]
St	[illegible]	Do. 4 per Cent. Mort. Deb. Stk. (red.)	101—104	3 16 6	May, Nov	102	..
10	[illegible]	[illegible]	[illegible]	5 4 6	Ja,Ap,Jy,O	13	12[illegible]
[illegible]	[illegible]	Do. [illegible] per Cent. Pref. Stock	[illegible]	3 18 6	Feb, Aug	..	..
100	4%	[illegible] Mort. Deb. [illegible]	[illegible]—10[illegible]	3 18 6	Feb, Aug	..	..
[illegible]	4%	Do. 4% Mauritius Sub. Debs. (red.)	[illegible]—10[illegible]	3 18 6	May, Nov	..	..
10	[illegible]	[illegible] with [illegible]	[illegible]—3½	[illegible] 19 [illegible]	Jan, July	.	..
100	[illegible]	[illegible]	[illegible]	[illegible]	June, Dec	..	..
25	12,6	[illegible]	[illegible]	[illegible]	May, Nov	..	..
100	[illegible]	[illegible]	58—63	[illegible]	Jan, July	.	..
100	[illegible]	[illegible]	12—16	6 0 [illegible]	Ja,Ap,Jy,O	.	..
1	..	[illegible]	[illegible]	..	April	..	..
10	[illegible]	[illegible]	[illegible]	[illegible] 19 [illegible]	June, Dec	.	—
10	[illegible]	[illegible]	[illegible]	3 16 [illegible]	June, Dec	..	..
[illegible]	[illegible]	[illegible]	[illegible]	8 6 [illegible]	May	..	—
100	[illegible]	[illegible]	[illegible]—101	3 19 0	Jan, July	..	..
10	..	[illegible]	[illegible]	.	May, Nov		
10	[illegible]	[illegible]	[illegible]	[illegible] 17 [illegible]	May, Nov	.	.
10	[illegible]	[illegible]	..		May, Nov		.
10	[illegible]	[illegible]	[illegible]	4 16 [illegible]	Jan, July	.	
10	[illegible]	[illegible]	13½—13¾	5 1 6	Mr,Jn,O,D	1[illegible]	1[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	3 18 6	June, Dec	.	.
..	[illegible]	[illegible]	[illegible]				

TELEPHONES.

Share	Last Dividend	Name	Price Tues., April 14	Rate Yielded £ s. d.	Dividend Due	Business Highest	Lowest
100	2⅜	Amer. Telephn. & Telegh. Cap. St.	111—118	6 15 6		117	11[illegible]
..	4%	Do. Coll. Trust $1,000 4 per Cent. Bds	85—87	4 14 9	Jan, July	.	..
St	5%	Anglo-Portug'se Tel. 5% 1st Mt. Db. Stk.	98½—101½	4 19 0	Mar, Sept	..	—
5	3/0	Chili Telephone	7—7½	5 6 6	August ..	..	..
1	0/9⅜	Monte Video Telephone Ord.	1⅛—1 1/16	5 13 0	Nov	1	..
1	0/6	Do. 5 per Cent. Pref.	⅞—1	5 0 0	May, Nov	..	..
St.	6%	National Co. Pref. Stock	107—109	5 1[illegible] 0	Feb, Aug	10[illegible]	108
St.	6%	Do. Def. Stock	108—110	5 9 0	Feb, Aug	109⅛	10[illegible]
10	6/0	Do. 6 per Cent. Cum. 1st Pref.	10—12	5 0 0	Feb, Aug	..	..
10	6/0	Do. 6 per Cent. Cum. 2nd Pref.	10—12	5 0 0	Feb, Aug	..	..
5	2/6	Do. 5 per Cent. non-Cum. 3rd Pref.	5⅜—5⅝	4 9 0	Feb, Aug	5[illegible]	5[illegible]
St.	3½%	* Do. Deb. Stock 3½ per Cent. (red.)	93—100	3 10 0	June, Dec	..	..
St	4%	Do. 4 per Cent. Deb. Stock (red.)	101½—103½	3 17 0	Jan, July	103	10[illegible]
1	0/7½	Oriental	1[illegible]—1½	4 13 6	April, Oct		..
1	0 7½	Do. 6 per Cent. Cum. Pref.	1⅛—1¼	4 16 0	April, Oct	..	..
St.	4%	Do. 4 per Cent. Red. Deb. Stock	90—93	4 6 0	Jan, July	..	..
St.	4½%	Telephone Co. of Egypt 4½% Db. Stk. (red.)	99—102	4 8 0	Jan, July	..	..
5	3/0	United River Plate	6—6½	6 3 0	July	6[illegible]	6[illegible]
5	2/6	Do. 5 per Cent. Cum. Pref.	4¾—5¼	4 15 0	June, Dec	..	..
St.	4½%	Do. 4½ Deb. St. Red.	99—102	4 8 3	Jan, July	10[illegible]	..

FINANCIAL, INVESTMENT, &c.

Share	Last Dividend	Name	Price Tues., April 14	Rate Yielded £ s. d.	Dividend Due	Business Highest	Lowest
5	3/0	Elec. & Gen. Investment 6% Cum. Pref.	3¾—4¼	7 1 0	Jan, July	—	..
10	2 0	Globe Telegraph & Trust	9[illegible]—10⅜	5 6 0	Sp De Mr Ju	10¼	9[illegible]
10	3/0	Do. 6 per Cent. Pref.	13[illegible]—14[illegible]	4 5 0	Sp De Mr Ju	1[illegible]	..
10	6%	Submarine Cables Trust (Cert.)	128—131	4 11 0	April, Oct	129	..

COLONIAL AND FOREIGN ELECTRIC RAILWAYS, TRAMWAYS, &c.

Share	Last Dividend	Name	Price Tues., April 14	Rate Yielded £ s. d.	Dividend Due	Business Highest	Lowest
5	3/0	Anglo-Argentine 6% Cum. 1st Pref.	6 1/16—6 5/16	4 15 0	April, Oct	6[illegible]	6¼
5	5 0	† Do. 10% Non-cum. 2nd Pref.	8⅛—8[illegible]	6 2 0	Jan, July	8⅛	8[illegible]
St.	6%	Do. Permanent 6% Deb. Stock	129—132	4 9 6	June, Dec	..	..
St.	5%	Auckland Elec. Trams. 5% Deb. (red.)	104—107	4 13 6	Jan, July	..	..
5	2 0	Brisbane Electric Trams. Invest. Ord.	3⅞—4⅛	2 8 6	May	4[illegible]	..
5	2 6	Do. 5 per Cent. Cum. Pref.	4¾—5	5 0 0	May, Nov	..	..
St.	4½%	Do. 4½ per Cent. Db. Prov. Certs.	98—102	4 8 0	Jan, July	100	..
St.	8%	British Columbia El. Ry. Df. Ord.	132—135	5 18 6	Mar, Sept	133[illegible]	..
St.	6%	Do. Pref. Ord. Stock‡	110—114	5 5 0	May, Nov	11[illegible]	..
St.	5%	Do. 5% Cum. Perp. Pref. Stock	106—119	4 11 0	Jan, July	109	108
40	4½%	Do. 4½ per Cent. 1st Mort. Debs.	101—104	4 6 6	April, Oct	..	..
100	4½%	Do. Vancouver Power Debs.	101—104	4 6 6	Jan, July	..	..
St.	4½%	Do. 4½% Perp. Con. Deb. St.	98—101	3 19 0	.	100½	98¾
5	3/0	Buenos Ayres & Belgrano Ord.	4⅝—4⅞	3 1 6	April, Oct	..	..
5	3/0	Do. 6 per Cent. "A" Cum. Pref.	4[illegible]—5⅛	5 17 6	April, Oct	..	..
5	3/0	Do. "B"	4[illegible]—5⅛	5 17 6	April	..	..
St.	5%	Do. 5 per Cent. Debs.	110—116	4 6 0	Jan, July	—	..
St.	5%	Do. 5 per Cent. 2nd Debs. (red.)	102—105	4 15 3	Jan, July	..	..
St.	5%	Buenos Ayres Elec. Trams (1901) Ltd. Deb. St.	95—99	5 1 0	Ja, Jul ..	..	—
5	..	Buenos Ayres Grand National Ord.	2[illegible]—2[illegible]	..		2[illegible]	
5	2/6	Do. 5 per Cent. Cum. Pref.	[illegible]—4¼	5 18 0	Feb, Aug	..	..
100	5½%	Do. 5½ per Cent. Pref. Debs.	100—104	5 5 9	Jan, July	..	..
100	6%	Do. 6 per Cent. 1st Deb. Bonds.	97—101	5 19 0	April, Oct	..	..
St.	5%	Buenos Ayres Lacroze Trams 1st Mt. Db.	91—94	5 6 0	Mar, Sept	93[illegible]	91½
St.	6%	Buenos Ayres Port & City Tram. 1st Mt. Deb. Stock £75 Paid	64—68	6 12 [illegible]	Feb, Aug	..	..
5	3/6	Calcutta Tramways (1 to 137,610)	6—7	5 11 0	Mar, Sept	6¼	—
100	2/6	Do. 5 per Cent. Cum. Pref.	5—5⅜	4 1[illegible] 0	Jan, July	..	..
1	4½%	Do. 4½ 1st Deb. Stock (red.	102—106	4 5 0	Ja, Jy	..	.
St	..	Cape Electric Tram Shares	1 5/16—[illegible]	.	..	½	—
5	1/3	City of Buenos Ayres Trams Co. (1904) Sh.	5[illegible]—5[illegible]	4 1[illegible] 6	F,My,A,N	5[illegible]	5[illegible]
St.	4%	Do. 4 per Cent. Deb. Stock	100—104	3 17 0	June, Dec	.	..
	5%	Colombo Tr. & Ltg. 5% 1st Mt. Db.	89—93	5 6 0	May, Nov	..	—
100	5%	Electric Traction Co. of Hong Kong 5 per Cent. 1st Mort. Deb.	87—92	5 8 6	June, Dec	.	..
100	5%	Havana Elec. Ry. Con. Mt. 5% $1,000 [illegible]0 year Coup. Bds.	81—86	5 16 0	Feb, Aug	..	..
1	..	Kalgoorlie Elec. Trams. Sh.	⅛	..	..		
100	5%	Do. 5 per Cent. "A" Deb. Stock	8[illegible]—91	5 8 9	Jan, July	..	—
[illegible]	6%	Do. 6 per Cent. "B" Ditto	71—75	7 17 0	Jan, July	..	..
5	1,0	Lisbon Elec. Trams. Ord.	[illegible]—1½	4 9 0	July	..	..
100	[illegible],7½	Do. 6 per Cent. Cum. Pref.	⅞—1⅛	5 6 6	Jan, July	..	—
St.	5%	Do. 5 per Cent. Reg. Mort. Debs	90—95	5 5 0	Jan, July	..	..
St.	5%	Madras Elec. Trams. 5% Deb. Stk.	95—98	5 2 0	Jan, July	.	..
	5%	Manila Elec. Ry. $1,000 Gold Bonds	86—90	5 1[illegible] 3	Feb, Aug		
1	$1	Mexico Trams Co. Com. St.	71—8[illegible]	4 18 [illegible]		7[illegible]	7[illegible]
500	5%	Do. Gen. Con. 1st Mort. 5% Gold Bds.	84—8[illegible]	5 15 0	..	[illegible]	[illegible]
St	4½	Montreal St. Ry. Sterling 4½ per Cent. Debs. (1922)	101—103	4 7 6	Feb, Aug	..	..
1	1 0	Perth Elec. Trams Ord.	[illegible]	7 5 6	May	..	..
St	[illegible]%	Do. 1st Mt. Db. Stock	10[illegible]—106	4 14 3	Jan, July	..	—
5	3 0	Rangoon Elec. Trams. & Supply Co. 6% Cum. Pf.	5⅛—5⅜	5 7 6	..		—
St.	4½	Do. 4½% 1st Mort. Deb. Stk	9[illegible]	4 11 0	..	.	..
..	[illegible]	Sao Paulo Tramway, Light & Power Co. $100 Stock	120—124	6 11 0	..	12[illegible]	..
	5%	Do. 5 per Cent. 1st Mt. [illegible]	[illegible]—98	5 2 0	June, Dec	9[illegible]	9[illegible]
100	4½	Toronto Ry. Co. 1st Mt. 4½% Ster. Bond	99—101	4 9 0	Feb, Aug		.

COLONIAL AND FOREIGN ELECTRICITY SUPPLY, &c.

Share	Last Dividend	Name	Price Tues., April 14	Rate Yielded £ s. d.	Dividend Due	Business Highest	Lowest
5	3 0	Adelaide Elec. Supply Co. 6% Cu. Pr.	[illegible]	[illegible] 17 0	Mar, Sept	.	—
10	[illegible]	Bombay E. S. & T. Co. Cum. Pf.	[illegible]—1[illegible]	5 1[illegible] [illegible]	..	1[illegible]	..
St.	4½	Do. 4½ per Cent. Deb. Stk. (red.)	[illegible]	4 13 [illegible]	Jan, July	[illegible]	
5	[illegible]	Calcutta Elec. Supply Ord.	6⅞—7½	6 8 [illegible]	April, Oct	[illegible]	..
100	7 2	Canadian Gen. Elec. Co. Com. St	9[illegible]—1[illegible]1	10 2 0	..		..
100	5%	Central Electric [illegible] U.S.A. 1st Mort. St. Debs.	94—99	[illegible] 1 0	Jan, July		
500	5	East [illegible] Development Co. [illegible]	74—77	6 10 0	..		..
5	..	Elec. Lt. & Trac. Co. of Aust. 6 per Cent. Cum. Pref.‡	2¼—2[illegible]	..	Feb, Aug	.	..
St	5	Do. 5 per Cent. Deb. Stock	84—88	5 11 0	Jan, July	.	..
St	5	Elec. Supply Co. of Victoria 5 per Cent. 1st Mort. Deb. St.	91—94	5 6 0	Jan, July	..	..
St	6%	Indian Elec. Sup. & Tras. Co. Deb. St. Reg. Prov. Cert.	10[illegible]—[illegible]	6 1 0	Jan, July	..	..
10s	..	Kalgoorlie Elec. Power & Ltg. Ord.	[illegible]			.	
[illegible]	1 [illegible]	Do. 6 per Cent. Cum. Pref.	[illegible]	8 0 0	April, Oct		—
St.	[illegible]	(Madras E. S. Corp. [illegible] per Cent. Constn. Deb. St.	89—9[illegible]	5 8 [illegible]	April, Oct		..
500	[illegible]	Mexican Elec. Light Co. [illegible] 1st Mort. [illegible]	[illegible]	[illegible]	..	[illegible]	
St	[illegible]	[illegible]	48—51	.	.	[illegible]	[illegible]
[illegible]	[illegible]	Do. [illegible] 1st Mort. [illegible]	[illegible]	[illegible] 1[illegible] [illegible]	..	[illegible]	[illegible]
[illegible]	[illegible]	Montreal Lt., Ht. & Pr. [illegible] Cap. St	[illegible]	[illegible]	F,M,A,N	[illegible]	
1	[illegible]	River Plate Electricity Co. Ord.	[illegible]	[illegible] 0 [illegible]	[illegible]		
1	1 [illegible]	Do. 6 per Cent. non-Cum. Pref.‡	[illegible]	[illegible]	[illegible]		
St	6%	Do. 6 per Cent. Deb. Stock	[illegible]	[illegible] 1 [illegible]	Jan, July		
[illegible]	[illegible]	Rosario Elec. Co. [illegible]	[illegible]	[illegible]	April, Oct		
1	[illegible]	†Shawinigan Water & Power Co. Cap. St	[illegible]	[illegible]	[illegible]	6[illegible]	6[illegible]
		Do. 5 per Cent. Bds.	102—104½	4 17 0	Jan, July	10[illegible]	10[illegible]
..	[illegible]	Victoria Falls Power Co. Pref.	½—⅝	—	Jan, July		

* In calculating the yields allowance has been made for accrued interest but *not* for redemption. † Ex dividend. ‡ The London Stock Exchange Committee have declined to quote these.

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CONTENTS OF THE CURRENT NUMBER.

NOTES.

The Marconi Company's Report.

THE long looked-for report of Marconi's Wireless Telegraph Co. has at length been issued. The unusual delay that has taken place has apparently been prompted, firstly, by the "complex and delicate situation" in which the Company found itself when the Government decided to ratify the Radio-Telegraphic Convention, and, secondly, is due to the feeling of the Directors that they ought, if possible, to be able to give a definite announcement as to the success of the trans-Atlantic service. The latter has now been in operation for about six months, and thus the Directors have had a fair opportunity of judging of the possibilities of the service, though during the greater part of that time the service has been very limited. Little is said as to the actual results that have been obtained, but it is mentioned (on the authority of the newspaper in question) that one newspaper in New York has received dispatches totaling 68,404 words during five months, promptly and efficiently transmitted. When the necessary enlargement and duplication of the machinery has been carried out it is claimed that the stations will be able to cope with a much larger volume of messages, and it is further estimated that the four stations—Poldhu, Clifden, Glace Bay and Cape Cod—working 12 hours a day at a speed of 20 words per minute, and at an average net rate of 4d. per word, will bring in a net revenue, after deducting working expenses, approaching to £150,000 per annum. Nothing is said in the report as to whether this rate of working has hitherto been maintained for any considerable period, though it is stated that "the service has been conducted at speeds varying up to 20 words a minute," and that it is expected to attain a speed of 30 words a minute with certain improvements in the apparatus. The estimate, therefore, of 20 words per minute as an average seems optimistic at the present time, not merely from the technical point of view, but also that of obtaining the necessary business turn-over.

THE Directors do not look with any greater favour than in the past upon the International Radio-Telegraphic Convention, which they regard as the result of foreign intervention following on their successful efforts in establishing a wireless service at sea; and it is pointed out that the Select Committee to which the question of ratification was referred expressed the view that, if the Marconi Company was found to be injuriously affected by the ratification, they should be "treated with a generous consideration quite irrespective of and without prejudice to their legal position." The Directors have, therefore, been carefully considering the course the Company should adopt, and although very little is said as to the outcome of the deliberations, it appears that the Board is about to modify its policy "so as to arrive at arrangements which will not only be satisfactory to the Governments concerned, but also remunerative to the Marconi Companies." It is noticeable that the share interests in the subsidiary Marconi enterprises, of the nominal value of £2,394,106. 10s., together with the 550 patents owned by the Company, are set down

in the balance-sheet at a value of only £244,960. 9s. 6d. But the most important point is that the Board will ask the shareholders to approve an issue of 250,000 7 per cent. fixed cumulative preference shares of £1 each, thus increasing the nominal capital to £750,000. This is a sting in the tail of the report which will not be comforting to the existing shareholders. These new preference shares will be entitled to dividend in priority to all other shares, and, subject to the payment of a non-cumulative dividend of 10 per cent. per annum on the paid-up ordinary share capital of the Company, they will have the right to participate, *pari passu* in proportion to the capital paid up, with the ordinary shares of the Company in any profits not required for the payment of such preferential dividend. Except so far as this new capital, should it be obtained, may serve to improve the general position of the Company, it is clear that the present shareholders have little prospect of any return upon their investment. Further, a large part of the new issue will be required to pay off the Company's existing financial engagements, so that, after meeting such liabilities and the cost of issuing, it will not provide any very considerable working capital for expansion. Finally, the mystery of Mr. CUTHBERT HALL is referred to at the end of the report, but is not cleared up. The net result, however, is that he has relinquished his position as managing director, together with any claims for commission, in consideration of a payment in cash and the allotment to him of 10,000 fully-paid ordinary shares in the Company. Mr. CUTHBERT HALL has since retired from the Board, and we conclude that a new era in the policy of the Marconi Companies has begun.

The Accuracy of Electricity Meters.

A TEMPORARY difficulty which will be met as soon as an 8 c.p., or even a 16 c.p., high-voltage metallic filament lamp is placed on the market is in the metering of the energy used by such lamps when used singly. At present, most electricity meters depending on the rotation of a disc or armature register inefficiently—*i.e.*, run slow—when only one or two lamps of small candle-power are in use; so that if 10 or 20 watt lamps were to become widely adopted the loss to the supply authority would be rather serious. There is little doubt that if this were found to be actually the case electrolytic meters would come more rapidly into favour, at any rate for all new consumers. On the other hand, since the consumers' maximum loads would be correspondingly reduced, meters of smaller capacity could be installed; but, even so, greater attention would have to be paid to rendering these more accurate at light load.

THAT there is room for improvement in the accuracy of existing electricity meters is evident from the annual report of the superintendent of street lighting of the Liverpool Corporation. It appears from this report that out of [illegible] meters passing through the testing department during the year 1907, including 510 received from contractors, 1,153 were rejected, the corresponding figures for the year 1906 being 3,623 and 1,069 respectively, the former figure including 1,191 meters received from contractors. It is interesting to notice that the larger sizes of meters—*i.e.*, for currents of 10 amperes and above—appear to be the most unsatisfactory. Thus, 245 out of 297 5 ampere meters were approved, whereas in the 10 ampere size only 924 out of 1,566 were found to be satisfactory. The superintendent remarks that, as regards new meters, there is a steady improvement, only 11 per cent. having been rejected during 1907, against 14 per cent. in 1906 and 17 per cent. in 1905.

Tramway Lifeguards.

ABOUT twelve months ago we referred to the good results attending the use of lifeguards of the plough type on the Liverpool Corporation tramways. Our remarks on that occasion are fully borne out by the annual report recently issued by Mr. C. W. MALLINS, traffic manager on these tramways. It appears that during the past year 27 people, who had been knocked down or had fallen in front of the cars, were pushed clear of the track by the plough lifeguards without any serious injury. Since in the previous year the same fortunate result occurred in no less than 44 cases, the plough lifeguard must certainly be considered to be most satisfactory. It is undoubtedly more efficient in the case of a snowstorm, since it serves to keep the track clear of snow, whereas considerable difficulty is often experienced with guards of the gate and trigger type, which, owing to an accumulation of snow, may require to be tied up and so rendered inoperative. Fortunately, heavy falls of snow are of rare occurrence in this country, so that this point is not of such importance as it would be otherwise, but there is no doubt that great interest is now being taken in plough lifeguards, especially by American tramway authorities.

Solidification of Helium.—The announcement made in our issue of March 13th that helium had been solidified by Prof. Kamerlingh Onnes, of Leyden, now requires modification. It appears from a letter by Sir James Dewar in *The Times* of April 16th that the presence of a small quantity of hydrogen was afterwards discovered in the gas under experiment; the transient solidification was therefore due to this gas, and the solidification of helium has yet to be realised.

Wireless Telephone Notes.—According to the Paris correspondent of *The Times*, Dr. Lee de Forest has recently been conducting various tests of his system in the presence of officers representing the French Government. These trials related to his method of sending telephonic messages without wires, as adopted in the United States Navy. The experiments, which were carried out between Villejuif and Mont Valerien, are stated to have been quite successful.

Wireless Telegraph Notes.—According to the *Elektrotechnische Zeitschrift* the steamer "Cap Arcona" of the Hamburg-Sud-Amerika Line, which is fitted with "Telefunken" apparatus, succeeded in interchanging messages with the coast station at Scheveningen (Holland) when steaming off Cape Ortegal on the north coast of Spain, a distance of 875 miles. Five messages were taken down at Scheveningen without a mistake. The equipment on the ship consisted of two masts, each 103 ft. high and about 300 ft. apart, and of a T shaped aerial made up of four wires having a natural wave-length of 450 metres. The transmitting wave lengths were 350, 450 and 800 metres. The transmitter capacity consisted of 288 Siemens jars in three groups. The maximum spark length was 15 mm.

Cable Interruptions and Repairs.

	Date of Interruption.	Date of Repair.
Paramaribo–Cayenne ...	Mar. 15, 1908 ..	April 20, 1908
Cadiz–Teneriffe ...	April 22, 1908 ...	—

Electric Lighting of Railway Carriages.—According to the *Elektrotechnik und Maschinenbau*, tests have been made on the Belgian State Railways as to the suitability of Osram lamps for this purpose. The Minister of Railways has reported that both as regards illumination and economy they appear to be eminently satisfactory.

Junior Institution of Engineers.—Through the munificence of Mrs. Frank R. Durham a bursary of the value of £25 per annum, to be called after the chairman of the Institution, the Durham Bursary, will shortly be established. This will be open for competition to those members and associates between the ages of 20 and 22, who submit a thesis on some technical subject chosen by the candidate. The first award will be made in October, and competing theses must be in the hands of the secretary, at 39, Victoria-street, Westminster, not later than September 1st next.

Electric Heating in Hotels.—The *Electrical World* gives a short account of the electrical heating installation which has recently been fitted at the Eagle Hotel, Grand Rapids. This installation, which consists of 27 radiators, is to be used as an auxiliary to the ordinary steam heating. Its first cost, including wiring, was about £83. Current is supplied at the average cost of about 1¼d. per horse-power hour. On the basis of an average of 10 radiators working four hours a day, seven days a week, the cost would be slightly over £6 per month.

Iron and Steel Institute.—As previously announced by us (see *The Electrician*, Vol. LX., p. 622) the annual meeting of this Institute will be held at the Institution of Civil Engineers on May 14th and 15th. Among the Papers to be read are: "An Experimental Electric Furnace for the Smelting of Iron," by Prof. B. Igewsky; "On the Pyrometric Installation of the Ordnance Factories, Woolwich," by Mr. J. W. Lambert; "On a New Fatigue Test for Iron and Steel," by Dr. T. E. Stanton, and "On the Physical Qualities of Steel in Relation to its Mechanical Treatment," by Mr. J. E. York. The annual dinner will be held at the Hotel Cecil, London, on Thursday, May 14th.

New Cable for Lift Work.—*L'Electricien* describes a new cable designed by the Deutsche Telephonwerke for the transmission of the electric signals necessary in lift operation. It is made up like a belt, and thus resists the destructive action of mechanical injuries to which ordinary cables are frequently subjected, often leading to the rupture of one or more of the constituent wires. This cable consists of seven metal strands placed side by side, each covered with a double layer of cotton and then with a strong braiding of the same material. These strands are assembled so as to form a large flat band which cannot get twisted or kinked. It is said that a cable of this kind has been in use for a number of years without sustaining the least injury.

Transformer with Adjustable Secondary Voltage.—A description of an apparatus possessing the above advantage, and recently patented by the General Electric Co. (U.S.A.) is given in *L'Eclairage Electrique.* The magnetic circuit is made up of three iron limbs. On the centre one is placed the primary winding, the secondary being wound on this and also on one of the outer limbs. An armature, built up of laminations, can be made to slide over the ends of these legs, thus altering the reluctance of the magnetic circuit. If the armature is moved to the right an increasing portion of the flux from the centre limb passes to that on the right, while that passing to the limb on the left decreases in like proportion. The secondary voltage is proportional to the difference of the fluxes, and increases, therefore, as the armature is moved from left to right.

Electric Power in Mines.—According to the *Electrical World*, the Pinos Altos Mine Co. are about to instal two 500 H.P. hydro-electric sets, together with the necessary auxiliary apparatus, at their new generating station. The energy from this station will be transmitted about 6 miles at 6,600 volts to a sub-station which will be equipped with lightning protection and line apparatus, as well as step-down transformers and switchboard. There will also be a motor-generator for converting the alternating current to direct current for a 3 ton mining locomotive. A direct-current switchboard will be provided to control the railway generator and feeder circuits. Two 50 H.P. motors will be installed at the mill to drive the stamps, crushers, pumps, &c., together with two 20 H.P. motors, one 40 H.P. motor and one 30 H.P. motor, and the usual circuit-breakers, switches, &c. In addition to the power equipment, there will be a complete lighting installation.

The Electrobus.—The London Electrobus Co. are gradually, but all too slowly, placing their popular vehicles on the London main thoroughfares. It is common comment among passengers and pedestrians alike that this vehicle will go far towards solving the difficult problem of London Traffic by the provision of a clean, comfortable, noiseless and odourless public conveyance, very little likely to break down (we have only seen one of the company's vehicles *hors de combat* since they started running, and this from no inherent fault in the vehicle), causing no unpleasant smells in the streets or in the shops, offices and houses on the routes, making no oily mess in the streets, emitting no noxious exhaust and absolutely under control. We understand that the eleven 'buses the company are already running are making excellent returns in the way of journey earnings, and we know that the public in the City precincts show a decided preference for the electrobus whenever it is available. For the ladies, with their easily oiled and spoiled apparel, the electric vehicle is a real boon.

Operation of High-Tension Direct-Current Railways.—The following summary of a Paper read by Mr. W. Murdock, of the Indianapolis & Louisville Traction Co., on this subject before the Central Electric Railway Association is given in the *Street Railway Journal*: So far no trouble has been caused by using 1,200 volts on any of the apparatus or wires carrying this voltage. The commutation of the motors is exceptionally good, the wear of both commutators and brushes being almost imperceptible. So far as the wear of the brushes is concerned, the indications are that a set will run a million miles. Since the equipment was placed in operation last October it has run more than 260,000 car-miles, 200,000 on 1,200 volts and 60,000 on 600 volts, and has operated equally well on each. The 1,200 volt system, as compared with the 600 volt system, requires less copper in the feeder system, fewer power houses and sub-stations, has a greater power-carrying capacity in the trolley wheel, and higher power motors. The 600 volt system has the advantage of less cost in car equipment. As compared with the single-phase system, the motors of the 1,200 volt direct-current system are more efficient, develop more horsepower per unit weight, have better commutation, and less complication in car control. The single-phase system, however, has the advantage in the feeder system and sub-station equipment.

ARRANGEMENTS FOR THE WEEK.

MONDAY, April 27th.

INSTITUTION OF CIVIL ENGINEERS.

8 p.m. Meeting at Great George-street, Westminster. Sixteenth "James Forrest" Lecture "On Some Unsolved Problems in Metal Mining," by Prof. Henry Louis.

TUESDAY, April 28th.

ROYAL INSTITUTION.

3 p.m. Meeting at Albemarle-street. Lecture on "The Development of the Modern Turbine and its Application," by Mr. G. Stoney. Lecture I.

FARADAY SOCIETY.

8 p.m. Meeting at 92, Victoria-street. Papers on "The Planimetrical Analysis of Alloys," by Prof. A. K. Huntington and Dr. C. H. Desch; on "The Interaction of Aluminium Powder and Carbon," by Messrs. F. E. Weston and H. R. Ellis; and on "Technical Electrochemistry in Russia," by Prof. N. Piltschikoff.

INSTITUTION OF CIVIL ENGINEERS.

8 p.m. Meeting at Great George-street, Westminster. Annual General Meeting of Corporate Members only.

WEDNESDAY, April 29th.

STUDENTS' SECTION OF THE INSTITUTION OF ELECTRICAL ENGINEERS.

7.30 p.m. Meeting at the Finsbury Technical College, Leonard-street, E.C. Paper on "Radio-Telegraphy," by Messrs. E. M. Marvin and A. Smith.

THURSDAY, April 30th.

INSTITUTION OF ELECTRICAL ENGINEERS.

8 p.m. Meeting at Great George-street, Westminster. First "Kelvin" Lecture, by Prof. S. P. Thompson, F.R.S.

FRIDAY, May 1st.

ROYAL INSTITUTION.

9 p.m. Meeting at Albemarle-street. Discourse on "The Scientific Work of Lord Kelvin," by Prof. J. J. Larmor, Sec. R.S.

COMPENSATION OF PRESSURE VARIATIONS ON ALTERNATE-CURRENT NETWORKS SUPPLYING MOTORS.

BY A. HEYLAND.

Summary. Variations in pressure in alternate-current networks are often produced by variation of load on motors, especially by alterations in the wattless currents: the present article describes several arrangements which not only compensate this drop, but may produce "over-compensation" if desired. This is possible by regulating the excitation of certain motors connected to the network by variations in the main current, thus giving an effect analogous to "compounding" in direct-current systems.

The present system of alternate-current pressure regulation is based on a principle depending on the operation of one or more motors connected to the system. For example, in Fig. 1, 1, 2

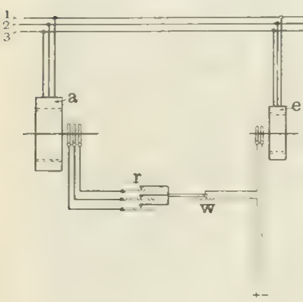


Fig. 1.

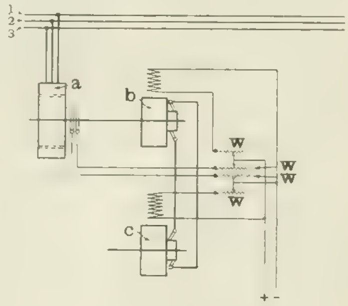


Fig. 2.

and 3 are alternate-current mains, *a* a motor connected to them, *r* its starter or regulating rheostat and *e* an alternate-current machine coupled to the network, excited by continuous current (+ and −), whose excitation may be regulated by means of the resistance *w*. If the motor *a* has a large starting torque the current at starting will be maximum, and will diminish until the short-circuit position of the rheostat *r* is reached. Further, the voltage drop in the network, caused by this motor, will be a maximum at starting, and will decrease for normal working. It is, therefore, very easy to make the resistances *r* and *w* interdependent, say, by connecting them mechanically, so that the excitation of *e* is varied approximately in the same degree, but in an inverse sense, as the voltage drop produced by *a*. The voltage drop of the network may thus be compensated, or even raised, when *a* is

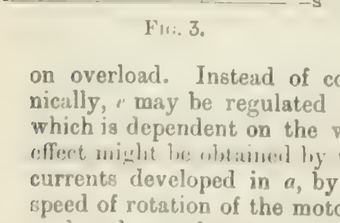


Fig. 3.

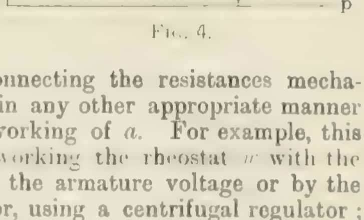


Fig. 4.

on overload. Instead of connecting the resistances mechanically, *r* may be regulated in any other appropriate manner which is dependent on the working of *a*. For example, this effect might be obtained by working the rheostat *w* with the currents developed in *a*, by the armature voltage or by the speed of rotation of the motor, using a centrifugal regulator; or by the acceleration of the motor, or, in fact, by any property which is dependent on the operation of the motor.

The machine *e* connected to the alternate-current network may be of any suitable type; for example, a synchronous motor running light, as shown in this case. But, in theory, the generator at the central station might be used by employing the current through *w* to alter its excitation or that of its exciters. The regulating current may be made dependent on the speed of the motor in any other way, say by generating or regulating it from a machine, connected mechanically to the motor.

Another application of this principle is shown in Fig. 2. A motor is supplied from a motor-generator, the object of which is to obtain economy in starting and regulation. The alternating-current motor is *a*, and *b* is the direct-current generator of the set, while *c* is the motor, in this case of the continuous-current type, connected to it. The regulating resistances of the different machines are represented by *w*, *w*, *w*, *w*, and it is supposed that these are connected up in an appropriate manner in order that the excitation of the alternating-current motor *a* may be regulated automatically according to the operation of the motor-generator and the state of the load, in such a way that the line voltage may be conveniently regulated. This may also be done in another way, as explained for the first arrangement, provided that the dependence of the alternate-current regulation on the opera-

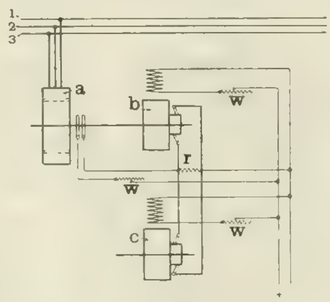


Fig. 5.

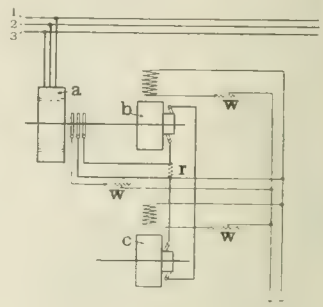


Fig. 6.

tion of the motors is taken into account. The arrangement described possesses another advantage of great practical importance. As is well known, sets of this kind are very often used on installations where a high rate of acceleration combined with a large torque is required—*e.g.*, machines for winding, haulage and other similar arrangements; or in places where the load varies greatly, as in rolling mills, &c. In such cases motor-generators are essential for another reason, besides that of economical speed regulation—namely, for compensating the effect of sudden temporary loads on the drop of pressure from the generating station and its effect on other motors connected to the network. It is not, however, sufficient to insert such a set in the motor circuit, because the voltage drop in the primary is not avoided at the time of sudden loads, and the only means known, up to the present,

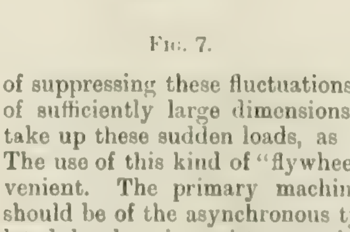


Fig. 7.

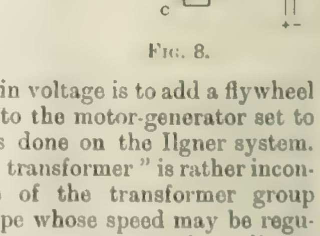


Fig. 8.

of suppressing these fluctuations in voltage is to add a flywheel of sufficiently large dimensions to the motor-generator set to take up these sudden loads, as is done on the Ilgner system. The use of this kind of "flywheel transformer" is rather inconvenient. The primary machine of the transformer group should be of the asynchronous type whose speed may be regulated by loss in resistances giving a greater or less slip, so that the flywheel may take effect. On the other hand, the flywheel to be of sufficient use should generally be of ample size so that the efficiency of the group may not become too low. All this adds to the complication of this type of installation which has the extra disadvantage of being difficult to start and stop. In the present system the flywheel may be entirely avoided, for to keep the voltage constant it is not necessary that the load on the generating station should be maintained the same. Further, the average load is decreased, as the losses due to the "flywheel transformer" can

be avoided. The voltage fluctuations may be compensated or even over-compensated so that the voltage increases with the load. The mean power factor can be kept very high. The regulation of the machine, connected to the network, is produced by the effect of the wattless current supplied by it to the network, thus proportionately increasing or diminishing its excitation. It is further evident that the regulation may be so chosen that the mean power factor is increased and the load on the primary installation thus reduced to a minimum. In the same way it is possible to obtain simultaneously flywheel effects by using slightly different couplings, as described below; though much smaller flywheels may be employed than in the present installations.

Lastly, the present system of regulation leads to other very interesting practical methods. In those installations where motors are worked from motor-generators, absolutely analogous effects can be obtained by simple electrical connections. The working of such motor-generators when these connections are used is shown in Figs. 3 and 4; it is supposed that flywheels are not provided.

Fig. 3 shows the shape of starting curves obtained from a motor worked by such a motor-generator—*e.g.*, on a winding machine. The abscissæ, s, represent the time in seconds, v the speed of the motor, e_2 the direct-current voltage supplied to the motor from the motor-generator, i_1 the primary current, and e_1 the primary voltage, while k represents the normal voltage at the generating station. The variable value x would, therefore, represent the primary drop, and it is obvious that this increases approximately in the same ratio as the direct-current voltage, e_2, supplied by the motor-generator, and whose corresponding variable value is represented by y.

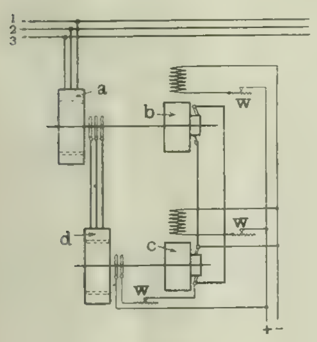


Fig. 9.

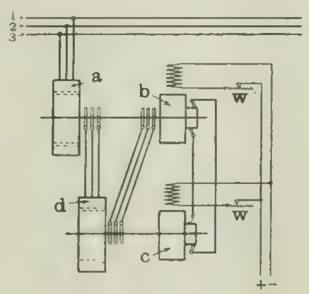


Fig. 10

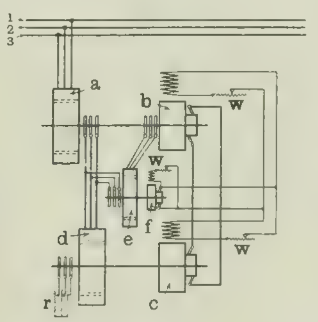


Fig. 11.

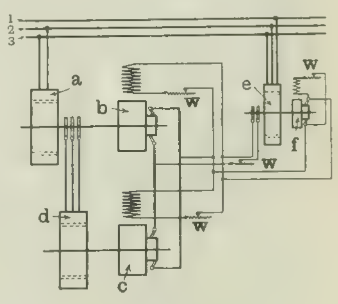


Fig. 12.

Fig. 4 shows the shape of the load curves of a motor, such as a rolling-mill motor on a varying load driven by motor-generator. The abscissæ, p, represent the power—*i.e.*, the continuous current from the motor-generator. While in this case i_1 is the primary current, e_1 the primary voltage and k the normal voltage at the generating station, the drop in primary voltage x increases approximately as the continuous current i_2, supplied by the motor-generator, whose corresponding variable value is y.

In the first case, Fig. 3, the drop may be controlled by supplying the primary machine with an exciting current which increases in proportion to e_2. In the second case, Fig. 4, an exciting current which increases in proportion to i_2 is provided. A method for effecting this is shown in Figs. 5 and 6.

Fig. 5 is an arrangement of the same type as Fig. 2. In this case, the excitation of the machine a is made dependent on the direct-current voltage, developed in the motor-generator, for its exciting circuit is connected in parallel with the direct-current circuit. A resistance, r, may also be provided, thus allowing a suitable regulation.

Fig. 6 is a similar arrangement, in which the excitation of the machine a is made dependent on the current supplied by the transformer. This arrangement is obtained by connecting the exciting-current leads to the field winding, or to a part of this winding, in series with the direct-current machines. Regulation can also be obtained by a resistance, r. If the two effects are required together, they must naturally be combined in an appropriate manner.

Fig. 7 is another arrangement in which the primary machine a is of the asynchronous type, thus permitting flywheel effects to be obtained at the same time. An independent alternating-current machine e is used for regulation, and is connected to the mains, its exciting circuit being connected to the secondary direct-current supply. Such a machine might also be simultaneously connected to an exciter, f, which would supply the ordinary exciting current for the group of machines. This exciter could be fitted on the other systems, being, for instance, connected to the motor-generator or to the motor, and thus producing a regulating effect. In the majority of cases this type of flywheel transformer is made up of continuous-current machines connected together on the Ward-Leonard system, and the connections may be arranged in such a way the direct-current machines supply both the exciting and regulating currents.

In the system shown in Fig. 8 the regulating current can be obtained directly from the motor, c. This is effected by providing it with slip rings connected to those on the primary machine, a. By increasing the excitation of c, it supplies wattless current to a and so to the network. This current increases with the speed of the motor and regulates the voltage drop. On the other hand, by increasing the excitation of the direct-current machine, b, wattless current which increases with the load, is supplied to the network and effects a proportionate regulation of the voltage drop. The machine, a, works at varying speeds, for the frequency at its slip rings increases with the speed of c. A flywheel could also be employed at the same time. Instead of using a for regulating the voltage any other machine could be used, if the rotor winding were connected to three rings in the secondary circuit of c.

In Fig. 9 c is coupled to a machine d, whose primary is connected to the slip rings of a, while its rotor is in the continuous-current circuit. Its excitation, therefore, and also that of a varies with the changes in the secondary circuit. The machines a and b, as well as c and d, both in this and the following arrangement, operate at varying speeds.

Fig. 10 shows an arrangement in which b is fitted with slip-rings connected to those on d, so that if its speed rises b produces wattless current which is supplied to the network through d and a, and thus regulates the voltage drop. If, in this case, the excitation of b is the greater, the wattless current increases with the speed of b, while if c preponderates a similar action takes place as its speed rises.

In Fig. 11, b is fitted with slip-rings which are connected to a machine, e, whose rings are in turn connected to those of a. The operation is similar to that described above. But e could also be used for other purposes. For instance, if a and b are provided with the same number of poles and e is so connected that its rotor and stator fields revolve in opposite directions it will turn at a constant speed and could then be connected to f providing the necessary exciting current.

The main machines are coupled in the same way in Fig. 12, but an auxiliary machine, e, is connected to the network in a manner similar to that shown in Fig. 7 and gives corresponding results.

As shown in Fig. 13, the machine c is connected to a balancer, g, working across a battery of accumulators, i, or any direct-current machine. The latter can work some arrangement such

as a flywheel or be driven by a motor connected to the network. In this case, this machine may also act as an exciter.

Fig. 14 shows an arrangement in which a balancer, g, is placed in series with the direct-current machines. This balancer is coupled to some arrangement such as a flywheel, or to a machine e, connected across the network or performing some other operation. The exciting current is in this case provided directly by the direct-current machines, and is obtained by dividing the exciting winding into two parts and connecting each separately to the brushes of b and c. The field windings of g are arranged in opposite directions, so that an automatic balancing effect may be obtained. The excitation of d is automatically regulated with the load, and any desired regulation may be obtained by conveniently adjusting the different resistances of the exciter windings. In order that the regulation may depend on the load compound windings may be used. The balancer g may be replaced by machines of other kinds, for instance by two connected together on the Ward-Leonard system, the first being in series and the second in parallel with the circuits of b and c. Or b and c might be combined into a single machine corresponding to the arrangement in Fig. 8.

The arrangements described above allow c or c and d to be used as motors, while a and b can be used as transformers. Similarly, c, or c and d can be used as transformers and a and b as motors. The advantage of using a and b as motors is that a part of the energy supplied to a is transformed directly into mechanical work, so that the efficiency of the group is increased. Besides the motor generator has only to transform a relatively small amount of energy, and with the same maximum

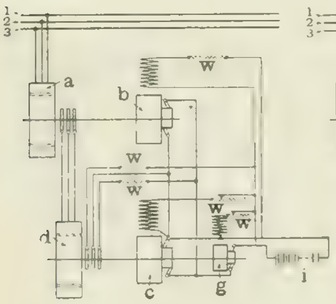


FIG. 13.

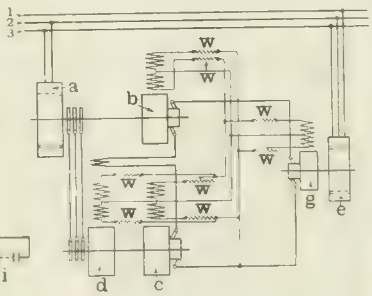


FIG. 14.

speed it becomes smaller than if a and b were used as auxiliary transformers. If a and b are used as motors it is advantageous to make a a single-phase machine, as shown in Figs. 12 and 14. In this case it is not necessary to provide a change-over switch in the high-tension leads of a if this motor has to be reversed. It is sufficient to place a change-over switch in the low-tension secondary, as a can then work in either direction without the primary connections being altered. If, on the other hand, the primary current is single-phase, and it is wished to operate the primary machine as three or polyphase, the second auxiliary motor e may be employed for generating a third phase, as indicated in Fig. 7. An advantage common to all these arrangements is that they permit a very easy change in direction to be obtained when the motors are required to operate in this manner. This also applies when one of the machines is synchronous. Given that the excitation of the different machines is regulated automatically, and that it is variable, it is possible to excite these synchronous machines, similarly to an asynchronous machine, with a relatively weak field, and to produce the change of speed in such a machine by bringing in two leads, as in an asynchronous machine, without giving rise to sudden variations of current and without fear of breakdowns.

Besides the method here described, the system allows a great number of other combinations to be obtained, and it is naturally possible to employ simultaneously several different arrangements. All these applications are characterised by the fact that regulation of the alternating current voltage is directly dependent on the operation of one or more motors connected to the network.

RULES OF THE SOCIETY OF GERMAN ELECTRICAL ENGINEERS, 1908.

A Paper on this subject was read by Mr. W. P. Steinthal, M.Sc., before the Leeds Local Section of the Institution of Electrical Engineers on Thursday, March 19th. The greater part of the Paper consists of a translation of the rules for electric installation work drawn up by the Society of German Electrical Engineers (Verband Deutscher Elektrotechniker.) [An abstract of these rules was given in the issue of *The Electrician* for December 27, 1907]. The author then proceeds to compare them with the regulations in force in this country. In what follows we give the substance of the author's criticism.

As far as the rules themselves are concerned, the general tendency is very similar to that of the I.E.E. rules. It is noticeable that the regulations are very minute in detail, far more so than the equivalent rules of the I.E.E.; but, on the other hand, some of the regulations are indicated as being merely recommendations. Also, provided an installation were erected according to the German regulations, no further specification could under any circumstances be required; but in the I.E.E. rules it is distinctly stated they are not intended to take the place of a detailed specification.

Current Density.—An examination of these figures shows that from 9 to 20 amperes the current density is three times or more, from 20 to 200 amperes twice or more, from 200 to 240 amperes one-and-a-half times or more, and for 500 amperes 1·3 times that of the I.E.E. rules. Thus the amount of copper used under V.D.E. rules is considerably less than under the rules of the I.E.E. This means that the loss of pressure at the end of a circuit, about which I can find nothing stated in the V.D.E. rules, is allowed to be considerably greater than in our case. This is a very notable difference between the two sets of rules.

Insulation.—Rubber-covered wires have been entirely discarded in this country except for flexibles; but in Germany they are retained to some extent for surface work up to 110 volts. This is what is referred to in this country as "Continental wiring with flexibles." The use of the word "flexible" here is really misleading, as the conductors are not flexibles in our meaning of the word. They are merely rubber-insulated wires, as against vulcanised rubber wires. For installations up to 125 volts, where the work is done on the surface, the use of this rubber-covered wire fixed on porcelain bobbins is very common. There can be no question that this method of installation is cheap, and, if properly carried out, neat and perfectly sound from an electrical point of view.

A table shows that the thickness of insulation required is appreciably smaller in the case of the German rules. The general conclusion is, therefore, that the German rules allow a very appreciable diminution in cost of installation as far as conductors are concerned, as compared with the usual practice in this country. I think we rather err on the safe side in the case of small cables.

Flexibles.—In an appendix to the Paper read by Prof. Schwartz* last year to this Institution will be found the German rules as they stood in 1905. The 1908 rules contain no appreciable modification, and I only desire to point out one rule in particular which relates to the supporting of a fitting by means of an additional wire carrying no current in addition to the actual conductor carrying the current. This appears to me to be an important point to which I find no reference in the I.E.E. rules.

Insulation Resistance.—They do not base their tests according to number of points, but require that the leakage current should not exceed 1 milliampere between any two fases, and, further, that a distributing board should have an insulation resistance of 1,000 ohms multiplied by the pressure of supply. An examination of these requirements shows that, more particularly in small installations, the Germans are content with a lower test than we are in this country.

The regulation stating that the normal working current and pressure should be marked on switches appears to be a useful one, referring to a practice which is more or less non-existent among English manufacturers, but would be of great utility to the contracting engineer.

The rule regarding the marking of the current capacity and pressure on sockets and plugs, and for altering the construction to prevent these being used on larger currents than designed for, deserves mention, as, in my opinion, sufficient care is not taken with regard to sockets and their plugs.

An examination of the rules for safety fuses points to the use of the Edison screw type of fuse plug, and my own observations of installations in Germany tell me that this type of fuse is used almost universally. The point to be particularly noticed is the value attached to non-interchangeability. The replacement of fuses is treated in this country in a most haphazard fashion, and I am

* *The Electrician*, April 19, 1907, pp. 11 and 53.

inclined to think that the Edison screw type of fuse is more scientific, and ensures more certain working and proper replacement.

It is interesting to note that switch lampholders are not permitted for use with hand lamps. Also the use of papier-mâché conduit with either a brass or an iron sheath appears to be very common in Germany. This type of conduit is, I believe, sold in this country under a trade mark "Adnil." From inquiries I have made, this conduit does not appear to offer any advantage as regards price. It is possible that there may be a saving in cost of labour with this type of conduit over the steel conduit in general use here.

With regard to insulated conductors for inside work it will be found that the general tendency is in the direction of higher current-density and thinner insulation. Thus the cables used under German regulations would be a great deal cheaper than under the regulations of this Institution. It is also noticeable that no mention is made of a layer of pure rubber between the copper and the vulcanised rubber.

A very pertinent question arises out of these comparisons namely, whether the extra cost involved by our practice is necessary or essential for the security, durability and efficiency of installations. I feel satisfied in my own mind that the German regulations are the result of experience and careful investigation, and it will be interesting to hear members' views as to how far it would be advisable for us to modify our existing rules. There is one point which I think must be taken into consideration, and that is the question of climate, which, generally speaking, may be taken as drier than the climate of this country.

DISCUSSION.

Mr. W. H. Campion said that the main question was whether installations could be erected more cheaply, and, of course, if they could, it would have the effect of increasing the number connected to the mains. But there was the other point that cheaper installations would eventually bring discredit, and it seemed to him that the only point was the difference of the current density in the V.D.E. and the I.E.E. rules. The Germans used a rating regardless of pressure drop, but if casing was used there would be trouble in this country with the fire insurance companies. All the wiring he had seen on the Continent, including the flexible wiring, had always been on low voltage, about 100, and it was much the same in America where they allowed a good deal of haphazard work. The V.D.E. suggested that the normal working current and pressure should be marked on the switch; that was where we had spent a good deal more money on installations than necessary. Five ampere switches were used for one 8 c.p. lamp, and so on. He knew there were smaller switches, but even now they were seldom used. The average Englishman was always in such a hurry that he would not have anything standardised in the shape of a screwed fuse. It was rather a big job going round replacing all home-made fuses. They made a great point of the protection from any inflammable material. Many engineers must have noticed the amount of inflammable material that was put on to the lamps, particularly in showrooms, windows, &c., and it was astonishing what this would stand before it was set alight. He suggested that with the current density they had taken for the conductors they were relying more or less on intermittent loads.

Mr. S. W. Cuttriss thought it would be very useful for the nominal working current and pressure to be marked on switches, and also plugs. The Edison form of plug fuse was recommended, but apparently not for sub-circuits for house purposes. He would not like to have enclosed fuses for these, as the present form was very convenient. For heavier currents it was useful to have them standardised, but there was a good deal to be said on both sides. Having an independent third wire in flexibles to support the weight of the fitting might be adopted with advantage in this country. The insulation of conductors was, he considerd, one of the most important points in the Paper, but the Germans did not appear to be so particular as we were in that respect. They allowed a lower insulation, and he was afraid that meant a lower quality of dielectric. Wood-casing did not seem to be used, but although despised a good deal by some people, it had a great many points in its favour. The Institution in the latest revised rules had allowed certain concessions with regard to running unprotected wires in houses, but we should be very careful how we adopted it at the normal pressures used in this country. It appeared that the "Continental wiring" was used for low voltages—*i.e.*, 100 volts or thereabouts.

Dr. R. Pohl said that in his opinion we might use very much higher current densities without in any way running the risk of exceeding the permissible temperature rise. This question was becoming of greater importance due to the rapid introduction of metal filament lamps. He thought a voltage variation of about 3½ per cent. with these gave the same change in candle-power as with carbon filament lamps was caused by 2½ per cent. variation. That meant in practice that the temperature rise was becoming more often the limiting factor in wiring installations, and that the voltage drop was losing in importance. He believed the number of breakdowns in Germany, where a much higher density was allowed, was by no means higher than in England. A difference between the German and English rules to which the author did not allude was that the former were generally adhered to whilst the I.E.E. rules were not much more than a set of recommendations. Further, there were so many different sets of rules. It was a deplorable state of affairs, and something ought to be done to bring about greater uniformity. Rules should be made not by Corporations or consulting engineers, but by the nation, and they should be international as far as possible. The electrical industry was an international industry. A few years ago the German people used to export a large quantity of machinery into England; now it was almost the reverse. We had, therefore, to construct machines in accordance with the rules adopted in the respective countries. If they were international it would be a very great advantage to the whole of the electrical industry. He thought it most important that the fuses for different current strengths should not be interchangeable. The climate in Germany was certainly somewhat drier than that in England; still they got sometimes four or five weeks of rain, so that he did not think climatic difference was of great importance.

Mr. H. Visger mentioned that the V.D.E. rules were accepted by everybody in Germany, and it would be very much more satisfactory if our own rules were treated in a similar manner. He could not agree with the opinion that fuses might be interchangeable. He thought that the insulation resistance specified for wires was frequently higher than was necessary. The way the work was carried out counted much more than the grade of wire used in many cases.

Mr. H. A. Jones did not see any reason why, for a low voltage circuit, bare conductors on insulators should not be allowed inside a building. He wondered, however, what would be the feeling of some of our borough electrical engineers and power companies if it was suggested; yet they could not say it was not a good, sound and substantial job, and their only reason to object would be because it had not been done before, and it was this conservative spirit in dealing with matters which had done so much, and which was doing so much, to keep the growth of electrical power supply from central stations smaller than it would otherwise be were a more liberal policy adopted by those in charge of power supply, and he would say that if the new suggested additional rules of the Home Office went through, then Heaven help the industry in this country. They had had considerable experience in this direction some two years ago when the suggested Home Office rules for the control of the use of electricity in mines were first brought out. He fully agreed with the idea of marking the current carrying capacity of switches and plug sockets, but he would suggest that they should be marked for the voltage also. Seeing that inflammable and hygroscopic material had been largely eliminated from our wiring systems, he thought that an increase in the current density might well be allowed.

Mr. I. F. Fawcett said that although the author pointed out that there was no rule recommending that rubber should be put against the conductor in a cable, he (the speaker) remembered buying a quantity of German cable some years ago, and found when stripping it that there was a rubber insulation inside the cable, but he did not know whether this was regular practice, or whether it was only done with cable sent here. He quite agreed with several of the speakers that there could be nothing more absurd than to find a country like England possessing so many different sets of rules. The only thing he could suggest was that the Government should pass an Act and make the Institution rules compulsory.

Mr. H. Dickinson was inclined to think that the size of conductor we allowed was too small. There was no doubt that there were many cases where the current density due to extensions was very much above the limits that the rules allowed, but they had no trouble except due to drop of pressure. In damp places, &c., special regulations ought to be made; but he certainly thought a greater density could be allowed with perfect safety under ordinary conditions. Respecting the dielectric, he was of opinion that the stipulation as to thickness ought to be kept up, since in many old installations they found that the rubber had perished, but they did not think of making a person renew it, except in very bad cases, and instead made a special point of the fusing. Wherever there was a change in section a fuse was put in, and he thought that if proper attention was paid to this matter ample safety was provided for.

Mr. Steinthal, in reply, said that the Germans up to very recently had been in the habit of using the so-called "Continental flexible wiring" when no installation probably exceeded 125 volts. There were a great many places now where they were contemplating going on to the higher pressure (250 volts), and in these cases they invariably used papier-mâché tubing. There were very few places in Germany where wood casing was used. As regards current-density he was perfectly satisfied that the German engineers would not make regulations which were not the result of very careful investigation. He agreed with the remarks made by Mr. Campion regarding inflammable material being in contact with incandescent lamps, but he thought that the danger would be obviated to some extent by the new lamps which undoubtedly burned very much cooler. The question of interchangeability of fuses was of very great importance. With the Edison pattern you had a plug of a certain diameter and of a certain length, and you could not screw it into a wrong socket. It was curious that throughout the German rules he could find no reference to pure rubber used in conjunction with vulcanised rubber. The pure rubber was only allowed in the case of installations which did not exceed 125 volts. Many engineers were inclined to turn up their noses at what was called "foreign cable," but he wanted to point out that most German engineers and manufacturers were far too 'cute business men to send over here the thin cable which passed their rules as they knew it was of no use. The German seemed to use only vulcanised rubber for flexibles on circuits over 125 volts. If there was one set of rules to which all engineers had to work, as in Germany, he was perfectly certain that we should be saved a lot of trouble and get rid of a great deal of inferior material. With private plants there was in this country no control whatever other than that of the Insurance company, and you never knew exactly what might be done.

THE ELECTROLYTIC ALKALI AND BLEACH INDUSTRY IN 1907.

BY JOHN B. C. KERSHAW.

The position and prospects of the electrolytic alkali and bleach industry have not altered materially in Europe during the last 12 months, although in America some expansion is occurring. In Europe, the older Le Blanc and ammonia soda processes are maintaining their position, and it seems probable that, as stated by the writer in a Paper read before the Faraday Society in February, 1907, all three types of works will continue to exist side by side for many years to come. The figures given in that Paper for the number of works operating electrolytic processes in Europe and America, and for the annual output of alkali and bleach, have not been materially affected by the criticism passed upon them.

These totals may, therefore, be given here as the nearest approximation yet published to the present capacity of the works now in operation :—Total number of works 36. Total power available 67,000 H.P., equivalent to an output of 134,000 tons of 70 per cent. caustic soda and 280,000 tons of 35 per cent. bleaching powder per annum. Details relating to the financial returns add new extensions of the various works during 1907, so far as these are available for publication, are given below.

UNITED KINGDOM.

1. *The Castner-Kellner Alkali Co. Works, Weston Point and Wallsend-on-Tyne.*—At the annual meeting of the shareholders of this company, held November 21, 1907, a net profit of £116,754 for the 12 months ending September 30, 1907, was reported. After payment of debenture interest and of the interim dividend on the ordinary shares (paid in May), a balance of £103,830 remained and was apportioned as follows ; £30,000 to depreciation reserve, £15,900 written off plant and machinery account, £7,500 written off suspense account, £36,000 to payment of 16 per cent. dividend on ordinary shares for six months ending September 30, making, with the interim dividend paid in May, 12 per cent. for the year.

The balance carried forward to the 1907-8 account was near y the same as in the previous year—£14,420, as compare d with £14,773. This is the best report the company have yet submitted to their shareholders, and the chairman and the directors of the company naturally claimed some credit for the policy of scrapping old plant, which, combined with a good demand for their products, had enabled them to achieve this advance upon the previous year's profits. The most notable instance of "scrapping" by this company has been the substitution of a Mond power gas plant and Koerting gas engines for the older steam plant at the Weston Point works. This plant is of 10,000 H.P. capacity, the gas engines being each of 700 B.H.P. It would be interesting to know how the cost of electric power at Weston Point compares with the cost at the Wallsend-on-Tyne works. The manufacture of sodium is carried on by this company at its new Wallsend-on-Tyne works, while at the Weston Point works, alkali and bleaching powder are the chief products. Zinc chloride, produced by the Swinburne-Ashcroft process, is also manufactured at the latter works. According to Blount there are 1,100 cells at this works, each cell having a capacity of $10\frac{1}{2}$ tons of caustic soda and 22·6 tons of bleach per year. Estimating that 1,000 cells are always in operation this equals an output of 10,500 tons of caustic soda and 22,600 tons of bleaching powder per year.

2. *The Electrolytic Alkali Co. Works, Middlewich.*—This company reported a net profit of £8,212 for the year ended August 31, 1907, and with the amount brought forward from the previous account, the directors were able to recommend the payment of six months' dividend on the 7 per cent. preference shares—on which $2\frac{1}{2}$ years' arrears of interest had accumulated. A balance of £6,840 was carried forward to the next account.

AMERICA.

1. *The Acker Process Co., U.S.A.* The works of this company at Niagara Falls were the scene of a disastrous fire in February, 1907, when they were completely burnt down, and a loss of £160,000 being incurred. The works have not been rebuilt, presumably because the cost of operating the process and of repairs was more than was at first estimated. The fusion process of electrolysing common salt with a molten lead cathode is, therefore, no longer represented in the manufacture of alkali and chlorine products. The works of the Acker Process Co. at Niagara Falls was established in 1899, and 2,000 H.P. was utilised in the production of caustic soda, bleaching powder, carbon tetrachloride, tin tetrachloride and sulphur bichloride.

2. *The Townsend Cell and Process.*—This cell and process have been in operation for nearly two years at Niagara Falls, in the works of the Development & Funding Co., and the results obtained are stated to be entirely satisfactory. A plant utilising 1,000 H.P. has been erected. Dr. Birkeland, in a Paper read before the New York Section of the Society of Chemical Industry in May, 1907, described the cell, and gave full details of the working and results obtained.* The cell is of the diaphragm type and is shown in sectional elevation in Fig. 1, while Fig. 2 shows the external view of the cell designed for industrial use. An anode compartment is enclosed between a lid, C, two vertical diaphragms D, and a U-shaped non-conducting body H. The graphite anodes G pass through the lid of the cell, while the cathodes, S, are formed of perforated iron plates and adhere closely to the diaphragms D. The cathode compartments of the cell are formed by the outer plates I, attached to the cathodes. The anode compartment is kept filled with saturated brine (T), while the cathode department contains kerosene oil (K). This oil serves to prevent diffusion and reunion of the ions liberated at the cathode, since the cathode liquor as soon as it appears on the outer surface of the cathode is surrounded with a chemically inactive and physically unmixable liquid.

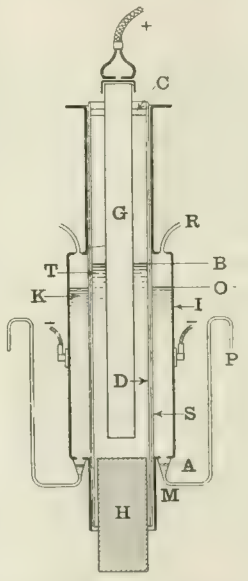


FIG. 1.—VERTICAL SECTION OF TOWNSEND CELL.

The cathode liquor, under these conditions, assumes a globular form as it detaches itself from the outer surface of the perforated plate, which acts as cathode, and sinks through the oil into the caustic pocket A, where it is at once removed from all danger of chemical action.

The flow of brine into the anode compartment is automatically governed by the current intensity, and the level of brine in this compartment is thus increased or diminished as the number of amperes passing through the cell rises or falls. The distance between anode and cathode scarcely exceeds $\frac{3}{8}$ in., and the E.M.F. required to work the cell is therefore low.

The cell described above has undergone some slight modifications since it was first tried upon a large scale, but in all essentials the cells now in use at Niagara Falls are constructed in accordance with the original plan and design.

The large cells measure about 8 ft. by 3 ft. by 12 in. wide, and, as shown in Fig. 2, the outward appearance resembles the Hargreaves-Bird type of cell. The diaphragm, which is the most important part of a cell of this description, is made of a woven sheet of asbestos cloth, the pores of which are filled with a paint made of a mixture of oxide of iron, asbestos fibre and gummy iron hydroxide. When a diaphragm of this kind has to be renewed the cloth is simply scrubbed and washed, and a new coat of paint is applied. The frequency of renewals of these diaphragms depends very much on the condition of the brine, and in ordinary work the diaphragms require repainting about once in five weeks. The cost of renewal is, therefore probably less than in the Hargreaves-Bird process. The chlorine gas obtained from the Townsend cell is used for

* The following particulars are drawn largely from Dr. Birkeland's Paper.

the manufacture of bleaching powder by the ordinary lead-chamber process. The cathode liquor on leaving the cell contains large quantities of unconverted sodium chloride; this is separated out as the liquor is concentrated by evaporation in a series of vacuum pans and open pots. As regards the electrical efficiency of the process, the current efficiency seldom falls below 90 per cent, and may rise to 97 per cent., while the energy efficiency when running with 2,000 to 2,300 amperes per cell (equal to a current density of 1 ampere per square inch) is represented by an E.M.F. of only 4·7 volts per cell, or 46 per cent.

The Niagara plant using this cell was producing 5 tons of caustic soda and 11 tons of bleaching powder per day during 1907, and an increase of the works to four times this capacity was decided upon early in the year. Messrs. Townsend and Sperry were the patentees of the original cell, while the diaphragm now in use, and some of the subsidiary plant is the invention of Dr. Birkeland.

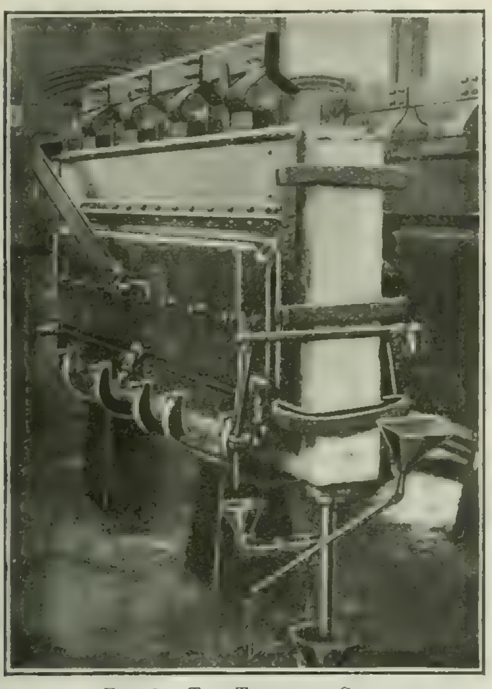


Fig. 2.—The Townsend Cell.

3. *The McDonald Cell and Process*.—A plant using this cell, and having a capacity of 6½ tons of caustic soda and 16 tons of bleaching powder per day, has now been in operation at the paper mill of the New York and Pennsylvania Pulp Co. at their Johnsonburg works for nearly two years. The caustic soda and hypochlorite of lime are delivered to the paper works in the form of liquor, and the installation can therefore hardly be classed as an alkali works. There are in America a large number of installations of this type, using generally a diaphragm type of cell, and Messrs. Zerr and Witham, in an article contributed to *Electrochemical and Metallurgical Industry* have given some cost figures based on the actual operation of a small plant producing bleaching liquor equal to 3·3 tons of bleach per day. The installation consisted of 96 cells, utilising 796 amperes at 205 volts, and the capital cost of engines, generators and cells, with subsidiary plant, was £10,000. The operating costs amounted to £5,030 per year and the value of the caustic soda and bleach produced was £8,123. This equals a return of 31 per cent. on the investment of capital, but it is questionable whether the allowance for depreciation and repairs, in this estimate, is large enough to maintain the plant in effective condition over a longer period than three months. There is also no allowance for skilled management and control, and electrolytic plant demands this to a high degree if a good efficiency is to be maintained. However, in America this type of plant is now being widely tried, and in many cases no doubt the installations are proving economical. McDonald utilises asbestos paper for the diaphragms, and an E.M.F. of 4·5 volts is required per cell.

Germany.

The Elektrochemische Werke G.m.b.H., Bitterfeld.—This company in its report covering the year 1906 declared a dividend of 9 per cent., as compared with a dividend of 7 per cent. in the previous year. The following details of the plant at Bitterfeld and at Rheinfelden may be given here:—

Bitterfeld Works. Started 1895. Fuel, lignite. Generating plant, 5 × 600 H.P. and 1 × 1,800 H.P. units = 4,800 H.P. Products, 7,200 tons of caustic potash and 12,250 tons of bleaching powder per year; also magnesium and sodium.

Rheinfelden Works. Started 1898. Water power. Generating plant, 4 × 850 H.P. units = 3,400 H.P. Products, 5,800 tons caustic potash and 10,000 tons bleaching powder per year; also calcium carbide.

Italy.

1. *The Società Elettrochimica del Caffro* has completed a plant for producing caustic soda and chlorine by a modification of the Kellner cell and process. The caustic soda is sold in the form of a solution concentrated to 38 deg. Baumé. The company uses common salt from Sicilian mines as raw material, and the plant has a working capacity of 20 tons a day.

2. *The Società Italiana di Elettrochimica.*—This company controls electrolytic alkali works at Piano d'Orte and Bussi. For the year 1905-6 a dividend of 6⅔ per cent. was declared, the net profit being £30,700. The extensions of plant which the company has completed on the Texera River in connection with the new water-power developments are to be devoted to the manufacture of other product, as the demand for chlorine products in Italy is limited.

POULSEN'S APPARATUS FOR WIRELESS TELEPHONY.

Mr. V. Poulsen lectured on Wireless Telephony at the London Institution, Finsbury-circus, London, last Wednesday to an audience presided over by Lord Aldenham, who read a message from H.M. the Queen regretting extremely her inability to be present and requesting that a copy of the lecture might be sent to her.

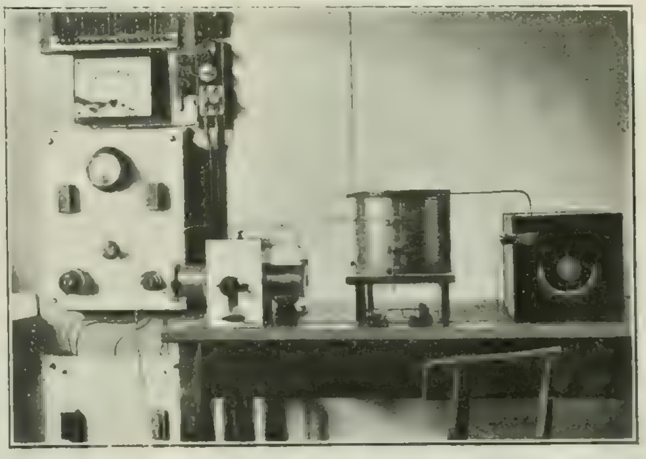


Fig. 1.—Transmitting Apparatus.

Though the lecture did not contain much information new to those who have followed the development of his system, as reported in the technical press, the experiments, and the beautifully designed and constructed apparatus, were worth going far to see. Beyond a practical demonstration of telephony without wires on a small scale in the hall, and the lecturer's confirmation of the fact that sound has been transmitted electrically over a distance of 460 km. without wires, little information was given as to wireless telephony proper, the greater part of the time being spent on a comparison between the properties of damped and undamped waves without a serious attempt to explain how the latter are employed in the transmission of sound. The fact is that the Poulsen system is now in the unsensational stage reached at one period or another

by all inventions during the process of their conversion into practical commercial utilities. The system has had its fundamental principles fixed and the main lines of its development determined, and now all the energy of the inventor is concentrated on the perfecting of details and on its adaptation to the needs of the community.

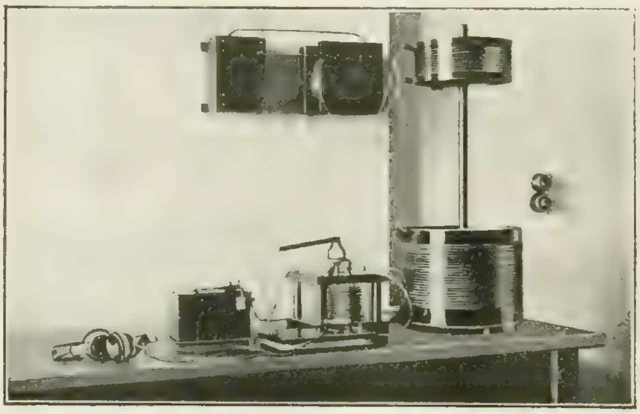


Fig. 2.—Receiving Apparatus.

The evidence of this was very obvious in the design of the apparatus shown at the lecture and in the experiments. These demonstrated what a remarkable amount of energy can now be obtained in the form of high-frequency alternating currents, even from apparatus which is simple and free from complications—indeed, wonderfully so, as compared with many telegraphic instruments in daily use in every country. In deference, no doubt, to the supposed desires of a non-technical audience, for which the lecture was chiefly intended, practically no explanation of the apparatus on the table was attempted; as, however, it was this feature of the demonstration which was of greatest interest to technical members of the audience, it will be as well to describe the instruments in some detail.

Fig. 1 shows the Poulsen transmitter, which is suitable equally for telegraphy or telephony, the only change being the replacement of the key by a microphone. On the left is the switchboard for the continuous current supply to the arc. At the same end of the table is the enclosed arc lamp, with, in this case, horizontal electrodes and transverse magnetic field, burning in hydrogen or alcohol vapour. Next comes the helix forming the inductance of the main oscillating circuit and of the aerial; and on the right is a variable condenser. The aerial wire is seen rising from the inductance and the key stands below, its usual function being to short-circuit some of the turns and thus throw the transmitted current out of tune with the receiver. In telephony the microphone may be placed in the aerial or earth wires or may influence the supply circuit inductively. The coupling of the main oscillating circuit to the aerial is "close," since a portion of the helix is common to both.

110 words per minute. 5×10^{-6} amp.

60 words per minute. 1×10^{-6} amp.

Fig. 4.—Tape Records.

Fig. 2 shows the receiving apparatus, which, like the transmitter, may be used for telegraphy or telephony at will by the mere alteration of one item. In this case the necessary change is the substitution of a continuously acting detector for the intermittent tikker. The aerial and earth wires are connected to the two terminals of the capacity on the wall, forming, with the variable condenser and the upper helix, the primary oscillating circuit. The secondary, or detector, circuit consists of another helix (at right-hand end of table), a variable and a fixed condenser, the detector and the telephone. The coupling or mutual inductance of the two receiving circuits is very weak, the primary and secondary helices being frequently used several feet apart, as shown in the figure. There is no conducting connection between any part of the secondary circuit (on the table) and anything else outside this circuit. The detector is generally of the crystalline rectifying type, which acts *without* a local battery, as was shown by Dr. Erskine-Murray in his demonstration with this apparatus at Nottingham

Fig. 3.—Arc Generator.

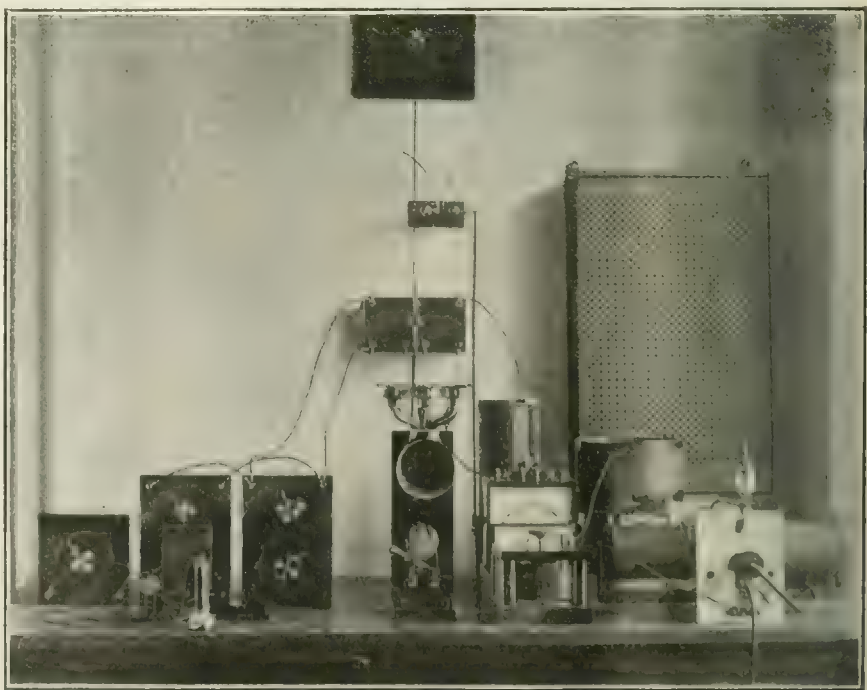


Fig. 5.—Telephonic Transmitter used in the Berlin-Copenhagen Experiments.

Fig. 3 shows an arc generator giving about 1½ kw. as high

frequency current. Like the other patterns, it is equally suitable for telegraphy or telephony, though the range for the latter is less than for the former. Alcohol vapour is used in the arc instead of hydrogen, since it is much more convenient for field use, and apparently quite as efficient.

Fig. 5 is taken from a photograph of the actual telephonic transmitter used in the Berlin–Copenhagen wireless telephony experiments. It will be seen that as many as six microphones are used simultaneously on one mouth piece in order to obtain as large a modulation of the transmitted current as possible. The arrangements are otherwise similar to the standard type shown in Fig. 1.

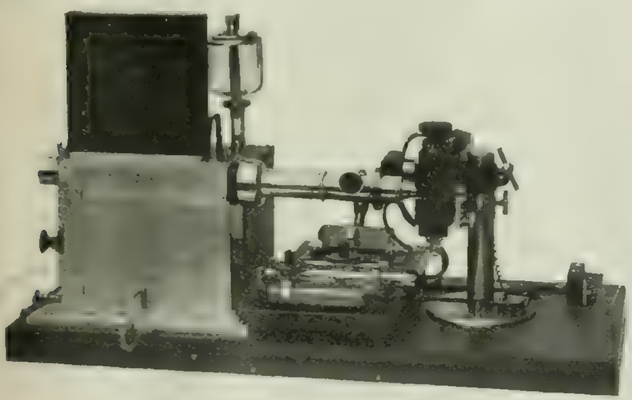
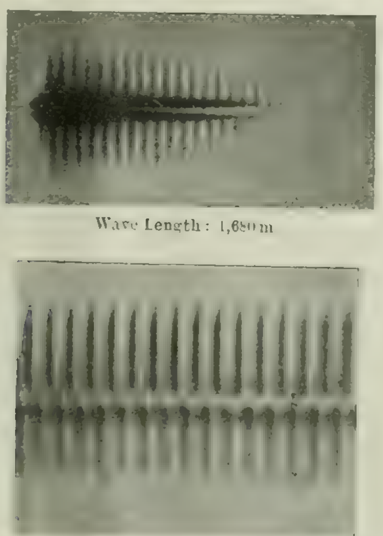


Fig. 6.—View of Photographic Printer.

Two most interesting pieces of apparatus were shown upon the lecture table, in addition to the fundamental instruments—viz., a high speed radio-telegraphic transmitter and a recorder with which speeds up to 120 words per minute have been obtained. Samples of tape records were shown at from 60 to 110 words per minute, and even at the higher speed the records were easily legible by the most inexpert telegraphist, which is more than can be said of records taken through submarine cables, even of moderate length. These are shown in Fig. 4.

In Fig. 6 is shown the receiver with which this "record"-breaking result has been obtained. It consists of a "thread," or single moving wire, galvanometer combined with a photo-



Wave Length : 1,680 m.

Wave Length . 3,000 m.

Fig. 7. Oscillographs of High Frequency Currents, showing Damped and Undamped Currents.
By Dr. Dieselhorst.

graphic recording tape, which is developed and fixed automatically by the instrument in the course of a few seconds after exposure. The automatic high-speed transmitter is an equally ingenious instrument, its chief point of distinction being that in its design the troubles due to the rapid make and break of a current exceeding 20 amperes have been overcome successfully.

Figs. 7 are a pair of oscillographic photographs of high-frequency currents taken by Dr. Dieselhorst by means of a glow oscillograph—*i.e.*, a tube containing two long aluminium electrodes with only a small gap between them, in a low vacuum. The length of the glow on an electrode is proportional to the current, and changes over to the other electrode as the current reverses. A revolving mirror is used to separate the discharges into a band—*i.e.*, to make the resulting photograph represent time as the abscissa. In each oscillograph here given, the upper part is positive and the lower part negative. It will be noticed that, in the case of the undamped oscillation, the current in the upper part is stronger than in the lower part; this agrees with the fact that the potential is greater on the positive side owing to the arc being supplied with direct current for the undamped oscillations.

THE TESTING LABORATORY OF THE HERMSDORF PORCELAIN WORKS.

BY WILLIAM WEICKER.

The progress in all branches of electricity and the increasing demands made in the electrical transmission of power have given rise to a constantly increasing demand for high-tension insulators possessing not only high insulating properties, but also sufficient mechanical strength to withstand the increased strains produced by the very large spans now so universally adopted. To combine both these qualities must be the chief aim of the manufacturer. Insulators can only be accepted as reliable after the most careful testing and inspection, so that no material showing defects is allowed to leave the works.

In view of the great interest taken at present in high-tension insulators, I propose to describe the testing laboratories of the noted porcelain works of "Hermsdorf-Klosterlausnitz," Altenburg, Saxony, Germany. This testing laboratory was started in 1901 and the results obtained were beyond all expectation, the methods employed proving eminently satisfactory. Especially since the demands have become more varied and extensions have been made, the laboratory of the Hermsdorf porcelain works may be described, without exaggeration, as the leading laboratory for the testing of high tension insulators.

In the laboratory there are :—

(1) Arrangements for subjecting each part of insulators or complete insulators to tests of dielectric strength.

(2) Arrangements to determine the arcing-over voltage of each insulator when mounted and to fix its working pressure.

(3) Apparatus for determining the mechanical strength of unmounted or completed insulators and of insulating material.

(4) Apparatus and instruments for tests in the nature of research.

The laboratory includes both an electrical and a chemical side, the latter being used for testing and examining raw materials. A careful observation of every process is made by an expert and a daily record of all results is accurately kept. The electrical engineering department is in constant use for commercial tests as well as for experimental work. It is furnished with the best precision instruments, frequency meters, very sensitive reflecting galvanometers, a registering Le Chatelier pyrometer with five thermo cells, a double-system oscillograph, &c. It also contains almost everything which can possibly be required for photographic and microphotographic researches. The interior of the high-tension station is remarkable both as regards the simplicity of its design and the systematic arrangement of the apparatus. There are five testing rooms, together with a special room where small insulating articles, standing in oil to avoid arcing over, are tested.

The extent of the work done in this laboratory can be realised from the fact that 2,500,000 high-tension insulators have been tested during the last six years, the daily average having advanced from 540 to over 4,000.

The piercing test is, beyond doubt, of the greatest importance, and is carried out as follows: The bell-shaped insulators are inverted, and the "heads" put into holes in a wooden board, which is immersed in a tank containing water up to a certain height, as shown in Fig. 1. The water in the tank, which is insulated from earth by insulators, forms one pole. The pin hole, or, if the insulator is made up of two or three parts, the opening for the reception of the "intermediate petticoat" or "centre," is also filled with water and connected by means of brass chains immersed in the liquid. The chains forming the connection to the high-tension wire system directly overhead are arranged with a sliding adjustment, so that the tank may be used for testing any size of insulators, and the number of chains is sufficient to test as many as 120 at the same time. The high-tension system itself is insulated from earth by six specially constructed high-tension insulators held together by means of iron clamps.

The testing of ribbed insulators is performed in a similar manner

the only difference being the mounting of the insulators on pins instead of placing them in the holes of the wooden board. For testing handles, leading-in pipes, &c., special electrodes are necessary.

The transformer plant, seen in Fig. 2, includes at present four transformers, three of which have a capacity of 10 kw. and give a pressure of 50,000 volts—100,000 volts. The fourth has a capacity of 30 kw. and is made to give 200,000 volts. Its ratio can be altered in the proportion 1 to 2, and, since the ends of the windings are accessible, it is a matter of but a few moments' work to change from series to parallel connections.

The transformers are erected in special compartments. To conduct the current to any of the testing rooms, special porcelain tubes are provided of sufficient strength to withstand a tension of more than 200,000 volts. The insulators consist of several small concentric tubes kept in place by two large discs fixed at each side of the wall (*see* Fig. 1). In constructing these special care had to be taken on account of the technical difficulties in porcelain manufacture and for this purpose the insulators which guard against piercing have been kept separate from the parts giving protection against arcing over. In addition to this, the tube, although passing through

Fig. 1.—Testing Board for Insulators.

Fig. 2.—High Tension Transformers.

the wall, is prevented from touching it. Arcing over to the wall, especially when moist, is prevented by two bobbin-like shades on both outer sides of the wall. Similar tubes may also be employed for damp places or as leading-out pipes, even for tensions of 200,000 volts.

The ratio of the two smaller transformers is 1 : 640, that of the larger sizes 1 : 1,280 and 1 : 2,560 respectively. The primary pressure of 78 volts is chosen on account of the easy transformation of the direct current at 110 volts to this voltage.

For supplying energy to the transformers two generators are provided, separately erected in the power house. One of them is provided with a collector and two slip rings, the other has six slip rings and is able to supply continuous, single, two or three-phase current. As a rule, the generators are belt driven, but may also be driven as motor generators by direct current, one dynamo providing energy for the other. Under the latter conditions the frequency of the alternator can be varied between wide limits. The terminals of the generators are brought to the main switchboard erected in the power house, from which several overhead cables are conducted to the testing laboratory, which is situated in another block of the factory. Four of these cables are provided for the control of the excitation of the generators. The overhead cables are taken to a general switchboard where connections can be made to the several transformer switchboards.

Fig. 3.—Testing under Climatic Conditions.

Each transformer switchboard contains one ammeter and one voltmeter, fuses, earth-connection indicator, maximum current cut-out, regulating resistance for the primary current of the transformer and regulating resistances for the generator excitation. The potential of the transformers is regulated either by the variable resistance in the field circuit or by regulation of the generators. The maximum current cut-out not only breaks the circuit automatically when an insulator breaks down (which generally short-circuits the transformer), but also calls the attention of the workmen by ringing a bell.

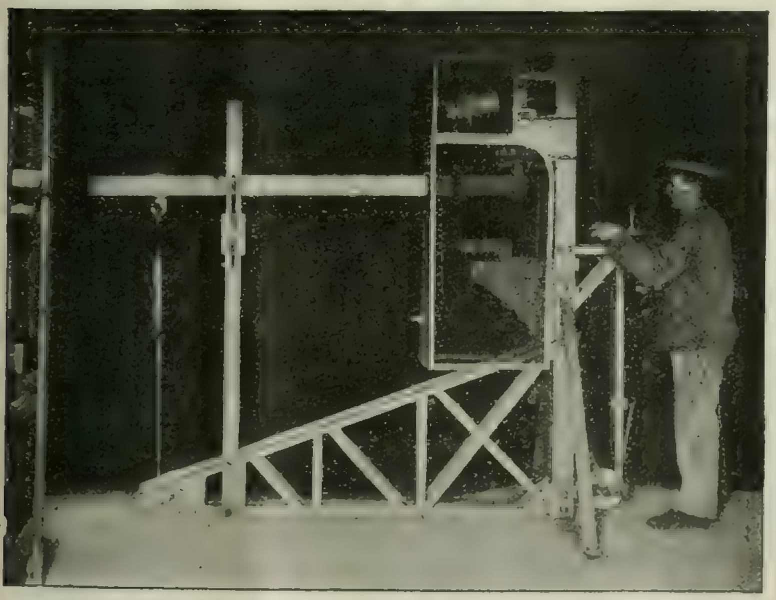


Fig. 4.—Mechanical Testing.

To find which of the many insulators under test has broken down the pressure is gradually raised (from zero) until the short-circuit current puts a special patented indicator in action which will show the faulty piece. The indicator is attached to the chains, as will be seen in Fig. 1, and consists of a solenoid which has a paper tube attached to its core, the former only showing when the core is raised, due to the increased current passing through the fault. In this way the faulty piece can quickly be removed and testing can be continued.

In order to avoid the danger of injury to the workmen employed in testing several precautions are taken. All high-tension wires leading from the transformers to the testing rooms are safeguarded by a special system. A gate midway between the tank and switchboard must be shut before pressure can be applied. On the other hand, the door is electrically locked until the current is switched off. While the current is switched on a red electric lamp is always burning. If the testing engineer has to remain within the gate, an Artemieff safety suit is provided, which has proved perfectly safe in all cases where very high tensions but small currents are used.

According to the rules of the "Verband Deutscher Elektrotechniker," every insulator for a working pressure of 2,000 volts and upwards must be tested at twice its working pressure. In most cases the working pressure is unknown and the Hermsdorf Porcelain Works, therefore, always tests all high-tension insulators until arcing over takes place—*i.e.*, to four or five times the working pressure for small insulators. No test lasts less than 15 minutes and full pressure is applied during this time. If an insulator should break down, testing of the whole lot is repeated. The testing time of 15 minutes has been fixed, as it happens very often that defective insulators are not pierced as soon as the current is switched on. On the other hand, breakdowns have very seldom occurred when insulators have been tested for a longer period than 15 minutes.

As mentioned above, it is absolutely necessary, not only to subject all insulators to the piercing test, but also to examine their working under all possible conditions, this being the best way to determine the maximum working pressure. In this way experiments can be made with a view to improve the reliability and structural design of insulators. In one of the testing rooms, therefore, a large overhead steam and water pipe system is provided to enable the engineer to have the air of the room moistened or the whole room filled with steam, as may be required. Several sprinklers with interchangeable nozzles are arranged so as to throw an artificial rain on the insulators in the tank at any angle and under any required pressure. Even the influence caused by the conductivity of water is taken into consideration.

The working of insulators under the most unfavourable circumstances which can be artificially produced may be experimented upon in this way, but no researches can be made inside the laboratory as to the effect produced by rain storms, snow, and other climatic influences. For tests of this kind the roof of the high-tension station is set apart. This testing plant arrangement, which is shown in Fig. 3, is arranged in the following manner.

Passing through the composite tubes, described above, the high-tension wire is conducted to the roof from the 200,000 volt transformer. The wire is fixed on strong insulators consisting of 4 parts cemented together. The diameter of each of the latter is 53 cm., height 68 cm., and weight 48 kg. The wires terminate in two brass balls, from which any desired connections are made to the channel iron structure erected on the roof. Bolts are screwed in to take the insulators to be tested, and several hundred insulators can be tested at the same time. The whole plant is insulated from earth and can be extended according to requirements. For observing the insulators during the test, as well as for researches of a scientific nature, there is a small laboratory fitted with all necessary instruments. Tests can be carried out at any time, and a continuous service at 200,000 volts pressure can be maintained even under the most unfavourable circumstances.

Having described the electrical tests, I may add a few words about testing the mechanical strength of insulators. As shown in Fig. 4, this is performed by mounting the insulator on a spindle wrapped with yarn to fill the core of the insulator, and a test stress up to 3,500 kg. is applied round the waist of the insulator and at right angles to the spindle. A stress in a direction parallel to the spindle can also be applied.

A third testing apparatus is used for compression tests on finished articles and serves for making researches on the elastic bedding, which is most important owing to the brittleness of porcelain. The safety of the workmen employed in carrying out these tests is also taken into consideration, metal screens being provided as a safeguard against flying pieces of porcelain.

The reader will have seen from this short description what an important part high-tension testing plays in porcelain manufacture for electrical purposes; indeed, this testing has nearly become a new branch of electrical work.

SINGLE-PHASE EQUIPMENT OF THE WINDSOR, ESSEX & LAKE SHORE RAPID RAILWAY.

The first company to adopt single-phase railroad equipment in Canada is the Windsor, Essex & Lake Shore Rapid Railway, running at present between Windsor and Kingsville, Ont., a distance of 28 miles. It is now being extended from Kingsville to Leamington, which will make a total line of 37 miles.

In the construction between Windsor and Kingsville 80 lb. T-rails are used, but in the remaining 9 miles 60 lb. steel is used. The bonds are soldered to the outside of the ball of the rail where the tracks are outside the towns; in the towns they are soldered under the rail joints, and have a carrying capacity equal to No. 00 wire. The rails are fastened with continuous rail joints. At present the company has five cars equipped with four passenger trailers. There are on each motor car two 160 H.P. Westinghouse motors. These motors are provided with compensating field coils for neutralising the armature reactance.

The regular Westinghouse pantograph is used on the cars, and is raised by tension springs and pulled down by a trolley rope. This rope is run in fibre conduit on the top of the car and passes over two pulleys. A complete diagram of the wiring of the cars is shown in Fig. 1. It will be noticed that provisions have been made to take current from the wire both at 1,100 and 6,600 volts. The change-over switch is shown and is located at the bottom of the car. Only one of the voltages mentioned is used, however, although when the equipment was bought it was intended to use 1,100 volts in the city of Windsor and to supply current at 6,600 volts over the rest of the

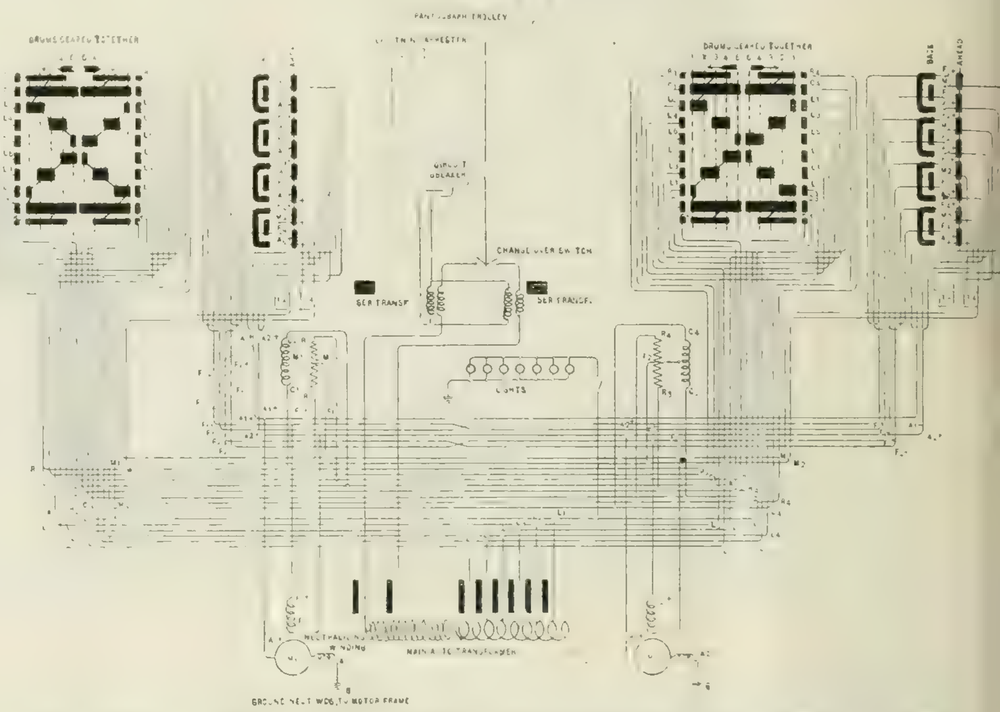


Fig. 1.—Diagram of Connections for Two No. 451 Controllers and Two A.C. Motors for Two Trolley Voltages.

line. As permission was granted to run the higher voltage at Windsor, the change-over switch is no longer necessary and only one lead to the auto-transformer is used. If the necessity should ever arise to use 1,100 volts at any point, it can be done without altering the car equipment.

The connection from the pantograph to the circuit-breaker is made with lead-sheathed rubber-insulated cable. The resistance and reactance coils R and C are connected between the controller segments and the armature to minimise sparking at the controller. The rating of the auto-transformer is 100 kw.; there is one of the oil-insulated self-cooling type to each car.

Line Construction.—The line is of catenary construction, with poles 120 ft. apart on the tangents and as close as 80 ft. on curves. Bracket construction is used exclusively, except where the line passes through towns. The trolley wire used is No. 000 grooved, and the hangers from the messenger wire to the trolley wire are spaced 10 ft. apart. Where the bracket construction is used the messenger wire rests in the grooves of the insulator fastened to the T-bracket arm. The hangers allow the trolley wire to hang below the arm, and no further insulating devices are needed on these poles, except where there is a lateral strain on the wire. A steady strain device of the wooden-arm type is used on all curves where brackets exist. This is the standard wooden arm steady strain with skirt type insulator which the Westinghouse Co. now furnishes for bracket catenary construction.

The porcelain insulator holding the steady strain rod is carried in a malleable iron yoke adjustable on the bracket arm. The steady strain rod is made of a thoroughly impregnated wooden rod having malleable iron end lugs. This is used on account of the trolley wire being closer to the bracket arm than when the sleeve-type insulator is used. In addition to using these on curves, one is put on in every 12 poles on the tangents.

Fig. 2 shows the section insulator used. Since the messenger and the trolley wire are both electrically connected, it is necessary to break the current on both these conductors. The messenger wire is cut at the point of the change of circuit, and the ends are fas-

tened to separate line insulators, the insulators being suspended from the horizontal arm of the bracket, as shown in Fig. 2.

To break the current upon the trolley wire a piece of second growth hickory, treated to make it moisture proof, is introduced into the line. The ends of this block are provided with terminals, into which the ends of the trolley wire are fastened, the construction of the terminals and the shape of the wooden arm being such that the trolley passes smoothly from one circuit to the other across the intervening space without leaving the line. The arc is broken on the terminal casting. It is found that the men can work with perfect safety from the trolley tower, even when the current is on the line, by mounting a platform on four double-skirt insulators, such as are used on the poles for spare wire construction.

Anchoring is done at every 30 poles by setting two extra poles opposite two adjacent bracket poles. These extra poles are on the opposite side of the track from the bracket poles. The guys are attached to the catenary structure midway between the two bracket poles, and the guys are then run to the two bracket poles and the two opposite poles in the shape of X, the catenary structure being at the intersection of the guys. Where the guys are fastened to the poles, strain insulators are used in every case.

The cross-span construction is of the steady strain cross-span skirt type. In this style of construction the only insulators ordinarily used are those on the poles, leaving the span wires alive. This has the advantage of cheaper and lighter construction, but the disadvantage of having all the cross wires alive. The construction in this case has been modified by placing wood strain insulators 3 ft. from the catenary structure. This makes the span wires dead, except for 3 ft. on each side of the trolley wires. In Windsor all of the poles are made of reinforced concrete and have been tested to stand a horizontal strain of 1,000 lb. The poles on the rest of the line are of cedar.

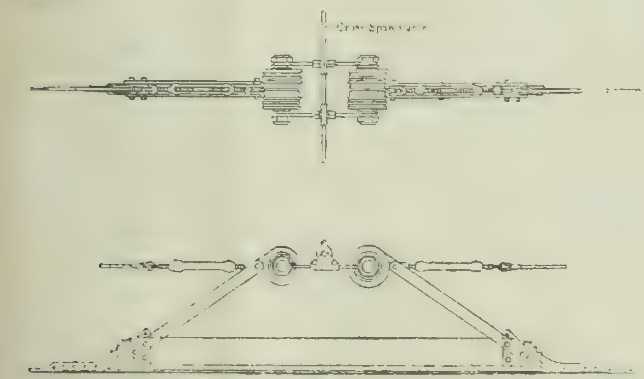


Fig. 2.—Section Insulator.

The catenary structure carries the whole current from the power house to the sub-station at Maidstone, a distance of 18 miles, at 6,600 volts. From this point to Windsor the line is fed by an auto-transformer. A special transmission line is used from the power house to the sub-station carrying current at a voltage of 13,200, and is carried on the same poles from which the catenary is carried, except in the town of Kingsville. Here it was found necessary to place the transmission poles on private right of way.

Power House.—The power house is located at Kingsville, by Lake Erie, from which the condensing water is pumped. Two Goldie Corliss cross compound engines at 125 revs. per min are used. The generators are 500 kw. 25 cycle single-phase Westinghouse machines, direct connected to the engines with belted 30 kw. exciters.

The plant was run for a little over a month and a half non-condensing, the average cost for running per horse-power hour being 0·577d., whilst with the condenser the cost fell to 0·354d.

There is only one sub-station, located 18 miles from the power house. This steps the voltage down from 13,200 to 6,600 by a 300 kw. oil-insulated and self-cooled auto-transformer.

DISCHARGE IN MONATOMIC GASES.*

BY FREDERICK SODDY, M.A. AND T. D. MACKENZIE, B.SC.

Helium and argon, purified by metallic calcium from traces of common gases or vapours, show a great disinclination to conduct the discharge. In ordinary spectrum tubes helium offers a resistance equivalent to an alternative spark gap of an inch in air, at a pressure of 0·05 mm, and argon at 0·02 mm. of mercury. This behaviour of the monatomic gases, together with the closely allied phenomenon shown by spectrum tubes filled with these gases of becoming non-conducting, or "running out" under the action of the discharge, have now been investigated in detail. The main object was to settle whether electric conduction in monatomic gases is essentially different from that in other gases. The first results raised at least a presumption that perfectly pure helium might be unable to conduct the discharge at all, so that the running out of spectrum tubes might be due to the absorption of impurities only by the electrodes and not by the absorption of the inert gas itself. This view, however, proved to be untenable.

The absorption of the monatomic gases during the discharge occurs rapidly and continuously under suitable conditions, and the nature of this action is now fairly clear. But, on the other hand, helium which has been subjected to the prolonged action of the discharge between aluminium electrodes, after initial purification with calcium, exhibits to an altogether extraordinary degree the peculiarity before noticed. In an ordinary spectrum tube such helium offers a resistance equivalent to that of an inch spark-gap at a pressure of over ½ mm. of mercury, and the discharge is accompanied by all the well known characteristics—intense fluorescence of the tube, production of cathode rays and incipient production of X-rays—which are usually supposed to be indicative of a high vacuum. But at higher pressures this very pure helium conducts the discharge in the same way as other gases. The authors' results leave no doubt that the difference between helium and other gases is one of deg ee only, and that the monatomic gases are relatively inert, electrically as well as chemically. The remarkable behaviour of helium in the region of low pressure is intimately bound up with the equally remarkable behaviour of the gas in the region of atmospheric pressure, when, as Ramsay and Collie have shown, it conducts the discharge much more easily than any other gas. A spectrum tube filled with helium at atmospheric pressure conducts the current from a small induction coil with ease. It is only necessary to regard the helium molecule at all pressures as only about one-fifth to one-tenth as effective electrically as a molecule of a common gas like hydrogen, in order to obtain a simple and consistent explanation of the behaviour of both high and low-pressure helium to the discharge. In the course of the work it became necessary to examine the common gases also, in order to be able to compare their behaviour with monatomic gases. The result transpired that the electrical effects usually supposed to be indicative of a high vacuum occur in all gases at degrees of rarefaction which cannot with any accuracy be described as high. Thus, the behaviour of argon is similar to that of the common gases hydrogen and nitrogen, all of which, when pure, cease to conduct at about 0·04 mm. The pressure in an X-ray tube filled with hydrogen, and giving good X-rays is above 0·01 mm. Some of the possible causes which may have contributed to the mistaken impression that the degree of rarefaction in a Crookes' tube is of the order of a thousandth of a millimetre are discussed in the Paper. During the investigation it became evident that the spectrum of one of the rare gases appeared in a set of new spectrum tubes during preliminary preparation before any of the gas had been introduced, and it has been put beyond doubt that the aluminium electrodes of spectrum tubes which have been used with either helium or neon, or argon, retain, even after months' exposure to the air, sufficient of the gas in question to give its spectrum when remounted in a new glass tube into which none of the gas is introduced.

The experiments described clearly show the nature of the process when a helium tube is run to non-conductance. Contrary to what was given as the explanation in the last Paper a real absorption of the helium takes place, and the greater part of the absorbed gas is very loosely retained, and can be recovered from the aluminium mirror volatilised from the electrodes. On the other hand, non-conductance obtains in pure helium long before all the helium is absorbed, and the gas so treated refuses to conduct the current at a pressure when any other gas would be at about its maximum conductivity. As, however, the residual pressure was practically the same for all the four tubes, one of which had been run for over 60 hours, the experiments do not support the idea that pure helium by itself is a non-conductor. They favour the view that the constant residual pressure is the real limiting pressure for pure helium itself, above which it will conduct in the same way as any other gas.

In the new apparatus, the pressure at which sparks from a small coil commenced to jump an inch gap was measured in helium which had been purified by calcium only, and not subjected to the discharge. It was found to be 0·275 mm. This is over five times the pressure given in the last Paper, and is due to a more thorough removal of gases from the electrodes prior to the experiment, and to the absence of vapour of lubricating grease. It is clear that running the tube produces a further purification of the helium by the absorption of the last remaining impurities in the electrodes, and that an otherwise undiscoverable trace of impurity makes a very great difference on the pressure at which helium becomes non-conducting.

Experiments were made to see if helium is absorbed during simple volatilisation of aluminium and magnesium by heating these metals in a furnace similar to that employed for heating calcium. No absorption occurred. This suggests that the absorption in the case of helium is electrical or mechanical rather than chemical. The gas

* Abstract of Paper read before the Royal Society.

molecules moving under the electric force with great velocity resemble the a particles, and are able, as Campbell Swinton's results indicate, to penetrate the surface of the glass wall to a very slight extent and remained embedded. If, however, the glass is covered with a mirror of aluminium, most of the gas is stopped there and does not reach the glass.

The results obtained with neon and argon were quite analogous to those recorded for helium. Similar experiments on the pressure at which non-conductance obtained were performed with the gases hydrogen, nitrogen and carbon dioxide. With these the non-conducting point was very well defined. Thus, with hydrogen, practically no current went through the tube at a pressure of 0·04 mm for a spectrum tube, and 0·3 mm. for a wide tube. At a pressure at which a hydrogen tube would give an inch gap a carbon dioxide tube would give only a millimetre gap.

The authors give reasons for believing that in no case is the real pressure in an X-ray tube below the hundredth of a millimetre. There are probably many reasons, more or less well recognised, that account for the impression that the degree of rarefaction in a vacuum incapable of conducting the discharge is extreme. Apparatus to be exhausted is usually made with a constricted orifice where it is to be sealed off. The free path of the gas becomes comparable with the diameter of this constriction at about 0·1 mm., or higher in heavy gases and vapours. Below this pressure there is, properly speaking, but slight difference of pressure between the two sides of the orifice, using the word pressure in a hydrostatic sense, even though on one side a perfect vacuum is maintained. Diffusion alone, not flow, operates to equalise the concentration of the gas on the two sides, and therefore gauge readings of pressure in apparatus connected to the gauge with a narrow orifice are not strictly pressure readings at all. A more important error, probably, of the readings is the usually invariable presence of vapour which a compression gauge will not detect and a pump will not remove. In the present measurements constrictions were avoided and vapours removed by the action of calcium, and these two facts probably account for the pressures at which non-conductance obtains being comparatively high. It is doubtful whether the lower pressure recorded in the case of carbon dioxide is real or due to the property of carbon dioxide of condensing on glass surfaces, vitiating the gauge readings.

Mercury vapour resembles the monatomic gases both in the effect of impurities and the high pressure at which it remains non-conducting.

The monatomic gases in general appear to be what has been termed electrically inert, and if the effectiveness of a molecule in permitting or resisting the passage of a discharge is to be associated with the number of relatively free electrons it contains, the monatomic gases appear, from their electrical as well as from their chemical inertness to be relatively deficient in easily displaceable electrons. But this point of view carries with it the corollary that their chemical inertness is relative rather than absolute, since even in the purest state the monatomic gases are undoubtedly capable of conducting and becoming ionised.

The glass parts of the spectrum tubes, of which the electrodes had been used in some of the experiments, were examined for the effect described by Campbell Swinton, who showed that if the glass of a vacuum tube used with hydrogen or helium is fused in a flame it becomes clouded, and under the microscope is seen to be permeated to some depth from the inside surface with a multitude of minute spherical bubbles. The argon tube showed the best effect. When the glass was fused it appeared to boil, and the bubbles could be seen and heard bursting. The authors describe experiments showing that the gas which causes the bubbles is not the discharge gas driven into the glass. The bubbles are in all probability a secondary effect, due to the chemical decomposition of the glass under the influence of local heating produced during the bombardment. There are probably in glass always sufficient undecomposed carbonates or sulphates to account for the effect, for porcelain, which is fired at a far higher temperature than glass, gives off a copious supply of gases consisting largely of carbon dioxide and hydrogen when heated in a vacuum above 1,000 C. If the experiment is prolonged several cubic centimetres of gas may be pumped off.

A NEW METHOD OF OBTAINING UNDAMPED OSCILLATIONS.*

BY O. M. CORBINO.

1. This method proceeds by coupling a series dynamo with a shunt motor, without condenser, and is based upon the following principle.

A shunt motor, with armature and field magnets of laminated iron, when subjected to an alternating sinusoidal P.D. applied to its terminals, behaves like an inductive resistance whose inductance may have a negative value. Hence the apparatus is equivalent to an inductance in series with a capacity. For a certain speed the inductance and the equivalent capacity are independent of the frequency.

Let r_1, r_2, L_1, L_2 be the resistances and self-inductances of the armature and field magnets respectively, K the numeric of the ratio between the counter-E.M.F. of the motor and the intensity i_2 of the current in the armature, and e the P.D. at the terminals. Then

$$e = r_1 i_1 + K i_2 + L_1 \frac{di_1}{dt} = r_2 i_2 + L_2 \frac{di_2}{dt}. \quad . \quad . \quad . \quad . \quad (1)$$

Putting $$i = i_1 + i_2 \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (2)$$

and denoting by r and L the resistance and inductance of a single conductor equivalent to the motor—*i.e.*, capable of carrying a total current, i, when subjected to a variable P.D., e—we shall have

$$ri + L\frac{di}{dt} = r_1 i_1 + K i_2 + L_1 \frac{di_1}{dt} = r_2 i_2 + L_2 \frac{di_2}{dt}. \quad . \quad . \quad . \quad (3)$$

Let us suppose that e varies in a sinusoidal manner with a periodicity ω, and take the phase of i as the origin. We have then

$$i = A \sin \omega t.$$

and by (2)

$$i_1 = A_1 \sin \omega + B_1 \cos \omega t,$$
$$i_2 = (A - A_1) \sin \omega t - B_1 \cos \omega t.$$

Then, separating the terms in $\sin \omega t$ from those in $\cos \omega t$, we get from (3)

$$r_1 A_1 + KA - KA_1 - rA - L_1 \omega B_1 = 0,$$
$$r_2 A - r_2 A_1 - rA + L_1 \omega B_1 = 0,$$
$$L\omega A - L_1 \omega A_1 + (K - r_1) B_1 = 0,$$
$$L\omega A - L_2 \omega A + L_2 \omega A_1 + r_2 B_1 = 0.$$

If the total intensity A is given, as well as the constants r_1, r_2, L_1, L_2, K and ω, these four equations determine A_1, B_1, r_1, L_1, and hence also the currents in the two parallel circuits of the motor, and the constants of the equivalent inductive conductor.

The following are the results of a lengthy calculation:—

$$r = \frac{\omega^2 (L_1^2 r_2 + L_2^2 r_1 - K L_1 L_2) + r_1 r_2 (r_1 + r_2 - K)}{(r_1 + r_2 - K)^2 + (L_1 + L_2)^2 \omega^2}. \quad . \quad . \quad (4)$$

$$L = \frac{L_1 L_2 (L_1 + L_2)\omega^2 + L_1 r_2 (r_2 - K) + L_2 r_1 (r_1 - K)}{(L_1 + L_2)^2 \omega^2 + (r_1 + r_2 - K)^2}. \quad . \quad . \quad (5)$$

Choosing the speed of the motor, which determines K, in such a manner that

$$r_1 + r_2 = K, \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (6)$$

we shall have

$$\left.\begin{aligned} r &= \frac{(L_1 r_2 - L_2 r_1)(L_1 - L_2)}{(L_1 + L_2)^2} \\ L &= \frac{L_1 L_2}{L_1 + L_2} - \frac{r_1 r_2}{(L_1 + L_2)\omega^2} \end{aligned}\right\} \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (7)$$

the last of which can be put into the form

$$L = \Lambda - 1/C\omega^2.$$

This shows that in that case the motor is equivalent for any value of ω to a system constituted by an inductive resistance (r, Λ) and a capacity in series with it, with the constants

$$\left.\begin{aligned} \Lambda &= \frac{L_1 L_2}{L_1 + L_2}, \\ C &= \frac{L_1 + L_2}{r_1 r_2}, \\ r &= \frac{(L_1 r_2 - L_2 r_1)(L_1 - L_2)}{(L_1 + L_2)^2} \end{aligned}\right\} \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (8)$$

This equivalence to the above values of the constants is the same at any frequency, and therefore also for alternating currents which are not sine currents.

2. At a certain value of ω the total reactance of the system may be negative; and then the resultant current will be in advance of the P.D., as in superexcited synchronous motors. This property of shunt motors was already pointed out by me in 1904.

3. Now, let us connect up a series dynamo, D, and a shunt motor, M, having field magnets and armature of laminated iron. The dynamo D is equivalent to an inductive conductor of negative resistance; the motor M (at a suitable speed) to a conductor endowed with resistance, self-inductance and capacity in series. Let ρ be the negative resistance and L the inductance of the dynamo D; r the resistance, Λ the inductance, and C the equivalent capacity of the motor. The entire system will be equivalent to a circuit composed of the resistance $r - \rho$, the inductance $L + \Lambda$, and the capacity C; therefore, if

$$r = \rho \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (9)$$

the system may be traversed indefinitely by alternating currents having a period determined by the conditions of resonance; the period will be given by

$$\omega^2 = 1/(\Lambda + L)C,$$

and the system has a proper period of oscillation, and the possibility of neutralising the damping of the oscillations. The values of r, Λ and C are given by (8).

* Translated from *L'Elettricista*.

4. If the condition (6)—for which we must remember that r_1 and r_2 represent the *total* ohmic resistances, including the effects of hysteresis and eddy currents—is not strictly verified, the system may still have a proper period, though the constants defined by (5) will not be independent of the frequency. Thus if $\rho > r$, since ρ and r are not constant, ρ decreasing as the currents increase, on account of well-known properties of iron cores, it may be foreseen that the system may generate oscillating currents of a period and amplitude difficult to determine beforehand.

5. The properties described above depend upon the behaviour of a shunt motor as the equivalent of a condenser. This quality is possessed by the motor when the armature has a uniform speed in a determinate sense; it must not be confounded with the analogous behaviour of the condenser of a separately excited motor, whose armature moves alternately in opposite directions (Leblanc), nor with that of Swinburne's electrodynamic condenser.*

SOME DEVELOPMENTS IN SYNCHRONOUS CONVERTERS.[1]

BY C. W. STONE.

Summary. The author describes recent improvements in the design of synchronous converters, including the vertical type, which is coming into favour in the United States. Particulars of some interesting methods of varying the voltage of the direct-current obtained are also given.

Most of the larger systems using synchronous converters operate at 25 cycles, but during the last four or five years many systems using 60 cycles have adopted synchronous converters and have found them very reliable. The general tendency in their design has been towards higher speed, which would naturally mean reduction in the space occupied by them, lower first cost, less weight, &c. All these changes result in smaller buildings, cheaper foundations, and consequently lower fixed charges. As an illustration of the changes that have been made, the 2,000 kw. 25 cycle 250 volt synchronous converter, as originally designed, operated at 115 revolutions, and had 26 poles. It occupied a floor space 190 in. by 204 in., and the total weight was approximately 186,000 lb., whereas the newer vertical machine is circular in form, the diameter being 182 in. and the total weight about 130,000 lb.

Vertical Synchronous Converters.—The vertical synchronous converter is so new that it seems advisable to point out some of its essential characteristics. The most novel features are in the shaft and bearings. The shaft, unlike that of the horizontal machine, is stationary; in fact it is nothing but a pedestal supported and fastened solidly to the foundations. There is only one bearing, which carries the entire weight of the revolving structure. Fig. 1 shows more clearly the construction. Oil is pumped up through a central hole in the pedestal and forced out between the cast iron plates, forming an oil film on which the machine revolves, and making practically a frictionless bearing. In addition to the main bearing, use is made of the entire length of the interior of the spider for a guide bearing. A cast-iron sleeve lined with babbitt is fitted into the spider to form the bearing surface. As the only weight on this bearing is that due to the unbalancing of the rotating structure, the bearing should last indefinitely. The oil after leaving the top or supporting bearing passes along the pedestal (thus oiling the guide bearing) down to the pocket at the base of the machine, were it is drained off and used over again. A new type of bearing has now been tried which gives promise of success. A cup-shaped cast iron piece is fastened to the top of the pedestal and forms a seat for the hardened steel bearing plate and carrier, the steel plate being simply dowelled in place. Both sides of this plate are accurately ground so that it can be reversed in case of any damage to one surface. It can readily be seen that this construction of the two lower members of the bearing makes it self-aligning. The top part of the bearing is bolted to the armature spider and is similar to the top of the oil-pressure bearing, except that another hardened steel plate is dowelled in place on the under part of this casting to form the wearing surface. Between these steel plates is a bronze carrier with a number of hardened steel rollers placed radially, thus forming the roller bearing. Oil is pumped by a small low pressure pump to this roller bearing and is drained off after passing through the guide bearing in exactly the same manner as with the oil step.

The stationary part carries the field spools and is split vertically so that the two halves can be drawn apart, making the armature accessible for inspection or repairs. This frame is supported on a number of cast-iron pedestals. By the above construction it will be noted that the field frame is entirely independent of the rotating structure, making it easier to assemble the machine. The armature being revolved around the pedestal, it is not possible to obtain any end-play, as in a horizontal machine. Some means must be provided to make the wear on the collector rings equal; this is accomplished by designing the brushes in such a manner as to make it possible to stagger them and thus cover the entire width of the collector rings. In addition there are placed on each ring some graphite brushes which act as lubricants.

It will be seen how accessible the machine is. It is possible to see and adjust all the brushes on both the commutator and the collector rings without climbing up on a bearing pedestal or going down into a pit, as would be necessary in a large horizontal shaft machine. The bearings in a 2,000 kw. vertical machine can be taken out, inspected and replaced in a little over two hours, which would hardly be possible in a horizontal machine of the same size. This construction makes it possible to build machines occupying minimum floor space; in fact, it has been found possible in stations which have been laid out for 1,000 kw. machines of the old type to place a similar number of vertical machines of double the capacity.

Voltage Regulation.—With a synchronous converter it is not possible to regulate the d.c. voltage of the machine by means of the field rheostat without changing the power factor. Hence, some means of changing the impressed alternating voltage is necessary. The different methods possible are:—

1. On the step-down transformers used with the converter, taps can be placed either on the primary or secondary side and switches used to transfer from one tap to another. This scheme has many objections and is seldom used now.

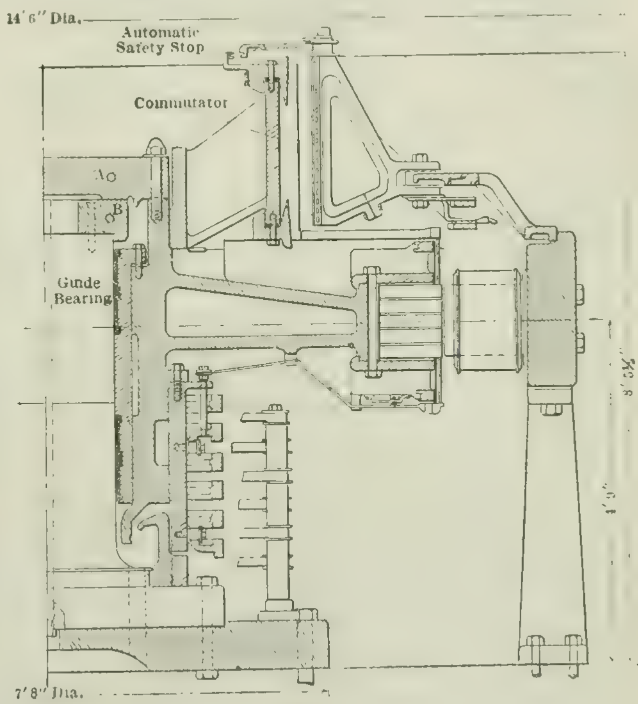


Fig. 1

2. The common method in railway work is to insert in the leads from the secondary of the transformer a reactance. This method, while simple and effective with the limited ranges in voltage required for such work, would not be applicable for large ranges.

3. The arrangement in most general use to-day is to connect between the secondary leads of the transformer and the synchronous converter an induction regulator, by which it is possible to obtain almost any range of voltage within the capacity of the machine. The principal objection is that another piece of operating machinery is used with each synchronous converter outfit.

4. Use is made of an alternating-current booster mounted on the same base with the synchronous converter. The field has the same number of poles as the converter, and the armature is mounted on the same shaft. Alternating current is generated in this armature and can be made to assist or oppose the impressed voltage. This booster is usually placed between the collector rings and the main armature, and the taps from the collector rings are connected to equidistant points of the booster armature; similar points on the booster armature are connected to the synchronous converter armature, thus placing the two in series, separate and distinct windings for each phase being used. The principal objection is the additional operating machine. Also extra weight is added to the shaft between its points of support, and the ventilation of the converter armature and its accessibility are impaired. Any serious trouble with this smaller machine results in the dismantling of the main converter.

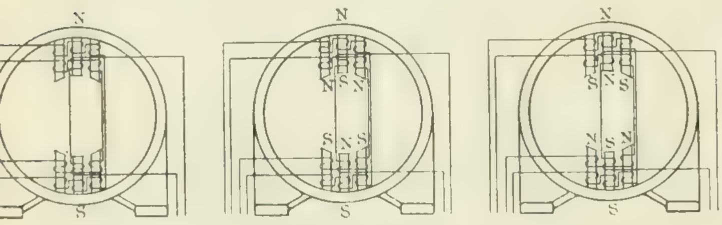
* Swinburne, *The Electrician*, Vol. L., p. 930, 1903.

[1] Abstract of a Paper read before the American Institute of Electrical Engineers.

Another way to construct such a machine is to make it a revolving field machine, mounting the field on an extension of the shaft beyond the bearing of the collector ring end of the synchronous converter. As the armature is stationary, the leads from the secondary of the transformer are led directly to this winding, and from this winding to the collector rings of the synchronous converter. This arrangement has the twofold advantage of being accessible and not interfering with the ventilation or accessibility of the synchronous converter.

5. This is unlike any of the other schemes used, and was first proposed by J. L. Woodbridge. It has been known for some time that the ratio of conversion between the alternating current and direct current sides of a converter could be changed by varying the width of the pole face. The Woodbridge method makes use of this idea in a very simple way. Fig. 2 (a) shows a two-pole synchronous converter equipped in accordance with this idea. Each field pole is divided into three sections, on each side of which are two windings. One of the windings on each section is the main shunt winding and the other is the regulating winding. All the main windings are connected in series and excited in the ordinary manner. The regulating windings, however, are connected differently. The winding on the two outer sections of all poles are connected in series with one another, and the windings of all the central sections are connected in series with one another.

The voltage of the direct current side of the converter is increased by exciting all the outer sections in a direction to assist the main shunt field, and the middle section an equal amount in opposition to the main field. This condition is shown in Fig. 2 (b). If both these windings are excited in the opposite direction the direct voltage will be lowered, Fig. 2 (c). All that is needed is a field rheostat in the regulating field circuits in addition to the main field rheostat. A number of machines arranged this way have been designed and placed in operation, and it is found that the power factor can be maintained constant at all loads, with all the range in voltage desired.



(a) (b) (c)

Fig. 2.

6. Another and still simpler method has since been brought out by Mr. J. L. Burnham. Instead of making each pole with three sections and with two windings on each, only two sections are used. On each section only one winding is used. The large section corresponds to the main shunt winding of an ordinary synchronous converter, while the regulation is obtained entirely by changing the excitation of the smaller section, exciting it in one direction to boost the voltage and in the other to lower the voltage.

Anti-hunting devices of many types have been designed and put in operation, most of which have been reasonably successful. The latest, and in many ways the most efficient, form of bridge is formed by placing some copper rods directly through the face of the pole tips. These copper rods are all joined together by heavy copper rings, thus forming a complete squirrel-cage winding similar to that used on the rotor of an induction motor.

BITUMINOUS CONDUITS.

Bitumen, as a preservative for underground networks has held its own almost ever since cables were first laid underground. In what is known as the solid system it is practically the only material now used for filling in the troughs in which the cables are laid. In localities where the ultimate demand upon the network can be so accurately gauged as to ensure that it will not be necessary at a later date to reinforce the carrying capacity of the conductor, and where there is no danger of excessive subsidence of the soil, the practice of laying cables solid has much to commend it. There are, however, many cases where some type of conduit system is the only feasible method.

Many attempts have been made during the past 20 or 30 years to construct conduits of bitumen, but these have in the majority of cases been abandoned. One of the great difficulties was that the bitumen became softened, either from the slight heat from the C^2R losses in the cable, or from the heat of the sun when the conduits were stored in the stockyards or lying by the side of the trench during laying. In the former case softening of the conduits led to the cables sticking to them, with the result that "drawing out" became impossible after a certain time had elapsed. In the latter case the conduits lost their original shape, and it became difficult to fit them together or to make a satisfactory joint. Various attempts were made to provide a foundation for the bitumen to get over this difficulty, but none of them appear to have been entirely satisfactory.

About five years ago the Key Engineering Co. (Ltd.) introduced into this country a bituminous conduit under the name

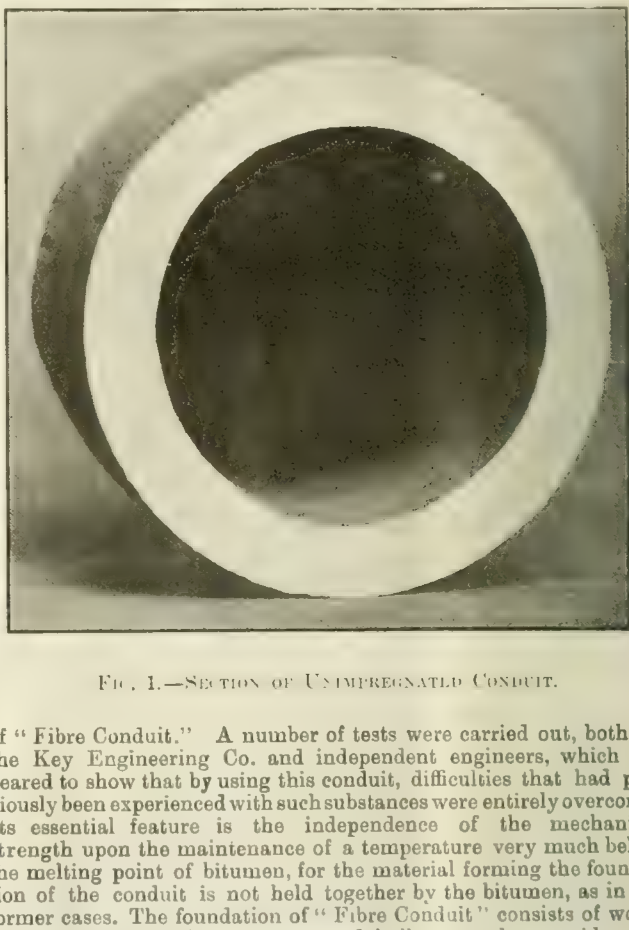


Fig. 1.—Section of Unimpregnated Conduit.

of "Fibre Conduit." A number of tests were carried out, both by the Key Engineering Co. and independent engineers, which appeared to show that by using this conduit, difficulties that had previously been experienced with such substances were entirely overcome. Its essential feature is the independence of the mechanical strength upon the maintenance of a temperature very much below the melting point of bitumen, for the material forming the foundation of the conduit is not held together by the bitumen, as in all former cases. The foundation of "Fibre Conduit" consists of wood fibre treated in such a manner, and built up under considerable

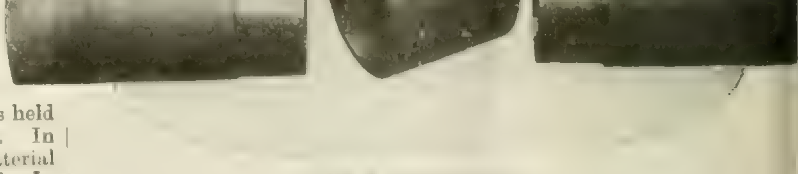


Fig. 2.—Sleeve Joint.

pressure, as to form a homogeneous wooden tube, which, after slow and careful drying, produces a conduit of considerable mechanical strength. A photograph of this unimpregnated conduit is given in Fig. 1. After careful drying it is thoroughly impregnated with the bituminous compound, which, owing to the absorbent nature of the fibre, soaks into the entire structure and so closes up the pores as to make the conduit absolutely watertight. An incidental advantage of using foundations of an absorbent nature is that the bitumen compound does not remain on the interior surface of the conduit, and troubles which arose with earlier conduits from the cables being stuck by the bitumen are, therefore, entirely avoided.

Over 3,500 miles of this conduit have already been laid, and the steadily increasing demand for it year by year would appear to indicate that it is finding favour with all users.

This conduit is made either with a short spigot and socket-alignment joint, the overall diameter of the joint being the same as that of the conduit, or with a sleeve coupling. The former type has a great advantage where it is considered necessary to lay the conduit in concrete, as the quantity then required is very much less than would be the case when a joint of appreciably larger diameter than other portions of the conduit is used. The sleeve-joint type of conduit, illustrated in Fig. 2, is becoming very popular in this country. No concrete protection is required with it, provided a plank of wood is laid a few inches above the conduit, as a precaution against the navvy's pick. It may be remarked that a plank of wood is better for this purpose than concrete, tiles or bricks, as a navvy will usually continue to expend his energy on such materials, believing them to be a portion of the road metalling, whereas immediately a wooden plank is struck he realises that care is required.

An incidental advantage of "Fibre Conduit" construction as compared with stoneware construction, with its mechanically weak joints every 2 ft., is that if, as so often happens, it is necessary to undermine the cable system, the conduits can be very much more easily supported, whether they be laid directly in the ground, and jointed with sleeve couplings, or in concrete. An interesting example of this is shown in Fig. 3. It represents a four-duct line carrying

FIG. 3.—LOWERING ALREADY LAID FIBRE CONDUIT CONTAINING LIVE CABLES.

"live" 13,000 volt cables; these are being lowered 4 ft. for a distance of 625 ft. This operation was carried through without any interruption of the supply, a piece of work which was found quite impossible with cables laid in stoneware conduits along the same road. This and other photographs have, it is said, been used by others to demonstrate the advantages of a conduit of this type. The Key Engineering Co. state, however, that the conduits successfully lowered, as shown in the photograph, were their well-known "Fibro Conduits."

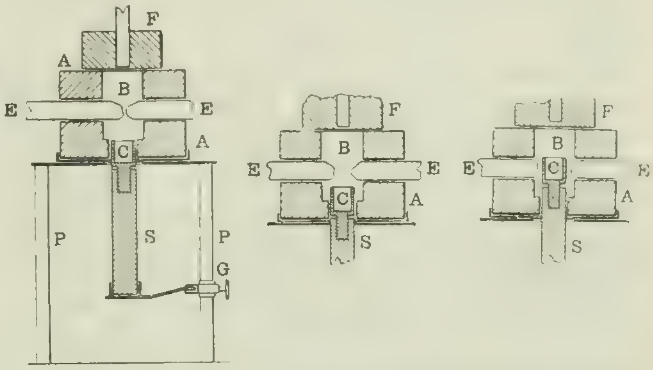
A NEW ELECTRIC FURNACE APPLICABLE TO LABORATORY WORK.*

BY L. CLERC AND A. MINET.

In the course of some studies on the "Soleil" lamp and on the electric furnaces which are derived from it, one of the authors noticed that the length of an arc playing in a cavity at the centre of a refractory mass, such as lime or magnesia, reached several centimetres for such electric constants as 40 amperes and 50 volts. When these experiments were repeated the two following facts were observed: (1) For a constant E.M.F., from 50 to 60 volts, the arc could be given any length on the condition that the transverse section of the cavity was varied in proportion to a certain power (greater than unity) of the arc length, and at the same time the current was varied in proportion to another power (less than unity) of this section. The values of these powers correspond to a practically constant arc temperature. (2) When the arc is burning properly a crucible of some refractory conducting substance, such as carbon, or non-conducting material, such as lime or magnesia, can be introduced into the arc without extinguishing or altering the electrical constants.

An electric furnace designed on these lines is shown in Figs. 1, 2 and 3, there being three different positions of the crucible. The furnace consists of two principal parts (A and F) and is made of a refractory substance, such as lime or magnesia. The part A is bored out cylindrically along a vertical axis, two chambers being thus formed. One of these (B) is the furnace, whose dimensions are 3 cm. in diameter and 6 cm. high. The other, whose diameter is 2 cm., is a continuation of the first, and through it the crucible (C), whose capacity is about 2 cubic cm., can be introduced. The crucible is held up by a support (S) made of a non-conducting substance, such as lime or magnesia, having an arm terminated by a slider (G), which is provided with a set screw, so that it can be moved along one of the supports (P) of the apparatus. The crucible, therefore, may be raised and occupy a position in the furnace (B) accordance to the distance apart of the electrodes (EE), which are made of carbon.

By employing 1 kw. to 2 kw. experiments can be made in this furnace at all temperatures, from a dark red, when the crucible and electrodes are in the position shown in Fig. 1, to the temperature of the arc (Fig. 3). The capacity of the crucible is sufficient in all



FIGS. 1, 2 AND 3.—VIEWS OF THE CLERC MINET FURNACE.

cases to contain from 2 to 40 grammes of material according to its density. With currents from 30 to 40 amperes the arc can be maintained in spite of the consumption of the carbons. It is, however, possible to separate the electrodes to their extreme limit without the arc going out, and if the electrode, having first been taken out, is reintroduced quickly into the apparatus the arc is struck when the carbons are still apart. Current leakage due to the walls of the apparatus when at a temperature equal to that of melting magnesia need not be taken into account.

* Translated from the *Comptes Rendus*.

The Upkeep of Commutators on Traction Motors.—The following interesting notes on this subject are contained in the annual report, for the year 1906-07, of the municipal tramways at Frankfort, and have been abstracted from the *Elektrotechnische Zeitschrift*. It is often difficult for manufacturers to use mica of about the same quality throughout their work. In consequence, the commutator is subjected to extra wear and tear, and a large amount of sparking is the result. This appears to be due to the fact that the mica sticks out between the copper segments, thus causing bad contact between brushes and commutator. Grinding only brings temporary relief, and the wear is naturally more pronounced. To prevent this the mica segments on one particular motor were hollowed out to a depth of 1·5 mm. (0·06 in.), so that the question of the varying hardness of the mica was no longer present, as the brushes came into contact with the copper alone. It was at first feared that carbon dust would get into these small slots and cause complications; for this reason a special dust brush was provided. But this was found to be unnecessary, as both the air currents and the centrifugal force were sufficient to keep the slots practically free from carbon. The tests were so successful that 400 motors have been dealt with in the same manner. Commutators thus treated work exceedingly well, after a time assuming a blue-black colour. The brushes run clean with a minimum of sparking, and the commutators become highly polished, thus tending towards a reduction in the brush wear. It also lessens the accumulation of carbon dust inside the motor and increases the safety of working. A small hand-driven slotting machine, which can be mounted on the shaft, has been specially designed for use in slotting out the mica. These commutators have to be protected from the paste formed by the lubricating oil and carbon dust, and for this reason a fat of high consistency, which has been employed for some years in the motor gear cases, is used.

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RESTRICTIVE RULES.

The revised rules issued last year by the Verband Deutscher Elektrotechniker have given rise to a Paper by Mr. W. P. STEINTHAL, read before the Leeds Local Section of the Institution of Electrical Engineers, comparing these rules with those issued by the Institution. In this Paper and the discussion, of which an account will be found elsewhere, the general feeling was expressed that the German rules were considerably the less restrictive of the two; further, they possess the advantage that they are more widely recognised officially than those of the Institution. Attention was more particularly called to the fact that the German rules allow a higher current density to be

used, and also cable having a lower insulation resistance. Moreover, the use of flexible cord and unprotected surface wiring is generally permitted. There is no doubt a good deal to be said in favour of a minimum of restrictions, although the view recently expressed by Mr. ARTHUR WRIGHT, that electrical engineers in the past should have avoided any strict rules, leaving the insurance companies to insist on what precautions they thought fit, will not receive general acceptance.

Owing to the important differences between electricity and gas, such rules are much more necessary in the case of electricity supply. It is far more easy for an electric light consumer to alter the consumption of electrical energy from any point than it is for a gas consumer to do the same thing in regard to gas supply. In the event of wiring being cut very "fine" a point might be wired only for a single 8 c.p. lamp, but the consumer would have no great difficulty in connecting up a radiator to such a point if he thought fit. In some cases this modification might merely result in the blowing of a fuse; but, owing to the fact that fuses are not standardised in any way, an enterprising consumer could easily strengthen any fuse sufficiently to take the desired load, and subsequently the result might be far from desirable from the point of view of fire risk. In a gas system, on the other hand, a stove might very easily be connected up to an ordinary batswing burner, but no harm would result by so doing, for there would merely be an insufficient supply. Excessive drop in gas pressure, unlike an excessive drop in electrical pressure, does not result in the production of a serious amount of heat; it merely inconveniences the consumer.

It is, therefore, impossible in practice to cut electric wiring very fine, and although metallic filament lamps will no doubt permit of smaller conductors being used for the same amount of light in many cases, wiring contractors will scarcely feel disposed to cut down the size of wires used in wiring to a serious extent until the position of the metallic filament lamp is more generally recognised. In some cases, no doubt, the greater current density, as permitted by the German rules, would allow smaller wires to be used, but in the great majority of cases the size of wire is determined rather by the permissible drop than by the current density. Metallic filament lamps being less sensitive than carbon lamps to variations of pressure, engineers may possibly feel disposed to allow more drop of pressure in the future than in the past, though we doubt if much change will be made in this respect for some time to come, as we can scarcely expect the carbon lamp to be completely displaced.

More important, however, than such considerations is the use of flexible cord and unprotected surface wiring, as used on the Continent, to which we have frequently referred. The cheapness brought about by such a system is far greater than that due to increasing the current-density and the general use of cable of lower insulation resistance. There seems to be a prejudice against this Continental system, and an idea that it is used only on 100 volt systems or thereabouts. This, however, is certainly a mistake, as it is being used increasingly on 200 volt systems. Whatever objections there may be to such work for the higher pressures, they certainly cannot be urged against such low pressures as 25 volts, and as the metallic filament lamp now renders the use of such a low pressure possible in many instances, an attempt might very well be made to introduce this cheaper method of wiring in the first instance for these lower pressures.

REVIEWS.

(Copies, of the undermentioned works can be had from *The Electrician* Office, post free on receipt of published price. Add 5 per cent. for abroad or for foreign books.)

"**Konstruktionen und Schaltungen aus dem Gebiete der elektrischen Bahnen.**" Edited by O. S. BRAGSTAD. (Berlin: Julius Springer.) Pp. 52. M. 6.

The term "schaltung" may mean a variety of things; as used by the author it means the diagrammatic representation of circuits with their switches and controllers and connections to line and motor. The term "konstruktionen" is used by the author to denote not only the mechanical construction of motors and accessories, but the construction of curves to show the characteristics of a motor or its performance as represented by the relations between time, current, speed, drawbar-pull, distance travelled and efficiency.

The work under review consists of 31 plates and a 52 page pamphlet of descriptive matter. As far as the construction of motors is concerned the reader will not find much that is new or particularly instructive. Most of the drawings on the first four plates have already appeared in the technical press, and the description does not add much to what the drawings tell us. If the author tells us that the motor built by So-and-so is split horizontally and hinged at one side, that the brush-holders are bolted to the case and that hand-holes are provided to give access to the brushes, &c., we learn nothing new, since all that can be seen from the drawing. If he had given winding data, induction, weight, temperature rise at various loads, reactance voltage and, in fact, such information which cannot be read off the drawing and is yet of great importance, the reader might derive some benefit from the study of the text; but it is just this important information which is lacking.

The other plates are more instructive, but the instruction can only be obtained at the cost of considerable mental labour. The author may appear easily intelligible to his students, who may be supposed to be accustomed to his notation and nomenclature, but as this notation is not explained, any other reader has to puzzle it out as best he can. When one reads that in a certain motor "c" is 45, it is not at once obvious that by c the author means the frequency, nor is it quite clear that the symbol ν stands for gear ratio. Then the author introduces the term "pole-distance," but does not explain it. He merely tells us that by a formula, which is stated but not explained, the pole-distance is so many centimetres for the time-speed curve and so many centimetres for the time-distance curve. In addition to the usual running diagram, with which English readers are familiar, he also gives curves showing how current and draw-bar pull vary with speed, both for series and parallel running and for various resistances in the armature circuit. Several of these curves are given for continuous-current and single-phase motors, but none for three-phase motors. Then follow about a dozen plates to represent various types of controllers and connections. These plates are carefully prepared, and to assist the reader in following the circuits the author adds, in some cases, simplified diagrams. Only such arrangements are, however, shown where the working currents pass through the controller; multiple unit systems with contactors and master controllers are not represented. A fair number of switchboard diagrams, various booster systems, methods for ensuring constant voltage under varying load, switching arrangements in trolley lines, overhead and third-rail details are also shown, but on what grounds one of the plates is devoted to a working drawing of the Westinghouse air-brake valve in a purely electrical book is not very clear. A set of time-speed curves on plate 28 compares the performances of various town railways. We are inclined to doubt the reliability of these curves, for that given for the Central London line

shows that it takes 80 seconds for the speed to attain the maximum value of 22 miles per hour, that is a little longer than is taken by the Berlin Town Railway, which is worked by steam. Those who have travelled on both lines will know that there is an enormous difference in favour of the electrical line. The work might be made useful if the author were to amplify the letterpress by explaining his notation and nomenclature and by giving the scientific basis for the various formulæ he uses. As the text stands at present, the work can only be studied with advantage by thorough experts. G. K.

The Patents and Designs Act, 1907. By J. Roberts and H. Fletcher Moulton. (London: Butterworth & Co.) 4s. net.

Inventions, Patents and Designs. By G. Croydon Marks, M.P. (London and Manchester: Technical Publishing Co.) 3s. 6d. net.

Patent Rights: Notes on the Procedure for their Acquisition and Maintenance and on the Manner in which such Rights are Affected by Recent Legislation. By G. G. M. Hardingham. (London: Crosby, Lockwood & Son.) 2s.

A new act is usually made the excuse for the publication of a number of books explaining the changes made in the law, and the Patents and Designs Act of 1907 is no exception to the rule, as we have already received several guides to that act. Widely divergent opinions have been expressed as to the general policy of the act, and we have ourselves criticised certain of its provisions. Among the avowed objects of the act were the cheapening and simplifying of the patent law and procedure, so as to benefit the poor inventor and the working man, but it is questionable how far these desirable objects have been effected. Much is, however, expected from the provisions as to compulsory licences and working in this country, but even if some German and other chemical firms establish works over here they will bring their own managers, foremen, &c., and only a limited number of British workmen will be employed; competition with British manufacturers will become keener than ever; and as Mr. Hardingham pertinently points outs in his work, it will compel foreign chemical inventors to withhold disclosure of their inventions and to elect to carry on their manufactures as secret processes. It is difficult, however, to give the effect of the provisions as to compulsory licences and working as these, as well as many other sections of the act, are obscurely worded. In fact, a bill is at present before the House of Commons to explain sec. 25 of the act.

Messrs. Roberts and Moulton simply claim to give assistance to the reader in the interpretation of the Patents and Designs (Amendment) Act and the Patents and Designs (Consolidation) Act, and to point out their practical effects. In a lucid introductory chapter the authors give a good summary of the existing Patent Law and the changes introduced by the act. The text of the Patents and Designs (Consolidation) Act is then set out, and as both authors are acknowledged experts on Patent Law their notes and comments on the act will be found useful in elucidating the many difficulties that are likely to arise in the interpretation of the act. In an appendix to the book, abstracts of recent cases before the comptroller and law officer are given, and also a table showing the sections in the new act corresponding with the sections of the old act which they replace. We have no hesitation in recommending Messrs. Roberts' and Moulton's work to anyone who wishes to have a good and accurate guide to the recent changes in the Patent Law of this country.

Mr. Marks is a well known patent agent and consulting engineer, and as he took a leading part in the discussion on the Patent and Designs (Amendment) Act in the last session of Parliament, he is peculiarly qualified to write on the law and practice as to patents and designs. After an introductory chapter on "Fostering of Losing Industries," which contains some severe but not entirely unmerited criticism of British methods, the author gives an excellent summary of Patent Law and Practice. Over 50 pages are devoted to this section, and as it is written in a lucid manner, it should prove useful to engineers and others who wish to get, in a clear and handy form, the elements of Patent Law. The remainder of Mr. Marks' little work is devoted to the text of the Patents and Designs Act, 1907, and as the sections of the Patents and Designs (Amendment) Act of 1907 are shown in italics, readers can readily see the alterations introduced by the latter act.

Mr. Hardingham's book is a useful and accurate summary of the leading features of the law and practice relating to Patent Rights as amended by the legislation of last year. Commencing with a statement of the essentials of a patentable invention, the author points out, briefly but clearly, the steps necessary to obtain a valid patent, how it may be subsequently affected, &c. In fact, everything likely to affect the life of the patent is dealt with. Those of our readers who are interested in patents will derive benefit from reading the work, but we should like to draw special attention to the sections on the drafting and amendment of specifications and compulsory licences and working, which are particularly good.

Experimentaluntersuchungen über die Selbstinduktion in Nuten gebetteter Spulen bei hoher Frequenz. By Dr. Hermann Niebuhr. Berlin: Julius Springer. M. 1.60

This monograph contains a number of experimental and theoretical investigations relating to the self-inductance of embedded coils at high frequencies. The method employed by the author for measuring the self-inductances of the coils is a modification of one due to Trowbridge. Around a laminated core are wound an exploring coil of a large number of turns (1,500) and two primary coils, the ratio of whose turns is 1 : 16. The primary containing the smaller number of turns is connected in series with the inductance to be measured, and the other primary in series with a variable standard of inductance and a rheostat. The two paths so formed are then connected in parallel, and a suitable indicating instrument (vibration galvanometer or telephone in series with a condenser) is connected across the exploring coil. Results of measurements obtained by this method are compared with calculated values of the self-inductance. The investigations are then extended to the damping effects due to neighbouring short circuited coils, to massive copper conductors and solid masses of iron. In connection with the latter the extremely low value of the effective permeability is very striking.

THE DESIGN AND USE OF TELEPHONE AND TELEGRAPH CABLES.*

BY F. TREMAIN.

Summary.—The author here only deals with paper insulated lead-sheathed cables, which are now almost universally adopted for telephone and telegraph circuits, and describes their construction and use.

The cost is governed in the case of large multiple cables by the quantity of copper required, although in small cables lead may become the governing factor. For telegraph purposes pure and simple a single wire insulated with paper and surrounded by a screening tape of copper is in general use, although in cables which may be used interchangeably for telephone or telegraph purposes pairs of wires are used for both purposes as will be explained later. In each case a copper wire, which varies in diameter from 25 mils for local purposes to 113 mils for trunk purposes, is insulated by means of paper carefully selected and of long fibre. The paper is generally applied longitudinally in a suitable covering machine which is sometimes arranged to supplement the longitudinal wrapping by a helical covering, both being applied without much tension, so as to leave as much air-space as possible between the wire and the individual wrappings of paper. In lieu of the helical wrapping of paper a whipping of thread is used. The paper used varies in thickness from 3 or 4 mils to as much as 10 mils in the case of very heavy conductors. In the case of screened conductors the screening copper tape is about 3 mils in thickness and about ¼ to ⅜ in. in width applied helically with a slight overlap, its object being to screen the conductor from the inductive effect of neighbouring conductors traversed by telegraphic impulses. The screened conductors vary in diameter from 50 mils, weighing 40 lb per mile, to 113 mils, weighing 200 lb per mile, and in the smaller sizes the screening tape, although rolled as thin as possible, is practically of the same weight as the conductor itself. Care is taken in stranding the wires into a cable that the screening tape is in contact with the lead sheathing and therefore earthed. The electrostatic capacity of such a conductor measured to earth is 0·09 to 0·133 microfarad per mile. The calculated dimensions for various capacities, &c., are given in a table.

When the conductors are not screened, two wires insulated in the manner described are twisted together in a twinning machine with

* Abstract of a Paper read before the Newcastle Local Section of the Institution of Electrical Engineers.

a definite length of lay varying in Post Office cables from 4 in. to 13 in., and each length of lay is indicated by the use of a coloured wrapping, which insures that no two pairs of the same lay are adjacent when the pairs are stranded to make a cable or cable core. The efficiency of such a pair of conductors depends on their conductivity, the electrostatic capacity from wire to wire, and the inductance of the loop formed by the pair of wires. The electrostatic capacity varies from 0·04 to 0·07 microfarad per mile and the self-induction from 0·9 to 1·4 millihenrys per mile.

A rough empirical rule for determining the space requisite for any desired wire-to-wire capacity, with the class of paper and method of covering usually employed, is that if the diameter of the completed pair of wires is three times that of one of the conductors, the wire-to-wire capacity measures about 0·07. If the ratio is four to one, the capacity measures 0·055 or thereabouts, whilst if the diameter of the pair of wires is increased to five times that of one of the conductors forming it, the capacity falls to a little over 0·04 microfarad per mile. It is not impossible, therefore, to obtain in a cable a more efficient loop with conductors weighing 100 lb. to the mile than with 150 lb. conductors; for if the latter are made to have a capacity of, say, 0·07 microfarad per mile and the former 0·045 microfarad, on the basis of KR alone the 100 lb. loop would be more efficient, and in addition it would have a higher inductance, say, 1·2 millihenrys per mile as against as little as 0·9 millihenry. It follows that in cable designing, paper and air being cheaper than copper, great advantages follow from a well-considered design.

The great importance of obtaining a low electrostatic capacity in a telephone loop will be seen from the illustrations of distortion given in Sir John Gavey's presidential address * in 1905, and in Cohen and Shepherd's Paper on telephone transmission measurements.† The table of equivalent circuits in the former Paper, some the results of experiments and others based on formulæ, are interesting from this point of view.

There is also room for much ingenuity in the assembling of the pairs of wires to form a cable—more so than in the case of screened conductors which usually form the outer layer or layers of the cable, and are not often stranded to form pairs or other cores.

The original method, and one still much in vogue, is to strand the alternate pairs up layer by layer in a stranding machine, each alternate layer forming a left-handed and right-handed spiral. The number of pairs thus stranded varies from seven pairs in a small distribution cable to as many as 606 pairs in the largest main telephone cable.

Two other methods of stranding the pairs are in general use: (*a*) the quadruple pair type, (*b*) the multiple twin type. Before describing these in detail the varied requirements which multiple subterranean cables are required to meet are discussed. These may be classified as follows: (*a*) trunk line telephone cables, (*b*) junction telephone cables, (*c*) main telephone cables wholly allocated to subscribers' lines from an exchange centre, (*d*) composite cables providing for any two or three of the above services, (*e*) composite cables primarily intended for telephonic purposes, but also containing telegraphic wires.

The chief defects in the original type which these special cables were designed to avoid are: (*a*) their inefficiency for anything but short distance communications, (*b*) their costliness in the provision of spare wires, (*c*) the waste involved in the uncertainty as to the ultimate requirements at the points selected for distribution. They are also unsuitable for superimposed circuits, in considerable use on aerial lines to which these are often connected, and they generally provide for the short-distance subscriber's circuit the same weight of conductor as for circuits of greater length. As regards the last point it may be noticed that an ideal conductor for subscribers' circuits would be one that tapered gradually, from the longest distance served on a route to the shortest from the exchange, the wire to wire capacity per mile being also reduced as the length increased. This would allow of any pair of conductors being appropriated for a new subscriber, wherever he may be, ensuring equality of treatment for all subscribers within the telephone area. Now it is clearly impossible to secure this ideal equality of treatment in a telephonic network, nor is it possible, when multiple cables are used for trunk circuits, to provide equal efficiency for lines of varying length unless the ultimate appropriation of all the wires can be foreseen. On an aerial line, on the contrary, conductors of suitable gauge can be added from time to time.

It is to meet these difficulties that composite cables, containing different gauges of wire, have been manufactured, but their utility is limited, and they have the disadvantage that a larger number of conductors of fixed gauge have to be provided for future use. This condition naturally suggests the grouping of wires in a cable to form conductors of larger cross-section, an arrangement which cannot be carried out with any electrical advantage in the case of cables in which the pairs of wires are arranged in layers in the usual manner.

In the two types above mentioned this difficulty is met by stranding pairs in such a way that, (*a*) in addition to the individual pairs being available to form a twisted looped circuit, the wires of two or more pairs may be bunched to provide double conductivity without materially increased capacity; (*b*) by the use of transformers, the unit loops can be utilised for a circuit at the same time as those of double conductivity. In quadruple pair cable four pairs of wire are stranded around a centre of yarn, to form quadruple pair cores, and where the conductors are large enough, weighing 100 lb. or more per mile, to worm these four pairs with four pairs of smaller gauge, weighing 10 lb. or more per mile, forming an eight-pair core. These cores are then laid up into a cable of any desired number of pairs. Quadruple pair cores, being large, allow of the helical interstices formed in each layer being utilised for smaller pairs of wires, as may be found necessary.

The quadruple pair formation admits of two diagonal pairs being each bunched to form conductors of double conductivity, the two pairs being used for a metallic telephone circuit. The stranding of the four pairs around a common centre ensures that those loops of double conductivity shall be non-inductive to any similar loops in the same cable. The mutual capacity between these conductors of double conductivity is not materially greater, and may be made actually less than that obtained between the conductors of the unit pairs of which they are made up. An electrical advantage is thus secured, and speech can, as a result, be carried over a much greater distance. In the same way all the four wires forming a part of two neighbouring pairs can be grouped together to form a conductor of fourfold conductivity and can be associated with the other four wires, similarly grouped to form a telephone loop, this loop of fourfold conductivity being non-inductive to other loops in the cable. The capacity of such a loop is necessarily higher than that formed of diagonal pairs, but the arrangement would sometimes prove advantageous. The worming pairs can also be grouped in the same way, and the mutual capacity results obtained with this combination are interesting.

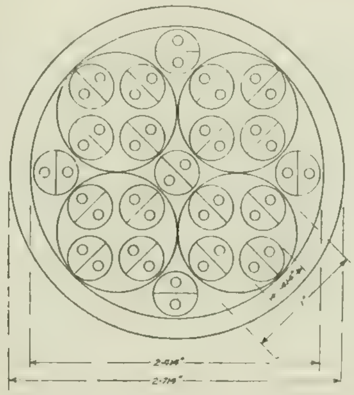

FIG. 1.

All the remarks as to bunching conductors apply to superimposed circuits, for one of these loops is obtained, in such a system, by bunching the initial conductors through one winding of a transformer. The general result obtained will be best illustrated by reference to a diagram of a 42 wire cable (Fig. 1), excellent electrical tests having been obtained with a cable of this type. It will be seen that the cable is formed of four quadruple pairs laid around a central pair of the same size and wormed with four pairs of equal weight, this being the correct geometrical formation. The wires of the pairs forming each core are laid up with a different lay, to ensure immunity from cross-talk and to ensure the same result when the pairs are bunched as described; the four quadruple cores have also different lengths of lay. The quadruple cores in this cable are about 1 in. in diameter, and the complete cable over the lead sheathing has a diameter of 2·71 in., which is nearly the maximum size permissible for a 3 in. pipe. This may be regarded as typical of trunk-line cables, but for long-distance transmission it would be desirable to provide 200 lb. conductors and a cable 3¾ in. in diameter drawn through 4 in. pipes (Fig. 2). With such a cable telephonic speech between London and Manchester would be practicable. The cost, including pipe-work, cabling, jointing and equipment, would be high—exceeding, probably, £300,000—but by the addition of 100 lb. worming pairs 24 circuits would be provided, adequate for intermediate distances—a total of 48 metallic circuits. This number could be increased to about 60 by the superimposing scheme shown diagrammatically in Fig. 3.

In the multiple twin type the facility for increasing the conductivity without abnormally increasing the capacity of the heavier loop is obtained by a system of successive twinning. Two pairs of wire having been made in the way already described, these are twisted together to form a double pair. These two pairs serve the same purpose as the diagonal pairs of the quadruple core described above. A similar double pair having been prepared, the two double

* *Journal*, Institution of Electrical Engineers, Vol. XXXVI., p. 4.
† *Ibid.*, Vol. XXXIX., p. 503, 1907.

pairs are in turn twisted together to form a pair of four-fold conductivity. Eight-wire cores formed in this way are laid up into a cable and, although the fourfold pairs cannot be wormed with smaller conductors as can the quadruple cores, layers of them can be wormed with small groups of pairs or by single pairs, as can layers of quadruple cores. Quadruple pair and multiple twin cable cores, say, 2 in. in diameter, are sometimes surrounded by a layer of ordinary twin conductors, or by one or more layers of screened conductors, for telegraph purposes, this latter being the method adopted in the case of the former type in connection with the West of England underground system, and in the latter type in connection with the Northern underground cables (Fig. 4) and the cable now being provided between Leeds and Newcastle.

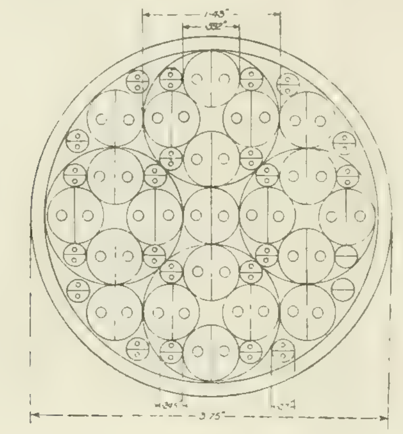

FIG. 2.

Cables thus completely laid up ready for sheathing are dried in ovens or vacuum chambers to raise the insulation prior to sheathing with lead by passing the core through a lead press in precisely the same way as that adopted for other lead-covered cables. Immediately after sheathing the cable is submerged, and when cool tests for conductivity and insulation are made. As regards the latter test, it is interesting to note that an insulation of from 10,000 to 20,000 megohms per mile is frequently obtained, and that if the insulation of a core is allowed to fall much below 5,000 megohms per mile the electrostatic capacity is raised. In this country these cables are almost invariably drawn into pipes, the sizes generally used being 3, $3\frac{1}{2}$ and 4 in., joints being made at every 176 yds. or thereabouts, and sealed by a lead sleeve and carefully wiped joints.

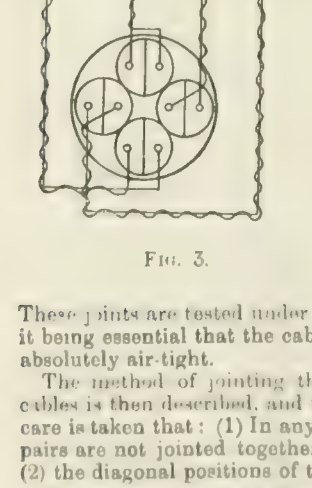

FIG. 3.

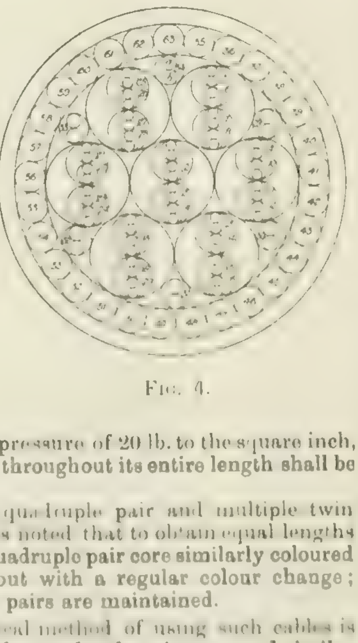

FIG. 4.

These joints are tested under a pressure of 20 lb. to the square inch, it being essential that the cable throughout its entire length shall be absolutely air-tight.

The method of jointing the quadruple pair and multiple twin cables is then described, and it is noted that to obtain equal lengths care is taken that: (1) In any quadruple pair core similarly coloured pairs are not jointed together, but with a regular colour change; (2) the diagonal positions of the pairs are maintained.

Superimposing.—An economical method of using such cables is illustrated in Fig. 3 by means of a quadruple pair core, and similar results are to be obtained with the multiple twin type. In the first quadruple cable cited, Fig. 1, the unit conductors, weighing 100 lb. per mile, would be used for distances up to 40 or 50 miles. At the end of these sections transformers would be installed, the primaries of which would be connected with telephone exchanges on the line of route between which traffic is probable. The secondary windings of the transformers would be connected across the A and B of the loop. The central point of the secondary winding being accessible, it would be connected to the central point of the secondary winding of a similar transformer connected to the A and B wires of the forward section of the same loop, this process being followed through the entire length of the cable. The diagonal loop having been similarly equipped at the same points throughout, we shall have available between the extreme ends of the cable a loop of 200 lb. conductors of low mutual capacity. The only disadvantage would be the insertion of non-inductive resistances at three or four places; whilst the great economical advantage will have been secured of having heavy conductors for communication between the termini, which have already been utilised for intermediate communications. The shorter circuits would be subject to the losses common to all inductive circuits; but doubtless transformers could be designed for such a purpose which would reduce these losses to a minimum, although the type in general use would be perfectly efficient for the distances indicated in this case. It is clear that, if four pairs forming a quadruple pair be symmetrically stranded around their common centre of yarn, the companion diagonal loops could be similarly utilised. Exhaustive experimental trials have been made on circuits 11, 33 55 and 77 miles long in quadruple pair cables with complete success; and in addition super-superimposing has been successfully obtained by the insertion of transformers in the 200 lb. circuits and using as the A wire of an additional circuit two diagonal pairs of wires (400 lb. per mile) and as the B wire the companion diagonal pairs of wire in the same quadruple core, thus obtaining seven circuits with four pairs of wire as shown in Fig. 3. There was a complete absence of cross-talk or inductive interference throughout the system.

The planning of an underground network for a local telephone system on economic lines presents a fascinating problem. Certain transmission standards having been agreed to for local and trunk

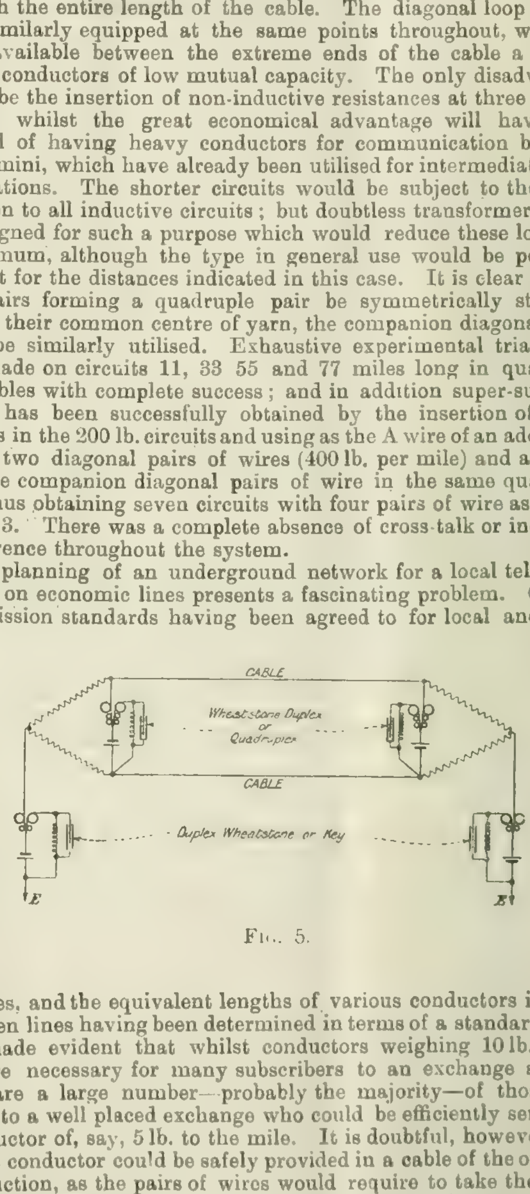

FIG. 5.

purposes, and the equivalent lengths of various conductors in cable and open lines having been determined in terms of a standard cable, it is made evident that whilst conductors weighing 10 lb. to the mile are necessary for many subscribers to an exchange system, there are a large number—probably the majority—of those connected to a well placed exchange who could be efficiently served by a conductor of, say, 5 lb. to the mile. It is doubtful, however, if so small a conductor could be safely provided in a cable of the ordinary construction, as the pairs of wires would require to take the strain of the large stranding machine used for building up the entire cable. In quadruple pair and multiple twin cables, on the contrary, pairs are first assembled in small machines into suitable cores, and these eight-wire cores so manufactured would be quite capable of taking the strain involved in the final stranding of the cable. These two types therefore bring within practical limits, in my opinion, much smaller conductors than are now used, with the advantage that whenever necessary they can be bunched to form 10 lb. or 20 lb. conductor circuits. This uniformity of type should prove of great advantage in planning a local system. Not only would it prove economical in the way indicated above, but it would avoid a very considerable amount of idle spare plant which is now practically unavoidable with the ordinary systems of cabling.

There is one other method of increasing the efficiency of the line, and securing approximate equality of treatment in connection with a telephonic network—viz., the economy of filling the pipe or duct, within certain limits, without regard to the number of conductors. It should, I think, be regarded as an axiom of telephone engineering that, a given duct space having been provided at a heavy cost, a main cable should as nearly as possible fill it, and a low mutual capacity be secured where the wires in the outer zone are few. It is interesting to note the facility which exists in the quadruple pair cores for providing in cables primarily intended for trunk-line purposes a large number of wires for junctions and subscribers' lines without detriment to the chief purposes, as all the helical interstices

of the cores can be utilised for smaller conductors without increasing the capacity of the bunched pairs of the quaduple core.

It will, perhaps, be well to emphasise the fact that, notwithstanding the great success which has been obtained by the use of telephone cables, even for considerable distances, it by no means follows that aerial lines cease to be necessary. Not only are they a vital necessity if long-distance telephonic communication is to be secured, but the enormous growth of this long-distance traffic makes it difficult to find room on the highways for all the wires required for that purpose. Moreover, the short-distance trunk circuits, largely placed in the underground cables, are not suitable for long-distance communication.

Reference in then made to Sir John Gavey's presidential address, in which particulars are given of the results to be obtained between London and Glasgow. Hughes instruments have been very successfully employed between London and Glasgow, without a repeater, both by means of working the telegraph circuit in a loop and superimposing thereon an earth circuit (Fig. 5), and also by the use of screened conductors. These screened conductors have also been used for long-distance undulator circuits without a repeater. A striking illustration of the efficiency of screened conductors is the 200 lb. wire of the West of England underground cable, and it is probable that before the end of the next financial year conductors of this type will be available between London and Land's End, the landing point of various Atlantic and other cables. One mile of this 200 lb. screened conductor is roughly equivalent to 1 mile of Atlantic submarine cable—although the conductivity of the latter is about $2\frac{3}{4}$ times that of the former—since the capacity of the Atlantic cable is 0·42 mfd. per naut, compared with 0·133 per mile for the screened conductor.

It, of course, remains to be seen if the screen which is effective for ordinary telegraphy would be adequate if the conductors were joined to long submarine cable wires, but whether underground cable wires be stranded in pairs for use interchangeably for telegraphic or telephonic purposes, or provided with a screening tape for the prevention of inductive interference, they are a complete success for inland telegraphic purposes.

Included in the Paper are several tables giving particulars of the air-space paper core cables referred to.

DISCUSSION.

Mr. DRUMMOND thought the title should have read "The Design and Use of Trunk Telephone and Telegraph Cables," as the Paper dealt almost entirely with that section, and he was surprised at the cheerful way in which the author dealt with super and super-superimposing of the circuits. It struck him that decentralisation was more the thing at the present day than centralisation. He asked if the author had met with any trouble due to the wires being affected by the colouring matter in the cable. In multicore wires he found the makers supplied a few extra conductors. If a 600 core wire was wanted, they supplied about 612.

Dr. THORNTON said the Paper gave a lot of information which was difficult to obtain, since scientific books gave no practical information on the subject. He asked if the telephones operated better when the wires were superimposed than when used singly. When superimposed there was more copper in use, but there was also greater capacity.

Mr. JOHNSON considered that the immense developments which had taken place in this country in telephone work during the last few years would have been impossible without the use of lead-covered paper-insulated cables. With regard to the use of small gauge wires he though these were the right thing for local networks, if the cable manufacturers could make them. He was inclined to think that the author was too sanguine as regards the use of super and super superimposing. Where some of the sections were run overhead the KR law was interfered with. If a fault occurred on the aerial section, he did not think it would be possible to shut out the effects of the fault from the remainder of the system. He asked if screening each alternate layer was sufficient protection. In doing so a good deal of copper would be saved. He also asked if tinfoil had ever been considered for such work.

Mr. GASCOIGN asked if the copper screening was only confined to the outer layers. The author had mentioned that the 600-pair wire cable was the largest in the country. He had probably forgotten that the Glasgow Corporation had laid an 800-pair cable which was now in use.

Mr. TREMAIN, in reply, said that the question of centralisation and decentralisation was a very debatable point, and it depended greatly on the district and its existing network. Slightly better speaking was obtained with superimposed circuits, but with super superimposed circuits no benefit was obtained due to increased copper. There was, however, on the whole, not much in it. Where a superimposed system was adopted the circuits were almost all underground. Faults in large trunk cables were very rare, when the insulation resistance got low they only had to pump in air to get the insulation normal. The greatest danger they would have to contend with, as far as he could see, was subsidence. He agreed with Mr. Johnson that alternate screening of layers might be good enough. Tinfoil was not strong enough for screening. Copper also proved itself to be more adaptable. He had seen one sample screened with aluminium, which also seemed satisfactory. He had forgotten about the 800 pair cable for Glasgow Corporation.

CORRESPONDENCE.

THE THEORY OF ALTERNATE-CURRENT TRANSMISSION IN CABLES.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: In his very interesting article Dr. Drysdale says (in your issue of January 10th, p. 469), "In an ordinary cable in good condition L is small and Ω large, hence the second term of $KR - \frac{L}{\Omega} = 0$ is negligible in comparison with the KR. In order, therefore, to fulfil the distortionless condition, L must be increased or the insulation resistance Ω diminished."

I think the Boer War did not cost Europe so much as this belief in the large value of Ω. All our cables are badly constructed because the cable factories thought that the insulation resistance for direct current and the dielectric resistance for telephone frequencies is the same thing. I have often measured direct-current insulation as 10,000 megohms, but never have I, nor do I believe has anybody in the world, found the dielectric resistance so high as 1 megohm at a telephone frequency of 1,000 ~ per second. The term "insulation resistance" seems to be a very bad one, and misleading for practical telephone men. The chief part of the lost energy G^2c is caused by dielectric hysteresis, by electrostatic influence, and by some other unknown causes. With more loss of energy G will be larger, $\Omega = 1/G$ smaller. In an ordinary cable under the best conditions Ω can generally be 100,000, while under conditions for higher frequency it may be 10,000 ohms.

I am compelled to make these remarks about Ω, because Dr. Drysdale pointed out so clearly the meaning of $p = \sqrt{RG}$, and I should be pleased if the experimental values of Ω, which I got by my barretter method, were better known, and if new experimental investigations were made in this direction, especially on submarine cables.—I am, &c.,

Budapest, March 31. BÉLA GÁTI.

[We have submitted Herr Gáti's letter to Dr. Drysdale from whom we have received the following reply.—ED. *E.*]

TO THE EDITOR OF THE ELECTRICIAN.

SIR: The interesting article by Mr. Cohen in a recent issue, together with Herr Gáti's letter, which you have kindly given me an opportunity of reading, raises several points of interest. The practical question appears to be whether high or low insulation is preferable for a cable. Mr. Cohen taxes me with insufficient attention to the total attenuation, and concludes that the higher the insulation the better. Herr Gáti, on the other hand, claims that the belief in a high insulation has wasted a greater sum than the Boer war. Both of these gentlemen are actively concerned with telephone work, and I am prepared to bow to either of them on questions of practical experience. I may, however, point out to Mr. Cohen that the statement which he quotes from my article merely refers to the means of attaining the distortionless condition, and I have nowhere claimed that this condition is the only one of importance. On the contrary, in the very sentence above the one he quotes, I said "The increase of inductance where possible is, of course, the better solution" (rather than decrease of insulation) "as when the circuit is distortionless $p = \sqrt{RG} = \sqrt{R/\Omega}$, showing that the higher the insulation the better." How, in the face of this, I am represented as advocating low insulation, and as disregarding the "volume attenuation," I am at a loss to understand.

Now, as to the formula quoted by Mr. Cohen, this is readily derived from my equation by assuming RB − XG to be small, instead of zero, and taking the approximate square root,

which gives $$p^2 = RG + \frac{(RB - XG)^2}{4\,(RG + XB)};$$

and if we then assume that RG is small in comparison with XB,

we obtain $$p = \frac{R}{2}\sqrt{\frac{B}{X}}\left(1 + \frac{GX}{RB}\right),$$

which, on cancelling the frequency, gives the formula

$$p = \alpha = \frac{R}{2}\sqrt{\frac{K}{L}}\left(1 + \frac{SL}{KR}\right),$$

as quoted. I have given this proof, as, in the case of any approximation formula, it is of importance to know what assumptions have been made, as we must obviously be bound by those assumptions in its use. This formula, in the first place, therefore, does not indicate a distortionless condition in itself, but only permits an approximate value of the attenuation constant to be obtained when the distortionless condition is nearly satisfied. We have, therefore, no right to vary the quantities arbitrarily and to increase S to infinity in a formula which expressly assumes it small. I fancy, however, that Mr. Cohen really meant to increase the insulation, instead of the leakance to infinity, as his statement would otherwise be contradicted by his own formula.

I am quite disposed to agree with Mr. Cohen as to a considerable amount of departure being permissible, or even desirable, from the strict distortionless condition. The curves, Figs. 21–23 of my Paper, indicate more clearly than any formula the variation of attenuation with the conditions, and they show that at high insulations the inductance may be varied anywhere between a fifth and five times its theoretical value, without serious effect on either the attenuation or its variation with frequency. Mr. Cohen, however, does not say how the distortionless condition was secured in his oscillograph experiments, so that it does not follow that the best result was obtained. It is interesting to hear from him that in practice a loading of 0·4 henry per mile can be attained without appreciable increase of resistance, as this is sufficient to give the distortionless condition with the standard cable with an insulation of 0·1 Ω per mile.

Finally, I think Herr Gáti has done us good service by calling attention to the influence of dielectric losses. In strictness the quantities R, X, G and B should be the "equivalent" resistance (including core losses in inductance coils), reactance, conductance and susceptance, as measured with alternate currents of the working frequency. These ought to be determined in exactly the same way as the no-load and short-circuit tests on a transformer are made, but on a short length of cable; and it is interesting to see that instruments are being devised which will render this possible. In any case Herr Gáti has shown us that it is useless to strive after an extremely high insulation, if dielectric losses are responsible for reducing its effective value to 100,000 or even 10,000 ohms per mile.—I am, &c.,

Northampton Institute, April 14. C. V. Drysdale.

THE REPRESENTATION OF ALTERNATE-CURRENT PHENOMENA.

TO THE EDITOR OF THE ELECTRICIAN.

Sir: In connection with the use of the imaginary exponential to represent periodic magnitudes, the following, from Stokes' celebrated Paper on "Pendulums" (1850), may be of interest:—

"We must now . . . introduce the condition that the function ψ shall be composed, so far as the time is concerned, of the circular functions $\sin nt$ and $\cos nt$—that is, that it shall be of the form $P \sin nt + Q \cos nt$, where P and Q are functions of r and θ only. An artifice, however, which has been extensively employed by M. Cauchy, will here be found of great use. Instead of introducing the circular functions $\sin nt$ and $\cos nt$, we may employ the exponentials $e^{\sqrt{-1}\,nt}$ and $e^{-\sqrt{-1}\,nt}$. Since our equations are linear, and since each of these exponential functions reproduces itself at each differentiation, it follows that if all the terms in any one of our equations be arranged in two groups, containing as a factor $e^{\sqrt{-1}\,nt}$ in one case and $e^{-\sqrt{-1}\,nt}$ in the other, the two groups will be quite independent and the equations will be satisfied by either group separately. Hence it will be sufficient to introduce one of the exponential functions."

As regards the application to electricity, I may instance the general theorems given in "Theory of Sound" (1877), with examples from electrical vibrations, and a "Note on the Theory of the Induction Balance" (B.A. *Report*, 1880). Possibly earlier examples might be found. In any case, it would be merely the application of an already well known method.—I am, &c.,

Rayleigh.

ELECTROLYTIC CORROSION.*

BY PROF. W. W. HALDANE GEE.

Summary.—The author has collected evidence relating to the cause of corrosion, and has made a number of experiments on the subject. He deals minutely with the various conditions which may produce corrosion, and with suggestions for its prevention.

Taking the convenient hypothesis that all corrosion is essentially electrolytic, the subject may be conveniently divided up as follows: (1) Corrosion produced by an external E.M.F. or ordinary electrolysis; (2) corrosion resulting from the contact of different metals; (3) ordinary or self-corrosion; (4) corrosion produced by alternating currents; (5) corrosion produced by the combinations of the above cases.

Anodic Corrosion.—When an electric current is passed through an electrolyte, such as a solution of sodium chloride, with an anode like copper, the electrochemical effect of the negative ions will be to dissolve a mass of the anode. A high anode efficiency is important in the electrolytic refining and the electroplating industries. Each case will vary according to the nature of the anodes, the electrolyte used and its temperature, and especially depends upon the current-density employed. Thus nickel, with a current-density of 0·05 ampere per square decimetre may dissolve quantitively in sulphuric acid or become passive in sodium nitrate and remain unattacked. Again, it has been shown that electrolytic nickel anodes may only give an anode efficiency of 12·7 per cent., whilst cast nickel anodes roughened with acids may have an anode efficiency as high as 91·3 per cent. Nickel anodes are peculiar in becoming pitted at a number of points, holes being soon formed in places, but in other parts the original thickness of the plates remains intact.

Reference is then made to experiments made by using the method of balanced electrodes as described by the author.†

Under certain conditions a corrodible metal behaves, when it is made the anode, as if it were a noble metal. For this passive condition the most obvious explanation is that a film of insoluble oxide is formed, which prevents further attack, and no doubt in some cases this is the fact. Practically the effect is of great importance in the prevention of metals from corrosion by stray currents. The results of a few experiments on passivity are then given.

Anodic corrosion furnishes convenient methods for the preparation of plating solutions and insoluble oxides and compounds. The anodic stripping of tinned iron is now an established industry.‡ Electrolysis may be employed for the drilling of holes in hard steel plates. Efforts are being made for the application of anodic etching in the printing, photographic processes.

Applications of the Kathode Effects.—When solutions of alkalies and their salts are used as electrolytes with iron kathodes, the effect of the liberated hydrogen will be to reduce any oxide films and leave the surface clean; beyond this there will be no further attack, for the alkaline solutions have no power of rusting iron. These facts may be utilised for the cleaning of iron and steel articles and for the prevention of corrosion. Electrolytic cleaning is coming into favour and is now often used instead of acid pickles. We have found that the following process gives very successful results: A 10 per cent. solution of caustic soda is placed in a large iron vessel, and a sheet of good soft iron is bent in a circular shape so as to fit closely to the sides of the vessel. This is used as the anode. The solution is heated to boiling, and the iron to be cleaned is attached to the negative pole and immersed in the solution. Thus in one test a sheet of iron of 40 sq. in. total surface (that was covered with rust and grease) was used and a current of 2 amperes was passed for 5 minutes. On removing the plate it was found that most of the rust could be removed by simple washing, and the application of a brush brought the surface at once bright.

The kathodic protection of metals is the method most frequently recommended to protect underground ironwork against stray currents. It may be also used in chemical works and in manufacturing processes where metal is brought in contact with corrosive liquids. H. S. Anderson and J. W. Bennie protect the metallic screens used in mining plant against the action of acids and salts by making them kathodes against a carbon or other suitable anode. They are then able to use steel wire or punched steel screens, which are much less expensive than those made of brass or copper. To prevent the surface condenser tubes from corrosion at the Long Island power station of the Pennsylvania Railroad Co. a small booster is used, the negative pole of which is connected to seven points in each condenser.§ J. H. Schoenberger and G. W. Frazier have designed a method for protecting the metal sheathing of ships by making it a kathode.

Simple Galvanic Couples.—When two metals are in contact and

* Abstract of a Paper read before the Manchester Local Section of the Institution of Electrical Engineers.

† *Trans.* Faraday Society, 1., 257, 1905.

‡ Kershaw, *The Electrician*, 63, Feb. 6, 1906.

§ *The Electrician*, 172, May 18, 1906.

are completely immersed in an electrolyte the arrangement constitutes a short-circuited primary cell, which is ideal in simplicity from a constructional point of view, but electrically it is of great complexity. Take two equal cylinders of lead and zinc, and place them vertically in a solution of dilute sulphuric acid with their curved surfaces in contact and their axes parallel. The zinc will commence to dissolve and the corrosion will be particularly rapid along the boundaries between the two metals. Generally, let E be the effective voltage and R the resistance between the cylinders measured between the curved surfaces and the electrolyte. The value of R will depend on the conductivity k of the electrolyte and the arrangement of the stream lines. Denoting a quantity depending on the size of the cylinders and on that of the containing vessel, the conductance capacity or K, we have for the current C flowing $C = kKE$. But by Faraday's law $M = Ctz$ where M = grammes of zinc dissolved in time t, and z = the electro-chemical equivalent of the zinc. Hence the velocity U of the solution of the zinc will be $U = M/t = Cz = kKzE$. This formula, then, enables the reaction velocity to be determined, for k and z are physical constants, E can be obtained experimentally, and the value of K can be calculated. The task of finding K has been kindly undertaken by Mr. S. Butterworth. His results are given in an appendix to the Paper.

The effective voltage E depends on the nature of the metals, the concentration and the nature of the electrolyte and its temperature, and on the action of the hydrogen at the kathode. The potential of the hydrogen at the kathode surface is known as the *ueberspannung*, over-voltage, and super-tension. It depends, among other circumstances, on the nature of the metal and the physical state of its surface. Over-voltage plays an important rôle in the solution of metals. Thus the reason that amalgamated zinc does not dissolve easily in acid is because the over-voltage of the mercury renders the effective voltage practically zero For metals which occlude hydrogen the over-voltage is small, hence platinum is a very effective member of a galvanic couple.

Measurements of the over-voltage that have hitherto been made do not apply to the conditions of galvanic couples. The anode and kathode compartments have been, as a rule, kept separate, and so important secondary reactions have been avoided. To get some idea of the value of the working pressure the following experiment has been made: A plate of iron 2 in. by 6 in. was fixed at a distance of about ½ in. from the plate of zinc of the same size so as to constitute a voltaic cell in a normal solution of sodium chloride. The poles were connected with various resistances and the P.D. was observed from time to time by the condenser method. The internal resistance was also repeatedly measured by a Kohlrausch bridge. From the observations the internal pressure of the cell was calculated. An approximate value for the short-circuited cell was found by plotting the E.M.F. values against the external resistance and continuing the line backward to find the value for $R = O$. The use of methods in which a rotating secohmmeter commutator has been applied to obtain the open circuit voltage, and separate measurement of the potentials of the electrodes confirm the conclusion that the E.M.F. of a galvanic couple is small. Nevertheless, since the electrical resistance of the galvanic couple may be also small, currents of sufficient magnitude will be produced and soon bring about the corrosion of the positive member. Taking $E = 0{\cdot}006$, U worked out at $4{\cdot}60 \times 10^{-3}$ grammes per hour for the zinc and lead cylinders. This has not been able to be confirmed.

Experiments showed that a galvanic couple is more effective when the electrolyte is in movement.

Many experiments have been made to test the actual relative rate of corrosion in the case of galvanic couples, and particulars of some are given in the Paper.

Effect of Oxide Coatings.—Iron and steel are electro-positive to the oxides of iron. Thus bright steel tested against the same kind of steel rusted in the Manchester atmosphere during 24 hours gave 0·104 volt. The thin coating of magnetic oxide formed by heating, or by special processes, is a good protector against rust as long as the oxide film remains unbroken, but if it be partly removed (and in some cases it is very brittle) there will be a certainty of local corrosion. Mill-scale or black oxide is likely to produce bad cases of pitting. The importance of removing scale from new ironwork before the preliminary painting is obvious. H. L. Hollis gives iron a non corrosive film by first using it as a cathode in caustic alkali solution, and when sufficiently clean as an anode. The oxidising action which then takes place forms a protective coating. The iron is now dried and immersed for a short time in a bath of palm oil heated to about 125°C. It is then removed and rubbed with bran to absorb the oil.

Concentration Cells.—If a metal be immersed in a liquid so that its lower end is in a solution of greater concentration than that surrounding the upper end a P.D. results, sufficient to cause corrosion. Such effects are found in the case of iron structures submerged in tidal rivers.*

Effect of Stress.—T. Andrews has investigated the effect of stress in causing a P.D. in the case of steels and found the strained material electro-positive. Jackson has shown that the corrodibility is increased practically according to the amount of the strain. This effect is thought to explain cases of grooving of bridge members. The most seriously strained parts are eaten by galvanic action. The effect of stress on P.D. has been recently studied by Hambuechen and others.

Corrosion by Galvanic Couples.—Many examples of the disastrous effects of disregarding the principle that the more positive metal is attacked are brought under notice from time to time. Mention is made of copper-bottomed ships lying in harbour causing damage to steel vessels, and of the investigation into the cause of the failure of the Tay Bridge, when cast and wrought iron were connected by rivets, the rivets and wrought iron work were corroded by local galvanic currents. An examination of the literature relating to the corrosion of boilers reveals many examples of the injurious effect of having metals in contact between which there is a P.D.

Reference is then made by the author to the use of couples for preventing corrosion and to multiple galvanic couples.

Self or Chemical Corrosion.—That local currents are the determining factor in the solution of metals is confirmed by the work of T. Ericson Aurén and W. Palmaer, yet a different way of viewing the matter has been developed in recent physical chemistry researches, the velocity reactions in heterogeneous systems being deduced from a number of physical conditions. Leaving future investigations to furnish a more complete explanation, the simple electrolytic hypothesis seems in accord with the chief facts of corrosion. Hence to corrode a metal we require a P.D. between its parts and a suitable electrolyte. The P.D. may be produced either by a physical or chemical difference in the constituent parts. A variation in the crystalline nature of the particles may, for example, be a sufficient cause of P.D., or parts may be amorphous and other parts crystalline.

The Corrosion of Associated Metals.—If an electrode consist of a mechanical mixture of metals, the potential of the electrode will be determined by the most positive constituent. For instance, a mixture of copper and zinc will give the pressure of the zinc, and this holds good as long as 0·2 per cent. of the zinc is present. If the metals form a solid solution then the alloy is found to be less positive than the most positive of the constituents, and may even be less corrodible than either of them. When the alloy itself corrodes the more positive metal is likely to be attacked first. Again the metals may form a chemical compound with each other, and when corroded the constituents may pass into solution together. These general principles explain the decay of alloys. Examples are given in the Paper.

The Corrosion of Iron and Steel.—For the rusting of iron three things are essential: oxygen, water, and carbon dioxide. All three are essential. The ferrous carbonate produced is oxidised by the oxygen to form ferric hydrate with the liberation of carbon dioxide, which latter is retained in solution and attacks a fresh portion of the iron. The action is thus cyclic. Some believe that hydroxyl is the effective agent. It is known that iron will not rust in an alkaline solution, and much of the earlier work has been thrown in doubt by the use of glass vessels which may have given up sufficient alkali to inhibit rusting. There, however, can be little doubt that the carbon dioxide of the air is an important factor in causing rust. Its solution in water will provide the necessary electrolyte to give a current with the aid of the anodic and kathodic particles in the iron. The presence of the positive and negative areas may be revealed by the use of a solution containing a mixture of phenolpthalien and potassium ferricyanide.

In revealing the polarity differences the microscope is useful. I find that when a highly polished piece of steel is etched under the microscope, by the use of acid, hydrogen can be seen escaping in the form of small bubbles from the electro negative areas.

The corrosion of iron by atmospheric influences presents an important difference to the case of the action of acids, for the product of corrosion being soluble the salt diffuses away when the metal is at rest, or is removed as fast as it is formed when the metal is washed by a moving solution, whereas the rust remains on the metal and creates with the iron a galvanic couple. When once a speck of rust is formed at a centre of infection the corruption continues with increasing rapidity, and is aided by the increasing bulk of the rust, which will help to retain the electrolyte.

For reasons of an electro-chemical kind that are now fairly well understood solutions of soda and potash and the carbonates of these metals, and in a less degree solutions of lime, protect iron and steel against corrosion. To this may be added chromic acid and a number of other compounds This fact deserves to be better known. Steel may be preserved from rusting for any length of time when placed in a solution of soda The presence of sulphur dioxide from the burning of coal and coal-gas may altogether change the nature of the decay of iron. The sulphur dioxide is readily oxidised in the presence of moisture to sulphuric acid, which will dissolve iron to form ferrous sulphate. This latter will then be oxidised to a basic

* *The Electrician*, 533, March 6. 1891.

eric sulphate, which is an insoluble brown substance. Reference is made to some of the recent work which supports the galvanic theory of corrosion. The seventh report of the Alloys Research Committee dealing with steels containing nickel and manganese confirms the views of the importance of structure in determining corrosion. It was found that alloys containing pearlite were the most readily attacked, with polyhedral the least attacked, whilst those with martensite were intermediate in their corrodibility. This is explained by the P.D.s set up in the complex structure of the pearlite, whereas the polyhedral materials are more homogeneous and less liable to attack. It was also found that as the percentage of nickel was increased the alloy was less corrodible. According to Dumas nickel steels present the most perfect examples of solid solutions, no segregation having been detected by the microscope.

Generally, it may be said that the main constituents of steel can be classified into electro-positive and electro-negative groups, and the distinction can be revealed by the use of etching reagents. With reference to wrought iron, all experiments confirm that the finer its quality and the more perfectly uniform its texture the slower and the more regular is its corrosion.

The Corrosion of Lead.—Lead is a very durable metal, as far as atmospheric corrosion is concerned, but its liability to corrode by the action of the salts in soil, plaster, ashes and refuse, &c., presents problems to the electrical engineer which cannot be lightly regarded. It is chiefly with the smaller sizes of lead-covered cables that the trouble is noticeable. The whole subject has already been brought under the notice of the Institution by Atkinson and Beaver. Lead being electro-positive to copper and brass the contact of the two must be avoided. The same applies when the copper is tinned. The use of solder always introduces risks if a suitable electrolyte is present, hence the wisdom of the electrical instrument maker in forbidding the use of soldering fluids which contain metallic salts. On the other hand, lead is electro-negative to iron, and should not be used for fixing iron in stonework. These facts are well known, but they are disregarded only too frequently.

The Corrosion of Aluminium.—The immunity that aluminium has from corrosive attack by the atmosphere is largely due to the remarkable film of oxide that is present on its surface and gives it some of the properties of a noble metal. The film when intact makes the metal more electro-negative than it should be, and renders, owing to the ease of its formation, it difficult to rightly place the metal in the electromotive series. A more durable film can be formed electrolytically by making the metal an anode in phosphate solutions. Aluminium protected in this way is better able to stand the action of hydrochloric acid. In spite of the protective film, aluminium remains electro-positive to iron and copper, hence its contact with these metals must be avoided.* Since it is difficult to solder aluminium, if a mechanical joint is made it is necessary that it should be also of aluminium, otherwise a detrimental electrolytic action may be expected.

When aluminium is in industrial use its decay may be slow or rapid, according to the purity of the metal. This has, unfortunately, been disregarded in a number of tests, and has led to the unjust condemnation of the metal. I have not been able to get much real information on the durability of bare aluminium transmission lines. J. B. C. Kershaw found that the samples tested by him were not suitable for overhead work near the coast. When light aluminium alloys are used the presence of copper (say 2 per cent.) is injurious to the life of the wire.

Aluminium paint is coming largely into use. As it will stand a high temperature it is useful for radiators, &c. The main matter of importance is that the iron should be well cleaned before the paint is applied. The oxide film being of an insulating character, aluminium wire without any other covering may be used for winding coils.† The film action gives us the rectifier, the condenser, the controller and the lightning protector. In the use of aluminium for the building of boats it is essential that only metal which has become homogeneous by means of a series of re-meltings should be used. It is still more important to avoid the contact of other metals. The eighth report of the Alloys Research Committee of the Institution of Mechanical Engineers shows that rich copper aluminium alloys do not corrode when in conjunction with mild steel in sea water. This I have confirmed.

(*To be continued.*)

New Resistance Material. According to the *Rundschau für Elektrotechnik und Maschinenbau*, Mr. A. L. Marsh has just patented a new material, to be used in the manufacture of resistance coils. It is composed of 88 parts of nickel, 8 of chromium and 1 of aluminium. The addition of aluminium doubles the resistance and causes the alloy to oxidise superficially. The substance thus formed has a resistance 50 times that of copper.

* W. M. Morrison, *The Electrician*, 339, December 27, 1901.
† *The Electrician*, 237, November 30, 1906.

TWENTY-FIVE YEARS OF THE ALLGEMEINE ELEKTRICITÄTS-GESELLSCHAFT.

A glance back over the history of 25 years is always interesting and provides food for much philosophical and not unprofitable reflection. The changes that have taken place in the welfare of the people at large are discovered by the searcher, and the developments of those comforts which so help our present civilised life are in themselves an interesting study. The slow march of the world towards some sort of Utopia is indicated when we examine such a period, though a yearly consideration often seems to point to a stationary state or even a retrograde movement. As regards the history of electrical engineering, the last 25 years have been remarkable for the development which has taken place. In 1883 its industrial utility was small, while in 1908 its claims to a place in our civilised economy are fully recognised, and its employment in the manufactures and for domestic purposes is not only assured, but is increasing by leaps and bounds.

Among the firms founded in those pioneer times, 25 years ago, was the one now so well known by the title of the Allgemeine Elektricitäts Gesellschaft. To celebrate its 25th birthday a record of its development has been issued in the form of an album containing views of the present works at Berlin, together with a history of their growth, and notes on the plant, apparatus and material which they are turning out in ever-increasing quantities.

The history of the firm begins with the Paris Exhibition of 1881. The electrical work there shown, and especially the incandescent lamp, led to Edison's German rights being taken over by Herr Emil Rathenau. After certain preliminaries, a company was formed on April 19, 1883, under the title of the Deutsche Edison Gesellschaft für angewandte Elektrizität. Central station work was soon undertaken, the Berlin electricity works, opened in 1885, being entirely equipped by this firm. The increasing development of this branch, combined with certain troubles regarding glow lamp patents, led to an increase in capital. Larger work could then be more successfully carried out, and in 1887 the name of the company was changed to that by which it is at present known.

The application of electricity to traction purposes was not neglected, experiments being made on the municipal tramways at Halle as far back as 1888. The firm also acquired a controlling interest in the Deutsche Lokal- und Strassen-Bahn-Gesellschaft, which led to many routes of like nature being converted to electric traction. The water-power of the Rhine opened out the possibilities of electricity for chemical works, and a subsidiary company, formed for the manufacture of aluminium, was established at Neuhausen in 1890. New works for the production of cables and insulating materials were also erected and improvements in the manufacture of glow lamps instituted.

The use of the three-phase system in industrial work forms a turning point in electrical history, and with it is bound up the name of Dolivo-Dobrowolsky and the transmission of power from Lauffen to Frankfort. The year 1894 saw the opening of the Rheinfelden works operated by this system, which has now become so universal where long distances are traversed.

It is impossible in the space at our disposal to do more than briefly note the more important developments in the history of the A.E.G. The volume under notice deals with the subject exhaustively and is well worth a detailed study. From the earliest days in 1883 until the present time the improvements which have been effected in electrical working are reflected in its history. The manufacture of all material connected with electrical work has been undertaken, and its scope now includes electrochemical products, such as calcium carbide, steam turbines of the Curtis type, metallic filament and mercury vapour lamps, and many other articles which are daily required by the electrical engineer. Although the primary object of such a firm is necessarily its own good, it cannot but exert a salutary influence on the progress of the electrical industry. The brains of its engineers, though in the first case devoted to the furtherance of their company's interests, are also exerted for the good of the entire community, and the facilities which such an undertaking can command are ultimately beneficial to engineering in general.

The second part of the volume is devoted to a detailed description of the modern works of the company. The scope of these works is well indicated, for the first section deals with the manufacture of incandescent and Nernst lamps, and the last with the erection of automobiles. The pages are illustrated by excellent heliogravures, and here it may be well to mention that the whole "get up," in both printing and general arrangement reflects the highest credit on the printers and binders.

As mentioned above, glow lamps were among the first articles manufactured by the firm. Great extensions of this part of the works have from time to time been necessary, while within its walls the exhaustive experiments culminating in the commercial form of Nernst lamp were conducted. The general arrangement of these works, and indeed of all those controlled by the firm, reflect the Teutonic love of order and the endeavour to reduce all operations to a workable system.

In the "Apparatus Factory" such articles as arc lamps, measuring instruments and heating apparatus are made. Starting on a small scale in 1888, it has gradually been extended, and is now a good example of modern factory arrangement. All the workrooms are lofty and well lighted, while the comfort of the staff and workpeople is considered throughout.

The next section deals with the manufacture of dynamos and motors, for which the firm is justly celebrated. Its tale is told by the photographs. Illustrations are given of the "flywheely" type of machine suitable for coupling to a reciprocating engine, and of the more compact design adapted to the steam turbine. In this section electric locomotives are manufactured, and a photograph of the erecting shops shows a variety of types, from that suitable for main line work to that adapted for underground mining operations.

Within the last few years the firm has turned its attention to the building of turbines. The Curtis patents were acquired and works for this purpose were opened in 1904. The steamer "Kaiser" was fitted with this type of turbine, and naturally the advantages obtained by their use in electrical work have not been overlooked.

The most striking feature of the cable section is a photograph showing the foundry. This may be justly called excellent, and in the midst of a number of other good examples of the photographer's art it is easily first. The history of the electric cable, from the wire-drawing stage to the finished product, is shown by the photographs, which clearly indicate the various operations necessary for this result.

The last section deals with the manufacture of motor cars, and is, in general, a repetition of its forerunners The complete history of electrical engineering has yet to be written, but until this monumental task is completed the present volume will be a not unworthy substitute. It provides pleasant reading for those interested in the development of a great industrial concern.

A NEW ARC-LAMP COUPLING.

In the ordinary types of arc-lamp couplings fitted with strain release it is essential that the user should hoist the lamp as far as possible and then lower back slightly on the winch, thus bringing a locking gear into action and releasing the strain from the suspension rope. To subsequently lower the lamp it must again be hoisted higher than when originally locking same, in order to release the locking catches, and it can then be lowered down. To ensure safety and ease in working it is essential that these upward and downward movements of the lamp should be definitely limited by stops in the coupling, so that the locking and release of the lamp does not depend on the skill or trustworthiness of the trimmer.

In arc-lamp couplings which do not comply with these requirements, and which have no definite stop, the lamp trimmer hoists the lamp to as far as he thinks necessary, and then lowers slightly to test whether the lamp is locked, and the strain, therefore, on the hoisting rope released. Frequently several attempts are necessary before he is able to securely lock the lamp, and thus there is a great loss of time and the ever-present possibility that, in hoisting the lamp too high, the locking device has been set to the unlocking position, and therefore the lamp is free to fall.

The Union Electric Co. (Ltd.) have now introduced a new arc-lamp coupling with strain release, in which all the movements requisite to lock or release the lamp are definitely limited by fixed stops. The lamp trimmer, therefore, hoists the lamp until he feels that he is against a stop, then lowers the lamp slightly, and the lamp is securely locked, and the strain on the suspension rope released. To lower the lamp he again hoists until he feels the stop and then lowers. There is absolutely no trial by the trimmer whether the lock has come into action or not, and, therefore, a great saving in time and also greater safety.

In the new coupling the lock ng action is controlled by metal balls which are used in sets of two, one forming the top, and the other the bottom stop, and the mechanism can be supplied either simply as a strain release, or as a combined arc-lamp coupling with strain release, in which case the circuit contacts are made with massive pins.

The general appearance of the combined coupling and strain release is shown in Fig. 1, whilst Fig. 2 shows same with the enclosing cover removed and the locking bolt lowered. By comparing with Figs. 3 and 4, showing the mechanism supplied simply as a strain release, an idea of the difference in size of the two arrangements can be obtained. The sectional drawings, Fig. 5, show the three steps of locking, strain taken off suspension cord, and lowering the lamp.

The rope clamp *a* in Fig. 5 supports a guide tube fitted with projecting boss, *b*, and a sleeve, *c*, which is free to turn on the guide tube, and carries the two contact pins. On hoisting the lamp, the boss *b* enters tube *d*, which is attached to the lamp bracket or other fixture. This tube is fitted with two longitudinal slots surrounded by a sleeve, *e*, which is free to move, and takes a bearing on screw *f*. In this sleeve on each side are two depressions, e_1 and e_2, which allow entry of balls *g* and *h* from the longitudinal slots of tube *d*. On hoisting up the lamp (Pos. 1), the boss *b* enters tube *d* and pushes the lower set of balls, *g*, into the depressions e_1, thus pushing the balls *h* upwards, so that the boss *b*, having passed balls *g*, meets balls *h*. which thus form a fixed top (Pos. 2). If the winch is now turned backwards, then boss *b* rests on balls *g*, and the hoisting rope is no longer under strain. Balls *h* also fall back into the depressions e_1. During these movements the contact pins for the circuit have entered the corresponding bushes: to ensure correct polarity, tube *d* is suitably pointed and slotted, and a guide pin, *i*, on the lower sleeve *c* engages therewith. To release the lamp, the winch is again wound upwards, thus raising boss *b* and with it sleeve *e* until this releases the fixed arm *k* (Pos. 3); owing to this

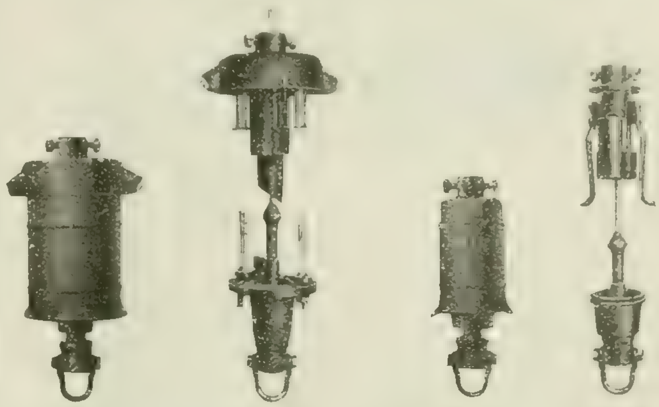

Fig. 1. Fig. 2. Fig. 3. Fig. 4.
Combined Coupling and Strain Release. Strain Release.

movement of sleeve *e* both parts of balls drop into the lower depressions e_2. In this position the sleeve is held by the friction of the circuit contacts, until, on lowering by the winch, the boss *b* passing the two balls, bears on the guide sleeve of pin *i*, thus bringing the weight of the lamp into action to withdraw the contact pins from the bushes, sleeve *e* then falls down to its original position.

The strain release without arc lamp coupling is of practically the same construction as the above, but the friction necessary to retain the ball sleeve in its top position is in this instance produced by two flat springs acting on sleeve *c*.

The main advantages claimed for this new type of coupling and strain release are that all movements which are in any way con-

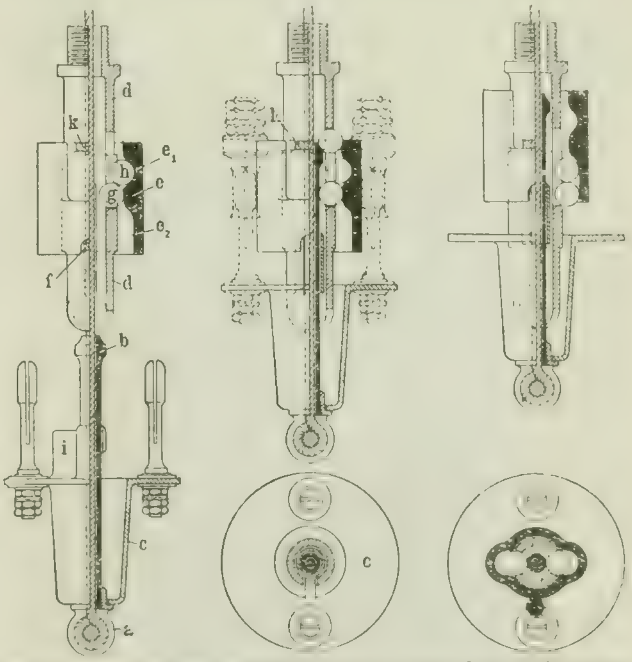

Fig. 5. Sections of Combined Coupling and Strain Release, showing its Operation.

trolled by the action of the winch are definitely limited by fixed stops, and also the use of locking balls whose movement is restricted to a definite path but uncontrolled by any mechanical connections. The whole mechanism is without joints or pins which might lead to sticking and consequent failure. If at any time it is necessary to take it apart, only one screw, *f*, has to be withdrawn to release every part of the mechanism. All parts carrying current are insulated throughout with mica and porcelain, and the whole coupling is enclosed in an enamelled sheet metal cover, rendering it perfectly rainproof, whilst the sleeve *c* fitting tight against the cover prevents dust entering into the coupling.

HIGH TENSION FUSES.

The distribution of electrical energy at high voltages is still largely dependent on fuses as circuit-protecting devices The oil circuit-breaker has not yet entered seriously into competition with the fuse for sub station and switch-pillar use, but it has created an element of safety to the operator which in many fuses has been deplorably absent. High-tension fuses have mostly laboured under the disadvantage of being unsuitable for front cable connections owing to the danger of exposed contacts and cable terminals. With a view to obviate this difficulty, Mr. A. H. Seabrook, engineer and

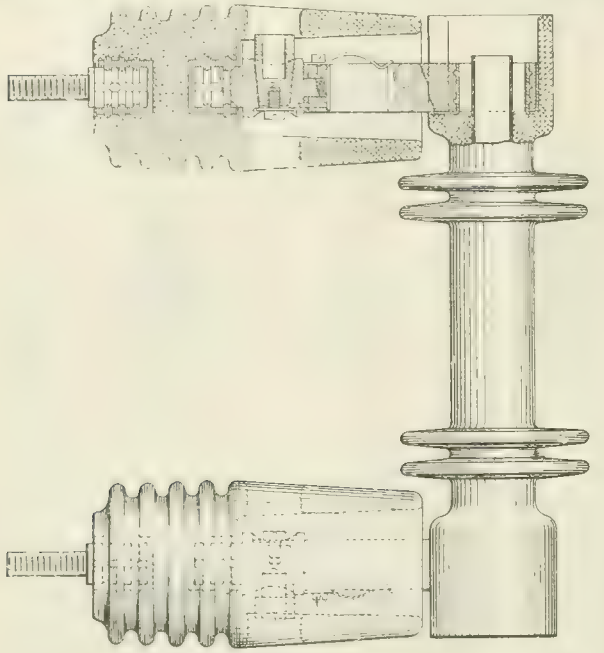

Fig. 1.—Front-connected 100 A. 6,000 v. Protected Fuse. (¼ full size.)

manager of the West Ham electricity department, has introduced a special form of fuse contact, which may be employed for wall or panel surface work with front cable terminals, which is absolutely safe from the normal operating standpoint. The sectional drawing in Fig. 1 shows this contact in detail, and it will be noticed that the terminal block, cable socket and clip contact are all recessed in porcelain. By nothing short of deliberate tampering with the

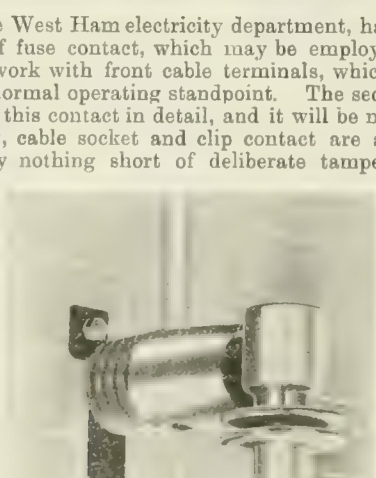

Fig. 2.—View of Fuse Fixed to a Wall.

terminals could an attendant receive a shock. The method of mounting the contacts and supporting screws in the porcelain insulator is also illustrated. Fig. 2 depicts the complete device as mounted on supporting base and bolted to a wall. This fuse is made by Messrs. A. Reyrolle & Co., Hebburn-on-Tyne.

MARCONI'S WIRELESS TELEGRAPH CO. (LTD.)

The directors of this company have now issued their report for the period to September 30, 1907. Regret is expressed at the delay in publishing the report, which delay was due, firstly, to the complex and delicate situation in which the company found itself when H.M. Government indicated an intention to ratify the conclusions of the Berlin Conference, and when other Governments were considering how far they should go in assenting to the principle of intercommunication. Secondly, the directors felt that they ought, if possible, to come before the shareholders with a definite announcement as to the achievement of the anticipated transatlantic service, the establishment of which had been repeatedly postponed owing largely to the delay in obtaining delivery of the necessary material. The transatlantic service having been established last October, the board considered it advisable practically to demonstrate its stability and possibilities by testing it in actual operation. The results after six months' continuous working are satisfactory and encouraging, and justify the confidence with which the directors have throughout regarded the feasibility of direct wireless communication with America. These and many other developments have been attained with a capital issue of about 384,190 shares, with the profits which have been allocated to capital account, and by financial engagements amounting in all to £94,263. 15s. 6d. at Sept. 30th last.

The credit side of the balance sheet shows share interests in the subsidiary enterprises of the nominal value of £2,394,106. 10s., which are, together with the patents, set out in the balance sheet at only £242,966. 9s. 10d. It is not possible at present to make a precise valuation of these assets, but the company's holdings represent more than 50 per cent. of the whole issued capital of those companies. These items include practically the whole of the £200,000 share capital of the Marconi International Marine Communication Co., representing the Marconi wireless exchange of messages at sea. By the completion of the arrangements now being made by the board dealing with the transatlantic service, there should be an early accession of income to several of these subsidiary companies with resultant profits, in which Marconi's Wireless Co. will largely share. When the patents were originally acquired, in 1897, communications could only be sent a distance of two miles, but as the result of the work on development since that date [a period of ten years], communications are now able to be sent 2,500 miles. In all, the company owns over 550 patents. The more recent patents are (the report continues) of great value, inasmuch as they cover for many years important improvements relating to new transmitters and receivers, which secure increased speed and improved syntonisation. On the patents are based the licences which are held by H.M. Government Lloyd's and the associated wireless companies. The British Admiralty are paying £5,000 per annum, for a term of years, for the right of using the company's system.

Transatlantic Communication.—The long distance station at Clifden, in Connemara, communicating with the long distance station at Glace Bay in Nova Scotia, was in October 1907, so far completed as to admit of its being opened for a limited press service, and in Feb., 1908, the stations were opened to the public for the transmission of messages between London and Montreal at an inclusive rate of 7½d. per word. A considerable amount of business has already been transacted by means of these stations, and this business is daily increasing. One newspaper in New York stated that it had during five months received despatches, totalling 68,404 words, "promptly and efficiently transmitted by the Marconi system." These stations will be able to cope with a much larger volume of messages when the necessary enlargement and duplication of machinery have been carried out. It is intended to bring up to the same level of efficiency as the Irish-Canadian stations the two long distance stations at Poldhu in England and Cape Cod in the United States, and when this has been accomplished there will be two pairs of Marconi high power stations engaged in the transatlantic service.

The shareholders are referred to the recent statements of Mr. Marconi at the Royal Institution, and at the Liverpool Chamber of Commerce,* for a full account of the successive stages passed before the stations were opened for a commercial service. With the duplication of the power plant, and the establishment of land line connections similar to those enjoyed by the cable companies, the company will (it is stated) be able to provide for the public a speedy and thoroughly efficient direct wireless service with America. The company has an agreement with the British Post Office, whereby the latter engages to grant the same facilities for the collection and delivery of messages by the Marconi transatlantic system as those afforded to the cable companies. A similar agreement has been entered into between the Dominion Government and their Canadian Company. Up to the present the service has been conducted at speeds varying up to 20 words a minute, but with a comparatively inexpensive modification of certain parts of the existing apparatus, it is expected to attain a speed of 30 words a minute. On the basis of the improved Irish-Canadian service, and of the contemplated English-American service, working the four stations at 12 hours a day at an average net wireless rate of 4d. per word, and at a speed of 20 words a minute, a net revenue (after deducting working expenses) approaching £150,000 per annum is capable of being earned by these four stations.

* These lectures have been reprinted in *The Electrician.*—Ed.

Following is the complete set of accounts issued by the Company:—

MARCONI'S WIRELESS TELEGRAPH COMPANY, LIMITED.

[illegible]		77,373 9 11
[illegible]		4,130 3 2
[illegible]		[illegible] 7
[illegible]		[illegible] 5
By [illegible] Shares and Debentures in Associated Companies:—		
[illegible] fully paid Shares of £1 each of The Marconi International Marine Communication Company, Limited	[illegible] 0 0	
50 Seven per cent. First Mortgage Debentures of £500 each of The Marconi International Marine Communication Company, Limited	25,000 0 0	
841,021 fully paid Shares of \$5 each Series "A" of Cia Marconi de Telegrafia sin hilos del Rio de la Plata (Argentine Company)	841,021 0 0	
88,250 Shares of \$5 each (25 per cent. paid) Series "B" of Cia Marconi de Telegrafia sin hilos del Rio de la Plata (Argentine Company)	22,062 10 0	[illegible]
[illegible] fully paid Shares of \$100 each of The Marconi Wireless Telegraph Company of America	[illegible] 0 0	
615,105 fully paid Shares of \$5 each of The Marconi Wireless Telegraph Company of Canada, Limited	615,105 0 0	
Sundry Shares ...	1,190 0 0	
Total Par Value	£[illegible]	
		£[illegible]

[illegible] ... have been ... to ascertain the ... has been ... Development ... Shares ... purchases of shares ... Shares in these ... Montreal, New York and Buenos Ayres. With regard to the shares held at ... at the Company's disposal unencumbered with regard to the shares held at New York we have seen a letter from the S[illegible] there stating that [illegible] their possession on behalf of the Company, and with regard to the shares held at Buenos Ayres we ... Argentine Company and a letter stating that the shares were held by them ... on behalf of the Company ... holds nearly the whole of the ... capital of The Marconi International Marine Communication Company ... to these remarks, in our opinion such Balance Sheet is properly drawn up so as to exhibit a true and correct view of the state of the Company's affairs as shown by the books of the Company.

COOPER BROTHERS & CO., Chartered Accountants, Auditors.

London,
April 15th, 1908.

In addition to the total earnings of the long distance stations at Poldhu and Clifden, the greater proportion of the profits derived from the corresponding stations at Cape Cod and Glace Bay will also pass to the company in the form of dividends, the company holding the majority of the stock in the American and Canadian Companies.

Maritime Business.—The report states that the maritime service is progressing most satisfactorily, the North Atlantic being covered by a network of wireless intercommunication. The number of steamers using the Marconi international organisation of ship and shore stations has increased from 80 in 1905 to 118 in 1907, warships being excluded from these totals. The number of words transmitted and received were 1,868,540 against 1,354,549 in 1906, and 643,534 in 1905. The net receipts by the Marconi International Marine Communication Co. and its associated companies from this source were £37,935. 13s. 7d., against £27,500. 16s. in 1906, and £13,065. 16s. 4d. in 1905. The Marconi companies are the only organisations carrying on an international telegraph business of this kind at sea and the same rate of progress has been maintained during the current year. On the establishment of this organisation large sums of money have been spent by the Marconi Wireless Companies, and no efforts have been spared to obtain an equally satisfactory and reliable service on ships of all nations. The Poldhu station has been supplying a daily press service to such of the Atlantic liners as are fitted with the Company's long distance apparatus. The receipts of the Poldhu station during the last two years amounted to over £9,000.

Intercommunication.—On the establishment of the above organisation the exepnditure was necessarily large, and it has been productive of most promising results, but the very success of the company's efforts in this direction has led to foreign intervention. The directors have been carefully considering the course the company should adopt in view of the ratification of the Berlin Wireless Telegraph Convention, and the directors now take the view that it would be wise for the company's business interests to consider how it may best be found practicable to modify the policy hitherto pursued by the board, and they believe that with mutual goodwill and regard to respective interests, arrangements may be arrived at not only satisfactory to the Governments concerned but also remunerative to the Marconi companies, who have invested so large an amount of capital in the establishment of the present wireless organisation.

Manufacture of Apparatus.—The Company owns a fully equipped factory adequate to cope with the expanding demand for instruments and installations. Over 500 wireless stations have already been equipped by the company, and the number is constantly being added to. Considerable orders are received each year from the British Admiralty and foreign governments for wireless telegraph apparatus and accessories. The Marconi system is also in use for naval and military purposes in Italy, Russia, Belgium, Chili, Brazil, China and Siam. This branch of the business is expected to lead to large and profitable demands for manufactured apparatus.

Foreign Countries.—With regard to the *Marconi Wireless Telegraph Co., of America*, the long distance station at Cape Cod has been supplying a daily news service to ships fitted with long distance receiving apparatus, and the four shore stations at Seagate, Sagaponack, Siasconsett and South Wellfleet on the American seaboard have contributed their quota to the wireless exchange. The action in respect of Mr. Marconi's magnetic detector patent has been decided in the company's favour. The *Marconi Wireless Telegraph Co., of Canada* has erected the transatlantic station at Glace Bay which corresponds with the station at Clifden, and for communication with ships further stations have been completed at Cape Bear, Prince Edward Island, Quebec, Grosse Isle and North Sydney, and there are now altogether 20 Marconi stations on the Canadian shores and the St. Lawrence River. Contracts have been made with the Government of *Newfoundland* for wireless stations, and five stations are working on the Labrador coast. One of these contracts secures to the company exclusive rights for wireless telegraphy in Newfoundland. During the period under review a company has been formed at Buenos Ayres and is now commencing to instal wireless telegraph stations with a view to extending the operations of the wireless exchange to *South America*. It is the intention of the Argentine company to erect a long distance station to communicate with the long distance station now being erected by the Italian Government under the supervision of Mr. Marconi, at Coltano, in Italy. In other parts of the South American Continent the Marconi system is gradually being adopted. The directors of the parent company are considering proposals of the *Cie de Télégraphie sans Fil, of Brussels*, to increase their capital by the admission of other international elements and to work a further portion of the continental business. In *France* the company's interests are represented by the Cie Française Maritime et Coloniale de Télégraphie sans Fil, which is earning profits and paying a dividend. In *Italy* there are 22 Marconi stations which are available for communication with ships fitted with our instruments, and 14 vessels of the Italian mercantile marine have already been installed with Marconi instruments. The long-distance station at Coltano is being erected by the Italian Government under the supervision of Mr. Marconi, for transoceanic communication with the other long distance Marconi stations This company is much indebted to the Italian Government for their far-sighted and cordial support.

Lloyds.—During the period under review Marconi apparatus has been installed at Lloyd's stations at the Butt of Lewis and the Flannan Islands. The company's relations with Lloyd's Corporation are of a friendly character.

The Admiralty.—The Marconi system of wireless telegraphy is in use throughout the British Navy, and at British naval stations in the

United Kingdom and abroad. Under the terms of its agreement with the company, the Admiralty continues to utilise the company's high power stations for communication with the ships of the fleet, whether in home waters, in the Atlantic, or in the Mediterranean, within a radius of 2,000 miles.

Trinity House and Board of Trade.—Six of the Trinity House lightships, viz., the "Sunk," "Gull," "South Goodwin," "Tongue," "Cross Sand," and "East Goodwin," are now fitted with Marconi apparatus. This business is capable of considerable development.

Increase of Capital.—The directors have decided to ask the shareholders to approve a resolution to be proposed at an extraordinary general meeting to be held immediately after the annual meeting to increase the capital to £750,000, by the creation of 250,000 preference shares of £1 each, conferring the right to a fixed cumulative preferential dividend (in priority to all other shares) at the rate of 7 per cent. per annum on the capital for the time being paid up on such preference shares, and also, subject to the payment of a non-cumulative dividend of 10 per cent. per annum on the paid up ordinary share capital, the right to participate pari passu in proportion to the capital paid up with the ordinary shares in any profits not required for the payment of such preferential dividend, and of a non-cumulative dividend of 10 per cent. per annum on the ordinary shares which it shall from time to time be determined to distribute, and the right in a winding-up to rank in priority to all other shares for the repayment of capital and pari passu with all other shares in any excess after repayment of capital paid up thereon. The proceeds of the new issue will serve to pay off the company's engagements to bankers and others, and to provide capital for carrying on and extending the business to complete the long distance stations, to provide these with the necessary land line facilities, and to enable the Company to deal with the orders already received and likely to be obtained.

Mr. H. Cuthbert Hall.—In March last the directors made an agreement with Mr. H. Cuthbert Hall that he should relinquish the position of managing director and his suggested present and future claims for commission in consideration of a payment in cash and of the allotment to him of 10,000 fully-paid-up shares in the company. Mr. H. Cuthbert Hall has since retired from the Board.

MUNICIPAL, FOREIGN & GENERAL NOTES.

APPOINTMENTS VACANT AND FILLED.

An electrical engineer, with some commercial training, is required to travel abroad, principally in France. See an advertisement.

Applications are invited for the chair of Civil Engineering at the University of Liverpool, which has recently been established in the Faculty of Engineering. Particulars from the Registrar, to whom applications, with 12 copies of testimonials and references, should be sent before May 15.

Sydney (N.S.W.) City Council have appointed Mr. Woof, who is superintending the work of overhauling the generating plant on behalf of Dick, Kerr & Co., as power-house superintendent at £400, rising to £500 per annum.

Mr. A. K. Taylor, electrical inspector for Bengal Presidency, has been appointed executive engineer of the Electrical Public Works Division, Calcutta, recently formed by the Government.

Mr. Cameron, assistant electrical engineer to Northampton Corporation electric tramways, has been appointed chief engineer in succession to Mr. J. McMahon, at a salary of £150, rising by annual increments of £10 to £180 per annum.

The following have been appointed to the vacant junior assistantships in the National Physical Laboratory: Mr. J. R. Pannell, who holds the diploma in engineering of the Northampton Polytechnic Institute and the diploma in electrical engineering of the City and Guilds Institute; Mr. A. Kinnes, B.Sc. in engineering (St. Andrews) and holder of diploma in electrical engineering of the City and Guilds Institute; and Mr. H. C. Booth, A.R.C.Sc., assistant demonstrator in physics at the Royal College of Science, previously assistant demonstrator in engineering.

Aberdare.—The Council have decided to engage an electrical engineer to report upon the question of electricity supply.

Aberdeen.—The Tramways committee offer to contribute £70 annually (instead of £140) towards the salary of the city electrical engineer.

Abertillery.—The Council have received a communication from the L.G. Board stating that the Board are not satisfied, upon the information before them, that the establishment of electricity works would be successful from a financial point of view. The revenue from private lighting was estimated at 6s. per 8 c.p. lamp per annum, but as the area to be supplied was composed almost entirely of houses of very low ratable value, the Board thought that an average revenue of 4s. per 8 c.p. lamp would be a safer estimate, and, therefore, there would be a net annual deficiency of between £300 and £400.

The Council decided to ask the L.G. Board to receive a deputation with a view to inducing them to reconsider their attitude towards the scheme, and also to ascertain whether, in the event of the Council adopting a scheme for the lighting of the southern portion of their district by gas, the Board would protect the Council from competition by an electric lighting company.

Acton.—Sir Alex. Kennedy has been asked by the Council to prepare a report on the present position of the electricity undertaking.

Barrow-in-Furness.—The L.G. Board have sanctioned the borrowing of the following sums: £3,233 for mains and services, £767 for meters and for excess expenditure, and £1,000 for public lighting, instruments and sundry works at generating station.

The Town Clerk has been instructed to protest against the period of five years allowed for the repayment of the loan of £767.

Extensions of mains, estimated to cost £309, have been authorised.

Beckenham.—The Education committee have decided to wire the Alexandra schools and cookery and manual training centres.

Birmingham-Perry Bar Tramway Service.—Through running from Birmingham to Perry Bar has been arranged on the following conditions:—

Birmingham Tramways committee to receive 1d., and the British Electric Traction Co. (who have powers over the Aston portion of the line) and Handsworth Council to receive 1½d. between them in equal shares, the fare being 2½d. Handsworth Council is to purchase the Villa-road line for about £1,850, the purchase to be completed and the Council to electrify the Villa-road line up to Soho-road. The B.E.T. Co. undertake to run cars through up to Soho-road and to make a new 1d. stage from Six Ways, Aston, to the end of Villa-road, Handsworth to receive in respect of this 0·34d. and the B.E.T. Co. 0·66d.

Bispham.—The Council's application for a provisional electric lighting order has been granted.

Blackpool.—An inquiry was held here last week into the application of the Corporation for sanction to borrow £5,000 for extensions of the electricity undertaking.

The town clerk (Mr. T. Loftos) said there were now 1,250 consumers, and the total expenditure was £200,000.

The borough electrical engineer (Mr. Chas. Furness) stated that the average capital expenditure per kilowatt installed in this country was £75, whilst at Blackpool it was only £48. In 1903 the net profit was £2,352, £6,120 in 1905 and £8,229 in 1907. It was proposed to put down a high-tension cable at South Shore to meet the demand in that neighbourhood.

The annual report of the tramways undertaking for the year ended March 31 states that 168,212 fewer passengers were carried than in the previous year and 15,567 fewer car miles run. The income was £53,740, against £56,586 in 1907, and the disposable balance, after paying all expenses, was £6,410, against £10,042.

Bournemouth.—The new electric lift erected by the Corporation on the east cliff was officially started by Lady Meyrick on 15th inst. It has been very busy during the Easter holidays, and seems to be generally much appreciated.

Brighton.—After a lengthy debate the Council adopted on Thursday last the scale of charges for electric lighting and power set out in our last issue.

Coding of Telegrams.—The holding of an International Telegraph Conference is usually the occasion for the discussion in commercial circles of questions affecting "codes" and code telegrams. There will be an International Conference at Lisbon next month, and the subject of telegraphic code vocabularies is, as will be seen from the following interesting letter, to be mentioned. It is generally agreed that the London Conference of 1903 went to extremes on this question, and that much trouble has been caused to the telegraph administrations owing to the liberty allowed to code compilers under the "pronounceability" provision in the Service Regulations. Mr. Babington Smith deals with a subject which has an interest for those engaged in submarine telegraph work:—

CODE TELEGRAMS.

TO THE EDITOR.

Sir,—I am directed by the Postmaster General to inform you that he has given careful consideration to the applications which he has received from the London Chamber of Commerce and various other bodies on the subject of the possible adoption of restrictive regulations with regard to code telegrams by the approaching International Telegraph Conference at Lisbon.

The Postmaster General thinks it scarcely necessary to assure the Chamber that the British delegates at such international conferences are always instructed, so far as is consistent with reasonable regard for the efficient working of the telegraph service, to support such concessions as it may be practicable to make for the benefit of the telegraphing public, and especially of those who are interested in commercial telegrams. Thus, when it became clear that the official vocabulary for code telegrams prepared by the International Telegraph Bureau could not be regarded as adequately serving the requirements of commerce, the British delegates at the London Conference of 1903 secured its rejection; and it was mainly due to their re-

presentations that the Conference, which was inclined to embark on a policy of severe repression, was induced, on the contrary, to show increased liberality to the public, by admitting "pronounceable" artificial words on the footing of code at 10 letters to the word.

When this concession was granted, it was assumed that the privilege of making up codes on this basis would be used in a reasonable manner so that the telegraph service might not unduly suffer, while the public would greatly benefit.

This expectation of the Conference can however, hardly be said to have been fulfilled. Before the new regulations came into force the Post Office found it necessary to issue a circular to the chambers of commerce, as well as to the principal code makers, in Feb., 1904, directing attention to the fact that codes were being compiled of artificial groups, which, in many cases, could hardly be regarded as "pronounceable," and that such words would be difficult to transmit, and would be likely to lead to error.

In many cases code makers have recognised the importance of avoiding combinations which are of doubtful "pronounceability," but in some cases a tendency has been shown to make an unreasonable use of the concession. As an instance of abuse such words as Bujkrocty, Bywrgrocbx, and Liqraqkrcr, may be mentioned—words which appeared in a code recently submitted, and which can hardly be said to be pronounceable.

It will be readily understood that a telegraphist can deal more rapidly and surely with a pronounceable word, which can be grasped and remembered while it is transmitted without a separate effort of attention for each letter, than with an arbitrary combination of letters. Thus greater speed and accuracy is obtained, and there is less need for repetitions and corrections.

The Postmaster General has no intention of supporting any proposal for the withdrawal of the privilege of using codes and artificial words, nor has any such proposal in fact been made. At the same time he thinks it is only reasonable to expect all concerned, the public as well as the code makers, to co-operate in keeping the privilege within reasonable bounds, and in carrying out the spirit of the regulations.

With this object the Postmaster-General thinks it desirable that the condition as to the pronounceability should be somewhat more clearly defined, in order to put some limit for the future to a growing tendency which, if unchecked, cannot fail to produce results highly injurious to the telegraph service generally and therefore to the public and to commerce. There is, however, no intention of adopting other than a wide and even generous interpretation which would cover the great bulk of the codes at present in use.

General Post Office, London, April 16. H. Babington Smith.

Cromer.—A special Electric Lighting committee has been appointed to take charge of the electricity undertaking, which has hitherto been under the control of the Highways committee.

Dundee.—The Electricity committee have decided to acquire two additional sites for sub-stations, one in Lochee and the other in the north end of the city.

East Ham.—The Council have decided to purchase from the North Metropolitan Tramways Co. those portions of the Romford-road lines belonging to the company (exclusive of depot and all rolling stock) within the borough of East Ham at the agreed sum of £8,000

Edinburgh.—The estimates of the Electric Lighting committee for the year ending May 15, 1909, were submitted to the Electric Lighting committee on Tuesday.

The estimated ordinary expenditure for the year is £70,230, against the estimate for the current year of £65,040. Interest and sinking fund are estimated at £56,070, against £50,065. The total estimated expenditure is £126,300, against £121,105. The estimated revenue for 1908-9 is £135,200, against £132,585, leaving a surplus of £9,900, compared with £11,408. The estimated capital expenditure for the coming year is £33,090, principally for alterations and additions at the McDonald Road station.

Electric Railways in Holland.—As stated in our issue for April 10 (p. 1008) a concession has been granted by the Netherlands Government to the Amsterdam & North Holland Electric Tramway Co. to construct and operate a system of electric railways in Holland. The system comprises about 50 km. (about 31 miles) of route running from Amsterdam North through Zaandam to Krommenie, from Zaandyk to Wyk-aan-Zee, and Wormerveer to Purmerend. The Amsterdam & North Holland Co. has entered into a contract with the Holland Development Co., 278, Heerengracht, Amsterdam, to construct the entire system.

Electricity at Devonport Dockyard.—It has now been decided to substitute electric motors for steam-driven machinery in the colour and sail lofts in the South Yard, Devonport. Special branch leads are being taken into the buildings from the main cables. There it a 10 B.H.P. motor on the second floor for driving the heavy machines; and two of 5 and 2½ B.H.P. respectively on the upper floor for driving the colour and carpet sewing machines. The substitution of electricity for steam will greatly conduce to the comfort and convenience of the workpeople, and it is expected that the installation will be in working order by June. Two additional underground extensions of the telephone system of the North Yard are in progress to link up the exchange with the flag captain's and engineering manager's offices respectively,

Exeter. The accounts of the electricity undertaking for the past year show, after paying all working expenses, interest and sinking fund charges, a net profit of over £2,000, which, it is suggested, should be carried to reserve.

The Electricity committee recommend a reduction of 10 per cent. in the price of current for lighting, and it is also proposed to reduce the scale of charges for power, which ranges from 2½d. to 1¾d. per unit.

Finchley.—It is estimated that there will be a net profit of about £100 on the current year's working of the electricity department.

Glasgow.—The Tramways committee recommend that the salary of the tramways manager (Mr. Jas. Dalrymple) be increased by £100 per annum. Mr. Dalrymple has been 27 years in the service of the Corporation, and joined the tramways department in 1894. He was appointed general manager in 1904 at £1,000, and has received no increase since his appointment.

The salaries of each of the following officials have also been increased by £25: Mr. L. Mackinnon, traffic superintendent, present salary £575; Mr. J. Ferguson, chief engineer, present salary £575; and Mr. J. N. Wilson, secretary and treasurer, present salary £325. The salary of Mr. E. T. Goslin, electrical engineer, who entered the service in 1900, and whose present salary is £475, has been increased by £75.

Halesowen.—The Board of Trade have granted a provisiona electric lighting order to Mr. Geo. Balfour.

Hendon.—Hendon Electric Supply Co. are to lay mains to supply the Hampstead Garden suburb with electricity.

India.—"Indian Industries and Power" says His Highness the Gaekwar of Baroda has granted a concession for the construction and working of tramways in the city of Baroda, and a company with a capital of 500,000 rupees has been formed to take over the concession. Rolling stock, rails, &c., have been obtained from the Bombay Electric Supply & Tramways Co. The service is to be worked by horses at the outset, but it is intended to adopt electric traction if the traffic is found to warrant the change. The concession gives power to adopt electric traction.

Inquest.—An adjourned inquest was held at Billinge last week into the death of James Grimshaw, collier, who was killed in the Day Eye Pit of the Bispham Hall Colliery Co., on March 27. The inquest had been adjourned to enable H.M. electrical inspector of factories, Mr. G. Scott Ram, to inspect the pit.

Evidence of identification having been given, medical testimony was adduced to the effect that death was caused by electric shock, but that the condition of the heart and kidneys militated against the man's recovery from the shock.

Mr. H. Woods, electrician, stated that he put in the electric plant for the proprietors of Bispham Hall Colliery. Electricity was generated on the surface for driving machinery below, and the cables were taken down the shaft and along the haulage road. At the place of the accident the haulage road was an average of 6 ft. 5 in. from warrant to roof. The "dip" of the road was about 1 in 5. The cable was suspended on bars which supported the roof, and which were on an average about 4 ft. apart. On the morning following the accident he found a short-circuit on the mains at that particular place. He made an inspection, and came to the conclusion that the short-circuit was sufficient to kill the man, who, he understood, was saturated with water, was standing in the water with his hands on the cable slightly wet, and formed an equally good conductor as the earth. The probability was that the man disturbed the cable, and the fault developed as he caught hold of it. He made an examination every day to ascertain if the cable was all right. The accident happened at 5:30, and at two o'clock the same day witness had made an examination by putting his hand on the cable all round. He did not get any shock, although it was quite possible if the cable had been wrong for him to have had a fatal one. The motor driving the machinery was not running at the time of the accident.

Questioned by Mr. Ram, Witness said that after the accident he found the fuses belonging to the pump intact, but the two fuses in the hut on the surface had blown. Had the motor been running at the time the blowing of the fuses would have stopped it.

Mr. Ram: For the man to have received the shock it shows that the outer conductor of the cable became charged to the full pressure?—Yes, 500 volts If both fuses in the hut had gone together it would have disconnected the cable entirely, and there would have been no pressure. It seemed evident that the negative fuse went first, and that at the time of the accident the positive fuse remained. As a kind of safeguard he had had an earth connection made at the place where the accident happened, but it did not do what they expected of it. There was another earth connection at the generation station. He examined the cabin afterwards to see if there had been any injury, and found several slight indentions which he did not consider dangerous.

Mr. Ram pointed out that according to Mines Regulation 24 if a concentric system was used it was necessary that proper arrangements should be made to reduce the danger from fire or shock to a minimum.

Witness replied that their arrangement as a safeguard was to get as good an earth system as possible.

Mr. W. A. Heyes, electrical engineer, stated that he had inspected a portion of the electrical installation. A fault developed on the armature and the cable which was sufficient to blow the fuses on the

switchboard and, unfortunately, there were double-pole fuses. The negative fuse must have blown first, and the positive fuse remained for a short time after, and that would account for the man receiving a shock sufficient to cause death. If the fuses had blown together the accident could not possibly have happened. The earth connection to the armature and the cable seemed to have broken loose and was making a very poor connection, not sufficient to carry the whole of the current to earth. He put in the first part of the installation five years ago. It was purely concentric, and he only put in single-pole fuses and single-pole switches. He thought a mistake in having double poles.

Mr. RAM: You think a mistake has been made in putting in such fuses and switches in the outer conductor extensions?—I think they have taken the rules too literally this time. They have read the rules to apply to a double-wire system.

Mr. RAM said he had visited the colliery and examined the place where the accident happened. He considered it was quite wrong to have fuses or switches on the outer conductor in such a system as that: in fact, the rules he was acquainted with strictly forbade it. The concentric system was a special system, for which special precautions had to be taken. The rules were specially drafted for the use of electricity in mines, and were supposed to be for people who knew all about electrical work; there were no detailed specifications for people who had not much knowledge of those things. It was presumed that the person who was in charge of that kind of work knew a good deal about it, and he thought that was where the trouble had arisen in this case. Mr. Woods appeared to have been careful in providing a special earth connection in addition to the one at the generating station. But one of the fuses they had put in ought not to have been there. If the earth connection had been in order the accident could not have happened. Mr. Woods was quite right in having the earth connection, but unfortunately he did not make a good connection; it was loose, and did not act. If there had been no fuse at all it would have been quite unnecessary to have another earth connection. There was another important point if they were to have the concentric system in the mine at all, it should be concentric throughout. He did not think there was any question of blame, but he thought it would be an excellent thing if Mr. Heyes went through the plant.

The jury returned a verdict of accidental death, and did not attach any blame to anyone.

Islington (London).—The Special committee appointed last year to consider the position of the electricity undertaking has issued a report.

The Lighting committee was instructed in July last to take into stock the unused material ordered or supplied in connection with the arc lighting extension scheme which the Council had resolved not to proceed with, and amongst the material was a quantity of cable ordered from the British Insulated & Helsby Cables, which had been stored at the company's works at Prescot, awaiting the Council's instructions. The committee, which has now arranged for its delivery, has been in negotiation with the company for the settlement of their claim for storage and hire of the drums. The recognised charge for hire is 1s. per drum per week, and having regard to the fact that there are 72 drums, and that they will be in stock for some time, the committee thought it desirable, in the Council's interest, to arrange for their purchase. The value of the cable at Prescot is £5,676, and the committee has agreed with the company to pay £478 to cover all claims in respect of storage and drum hire, and to include the purchase of the 72 drums referred to.

Middlesex Tramways.—The Lock Bridge, Harrow-road, to Wembley tramway service was inaugurated on Friday last week.

Morley.—The Council have applied for sanction to loans of £7,942 for additional plant and of £5,000 for cable extensions.

Northampton Polytechnic Institute.—A special advanced course of six lectures, followed by practical demonstrations, on wireless telegraphy and telephony, will be given on Monday evenings at 7 p.m., commencing May 4, by Dr. J. Erskine-Murray, M.I.E.E. Particulars from the offices of the Institute, St. John-street, London, E.C., or from the principal, Dr. R. Mullineux Walmsley.

Official Chemical Appointments.—We have received from the Institue of Chemistry of Great Britain and Ireland a copy of the second edition of the "List of Official Chemical Appointments," which contains a list of official appointments held by professional chemists, including professors and teachers of chemistry, in all parts of the British Empire. In preparing the second edition, the scheme adopted in the first, which was published in June, 1906, has been adhered to; the information has been carefully corrected, and considerable additions have been made, including an index of names. The list is arranged in two main divisions: The first contains appointments in Great Britain and Ireland, under the various departments of State, local authorities and public institutions, and the teaching appointments in universities, colleges, technological institutions, medical, agricultural and veterinary colleges, and in public and secondary schools. The second contains professional and teaching appointments in the Empire of India, the Dominion of Canada, the Commonwealth of Australia, the British Colonies and Protectorates, and in Egypt and the Sudan Provinces, together with an appendix giving concise information as to societies and institutions for the advancement of chemical science and of professional chemical interests. Intended primarily for the use of professional chemists and those who contemplate the practice of chemistry as a profession, the publication will be found useful by authorities and others interested in the applications of chemistry to purposes of state and in the promotion of higher education in the science. The list, which has been compiled by Mr. Richard B. Pilcher, registrar and secretary of the Institute of Chemistry, is published at 2s. net, post free 2s. 3d. [Copies can be obtained from "The Electrician" Company.

Paddington (London).—A special meeting of the Council has been held to further consider the question of lighting a portion of Harrow-road. Two tenders were submitted, one by the Metropolitan Electric Supply Co. for the erection and maintenance of 24 flame arc lamps at £13 each (total £312 per annum), and the other by the Gas Co. The tender of the Metropolitan Co. was made on the understanding that the arrangement would be in force for seven years, and the Works committee recommended the acceptance of their offer, but the Council rejected the recommendation.

Poplar (London).—The borough electrical engineer (Mr. John H. Bowden) reports that it is essential that the extensions of the electricity generating plant and mains be completed by the end of October, and in order that there may be no delay the Finance committee has applied to the L.C.C. for a loan not exceeding £24,000.

Redditch.—Sanction has been received to a loan of £1,500 for cable extensions.

Rochester.—The new tramways extending the Rochester system through High-street and Strood were opened for traffic on Thursday last.

Swindon.—The salary of the borough electrical engineer (Mr. A. Dimmack) has been increased by £50 per annum.

Telephony in America.—According to the annual report of President Theodore N. Vail, the total number of telephones in the Bell system of the United States and the Dominion of Canada stood at 3,839,000 at the beginning of 1908, an increase of 768,340 telephone stations over 1907.

On Jan. 1, 1899, there were 465,180 stations in the United States and Canada; the new century opened with 800,880 stations; 3,000,000 were exceeded by the end of 1906 and now the number approaches 4,000,000. The wire mileage now amounts to 8,610,592, of which 1,141,687 miles were added during 1907. More than 30,000 cities, villages and hamlets in the States and Canada are so interconnected that any subscriber can reach any other whether in the next house or 2,000 miles away. The number of employees to take care of the annual business of 5,997,000,000 messages was 88,274. The profits from operation amounted to about £4,700,000. The profits from operation amounted to about £4,700,000. The dividends paid amounted to about £2,000,000. Independently of the statements contained in the books of the companies composing the Bell system a careful appraisal was made by experts for determining the replacement value of the entire plant. No allowance was made for the value of franchises or way leaves not now obtainable. The results of the inquiry, which follows the general lines of one proposed for American railway systems by President Roosevelt, are as follows:—

All obligations of the American Telephone and Telegraph Co., and its associated operating companies in the United States, including capital stock at par, held by the public on Jan. 1, 1908	$554,939,000
Cash on hand, quick receivables, working assets and sundry investments	101,074,000
Balance, capital representing plants	453,865,000
Plants carried on books of the various companies at	492,496,000
Appraised value by engineers (copper at 15 cents)	488,296,000
Outstanding obligations against plant	453,865,000
Appraised value in excess of outstanding obligations	34,431,000
Book value exchange construction only, per exchange station	114
Book value all plant (toll line and exchange) of Bell operating companies in United States (not including long distance) per exchange station	149
Book value all plants in the United States, including long distance, per exchange station	162

The report states that there is no talk now in the United States, nor is there likely to be for generations to come, if ever, of any such momentous step as that which will be taken in Great Britain when the Government assumes the telephone system in 1911. The problem of national or state control of public service corporations privately owned and operated is, however, very much in discussion in North America. The state of New York already has a public utilities commission with power to regulate many of the acts and privileges of corporations engaged in transportation, lighting, telegraph, and other functions. Other states, like Massachusetts, have special commission for the regulation of particular forms of public service. Among corporation managers of the more enlightened type it has come to be seen that while such control may interfere with illegitimate stock jobbing, it in reality safeguards all genuine forms of investment, protecting the stockholders from unjustifiable competition and from demagogic legislation. Mr. Vail states that "there

is no serious objection to public control, provided it is independent, intelligent, considerate, thorough and just recognising, as does the Inter-state Commerce Commission in its report recently issued, that capital is entitled to its fair return, and good management or enterprise to its reward.

Wednesbury. The Council have received sanction to a loan of £8,000 for the purchase of electricity generating plant.

P & O. Batti Wallahs' Society.—A branch of this society has been established in Birmingham, and on the 15th inst. the branch held a smoking concert.

The society, as originally formed, was confined to electrical engineers who had served on P. & O. steamships. The success of the society, however, has induced the members to extend its sphere of influence, and to admit to membership all electrical engineers desirous of joining. Mr. Walter Riggs, president of the society, gave an address, in which he explained the objects of the society. The objects of the society are purely social, the idea being to promote social intercourse amongst those engaged in the electrical profession. The Birmingham branch already numbers about 30 members. Mr J. P. Kemp has been appointed chairman, Mr. P. S. Tasker vice-chairman, Mr. E. Sheppard local hon. sec., and Mr. A. Handley hon. treasurer. A local committee has also been appointed.

TRADE NOTES AND NOTICES.

TENDERS INVITED.

The Electricity committee of *Poplar* (London) Council invite tenders for supply and erection of various switchboards and gear at their electricity works and sub-stations. Drawing and specification from the borough electrical engineer, Mr. J. H. Bowden, Glaucus-street, Bromley-by-Bow, E. Tenders to the town clerk (Mr. Leonard Potts) Council Offices, High-street, Poplar, by noon April 29.

Poplar (London) Council want tenders by noon April 29 for erection of brick, ferro-concrete or corrugated iron sub station at Millwall. Conditions from Borough Electrical Engineer, Glaucus-street, Bromley-by-Bow, E.

Rawtenstall Corporation invite tenders for supply, delivery and erection of steel poles, overhead line equipment and accessories. Tenders to the town clerk (Mr. James Whalley), Municipal Offices, Rawtenstall, by May 4.

Glasgow Corporation invite tenders for supply of (1) main cables, (2) small cables and wires, (3) electricity meters and (4) arc lamp carbons for 12 months from May 31. Tenders to the town clerk (Mr. A. W. Myles) by 27th inst.

London County Council invite tenders for wiring and fitting for electric lighting of the tramway car shed at Mare-street, Hackney. Tenders, upon official forms, to the clerk to the Council (Mr. G. L. Gomme), County Hall, Spring-gardens, S.W., by 11 a.m. May 12.

London County Council want tenders by 11 a.m. May 9 for supply of 175 double-deck roof covered car bodies and maximum traction swing bolster trucks and complete electrical equipments for same. Forms of tender from the Clerk, Spring-gardens, S.W.

West Bromwich Corporation want tenders by noon, May 9, for the installation of modern destructor plant at the electricity works. Particulars from the Borough Engineer and Surveyor, Town Hall, West Bromwich.

Portsmouth Guardians want tenders by noon May 13 for wiring the additional blocks and the maternity ward at the workhouse infirmary. Specification from Messrs. Rake & Cogswell Prudential-buildings, Portsmouth.

Clacton District Council want tenders by noon April 29 for supply of two 25 kw. dynamos. Specifications from the Electrical Engineer.

Tenders are invited for the supply of a new battery at *Rochdale* workhouse. Particulars from the clerk, Mr. R. A. Leach.

The Deputy Postmaster-General, *Sydney*, N.S.W., wants tenders by 2:30 p.m. June 10 for supply of 8 tons h.d. copper wire (400 lb. per mile), 1½ cwt. copper tape binding (20 lb. per mile), 1,300 porcelain insulators, and 2,000 tallow wood crossarms ; and also tenders by 2:30 p.m. Aug. 12 for supply, &c., of branching metallic multiple magneto switchboard. Specifications, &c., from the Commonwealth Offices, 72, Victoria-street, London, S.W.

The Direcion General de Correos y Telegrafos, *Madrid*, require tenders by 1 p.m. May 4 for supply of 80,000 creoseted pine posts.

Tenders will be received until 11 a.m. May 8, at the Town Hall, *Villanubia de los Ojos*, Spain, for the public electric lighting of the town for 20 years.

The Board of Works of the port of *Tarragona*, Spain, require tenders by 5 p.m. May 31 for the provision of electrical energy for lighting and motive power at that port.

Local representation is necessary in each case. Copies of the "Madrid Gazette" for April 8, 9, and 12, which contain the notices inviting tenders, may be seen at 73, Basinghall-street, London, E.C.

TENDERS RECEIVED AND ACCEPTED.

Ilford Council have accepted the tender of the General Electric Co. for a 1,000 kw. steam dynamo (Belliss vertical engine coupled direct to multipolar dynamo), and that of Babcock & Wilcox for a water-tube boiler and accessories.

Barrow-in-Furness Council have accepted the tender of the British Insulated & Helsby Cables for the supply of 15 tons of copper at £59. 10s. per ton, to be delivered in the form of cable of various sizes as required.

Barking Council have accepted the offer of Kaye, Son & Co to supply coal to the electricity works during the ensuing 12 months in such quantities as may be required, at the uniform price of 0·35d. per unit generated.

Croydon Council has accepted the following tenders :—

Babcock & Wilcox, coal and ash conveyor, £1,154 ; Weber Concrete Construction Co., coal and ash bunkers, £631. 14s. ; St. Pancras Ironworks Co, builders' work at electricity works, £205. 17s., and switchboard flooring, £144 ; Cory Bros. & Co., large Welsh coal (for three months) ; J. H. Gilman & Co., large hard steam coal (from May 1 to March 31 next) and small nut coal (for six months).

East Ham Electric Lighting and Tramways committee has accepted the tender of W. R. Reynolds for fixing and supplying the necessary installation (exclusive of lamps) in connection with the hiring of arc lamps by consumers at £2. 17s. 6d. for a two lamp installation, £5. 15s. for a four-lamp installation, and £8. 12s. 6d. for a six-lamp installation.

For the supply of 1,500 tons of Ibstock fine slack coal during the ensuing year to East Ham Council the tender of E. Foster & Co. at 10s. per ton has been accepted. The tenders of Thos. Moy (Ltd.) for 500 tons of yard slack coal at 11s. 6d. per ton, and of M. H. Abbott & Co. for 365 tons at 11s. 6d. per ton have also been accepted.

Portsmouth Council have accepted the tender of McMillan & Co. (representing the Electerisk Bureau, Christiania) for a 200 line telephone switchboard and 10 junction lines at £104 ; and that of Felten & Guilleaume-Lahmeyerwerke for cables at £313. 12s. 11d.

Heston and Isleworth Council have accepted the tender of T. Hiscock at £17 for wiring the local baths. G. Weston & Sons' tender was £17 and E. A. Hellyer & Co.'s £17. 15s.

Malvern Council have accepted the tender of the British Insulated & Helsby Cables for house service and fuse boxes and compound, and that of Siemens Bros. Dynamo Works for meters.

Portsmouth Council have accepted the tender of Taylor & Co. for an electric light installation at the South Parade at £3,480.

Swindon Council have accepted the tender of Bays & Co. for electric cable.

Ravensthorpe Council have accepted the tender of Mr. J. D. Morton for wiring the Council's offices at £26. 17s.

The Postmaster-General's Department, Melbourne, Victoria, has accepted the following tenders :—

India Rubber, Gutta Percha & Telegraph Works Co., single conductor cords, fuses and lead strips, and attachments for Meidinger battery ; British Insulated & Helsby Cables, two conductor cords for metallic circuits ; Lawrence & Hanson, trembling bells, magneto-extension bells and extension switches ; J. Bartram & Son, complete wall-telephone conversers, receiver ear-pieces and fuses and holders ; R. B. Hungerford, indicators and metallic circuit jacks ; J. A. Newton

& Co. Proprietary, insulators, section switches and glow lamps; Davies, Shephard & Co., single cord plugs and screws; Cole Bentley, german-silver springs and brass washers for distributing boards; F. Vandeskelen & Co., g.i. tie wire, office wire and wire for switch boards; Jas. Beardshall, double-weight pulleys; Geo. Sweet, stone ware conduits.

The Postmaster-General's Department, Perth, W. Australia, has accepted the tenders of British Insulated & Helsby Cables, telephone cable; Siemens Bros. & Co., knife switches; Splatt, Wall & Co., accumulators; O. Haes, voltmeter and ammeters; Alfd. Bray, telephone cabinets.

The Postmaster-General's Department, Hobart, Tasmania, has accepted the tenders of British Insulated & Helsby Cables, paper insulated lead-covered cable; Mauri Bros & Thompson, c.i. pipes.

The Allgemeine Electricitats Gesellschaft are supplying high-tension lightning arrester equipment with a horn-type mast switch to the Mount Lyell Mining & Railway Co., a 1,600 H.P. three-phase generator to the Kalgoorlie Power Co., and Tirrell voltage regulators to the Mount Lyell, Golden Horseshoe, and Casillis mines.

Electricity in Steel Works.—The tender of Messrs. Wellman-Seaver & Head has been accepted for the erection of electric generating plant for the New Briton Ferry Steel Co. The Llanelly Steel Co. have also placed a contract for two 200 kw. steam generating sets, switchboard and power station crane with the same company, who have ordered the dynamos from Siemens Bros. Dynamo Works, and the engines from Bellis and Morcom.

BUSINESS NOTICES.

Mr. John J. Inniss, M.I.Mech.E., who has been on a long business tour through China, has opened a branch office in connection with his firm (Messrs. Inniss & Riddle, of Birmingham) at 40, Szechuen-road, Shanghai, where the firm will conduct their Chinese business as consulting electrical and mechanical engineers and machinery and general import merchants.

The central offices of the Kabelfabrik und Drahtindustrie A.-G. has been removed to 4, Stelzhamergasse, Vienna III/2. The telegraphic address remains "Kabel Wien."

N. T. Marquetti & Edmund C. Sparkes, electrical fittings manufacturers, &c., 118 and 120, Wardour-street, London, W., have dissolved partnership.

LIQUIDATIONS, &c.

Claims against the Receiver for the debenture holders of D. Santoni & Co. (1906) (Ltd.) by June 1 to Mr. H. G. Nordaby, 13 and 14, Abchurch-lane, London, E.C.

Meeting of Creditors.—A private meeting has been held of the creditors of Charles F. W. Zobel, electrical engineer, trading as Zobel & Son, 153, Euston-road, N.W.

Statement of affairs showed trade creditors £840. 6s. 7d., cash creditors £1,150 and preferential claims £80. 15s. 6d. Mr. S. H. Wood, 73, Basinghall-street, E.C., is trustee, with a committee of inspection. The following are the principal creditors: W. E. Chance & Co., £450; E. Brown & Co., £107; Evered & Co., £36; Edison & Swan Co., £10; Electrical Co., £10; Falk, Stadelmann & Co., £31; General Electric Co., £16; Siemens Bros. Dynamo Works, £16; Sterling Telephone Co., £31; Stearn Electric Lamp Co., £16; British Thomson-Houston Co., £13; Pilkington Bros., £19.

Sale by Auction.—Messrs. Fuller, Horsey, Sons & Cassell will include in their sale by auction at H.M. Dockyard, Sheerness, on Tuesday, May 12, at 11:15 a.m., 500 tons scrap iron and steel, 12 tons old foundry ashes, 12 tons zinc sheets and bottoms, a quantity of electric cable and electrical gear (various), 50 tons scrap brass, copper and mixed metal, 16 tons old lead, ships' anchors and stocks, some machine tools, including lathes, milling machines, six hydraulic jacks, weighing machines, vices and tools (various), three electric light engines, pumps, &c. Catalogues (6d. each) may be had at the Dockyard, and of Messrs. Fuller, Horsey, Sons & Cassell, 11, Billiter-square, London, E.C. See also an advertisement.

Plant for Sale.—Mr. E. J. Jennings, West Walls, Newcastle-on-Tyne, has for sale electrical machinery, suitable for isolated generating plants or extensions of existing plants. The machinery constitutes the whole of the generating plant at the Dale End electricity station of Birmingham Corporation, which has been purchased by Mr. Jennings. Photos and full list on application. Further particulars are given in an advertisement.

A 6 kw. second hand dynamo, with switchboard, and a quantity of fittings are offered for sale. May be inspected at Pauling's depot, Greenford Station (G.W.R.), Southall. See an advertisement.

An advertiser wishes to dispose of two 12 in. Blackman fans, with starters, for 220 volt d.c. circuit.

Partnership Wanted.—An electro-metallurgical engineer, having valuable patents and with large contracts pending, advertises for a partner who could take up foreign travel.

"Garcke's Manual of Electrical Undertakings."—We have received from the Electrical Press (Ltd.), 37 and 38, Strand, W.C., a copy of the 1908 edition of this useful work of reference of the electrical industry. The new volume (which is the 12th annual issue of the "Manual") contains close upon 2,000 pages and 70 maps, statistical and general information (including names of leading officials) relating to nearly 3,000 electrical undertakings. The general information is classified as follows: (1) Electric lighting, power and traction, (2) telegraph and telephone, (3) manufacturing and miscellaneous, (4) colonial and British possessions, (5) directory of officials, and (6) list of other electrical companies registered since 1856. These sections give a full record of both company-owned and municipal electrical undertakings. For convenience of reference each section is arranged in alphabetical order and a comprehensive index is also provided. The first 100 pages are devoted to "Progress of the Year," and give much useful statistical and general information as to Parliamentary and legal matters, finance, &c. A directory of the members of tramway and lighting committees of the United Kingdom has been included in this issue. All the other well-known features of the "Manual" have been amplified and corrected to date. The published price of the new edition is 21s net.

CATALOGUES, &c.

E.P.S. Batteries.—A very complete catalogue of the Electrical Power Storage Co.'s specialities has just been issued, and takes the form of an artistic folder, in which are bound up a quantity of leaflets. These are provided with a useful thumb index, so that one can immediately turn to the particular leaflet required. The leading types of cells manufactured by the company are illustrated, and complete dimensions and technical particulars as to number of plates, charge and discharge rates, weights, &c., are carefully tabulated. 13 distinct types of cells are manufactured, the range including patterns for heavy duty, as well as light weight cells suitable for motoring, electric launches, &c. There is also a special traction cell known as the "Faure-King," made in A and B types, listed and priced. A large number of pamphlets deal with launches, sundries, particulars of acids, special laboratory cells, miners' and hand lamps, and special instruments, such as cell testers, hydrometers, inspection lamps, &c. The pamphlets have been tastefully arranged, and are well printed in two colours on heavy art paper.

Station Literature.—The Borough Electrical Engineer and Manager of the Electricity Department at Loughborough is determined to leave no stone unturned to secure every power consumer possible for the electric service. Mr. W. H. Allen sends us some specimens of the literature which he is issuing on the subject of electric driving and the comparative cost of running electric motors and steam and gas engines. In conjunction with this information he is sending out follow-up circular letters, which are intended to impress their recipients with the necessity for dealing with a matter which is of undoubted importance to themselves.

Metalite Lamps. The Bryant Trading Synd., Horsell road, Highbury, London, N., forward us a copy of their new list describing the British "Metalite" incandescent lamp. This, the makers claim, is the first metallic filament lamp of British invention and manufacture to be put on the market. The list contains illustrations of a 64 c.p. 200 volt pattern and views of lamps for other voltages. The life of the lamps is given as 1,000 hours, the efficiency being in the neighbourhood of 1 watt per candle-power.

Variable-Speed A.C. Motors.—An advance specification of a variable-speed one-phase motor reaches us from Bergtheil & Young, who state that the machine is suitable for the driving of printing presses, calico printing machinery, lifts, machine tools, organ blowers, &c. The machine is of the commutator type and its characteristics are said to be the same as those of a series-wound c.c. motor, though the current consumption is stated to be less. The speed may be varied from zero to full speed.

Steel Boats. Messrs. Boulton & Paul, Norwich, send us a copy of a booklet entitled "Norvic" Steel Boats. From this we gather that the company build up special forms of steel boats suitable for pleasure purposes, either for river or sea. The company also manufacture two cycle valveless reversing petrol motors, which may be fitted to these boats if desired. These motors are also arranged to run on common paraffin.

BOOKS RECEIVED.

(Copies of the undermentioned works can be had from *The Electrician* office, post free, on receipt of published price. Add 5 per cent. for abroad or for foreign books.)

"Proceedings of the Royal Society." Vol. LXXX. No. 538. Series A—Mathematical and Physical Sciences. Series B—Biological Sciences. (London: Harrison & Sons.) A, 4s. 6d.; B, 2s. 6d.

"Machine Design, Construction and Drawing." By Henry J. Spooner. (London: Longmans, Green & Co.) 10s. 6d. net.

"Magnetism and Electricity." By S. S. Richardson. (London: Blackie & Son.) 5s. net.

"Telegraphic Systems and Other Notes." By Arthur Crotch. (London: Charles Griffin & Co.) 5s. net.

PATENT RECORD.

APPLICATIONS FOR PATENTS.

Note.—*The undermentioned Applications (except those marked †) are not open to public inspection until after acceptance of Complete Specifications. Those marked † are open for inspection 12 months after the date attached to them, if they have not been published previously in the ordinary course. Names within parentheses are those of communicators of inventions. When Complete Specification accompanies application, an asterisk is affixed.*

January 18, 1908.

1,252 Field & Ferranti. Electromagnetic devices for use on alternating current circuits.
1,253 Gerard. Producing and utilising electrical effluvia. (Date applied for, 19/4/07.)*†
1,260 Thomson. Telegraphic codes.

January 20, 1908.

1,320 Griffin. Rotary engines.
1,322 Handcock, Dykes & Smith. Boxes for electric wiring.*
1,332 Wildy & Vivian. Pressure operated valves for fluid-pressure engines.
1,333 Nicholson. Telephonic receivers.*
1,344 Salzer. Electrolytic deposition of chromium. (Date applied for, 21/1/07.)*†
1,359 Immisch. Manufacturing goods of rubber, ebonite or vulcanite and other materials by heat and compression.

January 21, 1908.

1,391 Maclean. Steam or other fluid pressure engines.
1,399 Parker. Telegraphic apparatus.
1,401 Brown. Insulating, supporting and jointing conductors.
1,404 Pearson. Mechanical stokers.
1,420 Chloride Electrical Storage Co. & Heap. Treatment of wood for batteries and electrolytic cells.*
1,424 Caught. Steam engines in which reciprocatory motion is converted into rotary motion.*
1,427 De Forest. Space telegraphy. (Date applied for, 29/1/07.)*†
1,428 Voss. Slipper-brake gear for tramcars and other vehicles.
1,431 Thompson. (Ges. für Drahtlose Telegraphie m.b.H., Germany.) Producing little damped oscillations for wireless telegraphy.*
1,450 Mavor & Mavor & Coulson. Electrical operation of haulage and winding gear and the propulsion of vessels, road vehicles and other bodies.
1,453 Dows & Telephos Limited. Electrical devices for controlling, igniting and extinguishing gas from a distance.
1,470 B.T.-H. Co. (G.E. Co., U.S.) Electric furnaces.

January 22, 1908.

1,491 Brook & Hirst. Manufacture of resistances.
1,502 Hookham & Chamberlain & Hookham. Electricity meters.
1,503 Chamberlain & Hookham & Holden. Electricity meters.
1,506 Crossley & Atkinson. Governing internal combustion engines.
1,513 Furniss. Turbine engine.
1,515 Von Madaler. Apparatus for wireless transmission and transmission by wires of photographs, drawings and the like.
1,532 Siemens & Halske A.-G. Electric signalling. (Date applic for, 23/1/07.)*†
1,546 Phœnix Dynamo Mfg. Co. & Pohl. Armature windings for commutator electric machines.
1,547 Lange. Radio-telegraphy. (Date applied for, 22/1/07.)*†
1,549 B.T.-H. Co. & Samuelson. Heat accumulators.

January 23, 1908.

1,596 Moul. Arc lamps.
1,615 Belin. Apparatus for reproducing at a distance photographs, blocks, drawings, &c. (Date applied for, 24/1/07.)*†

January 24, 1908.

1,670 Frost. Current generating and motive power machine.
1,696 Frank. Heating by electricity.

January 25, 1908.

1,721 Allen. Switch operating mechanism.*
1,723 Moorhouse. Actuating track brakes.
1,733 Schofield. Trolley retriever.
1,734 Taylor. Battery sub-stations fed from alternating current systems.
1,754 Lertourné. Recuperation of electric energy for projectors (Date applied for, 11/2/07.)*†
1,770 B.T.-H. Co. (G.E. Co., U.S.) Dynamo-electric machines.

SPECIFICATIONS PUBLISHED.

1906 Specifications.

23,016 Mackie. Dynamo-electric machines for maintaining a practically constant E.M.F. under variations of speed, specially applicable to train lighting.
23,223 Hulse. Smoke-consuming furnaces and utilising heat from same.
28,724 Oliver. Mechanical cars for carrying overhead transmission cables.
29,121 Warwick Machinery Co. & Halliwell. Turbines.

1907 Specifications.

1,264 Miura. Manufacture of electrical accumulators.
1,356 Ganz & Co. Eisengiesserei und Maschinenfabriks A.-G.). Regulating pressure of alternating current generators. (Date applied for, 19/2/06.)
1,393 Warwick Machinery Co. & Samuelson. Controlling supply of motive fluid to turbines.
1,517 Morcom & Walshe. Construction of choking coils for alternating current testing.
1,608 Radcliffe & Radcliffe. Mechanical stokers.
1,713 Eckstein & Heap. Fusible cut outs.
1,759 Raymond Barker & Amalgamated Radio Telegraph Co. Radio telegraphy.
2,138 B.T.-H. Co. (G.E. Co., U.S.) Brush holders.
2,417a Chambers & Bennett. Electric ignition switches. (Date applied for, 31/1/07.)
2,815 Best. Safety terminals for accumulators in mines.
2,937 Chambers & Bennett. Apparatus for making and breaking the current on electrically-fired internal-explosion engines and the like.
3,284 Venner & Griesbach. Time switches for electric circuits.
3,915 Reynolds. Electric-heating apparatus.
4,182 B.T.-H. Co. (G.E. Co., U.S.) Protective devices for electric circuits.
4,738 Allegmeine Elektricitats Gesellschaft. Electric rock drills. (Date applied for, 27/2/06.)
5,066 Hann, Ingle & Drake & Gorman. Electric couplings.
5,334 Eisenstein. Producing undamped electrical oscillations.
5,574 B.T.-H. Co. (G.E. Co., U.S.) Conductors for use as incandescing bodies in electric lamps.
6,057 Bill. Overhead conductors for electric tramways.
6,242 B.T.-H. Co. (G.E. Co., U.S.) Systems of electrical distribution employing vapour rectifying devices.
6,929 Siemens & Halske A.-G. Telegraphy. (Date applied for, 22/3/06.)*†
8,240 Damseaux. Holders for incandescent lamps.
8,379 Ljungstrom. Automatically balancing the axial pressure on rotating vane-carrying parts of turbines. (Date applied for, 11/4/06.)
8,379a Ljungstrom. Turbines with automatic axial balancing device. (Date applied for, 11/4/06, and under Rule 13, 10/4/07.)
9,851 B.T.-H. Co. (G.E. Co., U.S.) Maximum demand indicators.
10,007 Siemens Bros. Dynamo Works & Poynder. Means for altering the working speed of polyphase motors.
11,072 Margulis. Plates for accumulators.
13,175 Watkins, Bolster & Goodsell. Electric selecting apparatus for telephones.
13,942 Klein. Turbines.
14,083 Sefton-Jones. (McLellan.) Feed-water injectors for steam boilers.
14,221 Malson. Fuses for use in blasting and the like.
17,947 Faller. Automatic electrical gong ringing device.

COMPANIES' MEETINGS AND REPORTS.

BABCOCK & WILCOX (LTD.)—Net profit for 1907 was £309,768. 18s. 10d., making, with £25,895. 4s. 6d. from 1906, £335,664. 3s. 4d. Interim dividends of 3 per cent. on the preference shares and of 8 per cent. on the ordinary shares absorbed £69,400, leaving £266,264. 3s. 4d. The directors recommend the following dividends for the half-year ended Dec. 31: Balance 3 per cent. on preference (less tax), 8 per cent. on the ordinary (tax free) and a bonus of 4 per cent. on the ordinary shares, absorbing altogether £102,600. £100,000 has been placed to reserve, £25,000 to dividend equalisation, £38,664. 3s. 4d. is carried forward. The extension of the works referred to in last year's report have been completed and are in working order, and have enabled the increase in the business during last year to be dealt with. The volume of orders on hand at Dec. 31 and carried over for execution in 1908 is considerable.

BRITISH ALUMINIUM CO. (LTD.)—The profit for 1907 was £120,481. 17s. 3d. After deducting debenture interest (£28,514. 16s. 8d.), expenses of issue of new capital (£7,227. 9s. 8d.) and appropriating £10,764. 5s. 6d. in reduction of cost of temporary factory at Kinlochleven, the balance is £73,975. 5s. 5d. It is proposed to write off £20,000 for depreciation and, with £34,548. 11s. 9d. from previous year, the available total is £88,523. 17s. 2d. Interim dividends have absorbed £22,783. 8s., and the board now propose to pay the final preference dividend (£7,000), balance of interest on funding certificates (£1,288. 2s.), interest at 5 per cent. on conversion shares (£4,963. 5s.) and a final dividend at the rate of 7 per. cent. on the ordinary shares for the year (£7,000). Of the £45,489. 2s. 2d. remaining, £8,986. 8s. 10d. has been utilised in purchasing and cancelling 2,196 £5 funding certificates, leaving £36,502. 13s. 4d. to be carried forward. Compared with 1906, there has been a decline in the profits, which is attributed to the slump in copper last July, and to the resulting demoralisation in the metal markets. The temporary aluminium works at Leven only commenced producing during the last week of December, and those at Stangfjord in January. Progress continues to be made with the development of the permanent power scheme at Kinlochleven, but there is no prospect of any power being derived from this prior to the summer of next year, when the various sections of the work should be completed to enable the production of aluminium to be started. The development of the Orsières power scheme is being proceeded with, and a contract has been entered into for the construction of the first portions of the hydraulic section of the works. The construction of the Martigny-Orsières railway, which was commenced last year, is proceeding satisfactorily.

ELECTRIC TRACTION CO. OF HONGKONG (LTD.)—The report for 1907 states that the result of the years' working (after paying interest and other charges) is a profit of £5,950. The director have placed £6.000 to reserve for depreciation and renewals. The total receipts were £42.705, against £41,063, an increase of 4 per cent. Owing to the large loss sustained in respect of subsidiary coinage (£4,400) representing over 16 per cent. of the total working expenses, the profit has again been adversely affected.

MERTHYR ELECTRIC TRACTION & LIGHTING CO. (LTD.)—The gross receipts from light railways in 1907 were £11,265. 8s. 2d., and from electricity supply £5,872. 4s. 2d. The directors recommend a dividend of 5 per cent. on the ordinary shares. The gross profits on electric supply exceeded those of the previous year by £1,273. 2s. 5d., and there was an increase of £289. 5s. 6d. on the gross profit on the light railways.

ORIENTAL TELEPHONE & ELECTRIC CO. (LTD.) — Including £1,035. 15s. 3d. from 1906, and deducting interim dividends of 3 per cent. on both preference and ordinary shares, and making provision for redemption of debenture stock and other charges, the accounts for 1907 show that the amount to be dealt with is £15,838. 19s. 5d. The directors recommend payment of the final preference dividend (less tax) and a final dividend of 5 per cent. (tax free) on the ordinary shares (making 8 per cent. for the year). The changes in the company's systems by means of underground cabling have now been completed, but extensions to the scheme as originally laid out have become necessary. The increased business anticipated, as a consequence of these alterations, has made itself felt, and all the chief exchanges show an improvement for the year. In Mauritius, the Government has under consideration a scheme whereby it is hoped that the scope of the company's business will be extended to the whole of the island. The Indian local companies have declared the same dividends as for 1906—viz., Bengal Co. 5 per cent. and Bombay Co. 6 per cent. The Telephone Co. of Egypt has declared a dividend of 10 per cent. for the year on both its preferred and deferred shares. That company is engaged in numerous extensions. The Ministry of Public Works in Egypt granted to the company last year an authorisation for the installation of telephone lines in the province of Fayoum, Upper Egypt, for 35 years, from Dec. 17, 1907, and work in connection with this concession is now in progress. The China & Japan Telephone & Electric Co. at Hong Kong and Kowloon have also had a prosperous year subsequent to the re-construction of their system, and propose to declare a first dividend shortly on their ordinary shares.

PRIMITIVA GAS & ELECTRIC LIGHTING CO. OF BUENOS AIRES (LTD.)—The report for 1907 states that the balance of revenue account and the interest received from the Alemaña Co. amount to £122,104. After allowing for interest, interim ordinary dividend of 2s. 6d. per share, and placing £6,221 to reserve, the directors recommend a final dividend of 4s. 6d. per share, tax free (making 7 per cent. for the year).

SOCIETE ANONYME OTTOMANE DU GAZ DE BEYROUTH.—The directors' report states that, with a view to avoiding possible competition, a concession has been secured for the generation and supply of electrical energy, and land has been acquired for the erection of an electricity station.

TAUNTON ELECTRIC TRACTION CO. (LTD.)—The total receipts for 1907 were £2,438, and after paying expenses the profit was £232. Authority has been obtained to extend the system to Rowbarton, and the directors have approached the Corporation with a view to further reduction in the charge for electrical energy.

NEW COMPANIES, MORTGAGES AND CHARGES AND STATUTORY RETURNS.

NEW COMPANIES.

CALMONT KING & CO. (LTD.) (97,616.)—Reg. April 15, capital £3,000 in £1 shares, to carry on the business of electrical engineers, commission agents, factors, importers, exporters, &c. First directors, A. J. Mudlin, E. Browne and M. Wohl (all permanent).

IMESON, FINCH & CO. (LTD.) (97,639.)—Reg. April 15, capital £10,000 in £1 shares, to acquire business of Imeson Bros., Finch & Co., and to carry on the business of electrical, mechanical and general engineers, machinists, metal workers, manufacturers of trolley controllers, [illegible], trolley heads, lamps, [illegible] bronze, [illegible] equipment and insulators, car wheels, and parts for tramways and railways, &c. First directors, G. P. Lewis, J. H. Phillips, A. Imeson, A. H. Finch and Major H. Hart. A. Imeson and A. H. Finch are joint managers. Reg. office, 5 6, Great Winchester-street, London, E.C.

MORTGAGES AND CHARGES.

ASSOCIATED BATTERY CO. (LTD.)—Issue on April 6 of £100 5 per cent. debentures, part of series created Feb. 6, 1908, to secure £2,000, charged on company's undertaking and property, present and future, including uncalled capital. No trustees. Previously issued of same series, £1 675.

LEICESTERSHIRE & WARWICKSHIRE ELECTRIC POWER SYND. (LTD.)—Issue on April 13 of 6 per cent. debentures for £50, part of a series created Feb. 7, 1906, to secure £5,000, charged on company's undertaking and property, present and future, including uncalled capital. No trustees. Previously issued of same series, [illegible].

OLDBURY STEEL CONDUITS (LTD.)—A debenture dated April 2 to secure £1,000 charged on company's undertaking and property, present and future, including uncalled capital, has been registered. Holder, T. Pollock.

STATUTORY RETURNS.

EGERTON & CO. (LTD.)—In return to Feb. 17 capital is £2,000 in £1 shares, of which 1,511 have been taken up and paid for in full. Mortgages and charges, nil.

ELECTRIC CANAL HAULAGE CO. (LTD.)—Return to Feb. 17 gives capital as £3,000 in £1 shares, of which seven have been taken up. £7 has been received. Mortgages and charges, nil.

CITY NOTES.

MEMORANDA (April 23).—Bank rate 3 per cent. (since March 19, 1908). Price of silver $25\frac{1}{16}$—$25\frac{3}{16}$d. per oz. Consols $86\frac{9}{16}$—$86\frac{11}{16}$ for money, and $86\frac{11}{16}$—$86\frac{13}{16}$ for account. Consols Pay Day, May 6; Stocks and Shares Continuation Days, April 27 and May 6; Ticket Days, April 28 and May 7; Pay Days, April 29 and May 8; Mining Share carry-over Day, April 24.

PRICES OF METALS (London).—*Copper*, cash, 58—$58\frac{1}{4}$; three months $58\frac{1}{2}$—$58\frac{3}{4}$. *Lead*, English, $13\frac{1}{2}$—$13\frac{3}{4}$; foreign, $13\frac{1}{4}$—$13\frac{1}{2}$. *Spelter*, foreign $21\frac{1}{4}$—$21\frac{3}{8}$. *Tin*, English, 144—145; foreign, cash, 145—$145\frac{1}{2}$, three months, $143\frac{3}{4}$—$144\frac{1}{4}$. *Iron*, Cleveland, cash, 51/5—51/6; three months, 49/0—49/3.

COLOMBO ELECTRIC TRAMWAYS & LIGHTING CO. (LTD.)—The directors recommend a dividend of 4 per cent., tax free, for the past year.

HAVANA ELECTRIC RAILWAY CO.—The gross earnings for 1907 were \$2,143,122, increase \$224,019, and the net earnings \$924,951. Fixed charges were \$558,877, leaving \$366,074. After paying preferred dividends the surplus is \$91,074. The company has applied for a concession for constructing extensions of the lines.

STOCK EXCHANGE NOTICES.—The Stock Exchange committee have been asked to appoint a special settling day in and grant a quotation to provisional certificates (25 per cent. paid) for £301,630 $4\frac{1}{2}$ per cent. debenture stock of the *Charing Cross, West End & City Electricity Supply Co. (Ltd.)* and also to grant quotations to £109,500 $4\frac{1}{2}$ per cent. debenture stock of the same company; a further issue of 3,140 £5 fully paid $5\frac{1}{2}$ per cent. cumulative preference shares of the *Manx Electric Railway Co. (Ltd.)*; \$300,000 additional first mortgage 30 year 5 per cent. gold bonds of the *Mexico Tramways Co.*; 6,000 additional \$100 shares of capital stock of the *San Paulo Tramway, Light & Power Co. (Ltd.)*; a further issue of £75,000 $4\frac{1}{2}$ per cent. first mortgage debenture stock of the *Urban Electric Supply Co. (Ltd.)*; scrip fully paid for \$400,000 $4\frac{1}{2}$ per cent. first mortgage bonds of the *Montreal Light, Heat & Power Co.*; and a further issue of 25,000 £1 fully-paid 7 per cent. cumulative preference shares and £20,000 $4\frac{1}{2}$ per cent. first mortgage debenture stock of the *South Metropolitan Electric Light & Power Co. (Ltd.)*.

THE ELECTROBUS.—It is generally well known in motor 'bus circles that the petrol 'bus of every class is, to say the least, under a cloud financially; in fact, there is practical indisputable proof that this type of 'bus cannot pay. Already schemes are under consideration for amalgamating with the old-established horse omnibus companies, and this will undoubtedly prove the end of the chapter so far as the petrol 'bus is concerned. On the other hand, there is unquestionable evidence that the electrobus has, since its advent on actual service nine months ago, made rapid strides in public favour, and moreover is claimed by the owning company to have satisfactorily established its ability to not only cover all capital and working expenses, but to show such a margin of profit as will ensure its position as a dividend-earning investment. This position of affairs being granted, interest attaches to the issue by the London Electrobus Co. of a further 240,000 ordinary shares of £1 each and 18,000 deferred shares of 5s. each, which are now offered at par, payable 1s. per share on application, 4s. on allotment, 5s on May 30, and 5s. on June 30 next, the balance of 5s. being payable on Sept. 30. The whole of the amount of the deferred shares is payable on application. The prospectus of this issue will be found set out on another page, and from this it will be seen that the whole of the proceeds of the issue are to be devoted to the purposes of working capital with the exception of the expenses connected with this issue. There are no vendors' or promoters' shares in this company, and every share which has been allotted of the original issue has been for cash at par. This statement we take from the prospectus of the new issue, and is a guarantee that the company has established its position in the metropolis with a minimum of capital expenditure. From the prospectus it will be seen that from July 15 last to April 14 instant nearly 1,000,000 passengers were carried, 93,48[illegible] car miles run, and the average takings per car mile were 13·06d. The estimate made by Sir Douglas Fox & Partners of the working expenses is 9½d. per car mile. A report from Sir Douglas Fox & Partners dated April 15, 1908, vouches for this figure "after making careful calculations and allowing liberally for maintenance, renewals and depreciation." Accompanying the prospectus, copies of which can be obtained from the bankers and brokers, is some interesting information concerning the electrobus which will be of service to investors. The list of application opens on Monday next, April 27, and closes not later than Thursday, April 30 for both town and country.

ELECTRIC TRAMWAY AND RAILWAY TRAFFIC RECEIPTS.

Line	Week ended.	Amount.	Inc. or Dec. (a)	Aggregate. No. of weeks.	Aggregate. Amount.	Aggregate. Inc. or Dec. (a)
		£	£		£	£
[illegible] Corporation	April 15	1,214	+ 1	46	62,[illegible]	– 1,362
[illegible]	" 10	214	12	14	3,1[illegible]	+ [illegible]
Anglo Argentine	" 15	14,2[illegible]	+ 1,470	15	277,471	+ 33,840
[illegible]	" 18	240	+ 23	49	13,746	1[illegible]
Baker St. & Waterloo Ry.	" 18	2,7[illegible]	+ 210	16	48,[illegible]	+ 11,614
Barnsley	"	178	+ 40	14	2,342	+ [illegible]
Barrow	" 19	218	+ 15	14	3,051	– 62
Bath Electric Trams Ltd.	" 15	643	– [illegible]	15	8,703	– 1,363
Birkenhead Corporation	" 19	1,007	+ 76	...	...	
Birmingham Corporation	...	...	...	...	...	...
Birmingham & Mid.	" 3	[illegible]	– 384	13	10,366	+ 303
Blackburn Corporation	" 15	997	+ 36	3	3,071	– [illegible]
Blackpool Corporation	" 16	520	+ 67	§2	1,104	– 1,013
Blackpool and Fleetwood	" 18	610	+ 313	...	...	...
Bolton Corporation	...	...	...			...
Bombay	March [illegible]	2,34[illegible]	+ 418	12	29,[illegible]	+ 4,736
Bournemouth Corporation	April 15	1,483	– 13	2	3,213	– 1,2[illegible]
Bradford Corporation	" 11	1,27[illegible]	+ 395	2	6,9[illegible]	– 407
Brighton Corporation	" 19	91[illegible]	+ 171	2	2,171	+ [illegible]
Bristol Trams & Carriage	" 1[illegible]	4,7[illegible]	– 3	15	[illegible]	– 3,458
Buenos Ayres & Belgrano	" 15	3,941	+ 3	15	56,877	+ 745
Burnley Corporation	" 17	1,642	+ 488	3	4,143	+ 536
Burton Corporation	" 19	268	+ 14	3	702	– 6
Bury Corporation	...	...	...			...
Calcutta Tramways Co.	" 18	R14,141	– R2,582			...
Camborne & Redruth			...			
Cardiff Corporation	...	...	...	...		...
Cavehill	" 1[illegible]	74	+ 12	14	833	175
Central London Railway	" 18	4,984	+ 1,242	16	96,346	– 3,245
Charing Cross, Euston & Hampstead	" 18	3,1[illegible]	...	16	50,4[illegible]	...
Chatham & District Lt. Rys.	" 1[illegible]	[illegible]	+ 2[illegible]	§15	9,245	– 866
City & South London Rly.	" 19	2,[illegible]	+ 22	16	53,035	+ 5,[illegible]
City of Birmingham	" 10	2,746	+ 71	14	38,[illegible]	– 35
Colchester Corporation	" 15	161	– 17	15	2,339	– 242
Cork Electric Trams Co.	" 10	115	+ 1	§15	[illegible]	– 173
Croydon Corporation	...	...		...	...	
Devonport & District Trams	" [illegible]	417	+ 27	14	5,923	– 262
Dover Corporation	" 18	202	+ 13	3	482	– 178
Dublin & Lucan Railway	" 17	128	+ 28	16	1,[illegible]	– 20
Dublin United	" 17	4,[illegible]	– 5[illegible]	16	7[illegible],425	+ 381
Dudley Stourbridge	" 10	751	– 6	14	10,291	– 1,245
Dundee Corporation	" 1[illegible]	1,[illegible]	+ 21	48	54,050	+ 2,173
East Ham Corporation	" 18	[illegible]	+ 55	3	2,[illegible]	– 173
Exeter Corporation			...			...
Falkirk and District	" 1[illegible]	261	– 10	2	[illegible]	+ 19
Gateshead & District Trams	" 10	[illegible]	– 53	14	13,983	+ 183
Glasgow Corporation	" 18	17,50[illegible]	+ 449	46	798,[illegible]	+ 17,011
Glossop	" 18	150	+ 20	16	[illegible]	– 130
Gravesend & Northfleet	" 10	189	– 21	14	2,651	– 464
Great Northern & City Rly.	" 18	1,537	– 312	16	28,234	– 1,49[illegible]
Gt. Northern, Piccadilly, &c.	" 18	4,[illegible]	+ 910	16	86,265	+ 25,8[illegible]
Greenock & Port Glasgow	" 10	508	– 218	14	6,[illegible]	– 1,961
Hartlepools Tramways	" 10	1[illegible]	– 3[illegible]	14	2,[illegible]	– 562
Hastings Tramways Co.	" 1[illegible]	[illegible]	– 89	16	11,948	– [illegible]
Hong Kong	" 11	$7,2[illegible]	+ $[illegible]	2	$15,457	+ $322
Hull Corporation	" 18	2,4[illegible]9	+ 264	3	6,431	– 366
Ilford District Council	...	...	...	...	...	...
Ilkeston District Council	" 15	123	+ 6	3	382	– 57
Ipswich Corporation	" 18	385	+ 35	3	[illegible]	– 101
Isle of Thanet	" 18	423	+ 70	29	7,725	+ 567
Jarrow	" 10	91	– 11	14	1,363	– 178
Keighley Corporation	" 1[illegible]	145	+ 10	42	6,548	+ 262
Kidderminster & District	" 10	85	– 7	14	1,189	– 177
Kilmarnock Corporation	" 18	145	+ 6	48	7,487	– 208
Lanarkshire Trams Co.	" 15	1,242	+ 108	15	18,763	+ 2,491
Lancashire United	" 17	1,159	+ 82	15	17,429	– [illegible]
Leamington	" 10	174	+ 15	14	1,863	– 82
Leeds Corporation	" 11	6,124	+ 441	2	9,982	+ 1,082
Leicester Corporation	...			...	...	...
Leith Corporation	" 18	4[illegible]	+ 22	149	24,846	+ 150
Lincoln Corporation	" 18	124	+ 30	3	352	+ 17
Liverpool Overhead Rly.	" 22	1,324	– 73	16	22,[illegible]	– 242
Liverpool Corporation						
*London County Council	" 11	31,291	+ 3,308	12	50,[illegible]	+ [illegible],175
London United	" 18	6,430	+ 960	16	82,769	– 2,[illegible]
Lowestoft	" 18	171	+ 33	29	4,1[illegible]7	+ 71
Maidstone Corporation	" 18	[illegible]	...	3	[illegible]	...
Manchester Corporation	" 18	15,521	– 2,176	3	38,[illegible]	+ 2,241
Mersey Railway	" 18	1,807	+ 115	16	59,[illegible]	+ 1,260
Merthyr	" 10	214	+ 18	14	2,763	– [illegible]
Metropolitan District Railway	" 18	8,1[illegible]	+ [illegible]	16	142,299	+ 15,847
Metropolitan Elec. Trams	" 10	5,[illegible]	– 1,203	14	67,704	+ 11,0[illegible]
Middleton	" 10	3[illegible]	– 27	14	4,21[illegible]	– 222
Nelson Corporation	" 18	189	+ 67	•12	413	+ 1[illegible]
Newcastle-on-Tyne Corp.	" 18	3,917	– 17[illegible]	3	9,9[illegible]	– 2,061
Newport (Mon.)	" 18	[illegible]	+ 15	3	1,8[illegible]	– 123
Northampton Corporation	" 17	395	+ 2[illegible]	¶12	952	+ 2[illegible]
Oldham, Ashton & Hyde	" 10	5[illegible]2	+ 38	14	7,950	– [illegible]
Oldham Corporation	" 1[illegible]	2,1[illegible]	+ 44[illegible]	4	7,401	– 57
Perth (N.B.) Corporation	" 15	131	– 14	48	7,440	+ 3
Perth W.A. Elec. Trams	" 17	1,415	+ 16	¶16	22,615	– 1,[illegible]
Peterborough	" 10	1[illegible]	– 1	14	1,469	– 101
Portsmouth Corporation	" 18	1,825	+ 147	3	4,505	– 1,198
Potteries	" 1[illegible]	1,671	+ 42	14	26,037	+ 5[illegible]
Preston Corporation	...		...	...	...	
Rotherham Corporation	" 13	58[illegible]	+ 71	§2	1,288	– 241
Rothesay	" 1[illegible]	73	– 123	14	711	– 4[illegible]2
Salford Corp.	" 20	5,[illegible]	+ 1,166	3	13,371	– 86[illegible]
Sheerness	" 8	[illegible]	– 1	14	[illegible]	25
Singapore Trams	" 13	[illegible]	+ $155	2	$19,516	+ $1,[illegible]
Southend Corporation	" 15	2[illegible]	+ 3	3	621	– 227
South Metropolitan	" 1[illegible]	[illegible]	+ 75	14	9,258	– [illegible]
Southport Tramways	" 10	2[illegible]	– 20	14	2,829	– 518
South Staffs	" 1[illegible]	818	+ 27	14	12,[illegible]	– 2[illegible]
[illegible]	" 1[illegible]	[illegible]	+ 38	12	1,105	+ 314
Sunderland Corporation	" 18	1,214	– 31	3	3,107	– 903
Sunderland and District	" 15	4[illegible]	+ 49	21	10,[illegible]	+ 958
Swansea Trams	" 1[illegible]	950	+ 170	14	11,928	+ 587
Taunton	" 1[illegible]	37	– 6	14	5[illegible]	– 36
Tynemouth and District	" 1[illegible]	144	– 28	14	1,991	– 371
Tyneside Trams	" 13	3[illegible]	– [illegible]	16	5,246	– 1,130
Victoria Elec. Supply Co. of	March 15	1,023	+ 103		...	...
Wallasey District Council	April 18	8[illegible]8	+ 139	13	2,103	– 2[illegible]2
Walsall Corp.	" 18	5[illegible]	+ 12[illegible]	16	[illegible],030	+ 740
West Ham Corporation	" 16	2,[illegible]7	– 12[illegible]	3	6,283	– 1,230
Weston-super-Mare	" 8	35	– 30	14	553	– 239
Wolverhampton Co.	" 10	425	+ 10	14	6,[illegible]2	– 269
Wolverhampton Corpn.	" 15	742	..	45	3[illegible]	...
Worcester	" 10	256	+ 11	14	3,303	– 152
Wrexham	" 10	118	+ 8	14	1,278	– 74
Yorkshire W.R. Trams	" 10	1,9[illegible]	+ 198	16	17,182	
Yorkshire Woollen District	" 10	[illegible]7	– 11	14	1[illegible]	– [illegible]

(a) These comparisons are with the corresponding period last year. § Plus 2 days. ¶ Plus 3 days. * Partly electrical. † Minus 3 days. ‡ Minus 2 days.

ELECTRICAL COMPANIES' SHARE LIST.

Share	Last Dividend	Name	Price Wed April 22	Rate Yield-ed. £ s. d.	Dividend Due	Business done Highest	Business done Lowest
		ELECTRICITY SUPPLY.					
10	9 0	Bournemouth & Poole Elec. Sup. Ord.	1[illegible]–11¾	5 19 0	Mar, Sept	..	..
10	4 6	Do. 4½ per Cent. Cum. Pref	10 –11	4 2 0	[illegible]	..	..
10	6 0	Do. 6 per Cent. Cum. Second Pref.	10½–11	5 [illegible]	[illegible]	[illegible]	..
St.	4½	Do. 4½ per Cent. Deb. Stock (red.)	1[illegible]2 –10[illegible]	4 5 [illegible]	[illegible]	1[illegible]	..
5	3 6	†Bromley (Kent) El. Lt. & Power Shares	4 – 5	[illegible]	April, Oct		..
St.	4½	Do. Do. 1st Deb.	96 –99	4 11 0	May, Nov	..	
5	5 6	Brompton & Kensington Elec. Sup. Ord	7[illegible]	6 1	March....		.
5	3 6	Do. 7 per Cent. Pref.	6[illegible]	4 10 0	Mar, Sept	..	..
St.	4	Central Elec. Sup. Co. 4% Guar. Db Stock	98 –101	3 19 [illegible]	June, Dec	..	..
5	2 6	Charing Cross (W. End & City) El. Sup. Co	3¾–4¼	[illegible] 1 6	Feb, Aug	..	..
5	[illegible] 3	Do. 4½ per Cent. Pref.	4⅜–4⅝	4 17 0	[illegible]		..
St.	4%	Do. 4 per Cent. Deb. Stock (red.)	96 – 99	4 1 0	[illegible]	97½	..
5	2 3	Do. City Undertaking 4½% Cm. Pref.	4 –4½	[illegible] 0	Jan, July		..
5	2/6	Chelsea Electric Supply Ord	3 –[illegible]	6 8 6	March ..	[illegible]	..
St.	4½	* Do. 4½ per Cent. Deb. Stock (red.)	101 –104	4 6 9	June, Dec	..	
10	7 0	City of London Electric Lighting Ord.	[illegible]	5 14 0	[illegible]		..
10	6 0	Do. 6 per Cent. Cum. Pref.	11[illegible] –1[illegible]	4 14 0	[illegible]	..	..
St.	5	Do. 5 per Cent. Deb. Stock (red.)	12[illegible] –12[illegible]	3 19 6	June, Dec	..	..
St.	4½	Do. 4½ per Cent. 2nd Deb. Stock (red.)	101 –104	4 0 6	Jan, July	103	..
5	1 [illegible]	County of Durham Elec. P. D. Ord	2¾–3	3 [illegible] 7	April, Oct	..	..
5	5	Do. 5 per Cent. non Cum. Pref.	4⅜–4⅝	5 17 [illegible]	April, Oct	..	..
10	6 0	County of London Elec. Supply Ord.	7¾–8[illegible]	6 1 3	Feb, Aug	[illegible]	
10	6 0	Do. 6 per Cent. Cum. Pref.	1[illegible]–11[illegible]	4 1 3	Mar, Sept	11	1[illegible]
St.	4½	Do. 4½% Deb. Stock (all paid) (red.)	107 –110	4 2 6	Jan, July	..	..
St.	4½	Do. Second Deb. Stock Prov. Certs.	98 – 101	4 9 0	May, Nov		..
5	3 6	Folkestone Electricity Supply Co. Ord.	4[illegible] –5	5 1 0	April, Oct	..	..
5	2 6	Do. 5 per Cent. Cum. Pref.	4[illegible]–5[illegible]	4 12 6	Mar, Sept	..	..
St.	4½%	Do. 4½ 1st Deb. Stock (red.)	94 –97	4 1[illegible] 0	Feb, Aug	..	..
5	4 6	Hove Electric Lighting Ord.	6½–[illegible]	6 7 0	April, Oct	..	..
5	5 0	Kensington & Knightsbridge Ord.	7[illegible]–[illegible]¾	5 11 0	Feb, Aug	..	..
5	6%	Do. 6 per Cent. 1st Pref.	6½–7	4 5 9	Jan, July	.	..
St.	4	Do. 4 per Cent. Deb. Stock (red.)	96 –99	4 1 0	..	..	..
St.	4[illegible]	Kensingtn. & Kngtbg. Co. & Notting Hill Co. (Joint Station) 4% Deb. Stock (red.)	97 – 101	3 19 0	April, Oct	..	..
St.	4½	Kent Elec. Power Co.	88 –92	4 18 [illegible]	Jan, July	..	..
3	1 6	London Electric Supply Ord.	1 –1¼	5 0 0	Mar, Sept	..	..
5	3 0	Do. 6 per Cent. Pref.	4½–5	6 0 0	Mar, Sept		..
St.	4%	Do. 4 per Cent. 1st Mort. Deb.	90 –93	4 8 0	Jan, July	..	..
5	3 6	Metropolitan Electric Sup. Ord.	4[illegible]–5¼	6 4 0	April, Oct	[illegible]	4[illegible]
5	2 3	Do. 4½ per Cent. Cum. Pref.	4¾–5¼	4 6 0	Jan, July	..	..
St.	4½	Do. 4½ per Cent. Deb. Stock 1st Mort.	107 –111	4 1 0	June, Dec	..	..
St.	3½	Do. 3½ per Cent. Mrt. Deb. Stock (red.)	85 –91	3 18 0	Jan, July	..	..
100	4½	Midland Elec. Corp. for P.D. 1st Mort. Db.	96 – 99	4 11 0	June, Dec	..	..
10	4	Newcastle & Dist. Elec. Ltg. Ord.	[illegible]–[illegible]⅝	4 11 [illegible]	Feb, Aug	..	..
100	4½%	Do. 4½ per Cent. Deb.	9[illegible] –9[illegible]	4 12 9	Jan, July	99	..
5	8%	Newcastle Elec. Supply Ord.	[illegible]	6 19 3	Feb, Aug	..	..
5	5	Do. 5 per Cent. non Cum. Pref.	[illegible]	4 15 3	Feb, Aug	..	..
100	4	Do. 4 per Cent. Mort. Deb. red. 1907.	96 –98	4 2 6	Jan, July	..	..
1	3	Northern Counties Elec. Sup.	—	..	Mar, Aug	..	..
100	4½	Do. 4½ per Cent. Deb.	95 –97	4 13 9	Jan, July	..	..
10	8 0	Notting Hill Electric Ord.	11¾ –12¼	5 14 0	March ..	..	..
5	4 6	Oxford Electric Ord.	[illegible]–6⅝	5 10 0	March ..	..	..
St.	4	Do. 4 per Cent. Deb. Stock	93 –95	4 4 6	Jan, July		..
5	5 0	St. James' & Pall Mall Elec. Ord	7½–8½	6 1 3	Feb, Aug	[illegible]	..
5	3 6	Do. 7 per Cent. Pref.	6¾ –7	[illegible] 0 0	Feb, Aug	..	..
St.	3½	Do. 3½ per Cent. Deb. Stock (red.)	85 –90	3 17 9	Jan, July	..	..
5	.	Smithfield Markets Electric Sup. Ord.	½–1½	.	Feb	..	..
St.	4%	Do. 4 per Cent. Deb. Stock	70 –74	5 8 0	Feb, Aug	..	..
5	4 0	†South London Electric Supply Ord.	[illegible]	6 18 0	April	..	..
1	0 6	South Metrop'n Elec. Lt. & Power Ord.	[illegible]	4 0 0	..	.	..
1	0 8[illegible]	Do. 7 per Cent. Cum. Pref.	1⅛–1[illegible]	5 2 0	Feb, Aug	.	..
St.	4½	Do. 4½ 1st Db. Stk. Red.	99 –102	4 8 0	April, Oct	..	..
5	2 6	Urban Electric Supply Ord.	1[illegible]–[illegible]	10 18 0	April, Oct	..	..
5	2 6	Do. 5 per Cent. Cum. Pref.	1[illegible]–[illegible]	11 14 0	April, Oct	..	..
St.	4½	Do. 4½ per Cent. 1st Mort. Deb.	87 –90	5 0 0	April, Oct	.	..
5	5 0	Westminster Elec. Sup. Ord.	7¾–8	6 5 0	Mar, Sept		..
5	2 3	Do. 4½ per Cent. Cum. Pref.	4¾–5¼	4 5 6	Jan, July	..	..
		ELECTRIC RAILWAYS, TRAMWAYS, &c.					
St.	4%	Baker St. & Waterloo 4% Perp. Db. St.	89 –92	4 7 0	Jan, July	91	89[illegible]
1		Bath Elec. Trams Pref. Ord.	⅜–[illegible]	8 0 0	April....	.	..
1	0/6	Do. 5 per Cent. Cum. Pref.	[illegible]–⅞	5 14 0	Jan, July		..
St.	4½	Do. 4½ 1st Mort. Deb. Stock (red.)	89 –94	4 16 0	April, Oct	..	..
St.	4½	B'ham & Midland Trams 4½ 1st Db Stk.	93 – 96	4 5 0	Jan, July	..	..
10	9%	Bristol Tramways & Carriage Ord.	10 –10½	8 11 9	Feb, Aug	..	..
10	4%	Do. Cum. Pref. (fully paid)	8½–8[illegible]	4 11 6	..	..	..
St.	4%	Do. 4 per Cent. Debs.	100 –102	3 18 0	Feb, Aug	.	..
10	..	British Electric Traction Ord.	1½–[illegible]	..	June, Dec	1	[illegible]
10	6/0	Do. 6 per Cent. Cum. Pref.	4 –4½	12 12 0	Feb, Aug	[illegible]	4
St.	5%	Do. 5 per Cent. Perpetual Debs.	90 –9[illegible]	5 5 0	April, Oct	[illegible]	[illegible]
St.	4½%	Do. 4½ per Cent. 2nd Deb. Stock	72 –76	6 0 0	May, Nov		..
St.	3%	Central London Ordinary Stock	75 –78	3 17 0	Feb, Aug	7[illegible]	7[illegible]
St.	4%	Do. 4 per Cent. Pref. Stock	83 –85	4 14 6	Feb, Aug	[illegible]	..
St.	2%	Do. Deferred Stock	51 –57	3 10 0	Feb	.	
100	4%	Do. 4 per Cent. Debs.	100 –103	3 18 0	Jan, July	10[illegible]	..
St.	4	Charing X, Euston & Hmpstd Per Db. Stk.	81 –84	4 15 3	Jan, July	83	
5	2/6	City of Birmingham Trams. 5% Cm Pref.	4½–5	5 0 0	April, Oct	..	..
100	4%	† Do. 4 per Cent. 1st Mort. Debs.	97 –100	4 0 0	April, Oct	..	..
St.	1¾%	City & South London Ry. Co. Ord.	39 –41	4 5 0	Feb, Aug	..	..
St	5%	Do. 5 per Cent. Perp. Pref. (1891)	113 –116	4 6 0	Feb, Aug	.	..
St.	5%	Do. (1890)	112 –115	4 7 0	Feb, Aug	11[illegible]	11[illegible]
St.	5%	Do. (1901)	110 –113	4 8 6	Feb, Aug	..	..
St.	5	Do. (1903)	1[illegible]6 –109	4 11 6	Feb, Aug	.	..
St.	4%	Do. 4 per Cent. Perpetual Debs.	101 –104	3 17 0	May, Nov	[illegible]	..
10	7/0	Dublin United Trams. Ord	12½ –13½	4 10 6	Feb, Aug	..	..
10	6/0	Do. 6 per Cent. Pref.	12½ –13½	4 9 0	Feb, Aug	..	..
10	.	Gt. Northern & City Ry. Pref. Ord.	½ –1½	..	Feb, Aug	1	..
10	4/0	G. Northern, Piccadilly & Brompton Ord.	6 –7	5 14 0	Feb, Aug	[illegible]	6[illegible]
St.	4%	Do. 4 per Cent. Deb. Stock	87 –90	4 9 0	Jan, July	8[illegible]	..
5	4 0	Hastings & Dist. Elec. Trams 6% Cm. Pf.	4 –4½	7 5 [illegible]	Mar, Sept	4	..
St.	4½%	Do. 4½ 1 Db. St.	9[illegible] –98	4 12 9	April, Oct	..	..
10	9%	‡ Imperial Tramways Ord.	1[illegible] –11½	7 17 0	Mar, Sept	..	.
10	6%	‡ Do. 6 per Cent. Pref.	[illegible] –10	9 5 6	Mar, Sept	.	..
St.	4½%	‡ Do. 4½ per Cent. Debs.	93 –[illegible]	4 15 [illegible]	Jan, July	..	..
5	..	I. of Thanet E. T. & Lt. 5 per Cent. Pref.	⅞–1⅛	.	Mar, Sept		..
St.	4%	Do. 4 per Cent. Deb. Stock	58 –63	6 7 [illegible]	Jan, July	.	..
10	6 0	Lanarkshire Tramways	9¾ –10¼	5 13 [illegible]	Feb, Aug	..	..
St	5%	Lancs. Utd. Trams 5% Prior Lien Db. St.	91 –94	5 6 0	Jan, July	..	..
10	..	Liverpool Overhead Railway Ord.	1⅜ –1⅝	..	Feb, Aug	..	..
10	5%	Do. 5 per Cent. Pref.	6½ –6¾	7 10 0	Feb, Aug	..	..
St	4%	Do. 4 per Cent. Deb.	85 –87	4 11 0	Jan, July	.	..
10	5 0	London United Trams 5% Cum. Pref.	[illegible]	6 17 6	[illegible]	[illegible]	[illegible]
St	4%	Do. 4 per Cent. 1st Mort. Deb. Stock	79 –8[illegible]	4 1[illegible] 0	Jan, July		[illegible]0
St.	..	Mersey Co. Ord. Stock	2 –4	—	Feb, Aug		..
St.	..	Do. 3 per Cent. Perp. Pref.	3 –6	—			..
1	..	Metropolitan Elec. Tramways Def.	[illegible]	.	[illegible]		.
1	0/6	Do. 5 per Cent. Cum. Pref.	[illegible]	[illegible]	[illegible]		[illegible]
St	4½%	Do. 4½ per Cent. Deb. Stock	9[illegible] –97	4 1[illegible]	[illegible]	9[illegible]	[illegible]
St	[illegible]	Metropolitan Railway Consolidated	[illegible] –4[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
St	2[illegible]	Do. Surplus Lands Stock	[illegible]	4 [illegible]	[illegible]	[illegible]	..
St.	[illegible]	Do. 3½ per Cent. Preference	86 –89	[illegible]	[illegible]	[illegible]	[illegible]
St.	3½	Do. 3½ per Cent. "A" Preference	76 –79	4 [illegible]	[illegible]	[illegible]	..
St	[illegible]%	Do. [illegible]	7[illegible]	4 [illegible]	[illegible]	[illegible]	..
St	[illegible]	Do. [illegible]	[illegible]	[illegible]	[illegible]	[illegible]	..
St.	[illegible]	Do. [illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

* In calculating the yield, allowance has been made for accrued interest but *not* for redemption.

† Ex Dividend

ELECTRICAL COMPANIES' SHARE LIST.—*Continued.*

Share	Last Dividend	Name	Price Wed., April 22.	Rate % Yield £ s. d.	Dividend Due	Business 8 Days to April 22. Highest	Lowest
		ELECTRIC RAILWAYS & TRAMWAYS *Continued.*					
St.	..	Metropolitan District Railway Ord.	11½—12½		Feb, Aug	12⅛	11⅞
St.	..	Do. Extension Pref. (5 per Cent.) ..	20 —26		Feb, Aug	21½	21⅛
St.	3½	Do. Assented Ext. Ltd. (Int. Guar. by Und. Elec. Rlys. Co. of London, Ltd.	44 —48	7 6 0	Feb, Aug	46½	46¼
St	3%	Do. 3 per Cent. Consoldtd. Rent-charge	73 —78	3 17 0	Jan, July	..	..
St.	4%	Do. 4 per Cent. Midland Rent charge	100 —104	3 17 0	Jan, July	..	..
St.	1½	Do. Guar. Stock 4 per Cent.	42 —47	3 13 0	Mar, Sept	43	..
St.	6%	Do. 6 per Cent. Perp. Deb. Stock ...	108 —113	5 6 3	Jan, July	110½	109½
St.	4%	Do. 4 per Cent. Ditto		5 7 3	Jan, July	70	..
5	..	New Gen. Trac. 6 per Cent. Cum. Pref.	¼—1		May	..	—
1	0/9⅜	Potteries Electric Traction Ord.	⅛—⅜	8 0 0	April, Oct	..	..
1	0/6	Do. 5 per Cent. Cum. Pref.	⅝—⅞	6 13 0	Feb, Aug	..	..
St.	4½	Do. 4½ per Cent. Deb. Stock	93 —96	4 13 9	May, Nov	..	..
1	0 7½	S. Met. Elec. Trams. & Ltg. 6% Cm. Pref.	⅞—1⅛	5 7 0	Feb, Aug	..	..
St.	4%	Do. 4 per Cent. Deb. Stock	78 —82	4 17 0	Jan, July	..	..
10	5%	Sunderland Dist. Elec. Trms. 5% 1st Mt. Db.	73 —78	6 8 0	Jan, July	..	..
..	5%	Underground Elec. Rys. Co. of London...	39 —43	11 12 0	June, Dec	40½	39
5	..	Yorkshire (W.R.) Elec. Trams. Ord. ...	1 —1½	—	March ..	..	..
5	..	Do. 6 per Cent. Cum. Pref.	3 —3½		..	..	..
St.	4½	Do. 4½ per Cent. 1st Debs.	84 —87	5 3 6	Jan, July	..	..
		ELECTRIC MANUFACTURING, &c.					
1	..	Aron Electricity Meter Ord.	⅛—⅜			..	..
1	1/5	Do. 6% Cum. Pf.	3⅞—4⅛	7 7 6	April, Oct	..	..
1	1/7½	Babcock & Wilcox Ord.	3⅛—3⅜	6 12 6	April, Oct	3⅛	..
1	0/7½	Do. Pref.	1⅛—1 5/16	3 16 9		..	..
5	6/0	British Insulated & Helsby Cables Ord.	6⅛—6⅝	7 10 6	July, Feb	..	..
5	3/0	Do. 6 per Cent. Pref.	5⅝—6⅛	4 18 0	Jan, July	..	..
St.	4½%	Do. 4½ per Cent. 1st Mort. Deb. (red.)	102 —105	4 5 6	Jan, July	..	..
St.	4½%	British Thomson-Houst'n 4½% 1st Mt. Db.	94 —99	4 11 0	Mar, Sept	..	..
5	..	British Westinghouse 6 per Cent. Pref...	½—⅝	..	Feb, Aug	..	..
St.	4%	Do. 4 per Cent. Mort. Deb. Stock	46 —50	8 0 0	Jan, July	..	..
2	..	Brush Electrical Engineering	⅛	—	March ..	—	..
2	..	Do. 6 per Cent. Pref. non-Cum.	⅛—⅜	..	Mar, Sept	..	..
St.	4½%	Do. 4½ per Cent. Perp. 1st Deb. Stock	74 —79	5 11 0	Mar, Sept	..	—
St.	4½%	Do. Perpetual 2nd Deb. Stock	59 —64	7 0 0	Jan, July	..	..
5	5/0	Callender's Cable Con. Ord.	10¾—11¼	6 10 0	Jan, July	10¾	10 5/16
5	2/6	Do. 5 per Cent. Cum. Pref.	5½—6⅛	4 7 0	Jan, July	..	..
St.	4½%	Do. 4½ per Cent. 1st Mort. Debs. (red.)	100½—106½	4 2 6	Nov. May	..	..
1	1/7½	Castner-Kellner Alkali Co.	1 1/16—1 3/16	8 11 0	May, Nov	1⅛	..
St.	4½%	Do. 4½ per Cent. 1st Mort. Deb. (red.)	100 —103	4 7 6	Feb. Aug	102	..
1	0/9⅜	Chadburn's (Ship) Telegraph Ord.	1 1/16—1 3/16	8 [illegible] 0	March ..	..	..
1	0/7½	Do. 6 per Cent. Cum. Pref.	1 —1⅛	5 6 6	April, Oct	..	..
1	0/8½	Consolidated Electrical Co.	7/16—9/16	6 4 6	August ...	..	..
1	1/0	†Consolidated Signal Co.	1½—1¾	4 5 6	April, Oct	..	..
1	0 7½	† Do. 6 per Cent. Cum. Pref.	⅞—1	6 4 0	April, Oct	..	..
3	3/0	* Crompton & Co. (Nos. 1 to 95,000)	1½—1⅞	8 1 0	Jan, July	..	..
100	5%	Do. 5 per Cent. 1st Mort. Debs. (red.).	92 —95	5 5 0	Jan, July	..	..
1	0 7½	Davis & Timmons	⅞—1½	..	Mar, Sept	..	..
5	2/0	Dick, Kerr & Co. Ord.	1⅝—1⅞	7 5 6	Sept	..	..
5	0/7½	Do. 6 per Cent. Cum. Pref.	1 —1¼	4 16 0	Sept	..	..
St.	4½%	Do. 4½ per Cent. Deb. Stock	100 —103	4 7 3	Jan, July	101	—
5	2/6	Edison & Swan United ("A" Sh.) (£3 pd.)	¾—1	12 0 0	Feb, Aug	..	..
5	4/2	Do. (£5 paid)	1½—2½	5 0 0	Feb, Aug	..	—
St	4%	Do. 4 per Cent. Mort. Deb. Stock (rd.)	78 —81	4 19 3	June, Dec	..	..
St.	5%	Do. 5 per Cent. 2nd Deb. Stock	85 —87	5 15 0	Mar, Sept	—	..
5	..	Edmundson's Elec. Corp. Ord.	⅛—⅜	..	Jan, July	..	..
5	..	Do. 6 per Cent. Cum. Pref.	¾—1¼	..	May, Nov	—	..
St	4½%	Do. 4½ per cent. 1st Mort. Deb. (red.)	57 —62	7 5 0	Jan, July	..	..
2	..	Electric Construction Co.	¼—½	..	Jan, July	..	..
2	..	Do. 7 per Cent. Cum. Pref.	1¼—1¾	..	July	..	..
St	..	Do. 4 per Cent. Perp. 1st Mort. Debs.	64 —68	5 17 0	Jan, July	..	..
10	5/0	General Electric (1900) 5% Cum. Pref...	7¾—8¼	6 1 8	June, Dec	8	7⅞
St.	4%	Do. 4 per Cent. 1st Mort. Debs.	87 —90	4 9 0	Mar, Sept	..	
5	10/0	Henley's Telegraph Works Ord.	10½—11½	6 10 0	Feb, Aug	11	10⅝
5	2/3	Do. 4½ per Cent. Pref.	4⅞—5⅜	4 3 6	Feb, Aug	..	..
St.	4½%	Do. 4½ per Cent. 1st Mort. Deb. Stock	106 —108	4 3 0	Mar, Sept	..	..
10	15/0	India Rubber, Gutta Percha, &c., Wrks.	15½—16½	6 2 0	Feb, Aug	..	..
100	4%	Do. 4 per Cent. Debs (red.)	98 —100	4 0 0	April, Oct	98¼	98
1	2/0	National Elec. Construction Co.	⅜—⅝	..	April	..	..
1	1 8½	Richardsons, Westgarth & Co., Ltd. Ord.	[illegible]	7 2 0	Nov	..	..
1	0/7½	Do. 6 per Cent. Cum. Pref.	[illegible]	6 8 0	May, Nov	..	..
St.	4½%	Do. 4½ per Cent. Perp. Deb. Stock	87 —91	4 19 0	Jan, July	—	..
1	..	Simplex Conduits Ord.	1½	..	..	—	—
5	..	Do. 6 per Cent. Cum. Pref.	5½	..	..	..	..
12	30/0	Telegraph Construction & Maintenance	30½—32½	6 8 6	Mar, July	32	30¾
100	4%	Do. 4 per Cent. Deb. Bonds (1909) ...	100 —103	3 17 6	Jan, July	..	..
1	2 0	Vickers, Sons & Maxim, Ltd., Ord.	1 11/16—1 13/16	8 6 0	..	1¾	1 11/16
1	0/6	Do. 5 per Cent. non-Cum. Preference	⅞—1 1/16	4 14 6	..	1	..
St.	5%	Do. 5 per Cent. non-Cum. Preferred	101 —105	4 15 6	..	..	..
St.	4%	Do. 4 per Cent. 1st Mort. Db. Sk. red	102 —104	3 16 6	June, Dec	..	..
100	4½%	Do. 4½ per Cent. 2nd Mort. Deb. (red.)	102 —104	4 6 6	June, Dec	103¾	103
10	6 0	J. G. White & Co. 6 per Cent. Cum. Prf.	8 —9	6 13 0	Jan, July	..	..
5	1/0	†Willans & Robinson Ord.	1 —1½	3 6 8	Apr, Oct	1	..
5	3/0	† Do. 6 per Cent. Cum. Pref.	3⅝—[illegible]	7 15 0	Apr, Oct	3½	..
100	4%	Do. 4 per Cent. 1st Mort. Debs.	72 —77	5 4 0	May, Nov	..	..
		TELEGRAPHS.					
10	..	Amazon Telegraph	2 —3	—	June, Dec	..	—
100	5%	Do. 5 per Cent. Debs. (red.)	84 —87	5 15 0	June, Dec	..	..
St.	15/0	†Anglo American	56 —58	6 1 0	F,My,Ag,N	..	..
St.	50/0	† Do. Preferred	101 —104	5 19 6	F,My,Ag,N	100	98½
St.	1%	Do. Deferred	13½—14	7 3 0	F,My,Ag,N	13½	13⅜
St.	4%	Commercial Cable 4 per Cent. Deb. Stk.	84 —87	4 12 0	Jn,Ap,Jy,O	85	84¼
10	6 0	Cuba Submarine Ord.	7½—8½	6 9 6	Feb, Aug	..	..
10	10/0	Do. Preference 10 per Cent.	16 —17	5 17 9	Feb, Aug	..	..
5	2 0	Direct Spanish Ord.	2¾—3¼	5 13 0	April, Oct	..	..
5	5/0	Do. 10 per Cent. Cum. Pref.	8¼—9¼	5 8 0	April, Oct	..	..
50	4½%	Do. 4½ per Cent. Deb.	99 —102½	4 8 0	Jan, July	..	..
20	4 0	†Direct United States Cable	13½—14	6 11 6	Ja,Ap,Jy,O		
100	4½%	Direct West India Cable 4½% Rg. Db. (rd.)	99 —101	4 9 0	June, Dec		..
St.	5/0	Eastern Ordinary	130 —135	5 3 6	Ja,Ap,Jy,O	134	130
St.	17 6	Do. 3½ per Cent. Pref. Stock	84 —87	4 0 6	Ja,Ap,Jy,O	86	85½
St.	4%	Do. 4 per Cent. Mort. Deb. Stk. (red.)	101 —104	3 16 6	May, Nov	103¼	102¾
10	2/6	Eastern Extension	13—13½	5 4 6	Ja,Ap,Jy,O	13½	
St.	4%	Do. 4 per Cent. Deb. Stock	99 —102	3 18 6	Feb, Aug	.	..
100	4%	Eastern & S. African 4% Mort. Deb. 1900	99 —101	3 18 6	Feb, Aug	..	..
25	4%	Do. 4% Mauritius Sub. Debs. (red.) ...	100½—102½	3 18 6	May, Nov	..	..
10	5 0	Gt. Northern Copenhagen, with Coupon 72	31½—33½	5 19 6	Jan, July	..	.
100	4½%	Halifax & Bermudas 4½% 1st Mt. Db. red.	99 —101	4 9 0	June, Dec	..	..
..	12/6	Indo-European	56 —58	5 12 0	May, Nov	..	..
100	$1	Mackay Companies Common	58 —63	6 7 0	Jan, July	..	..
100	$1	Do. Preferred	[illegible]	6 0 0	Ja,Ap,Jy,O	..	..
1		Marconi's Wireless Teleg. Co. ...	[illegible]—⅜	..	April		..
100	4	Pacific & European Tel. 4% Guar. Dbs. red.	98 —101	3 19 0	June, Dec	..	—
10	10	West African Telegraph Shares	10 —10½	3 10 0	June, Dec	..	..
7½	1 3	West Coast of America	1⅛—1½	3 6 6	May		..
100	4%	Do. 4 per Cent. Deb.	98 —101	3 19 0	Jan, July	99	..
10		West India & Panama	[illegible]	..	May, Nov		..
10	6/0	Do. 6 per Cent. 1st Pref.	7¾—8½	6 17 0	May, Nov	..	..
10	20/0	Do. 6 per Cent. 2nd Pref.	8 —9	..	May, Nov	.	..
100	5%	Do. 5 per Cent. Deb.	103 —104	4 16 0	Jan, July		..
10	[illegible]	Western Telegraph	12¾—13¼	5 1 0	Mr,Jn,S,D	13	13
St	4%	Do. 4 per Cent. Deb. Stock (red.)	99 —101	3 18 6	June, Dec	100	..
..		Western Union Teleg. 4½% Bonds	76 —80			.	..

Share	Last Dividend	Name	Price Wed., April 22.	Rate % Yield £ s. d.	Dividend Due	Business 8 Days to April 22. Highest	Lowest
		TELEPHONES.					
100	28	Amer. Telephn. & Telegh. Cap. St.	118 —122	6 11 0	Jan, July	120	
..	4%	Do. Coll. Trust $1,000 4 per Cent. Bds	85 —87	4 14 9	Jan, July	83	
St.	5%	Anglo-Portug'se Tel. 5% 1st Mt. Db. Stk.	98½—101½	4 19 0	Mar, Sept	..	—
5	3 0	Chili Telephone	7 —7½	5 6 6	August ..	..	—
1	0/9⅜	Monte Video Telephone Ord.	1 1/16—1 3/16	5 13 0	Nov	1	..
1	0/6	Do. 5 per Cent. Pref.	⅞—1	5 0 0	May, Nov	..	—
St.	6%	National Co. Pref. Stock	107 —109	5 10 0	Feb, Aug	108½	—
St.	6%	Do. Def. Stock	108 —110	5 9 0	Feb, Aug	109½	108½
10	6/0	Do. 6 per Cent. Cum. 1st Pref.	10 —12	5 0 0	Feb, Aug	..	..
10	6/0	Do. 6 per Cent. Cum. 2nd Pref.	10 —12	5 0 0	Feb, Aug	..	..
5	2/6	Do. 5 per Cent. non-Cum. 3rd Pref.	5⅜—5⅞	4 9 0	Feb, Aug	..	..
St.	3½%	* Do. Deb. Stock 3½ per Cent. (red.)	98 —100	3 10 0	June, Dec	98½	..
St	4%	Do. 4 per Cent. Deb. Stock (red.)	101½—103½	3 17 0	Jan, July	102¼	..
1	0/7½	Oriental	1⅛—1¼	4 13 6	April, Oct		
1	0 7½	Do. 6 per Cent. Cum. Pref.	1⅛—1¼	4 16 0	April, Oct	..	..
St.	4%	Do. 4 per Cent. Red. Deb. Stock	90 —93	4 6 0	Jan, July	..	..
St.	4½%	Telephone Co. of Egypt 4½% Db. Stk. (red.)	99 —102	4 8 0	Jan, July	..	—
5	3/0	United River Plate	6 —6½	6 3 0	July		
5	2/6	Do. 5 per Cent. Cum. Pref.	4¾—5½	4 16 0	June, Dec	5½	..
St.	4½%	Do. 4½ Deb. St. Red.	99 —102	4 8 3	Jan, July	..	..
		FINANCIAL, INVESTMENT, &c.					
5	3/0	Elec. & Gen. Investment 6% Cum. Pref.	3¾—4¼	7 1 0	Jan, July	—	..
10	2 0	Globe Telegraph & Trust	9⅝—10⅛	5 6 0	SpDeMrJu	10½	9⅞
10	3/0	Do. 6 per Cent. Pref.	13¾—14¼	4 4 0	SpDeMrJu	14	13¾
10	6%	†Submarine Cables Trust (Cert.)	126 —129	4 13 0	April, Oct	126	..
		COLONIAL AND FOREIGN ELECTRIC RAILWAYS, TRAMWAYS, &c.					
5	3/0	Anglo-Argentine 6% Cum. 1st Pref.	6¼—6¾	4 13 6	April, Oct	6⅜	6¼
5	5 0	† Do. 10% Non-cum. 2nd Pref.	8 —8½	6 1 3	Jan, July	8⅛	8⅛
St.	6%	Do. Permanent 6% Deb. Stock	132 —137	4 7 6	June, Dec	..	..
St.	5%	Auckland Elec. Trams. 5% Deb. (red.)	104 —107	4 13 6	Jan, July	106½	105½
5	2/0	Brisbane Electric Trams. Invest. Ord.	3¾—4½	2 8 6	May	..	..
5	2 6	Do. 5 per Cent. Cum. Pref.	4¾—5	5 0 0	May, Nov	..	..
St.	4½%	Do. 4½ per Cent. Db. Prov. Certs.	98 —102	4 8 0	Jan, July	..	..
St.	8%	British Columbia El. Ry. Df. Ord.	132 —135	5 18 6	Mar, Sept	..	..
St.	6%	Do. Pref. Ord. Stock	110 —114	5 5 0	May, Nov	113½	..
St.	5%	Do. 5% Cum. Perp. Pref. Stock	106 —110	4 11 0	Jan, July	..	..
4½	4½%	† Do. 4½ per Cent. 1st Mort. Debs.	99 —102	4 8 0	April, Oct	..	..
100	4½%	Do. Vancouver Power Debs.	101 —104	4 6 6	Jan, July	..	..
St.	4½%	Do. 4½% Perp Cons. Deb. St.	98 —101	3 19 0		..	..
5	3/0	Buenos Ayres & Belgrano Ord.	4⅝—4⅞	8 1 6	April, Oct	..	..
5	3/0	Do. 6 per Cent. "A" Cum. Pref.	4⅝—5⅛	5 17 6	April, Oct	..	..
5	3 0	Do. "B"	4⅝—5⅛	5 17 6	April	..	..
St.	5%	Do. 5 per Cent. Debs.	110 —116	4 6 0	Jan, July	—	..
St.	5%	Do. 5 per Cent. 2nd Debs. (red.)	102 —105	4 15 3	Jan, July	..	..
St.	5%	Buenos Ayres Elec. Trams (1901) Ltd. Deb. St.	95 —99	5 1 0	Ja, Jul ..	..	..
5	..	Buenos Ayres Grand National Ord.	2⅛—2⅝	..		..	..
5	2/6	Do. 5 per Cent. Cum. Pref.	3¼—4¼	5 18 0	Feb, Aug	..	..
100	5½%	Do. 5½ per Cent. Pref. Debs.	100 —104	5 5 9	Jan, July	101½	..
100	6%	Do. 6 per Cent. 1st Deb. Bonds.	97 —101	5 19 0	April, Oct	..	..
St.	5%	Buenos Ayres Lacroze Trams 1st Mt. Db.	92 —95	5 5 0	Mar, Sept	93½	..
St.	6%	Buenos Ayres Port & City Tram. 1st Mt. Deb. Stock £75 Paid	64 —68	6 12 0	Feb, Aug	..	..
5	3/6	Calcutta Tramways (1 to 137,010)	6 —7	5 14 0	Mar, Sept	..	..
100	2/6	Do. 5 per Cent. Cum. Pref.	5 —5¼	4 13 0	Jan, July	..	..
1	4½%	Do. 4½% 1st Deb. Stock (red.)	103 —106	4 5 0	Jan, July	..	..
St		Cape Electric Tram Shares	⅝—[illegible]	..			—
5	1 3	City of Buenos Ayres Trams Co. (1904) Sh.	5¼—5¾	4 10 0	F,My,A,N	5⅝	..
St.	4%	Do. 4 per Cent. Deb. Stock	99 —103	3 17 6	June, Dec	..	..
	5%	Colombo Tr. & Ltg. 5% 1st Mt. Db.	89 —93	5 6 0	May, Nov	..	..
100	5%	Electric Traction Co. of Hong Kong 5 per Cent. 1st Mort. Debs.	87 —92	5 8 6	June, Dec	..	..
1	5%	Havana Elec. Ry. Con. Mt. 5% $1,000 50 year Coup. Bds.	80 —85	6 17 6	Feb, Aug	84¼	83¾
1	..	Kalgoorlie Elec. Trams Sh.	⅛—[illegible]	..			..
10	5%	Do. 5 per Cent. "A" Deb. Stock	87 —91	5 8 9	Jan, July	..	..
St.	6%	Do. 6 per Cent. "B" Ditto	71 —75	7 17 0	Jan, July	..	..
5	1/0	Lisbon Elec. Trams. Ord.	1 —1¼	4 0 0	July	..	..
100	0/7½	Do. 6 per Cent. Cum. Pref.	1 —1¼	4 16 0	Jan, July	..	..
St.	5%	Do. 5 per Cent. Reg. Mort. Debs	90 —95	5 5 0	Jan, July	..	..
St.	5%	Madras Elec. Trams. 5% Deb. Stk.	95 —98	5 2 0	Jan, July	..	..
	5%	Manila Elec. Ry. $1,000 Gold Bonds	86 —90	5 11 3	Feb, Aug	..	..
100	$1	Mexico Trams Co. Com. St.	82 —84	4 15 0	..	83½	81
500	5	Do. Gen. Con. 1st Mort. 5% Gold Bds.	85½—86½	5 16 6	..	86	85
St.	4½%	Montreal St. Ry. Sterling 4½ per Cent. Debs. (1922)	101 —103	4 7 6	Feb, Aug	..	..
1	1/0	Perth Elec. Trams Ord.	9/16—11/16	7 5 6	May	.	..
St	5%	Do. 1st Mt. Db. Stock	103 —106	4 14 3	Jan, July	—	..
5	3/0	Rangoon Elec. Trams & Supply Co. 6% Cum. Pf.	[illegible]	5 7 6	..	..	—
St.	4½	Do. 4½% 1st Mort. Deb. Stk.	97 —99	4 11 0	..	..	..
.	[illegible]	Sao Paulo Tramway, Light & Power Co. $100 Stock	128 —133	6 15 0	..	..	..
	5%	Do. 5 per Cent. 1st Mt. $500 Db.	96 —98	5 2 0	June, Dec	97½	97
100	4½%	Toronto Ry. Co. 1st Mt. 4½% Ster. Bonds	99 —101	4 9 0	Feb, Aug	..	..
		COLONIAL AND FOREIGN ELECTRICITY SUPPLY, &c.					
5	8 0	Adelaide Elec. S'ply Co. 6% Cu. Pr.	4⅝—5⅛	5 17 0	Mar, Sept	..	—
10	5/2	Bombay E. S. & T. 6% Cm. Pf.	9⅝—10⅝	5 15 6	..	10	..
St.	4½%	Do. 4½ per Cent. Deb. Stk. (red.)	93 —95	4 15 0	Jan, July	..	.
5	3/3	Calcutta Elec. Supply Ord.	6⅞—7⅛	6 8 6	April, Oct	..	..
100	7/2	Canadian Gen. Elec. Co. Com. St.	97 —101	10 2 0	..	99½	97½
100	5%	Castner Electrolytic Alkali Co. (of U.S.A.) 1st Mort. Stl. Debs	94 —99	5 1 0	Jan, July	.	..
500	5	Elect. Development Co. of Ontario	74 —77½	6 10 0	..	75½	75
5	..	Elec. Ltg. & Trac. Co. of Aust. 6 per Cent. Cum. Pref.‡	2¼—2¾	..	Feb, Aug	..	..
St.	5%	Do. 5 per Cent. Deb. Stock	81 —85	5 14 0	Jan, July	..	..
St	5%	Elec. Supply Co. of Victoria 5 per Cent. 1st Mort. Deb. St.	91 —94	5 6 0	Jan, July	..	..
St.	6%	Indian Elec. Sup. & Trac. Co. Deb. St. Rd. Prov. Certs.	95 —98	6 2 0	Jan, July	..	..
10		Kalgoorlie Elec. Power & Ltg. Ord. ...	[illegible]	.	..	..	..
.	1/7½	Do. 6 per Cent. Cum. Pref.	[illegible]	8 0 0	April, Oct	..	—
St.	6%	†Madras E. S. Corp. 6 per Cent. Constn. Deb. St.	89 —92	5 8 6	April, Oct	..	..
500	5%	Mexican Elec. Light Co. 5% 1st Mort. Gold Bonds	76 —78	6 8 0	..	76⅞	76½
St.		Mexican Lt. & Power Co. Cap. St.	49 —51	..	..	50½	49½
100	5%	Do. 5% 1st Mort. Gold Bnds	83 —85	5 17 6	..	84½	84¼
100	4	Montreal Lt. Ht. & Power Co. Cap. St.	97 —100	6 0 0	F,My,A,N	96½	..
1	0/6	River Plate Electricity Co. Ord.	[illegible]	[illegible] 8 6	April ..	[illegible]	[illegible]
1	1 2½	Do. 6 per Cent. non-Cum. Pref.‡	[illegible]	6 12 6	May	[illegible]	1
St.	5%	Do. 5 per Cent. Deb. Stock	96 —99	5 1 0	Jan, July	.	..
5	3/0	Rosario Elec. Co. 6% Pref. (1–20,000)	4¾—5¼	5 17 6	April, Oct	4⅞	..
100	$1	†Shawinigan Water & Power Co. Cap. St.	63 —65	6 3 0	..	64½	..
	5%	Do. 5 per Cent. Bds.	102 —104	4 17 0	Jan, July	..	..
..	7 [illegible]	Victoria Falls Power Co. Pref.	[illegible]	—	Jan, July	..	..

* In calculating the yields allowance has been made for accrued interest but not for redemption. † Ex dividend. ‡ The London Stock Exchange Committee have declined to quote these.

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CONTENTS OF THE CURRENT NUMBER.

NOTES.

The Institution of Electrical Engineers.

AT the meeting of the Institution held yesterday evening the following nominations for election of Council and officers for the year 1908-9 were announced:—

President.
Mr. W. M. Mordey.

Vice-Presidents.
**Mr. F. Gill.* — Dr. G. Kapp.
Col. H. C. L. Holden, F.R.S. — **Mr. C. P. Sparks.*

* These members having served only two years as vice-presidents are both eligible for re-election for one year in that capacity.

Members of Council.
Mr. S. Evershed. — Mr. M. O'Gorman.
Mr. H. E. Harrison. — Mr. G. W. Partridge.
Dr. E. Hopkinson. — Mr. W. H. Patchell.
Mr. J. W. Jacomb-Hood. — Mr. W. Rutherford.
Mr. J. E. Kingsbury. — *Prof. A. Schwartz.*
Mr. T. Mather, F.R.S. — *Mr. J. F. C. Snell.*
Major W. A. J. O'Meara, C.M.G. — *Mr. G. Stoney.*
Mr. A. A. C. Swinton.

Associate Members of Council.
Mr. J. E. Taylor. — Mr. J. Hunter Gray.
Mr. H. Human.

**Hon. Treasurer.*
Mr. Robert Hammond.

* The hon. treasurer retires annually, and is eligible for immediate re-election.

Members of the Institution will no doubt be glad to see Mr. MORDEY at length nominated as President, for many of us have felt that this honour should have been given sooner, and have failed to understand why preference has been given to others. The new members of the Council are well known to our readers: Mr. MATHER, in connection with electrical instruments and accurate measurements; Major O'MEARA, as engineer-in-chief to the Post Office; Prof. SCHWARTZ, as the author of some very thorough Papers read before the Institution; Mr. SNELL, in connection with power supply at Sunderland and more recently in London; and Mr. STONEY, as an engineer closely associated with the progress of Messrs. Parsons' turbo-generators. Mr. J. E. TAYLOR, the new associate member of Council, is assistant superintending engineer in the Postal Telegraph Department, of London, and was joint author of a Paper on "Wireless Telegraphy Measurements" with Mr. DUDDELL which was read before the Institution in 1905. Hitherto, the nominations have not been made known prior to the general meeting at which they were announced, and, therefore, it has been practically impossible for members to put forward any rival nominations in time for consideration. At the last annual general meeting, however, it was made known that the Council had decided to publish the nominations in advance of the meeting at which they would be announced, so as to give more time for their consideration. This course has now been followed, but on the present occasion we do not think the members will have any desire to modify the list as drawn up by the Council.

A Groove Skid Emergency Brake.

ALTHOUGH brakes of various types operating upon the tread of the rail have been extensively adopted on electric tramways, very little, if any, use has hitherto been made of the rail groove for braking purposes. The groove, of course, offers several advantages over the rail tread. The tendency of the latter to become smooth and greasy when covered with mud has brought about many of the serious tramway accidents which have occurred, only too frequently, during the last few years. The rough surface of the groove presents, however, a much more efficient braking surface, and, as it is also possible to design a groove-brake to operate, at the same time, to some extent as a wedge, the retarding force obtainable may be very considerable, and thus, although the weight on a skidding wheel is as great as that on a skid brake, the latter has a much greater effect. This type of brake is also less likely to cause derailment of the car than are some forms of track brake, for with the latter it is possible to remove so much weight off the wheels that

the flanges have less power to control the motion of the car. For these reasons, great interest attaches to the groove skid-brake, described elsewhere, which has been brought out by Mr. P. J. PRINGLE, borough electrical engineer and tramway manager to the Burton-upon-Trent Corporation.

IT is, however, not only to the actual brake itself that we desire to draw attention, but to its method of application. With the majority of existing tramway brakes, a considerable amount of care and thought is necessary on the part of the motorman, in order that he may not, when an emergency arises, so apply his brakes that their combined effect is to a large extent useless. Thus, before applying any form of electric brake, he must release his wheel brakes so as to run no risk of rendering the former inoperative by reason of the locking of the wheels, or, if from a failure of current the car should begin to run backwards, a different application of such electric brakes becomes necessary. Whilst, even in the case of the correct application of the brakes by the motorman, his efforts may be rendered useless by the action of the conductor on the rear platform. It seems, therefore, that an emergency brake, to be perfectly satisfactory, should at least provide for the above contingencies, and the brake devised by Mr. PRINGLE certainly seems to do this. As will be seen from the description elsewhere, this brake is independent of any other, the application requires a minimum of thought on the part of the motorman, and as it can be applied with equal efficiency from the rear platform, either by the conductor or passengers, it provides the greatest security against accidents caused by sudden illness of the motorman. Any failure of the brake mechanism also results in the application of the brake, and in this respect it is again superior to electric or air brakes, which are dependent on the condition of their connections. It would certainly seem that all possible contingencies have been provided for in the Pringle groove skid brake. Probably such a brake will not give such a large retarding force as may be obtained by an electric track brake; and there is the standing objection against an emergency brake, that it is generally forgotten when the emergency arrives. But, given that an emergency brake is desirable, the groove skid has the very important advantage that it is purely mechanical, and is simplicity itself. From the tests we witnessed we are inclined to the view that the brake, as at present made, does not give quite sufficient retardation for all emergencies. In fact, its defect is that the brake is simply on or off, and the effect cannot be varied; it is a maximum or nothing, and the maximum has its least value on the maximum gradient of the line. Nevertheless it appears to be a very valuable addition to the brakes now available and offers another solution of the brake problem.

Metallic Filament Lamps.

If proof were needed of the great progress now being made in metallic filament lamps, we need only refer our readers to the notes given elsewhere on the lamps at present available. So rapid has been the advance that the purchaser is apt to be bewildered by the number of lamps from which his choice may be made. The short account that we give will, therefore, no doubt be found useful by our readers. Numerous as the lamps are at present there are indications that the number will be very considerably increased in the near future, and our list would be materially longer were we permitted to give some account of the lamps which are not yet upon the market, but which the makers hope very shortly to render available. The most noticeable feature, no doubt, is the persistent way in which the problem of providing a unit suitable for use on high-voltage circuits has been dealt with. Considering the youthfulness of the metallic filament lamp, and the fact that only a short time has elapsed since great difficulty was experienced in making a lamp suitable for a pressure of even 100 volts, the progress that has been made is little short of marvellous.

The Indo-European Telegraph Co.

THE annual meeting of the shareholders in the Indo-European Telegraph Co., held on Tuesday, marked the fortieth year of the existence of this pioneer undertaking. The "Indo" was splendidly organised at the start, has been splendidly managed throughout, and has always possessed the services of a most competent and devoted staff both at home and abroad. It was, therefore, fitting that the fortieth anniversary of the formation of the Company should be made the occasion to present to Mr. J. HERBERT TRITTON, the chairman of the Company, who has been a member of the Board of Directors from the first, a token of the great regard in which he is held by his colleagues and by the home and foreign staff. A large public outside the Company, including the whole telegraphic world, will join in wishing Mr. TRITTON many years of continued good health and activity, and the "Indo" a continuance of that prosperity which its well-rendered service so thoroughly merits.

Royal Society.—Among the Papers read at a meeting of the Society yesterday afternoon was one "On the Hysteresis Loss and other Properties of Iron Alloys under very Small Magnetic Forces," by Prof. E. Wilson and Messrs. V. H. Winson and G. F. O'Dell.

Proposed University for Bristol.—It is announced that the Gloucestershire County Council have passed the following resolution in support of this movement:—"That this Council approves of the scheme for promoting the Bristol University and will consider what, if any, financial assistance they can accord to it when the scheme is more fully developed."

Electric v. Steam Traction on German Main Lines.—As is well known, the Prussian railway authorities have been for some time past conducting experiments to decide whether the adoption of electric traction on main lines is economically practicable. Possibly as a result of these experiments it is now announced that the lines from Leipzig to Magdeburg, a distance of 80 miles, and from Leipzig to Halle, a distance of 23 miles, are to be equipped electrically. It is proposed to use shorter trains running at more frequent intervals than at present, and careful comparisons of the cost and practicability of electric and steam traction are to be made.

Incorporated Municipal Electrical Association.—The provisional programme of the thirteenth annual convention of this Association, to be held at Nottingham, under the presidency of Mr. H. Talbot, from June 30th to July 3rd. A reception will be held by the Mayor of Nottingham, and a number of visits and excursions to places of interest in the neighbourhood have been arranged. The following are some of the subjects which, it is hoped, will be discussed: "The Experiences of a Convener in Establishing an Electrical Undertaking," "The Equipment of a Testing Department," "Alternating-current Accumulator Sub-stations," "The Designing of Electrical Generating Stations," "Overhead Equipment."

Cable Interruptions.	Date of Interruption.
Cadiz—Teneriffe	April 22, 1908
Alexandria—Larnaca	April 29, 1908

Manchester Section of the Institution of Electrical Engineers.—The following have been elected to serve on the committee of this section during the session 1908-9: *Chairman*—Mr. Miles Walker. *Vice chairman*—Mr. S. J. Watson. *Hon. Secretary and Treasurer*—Mr. H. W. Wilson. *Committee*—Messrs. W. Cramp, A. P. M. Fleming, J. Frith, G. Layton, V. A. H. M'Cowen, W. P. Maycock, J. S. Peck, P. A. Ramage, Prof. A. Schwartz, C. F. Smith, C. D. Taite, A. P. Wood.

The Institution of Civil Engineers.—At the annual general meeting of the Institution of Civil Engineers, held on Tuesday evening, April 28th, the result of the ballot for the election of officers was declared, as follows: *President*—Mr. James Charles Inglis; *Vice-Presidents*—Mr. W. R. Galbraith, Mr. G. H. Hill, Mr. A. Siemens and Prof. W. C. Unwin; *Other Members of Council*—Mr. J. A. F. Aspinall, Mr. B. H. Blyth, Mr. C. A. Brereton, Mr. W. B. Bryan, Mr. R. Elliott-Cooper. Col. R. E. B. Crompton, C.B., Dr. G. F. Deacon, Dr. F. Elgar, Mr. M. Fitzmaurice, C.M.G., Mr. A. T. Grant-Dalton, Mr. R. A. Hadfield, Dr. C. A. H. Harrison, Mr. J. Hobson, Mr. W. Hunter, Mr. G. R. Jebb, Sir Wm. Thomas Lewis, Bart., Sir George T. Livesey, Mr. A. G. Lyster, Mr. Thos. Matthews, Mr. A. B. Moncrieff, Mr. A. Ross, Mr. J. H. Ryan, Mr. J. Strain, Sir Frederick R. Upcott, K.C.V.O., Mr. W. B. Worthington, and Mr. A. F. Yarrow. This Council will take office on the first Tuesday in November, 1908.

Wireless Telegraph Notes.—We understand that, owing to the success attained by the special type of wireless instruments used on destroyers, larger vessels are also to be fitted with this equipment. The "Moy," which is refitting at Devonport, will be the first vessel to be so equipped, and she lately received her new insulated rigging and wireless yards. The rigging is fitted so that the maximum support is given to the light mast and yard to meet the exceptional strain put upon them in a seaway owing to the quick motion of this class of vessel.

It is announced that wireless telegraph stations are being erected by the Italian Government authorities at Asmara (in Eritrea), and Giumbo, Merca, Brava and Mogadishu (in Italian Somaliland). The apparatus installed at Giumbo, Merca and Brava will have an effective range of 200 to 250 miles, while at Mogadishu and Asmara more powerful installations will be erected, as the distance between the two stations is about 1,000 miles. It is also intended to provide for communication between the latter place and the Monte Mario station at Rome.

A suggestion has been made to the Colonial Office by the Liverpool Chamber of Commerce that the Department should establish short-distance wireless telegraph stations between British colonies. The Chamber has been notified that the subject is receiving the attention of the Department.

The *Dundee Advertiser* states that the Cunard liner "Caronia," which recently arrived at Liverpool from New York, succeeded in establishing communication with Glace Bay (Nova Scotia) when 2,260 miles distant, and at the same time communication, it is stated, was established with Clifden (Galway) when the vessel was 936 miles distant.

The Politics of Radio-Telegraphy.—The *Edinburgh Review* for April contains an instructive article with the above title in which the author reviews at some length what may be termed the radio-telegraph position, the object being to place readers of the *Edinburgh* in possession of the main facts concerning the history of what may be termed the new science and practice of communication by means of electromagnetic waves. The value of the investigations of several of the principal workers in radio-telegraphy is duly credited, including that due to Sir Oliver Lodge for his famous lecture introducing the subject at the Royal Institution in 1894. The bearing of recent legislation upon the practice and industry of wireless telegraphy is well shown, as is also the necessity for legislation in order that radio-telegraphic working may be under effective control. How necessary such legislation had become and how desirable it was that the State should step in and organise the business of radio-telegraphy is also well shown by the writer, who has a clear grasp of his subject and writes in a manner both instructive and interesting to the lay reader. It is, of course, in the field of ship and shore work that the greatest advance in radio-telegraphic operations has been made, and the writer of "The Politics of Radio-Telegraphy" has a great deal to tell us of the political aspects of the question. The interest taken by the German Emperor in this subject from the earliest date, resulting in his invitation to the powers for a Conference in Berlin, as far back as 1903, is noted. The *Edinburgh* writer has also, of course, a good deal to say concerning the methods of the Marconi Company in pushing its claims to recognition, and also of the methods adopted by the Press in this and other countries in the interests of the Marconi Company. With such matters we have little to do, but it is clear that politics (and not very high politics) played a considerable part in the "development" of radio-telegraphy up to a quite recent date. Readers of *The Electrician* have been kept well-informed of the progress of events radio-telegraphic, but the public generally have not been quite so well treated, with the result that there is a good deal of misconception, not to say ignorance, of the real truth concerning the rise and progress of this branch of industrial enterprise. We may very well refer all for whom the subject has an interest to the pages of the *Edinburgh Review* for April for a full account of the happenings, from the "political" side at any rate, in respect to this branch of practical electrical work during the past decade. We cannot conclude this brief summary of the *Edinburgh* article without saying that we think the writer scarcely does justice to the technical press in his somewhat copious notes. This is probably due to the fact that the main object of the article is to show the political side of the question, with which the technical press has little, if anything, to do. But a few additional notes would, we think, have been of assistance to the general reader. There are several references in the *Edinburgh* article to which exception might be taken, and we have no doubt that Mr. Marconi and his advisers will be afforded an opportunity to reply. If, too, the article were not ostensibly devoted to the "politics" of radio-telegraphy, some exception might be taken to the omission of several names from the list which finds favour at the hands of the *Edinburgh* writer. His grip of the subject precludes the presumption that he is unacquainted with the pioneers and others whose claims to notice are not included in his review.

ARRANGEMENTS FOR THE WEEK.

FRIDAY, May 1st (to-day).

ROYAL INSTITUTION.

9 p.m. Meeting at Albemarle-street. Discourse on "The Scientific Work of Lord Kelvin," by Prof. J. J. Larmor, Sec. R.S.

MONDAY, May 4th.

SOCIETY OF ENGINEERS.

7:30 p.m. Meeting at the Royal United Service Institution, Whitehall. Paper on "The Design and Waste and Wear of Wheel Teeth," by Prof. R. H. Smith.

TUESDAY, May 5th.

ROYAL INSTITUTION.

5 p.m. Meeting at Albemarle-street. Lecture on "The Development of the Modern Steam Turbine and its Applcation," by Mr. G. Stoney. Lecture II.

WEDNESDAY, May 6th.

STUDENTS' SECTION OF THE INSTITUTION OF ELECTRICAL ENGINEERS.

7:30 p.m. Meeting at 92, Victoria-street. Annual General Meeting. Paper on "The Swiss Visit," by Messrs. Moss and Abel.

THURSDAY, May 7th.

INSTITUTION OF ELECTRICAL ENGINEERS.

8 p.m. Meeting at the Royal Society of Arts, John-street, Adelphi, W.C. Paper on "The Manufacture of Electrical Condensers," by Mr. G. F Mansbridge.

CIVIL AND MECHANICAL ENGINEERS SOCIETY.

8 p.m. Meeting at Caxton Hall, Westminster. Paper on "Abbreviated Formulæ for Structural Engineers," by Mr. E. F. Etchells.

FRIDAY, May 8th.

PHYSICAL SOCIETY.

8 p.m. Meeting in the Physics Laboratory, Royal College of Science, Imperial Institute-road, South Kensington. Agenda: "A Modified Theory of Gravitation," by Dr. C. V. Burton; "An Examination of the Formulæ for the Grading of Cables," by Mr. C. S. Whitehead; and "Illustrations of Geometrical Optics," by Mr. R. M. Archer.

ASSOCIATION OF ENGINEERS-IN-CHARGE.

8 p.m. Meeting at St. Bride's Institute, Bride-lane, Fleet-street. Annual General Meeting.

ROYAL INSTITUTION.

9 p.m. Meeting at Albemarle-street. Discourse on "Ice and its Natural History," by Mr. J. Y. Buchanan.

DIRECT-CURRENT GENERATORS FOR LIGHT, POWER AND TRAMWAY SERVICE.

BY E. KORRODI.

Summary.—Combined light-and-traction plants have a smaller generator capacity than separate plants, as the combined maximum demand is much less than the sum of the two maxima, and fewer spare sets are required with only one type of generator. This advantage is, however, somewhat reduced by an increase in the size of the generators, which, in the case of ordinary direct-current machines at 440 to 480 volts and 500 to 550 volts, is about 30 per cent., and is partly due to the more severe commutation conditions at the lower voltage.

As the size of interpole machines depends entirely upon the product of maximum current and maximum voltage, their increase in capacity is only 15 per cent. Thus, it is possible to build interpole machines of sufficient capacity to carry the maximum overload, under any condition of voltage, more economically than those of the ordinary non-interpole type, and with at least as good a performance.

As the vast majority of electric light and tramway undertakings in Great Britain are owned by municipalities, the energy for light, power and tramways is often generated in one station.

The tramways are operated from compound-wound generators at from 500 to 550 volts; while light and power distribution is usually laid out on the three-wire system, with either shunt or compound-wound generators giving from 440 to 480 volts across the outer wires. The highest voltage possible for both circuits has been adopted, through reasons of economy, and the limit of this voltage is mainly fixed by the design of the consuming apparatus—motors and lamps.

Due to the difference in voltage for tramways and lighting, it is difficult to employ *duplicate* generators for both services, and, therefore, from a purely technical point of view, two different generating plants are necessary, each of which must be capable of meeting the maximum demand of its particular circuits, and each must have additional sets to provide for emergency loads.

An economical advantage is gained by using one type of generator for the two services, thereby reducing the number of spare sets and making smaller plants sufficient for the output if the maximum demands of the two circuits occur at different times; for instance, at different seasons of the year. The generators are then required to give their normal load and overload on the lighting system at 480 volts, either shunt or compound wound, and at 550 volts compound wound on the tramway system.

An investigation of the operation of the machines over wide ranges of voltage shows how these conditions can be met in practice with either the ordinary type of generator or the interpole machine.

Straight (or Non-Interpole) Machines.—The main feature to be considered is commutation, as, in the interests of reliable service, it is essential to make this sparkless. Sparking is traceable to the reactance voltage caused by the reversals of current in the coils short-circuited by the brushes. This voltage is practically proportional to the main current, and causes an extra current to circulate through the brushes and short-circuited coils. Again, this extra current, and, consequently, the sparking, may be reduced by high brush resistance, which also allows higher reactance voltage and larger current-capacity of a machine at given commutation conditions.

A further method of obtaining a high sparking limit is to compensate the reactance voltage with an E.M.F. of opposite direction. To effect this, the coils under commutation must rotate in magnetic fields of proper strength and polarity. The compensation of the reactance voltage is secured by simply shifting the brushes forward from the neutral position in the direction of rotation; thus making the short-circuit on coils rotating in the fringing field of the main poles. The strength of this commutation field can be apportioned for different loads by changing the brush position, and the sparking limit is then reached when the cross-magnetising effect of the armature so weakens the commutation field that the reactance voltage considerably exceeds the compensating E.M.F., irrespective of the position of the brushes. This happens usually when the short-circuited coils are directly under the pole tips, in which position the air path for the magnetic field, linked with these coils, is reduced, and, consequently, the reactance voltage is above normal.

The practice of shifting the brushes with variable load, however, rarely meets the requirements of modern service, good commutation being desirable with fixed brush position. Only imperfect compensation can be obtained with the fringing field of the main poles under this condition, and the reactance voltage must necessarily be kept low. The maximum forward lead of the brushes is then determined at no-load, when the sparking is due entirely to the E.M.F. induced by the fringing field in the short-circuited coils and the currents thereby produced in them. With increasing load such sparking as may exist at no-load will gradually disappear; the amount by which the compensating E.M.F. exceeds the reactance voltage becoming smaller, until at a certain load it is nil. After this the reactance voltage predominates, and the commutation is less satisfactory the higher the load.

The difference between reactance voltage and compensating E.M.F.—rightly called sparking voltage—is thus really the proper criterion for commutation. The cross-magnetising effect of the armature, and the consequent weakening of the commutation field with increasing load, which distinctly affects commutation, is thereby taken into account by the diminished value of the compensating E.M.F.

Voltage Variation and Sparking Limit.—The no-load characteristic of a direct-current generator (Fig. 1) shows the values

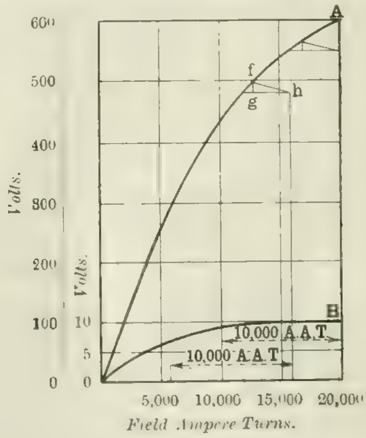


FIG. 1.

of the voltage, on open circuit and constant speed, for different field ampere-turns. The lower part of the curve is nearly straight, and its inclination depends upon the field ampere-turns required to overcome the magnetic resistance of the air-gap; while the gradual increase in excitation at higher voltages shows decreasing permeability of the iron as the latter approaches saturation.

Curve B (Fig. 1) is somewhat similar to the no-load characteristic, and gives the voltage induced in the short-circuited coils, at the maximum forward lead of the brushes, for varying field ampere-turns.

A comparison of curves B and A show that the iron path of the commutation field is saturated at lower excitation than that of the main field, which difference is due to the relatively small section of the pole tips, as compared with their surface.

As the commutation field is weakened under load conditions through the combined demagnetising and cross-magnetising effect of the armature, the resulting excitation of this commutation field is only the difference between field and armature ampere-turns. The value of the resulting excitation may be used to determine from curve B the compensating E.M.F. for any given load at any given voltage, as shown in Fig. 1, at 450 and 550 volts for a load corresponding to 10,000 armature ampere-turns. The ohmic drop and the demagnetising effect of the armature are represented by *fg* and *gh* respectively. The values of the compensating E.M.F. thus obtained show that commutation conditions become more difficult at the lower voltages. The sparking limit—*i.e.*, the maximum load obtainable with a given sparking voltage—can be found for any desired range of voltage from Fig. 2, where curve B of Fig. 1

is reproduced on a different scale of ordinates, and shifted parallel to the ordinate by an amount equal to 3 volts. These 3 volts represent the sparking voltage. The figures on the left of the ordinate axis give the armature ampere-turns, the corresponding reactance voltage and the compensating E.M.F., the reactance voltage being equal to the sparking voltage if there is no compensation. The distance OA represents both field ampere-turns and armature ampere-turns existing with a reactance voltage of 3, and is determined from the design of the machine.

If a straight line is drawn through A and the point on the ordinate fixing the sparking voltage, also a series of parallel lines through the points B, C and D to correspond to various

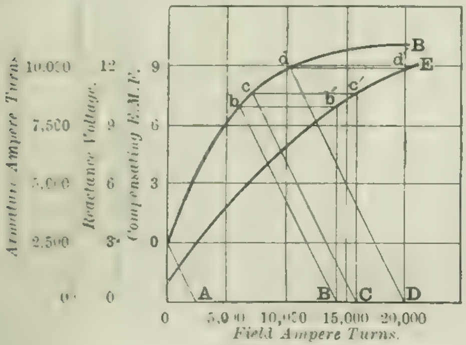


FIG. 2.

values of full-load field ampere-turns, the intersection of these lines with the ordinate axis give the reactance voltage existing with armature ampere-turns equal to field ampere-turns. Also, the intersections with curve B in the points b, c and d give the sparking limits. If the points b, c and d are now projected on the ordinates through B, C and D, the distances Bb', Cc' and Dd' represent, for different values of full-load excitation, permissible armature ampere-turns. These latter are proportional to the reactance voltage.

The curve E, drawn through points b', c' and d' is the commutation characteristic. It represents the relation of field ampere-turns to armature ampere-turns for given commutation conditions, and is thus the key to a comparison of the generator-output obtained at different voltages for given capital outlay.

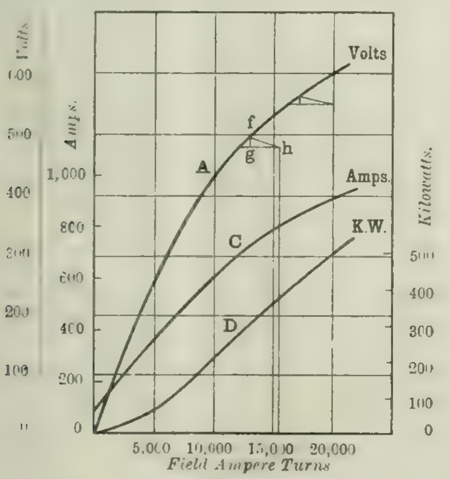


FIG. 3.

Fig. 3 shows the no-load characteristic A, and the commutation characteristic C for a 500 kw. generator. The voltage drop from no-load to full-load is given by the ohmic drop fg, and the demagnetising ampere-turns gh. The current capacity is represented by the ordinates of curve C, and the corresponding output in kilowatts by those of curve D.

The following table of ampere and kilowatt values for the main voltages, shows that over the normal range of voltage the current capacity diminishes approximately as the voltage. Consequently, the output changes with the square of the voltage.

Volts.	Amperes.	Kilowatts.
550	910	500
480	800	385
450	740	334

This rule applies fairly well to machines of modern and good design. It also shows, at a glance, the special difficulties existing with straight machines on combined light-and-traction service, which may be summarised as follows: In order to avoid commutation trouble with combined light-and-traction generators working on lighting systems at full-load or over-load, it is essential that the generators should be of 30 per cent. larger capacity than that required for separate lighting and traction plants. Also, the efficiency and temperature rise are usually lower than normal, on account of the larger machines being run at reduced rating. The economical advantage of a combined plant is thereby reduced.

Interpole Machines.—With properly designed auxiliary poles, excited by the main current, it is easy to obtain a commutation field which varies in strength with the load. The E.M.F. of self-induction can thus be overcome, without difficulty, if the compensating E.M.F. increases in direct proportion to the load. This condition exists only when the magnetic circuit of the commutation field is not saturated; but this can be obtained up to very heavy overloads. Commutation is, consequently, an unimportant consideration in the rating of interpole machines.

It is always possible to obtain, with the interpole type, such proportions that the maximum current commutated satisfactorily is large enough to become dangerous to the windings through excessive heating. The limiting output is thus practically decided by the operating temperature safe for the insulation; and this, again, depends upon the process of manufacturing and the insulating material used. An insulation

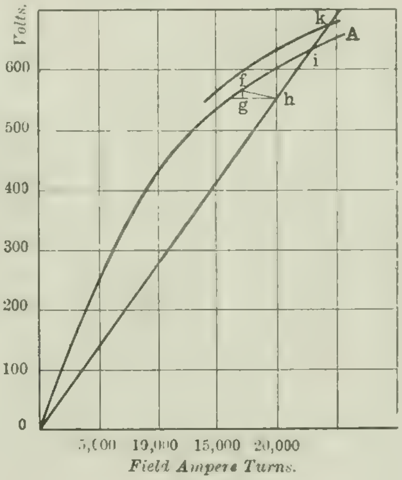


FIG. 4.

withstanding high temperature is, therefore, most desirable for interpole machines; and it is thus advantageous to use mica preparations on the parts of the coils embedded in the armature core, which are subject to the highest temperature. Treated taping is usually satisfactory for the end windings, as good ventilation—and, therefore, low temperature—can easily be secured for this portion of the winding. The temperature limit for treated tape is fixed at 85°C. by the German Normalien—a safe figure if reached during times of overload only.

Interpole machines, designed on the above basis, are as cheap and even cheaper than straight machines, and more flexible, it being possible to commutate the maximum current at any voltage. The increase in capacity of the machines for combined light-and-traction service is thus only in direct proportion to the difference in voltage of the two systems. A 500 kw. generator developing full-load at 480 volts shunt-wound, and 550 volts compound-wound, will consequently have a capacity of 1,042 amperes and 550 volts—*i.e.*, of 575 kw. or 15 per cent. more than is required for separate light-and-traction plants. The efficiency of interpole machines is practically constant over a wide range of load, the iron loss being usually kept low. For this reason the reduction of 15 per cent. in the output does not appreciably affect economy.

Voltage Regulation.—The inherent regulation of shunt-wound generators is generally poor at voltages much below the normal. This is due to the fact that on the lower part of the

saturation curve a large difference in voltage corresponds to a small magnetising or demagnetising effect. Interpole machines, with brushes in the neutral position, offer an advantage in that they have no demagnetising effect, and therefore they have small voltage drop from no-load to full-load with fixed field resistance. By shifting the brushes backwards a compounding effect may even be obtained, which further reduces the voltage drop. This expedient, however, is not to be recommended for practical purposes, owing to the fact that, should the current be reversed, the magnetic field is weakened and a short-circuit occurs. In Fig. 4 the ohmic drop in volts is represented by fg, and the demagnetising effect in ampere-turns by gh, and the intersection of the straight line through o and h, with the curve A, gives the no-load voltage at constant speed for the corresponding full-load pressure of 550 volts. In considering the effect of speed variation the ordinates of curve A are increased in proportion to the speed, and intersection of the straight line through o and h, with the second curve in the point k, gives the no-load voltage for a definite speed variation.

ELECTRIC SUPPLY PROSPECTS AND CHARGES AS AFFECTED BY METALLIC FILAMENT LAMPS AND ELECTRIC HEATING.

We give below an abstract of the important discussion which was resumed on Thursday, April 23rd, in connection with Messrs. Handcock and Dykes' Paper on this subject. An abstract of the Paper appeared in our issue of April 10th, and in our issue of April 17th we gave an account of the discussion which took place at the meeting on April 9th. Owing to the great interest taken in this subject at the present time, there was an unusual number of would-be speakers. Those who spoke were mostly limited to four or five minutes, and notwithstanding this restriction, many were "crowded out." The criticisms of the latter we have secured as far as possible and have reproduced them in abstract at the end of the discussion.

Mr. C. P. Sparks personally welcomed the metallic filament lamp as being the greatest step forward in the supply business that they had seen for the past 20 years, and he did not take such a pessimistic view as the authors. Any new development, such as the metallic filament lamp, came about gradually, and therefore the suppliers of electricity had a period in which to deal with the development. Then, if the public were going to keep to the present standard of lighting, it was true that the supply of electrical energy might fall off to, say, one-half, allowing for new consumers, but that would not be the case—the standard of lighting would be improved by the metallic filament lamp. Every improvement in lighting introduced had raised the standard of lighting. By the introduction of the incandescent mantle the gas industry received an enormous impetus, and became a real competitor of the electrical supply business. Now electrical engineers had in their hands a weapon that would enable them to compete with the gas companies. The authors put it that it would not pay, owing to the high cost of connection, to connect small consumers. He was sure, however, that there were an enormous number of small and moderate-size consumers that it would pay to connect. Then, again, as to the standard of light, people paid a certain amount for illumination and would continue to pay about the same figure. The great effect, however, would be felt in the private lighting business, and small companies supplying nothing but private lighting might receive a certain set back, but local authorities supplying large areas and doing a mixed class of business would find that the metallic filament lamp would lead to a general advance. As to tariffs, he had the greatest appreciation for Mr. Wright's methods, but he felt that they owed him a grudge for having invented the demand indicator, and its complication was probably one of the principal reasons why electrical business had progressed so slowly during the last few years. His own experience of demand indicators had been most unfortunate. The only method of charging that would find favour on a large scale would be a flat rate. The method suggested of charging a rate on the ratable value, and a small charge for current, was very ingenious, and might be workable for a small corporation or municipality, but could not be carried out by a company.

Mr. C. H. Stearn fully agreed with the authors that the most satisfactory transition from carbon to metallic filament lamps was made, on alternate-current circuits, by the use of local transformers. With direct current the problem was very much more difficult. Owing to the low specific resistance of metallic filaments they were bound to use them in series. In running them in series they could collect a number of filaments in one bulb, or they could put them separately in bulbs and then collect them together on one base, or they could distribute the small units at a distance from each other. The drawback to that system was that the higher the voltage the higher must be the unit of light that was concentrated in one spot, which was, of course, not the most efficient method of lighting. If they must run the lamps in series, however, it was much more economical to put the filaments in separate bulbs and collect them on to a common base, as if the filament in one bulb broke only that portion would require to be renewed. The cost of material in the several bulb fitment would be slightly higher, but the average life would be enormously increased. He had carried out one experiment with a five-filament fitment. At the end of 600 hours one of the filaments broke; this was renewed, and at the end of 2,000 hours another broke, and at 2,600 hours a third broke, leaving two which had been running all the time. Taking the original cost of the lamp at 5s. and 1s. for each separate filament renewal that would mean a cost of 8s. for 2,600 hours, instead of 5s. for 600 hours. If instead of assembling the filaments on one base they distributed them, running several in series, they had a more efficient system of lighting, but they had the disadvantage that if one lamp went out the whole lot would go out. The authors had suggested to him a method by which that difficulty might be overcome, and after some experiments they had hit upon the arrangement which he exhibited. (A description of this arrangement will be found elsewhere in this issue.)

Mr. P. Still thought that the authors' suggestion for charging on the contract demand was satisfactory in providing a satisfactory return on the capital. He had come to the conclusion, however, that it would not be practicable, as very serious difficulties would arise. The arbitrary fixing of the contract demand by the electricity supply manager would be a very difficult matter, and he felt sure that it would lead to interminable discussion with the consumer, who would be unable to form an idea of his load. It was true that the authors proposed the demand indicator to get over the difficulties, but he was sure that any such scheme would be not only unsatisfactory but expensive to maintain. A charge based on the contract demand might be workable with shops and business premises, but not with private houses. In the case of power supply for factories, of course, it was very different, and in that case such a system of charging might work very well. For private house lighting, what the consumer wanted was a flat rate, so that he could understand exactly what the charge was

Mr. L. Andrews considered that metallic filament lamps were an excellent thing for them all, particularly for the lamp manufacturers and wiring firms, and ultimately for the supply companies. It was true, however, that in some places the effect of metallic filament lamps was being seriously felt. As to systems of charging, it seemed to him that, however much they discussed that matter, they got no nearer to a satisfactory solution. Some speakers had said that a flat rate was best, but it seemed to him that even a flat rate was very inequitable. At Hastings they made a fixed charge of 10s per 8 c.p. lamp, as registered on a maximum demand indicator, and 1½d. per unit, and found that to work remarkably well, principally because every consumer understood it. Unless the system of charging could be understood by the consumer half the advantage was gone. The effect of introducing that system of charging was that the growth of business in three years following its introduction was greater than in the previous 15 years, and also there was an improved load factor.

Mr. J. F. C. Snell took a more optimistic view of the advent of the metallic filament lamp than the authors. By photometric comparison of gas mantles and metallic filament lamps, he found the equivalent cost of electricity, for the same amount of light, to be 3½d. per unit, a figure at which many stations were now supplying current. He could not help thinking that the use of transformers was a temporary expedient, as he was quite sure that makers would shortly produce lamps that would work singly on a 240 volt circuit. The figures of capital invested, given by the authors for gas and electricity, produced a pessimistic view of the electrical industry. He differed from the authors in their statement that a flat rate was not the best system. He had had some experience in the provinces, where gas was extremely cheap, of demand indicators and several methods of charging, and he thought that when electricity supply became more general a flat rate, varying according to the kind of consumer, would be the most successful.

Mr. Robt. Hammond believed that the metallic filament lamp was a magnificent thing for the industry. They were all acquainted with the fact that in many foreign cities gas had been entirely abolished, and he would say to the English gas managers of to-day that their tenure was a very short one. He was, however, not so sanguine that they were going to raise the standard of lighting, but an increase would be shown in the number of rooms wired, and electricity would be adopted in houses where it had not previously been used. So long as the gas companies paid such enormous dividends, he felt confident for the future of electricity, because it showed what an enormous field was open to electricity undertakers. With regard to the falling off of revenue, that would result in many places by the introduction of the metallic filament lamp; he was sure it was only temporary, although the immediate effect might be a dull one for the industry. He was entirely with the authors in ridiculing the idea of charging heating and cooking at a different rate to lighting. He could understand factories having power at a different rate, but he could not understand the double meter system in private houses.

(*Communicated.*)—The main point was what form of charge would secure the most profitable class of consumer. It was agreed that that class was the one which used the light the greatest number of hours. Some seemed to think this consumer could be best obtained by a flat rate. He entirely dissented. His opinion was that the authors were working on the right lines, and that the proposed system was one which would abolish many of the complaints connected with the maximum demand system. He saw, however, some objection to a system which might entail a constant source of anxiety upon the consumer, and he welcomed Mr. [illegible] that each consumer should be charged a rental based upon the [illegible] value of his house, and

in addition, a small running charge. He trusted that the outcome of this debate would be a determined attempt on the part of the leaders of the industry to get the Board of Trade to insert into their next electricity bill a provision enabling supply undertakings throughout the kingdom to make a fixed charge, whether by means of a "rate per kilowatt of maximum demand" or by a proportion of the assessment of the premises. With regard to the "fixed rate per kilowatt of maximum demand," this had figured in all the recent power acts and bills, and was included in the three bills of this session.

Mr. L. GASTER thought that if a flat rate system of charging were adopted a consumer ought also to have the advantage of the maximum demand system if it was found to work out at less than the flat rate. The maximum demand system was a great help to the station, and it was not right to charge a long-hour consumer at the same rate as a short-hour consumer. He was sure the metallic-filament lamp was going to be of immense advantage to the industry. The central station staff ought to educate the consumers as to the use of the lamps; and to increase the load he suggested that properly educated and efficient canvassers should be employed. Further, why should the electrical companies tie the consumer up with a lot of agreements, when the gas companies made it very simple?

Mr. SCOTT MONCRIEFF said that, if they were to secure the large number of small consumers, they must reduce the cost of service, and there was great scope for such a reduction. Another important point in that connection was that if the number of services was increased the cost of distributing mains per kilowatt would be reduced. He thought they had paid too much attention hitherto to very small houses with two or three rooms. The £34 or £35 per annum houses, of which there were a very large number, would pay for connecting. He regretted that the authors had not given some description of the method of dealing with the contract demand. He had seen some mechanism in America for measuring this, but he did not think it was worth adopting. Possibly a meter could be provided that would, when at maximum load, either record at double speed or at a considerably increased speed. There was a great field for extensions. If light was cheap, people would waste it, and in that way they might hope to largely increase their output and at the same time secure a much better load factor. In that event a different rate for lighting and power supply would be unnecessary, as they would be able to quote a rate for domestic lighting low enough to secure the use of current for domestic heating also.

Mr. E. K. RUTHVEN-MURRAY said that he had heard a rumour that the power factor of the small transformers suggested was exceedingly low, but he had found that that was certainly not so, and, in fact, it went up to nearly unity. Otherwise, it would be a rather serious drawback to alternate-current systems. The authors also considered that small consumers could not be profitably served by electricity supply undertakings. In his district 23 per cent. of the consumers were free wired, and the business resulting was quite satisfactory. Furthermore, it enabled them to get into districts where they would otherwise do very little. In that respect the free-wiring system was excellent. Another scheme which had a good deal to commend it, and which the advent of the metallic filament lamp made possible, was the supply of free lamps, charging for current at a high figure. The maximum demand system of charging caused much trouble, because many of the wiring contractors did not understand it. Mr. Andrews had referred to a system of charging 10s. per lamp and a low price for current. The low charge for current would have an enormous advertising value. He agreed with previous speakers that the contract demand system would be rather difficult to carry out.

Mr. F. GILL said the Paper seemed to show that it was desirable to consider the question of rating, and to take some steps in the matter. He had not studied electric light questions, but had made a special

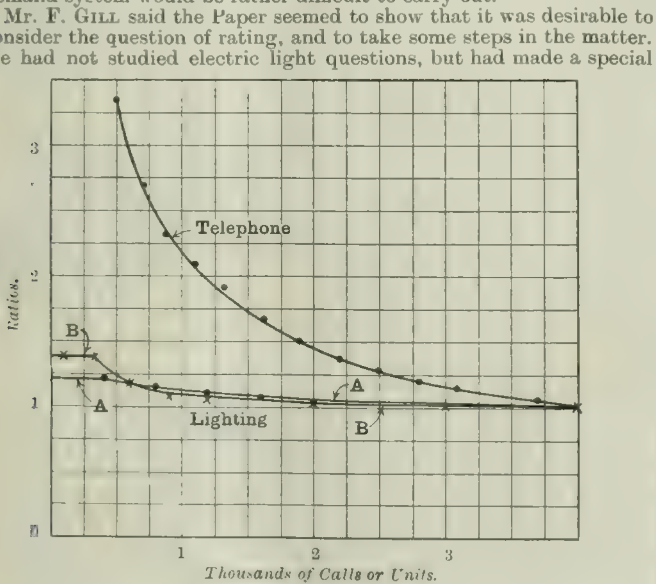


FIG. 1.

study of rating in telephone work, and the same lessons applied in both systems. A maximum demand system of any kind acted as a discouragement to the consumer to put in lamps or other devices which would be used for short hours. It was very important that a schedule of prices should be adopted which would be not only satisfactory to the suppliers, but also could be understood by the consumers. He exhibited a diagram (Fig. 1), two of the curves dealing with published electric lighting tariffs and the third with a telephone tariff, covering 4,000 calls per annum on the telephone and 4,000 units per quarter in the case of electric lighting, the idea being to show the ratio of charge to large or small consumers. Birmingham started at 5d. and went down to 3·61d. average cost. The Wimbledon charges began at 4½d. and went down to 3·65d. If a considerable reduction in consumption took place, as the authors alleged, the electricity supply people might get a bad set back, because the range over which the tariff operated was insignificant. In the telephone business they had a very much larger sliding scale, and those taking only a few calls paid a higher price than those taking a large number. Could not electric lighting folk get their tariff into some such simple form as used for telephone service and print it for the use of the consumer?

Mr. R. B. MATTHEWS said that the introduction of the metallic filament lamp had certainly been beneficial in getting electrical engineers to seriously consider what should be done to avoid decline. The new lamp would only have a temporary effect upon the profits of electric lighting stations, and in the end would do good by causing the consideration of what should be done to improve electric lighting generally. The points to be aimed at should be: (1) To increase the standard of illumination, (2) to encourage the demand for current-consuming devices besides lighting, such as for heating and cooking, (3) to increase the number of consumers, and (4) to reduce the cost of a service connection. Those points could be best attained by the aid of an efficient scheme of publicity and by a revised system of charging which would appeal more directly to the ordinary consumer, and at the same time would lead to meters, &c., being simplified and not duplicated. As to the cost of house service, in one district in London the average cost of a service was only £4, and in the case of meters there was a slot meter now on the market which cost only 30s. With a low cost for connection there were a large number of small consumers along the line of existing mains whom it would pay very well to connect. The Wright maximum demand system was an excellent one, but it failed as people could not understand it, and those who did try to understand it did not use as much current as they might otherwise. It had a retarding effect and led to economy more than it should.

Mr. W. M. MORDEY suggested, for the sake of simplicity, "wire" lamps instead of metallic filament lamps. They had no business with the word filament, which was introduced by the patent agents as determining what was a filament and what was a stick. He thought that the wire lamp was going to be a great advantage to the electrical industry. Mr. Wright had advocated the broad and easy methods of the gas companies, and he, the speaker, wished to emphasise that as much as he could. They were too anxious to make their system absolutely perfect. Their systems of charging had been based on a misunderstanding. There was no reason why a man who gave a party should be penalised for using an extra quantity of current. There had been a gradual change of opinion on that subject since 1901. Taking the average over the country it was found that the maximum demand system did not do what it was supposed to do. The load factor was no better; in fact, it was worse. The units sold per lamp were not higher, and the price per unit was not improved either. He found that since 1901, while the output had gone up fourfold, the average price per unit had come down threefold—*i.e.*, to one-third the former price—a very satisfactory result.

The PRESIDENT (Col. R. E. B. Crompton) said that the debate showed how completely everyone had taken part in it from his own particular point of view. Those who looked with a pessimistic eye on the diminished output were no doubt perfectly right. They had before them certain classes of districts where the ground was already filled up, where the rate of increase was very slow, and where the demand was about as much as it could very well be. It was impossible in that case to overlook the fact that if people had to spend more money on the lamps that they would want to save the amount out of the account they paid the supply company. Of course, in districts where consumers were very few, and there was considerable room for increase, the stations would be improved by the advent of the wire lamp. The load factor had an important bearing, and enormous efforts had been made to improve it. Publicity departments had been organised, and everything had been done to improve the lighting load and to secure a heating and power load at the same time, but instead of improving the load factor it had had the reverse effect, and the power load also was very disappointing. There were several causes which were tending to increase the cost of electricity. They paid about 10 per cent. back to the local authorities for rates, and that was an item that was likely to increase rather than diminish. The cost of fuel also would be likely to go up, and those increases would quite likely counterbalance all they as engineers could do by improving their machinery or their organisation. As to systems of charging, he was very much surprised that none of the speakers had considered the Norwich system. When all the electric lighting concerns passed into the hands of the local authorities, some such result was bound to come about, and it was a most equitable system.

Mr. W. R. COOPER (communicated) thought the authors were to be congratulated on bringing this subject before the Institution, although there might be great differences of opinion as to the metallic filament lamp doing any harm to the industry. It was a curious fact that we had all devoutly desired the advent of the high-efficiency lamp for years past, and yet when it came it was not received with universal thanksgiving, except by the consumer. In this connection it was worth while to remember that a great deal had been done in recent years for the station engineer, and it was only fair that the consumer should now begin to benefit. The consumer had suffered by having

to use comparatively inefficient lamps to enable the station engineer to use higher pressures. Doubtless the consumer had benefitted in a way: he got his energy at 4d. instead of 6d., but he had to use 6 units where 4 units ought to be enough. Nevertheless, we had no wish to see the station engineer in difficulties. He (Mr. Cooper) thought there would not be any great falling off in revenue, except on alternating-current networks, and this would be more than counterbalanced in many cases after a time by the new fields rendered available by metallic filament lamps. Meanwhile there might be some difficulty. But any restrictions on consumers would be most unwise, and the raising of prices as a solution of the difficulty should be adopted only as a last resource, as it might interfere seriously with the use of electricity for purposes other than lighting. Probably the most important point raised by the authors was the question of the small consumer. Cheapness in light was essential to the small consumer, but if he became unremunerative owing to the cost of the service it would be a serious matter. It would be necessary to modify our methods and to imitate those in use on the Continent. Hitherto we had done our work in many instances in too solid a style. There should be no great difficulty in running a service cheaply along a whole block of buildings, say, under the first-floor windows. Such methods, combined with the cheap Continental method of wiring with unprotected wires, would do much to improve the situation. But this would not come about without some combination between contractors and station engineers. Another most important point raised by the authors was that of tariffs. There was much to be said in favour of the tariff suggested by the authors, and it was often absurd, as had been pointed out, to distinguish between different uses to which the energy was put. The great defect, however, of all systems depending on a maximum demand was that no distinction was drawn between different times of day. There was no objection to a comparatively heavy load from a consumer if it did not come at the time of peak load at the station—in fact, it would be welcomed; but any maximum-demand tariff discouraged it, and thus the use of energy for heating was penalised.

Mr. J. E. Tapper (Beckenham), in a written communication, said that it was remarkable that on the question of metallic filament lamps the majority of engineers showed a wonderful optimism and appeared to believe that the introduction of these lamps was going to be the saving of the industry. In districts where gas was greatly predominant and where new buildings were springing up, it might be so in course of time, though even to these the temporary set back was likely to be serious, but to the alternating-current undertaking supplying a purely residential district, such as the one of which he had an intimate knowledge, the outlook was, to say the least, alarming. In the district supplied by the station referred to, one house in six was already supplied, against an average all over the country of only one in ten, and the prospect of picking up a sufficient number of new consumers to cover the immediate loss was very remote. Under-estimating the position if anything, it was quite possible for their 1,200 consumers to effect a reduction in their total consumption of 25 per cent. To give the same revenue, therefore, as at present, 33⅓ per cent. new consumers must be added to the mains at a capital cost of £3,500 for services only, or an additional annual charge of £200 plus extra cost of maintenance of services and collection. One speaker remarked that it would be a great mistake to raise the price of current, the present being the opportunity to prove the cheapness of electricity as compared with gas. It was quite possible, no doubt, to work on these lines and gain a large increase in consumers, but only at an immediate reduction in revenue, and the same result might as easily have been obtained by a reduction in the price charged under the old conditions. The whole thing amounted to this: If the finances of the station would not allow of such a reduction in the charge for current supplying ordinary carbon lamps, then they could not stand the reduction in consumption due to the metallic filament lamps, and either meter rents or current charges must inevitably be raised. A serious feature, but one which might prove only temporary to alternating-current stations, and which had been dealt with but lightly was the introduction of small transformers. These, being cheaply designed, gave a very low power factor unless worked at full load. It was a hard thing to have the revenue reduced by something like one third, as well as the reduction of the capacity of the plant and mains by 50 per cent. To prevent this in the station referred to, consumers were advised to put in transformers which on normal working load were nearly fully loaded, and it was hoped by this means the power factor might be kept within reasonable limits.

Mr. J. H. Bowden (communicated) said that he was, possibly, placed in a unique position, having control of an undertaking possessing a power load which preponderated over the lighting load, and, in consequence, he viewed the question from a totally different standpoint to the authors. During the current year he estimated that the maximum demand for power at Poplar would be 1,700 kw., and the output 4¼ million units, equal to a load factor of 28·54 per cent.; private lighting 1,000 kw., with an output of 1 million units, and a load factor of 11·41 per cent.; public lighting 200 kw., output ¾ million units, and load factor of 42·81 per cent., making a total maximum demand of 2,900 kw., with an output of 6 million units, equal to a net load factor of 23·62 per cent. He anticipated that the average prices received would be—power 1·05d., private lighting 3·43d. and public lighting 1·5d., or a net price of 1·52d. The diversity factor for power upon that estimate was 3·75, private lighting 2·5 and public lighting unity, or a net diversity factor of 3·66, with a total of 9,075 kw. connected. The standing charge would be, approximately, £22,000, and he wished to show a net profit of about £4,000, making a total standing charge upon the consumers of about £26,000, whilst the running charge would probably be about 0·45d. per unit. According to the principle laid down by the authors each consumer should be charged a proportion of the standing charge equal to the extent of his possible maximum demand—*i.e.*, the capacity of his total connections, although in their examples they did not adhere to the principle. By that system the charge at Poplar would be £2. 18s. 6d. per kilowatt connected and 0·45d. per unit, making the average price per unit for power 1·5d., private lighting 2·21d., public lighting 0·64d. and for all units 1·52d. It would be observed that the author's system would reduce private lighting by 1·22d. per unit and the public lighting by 0·86d., but the price to power consumers would be raised on the average by 0·45d. to produce a similar net profit in each instance. In that statement 71 per cent. of the business was for power purposes, upon which the metallic filament lamp had no effect, and yet it was proposed to impose a tax upon that class of business to the extent of 43 per cent. which was, to say the least, impracticable. The whole Paper, in his opinion, was based upon a misconception of the fundamental principle of equitable charging. The authors clearly showed the absurdity of differentiating between heating and lighting on private premises. Perhaps the greatest hindrance to the development of electricity was this class of distinction between light, heat and power; but it was impossible to compute the actual value of each individual connection to a system unless the demand was constant throughout the year, and it was, therefore, necessary to resort to classification and to allocate to each class its full share of the standing charges, as ascertained by the maximum demand upon the station. Public lighting had unity-diversity factor, and, therefore, the standing charge applicable to that class of supply was easily ascertained, a cheap supply being obtained by reason of the load factor alone. The charge to power users must be governed by diversity as well as load factor. It was, however, the method of charging for domestic purposes to which the most serious consideration must be given. Here was a field capable of enormous development. Metallic-filament lamps would do much, but cheap and more perfect cooking and heating appliances would do more, and central station engineers must make up their minds to entirely separate that class of supply from all others and charge upon its merits. Personally, he was of the opinion that the authors propounded the rudiments of the correct system, and that the time was not far distant when it would be feasible to separate the standing charges in such a manner as to allocate the cost of each individual service and fix an annual service charge to each consumer, and the latter would include wiring, fittings, meter and connections to mains.

Mr. C. E. Skelton (communicated) said that the Paper seemed to resolve itself into a plea for higher prices for current sold; but he did not envy the task of those who would seek to convince the British public that a unit was worth more, say, between 5 p.m. and 7 p.m. than at any other hour of the day. Could not more be done in connection with costs of production? If uniformity of pressure of supply could be achieved, would it not tend greatly to reduce the cost of manufacture of dynamos, and so lessen somewhat central station outlay and the cost of motors, cooking apparatus, lamps, &c.? As to the maximum-demand system, it might be ideal theoretically, but to his mind it was not so practically. He had had that system for his house, and now had the flat rate. His bills were the same, but the increase in the comfort of use was enormous, due to less need of supervision, and he found the same opinion held by other consumers.

Mr. A. H. Dykes, in reply, first dealt with the effect of metallic filament lamps on the station output if the rates were kept as at present. Mr. Wright had said they must induce people to use three times the amount of light to keep their consumption the same—a

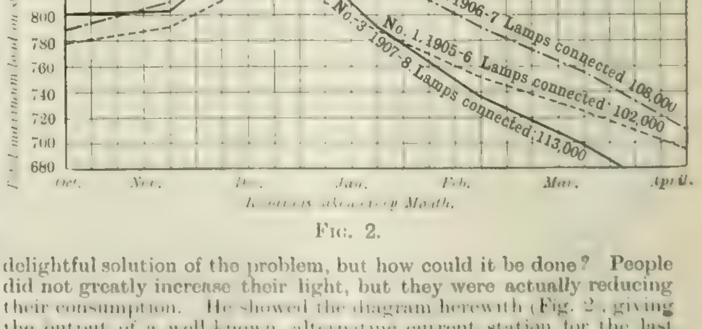


Fig. 2.

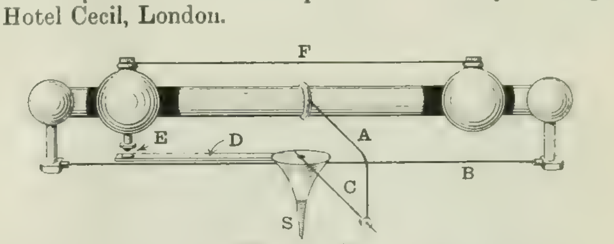
delightful solution of the problem, but how could it be done? People did not greatly increase their light, but they were actually reducing their consumption. He showed the diagram herewith (Fig. 2), giving the output of a well known alternating current station for the last three years, and it was seen that although the connections had increased with satisfactory regularity the station output at the present time was well below what it was two years ago. Certain electrical journals and several speakers apparently advised the engineers in charge of these stations not to be troubled, but to wait patiently, and in a few years' time the increase in the number of consumers would more than repay them for the temporary diminution in their receipts. If it was true that the effect of these lamps would be to induce such a rush of customers as to more than repay the station engineers for their initial loss, surely the same thing might have been met in the days of carbon lamps by boldly reducing the price of current to one half. Mr. Wright stated that if the output of the Marylebone station were doubled the cost would immediately come down from 4½d. to 2¾d. Surely, then, if the critics were right, this reduction should have been made a year

or two ago, when the increase in new consumers would have more than recouped the loss. He did not do so, however. Both he and Mr. Bottomley Smith were well aware of the service difficulty, and both hoped that it would be overcome in the future, but that day was not yet, and meantime it might be taken that the discussion had endorsed the authors' view that, if matters were left as they were, the stations would be, for a longer or shorter time, badly affected. The effect of a cessation of dividends or a call on the rates, even if only for a short time, would be very far-reaching, and would greatly affect every section of the electrical industry. Since a consumer, using the new lamps, could pay, say, 1s. 2d. per unit without affecting his total lighting bill, what possible reason was there for the industry incurring a loss? Given that a readjustment of price was necessary, on what basis should it proceed? Since the Paper was written, they had been gratified to find that many others who had given thought and attention to the subject had arrived at practically the same conclusions. Mr. Long's system was practically the same as the authors', with the exception that he did not use limit indicators, and relied for carrying it into effect on his knowledge of every consumer's load factor and maximum demand, the latter obtained, apparently, by maintaining their lamps. He also stated that the consumers easily understood the system and did not object to it, and also that the consumption per lamp increased. Mr. Bowden, in a communication, had referred to an article by himself and Mr. Tate, written in 1905, in which, without having metallic filament lamps in mind, they came to the same conclusions as the present authors—viz., that consumers should be charged a rental depending on their demand on the station, and, in addition, a meter charge to cover the running costs. The Poplar figures clearly showed that there was no justification for charging a flat rate and for retaining the 8d. limit. Mr. Bowden, in attempting to apply the authors' system to the Poplar figures had made two mistakes. The first was that he had added all his expected profit on to the rental charge; and the second, that he had charged the consumers on the capacity of plant or lights installed instead of on their contract demand. The effect of this, of course, would be the same as the original Hopkinson method—to reduce the lights installed. The authors agreed, nevertheless, that the effect of their system on the Poplar figures would be to somewhat increase the charge for power and reduce it for private lighting. This Mr. Bowden considered absolutely wrong. It would, however, be seen that the lighting consumer paid nearly 40 per cent. more per kilowatt of demand on the station, although the power consumers used the plant 2½ times as long. It was clear also that public lighting was penalised to subsidise the power consumer. Mr. Wright had pointed out that the current for power should be supplied at less cost than for lighting, owing to its greater diversity factor. The authors' system, as proposed, went a long way towards meeting this, and could, and should be made to do so absolutely. If a consumer had lamps connected equivalent to 100 kw. he would probably put his contract demand at 70 kw. Whereas, if he had motors equivalent to 100 kw., owing to the greater diversity factor, he would probably put his contract demand at 35 kw. In the first case, therefore, his rental charge would be double what it would be in the second. This, however, like the maximum-demand system, was not quite fair to the consumer with only one motor, as his diversity factor in that case would be unity. The point, however, was easily met by charging power consumers a lower rental per kilowatt of contract demand, and public lighting a somewhat higher one than lighting consumers, the exact difference depending on the ratio between their diversity factors and the proportion which each bore to the total demand on the station. To illustrate this, he took Mr. Bowden's figures and showed that on the proposed system these would work out as follows: The revenue received from power consumers £22,945 –*i.e*, 1·29d. per unit and £3·84 rent per kilowatt contract demand; private lighting £10,405, 2·494d., £5·55; and public lighting £3,218, 1·027d., £8·3, respectively. At first sight, some might be surprised that the rental per kilowatt for public lighting should be more than for power or private lighting. The reason, was, of course, that owing to the long hours and unity diversity factor of public lighting load a portion of the plant was practically reserved entirely for it. As regards temporary extensions of installations for entertainments, this would be met by a special charge for the evening being made, and the amount of this charge would obviously depend on the time of year and whether the plant of the station was fully loaded or not, and would easily be arranged by the engineer. A complaint was often made against electrically-lighted houses that, owing to passage and bedroom lights, &c., being immediately switched off when not actually required, the houses looked dark, also kitchen lights and other long-hour lamps were frequently gas. This state of affairs had been brought about entirely by the use of the flat rate. Once the contract-demand system was adopted it made very little difference in the annual bills if such lamps were used for double the length of time, a result which would go very far to make electric lighting popular. This effect was clearly borne out by Mr. Long's results. The system could, of course, be adopted without increasing the average price at all, if it was not considered that an increase was necessary. In many districts it would probably be found advisable to boldly recommend all consumers to use the new lamps, pointing out to them the saving to be effected, and adjusting the rental charge to such a figure as would give an increased return per unit – sufficient to counteract the falling off in the demand of individual consumers. Although this would meet the position in most cases, they were strongly of opinion that the inequality of the present legal flat rate should be brought before the authorities. The Board of Trade, they had reason to believe, would consider sympathetically any representations made by this Institution. The average price need not be raised above the present statutory limit, but they were convinced that suppliers should have powers to charge unprofitable short-hour consumers more than they were at present paying.

Communicated.—He could not quite follow the argument used by Mr. Mordey that if a party was given in one house there were less lights used in the others. In practice it must mean a somewhat larger load on the mains, although, of course, in a large district the effect of any individual entertainment would scarcely be felt, although small country stations repeatedly found that entertainments simultaneously at one or two large consumers' premises did increase the load. With regard to the supposed difficulty in working the contract-demand system, there was no need for the station to fix the contract demand. In practice the system would probably be worked as follows: On a new consumer being connected, the supply station representative, after inspecting the premises and getting an idea of what the number of lights would be, would ask the consumer how many lights he would be likely to want to burn at once, a question which, with a little assistance from the engineer, few consumers would have any difficulty in settling. He would then say, "we shall put you in a meter which will give you current up to this amount, and for the facility you will be charged a fixed rental per annum, divided into four quarterly instalments of so much, and, in addition, all the current you use will be charged at, say, 1d. per unit." It would be pointed out to the consumer that the charge for current would only amount to a small sum, and that, therefore, there was no necessity to be always troubling to turn off the lights, as was done at the present time, and that within a little he would know what his bill was going to be. Occasionally the consumer might find that after a few days or weeks he was exceeding his demand and the lights were becoming dimmed. He would inform the station of this, when they would point out to him that he could either keep to his original price by switching off some of his lamps, or could have the capacity of his meter increased. Incidentally, the system had one very great advantage in that it would tend to equalise the amounts for the four quarters of the year.

KNUDSEN'S SYSTEM OF WIRELESS TRANSMISSION OF PHOTOGRAPHS.

The telegraphic transmission of photographs has recently received much attention, and bids fair to become an acknowledged accessory of modern journalism. Our readers are already familiar with the ingenious system of Prof. Korn, in which use is made of the sensitiveness of selenium. Other systems also have been developed, but, so far as we are aware, they all depend upon wire telegraphy for transmission. Mr. H. Knudsen, who is already well known by his work on liquid air for the Liquid Air, Power & Automobile Co. of Great Britain, Ltd., has now produced a system for use with wireless telegraphy (though wire transmission could, no doubt, be used if desired), and a demonstration of its working was given to representatives of the press last Tuesday evening at the Hotel Cecil, London.



Direction of motion of carriage.

FIG. 1.—STYLE MECHANISM ON CARRIAGE.

A, Support for style S so that a motion about C is possible. B, Suspension wire carrying the style. D is a lever attached to the style so that when the latter meets an obstruction causing rotation about C, contact is made at E, the circuit being completed through the wire F.

In this system the transmitter consists essentially of a travelling carriage, operated by clockwork, carrying a light style moving backwards and forwards. The style travels over the surface of the picture to be transmitted so that every part of the surface is traversed once during the complete operation. Mechanical action alone is relied on for giving the radio-telegraphic impulses, the style being normally at such a height that a gap exists in the relay circuit controlling the current to the primary of the coil. If the style is pushed up, a contact is made completing this circuit (as indicated in Fig. 1). In order, therefore, to operate this system, it is necessary to so prepare the picture that those parts which are dark are in relief as compared with the parts that are light, or vice versâ. This is effected by "dusting" the usual photographic negative with a powder (for example, of iron), which adheres to the dense parts of the negative, but not appreciably to the transparent parts. The sensitive plate on which the photo-

graph is taken is made with a much thicker film of gelatine than usual; after development, and before it is quite dry, it is "dusted" with the powder, which adheres to those parts that are most damp (that is, the dense parts), but not to the parts that are dry. Thus the dense parts of the negative become raised. Consequently, when the style traverses a dense patch waves are transmitted during that period.

FIG. 2.—PORTRAIT OF MR. KNUDSEN WITH TRANSMITTER ON HIS LEFT, AND RECEIVER ON HIS RIGHT

The receiver is a similar instrument, but in this the style is normally raised, being depressed when a wave is received, this being effected by a coherer and relay circuit. The plate for receiving consists of a glass plate with a blackened surface; experimentally lamp black may be used, but in practice some more permanent coating would be adopted. In this way a negative is at once obtained corresponding with the original picture or negative. It is found that a quarter of an hour is sufficient to transmit a 5 in. by 4 in. picture. In Fig. 2 is shown a transmitter on the right and a receiver on the left with Mr. Knudsen as the centre figure.

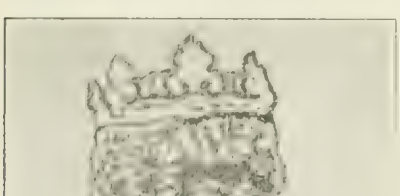


FIG. 3. ROUGHLY PREPARED TRANSMITTING NEGATIVE.

Synchronism is, of course, a necessity. This is effected by stopping the carriage of the transmitter at the end of each backward stroke for a short time, a brake being applied to the clockwork. The carriage of the receiver similarly stops at the end of the stroke. A second clockwork movement, which still remains in action, restarts the carriage of the transmitter after a short interval, and at the same time brings the coil into action, transmitting a wave, which again starts the carriage of the receiver. Thus synchronism is effected at the beginning of every forward stroke in a very simple way. There is no device to prevent interference by other wireless stations in this respect, though probably such interference would not be serious unless persistent.

Fig. 3 shows a roughly prepared negative (this particular example is really only a sketch on glass with seccotine, which is subsequently powdered over) for transmission, and Fig. 4 is an example of a photograph printed from a negative "received." As an example of what has been accomplished without reaching the commercial stage, this must be regarded as promising. It will be realised that the receiving style is necessarily up or down, and, consequently, no gradation in shading is possible; but for the transmission of line sketches, as distinct from photographs, the system should, doubtless, have a future before it.

FIG. 4. PHOTOGRAPH FROM RECEIVED NEGATIVE.

Mr. Knudsen also made the interesting announcement that he had perfected a wireless arrangement for setting type on a linotype or similar machine; this, of course, would be extremely important if successful.

PRINGLE'S GROOVE SKID EMERGENCY BRAKE.

It is a well-known fact that the great majority of tramway accidents result from a failure in the personal element. This failure is brought about by two causes: the first, for which the motorman must be held entirely responsible, is allowing the car to attain a higher speed than that allowed by his instructions for the particular gradient on which the accident occurs, and is often brought about by his over-confidence, due to the provision of a powerful service brake, or else his inability to estimate speeds. The second cause of the failure results from the first and is due to the motorman, when faced by an emergency, having to decide which of two or three brakes he should use; and any indecision is of great importance, since on many gradients each second lost due to indecision means an addition of 2 miles per hour to the speed of the car. Also the particular brake chosen may be wrongly applied, or may need the additional operation of sanding the track, or its effect may be nullified by conjunction with one of the other methods of braking.

A failure in the personal element under such conditions is easily conceivable, but it is questionable whether for this second cause the motorman should be held strictly to blame and responsible for the accident that ensues. The position he has placed himself in often means a severe ordeal, and it is to the credit of motormen as a class that the present serious frequency of accidents is not even greater than it is.

Mr. P. J. Pringle, borough electrical engineer and tramway manager to the Burton-upon Trent Corporation, holds very decided views on this brake problem, and has frequently given expression to them during the last two years. He believes that every car should be fitted with an alternative brake capable of being simply and readily applied for effectively controlling the car under any conditions that may arise in the event of the service brake being defective or wrongfully operated. Also, that the brake problem is not one of improvements in existing brakes, although, undoubtedly, much can be done in this direction.

Almost every serious accident is a case of the service brake, which may, according to the gradient being dealt with, be the hand brake, mechanical slipper (hand or power applied), or the magnetic track brake, failing to control the car, either due to a defect, or what is more often the case, its faulty operation. The standby brake under such conditions is either one which is much less powerful, such

as the hand and mechanically applied slipper brake, or the rheostatic electric brake. These are either not powerful enough to deal with the high speed condition which ensues when the motorman has realised that his service brake is not going to control his car, or call for such care in their operation as to warrant easily a failure in the personal element. The more powerful the brake, the greater are the risks the motorman will run, and the higher the speeds before the realisation is brought home to him that control of the car is being lost.

Instantaneously applied slipper brakes, such as air brakes, have been put forward as a solution of the brake difficulty, not because in efficiency. The rail groove, however, after very exhaustive experiments, has been found to comply with the requirements.

Fig. 1 shows a single truck fitted with groove skid brakes and their operating gear. A is a cast malleable-iron bracket attached to the truck frame by four bolts. B is a malleable iron block with a recess in it shaped to, and engaging with, the flange of the car wheel. Its bottom edge is shaped to hold a renewable skid bar, C, which is of a special form of manganese steel to stand the enormous strain to which it is subjected. D shows one of two links. These are placed on each side of B, and support this block from the bracket A, somewhat in the same manner as an ordinary brake block is hung.

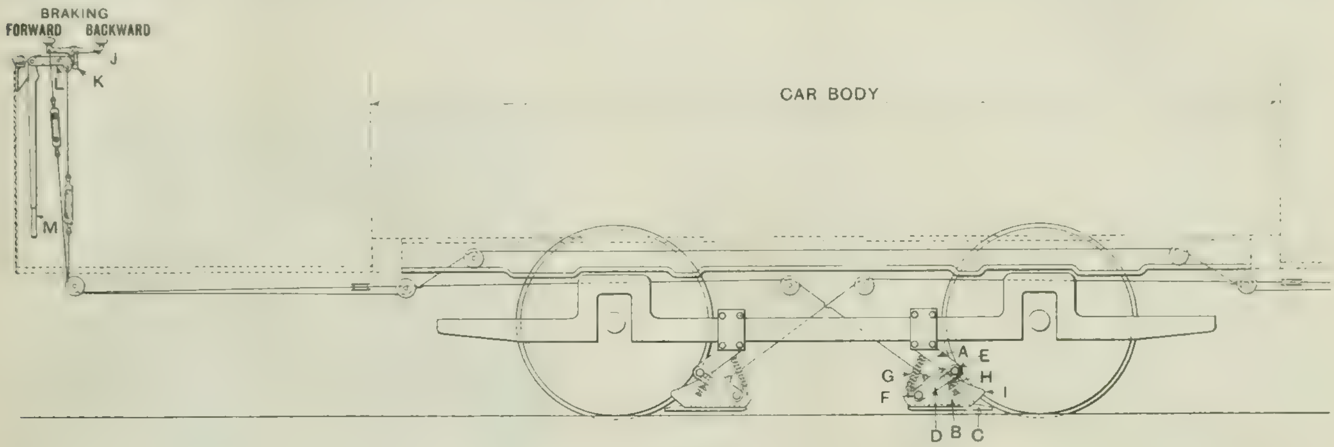


Fig. 1.—Diagram showing Arrangement of Groove Skid Brake.

of their having any increased power, but from their method of application. With such an instantaneous brake the motorman will rely on the instantaneous nature of the brake, and allow the car to attain a considerable speed before applying it; and, given a sufficiently severe gradient and adverse track conditions, such a speed may easily result in loss of control.

It is frequently laid down that the emergency brake must be the service brake. This view is quite correct so long as the emergency condition is purely one of a rapid stop to avoid an accident to life or property. If, however, the car has got out of control there arises another emergency condition of greater seriousness which has not received due attention in laying down this dictum.

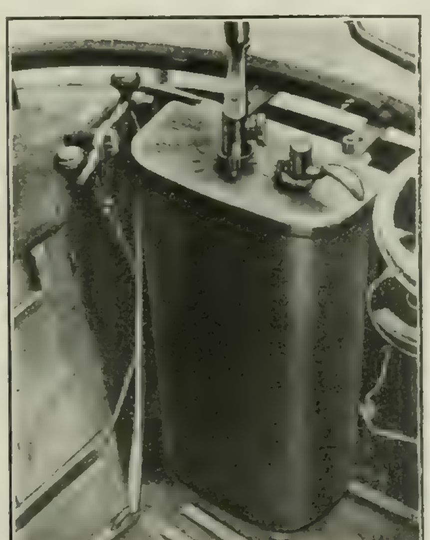


Fig. 2.—Operating Gear by the Side of the Controller.

The alternative brake, previously referred to, must be of the emergency class, and must reduce the liability of failure in the personal element to the minimum possible, and must also be sufficiently powerful to control the car under runaway conditions.

The Pringle emergency groove skid brake has been designed to conform with the above requirements. In considering the problem, any brake which utilised the car wheels was condemned; all that remained, therefore, was to make use of the tramway track. The rail tread, unless used magnetically, can only give a limited amount of brake power, which is seriously affected under adverse track conditions, such as grease and wet. Grease affects all classes of braking materials, and wet causes wood slipper blocks to fall off very much

The spring G is a compression spring, and has the following uses: When the skid bar is dropped into the rail groove it increases the pressure between the bar and the groove, and this may be useful in certain conditions of track when operating, say, with the wheels locked by the hand brakes. It also keeps all the gear and pins in a state of rigidity, so that no chattering of the parts can occur which in the presence of wet and grit would lead to wear and tear, and in addition it increases the instantaneous nature of the brake. Being a compression spring and subject to less work when called upon to act, its action is very reliable.

H is an adjustable set screw. Assuming that the block has been dropped, then when the steel wire is pulled for lifting, it causes the block to swivel on centre F, and force the tapered end of skid bar against the wheel flange. On further lifting, the set screw H will come in contact with the link, and the block will then entirely swivel from the centre E, and this will cause the tapered end of C to stand clear of the flange. I is a guide plate cast with B and embracing each side of the wheel. When the brake is in

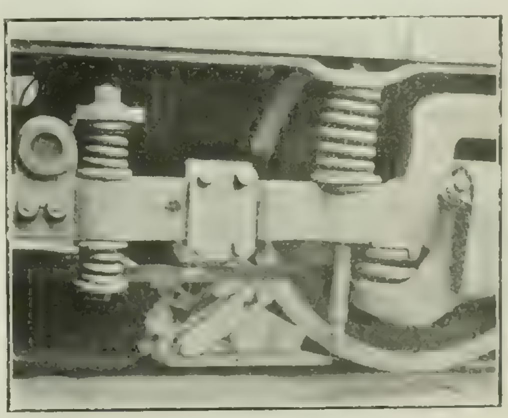


Fig. 3.—Skid Brake Out of Action.

operation these guide plates, together with the skid-bar engaging with the groove, cause a very powerful keying action between the wheels and track. This reduces the liability of derailment, compared with the ordinary case when the wheels alone engage with the rail groove.

The operating gear is the same at both ends of the car and is of very simple design. It consists of a lever, L, to which the steel wire supporting the brake is attached. M is the lifting lever, and when this engages with L the brakes can be lifted. The catch K is loose from the operating handle J, and holds lever L in the lifted position. To operate the brake all that is required is to depress the handle pointing in the direction in which the car is going. For

forward braking the left hand handle in the drawing would be depressed, thus causing catch K to release L, and consequently the brake. The handles are conspicuously marked "Forward braking" and "Backward braking." When using the backward braking handle the steel wire attached to lever J is pulled, and this causes the catch K on the operating gear at the other end of the car to release the brakes.

The arrangement of the connecting gear between the operating part and the brakes has the important advantage that any fault indicates itself at once by applying the brakes, instead of possibly failing at the critical moment. This principle would be of value where trailer cars are in use, since a failure of the couplings would automatically apply the brakes.

Fig. 2 shows the operating gear as applied to the cars in use on the Burton-upon-Trent Corporation tramway system. The gear is immediately accessible to either the motorman or conductor. Fig. 3 shows one of the brakes when out of action, and Fig. 4 when in action and the wheel raised above the tread of the rail, the whole weight on this wheel being transferred to the brake block and thus to the rail groove. The position of the spring and the link in these different positions is clearly shown. The slot in the link has an important function in that it permits of the brake adapting itself to wheel wear, and provides also that none of the severe strain that the brake has to stand comes upon the bracket attachment to the truck frame.

It will thus be seen that the brake is of very simple and cheap design, and its cost should be less than half that of most other brake gears usually adopted; and, as it is not intended that this brake should supplant any other, but supplement the existing ones, cheapness of installing is a matter of importance.

A brake of this pattern has been in use on one of the Burton-upon-Trent Corporation cars for a considerable time. In its earlier form sufficiently satisfactory results were obtained for a request to be made to the Board of Trade to inspect it, and approve its adoption on six of the cars operating on a route having a dangerous gradient of 1 in 11·7. This approval was granted on July 3, 1907, and it is interesting to note the Board of Trade proviso, "that the use of the skid brake is limited to cases of emergency such as runaways, &c." Since that date considerable improvements have been made in the brake, and the Board of Trade have expressed a desire for further inspection.

Mr. Pringle claims the following advantages for this groove skid brake: –

1. It reduces the failure in the personal element to the minimum possible, since the braking operation is a simple elementary motion requiring no care or consideration in its application.

2. The conductor and, if desirable, the public, have the same power of control as the motorman, thus further reducing the liability of failure of the personal element.

3. It is a certain run-back brake preventing any down-hill motion.

4. It is a mechanical brake.

5. It is entirely independent of other brakes. An alternative brake combined with another may mean failure of both.

6. It is instantaneous in action and subject to no gradations, and when applied must be at maximum power and efficiency.

7. It calls for no expenditure of power or sand in its application.

8. It operates equally well whether the wheels are locked or not.

9. It will fully control a car on steep gradients even if power is left on. This latter might occur due to illness of the motorman, in which case the conductor would operate the brake.

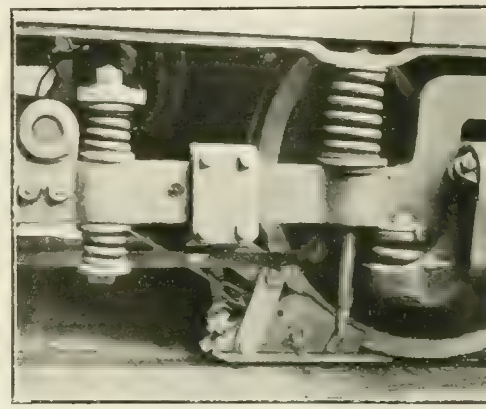


Fig. 4.—Skid Brake in Action, showing the Wheel Raised Off the Track.

It might be thought, at first sight, that trouble would be experienced with this skid brake, when in operation, at points and crossings. This, however, is not found to be the case. It will be noticed from Fig. 4 that the downward movement of the skid bar is limited by the side flanges coming in contact with the top of the rails: thus in passing through points no fouling can take place, and, as the front of the skid is rounded, it moves smoothly over any obstructions.

Through the courtesy of Mr. P. J. Pringle and Mr. J. Toulmin, Engineer and Manager of the Burton and Ashby Light Railways,

Test No.	Gradient.	State of groove.	Speed in miles per hour.	Distance to stop in ft.	Time to stop in secs.	Retardation in ft. per sec. per sec.	Remarks.
1	1 in 12		13	38½	...	...	...
2	..	Damp and washed clean by heavy rain.	18	62	5	5·27	...
3	..		24	157	6¼	5·46	...
4	..		16	66½	...	..	Wheels locked by hand brake and rheostatic brake.
5	..		13	75	...	...	Right hand skid-brake tied out of action, left-hand skid only used.
6	..		21	128	...	...	Full power left on, circuit-breaker did not blow till car stopped, as wheels slowly revolved on skid. Brake applied by conductor, motorman supposedly incapacitated.
7	..		4½	2	..	...	.....
8	..		7	12¼	..	..	.....
9	..		10½	24	...	...	..
10	1 in 12		12¼	32½	3½	5·18	Concrete in groove was removed previous to these tests.
11	..	Dry and quite clean.	18	84	5½	5·05	....
12	..		23	165	8½(?)	3·91	......
13	..		15	65½	5	4·38	Wheels locked by hand brake and rheostatic brake,
14	..		18	66	5½	4·53	Full power on, as in Test No. 6, but cut off a yard or two before stopping.
15	..		4½	3¼	1	8·22	..
16	..		7	11½	2½	4·27	....
17	..		10½	40	4	...	..
18	..		10½	34¼	2½	...	....
19	..		10½	59	5	...	Rail groove probably getting burnished and skid worn.
20	..		10	28	...	..	This test taken on a fresh section of track.
21	..		...	...	...	...	Car was driven uphill and circuit breaker knocked out, the motorman applied skid brake and car came to rest without running back at all.
22	.		...	...	...	...	With skid still applied from Test No. 21, the controller was reversed and power applied until the circuit breaker blew (180 amperes) without any downward movement of the car.
23	Level	About half filled with dry dirt	4½	1½	½	av. 20	Difficult to obtain an accurate time.
23A	.		4½	1	½		...
24	.		7	6½	½	17	...
25	..		10	13½	1½	12·15	..
26			13	29½	2½	7·9	...
27	1 in 70		16	36	3¼	7·2	..

Brill single truck car with open top deck and equipped with two 25 H.P. Dick Kerr motors used for above tests.
Weight of car 8 tons. Seven people on car during tests 1 to 9, ten from 10 to 22, and four from 23 to 27.
Track gauge 3 ft. 6 in., No. 1 British Standard rails.
In the third series of tests on 20 steps were made, but the wear of the skids would only allow them to drop a further ¼ in. into the rail groove.

we were recently able to witness some tests made with this skid brake in Hill-street, Swadlincote, a long gradient of 1 in 12, on the route of the Burton and Ashby Light Railway. The rails were dry and clean, and were, therefore, not in an ideal condition for severe brake tests. We fully expected that the action of the brake would be rather violent; this, however, was far from being the case, and after a slight jar, when the wheels first mounted the skid, the retardation was very gentle, much more constant than in the case of a magnetic brake, and not at all likely to cause alarm or inconvenience to passengers. In fact, the considerable distance required in some cases for bringing the car to rest might be brought forward as a disadvantage of the brake. It will be seen, however, from the particulars of some additional tests, made on a level stretch of track at slower speeds, that very rapid stops are possible, and it will be noticed that at slow speeds even better results are obtained than those recorded by Mr. A. L. C. Fell in connection with electromagnetic track brakes in his Paper read before the Tramways and Light Railways Association, an abstract of which was given in *The Electrician* of January 19 and 26, 1906, pp. 543, 586.

We give above particulars of the tests (Nos. 10 to 22) at which we were present, also of some that were made a few days earlier, when there was a considerable amount of concrete in the groove of the rail (this concrete had been removed previous to the tests we witnessed), and of those made later on a stretch of level track.

In calculating the total retardation in tests Nos. 1 to 22 an allowance of 2·68 ft. per second per second must be added for the gradient. An inspection of the application of the skid seemed to show that the car was not unduly strained during the process of retardation, and this is borne out by the fact that the car upon which the tests were made had previously been subjected to over 300 applications of the skid brake without showing any signs of splintering or straining. This is probably accounted for by the fact that the shock is entirely in line with the body of the car. It is also interesting to notice that the braking effect is proportional to the load on the car; thus there is less danger in the ca e of an overcrowded car.

As the skid is only intended for use in an emergency, it would rarely be required and would need little upkeep. After a number of applications its biting power on the groove of the rail is to some extent decreased, and this was apparent in some of the later tests which we witnessed, the skid having been applied nearly 20 times.

It may be added that Messrs. Mountain & Gibson (Ltd.) have taken up the manufacturing rights of this brake, which has aroused considerable interest among tramway managers, and of which more is certain to be heard in the future.

DUDDELL'S PATENT THERMO-AMMETER.

In all branches of electrical science there is a steadily increasing demand for the accurate measurement of all the quanti ies involved. In one branch—namely, the measurement of small alternating currents—the progress, though steady, has not been quite as fast as could be wished. The want of a convenient portable ammeter for measuring small alternating currents of any frequency and wave-form has been especially felt in connection with telephonic measurements, wireless telegraphy, and for medical purposes. In the present note it is proposed to pass in review the main methods upon which sensitive portable pivoted ammeters can be built, and to describe a new instrument which is being made by the Cambridge Scientific Instrument Co., Ltd., and which, it is believed, constitutes a step forward in providing for the convenient measurement of small alternating currents.

For the measurement of small alternating currents of any frequency the principles on which the instrument can be based may be classified as follows:—

1. *Electromagnetic Instruments.*—Instruments depending on the electromagnetic forces exerted between coils and coils or between coils and iron can be constructed of very high sensibility, but in this case their self induction is comparatively high, and the electrostatic capacity from layer to layer of the winding may be appreciable.

For frequencies of 1,000 per second, such as often occur in telephone work, these defects become extremely important. In addition, in those instruments which contain iron, the errors due to the calibration depending on the shape of the wave-form of the current to be measured, may be serious.

2. *Electrostatic Instruments.*—Measurements of alternating currents may be made by measuring the P.D. between the terminals of a non-inductive shunt by means of an electrostatic voltmeter. For a small current, however, the P.D. available is small, unless the shunt resistance is very high. Pivoted electrostatic voltmeters for the measurement of very small P.D.s are not yet available. At the same time, for currents of high frequency, an electrostatic instrument, on account of its capacity, takes an appreciable current, and, at frequencies as high as 100,000 per second, it may take actually more current than a thermal instrument.

3. *Rectifying Instruments.*—With these instruments the alternating current to be measured is first rectified by being passed through some form of rectifier, generally of the electrolytic type. Up to the present, the development of instruments based on this principle has not made very great progress, owing to the uncertainty that exists with the present electrolytic cells in the relationship between the magnitude of the rectified current and the alternating current that is being measured.

4. *Thermal Instruments.*—Instruments based on the heating of a conductor by the current to be measured have, so far, given the best results in the measurement of small currents of high frequency.

Thermal instruments have the great advantage that they do not depend for their operation on magnetic fields, and are practically free from self induction and capacity errors. All thermal instruments depend on the measurement of the rise in the temperature of a conductor when the current is flowing. It is in the estimation of this rise in temperature that the greatest number of practical difficulties are encountered.

One of the earliest thermal instruments was that invented in 1827 by Sir W. Snow Harris, which consisted of an air thermometer, having sealed into its bulb a wire which was heated by the current to be measured. The air in the bulb expanded, and forced the thread of liquid along the tube.

Three other methods are employed to indicate the rise in temperature of the conductor in designing thermal instruments. They are:

(*a*) The measurement of the linear expansion of the wire.

(*b*) The measurement of the change of resistance of the conductor.

(*c*) The measurement of thermo-electric forces.

Satisfactory pivoted instruments are constructed on the principle (*a*), but so far their sensibility has been limited by mechanical difficulties. The best pivoted pointer instruments at present available require something like $\frac{1}{10}$ watt to give the full scale deflection.

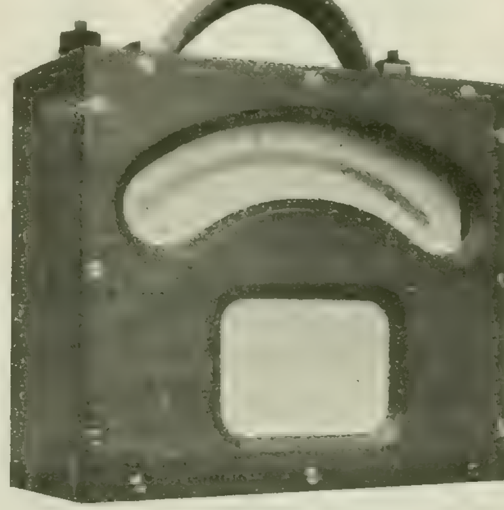


Fig. 1.

As their sensibility depends on the magnification of the small expansion of the wire when heated by the current, if the frame which supports the wire and the wire itself have not exactly the same coefficient of expansion then, when the room temperature rises or falls, deflections will be produced on the instrument, producing an uncertain zero.

To get sensibility it is generally necessary to stretch the wire under an appreciable tension. The contraction and expansion of the wire under tension produces fatigue of the material, so that the instrument may fail with a comparatively small overload.

Instruments based on method (*b*) involve the measurement of the resistance of a conductor while the alternating current to be measured flows through it. This leads to rather complicated arrangements and the use of an auxiliary measuring circuit containing a source of current, resistances and a galvanometer of some kind. In the laboratory excellent results can be obtained by this method, but it cannot be compared for ease and simplicity with a direct-reading pointer instrument such as the thermal ammeter. In common with instruments of type (*a*) instruments of type (*b*) will only stand a comparatively small overload without damage.

Method (*c*) is represented by the thermo-ammeter.

This instrument is constructed on the same principle as the now well-known Duddell thermo-galvanometer, in which the current to be measured passes through a "heater" resistance, causing its temperature to rise, and heating a thermo-junction attached to a wire loop suspended in the air-gap of a permanent magnet similar to the suspended loop of the "Boys" radiomicrometer. The thermo-

ammeter is, of course, a much less sensitive instrument than the thermo-galvanometer, as it is pivoted and fitted with a pointer, and bears much the same relation to the thermo-galvanometer as a sensitive ammeter of the ordinary pivoted moving-coil type does to a moving-coil galvanometer. Nevertheless, it is extremely sensitive and may be used to measure the current in an ordinary telephone line.

The general appearance of the instrument is shown in Fig. 1, while Fig. 2 is a sectional diagram showing the general arrangement of the heater and coil, &c. D is the moving coil which moves in the field produced by the permanent magnet BB. AA are soft iron pole pieces, and C is a cylindrical core, so that the field in which the coil moves is truly radial. EE are the pivots which it will be seen are fixed *inside* the coil, so that when the instrument is in a horizontal position (the correct position for use) the coil is practically suspended from the top pivot, the lower pivot being almost entirely out of action. By this means pivot friction is reduced to a minimum. The ends of the coil are brought out at the bottom and soldered to the ends of the thermo-junction LM, the elements of which are made from special alloys which have a very high thermo-electric force. The lower ends of the couple are soldered to a thin circular "receiving plate." Immediately below the receiving plate the heater K is fixed. In instruments to give the full deflection for 20 milliamperes or less, this heater consists of a sheet of platinised mica, the platinum being scraped away to form a sort of gridiron. By this means resistances of several hundred ohms may be easily obtained in a space of less than 0·2 cm. For currents above 20 milliamperes the heater is made of wire. When in use the current to be measured passes through the heater K, which, in consequence, becomes heated and so warms the receiving plate J and thermocouple LM. The resultant E.M.F. of the couple causes a current to flow round the coil which turns in the magnetic field, the deflection being indicated by a pointer moving over a scale in the usual way. It will be seen that no current passes through the control spring F; the material for the spring may, therefore, be selected without reference to its electrical resistance; one end of the control spring is attached to the lever G, which is connected to the zero adjusting screw outside the case. The whole instrument is contained in a polished teak case with a leather handle.

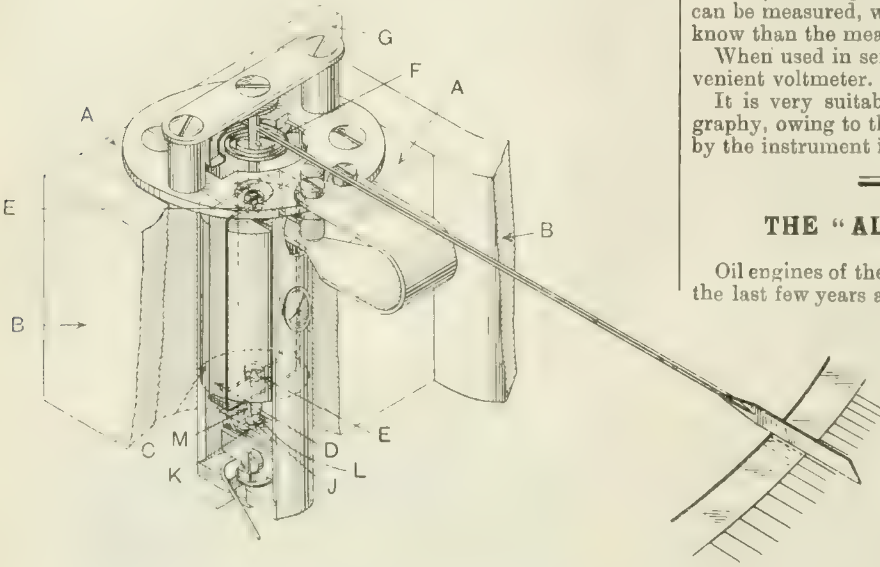


Fig. 2

In the usual pattern (with a resistance of about 150 ohms) the full scale deflection is produced by a current of 10 milliamperes either continuous or alternating, and by constructing heaters of higher or lower resistance the sensibility to current may be increased or reduced as required. The scale is a long one—viz., 160 mm. The maximum power taken by the instrument is extremely small—namely, about 0·016 watt, which is far less than that taken by the average "hot-wire" ammeter, and it will stand a much greater overload—namely, about three times its maximum working current.

The thermo-ammeter has excessively small self-induction owing to the "gridiron" shape and small size of the heater. The total number of "bends" does not usually exceed eight or nine.

It is perfectly dead beat, but like other thermal instruments, takes a certain time to attain its final deflection.

When used as an ammeter the temperature coefficient is about 0·114 per cent. per degree Centigrade. When used as a voltmeter (without series resistance) the temperature coefficient is about 0·1 per cent. per degree Centigrade. Of course, if a high resistance of negligible temperature coefficient is used in series with the instrument, this value will be correspondingly reduced.

The principal advantages and some of the uses of the thermo-ammeter may be summarised as follows:—

1. It takes a very small power to give the full scale of deflection.
2. It is extremely sensitive as an ammeter or voltmeter according to whether it is constructed with a high or low resistance heater.
3. It can be calibrated with continuous and used with alternating currents.
4. It has practically no self-induction or capacity and measures accurate currents of any frequency or wave form.
5. It has a low temperature coefficient.
6. It is very portable and does not require levelling.
7. It is direct reading
8. It will stand a 100 to 200 per cent. overload easily.
9. The resistance through which the current to be measured passes is not subjected to any tensile or bending strains.
10. The current in telephone lines can be easily measured.
11. The root-mean-square current (or the heating value of the current) in X-ray tubes and in secondaries of medical induction coils can be measured, which for many purposes it is more important to know than the mean value usually measured.

When used in series with high resistances it forms a very convenient voltmeter.

It is very suitable for use with wave meters in wireless telegraphy, owing to the small damping produced, as the power taken by the instrument is small.

THE "ALLEN" VERTICAL OIL ENGINE.

Oil engines of the vertical type have secured for themselves during the last few years a strong position in the world's markets. They offer many advantages over the older horizontal patterns in the matter of compactness, lightness and low running costs, and they are most suitable for direct coupling to dynamos and centrifugal pumps. One of the most prominent features of this class of engine is its low weight, and it is for this reason, when combined with a centrifugal pump, that it is so much used for irrigation work in countries where the cost of transport is excessive, and where the difficulty of conveyance makes it practically impossible for heavier machinery to be employed.

The "Allen" four-cycle paraffin engine has been designed to withstand rough usage, and is suitable for continuous running with the minimum amount of attention. It is totally-enclosed, and splash lubrication is employed, the cam shaft, which is driven by spur wheels and carries the governor, being arranged inside the crank-chamber. Fig. 1 gives an excellent idea of the general construction of the engine. The trunk is a rigid box-form casting, carrying the main bearings and cam shaft bearings, the bottom of this casting forming a well for the lubricating oil. A very simple form of splash-guard is bolted inside the crank chamber to prevent excessive lubrication of the piston. As an extra precaution against over lubrication

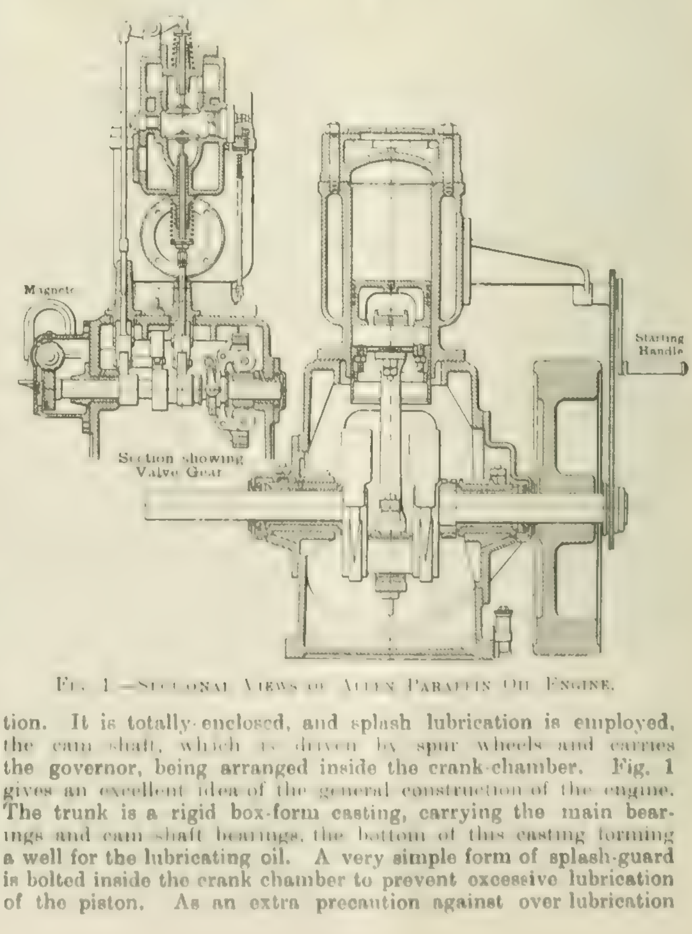


Fig. 1.—Sectional Views of Allen Paraffin Oil Engine.

in the larger engines, a ring is fitted near the bottom end of the piston; these fitments reduce the lubricating oil bill to a minimum.

The cylinders are of close-grained cast iron, and the pistons are ground to fit the cylinders accurately. All the working parts are of Siemens-Martin steel, having a tensile strength of 28 to 32 tons per square inch, with an elongation of 27 per cent. in 2 in. The main bearings and crank pin have very large wearing surfaces, lined with white metal and suitable for continuous running. The trunk and bedplate are cast in one piece, and suitable doors are provided in the former to give access to the interior. The flywheel is of cast iron with heavy rim to ensure even turning moment, and the rim also has holes provided for barring purposes. The circulation of the cooling water is made positive and rapid by the use of a small pump driven from the main shaft. When the engine is driving a centrifugal pump this small pump is not supplied, but copper pipes with cock and check valve are fitted to pass a portion of the main water through the engine jacket.

The vaporiser is heated for starting up with a small blow-lamp, but when the engine commences to work this lamp is extinguished, the vaporiser being maintained at a suitable temperature by the heat of the exhaust. It is designed in such a manner as to thoroughly evaporate the paraffin without overheating the air which is required to complete the charge. The makers claim that perfect combustion is obtained with this vaporiser, which remains clean and free from any deposit after months of continuous working. The governor controls a balanced throttle valve placed close to the inlet valve.

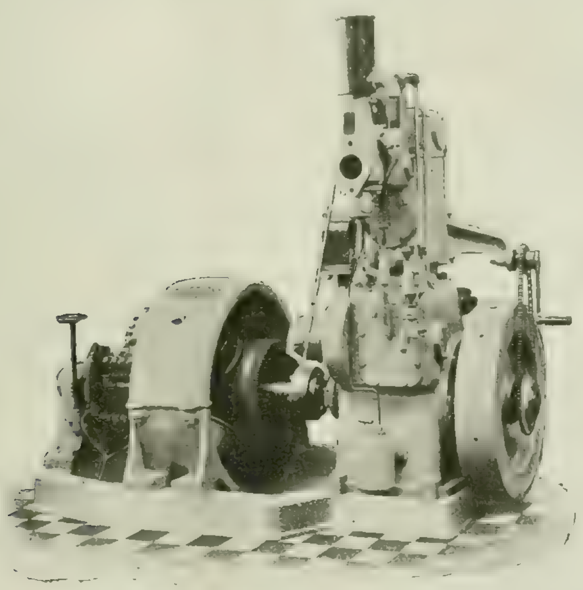


FIG. 2.—GENERAL VIEW OF ALLEN PARAFFIN ENGINE (SINGLE CYLINDER) DIRECT COUPLED TO DYNAMO.

After exhaustive experiments low-tension magneto ignition has been adopted, and is driven by spiral gear from the cam shaft. One hand-lever operates the retarded ignition and exhaust relief cam for facilitating the starting up of the engine. Small brass plates indicate the "starting" and "running" positions of all levers, making it difficult for anyone to forget what to do when about to start up. Fig. 2 illustrates the engine direct connected to a direct-current dynamo.

These engines are built for a variety of duties, but are suitable more particularly for driving dynamos and centrifugal pumps, or other rotary machinery adaptable for direct coupling to the driving agent. They are also built in the multi cylinder patterns, this type having very even turning moment.

We are indebted to Messrs. W. H. Allen, Son & Co., Queen's Engineering Works, Bedford, for the particulars embodied in the above description.

AN ALKALI ELECTRODE.*

BY P. TH. MULLER AND H. ALLEMANDET.

The present work was commenced to find out how yellow mercuric oxide behaves in dilute alkaline solution, and to investigate if it were possible to use this body as a stable depolariser in the chain

$$Hg \mid HgCl + KCl \mid KNO_3 + KOH + HgO \mid Hg.$$

The temperature chosen for this investigation was 25°C. As it was necessary to maintain this temperature for a considerable period, in spite of very severe external weather changes, a special form of thermostat had to be designed. The essential feature of this latter consists of a water jacket separated from the thermostat proper by a non-conducting air space. In this manner the temperature could be kept perfectly constant for a period extending over several months. The method of investigation consisted of a series of potential readings of the above chain by the Poggendorf method on a potentiometer provided with a galvanometer capable of detecting 10^{-9} amperes. In the initial stages all measuring instruments were very carefully standardised, and very special care was taken with the standard cells in use. From this preliminary investigation the authors conclude that the normal calomel electrode of Ostwald gives a remarkably constant value, but the decinormal electrode introduced by Richards varies between 0·6168 and 0·6175 volt, depending on the method of making up. This latter variation does not introduce any irregularity into an individual electrode, and, therefore, these electrodes can be used after a preliminary standardisation. Very special care was taken with all the reagents used, so as to exclude all possibility of contamination with the impurities of the air. The yellow mercuric oxide was always prepared by precipitation of mercuric chloride and potassium hydroxide in boiling solution, and subsequently washing in an atmosphere deprived of carbon dioxide. In this manner a homogeneity of reagents was ensured.

The normal electrodes employed differed only slightly from those in common use, but special precautions were taken to exclude carbonic acid gas. In the alkaline electrode pure mercury was used covered with the depolariser of yellow mercuric oxide. To this was added the solution of alkali, along with N/10 potassium nitrate to increase the conductivity of the electrolyte. Connections were made through N/10 potassium chloride to a decinormal calomel electrode. Readings were taken with different strengths of alkali, and the results agree closely with theory. The potential of diffusion was calculated from the formula of Planck,

$$E = 1{\cdot}98 \times 10^{-4}\, T \log \xi,$$

$$\frac{\xi u_2 - u_1}{v_2 - \xi v_1} = \frac{L_n \frac{C_2}{C_1} - L_n \xi}{L_n \frac{C_2}{C_1} + L_n \xi} \times \frac{\xi C_2 - C_1}{C_2 - \xi C_1},$$

in which $U = up + u'p' + \dots$ and $V = vq + v'q' + \dots$, all the letters having the usual significance. With the very small dilution of OH′ ions one factor may be neglected without appreciable error, and the modified form is obtained.

$$\epsilon = 1{\cdot}98 \times 10^{-4} \times T \log \frac{u_1 + v_2}{v_1 + u_2}.$$

The mobilities of the ions were obtained from Kohlrauch's figures determined at 18°C. and transformed to 25°C. In this manner corrected potential readings were obtained, of which the following table is typical:—

C.	E(KOH).	E(NaOH).	E($Ba(OH)_2$).	E(calculated).
0·01	0·5067	0·5066	0·5078	0·5087
0·002	0·5516	0·5505	0·5489	0·5499
0·001	0·5727	0·5708	0·5689	0·5676

where C represents the concentration of the alkali and E the E.M.F. corrected for the diffusion factors in the various alkalis employed. The calculated E.M.F. was made from the Nernst formula

$$E = NT \log P/C,$$

but this agrees with the actual figures only at extreme dilution, for it is impossible to calculate the diffusion factor except by the modified formula of Planck. It is of great interest to note that the figures of potassium hydroxide are persistently higher than any others, the mean deviation being 0·0015 volt and this is accounted for by the influence of potassium nitrate on the ionisation of potassium hydroxide in the normal element. From this it is possible to calculate the affinity constant of the given base. From the well-known mass reaction $\frac{(K) \times (OH)}{(KOH)} = k$ by modification, $\frac{(OH)}{(KOH)}$ is constant and equal to A. The coefficient of ionisation of potassium hydroxide is $\gamma = \frac{(OH)}{(OH) + (KOH)} = \frac{A}{A+1}$, or where C is the concentration $OH = \frac{C}{1 + \frac{1}{A}}$. This introduced into the Nernst formula gives

$$E' = NT \log \frac{P\left(1 + \frac{1}{A}\right)}{C}, \text{ or } 0{\cdot}0015 = E - E' = NT \log \left(1 + \frac{1}{A}\right),$$

from which the affinity constant 1·37 is obtained by simple substitution. The authors give this method, however, with some reservation and desire to state that their experiments are still in progress. Further results, similar to the above, were obtained with sodium hydroxide in sodium nitrate solution, and the agreement is as close as can be expected. The substances investigated were lithium, sodium, potassium, thallium, barium, strontium and calcium hydroxides.

* Abstracted from the *Journal de Chimie Physique*.

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ELECTRICITY SUPPLY PROBLEMS.

In the discussion which followed the reading of Messrs. HANDCOCK and DYKES' Paper at the Institution of Electrical Engineers on the subject of "Electric Supply Prospects and Changes as affected by Metallic Filament Lamps and Electric Heating" there was a fairly general expression of opinion that the metallic filament lamp will do good to the electrical industry. On the other hand, the authors showed conclusively that, in certain cases, particularly on alternate-current systems depending for the greater part of their load on lighting, the metallic filament lamp will cause a serious falling off in revenue, which there will be some difficulty in replacing by connecting new consumers at a sufficient rate to maintain the load, although in due time this state of affairs will, no doubt, rectify itself.

In this connection the small consumer becomes of supreme importance. The advent of the metallic filament

lamp has always been regarded as the salvation of the central station engineer in regard to the small consumer, for it has long been recognised that this class of consumer considers, and must consider, economy in preference to convenience. From the economical point of view, gas hitherto has had very distinct advantages in small houses. It has, therefore, always been considered, without looking carefully into the problem, that a highly efficient lamp would provide the poor man's light. The metallic filament high-efficiency lamp has now come, and the poor man's light is with us; but, unfortunately, this is not a complete solution of the problem, for the question has also to be viewed from the standpoint of the central station engineer. If it is found that the cost of a service is out of proportion to the income which it provides, the problem is only partly solved, and the situation is increasingly serious if we find that the small consumer is still out of reach. In the case of gas, a service is a simple matter and is comparatively cheap to instal. In the case of electricity it is otherwise. In fact, in the discussion to which we have referred, it was stated that the cost of services is apt to be nearly as high per kilowatt as the cost of a generating station.

If this is really found to be the case, we must conclude that our methods are wrong for this class of consumer. On the Continent he is handled with success. The fact is, British engineers began at the "wrong end of the stick." We have made everything as good, as solid and as safe as possible, the result being that everything is as expensive as possible, and there is great difficulty in descending from the best to the inferior. On the Continent the course followed has frequently been the reverse. Services have been put in on methods which are extremely cheap, although, perhaps, not quite as free from the element of possible danger as is desirable; only when required by the authorities have more expensive methods been adopted. The result has been that electric light has been provided on the Continent in villages which would be hopelessly unremunerative in this country. We see no reason why services should not be materially cheapened in this country on similar lines. In towns we can scarcely expect bare wires to be used, but there seems to be no serious reason why blocks of houses should not be served by one cable which might be run along an outside wall at some convenient height, say just below the first-floor windows, so that a service might be tapped off from this cable without difficulty to any house requiring it. It might even be worth while to omit the meter altogether in houses of this class.

Methods of this kind would cheapen the supply from the station engineer's point of view, but it would not solve the problem of high cost of wiring, which is a difficulty that must be overcome for the small consumer. As regards this point, the methods followed on the Continent certainly provide a solution. We do not doubt that under certain circumstances unprotected wiring would be willingly accepted, but the chief difficulty at present in this respect is that it is nobody's business in particular to agitate the question. The station engineer has fixed ideas as to the class of wiring which should be put in, and he objects to what may be described as an inferior system. The contractor, no doubt, would be pleased to carry out work of this kind, but he is not inclined to do so if on completion the engineer from the station may say that such work cannot be accepted. Consequently, the wiring problem is left where it was, and we cannot expect any advance to be made in this direction unless the station engineer makes some effort to get into touch with the contractors, and to let them know what will be acceptable, and how the problem is to be tackled.

REVIEWS.

(Copies of the undermentioned works can be had from *The Electrician* Office, post free on receipt of published price. Add 5 per cent. for abroad or for foreign books.)

Mueller-Pouillet's Lehrbuch der Physik und Meteorologie. 10th edition. Vol. III. Edited by L. Pfaundler. (Brunswick: F. Vieweg & Sohn.) Pp. xiv.—914. M. 14.

The composite editorship of this volume is dictated by the necessity of keeping in touch with Ostwald's school on the one hand, and the more rigidly mathematical school of thermodynamics on the other. Molecular physics has been expanded into a number of chapters on chemico-physical statics and thermochemistry, and the phase rule has for the first time been embodied in this work. The phase rule was established by Willard Gibbs in 1874. It comprises the whole range of conditions, compositions and possibilities of existence of bodies in so far as they are independent of time; in other words, it deals with all cases of equilibrium of states of aggregation. The three phases of a saline solution are the solid salt, the solution, and aqueous vapour, and salt and water are its "components." Chemical physics cannot be presented in any up-to-date manner without embodying Gibbs' great generalisation. Yet it is surprising that it found acceptance for many years only in the Netherlands, chiefly owing to the exertions of Bakhuis Roozeboom in Amsterdam. The rule in its simplest formulation states that the number of "freedoms" or independently variable conditions is obtained by adding 2 to the number of components (B) and subtracting the number of phases (P). In symbols $F = B + 2 - P$. In a saline solution $F = 1$, which means that pressure and temperature cannot be varied independently. The matter is dealt with in this work in an admirably lucid manner. Other favourable points are the account of low-temperature researches and Lehmann's liquid crystals of benzoic cholesterylester, to which, of course, many other substances have been recently added. The short treatment of the steam engine might well be further modernised. It does not look well to have models of 60 years ago presented as the sole representatives of the industry, and some reference to steam turbines would surely not be out of place in even a purely scientific treatise. The meteorological chapters are correctly described as an outline, and can hardly claim any merits of originality. The volume, as a whole, is brought out with that scrupulous regard for the "weaker brethren" which has made this work so deservedly popular.

E. E. F.

The Engineering Index for 1906. (London: The "Engineering Magazine.") Pp. 395. 10s.

This book is practically a continuation of the other volumes under the same title which have appeared from time to time. This issue brings the index down to the end of 1906. In its preparation practically all the well-known English, American and Continental engineering periodicals are consulted and the result is a very fair résumé of what has actually appeared in the technical press. The book is not entirely free from misprints, but otherwise it appears to fulfil its mission very well.

Die elektrochemische und elektrometallurgische Industrie Grossbritanniens. By J. B. C. Kershaw. Translated into German by Dr. Max Huth. Vol. XXVIII. of "Monographien über angewandte Elektrochemie." (Halle a.S.: Wilhelm Knapp.) Pp. ix.—130. M. 9.

This book contains a large amount of information and some very good diagrams. In his preface the author states that he has endeavoured to give as complete a review as possible of the development of the electrochemical and electrometallurgical industry of this country and of its present position.

For some years past the author has been known as a prolific writer upon electrochemical and electrometallurgical subjects; consequently he should have compiled a large number of facts

which should be useful in such a work as he has now attempted. Such indeed is the case, but instead of writing a new work he has taken a number of his old articles, some dating back to 1896, and in many cases these have been pieced together without his having taken the trouble to rewrite them. For example, the introduction to Chapter III. was originally written in 1897, and thus, on p. 24, we find the following expressions of opinion :—

"In consequence of these circumstances it is not at present possible (1897) to predict the financial possibilities, although the works have been in operation for two years."

Certainly on p. 29 it is stated that the "Electrochemical Company" existed until the year 1900, when it went into liquidation. But as this monograph was written in 1907, why quote remarks which in the light of present knowledge are, to say the least of it, misleading?

In connection with the production of aluminium the price of the metal with its fluctuations is given to 1902 ; why has this not been brought up to date? As the author is strong upon historical detail, it is strange that he dismisses the Cowper-Coles electro-zincing process with the words, "so far as is known the process has not been introduced into any manufactory in Great Britain." As a matter of fact it was taken up by at least four firms. Furthermore, why is there no mention of the Cowper-Coles centrifugal copper process?

It is naturally a very difficult matter to obtain authentic commercial information, particularly from manufacturers in Great Britain. Consequently, merely because the author has omitted certain things, his book is not to be condemned purely on that account ; it contains much very useful information, but it cannot be considered an absolutely trustworthy guide to the present state of electrochemistry in this country.

ELECTROLYTIC CORROSION.*

BY PROF. W. W. HALDANE GEE.

(*Concluded from page 68.*)

Summary. The author has collected evidence relating to the cause of corrosion, and has made a number of experiments on the subject. He deals minutely with the various conditions which may produce corrosion, and with suggestions for its prevention.

Electrolysis due to Stray Currents.—Fortunately the delay in establishing electrical traction in this country under wise conditions enables one to say that our gas and water pipes, as well as our telephone, telegraph, electric light and traction cables are depreciated little, if at all, by stray currents. In the United States and Germany, however, a different state of affairs exists. Reports of electrolytic injury to pipes come from all parts of the United States.† Between the ends of Brooklyn Bridge a difference of 20 volts has been recorded. Gas services and water-service pipes have been extensively corroded. Cast-iron mains, on the other hand, have been to a large extent immune, owing to their siliceous coating. It is mainly at the joints that trouble is found. Measurements made by L. T. Blake ‡ upon a line of 6 in. cast-iron water mains, which had been in service for 13 years, in the case of a length of 339 ft. having 19 joints gave a resistance of the joints as 88·2 per cent. of the total resistance of the pipe. C. E. Phelps § records that 20 per cent. of the whole faults in underground cables at Baltimore during seven years were due to electrolytic action. With reference to Germany, the work of the Deutscher Verein von Gas und Wasserfachmännern has given us exact information.|| The smallness of the current through cast-iron pipes has been verified by Claude. The current through the pipe is not only small, but only a small proportion of it causes electrolytic effect. Herrick shows that the corrosion of iron only reached 3·5 per cent. of the theoretical loss. The researches of the German investigators have thrown light on the reason of these small losses. The details will be found in two important Papers by Haber,¶ first in conjunction with Goldschmidt and then with Liese. Great importance is attached to whether the iron is active or passive, the corrosion of the iron being generally represented by $(1-x)$ 1·024 grammes per hour. When $x=0$, then the iron is completely active, but when $x=1$ we have total passivity.

* Abstract of a Paper read before the Manchester Local Section of the Institution of Electrical Engineers.

† *The Electrician*, p. 815, September 21, 1900.

‡ *The Electrician*, p. 339, December 29, 1899.

§ *The Electrician*, p. 521, July 13, 1900.

|| See *The Electrician*, August 25, 1905, and July 20, 1907.

¶ *Zeit. f. Elektrochemie*, XII. 49, 1906; XII. [illegible], 1906.

The change from the active to the passive state (as shown by the experiments described in this Paper) depends on the current density and the nature of the salts in the soil, the most important being the nitrates. Iron in an alkaline carbonate becomes passive, but in the presence of free carbonic acid it is attacked; on the other hand, the chlorides are always likely to produce corrosion. Generally it is found that the earth conducts electrolytically and not metallically, and its specific conductivity can be calculated from the concentration of the salt solution present in the soil. When the iron is active electrolysis is produced with just sufficient voltage to overcome the hydrogen at the kathode, but since the air of soils acts as a depolariser, this voltage will be small. Finally it is decided that a P.D. of 1 volt will not, as a rule, be harmful.

A serious aspect of electrolysis due to stray currents is the possibility of causing the solution of lead in drinking water. A case of "Plumbism due to Electrolysis" is said to have taken place in the district of the South Hants Waterworks Co., and is discussed by B. Latham,* a difference of 1·8 volts between an earth return and a lead water pipe being the possible cause of the trouble. This conclusion is doubted by A. H. Dykes.† Fortunately such cases are very rare, and a little consideration will show that the conditions for electrolysis to produce corrosion within a pipe must be altogether exceptional. Where cases of plumbism are announced as due to electrolysis, the plumbo-solvency of the water should be directly tested. Certain waters from moorland sources are especially open to suspicion. A. C. Houston has shown that such waters may be acid and then have the power of dissolving lead.‡

Some alarmist statements have been made by Tweedy and Dudgeon§ on the destruction that is taking place in the overhead equipment of tramways. Through the combined effects of chemical corrosion, local action, and direct electrolysis, a very short life is predicted for overhead work. I am unable to verify that these troubles are so bad as is represented.

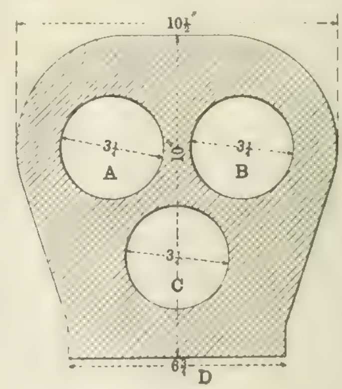


FIG. 1.

I am informed by Mr. A. Watts that about five years ago he undertook a series of tests for the National Telephone Co. at Liverpool, Dundee, Sheffield, Leeds, Bradford, and Hull, but found no evidence of sufficient P.D.s due to stray currents likely to cause electrolytic trouble. The engineers of the Postal Telegraphs in London are experiencing trouble with small distribution cables, but they find that it can be guarded against by the use of petroleum jelly liberally supplied when drawing in lead-covered cables.

Electrical Endosmose.—An electrical current exerts a certain force on water whether in the ionic state or not. This action is made manifest in the case of moisture in porous materials and is included under the phenomena of electrical endosmose. It has been found that the mass of the water transferred is proportional to the coulombs that pass and is independent of the area and thickness of the porous substance. The endosmose effect is a common cause of faults in buried conductors, which are usually found at the negative main. On the negative side there is a constant strain on the insulation tending to drive water through the insulation to the copper.|| When the water gets in, electrolysis of the alkaline salts that are in solution takes place, and alkalies or alkaline metals are produced. An interesting example is detailed by H. Bassett, jun.¶ The endosmose trouble will be aggravated at high voltages and may prove an obstacle in high-pressure direct-current systems. C. H. Wordingham has noted that certain makes of rubber are porous and water may enter and eventually destroy the whole of the rubber on the negative conductors. Not finding much experimental evidence on the effect

* *The Electrician*, p. 348, 1905.

† *The Electrician*, p. 533, January 12, 1906.

‡ Report of the Local Government Board, 1893-4. Also see Carnelley and Frew, *The Electrician*, September 14, 1888.

§ *Journ.*, Institution Electrical Engineers, Vol. XXXVII., 161, 1906.

|| F. Fernie, *The Electrician*, p. 125, May 11, 1906.

¶ *The Electrician*, April 12, 1907.

of the conveyed water on the resistance of concrete, soils, and other porous materials, a number of observations have been made.

A three-way duct used was kindly provided by the National Telephone Co. Its dimensions are shown in Fig. 1. It was placed in a tray containing mercury, and mercury was also placed in the ducts, being retained in place by walls of plaster of Paris. The resistance between C and D was measured by the alternating-current method of Kohlrausch. The mean resistance was found to be 3,550 ohms. A voltage of 110 was now applied and readings of the current by a milliammeter were taken at intervals of time. The results are plotted in Fig. 2. The polarity was some time afterwards reversed and readings given in Fig. 3 resulted. Next the resistance was measured between A and B. This was 6,600 ohms. On applying the direct voltage the figures in Fig. 4 resulted. In the above cases, the duct having been exposed to the air of the laboratory for some weeks, the concrete was fairly dry. The duct was then soaked for two days in water and the resistance measured by the Kohlrausch method from time to time for about four weeks, particulars of which are given in

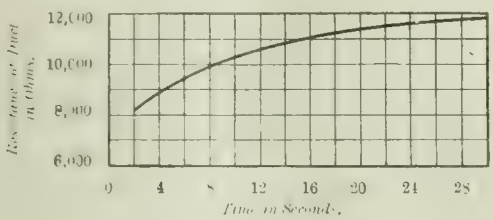


FIG. 2.

the Paper. It shows that the resistance between the outside and inside a duct will, when in a wet condition, be less than 1 ohm for 100 yds.

Concrete was then cast within a tinned iron cylinder provided with a central iron cylinder so as to give concentric electrodes. Successive measurements by the alternate-current method gave the specific resistance as 3,840 ohms per centimetre cube. A determination made in the same way, but with a mixture of equal parts of concrete and fine sand, gave 5,970 ohms per centimetre cube.

In order to test the influence of different electrodes on the change of resistance with time, a block was cast of equal parts of concrete and fine sand. It was a cube of 3 in. side. Two plates of carbon were used as electrodes, one being placed at the bottom and one at the top. As good a contact as possible was obtained by the pressure of a 56 lb. weight placed on the top. On applying 110 volts the resistance increased in the same manner as in the previous cases. The resistance measured by the alternating-current method gave a very high value (1,164,000 ohms). Mercury electrodes were then substituted. The block was placed in a layer of mercury and an upper electrode also of mercury was used. This was held in place

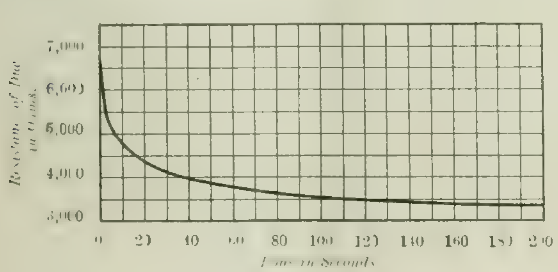


FIG. 3.

by cementing paper round the upper edges of the block. The resistance now was about 30,000 ohms. The experiment shows that the contact of the carbon with the cement was very imperfect. The specific resistance calculated from the last figure was 228,000 ohms per centimetre cube. A block of the same size, but made of pure cement, gave specific resistance per centimetre cube = 158,000. Particulars of experiments on concrete made according to the specification of the Standards committee are also given.

In further experiments standard sand from Leighton Buzzard was placed in a glass trough and provided with soft-iron electrodes of 10·5 sq. cm.; when the sand was quite wet but without surface-water, and with the electrodes 5 cm. apart, the specific resistance was measured by the alternating-current method and found to be 15,750 ohms per centimetre cube. A current from a 110 volt and 220 volt circuit was now passed through the sand and time observations taken as before. Particulars are given in the Paper.

Roughly-powdered coke with iron electrodes and moistened with Manchester rain water was also tried. The resistance gradually decreased on applying a voltage of 10, probably due to the heating of the carbon. The polarisation was 1·95, and the specific resistance about 20·6 ohms per inch cube.

Pure aluminium-foil electrodes used with damp sand moistened with a dilute solution of salt gave with 25 volts a gradually increasing resistance. The anode corroded during the experiment. The current density at the end was about 0·0056 ampere per square centimetre. Experiments were also made with plaster of Paris.

It does not seem that the change of resistance in these endosmose experiments that takes place is due to the effects of polarisation, or to a gradual building up of a non-conducting film at the electrodes. It was the same with mercury, carbon, and non-passive iron and aluminium electrodes. The values of the E.M.F. of polarisation obtained were low. There was plenty of evidence of the gradual drying of the positive electrode causing a change of the resistance around it. The experiments with the plaster of Paris rods show the influence of the conveyed water on the resistance. The phenomena has some resemblance, as far as the rate of change of the resistance, to the observations of Trouton and Searle,* which relate to the change of resistance of surface films on glass.

The rapidly increasing use of concrete for structural purposes, &c., makes the study of its electrical properties of some importance. Its specific resistance, according to the measurements that have been given in the case of pure cement, vary from 20 ohms per yard cube when wet to 1,900 when fairly dry. The addition of sand does not make much difference when the concrete is wet, but its effect when very dry is to greatly increase the specific resistance. The specific resistance thus depends on the presence of water to a very important extent. The experiments on electrical endosmose show that water may be electrically conveyed and accumulate at kathodes. The corrosion of structural steel embedded in concrete by the action of stray currents is a matter of concern in the United States. Toch has shown that steel embedded in steel can be electrolytically corroded at the anode, but if a good insulating paint be applied to the steel corrosion

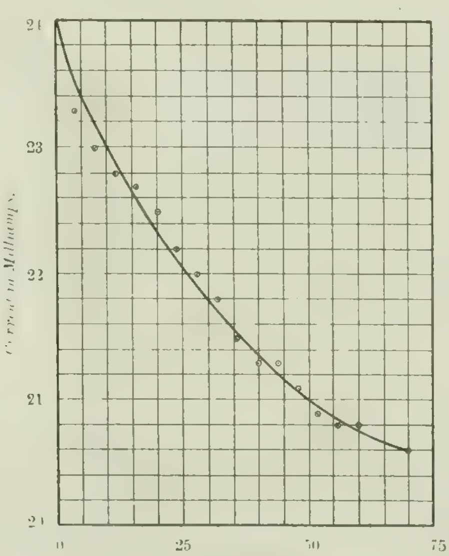


FIG. 4.

can be prevented. Some drastic experiments, showing the effect of relative large currents on iron in concrete, have been described by A. A. Knudson.† In the absence of vagabond currents iron in properly made concrete is perfectly preserved without loss of weight, and even if used in a rusty state it will recover after some time the tint which it originally possessed. This almost incredible fact is thought to be due to the action of the cement in forming a protective coating of silicate of iron.

Electrical engineers will be interested in the efforts that are being made to apply electrical endosmose for the drying of peat, the extraction of sap and in the processes of tanning. The method of drying peat is then described.

Alternating-current Corrosion.—The Metropolitan Water Board, having been successful in forcing the North Metropolitan Electric Supply Co. to include in their 1907 Bill a clause by which the company is liable for any electrolytic action from their alternating system, has brought under debate the question whether or not alternating currents can produce corrosion. The question is one of considerable scientific interest, and is settled as far as laboratory methods are concerned. Even with a frequency as high as 600 per second copper can be rapidly corroded in a solution of potassium cyanide. This may be due to the great rapidity of the reaction between the copper liberated during half a period and the cyanide leading to the formation of complex substances which cannot be decomposed by the reversed current. The frequency of commercial alternating currents being more of the order of 50, the conditions for

* *Phil. Mag.*, p. 336, Vol. XII., 1906.

† *Proc.* Am.I.E.E., February, 1907.

corrosion are more favourable, but, fortunately, the salts in the earth have not, so far, been found to give rise to complexes. On the other hand, it is found that the efficiency of corrosion is very small, and that passivity may be produced and prevent corrosion altogether.

J. L. R. Hayden* has made a long series of experiments with lead and iron electrodes, using solutions of salts contained in the soil, and with the soils themselves, and he finds that the amount of corrosion rarely exceeds ½ per cent. of the amount that would be produced by the equivalent direct current. The result of some experiments made under the author's direction are then given. These showed the percentage of alternating-current corrosion to direct-current corrosion to be 0·06 in the case of lead plates, 0·15 for copper and 0·5 for iron, the plates being placed in sodium sulphate solutions and 2·5 amperes at 80 ~ used. In a second series of experi-

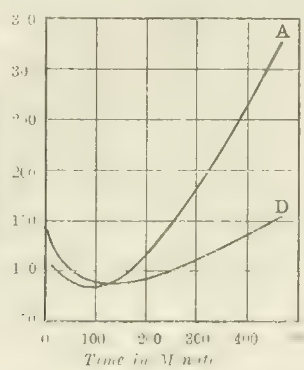
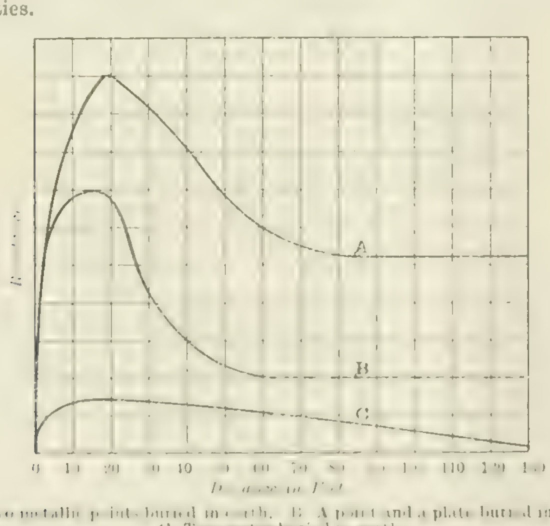


Fig. 5.

ments a normal solution of sodium chloride was used, and the electrodes were of soft commercial lead and transformer iron. Frequency was 60 and current 1·5 amperes for plates of area 100 sq. cm. In the case of lead, the percentage of alternating-current to direct-current corrosion was 0·015 for lead and 0·33 for iron.

One aspect of the leakage of alternating currents is whether they are capable of rectification by the valve action of certain metals, such as iron, lead and copper. This requires investigation. In an appendix to the Paper is given Mr. Butterworth's calculation of the conductance capacity of an electrolyte due to the presence of galvanic couples of simple geometric form, and also a description of some experiments showing electrode phenomena at high current densities.



A. Two metallic points buried in earth. B. A point and a plate buried in earth. C. Two plates buried in earth.

Fig. 6.

The Paper was illustrated by experiments and lantern slides, and additional details were given. In the case of passivity of iron, it was shown that an increase of current density from 0·0045 to 0·0055 ampere per square centimetre required, in one test with sodium nitrate solution, an increase of terminal voltage from 1·47 to 3·78, and the potential tested against a cadmium electrode at the anode rose from 0·521 to 2·[illegible] volts. Measurements relating to the effective voltage of copper and zinc in normal sulphuric acid by the use of a capillary electrometer and a Caldwell electrode, gave a value of 0·0041 volt with 1 ohm in the external circuit.

Reference was made to the impurities of the atmosphere of Manchester as causing corrosion. An analysis of a sample of rain water collected in the middle of the town and tested by Dr. Knecht gave 0·816 part of free sulphuric acid and [illegible] part of ammonium sulphate in a total of 100,000 parts. It was generally known that ammonium salts were apt to corrode ironwork.

The diagram (Fig. 5) shows the particulars of the resistance of a block of concrete under the influence of a pressure of 220 volts. The curve A shows the change at the anode, and curve D the change at the cathode. The early parts of the curves show the effect of the change of resistance with temperature.

* [illegible] April [illegible], 190[illegible].

DISCUSSION.

Mr. A. Watts (National Telephone Co.) confined his remarks to stray currents. When electric traction was introduced into this country considerable alarm was felt concerning the ill effects which were said to have been experienced by telephone companies, more especially in America. In Sheffield, where much investigation work was carried out, the highest voltage between cable sheath and rail was 1·25. He showed to the meeting an earth plate which had been used in Sheffield and which was very much corroded. A survey made in South Staffordshire showed that between a certain point on the track and the power station there was a P.D. of 13·4 volts, but, fortunately, the telephone cables had not been influenced by this abnormal difference of pressure. He did not consider the author's tests on standard concrete to be of much service in practice, as commercial concrete varied very much in composition from the standard specified.

Mr. J. G. Cunliffe (Manchester Corporation Tramways) said he had endeavoured to find a reason for the fact that, although comparatively large currents were found to flow in the earth, only small currents of about 1 ampere were found in the pipes alongside the track. Fig. 6 showed the results of some experiments made, and he wished to draw attention to the general shape of the curves which appeared the same under all conditions within the range of the experiments. Also at small distances the resistance was high as compared with that at greater distances. Fig. 7 showed that with earth plates close together the

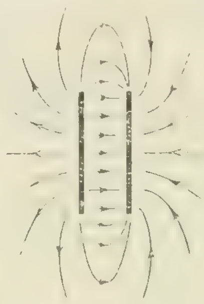


Fig. 7.

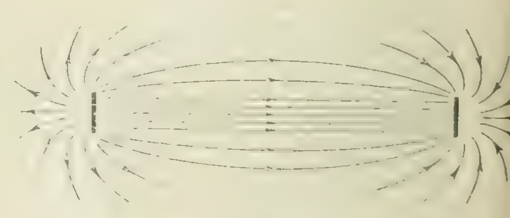


Fig. 8.

length of the extended stream lines was disproportionately great, so that the effective area of the path was not much greater than the area of the plates themselves. Fig. 8 showed the plates far apart, and in consequence the effective area of the path was enormous as compared with that of the plates, hence the shape of the curves in Fig. 6. He had found in some cases a resistance of 30 ohms at pipe joints with only ⅛ in. space between the pipes. Mr. Cunliffe claimed that electrolytic surveys were of no service, as the smaller the leakage between a pipe and rail the greater would be the P.D.; and it was this value which was generally taken as a sure sign of danger, when, in reality, it was a sign of maximum safety. A type of line in-

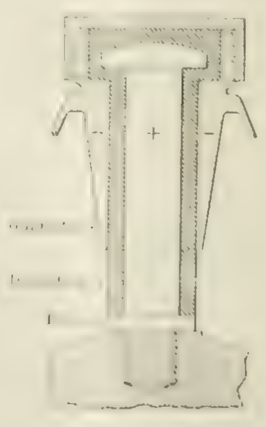


Fig. 9.

sulator (Fig. 9) was shown which was so much affected by capillary attraction and electrical endosmose that water was drawn between the iron bolt and the insulating material and forced through from the positive metal of the bolt to the negative metal of the hanger, causing rapid corrosion and failure of insulation. This applied to nearly every type of line insulator, and could be remedied by the inversion of the bolt or by reversal of the line polarity.

Prof. A. Schwartz remarked that electrolytic corrosion was usually associated with tramway traction; but, as in this country corrosion

was almost non-existent, engineers were inclined to dismiss the idea from their minds. He showed an earth clip which was ingeniously and effectively designed, but regarded from the point of view of the contact difference of potential of the metals employed—viz., lead, tinned copper, galvanised iron and brass—could only be considered as a concentrated sin. As regards the corrosion of ferro-concrete, which was employed extensively in structures of all kinds, including towers for long-distance transmission work, he found that coke breeze concrete was not protective, but that neat cement was very efficient in this respect, and he suggested that all ironwork should be washed over with neat cement before being embedded in concrete. Cast-iron pipes dipped hot in Dr. Angus Smith's composition were practically immune from corrosion. He thought the author was incorrect in attributing the explosions on mains to the firing of the hydrogen produced by electrolysis. In the St. Pancras system, with which he was connected some years ago, a number of explosions occurred on the bare copper mains in brick and concrete culverts, and in every case the explosion was found to be due to the presence of coal gas in the culverts. It was hardly possible to excavate a trench or hole in the streets of our great cities without finding coal gas. Prof. Marchant had been unable to stay to the discussion, but had left a large sample of the salts found on the negative mains in the Liverpool breakdown mentioned in the Paper. Prof. Schwartz had seen similar specimens on the mains at Chelsea. The metallic sodium and potassium, he had found, existed in the form of globules in the interior of the mass of salt, the latter cracked or disintegrated owing to the heat developed, and if a drop of water from a pipe or manhole cover fell on one of these globules the hydrogen was ignited and caused to fire the explosive mixture of coal gas and air. With regard to the rusting of iron and steel, he understood that this took place in the presence of CO_2, and he wished to ask the author whether there was a possibility of the gas occluded in the metal assisting the rusting under a protective coating. Iron and steel were capable of occluding 10 or 12 times their volume of gas, and on heating the gas given off at the lower temperatures was almost entirely CO_2. In conjunction with Mr. W. Grant he had worked out from figures supplied by Mr. Lackie (Glasgow), the resistance, in a given case, of the return path through the lead sheath of a cable and through the earth, the resistance in the latter case being measured between earth plates, and he found that the earth resistance was considerably smaller, so that elctrolysis was possible in spite of the bonding.

Dr. C. C. GARRARD thought that the voltage between the electrode and the solution should be taken as a criterion in preference to the current density as stated by the author.

Mr. W. CRAMP had observed the formation of a very hard oxide of iron on tram rails, due to the combined pressure and heating, and he wished to ask the author whether any such method was at present employed in the production of durable iron oxides.

Dr. E. ROSENBERG referred to the aluminium rectifier, and stated that an eminent German authority concluded that the peculiar effects were due to a film of oxygen formed on the electrode.

Prof. GEE, in reply, said as regarded the remarks on commercial concrete, the first experiments were made with commercial materials, but the results were so inconsistent that it was considered advisable to employ standard cement and standard sand. The subject which was under investigation related to the resistance of porous materials, especially in connection with electrical endosmose. A point of practical difficulty was the surface drying, which might be very rapid, causing the apparent resistance to be very high, whereas the interior might be very wet and of low resistance. It had, therefore, been found necessary to follow the change of resistance by testing P.D.s between different parts of the concrete. He would like to consider further Prof. Schwartz's remarks on the effect of occluded gases, but in the case of carbon dioxide it should be remembered that the addition of water was necessary in order to make it an electrolyte. Many phenomena were dependent upon current density. The strength of the current was dependent upon the voltage, but after the voltage of decomposition had been exceeded, passive phenomena might be produced at various current densities. The laws of reaction velocity could be deduced from mass action, but the rate of solution of metals as connected with electrical constants was not yet clear. Recent investigations had shown that chemical changes could be brought about in non-conducting solutions. As one speaker had said, there was too much optimism in this country with regard to electrolytic corrosion, and he ventured to think that the rapidly increasing use of direct and alternating currents for lighting and traction would give trouble in the immediate future. Experiments had shown that it was quite possible to rectify alternating currents in the earth. Dr. Rosenberg had mentioned the oxygen theory of passivity, but on this point he would reserve his opinion, as, on account of the varied opinions of investigators, it appeared that some further knowledge about electrons would be necessary before the real cause of passivity would be clear.

More Electrical Marvels.—According to a newspaper dispatch from Phillipsburg, N.J., says the *Electrical World*, a man named John Miller had the sight restored to one eye, which had been blind for 30 years, by a shock from an electric wire. According to the account, when Miller recovered from the shock he saw a woman wearing a blue dress walking in the street. "By gracious, Schooley!" exclaimed Miller to his employer, "I see her with my bad eye."

CORRESPONDENCE.

THE THEORY OF ALTERNATE-CURRENT TRANSMISSION IN CABLES.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: I have read Herr Gáti's and Dr. Drysdale's letters in your last issue with a great deal of interest. Herr Gáti refers to the large decrease in insulation resistance, or, perhaps, to put it in a better way, the increase in leakance for ordinary cables when measured at telephonic frequencies.

This is now a fairly well-known phenomenon. Some measurements made by Mr. Shepherd and myself, which were published last year, practically confirm those of Herr Gáti to the extent that cable with a direct-current insulation of several hundred megohms has an actual alternate current insulation (at telephonic frequency) of about 0·2 megohm. I do not think, however, that many will agree with the conclusion arrived at by Herr Gáti and Dr. Drysdale (last paragraph of latter's letter).

The cable manufacturers and users are, in my opinion, quite justified in attaining and maintaining high insulation, and the reason for this is not far to seek.

The attenuation over any ordinary telephone cable, whether the insulation is taken as, say, 1,000 megohms or as 0·2 megohm is the same, within a small fraction of 0·1 per cent. It is true that with a loaded cable line the attenuation when calculated on the direct current insulation will be too low, but this is well known and allowed for in practice. The probability is that the insulation as measured by alternating current varies to about the same extent as the insulation measured by direct current, and I would point out that for ordinary unloaded cables the insulation can drop to a point of the order of 0·1 megohm before the attenuation is appreciably increased, but that this point is a critical one below which the attenuation rapidly increases. It would appear, therefore, that Herr Gáti's contention (which is accepted by Dr. Drysdale in the last paragraph of his letter) arises from a misconception of what is meant by high insulation.

Those who have to deal with paper-insulated cables know that the cost of attaining high insulation is not by any means the expensive item in cable construction.

Also the direct-current insulation test is only made as a ready means of checking the condition of the dielectric.

Of course, this question of variation of insulation, when measured by direct current and by alternating currents of the nature of those with which the cable is actually used, emphasises the importance of making all measurements with speech frequency currents, and the introduction of simple and reliable methods of producing and using such currents is undoubtedly, therefore, of the first importance.

It would be interesting to hear whether Herr Gáti has to deal much with paper cables in Budapest and if he has made measurements of the insulation with alternating currents, when the direct-current values are down to a few megohms per mile.

Dr. Drysdale is correct in assuming that I meant increase in insulation and not in leakance in the paragraph of my article he refers to. With regard to the distortionless circuit used by me in obtaining an oscillogram, Dr. Drysdale can rest assured that it was absolutely distortionless, as it consisted of a pure ohmic resistance with quite a negligible amount of capacity and inductance.—I am, &c.,

London, April 27. B. S. COHEN.

THE COMMUTATION PROBLEM.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: In your issue of April 17th, Mr. Menges finds it contradictory if I state in a general way that with bridges of $\frac{1}{32}$ in. to $\frac{3}{64}$ in. thickness the sparking is not affected, and that in a special case an increase to $\frac{3}{64}$ in. reduced the sparking limit about 20 per cent. I do not think that this is contradictory, as I meant to give $\frac{1}{32}$ in. to $\frac{3}{64}$ in. as an actual limit. (See the article in the *Elektrotechnische Zeitschrift.*)

Mr. Menges gives the cause of sparking through the use of $\frac{3}{64}$ in. wedges as "weakening of the main flux." A simple

calculation shows that the wedges do not "deviate" more than a per cent. or two of the main flux—*i.e.*, the flux in the magnets—even if the wedges are entirely saturated. They do not weaken the flux in the armature at all. On the contrary, the latter is increased with constant exciting current, due to improved magnetic conditions in the air gap. (See the original article.) I suppose Mr. Menges has overlooked this.

I shall be glad to carry out tests on an experimental apparatus. It will not be easy, however, to design a really satisfactory apparatus.—I am, &c.,

Darmstadt. April 25. R. GOLDSCHMIDT.

BOOKS RECEIVED.

(Copies of the undermentioned works can be had from *The Electrician* office, post free, on receipt of published price. Add 10 per cent. for abroad or for foreign books.)

"Questions and Answers in Electrical Engineering." By A. E. Moore and Frank Shaw. (London: Longmans, Green & Co.). 2s. 6d.

"Electricity: What is it?" By W. Denham Verschoyle. (London: Swan Sonnenschein & Co.) 2s. 6d. net.

"Development and Electrical Distribution of Water Power." By Lamar Lyndon. (London: Chapman & Hall.) 12s. 6d. net.

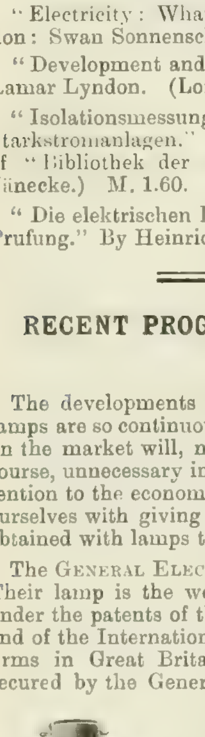
"Isolationsmessung und Fehlerortsbestimmung in elektrischen Starkstromanlagen." By Dipl.-Ing. Paul Stern. Vol. LXXXI. of "Bibliothek der gesamten Technik." (Hanover: Dr. Max Jänecke.) M. 1.60.

"Die elektrischen Kohlengluhfadenlampen ihre Herstellung und Prufung." By Heinrich Weber. (Hanover: Dr. Max Jänecke.) M.9.

RECENT PROGRESS IN METALLIC FILAMENT LAMPS.

The developments at present being made in metallic filament lamps are so continuous that a short account of the lamps at present on the market will, no doubt, be useful to our readers. It is, of course, unnecessary in a journal such as *The Electrician* to draw attention to the economies effected by their use, and we shall content ourselves with giving some figures of efficiency and candle-power obtained with lamps turned out by various makers.

The GENERAL ELECTRIC Co. are well to the fore in these matters. Their lamp is the well-known "Osram," which is manufactured under the patents of the Deutsche Gasgluhlicht Aktien-Gesellschaft and of the International Wolfram Co. The selling rights of these firms in Great Britain and the Colonies have been exclusively secured by the General Electric Co., while it is hoped that a new factory, which is being established at Hammersmith, and is capable of turning out the "Osram" lamps at the rate of 10,000 a day, will be in operation before the end of the year. The general characteristics of this lamp are so well known to the electrical engineer that any detailed repetition of its advantages is quite unnecessary. We must, however, draw attention to an "Osram" lamp which has lately been put on the market. It is suitable for burning singly on voltages from 200 to 260 volts, and as such is a distinct step forward. Two types of this lamp are supplied consuming 65 and 125 watts respectively, and are capable of burning in any position, though, as in the case of other similar products, "slanting" lamps have to be specially ordered. It must be recognised, however, that such a lamp, though very welcome for many reasons, is by no means cheap. The increase in the number of filaments is responsible for this, and the company have, therefore, decided not to introduce high-voltage lamps for lower candle-powers than 50 and recommend the running of lamps in series where smaller units than 50 c.p. are required. An illustration of a lamp suitable for burning singly on 210 volts and consuming 60 watts is given in Fig. 1.



Half-size.

FIG. 1.—VIEW OF 210 VOLT "OSRAM" LAMP.

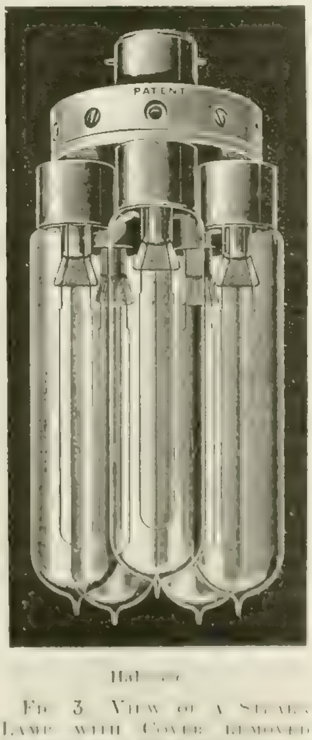
Next on the list comes SIEMENS BROS. DYNAMO WORKS (LTD.). Their product is the well-known "Tantalum" Lamp, which holds the proud position of pioneer in this branch of the industry. Its advantages are patent to all, for while not so economical as some of its colleagues, it is considerably cheaper and handy. We need scarcely remark that the position of the high voltage lamp is of supreme importance to the electrical engineer, and we are glad to state that though not yet on the market, a 200-volt Tantalum lamp is actually in being, and full details of its manufacture and efficiency will be available in the course of a few months. It will be of general interest to our readers to know that the initial difficulties met with when this lamp was used on alternate-current circuits have been overcome. We are informed that their employment under such conditions is steadily increasing, and that many supply engineers have expressed their satisfaction with the way in which these lamps are now working, both as regards length of life and efficiency.

The ELECTRICAL Co. are making a lamp known as the "Aegma," which can be obtained for any voltage between 1 and 140 volts, but is divided into a number of separate classes. The upper limit of the first class is 14 volts; in this class lamps for use with batteries are made, the consumption being about 1 to 1½ watts per Hefner candle-power, while the current taken in all but the smallest size is 0·5 ampere. The next lamp is suitable for a voltage of 20, and is made in two candle-powers—viz., 5 and 10. The 50 volt lamp is made in two sizes also, of 12 and 25 c.p. respectively, while the lamp which may be used on voltages from 100 to 140 can have candle-powers of 25/35 and 50/70 respectively. The lamps are made in ¼ and ½ ampere sizes, their efficiency being 1 watt per Hefner candle-power. Their average life is from 800 to 1,000 hours, during which time it is claimed that no diminution in candle-power takes place. The "Aegma" lamp gives a pure white light, and is equally suitable for both alternate and direct currents. The standard type has to be burnt in a vertical position with the cap upward, but if desired a lamp marked "slanting" can be obtained, which is suitable for all positions. We give an illustration in Fig. 2 of one of the 100 volt 50 c.p. lamps turned out by this firm.

Half-size.

FIG. 2.—VIEW OF THE ELECTRICAL CO.'S "AEGMA" LAMP.

In another part of this issue we publish some remarks by Mr. C. H. Stearn in the discussion on Messrs. Handcock and Dykes' recent Institution Paper, in which he outlines the policy adopted by the STEARN ELECTRIC LAMP Co. in the treatment of metallic filaments. The argument advanced is that, on account of their low specific resistance, metallic filaments must be burned in series, and, provided that some satisfactory and simple automatic device can be employed for keeping the circuit unbroken in the case of failure of one or more filaments, there need be no objection to placing these separately enclosed filaments in different illuminating positions. By the employment of separate filaments the difficulty of low candle-power is overcome to some extent, as each series unit has an illumination of 6 c.p. or upwards. With this unit as a starting point, it is possible to obtain any desired candle-power at any point by the multiplication of the number of units. Special fittings are supplied, by which 1 to 10 of the series units can be employed in a single lamp holder. The fittings are of porcelain and are provided with contacts, into which the special lamps are plugged, these contacts having a short-circuiting socket, into which a plug can be introduced for cutting out any required unit. In the lamp in which the substitutional resistance is employed this short-circuiting socket is not really required, as its purpose is mainly to enable a broken filament to be found. The device adopted for cutting-in the substitutional resistance was suggested, as Mr. Stearn points out, by Messrs. Handcock and Dykes. It consists of two



Half-size.

FIG. 3.—VIEW OF A STEARN LAMP WITH COVER REMOVED SHOWING THE FIVE ELEMENTS.

small plates of tin foil separated by a layer of insulation which will withstand a P.D. of 20 to 25 volts. Should the lighting filament break, this P.D. is immediately increased, and by puncturing the insulation a path for the current is provided through the substitutional resistance. This automatic device is sufficiently small to be enclosed within the brass cap of the series unit. In the case of failure of the filament included in a bunch of lamps there is no difficulty in immediately finding the faulty unit by this simple arrangement. The same device can also be used external to the lighting unit, in which case it takes the shape of a small metal ball which is inserted in convenient clip contacts provided for the purpose. When a filament breaks the circuit is maintained between the two plates inside this ball in the manner already explained, and when a new series unit is put in the automatic device must also be replaced. The combination of the lighting filament and its resistance in one globe is a satisfactory one, and enables series wiring to be carried out for the lighting of lamps from any different parts of a room or in different rooms. We show a combination of series units with the globe removed in Fig. 3. These lamps are being marketed under the trade name of "Leuconium." The arrangement suggested is certainly ingenious, and has many features to recommend it. Not the least important of these is economy, which the makers claim obtains in the matter of renewals. The series units cost 1s., or 1s. 4d. with the safety fuse complete, and where a number is used to form a cluster the failure of one means that the original candle-power (50 or 100) can be maintained at a cost of 1s. or 1s. 4d. respectively, instead of anything above 2s. 6d. In the case of independent series lighting the economy is more marked, and it must also be considered in conjunction with the advantage of low-candle power which the series units offer. We shall be interested to watch the reception which is given to this ingenious suggestion by users of electric lamps and the trade generally.

Simplex Conduits (Ltd.) is another firm which has lately placed on the market a metallic filament lamp for both high and low voltages. This is suitable for use on both alternate and direct-current circuits, though in this case no special care need be taken in ordinary lamps required for mounting in positions other than the vertical, as all "Simplex" lamps are capable of being used at any angle, no extra charge being made for sloping position lamps—a point worth remembering. These lamps, it is claimed, have an average useful life of 1,000 hours. Their efficiency is 1 watt per Hefner candle-power, which is equivalent to about 1¼ watts per candle-power in British units. The lamp belongs to the tungsten group, and is supplied suitable for all votages, from 50 to 250. The following table gives other details:—

Candle-power.	Limits of voltage.	Candle-power.	Limits of voltage.
25	50	50	70 130
32	70—130	50	200—250

The above lamps have the usual size bulbs for metallic filament lamps, but they can all be supplied with a bulb of the size of an ordinary 32 c.p. carbon lamp at an extra charge of a few pence each. With regard to the life of these lamps, Simplex Conduits (Ltd.) have received a letter from a well-known City electrical engineer stating that in his case the 220 volt lamps, after running for 1,370 hours, showed no blackening. This, we are informed, is nothing phenomenal. There is one point which will appeal to contractors and others dealing largely in metallic lamps, and that is as regards breakages. Simplex Conduits (Ltd.) take all risks of breakages, whether lamps are sent in small or large quantities, and they can send small parcels to any part of the country, without fear of damage to the lamps, by means of specially designed cases.

The "Orieco" metallic filament lamp, illustrated in Fig. 4, has been put on the market by the International Electric Co., and is the outcome of prolonged experiment. Its filament is different from that of other metallic filament lamps, and it is said that none of the component parts used by other manufacturers enter into its production. The special process employed in its manufacture, it is claimed, makes the filament of greater strength, thus rendering the lamp less liable to breakage in transit. The "Orieco" lamp is made to burn either in parallel or in series on circuits up to 125 volts, in which case two types—one for 32 c.p., and the other for 50 c.p., can be obtained. The high-voltage lamp, from 200 to 250 volts, is only made in one size, 50 c.p. All lamps of this type, whether for low or high voltage, can be used in any position, and are suitable for both direct or alternate currents. It does not consume more than 1¼ watts per English candle-power, and its efficiency remains the same for about 1,000 hours, the average life of the lamp. After that time, a diminution in the candle-power of from 2 to 10 per cent. takes place. The International Electric Co. are, however, also making metallic filament lamps for very low voltages, especially suitable for use with auto-transformers, or economy coils, and for employment on a standard voltage of 25 volts. These lamps can be obtained in candle-powers of 8, 16 or 20. In the manufacture of these lamps a filament of platinum-rhodium is employed, a layer of oxides of rare earth deposited thereon, which becomes incandescent through the heat developed in the filament when a current is passed. The filament being metallic throughout in its construction it attains a high degree of strength, and it will, therefore, withstand even rough handling, which is of special importance when the lamps are used for lighting motor cars, taxi-cabs, or railway trains, which generally are subject to jolting and jerking.

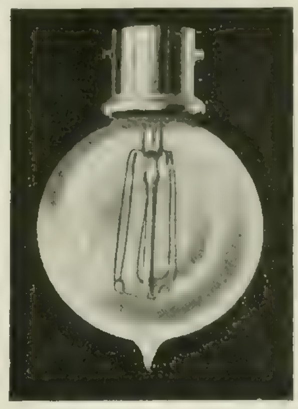


Fig. 4.—A Low-Voltage "Orieco" Lamp.

Another firm who are making progress along these lines are the E.M.F. Mfg. Co. Besides manufacturing what may be called the ordinary type, giving 32 c.p. and suitable for burning on voltages from 70 to 130, they are now placing on the market a 250 volt 50 c.p. lamp. The consumption of both types is slightly over 1 watt per candle power. Unfortunately at the present time all metallic filament lamps are rather fragile, and, in spite of careful packing, breakages in transit will occur. As it is not equitable that any loss should fall on the consumer, the firms concerned are making special arrangements for avoiding this difficulty. At the present time the breakages in a large consignment are replaced by good lamps, or the amount is credited to the consumer. It must, however, be recognised by the consumer that these lamps cannot be handled with such ease as those of the ordinary type, and special care has to be taken in laying them down on a table or similar flat surface.

In our issue of April 17th we gave a short note on the "All-British" lamp made by the Bryant Trading Synd. We are now in a position to indicate more fully some of the most interesting features of the product. The lamps are made for all pressures

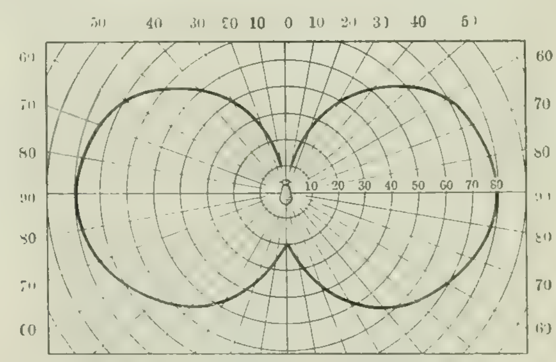


Fig. 5.—Illumination Curve of "Metalite" Lamp.

up to 210 volts. Fig. 5 shows an illumination curve and Fig. 6 a life-curve giving the alteration in candle-power and consumption of one of these lamps. It is claimed that the lamp has an efficiency of 0·9 watt per candle, can be burnt equally well on both continuous

Fig. 6.—Life Curve of "Metalite" Lamp.

and alternating current circuits and it will burn at any angle, though a position other than the vertical is not recommended, while the blackening is very small. The curve in Fig. 7 is interesting; it shows that if reduced candle-power is required it is still very eco-

nomical to "under-run" the lamps. Thus if the lamp be under run 4 per cent. in volts the candle-power will be reduced 20 per cent. and the efficiency will still be 1 watt per candle. It is, therefore, possible for a 115 volt 20 c.p. "Metalite" lamp, burning at 0·9 watt per candle-power to be suitable for 100 volts when it will give about

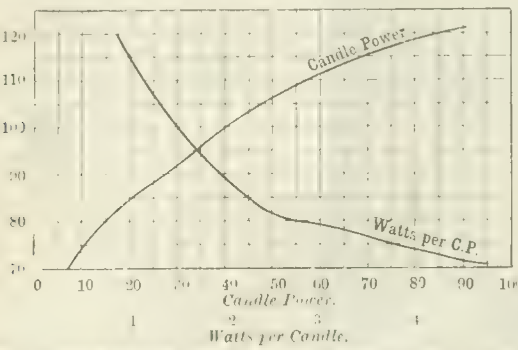


Fig. 7.—Curves showing the Economy effected by Under-running a "Metalite" Lamp if Reduced Candle-Power is Required.

10 c.p. and take 1·5 watts per candle-power. This lamp is not made purely of tungsten, but is a combination of metals, the composition of which is naturally not made public.

In conclusion, it must not be thought that the above paragraphs are intended to form a complete survey of the subject of metallic filament lamps. Many other firms besides those mentioned above are also making experiments, but for commercial reasons do not wish at present to give any details. Within the next few months further developments may be expected and we shall be able to indicate more fully the advances that have been made.

WESTINGHOUSE ELECTROLYTIC LIGHTNING ARRESTERS.

During the discussions which took place at meetings of the Institution of Electrical Engineers in connection with Mr J. S. Peck's recent Paper on "Protective Devices for High-tension Transmission Circuits," considerable interest was taken in arresters of the electrolytic type. For this type the Westinghouse Electric & Mfg. Co.

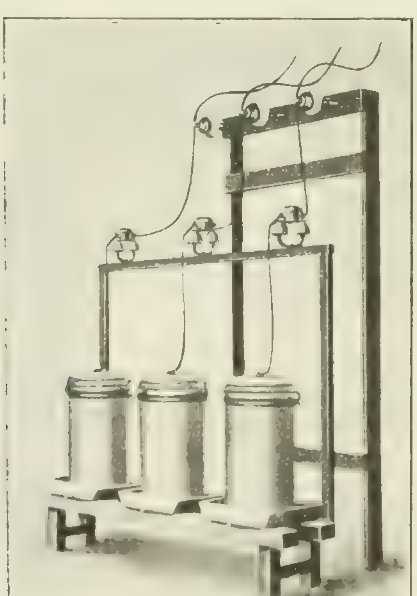


Fig. 1.—Westinghouse Electrolytic Lightning Arrester with Indoor Mounting.

are largely responsible. The electrolytic lightning arrester illustrated in Figs. 1 and 2 consists of a number of aluminium plates pressed into tray form, so that, when set one within the other and separated by small insulating washers, they may be built into a column capable of withstanding high voltages and still retain the safety valve characteristics of a single plate. These columns are made in two sizes, one for voltages between 1,000 and 7,500, the other for voltages between 7,500 and 15,000. The columns are enclosed in substantial stoneware jars, which may be mounted one upon the other to form arresters for any desired voltage. A gap on the line side of the electrolytic elements, which will withstand the normal voltage of the system, breaks down with over-voltage, and permits the surge to discharge through the electrolytic units. For pressures up to 13,500 volts actual stress, the gap is formed between non-arcing metal cylinders, as the line current is very small—approximately 1 ampere—and easily suppressed by the non-arcing power of the cylinders. For higher voltages a horn-type of gap is used, designed to suppress the line current which tends to follow the lightning discharge through the arrester. It is not advisable to use a horn gap for less than 13,500 volts, as the gap becomes so small that the arc fails to rise and give the horn effect. The gap is always so combined with a disconnecting switch that the gap element

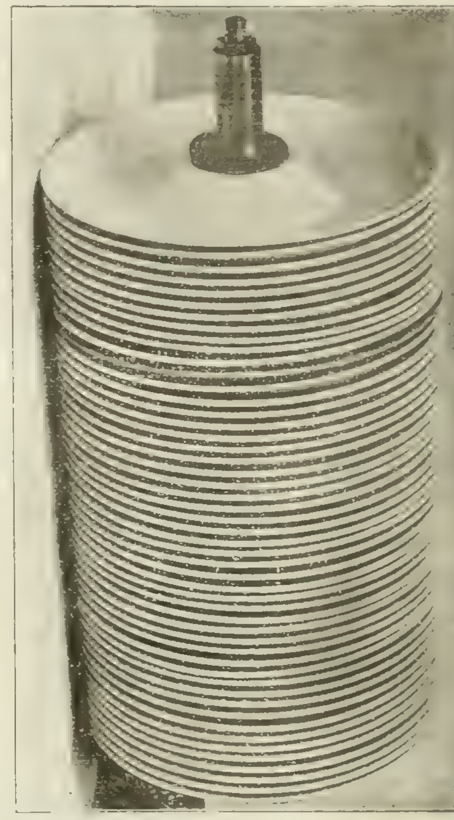


Fig. 2.—Electrolytic Lightning Arrester with Cover Removed.

forms the blade of the switch, which when open disconnects the arrester from the line.

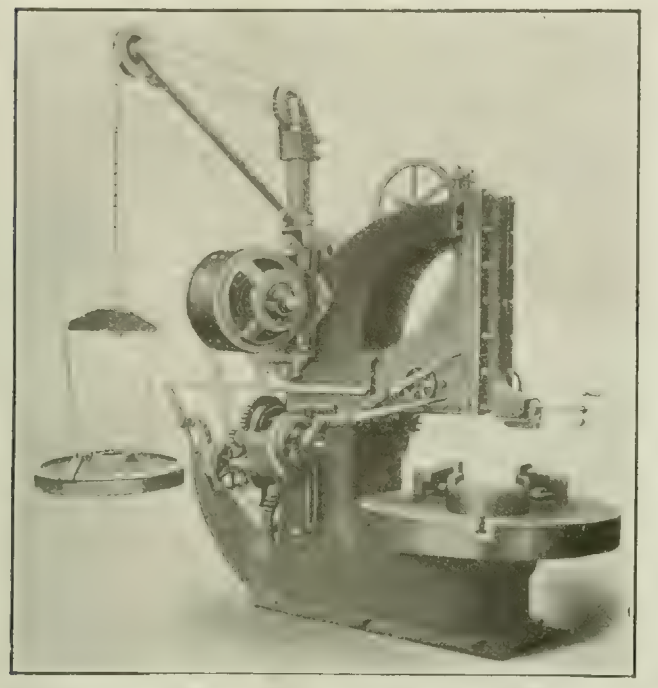
The electrolyte is dissolved in pure water and poured into the top of the arrester unit. It thus fills the first tray and runs over into the second, and so on through the column, the surplus escaping through a hole in the bottom of the containing jar, through the next jar, if there be more than one, to the pan at the bottom. The electrolyte fills only the trays and not the jar, so there is no opportunity for the current to pass except from tray to tray. Each unit, when placed in the pan or on another unit, automatically makes contact. The electrolytic solution causes a very thin film to form on the aluminium plates, the film having an apparent resistance of very high value when moderate voltages are impressed upon it. When the voltage reaches a certain value, the film breaks down in myriads of minute punctures, making almost a short-circuit. As soon, however, as the voltage is reduced again, the punctures seal up at once, and the original high resistance reasserts itself. These arresters are arranged for installation either indoors or out, to suit the convenience of the user.

IMPROVED MOTOR-DRIVEN CAR WHEEL BORING MILL.

The accompanying illustration shows a late type of motor-driven car wheel boring mill with improved automatic chuck, friction feed discs and crane attachment, which has recently been supplied by the Westinghouse Electric & Mfg. Co. It is a solid machine and its heavy construction and powerful gearing render it capable of taking the heaviest cuts required for this class of work. The automatic chuck is self-closing, self-opening and self-centreing. It has three adjustable abutments, each provided with an equalising steel jaw with two bearing points. The work is thus held and centred by six points on the circumference, insuring accuracy in centreing.

The first movement of the driving shaft causes the jaws to close in upon the work, after which the motion is transmitted to the table to produce rotation. When the work is completed, the chuck is released by disengaging the driving clutch and retarding the driving shaft by means of the friction brake provided for the purpose. The inertia of the table and work thus imparts the necessary force to open the jaws. The work is secured in its correct position in the machine and released with no loss of time and without labour. Since the power of the clutch grip increases with the resistance of the cut, it is never necessary to stop the table to tighten the chuck.

The boring mill is especially arranged for electric drive, and the motor is mounted on the vertical housing of the frame. The motor is of the Westinghouse direct-current non-interpole type with a variation in speed of approximately 2 to 1, and, therefore, eliminates the cone pulley required by line shaft drive. This increases the machine capacity, as the variable-speed motor gives the



54 in. Car-wheel Boring Mill driven by 7½ h.p. Westinghouse Motor.

desired range of speed in much smaller steps, permitting the mill to be run at all times at the maximum permissible cutting speed. With Westinghouse motors of the interpole type a speed variation of 4 to 1, and even higher in special cases, can be obtained.

THE EASTERN & ASSOCIATED TELEGRAPH COMPANIES.

On Tuesday evening, at Prince's Restaurant, Piccadilly, London, Sir John Wolfe Barry, K.C.B., gave a dinner to the directors and staff of the Eastern & Associated Telegraph Companies.

Besides the chairman, the company included the following directors and staff connected with the Associated Companies: The Marquess of Tweeddale, K.T., the Right Hon. Lord Allerton, Hon. A. G. Brodrick, Sir W. R. Brooke, K.C.I.E., Sir Albert J. Leppoc Cappel, K.C.I.E., Mr. T. W. Bischoff, Hon. George Peel, Mr. B. J. Wolfe Barry, Mr. F. Dawes, Sir J. Denison-Pender, K.C.M.G., Mr. J. C. Denison-Pender, Mr. F. A. Johnston, Sir Henry C. Mance, C.I.E., Mr. T. W. Stratford-Andrews, Mr. H. A. C. Saunders, Mr. C. W. Adye, Mr. W. H. Ash, Mr. T. A. Bullock, Mr. W. H. Burman, Mr. J. Cambrook, Mr. J. T. Crowe, Mr. W. Dover, Mr. A. R. Hardie, Mr. F. E. Hesse, Mr. W. Hibberdine, Mr. E. Steer Hodson, Mr. G. C. Jack, Mr. W. Judd, Mr. G. R. Neilson, Mr. H. E. Plank, Mr. F. T. Preddle, &c.

Among the guests were also present: Sir W. H. Allchin, M.D., Mr. Kenneth Anderson, Mr. A. Beck, Mr. J. H. Carson, Rear-Admiral A. M. Field, F.R.S., Mr. J. G. Griffiths, Mr. J. H. Hutt, Mr. G. W. Johnson, C.M.G., Sir George H. Murray, K.C.B., Mr. F. C. C. Nielsen, Mr. K. Suenson, Mr. C. E. J. Twisaday, Mr. G. G. Ward, and Mr. F. Ward.

After the loyal toasts had been honoured, Sir John Denison-Pender proposed "Our Allied Companies," and said it was the endeavour and daily work of those connected with the Eastern and Associated Companies not only to promote the success of their own companies, individually and collectively, but also to promote the success of their friendly rivals the allied companies, for the cause of telegraphy was common to all. There were present gentlemen associated with telegraph enterprise who, while they could not be counted as allies, had shown their goodwill by accepting the friendly invitation of Sir John Wolfe Barry to dinner. It was a long time since the telegraph service was limited to what might be termed "local communication," and it was soon found that a more extended telegraphic service was essential to public requirements. So soon as this necessity became apparent, men of great foresight came forward to undertake that work. It was due to the pluck and determination of a handful of men, who put down their money and devoted their time and energy to carrying the enterprise to a practical conclusion. Of course, many failures were experienced at first, but these men were only further inspired by such failure, and their gathering that night was convincing proof of the prescience and the judgment of these pioneers. If he were to tell those present the whole story of the development of submarine telegraphy it would be only telling them a story in which many of them had taken a prominent part. The few words he had to say would, therefore, deal with the present. They were face to face with another International Telegraph Conference, and he felt he must say, so far as the telegraph companies were concerned, that it was unfortunate that these meetings were held so often, and he was not sure that there was much benefit derived by the Governments of the world from these Conferences. The companies had no vote, and were only able to put forward statements and to ask the Governments to support them in maintaining a fair and reasonable tariff for their messages. Up to quite a few years ago Great Britain and Denmark could claim the parentage of all the companies owning the submarine cables of the world, but more recently America, France, Germany and Holland had come into the business and were competing for traffic. So far as their American friends were concerned they were in a different position to the others. They were independent of Government control of their submarine service, and could also control the land lines of the country. In the early days of submarine cable enterprise fighting was considered the proper course to adopt. But it was not long before those who promoted this great enterprise arrived at the decision that friendly rivalry was to be preferred to fighting, and while the Great Northern and the Indo-European companies were amongst those who engaged in the contest, and fought with an energy which was to be expected from the able men who directed the fortunes of those companies, it was pleasant to know that satisfactory working arrangements were the ultimate outcome of the negotiations which ensued. Although the companies remain on competitive terms for traffic, they now all work in the most amicable way. The arrangements between the companies were in no sense against the public interest, which were well cared for by the Governments of the world, apart altogether from the steps taken by the companies to safeguard them. The rates charged for submarine telegraph messages were fair and moderate, and only allowed a reasonable dividend to be paid and a proper strengthening of the reserve funds of the companies in order that existing cables may be renewed when necessary and that new cables may be laid to meet the public requirements. The strength of the British cable companies was in the fact that they had not only laid additional cables alongside the older cables, but had endeavoured by alliances to form such a network that total interruption had become almost impossible. What was required now was a certain strengthening of the land line communication. This was gradually becoming accomplished by the laying of underground cables, and for this improved service the cable companies had to pay their share. He was sure the cable companies suffered more from the breakdown of the land lines than from the breakdown of their own submarine lines. He coupled with the toast the names of Mr. George G. Ward, of the Commercial Cable Co., and Mr. K. Suenson, of the Great Northern Co.

The toast was drunk with enthusiasm.

Mr. George G. Ward thanked the company for the cordial manner in which the toast had been received. The Associated Companies always seemed to him to enjoy peace and harmony, while those who were engaged in the Atlantic service seemed always armed for war, and he usually found himself on the fighting side. This was probably due to the keen competition they had to encounter. He was very pleased to see present his great opponent and old friend, Mr. Carson. He had always thought that Mr. Carson and himself could furnish the material for an interesting book on "The Trials and Tribulations of a Competitive Cable Manager." This book should have a large circulation, for it would give hints as to how to regain and to retain a customer, and how to deal with a customer who complained that he had lost a large sum of money owing to his message arriving too quickly (laughter). In such a case as this the customer always ended by threatening to go to the "other company," and he supposed that meant that he went to the Anglo because he could there get a little slower service (laughter). He felt sure such valuable hints would be of service to their friends the Associated Companies. This was, however, hardly to the point. Speaking of the Associated Companies took him back nearly 40 years, and one could not mention this great enterprise without asking who created it? It was a master mind, a man of great courage and untiring energy, of great foresight and broad views. When they considered what the late Sir John Pender did for the British Empire and for the public at large he might well be termed the "Cable King" (cheers). He brought the Colonies within a few minutes' touch of the mother country. He commenced with the Atlantic in the early sixties, and was continuously engaged in the extension of submarine telegraphy to the day of his death. He (Mr. Ward) served under him for several years, and appreciated his work. He had often asked himself whether the services of this great man had been adequately recognised, and he felt that this had not been the case (hear, hear). They

were all gratified to know that the management of the Associated Companies was being carried on by his son, Sir John Denison-Pender (cheers), a man devoted to his work, and with every detail at his fingers' ends. Then as to the rank and file. He did not know where they could find a more loyal and efficient staff. Before resuming his seat he would like to say a word about their chairman, Sir John Wolfe Barry. The Associated Companies had at their head a man with such ability that they could not go wrong. His broad views and his grasp of the situation were remarkable. With such a chairman, and such a managing director, and such a staff the ship could never sink. It afforded him great pleasure to respond to the toast (cheers).

Mr. KAYE SUENSON said he was sorry that circumstances had prevented Commodore Suenson from accepting Sir John Wolfe Barry's kind invitation, as he was sure it would have given him great pleasure to be present. For his own part he desired to refer to the cordial relations which had existed for a great number of years between the Eastern and Great Northern Companies, and he hoped these relations would continue. At the same time there existed friendly competition, and he was of opinion that such competition tended to ameliorate the telegraph service, and was for the good of the public. The splendid service which the Associated Companies had established proved a powerful stimulant for competitors, friendly as well as unfriendly, to strain every nerve to attain the same high standard. Despite the competition which the Associated Companies had to contend with, he could say that, as far as the Great Northern Co. was concerned, the vast experience in technical matters which the Associated Companies had gained had always been placed at the Great Northern's service. He was pleased to have the opportunity of testifying to this broad-mindedness (cheers).

Sir JOHN WOLFE BARRY then proposed "The Directors and Staff," and expressed his pleasure at meeting the large company present. The Associated Companies, who now owned something like 100,000 nauts of cable, equivalent to a band of five cables round the circumference of the world, represented a vast interest. Their staff numbered nearly 6,000 persons, 830 of whom were on board the companies' ships. They had 170 stations in different parts of the world, the capital was close upon £20,000,000, and their income was sufficient to pay a reasonable and modest dividend on the money entrusted to them for operating the companies. To his co-directors he tendered, in the most public way, his hearty thanks for the loyal support given to him since he became chairman, and for their many acts of friendship. To the staff he tendered, one and all, far and wide, senior and junior, the heartfelt thanks of himself and co-directors for their loyal service. Everywhere devotion to the Companies and the strongest esprit de corps were evident. It was an arduous service, whether performed in London or elsewhere, and it was admittedly well done. He wished also to thank the visitors who were present, who were most of them connected officially with the work of the telegraph and cable companies, or with the great Government departments who conducted business with the Companies. Important negotiations were carried on from time to time with these departments from which the Companies received material assistance, and in return the Companies were able and willing to render assistance to the departments whenever the opportunity arose. Several gentlemen who would have been present that evening were prevented by the occurrence of the International Conference at Lisbon. They all wished success to the Telegraph Conference, not, perhaps, too much success, because the usual effect of the Conferences was to demand from the cable companies concessions which they were not always able or disposed to give. Before concluding, he wished to say a word in regard to the pension and superannuation funds of the Eastern and Associated Companies. The Pension Fund now amounted to the capital sum of £450,000 (applause). This sum had been built up by equal contributions from the staff and from the shareholders, and it was an unquestionable advantage to both that the fund should have arrived at such a figure.

The MARQUIS OF TWEEDDALE, responding for the directors, expressed his great satisfaction at having been enabled to serve on the boards of the Eastern Companies under two such excellent chairmen as the late Sir John Pender and Sir John Wolfe Barry.

Mr. A. R. HARDIE, on behalf of the staff of the Eastern Telegraph Co., desired to thank Sir John Wolfe Barry for joining the toast of "The Staff" with that of "The Directors," and for the kind manner in which he had referred to them. The staff were proud to serve under the presidency of their distinguished host, and to belong to the service.

Mr. F. E. HESSE, on behalf of the staff of the Eastern Extension Co., expressed cordial thanks for the gratifying manner in which the toast of "The Staff" had been proposed, and his sincere appreciation of the sympathetic and generous treatment which they had always received from the Board.

Mr. E. STEER HOBSON also briefly replied for the staff of the Western Telegraph Co.

The Right Hon. Lord ALLERTON then proposed the toast of "The Chairman," and said: I am sure we are all grateful to him and appreciate very highly the hospitality which he has extended to us. It is with great pleasure, as the colleagues of Sir John Wolfe Barry, we have heard the appreciation expressed by Mr. George Ward with regard to our Chairman. He is not only a great administrator, but he brings to bear in his dealings with men a tact that wins their confidence. He is always sound in his judgment and moderate in his criticism, and the public at large has reason to be glad that we have at the head of these Associated Companies a man so competent to fill that position (hear, hear). I consider the Associated Companies are a great object lesson, for it can hardly be doubted that co-operation of this kind has been growing, not only in this country but throughout the world. The organisation of submarine telegraphy is really a marvel, and when you hear, as we have to-night, on the authority of our Chairman, of the loyalty and the interest with which the administration is carried on by the staff it is eminently creditable to all concerned. Our Chairman sets us a great example, and the devotion to duty and the esprit de corps throughout the service is largely founded upon the example which he sets to the staff (hear, hear). I have great pleasure in asking you to drink the health of our Chairman, and wish him a long and happy life (cheers).

In replying, the CHAIRMAN said he considered it one of the pleasures and privileges of his life to be associated with submarine telegraphy.

The evening's proceedings then terminated.

During the evening members of the Associated Companies' staffs contributed an excellent programme of vocal and instrumental music.

LEGAL INTELLIGENCE.

E. Scott & Mountain v. Kent Collieries (Ltd.).

On Wednesday, Mr. Muir Mackenzie, K.C., Official Referee, resumed the hearing of this action. The previous proceedings were reported in our issues for April 10 and 17.

Mr. JOHN J. PREST, a Durham colliery manager and mining engineer, inspected the plans of the machinery supplied by plaintiffs to defendant colliery and read the specification according to which the machinery was to be supplied. The former was absolutely in accordance with the latter.

Mr. MORLEY, employed by plaintiffs, and in charge of the work, gave evidence of the difficulties experienced in working the pump in the shaft, owing to the amount of floating solids in the water. So frequent were stoppages, &c., due to silt in the pumps, that it was impossible to enter all the occasions in the log book. He continually advised defendants to take some steps to keep the bottom of the shaft clear of mud and sand, declaring that if they continued to pump these solids he would not be responsible for the machinery. Eventually the pump lost its efficiency, and became damaged. He afterwards found in the pump a lot of sand, mud and small stones, and generally it was in a very bad condition. It was taken to pieces and completely overhauled, an operation which took some days. They started pumping again, and after running for several days the pump stopped altogether; it was choked up absolutely, and they could not move it, even with a steel bar. The rings were broken and the machinery considerably damaged. Subsequently the pump got choked again. It was flushed out and re-started. He had examined the motor in December. It was badly damaged owing to the extreme heat which it had been subjected to combined with the centrifugal force. It was found that the spindle of the pump was reduced in diameter from 3¼ in. to 2⅝ in. caused by the sand which was held by mechanical suspension in the water. The logs were kept in the desk in the engine room.

Owing to the illness of Mr. Bousfield, K.C., defendants' counsel, the case was not taken yesterday, and was again adjourned.

MUNICIPAL, FOREIGN & GENERAL NOTES.

APPOINTMENTS VACANT AND FILLED.

An electrical engineer is wanted to take charge of power plant in the Pacific. Experience of three-phase work essential. Passage out and home and board and lodging provided. See advertisement.

Applications are invited for the position of assistant professor of physics at Heriot-Watt College, Edinburgh. Salary £225 per annum. Applications by May 23. See advertisement.

A draughtsman is wanted for turbo-dynamo work. Must have had up-to-date experience in both a.c. and d.c. Applications to Phœnix Dynamo Mfg. Co. (Ltd.), Bradford. See an advertisement.

Applications are invited for the chair of Civil Engineering at the University of Liverpool, which has recently been established in the Faculty of Engineering. Particulars from the Registrar, to whom applications, with 12 copies of testimonials and references, should be sent before May 15.

A professor of mechanical engineering is required for Poona College of Science, India. Salary R.500, rising to R.1,000 per month. Applications to the Secretary, Public Department, India Office, London, by June 15.

Antwerp-Brussels Electric Railway.—Fresh proposals for the construction of a high speed railway between Antwerp and Brussels are to be submitted to the Belgian Government. The length of the proposed line would be about 26 miles, and the estimated cost is £625,000.

Australasia.—The gross profit on the Wellington (N.Z.) municipal electricity supply undertaking for the half-year ended Jan. 31 last was £8,751, compared with £7,045 for the corresponding period of the previous year, under the control of the syndicate who then owned the undertaking. A new Babcock & Wilcox boiler has recently been put in at the works and a contract has been let for additions to the buildings.

Prahran (Victoria) Council are (according to the "Australian Mining Standard") considering the feasibility of utilising the steam from the refuse destructor to generate electrical energy for working the projected Prahran-Malvern electric tramway. The Electric Light & Traction Co. has the contract for street lighting.

The Commonwealth Postmaster-General, Mr. S. Mauger, recently stated that the amount required to put the telegraph and services in order would be at least £3,000,000. For the Melbourne telephone service alone £250,000 would be wanted. £250,000, chiefly for telegraph and telephone purposes, has been included in the supplementary estimates of the Postmaster-General's Department for this year.

Aylesbury.—E. T. Mackrill & Sons have been appointed electricians to the Council for a year.

Battersea (London).—In order to maintain the pressure of supply in the Nine Elms district next winter the Lighting committee have either to provide an additional l.t. cable (estimated to cost £8,833), or a feeder booster and accessories (estimated to cost £1,847). After consideration, the committee recommend that though greater security against breakdowns would be given by the former method they cannot incur the expenditure involved, and for the present purposes the smaller scheme must suffice.

Application has been made to L.C.C. for sanction to a loan of £8,558 for extensions of the mains and services.

Bexley.—An alternative daylight tariff for power has been adopted for power as follows: Up to 2,000 units per annum, 3d. per unit; from 2,000 to 2,500, 2¾d.; from 2,500 to 3,000, 2½d.; from 3,000 to 3,500, 2¼d.; above 3,500, 2d. per unit. Minimum charge to be £2. 13s. 4d. per annum, and charges to be net. Meter rents additional.

Birmingham.—An inquiry was held on Tuesday into the application of the Council for sanction to borrow £251,285 for extensions of the electricity undertaking.

The Town Clerk (Mr. E. V. HILEY) said that £231,285 was required for general electricity supply purposes and £20,000 for the purchase of electric motors to be let on hire. Mr. Hiley gave a sketch of the development of the undertaking. The progress had been most remarkable. When the Council acquired the works in 1900 the number of consumers was 1,530, but on March 31 last the number was 3,549. The total number of 8 c.p. lamps installed had increased from 65,031 in 1900 to 278,172 in March 1908. The units sold increased from 5,383,904 in 1906 to 10,887,684 in 1907, the greatest increase being in the units sold for traction. The units sold for traction in 1907 8 amounted to 11,192,776 out of a total of 20,793,670, which left 9,600,894 for private consumers. The revenue for the year ended March, 1908, showed an increase of 52·87 per cent. on the previous year. The surplus profit had been allocated to reserve. The loan now applied for would be split up as follows: Summer-lane station £183,635, Water-street station £17,300, Dale End station £11,500, and other sub-stations collectively £14,850. In addition to the £20,000 for motors, it was proposed to spend £4,000 for meters. The loan would suffice for the next three years. At the Summer-lane station they proposed each year to put in one 1,500 kw. d.c. generating set, and one 1,500 kw. a.c. generator. Engines and foundations would absorb about £73,000 of the required loan. Rotary converters and switch gear would cost £6,000. It was proposed to instal 10 boilers, six in 1908 and two in each of the two following years. It was also proposed in 1908 to put in one set of economisers. In 1909 a second chimney would be erected at Summer-lane at a cost of £3,100. At the wharf it was proposed to erect a reserve coal bunker and conveyor. In the pumping station they wished to put in electrical and steam pumps, and at the sub-stations rotary converters with transformers. At Dale End station it was proposed to do away entirely with the generating plant. The capacity of the machinery there at present was 1,520 kw., but it was found that the cost of generating current at Dale End was considerably more than at Summer-lane. At Dale End the cost was 2·1d. per unit, at Summer lane only 0·284d. It was proposed to use Dale End as a distributing station, and machinery would have to be provided at a cost of £11,500. It would be necessary to supersede certain plant upon which there was an outstanding loan of £33,204, and some of the plant had been sold for £4,300. As to the £20,000 for motors, the Council decided in February, 1906, to let motors out on hire. Up to March last they had let out 259 machines, with a total of 1,659 H.P. They were satisfied after two years' experience that the motors were meeting a need. Of the £20,000 asked for, £8,864 was wanted to recoup the Corporation for the amount already spent out of revenue for motors. It was believed that the life of the motors would be quite as long as that of the machinery at the generating stations. The city electrical engineer (Mr. R. A. Chattock) supplied technical details.

Birmingham Wiring Contractors.—The City of Birmingham electric supply department have decided to draw up a list of wiring contractors who are authorised to carry out work in the city, and notice is given in an advertisement in another column that, after June 30, installations intended to be connected to the department's mains should be carried out by authorised contractors. Applications from contractors who wish to be put on this list are now being considered, and forms of application may be obtained from the city electrical engineer and manager (Mr. R. A. Chattock, M.I.E.E.), 14, Dale-end, Birmingham.

Bristol.—There are 3,089 private customers of the electricity department, representing 223,519 8 c.p. lamps connected. The number of lamps for street lighting is 702 and the horse-power of motors on consumers' premises supplied from the system is 7,061.

Electricity in Mining.—The Cornish Consolidated Tin Mines (Ltd.) recently adopted electric driving at their South Crofty Mines at Carn Brea with satisfactory results.

Electrical energy is supplied by the Urban Electric Supply Co. at £6 per kilowatt of maximum demand, plus 0·45d. per unit, these figures to be rearranged as the maximum demand reaches 1,000 kw. The estimated cost of driving the mill and the auxiliary plant on the above basis was 1·8s. per ton; the actual cost works out at 1·08s. per ton of ore treated. The concentrates from ore previously won from the upper levels of the mine contained at least 30 per cent. of wolfram (tungsten), together with tin and arsenic, which could not at first be satisfactorily separated. These levels were abandoned, and the lower levels, which contained a less percentage of wolfram, were worked, the wolfram being treated as an impurity, and a low price being accepted for the tin produce. When the mine passed into the possession of the present company magnetic separation was resorted to, and the previously unsaleable complex ore was separated into a tin and wolfram produce, the tin commanding a much higher price and the wolfram finding a ready market.

The tin and wolfram produce, which contains a heavy percentage of iron, after being calcined to remove the arsenic, is fed on to a 16 in. rubber belt, that travels between the pole-faces of three pairs of magnets, which are spaced apart and supported on a frame. As the belt carrying the product passes under the first pair of magnets, the iron produce is drawn up on to a canvas transverse belt that removes the magnetised particles beyond the magnetic field, when the particles drop from the transverse belt into a bin. The product, that now contains tin and wolfram only, which are much less magnetic than the original product, is carried by the main belt under a second pair of magnets, having a stronger field than the first pair, where the wolfram is separated from the tin in a similar manner, the third pair of magnets removing the last trace of iron and wolfram from the tin product, which is now carried by the main belt into a bin and is ready for the smelter.

The mill, which at present consists of 40 heads, is arranged for driving in sections of 10 heads, each section being driven by a 30 B.H.P. motor, only one section being interrupted should a motor fail or when the heads require attention, a spare armature being in readiness to ensure practically continuous running; whilst for future extensions, which will be commenced at an early date, extra units can be easily installed.

The present installation consists of: Four 30 b.h.p. motors for mill drive, two 30 b.h.p. motors for Blake rock breakers, two 20 b.h.p. motors for mill-dressing plant, one 20 b.h.p. motor for sorting table and dodge crusher, one 20 b.h.p. motor for vertical pulverisers and calciners, one 20 b.h.p. motor for tube mills, one 20 b.h.p. motor for workshops, one 17 b.h.p. motor for return water pump, two 5 b.h.p. motors for circulating pumps and one motor-generator for magnetic separators. The present cost of electric driving is 1·08s. per ton, against 2·4s. per ton by steam power.

Engineering Education in India.—The Lieutenant-Governor of Burma recently performed the opening ceremony at the new school of Engineering and Technical High School at Insein. The new curriculum has been augmented by a course in theoretical and practical engineering, and later on other branches of technical instruction, including practical electricity and telegraphy, are to be added. The school has received the magnificent gift of the physical laboratory of the late Royal Indian College of Engineering, Coopers Hill, England, while a hostel for the accommodation of some 100 students, workshops, &c., have been provided. The technical high school is for teaching elementary science generally.

English Electrical Engineers in Belgian Gaols.—Four young Englishmen were recently kept in prison at Antwerp and Brussels for 30 days on a charge of petty larceny. We have been furnished with the following particulars of the incident:—

The four young Englishmen have been dealt with in a manner different to Belgians, who for such charges as petty larceny are rarely, if ever, incarcerated. The heavy bail demanded by the magistrate (which was, however, cancelled by the Court of Appeal at Brussels) was out of all reason, as the total value of the articles alleged to have been stolen, such as pencils, erasers, drawing paper, blue prints, &c., amounted to only 16s. One of the engineers (Burton) was enticed off the steamer "Colchester" as she was about to leave Antwerp quay for Harwich on March 23. Great indignation is expressed at the treatment received by these young men.

The above particulars (furnished by a correspondent) do not seem to us by any means complete. If the facts are, however, as stated

the proceedings were certainly very high-handed, and call for explanation.

Exhibitions.—Applications for space at the exhibition to be held at Cardiff from July 13 to 22 next in connection with the 24th Congress of the Royal Sanitary Institute are to be sent to the Institute, Parkes Museum, Margaret-street, London, W. The exhibition will include sections devoted to lighting and ventilation and the hygiene of special trades, &c.

The Prince of Wales will open the Franco British Exhibition on May 11. In honour of the French Minister of Commerce and Indnstry (M. Cruppi) and the French Ambassador (M. Cambon), a luncheon will be given at the Grand Restaurant in the grounds of the exhibition on May 8.

The Scottish National Exhibition will be opened to-day (Friday) by Prince Arthur of Connaught.

The opening of the grounds of the Marseilles Electrical Exhibition took place on April 23, but the pavilions, reading room, &c., will not be opened for a few days. There are very few British firms represented at the exhibition The great majority of the exhibitors are French, though Swiss, Italian and German firms make a fair show.

Gloucester.—The Council on Wednesday rescinded the resolution passed at the last meeting to refer to the city electrical engineer of Birmingham, Mr. R. A. Chattock, the question of the charge to be made for electricity supplied to the Light Railways committee.

Greenock.—Recently the Corporation arranged terms with Port Glasgow Corporation for the supply of electricity to the latter burgh. It now appears that the Clyde Valley Electrical Power Co. have statutory powers to supply electricity within Port Glasgow, and Greenock Corporation have intimated to Port Glasgow Corporation that these powers must be revoked before any agreement can be entered into between the two burghs. Subject to this request being complied with, the proposed heads of agreement have been arranged as a basis of negotiation, and the Electricity committee is to continue negotiations.

Huddersfield. In submitting the estimates of expenditure during ths ensuing year,

Ald. WINANS stated, at the Council meeting last week, that the tramways produced a surplus of £6 154 in the last financial year, an increase of £1,488 upon 1907, and the committee were able to transfer an amount equal to 3½d. in the £ in relief of rates after carrying forward £12,387 (or 3 per cent. on capital outlay) to depreciation and also meeting sinking fund requirements. The receipts were £84,704, an increase of £3,508. The reserve or renewals account stands at £46,693.

The income of the electricity undertaking was £30,353, compared with £27,923. The surplus, after providing for interest and sinking fund, was £985, which had been carried to depreciation and contingencies account, bringing this up to £11,874.

Hythe.—The National Electric Construction Co. has notified the Council that the scheme for the construction of electric tramways will be proceeded with as soon as the necessary capital has been provided.

Ilford.—An inquiry has been held into the application of the Council for sanction to borrow £27,000 for extensions of the electricity undertaking. There are 3,045 customers of the electricity department.

Indian Electricity Act.—The Public Works Department of the Government of India propose to appoint a committee to advise it in respect to the revision of the rules under the Indian Electricity Act.

International Conference of Post and Telegraph Officials.—An international conference of officials and technical officers of posts and telegraphs will be held at Budapest from Sept. 21 to 26 next.

Leeds.—The total receipts of the tramways department for the year ended March 31 were £340,368. 5s. 5d., an increase of £12,574 over 1906.

Actual working expenses were £177,316. 17s. 2d., and after paying all operating charges there remained a gross profit of £163,051. 8s. 3d. Adding £6,090 for bank interest, the total net revenue was £169,1[illegible]4 19s. 7d., against £166,096. 5s. 3d. Interest and income tax absorbed £46,186. 19s. 8d., leaving £123,337. 19s. 11d. Contributions to sinking fund require £37,452 (last year £33,025), permanent way renewals £21,252 (£11,480) and amounts written off provisional orders £385 (£372), leaving £64,246. 13s. 7d. to be transferred to city fund in aid of rates, against £69,262. 8s. 7d. During the past two years £250,000 has been contributed by the tramways for relief of the rates.

Liverpool.—The National Telephone Co. are about to erect a new exchange in South John-street.

Maidstone.—An unopposed inquiry was held last week into the application of the Council for a loan of £18,440 for extensions of the electricity undertaking.

Metropolitan Association of Electric Tramways Managers.—The members of this Association met in conference at the Municipal and County Club, Whitehall, S.W., on Friday last, to receive and discuss the report of their committee on matters relating to the licensing of electric cars, &c. It was unanimously decided to press for modification of such clauses of the Metropolitan Public Carriage Act, 1869, as were deemed necessary for present day practice.

The members subsequently held their usual dinner, and those attending were Messrs. H. E. Blain (West Ham, chairman of Association), J. K. Bruce (L.C.C.), A. Coveney (Erith), J. Schofield (Leyton), J. Hammond (M.E.T.), A. Shaw (Ilford), H. Howard (Barking), C. Mittelhausen (Bexley), W. C. Ullman (East Ham), and T. B. Goodyer (Croydon, hon. sec.). Sir Clifton Robinson (London United Tramways), Messrs. W. Murray (Walthamstow), G. Spurr (Walthamstow), G. R. Hulme (South Metropolitan), and G. Balfour (Dartford) were unavoidably absent.

Perth.—The Corporation are applying for a provisional order for powers to extend the area of electricity supply, to construct additional tramways, &c.

Plymouth.—At the end of March there were 941 consumers of the electricity department, against 830 in 1906, and the lamp connections were 73,670 8 c.p., against 66,114. During the quarter ended March 635,453 units of current were sold, producing estimated receipts of £6,874. 15s 1d., compared with 583,145 units sold and £6,526. 15s. 7d.

Presentations.—On the occasion of his marriage, Mr. Frank Henry Whysall, resident engineer at Bloom-street and Dickinson-street stations, Manchester, has been presented by the officials and employés of the electricity department with a silver tea service.

As a token of esteem, Mr. F. O'Hara, resident engineer at Torquay of the National Electric Construction Co., has been presented by the staff with a gold signet ring and an illuminated address.

St. Pancras (London).—An artesian well is to be sunk at the King's-road generating station at a cost of £2,000.

Swansea.—The Harbour Trustees have appointed a committee to report as to whether electric or hydraulic power shall be adopted at the new docks

Switzerland.—The Federal Council recommend the Federal Assembly to adopt projects for a funicular 1 metre gauge electric railway from Place Léonard, Zurich, to Susenberg (Zürichberg), about 1 mile in length, and a 1 metre gauge electric railway, partly cogged, from Brigue to Belalp, about ¾ mile long.

Telephone Rates.—A special meeting of Sunderland Chamber of Commerce was held on Wednesday to meet Mr. S. J. Goddard, the general superintendent of the National Telephone Co., who gave a lengthy explanation of the "measured rate" system.

The Motor 'Bus Problem.—Electric traction seems to be the solution of the motor omnibus problem. The only omnibus in London which is at once unobjectionable and mechanically successful is the electrobus, and on Easter Sunday its value as a road vehicle was further demonstrated by its being run from London to Brighton on one charge of the battery. This, for so large and heavy an electrical vehicle, is claimed to be an unprecedented feat. The 'bus, entirely British built by the Electric Vehicle Co., of West Norwood, was delivered to the Brighton & Hove Omnibus Co., which, in common with many other provincial corporations and omnibus companies, have had their attention directed to this form of public service automobile by the character of its operation in the metropolis, and in this fact is foreshadowed an important and possibly a wide development of electric road traction without rails. The London electrobus is, it is stated by those who have had the materials before them for the calculation, operated at an inclusive cost of 9d. per car-mile, and its receipts are said to have averaged over 13d. per car-mile during nine months of service. These results are mainly due to its remarkable freedom from breakdown, as in upwards of 100,000 miles of travel the London Electrobus Co. has not experienced one serious delay. The cost of a day's "hold up" in the London motor 'bus service is estimated to involve a loss of £5. 18s. 2d. No one has yet seen an electrobus "at rest" in the gutter of a London thoroughfare from any electrical failure.

Walthamstow.—The Council have received sanction to borrow £17,189 for additional generating plant and £222 for an air compressor and weighbridge. A charge of 1½d. per unit is to be made for current supplied to the light railways for the year ended March 31.

Woolwich.—Extensions of the electricity supply mains, estimated to cost £811, have been authorised.

Workhouse Lighting.—Haslingden Guardians have received amended terms from Rawtenstall Corporation for the supply of electricity for lighting the workhouse and new infirmary, and a conference is to take place between representatives of the two authorities on the subject. Messrs. Peers, Copland & Cardin are consulting engineers to the Guardians.

P. & O. Batti Wallahs Society.—In reference to the note in our last issue (p. 75) relating to the first smoking concert of the Birmingham Local Section of this society, we are asked to state that all particulars of the society can be obtained from the local hon. sec., Mr. E. Sheppard, 59, Alcester-road, Moseley, Birmingham.

TRADE NOTES AND NOTICES.

TENDERS INVITED.

Derby Electric lighting committee invite tenders for the supply of bitumen cable. Full particulars from the borough electrical engineer, Mr. T. P. Wilmshurst, Full street, Derby. See also an advertisement.

London County Council invite tenders for wiring and fitting for electric lighting of the tramway car shed at Mare-street, Hackney. Tenders, upon official forms, to the clerk to the Council (Mr. G. L. Gomme), County Hall, Spring-gardens, S.W., by 11 a.m. May 12.

London County Council want tenders by 11 a.m. May 9 for supply of 175 double deck roof covered car bodies and maximum traction swing bolster trucks and complete electrical equipments for same. Forms of tender from the Clerk, Spring-gardens, S.W.

London County Council want tenders by 11 a.m. May 19 for supply of about 2,000 tons (or alternatively for 5,000 tons) of steel girder tram rails and fastenings. Specifications from the Chief Engineer, Spring Gardens, S.W.

London County Council also want tenders by 11 a.m. May 12 for supply of 3,500 31¾ in. and 2,000 21¾ in. steel tyres for electric cars. Forms of tender from the Chief Officer, L.C.C. Tramways, 62, Finsbury-pavement, E.C.

West Bromwich Corporation want tenders by noon, May 9, for the installation of modern destructor plant at the electricity works. Particulars from the Borough Engineer and Surveyor, Town Hall, West Bromwich.

Portsmouth Guardians want tenders by noon May 13 for wiring the additional blocks and the maternity ward at the workhouse infirmary Specification from Messrs. Rake & Cogswell, Prudential-buildings, Portsmouth.

Stockport Tramways committee want tenders by noon May 4 for taking up and re-laying permanent way, paving, &c., and for repairs and renewals of tramway track. Specifications from the Borough Surveyor.

Manchester Tramways committee require tenders by 10 a.m., May 5, for supply of h.d. copper trolley wire. Specifications from Mr. J. M. M'Elroy, 55, Piccadilly, Manchester.

West Riding Rivers Board, *Wakefield*, want tenders for supply and fixing of exhaust electrical fans, with switches, &c., at their laboratory.

Glasgow Corporation want tenders by May 7 for 12 months' supply of coal to their electricity stations. Specification from Mr. W. W. Lackie, 75, Waterloo-street, Glasgow.

East Ham Corporation want tenders by noon May 5 for reconstruction and overhead equipment of tramways for electric traction. Specification from the Borough Engineer.

Portsmouth Corporation want tenders by 10 a.m. May 6 for wiring the laundry at the Infectious Diseases Hospital, Milton. Specification from the Borough Engineer.

Darlington Corporation want tenders by May 11 for supply of a Lancashire boiler and superheater. Specifications from the Borough Electrical Engineer.

Aston Corporation want tenders by noon May 13 for supply and erection of pipework, &c., for the electricity department. Specifications, &c., from the Borough Electrical Engineer.

Bedford Corporation require tenders by May 15 for supply of Derbyshire and Nottinghamshire coal to the electricity works.

The *Commonwealth of Australia* Government invite tenders (to be sent to the Postmaster-General, Melbourne, by Aug. 26) for installation of wireless telegraph apparatus at Cape York, Thursday Island, Goode Island, Port Moresby and Fremantle. Specifications, &c., from the Deputy Postmasters-General, and will, it is expected, be received shortly by the representative of the Commonwealth in London.

TENDERS RECEIVED AND ACCEPTED.

The Metropolitan Asylums Board has received the following tenders for an electric lighting installation, &c., at the South-Western hospital and ambulance station:—

W. J. Fryer & Co. (acc.)	£3.434	0	A. Hawkins & Sons ...	£4,475	0
Cox-Walkers	5.995	0	G. Weston & Sons	4,368	0
J. H. Taylor & Co.	5,899	0	Pinching & Walton......	4,157	12
Laing, Wharton & Cunnington	5,750	0	Tilley Bros.	4,095	0
F. A. Glover & Co.	5,700	0	C. Pullan	4,027	16
A. C. Smith (Lincoln)..	4,956	16	Lund Bros. & Co.	3,930	0
T. Potter & Sons.........	4,865	0	Tamplin & Makovski ..	3,926	0
Wenham & Waters......	4.741	0	J. S. Anderson...........	3,900	0
H. J. Godfrey	4,735	0	H. & C. Davis & Co. ...	3,833	0
A. Arthur & Ure.........	4.685	0	W. Barton & Sons	3,825	0
W. G. Cannon & Sons..	4,560	10	H. J. Cash & Co.	3,819	0
Perry & Co.	4,486	0	G. E. Taylor & Co.	3,787	0
			Electrical Co.	3,700	0

Engineer-in-chief's estimate, £4,000.

C. & A. Musker have recently installed a large electric crane at the Alexandra Docks goods station of the Lancashire & Yorkshire Railway.

The crane is to be used for stacking timber, and command an area measuring 540 yds. by 57 yds., lifting capacity 10 tons. It is of the double cantilever type, and runs on a pair of rails spaced 23 ft. apart. The span of the cantilever is 172 ft., its over all length 188 ft., and height from the ground 63 ft. Electric current is taken from an overhead cable at 600 volts, a pair of trolley poles being arranged at one end of the cantilever. With a full load of 10 tons the crane will hoist at the rate of 93 ft. per minute, taking 93 B.H.P. It will traverse the same load at 482 ft. per minute, and move along the track bodily at a speed of 435 ft. per minute.

Southend on Sea Council have accepted the following tenders:—

E. & B. H. Davey, condenser tank, £370; British Thomson Houston Co., switchboard panel and gear for 500 kw. set; J. E. & S. Spencer, steam pipes, £50. 10s.; Aiton & Co., exhaust pipes, £315. 5s.; Hopkinson & Co., Glenfield & Kennedy, Holden & Brook and J. Dore & Co., valves; Tudor Accumulator Co., positive battery, £369 and £46 per annum for 10 years for maintenance.

The Stalybridge, Hyde, Mossley and Dukinfield Electricity and Tramways Board recently received the following tenders for a 2,000 kw. turbo-alternator and condensing plant: Willans & Robinson (*accepted*), £8,250; C. A. Parsons & Co., £7,900.

St. Pancras (London) Council have provisionally accepted the tender of Charrington, Sells, Dale & Co. for 600 to 800 tons "Babbington" large hard steam coal at 16s. 3d. per ton, and that of Spenser Whatley (Ltd.) for 600 to 800 tons of "Desford" steam cobbles at 14s. 11d. per ton.

Woolwich Borough Council have accepted the tender of Davis-Perret (Ltd.), for the supply of oil eliminating plant at £299. 15s., to be delivered in 4—5 weeks. Seven tenders, varying from £90 to the amount of the accepted tender, were received.

Battersea (London) Council have accepted the tender of the Lancashire Dynamo & Motor Co. for a feeder booster, switchgear, spares, &c., at £1,502. 4s.

The following tenders have been accepted by Huddersfield Corporation: British Thomson-Houston Co., meters; McPhail & Simpson, superheaters; and John Radcliffe & Son, foundations for new plant.

Woolwich Council received 10 tenders from 9 firms for the supply of electricity meters, and the offer of Chamberlain & Hookham has been accepted.

Harrogate Council have accepted the tender of R. W. Ledger for meter boards: large £2. 8s. per gross, small £1. 16s.

Kettering Council have accepted the tender of Chamberlain & Hookham for electricity meters.

The Postmaster-General's Department, Adelaide (South Australia) has accepted the tenders of R. B. Hungerford, for common battery switchboards and cables and subscribers' sets; W. McLean & Co., jacks and metallic circuit plugs; Unbehaun & Johnstone, clearing indicators; A. W. Dobbie & Co., Kellogg listening and ringing keys; Geo. Wills & Co., h.d. copper wire and porcelain insulators; O. Haes, soft binding wire; and Rabone, Feez & Co., copper tapes and binders and insulators.

Melbourne (Victoria) Corporation have accepted the tenders of W. T. Henley's Telegraph Works Co., J. A. Newton & Co., Lawrence & Hanson and Wm. McLean & Co., for electrical stores for 12 months.

The tender of Mace & Nicholson has been accepted for the extension of Wellington (N.Z.) municipal electricity works, at £9,946.

Transformer Contracts.—Among recent contracts obtained by the transformer department of Messrs. Ferranti Limited, Hollinwood, Lancs., is that for the supply of 55 transformers for St. Petersburg Municipal Council. The competition for this contract on the part of the chief Continental manufacturers was extremely severe. Owing to the very high Russian import duty, which is assessed upon the weight of the articles, light but bad efficiency transformers are at an advantage as regards initial cost, and such transformers have as yet been exported to Russia by the German and other manufacturers who have hitherto handled this trade. Some time ago Dr. C. Garrard, manager of Messrs. Ferranti's transformer department, secured permission to submit several special high-efficiency type "E. X" transformers as samples to St. Petersburg Council. The tests on these were so satisfactory, and the saving shown to be possible over a number of years was so large, that the result has been the above contract.

Electricity in Mining, Textile Mills, &c.—The following orders have recently been secured by the power and mining department of the British Thomson-Houston Co.:—

Sheffield Coal Co. (for their Birley Collieries, near Sheffield), one 250 kw. 375 revs. per min. 3,000 volt 50 cycle three-phase B.T.-H.-Belliss generating set, three panel main switchboard, five sets of main and tail haulages (two 30 H.P. and three 50 H.P.), two motor driven pumps (30 H.P. and 80 H.P.), and one 100 kw. and two 70 kw. transformers and high-tension and low-tension panels.

Pease & Partners (Darlington), plant to be installed at Bowden Close Colliery: One 120 H.P. 480 revs. per min. 440 volt 40 cycles three phase

slip ring protected type haulage motor, with tramway type reversing controller and panel, one 25 H.P. 770 revs. per min. fan motor and one 130 kw. three phase 2,750/440 volt oil-cooled transformer, with the necessary switchgear.

Morris & Shaw (Polesworth, near Tamworth): Main switchboard, pit bottom and feeder panels, one 75 H.P. three-phase motor for driving endless haulage gear and the requisite feeder cable.

Gwynnes Limited (Hammersmith, London): Testing plant (120 kw. motor-generator set, made up of two 60 kw. c.c. generators tandem coupled to one induction motor, one 110 k.v.a. three-phase motor generator, and a motor exciter of 10 kw.).

D. Selby Bigge & Co. (for Earl Fitzwilliam's Colliery, at Elsecar, near Sheffield): One 350 kw. exhaust steam turbo-alternator, with heat accumulator, condenser and the requisite switchgear; and (for Cannop Collieries, near Lydney, Glos.) two 300 kw. 375 revs. per min. 2,750/3,000 volts 50 cycles three-phase alternators complete with exciters and rheostats, for direct coupling to high-speed engines.

Vickers, Sons & Maxim (on behalf of the Admiralty): 21 motor-generator sets, each giving 120 amperes at 55 volts (6·6 kw.) 1,600 revs. per min. with the necessary control panels. (These are to operate searchlights on board H.M.S. "Vanguard" which Messrs. Vickers, Sons & Maxim are building.)

Glenboig Union Fireclay Co. (Glenboig, N.B.): Two 45, one 25 and one 15 H.P. three-phase motors and panels and two transformers, for driving pumps at their works.

Finlayson, Bousfield & Co.'s Linen-thread Mills (Johnstone, N.B.): One 200 kw. 428 revs. per min. 300/550 volt 50 cycle three-phase alternator, with three pedestal bearings, protection caps, rope pulley, base plate and direct-coupled exciter, together with necessary switchgear.

Joshua Whiteley & Co. (Huddersfield, for their Albert textile mill): Complete installation, consisting of 23 three-phase induction motors, totalling upwards of 600 H.P., with necessary steel work for mounting coiling motors and controlling gear and cables. (This is the first textile mill to be electrically driven from the Corporation three-phase mains in the Huddersfield district, one of the main centres of the textile industry. This contract should be as far reaching in its influence on the development of textile driving in this district as the Acme Mill has been in Manchester.)

Steel, Peech & Tozer (Sheffield): One 750 kw. 285 revs. per min. "MP" type c.c. generator for direct coupling to Belliss engine.

J. Booth & Bros. (Rodley, near Leeds): Equipments for four cranes —two 24, two 15, one 10, one 8, four 7½, one 5 and two 3 H.P. three-phase 400 volt induction motors, 710 revs. per min., in all 13 machines, complete with tramway-type controllers and brake magnets.

Admiralty: Nine motor-generators (eight 120 and one 8 amperes) for operating searchlights on H.M.S. "Defence."

Robt. Addis & Son's Collieries (for Ronshal Colliery, No. 7 pit, Coatbridge): One 250 kw. (310 k.v.a.) three-phase generator 550 volt 50 cycle coupled direct to Belliss engine.

Stevenson, McGuffie & Milne (for Binley Colliery, of Merry & Cunningham, Glasgow): Two 62½ kw. c.c. generators coupled on combined base to one Howden engine and a four-panel switchboard.

Ansley Hall Coal & Iron Co. (Atherstone, Warwickshire): One 500 kw. 340 revs. per min. 500 volt compound-wound open-type c.c. generator, to be driven by ropes by a pair of Robey engines running at 85 revs. per min., and two switch panels for above.

Bolckow, Vaughan & Co. (Dean & Chapter coke oven plant): Eight 16, two 10 and four 3½ H.P. three-phase motors, complete with the needful controllers and switches.

BUSINESS NOTICES.

Owing to the very large increase in their business, Messrs. Everett, Edgcumbe & Co. (Ltd.) have had to make considerable extensions to their works at Hendon, and also to add to the personnel of the company. Mr. Patrick Hamilton, B.Sc., A.M.Inst.C.E., M.I.E.E., formerly manager of the electrical department of Kelvin & James White, has joined the board of directors of the company, and will take an active part in the supervision and design of their various products and in the management of the business generally. Mr. Hamilton will be located chiefly at the Westminster offices (87, Victoria-street, London, S.W.).

Mr. John F. B. Vandeleur, 3, Dineen-building, Toronto, informs us that he is sole agent in Canada for Messrs. Evershed & Vignoles, and that he is making arrangements with other firms for acting as their representative. Mr. Vandeleur is at present in this country (addre s, 18, Salisbury-road, Hove, Sussex).

LIQUIDATIONS, &c.

Claims against the Kevan Electric Co. (Ltd.) by June 3 and against Kevan Signs (Ltd.) by June 5 to Mr. E. Heisch, 120, Fenchurch-street, London, E.C.

Claims against the Monobloc Accumulator Synd. (Ltd.) by May 30 to Mr. H. Newson-Smith, 37, Walbrook, London, E.C.

Plant for Sale.—Mr. E. J. Jennings, West Walls, Newcastle-on-Tyne, has for sale electrical machinery, suitable for isolated generating plants or extensions of existing plants. The machinery constitutes the whole of the generating plant at the Dale End electricity station of Birmingham Corporation, which has been purchased by Mr. Jennings. Photos and full list on application. Further particulars are given in an advertisement.

A 6 kw. second-hand dynamo, with switchboard, and a quantity of fittings are offered for sale. May be inspected at Pauling's depot, Greenford Station (G.W.R.), Southall. See an advertisement.

An advertiser wishes to dispose of two 12 in. Blackman fans, with starters, for 220 volt d.c. circuit.

Metallic Filament Lamp Patents.—An important firm in the United States advertises that it is open to take licences under patents in that country relating to high-efficiency metallic filament lamps. Applications to Messrs. Lloyd-Wise & Co., chartered patent agents, 46, Lincoln's Inn-fields, London, W.C.

Manchester Electrical Exhibition.—An advertisement on another page gives some particulars relating to this exhibition, which will be open from Oct. 3 to Oct. 31 next inclusive. There is good evidence that the project is being widely supported by the electrical industry, and on the General committee are representatives of Bolton, Bradford, Bury and Nottingham Corporations, of the Supply Companies, the Institution of Electrical Engineers, the Municipal Electrical Association, the National Electrical Manufacturers' Association, the Electrical Contractors' Association, and of the general exhibitors. The prospectus of the exhibition and floor plan can be obtained from the London office of the exhibition, 2, Queen Anne's-gate, S.W., where applications for space will also be received. The profits will be allocated to a percentage return to exhibitors, contributors and donors and to contributions to charities connected with the electrical industry, and the surplus (if any) will be dealt with as the General committee decides.

CATALOGUES, &c.

Marelli Fans.—With the approach of summer (approach is the right word during this Yuletide weather) the thoughts of the electrical dealer not unnaturally turn to fans. Should the Clerk of the Weather allow them to continue to wander in this direction during the next few weeks they might turn towards the price list of Ercole Marelli & Co., 26, Garlick-hill, London, E.C., dealing with a very wide range of electric fans. The list contains good illustrations of the different makes of fans which the company offers for the coming season. These include ceiling fans, porthole fans, table, desk and bracket fans, also combinations of ceiling fans with fittings. The "Maestrele" type of ceiling fan is made for use on alternating-current single phase circuits. The list is completed by a page devoted to small electric motors for a.c. and d.c. circuits.

The "Arcoflame."—J. & H. Grevener, Eldon-street House, London, E.C., inform us that they are the sole vendors of the "Santoni" flame arc, and that this lamp, which they are marketing under the name of the "Arcoflame," can be delivered from stock, together with accessories. They are also offering a 4½ amp. d.c. flame arc. The lamps are described in list A10.

Time Switch.—A loose leaflet is being issued by Venner & Co., Old Queen-street, London, S.W., describing their R.B. type time switch for incandescent street lighting.

Fans.—We are uncertain as to the wisdom of calling attention to the latest list of the Electrical Co., Charing Cross-road, London, W.C., which deals with fans. We can vouch for the cool appearance of the lady on the cover, but we dare not recommend her appearance in public this weather, unless her presence would at once clear the air of its vapours. We had better reserve details of the fan list for a later issue.

Metal Filament Lamps.—The supplies department of Neville, Williams & Co., 11-13, Southwark-street, S.E., send us two of their latest lists dealing with metal filament lamps of English make, and an automatic switch for isolating small transformers used in connection with metal filament lamps.

Transformers.—A list describing and pricing the small transformers made by W. E. Burnand & Co., Heeley, Sheffield, is to hand. Accompanying it is a small brochure comparing electricity and gas for power purposes, to the advantage of the former. This should be in the hands of every power user.

Accumulators.—From the latest list of A. J. Wright (Ltd.), Leyton Green-road, London, N.E., we gather that every kind of ignition and portable accumulator is made. A large stock of accessories is also kept. Lists M and L give full details.

COMPANIES' MEETINGS AND REPORTS.

Indo-European Telegraph Co. (Ltd.)

The forty-first ordinary general meeting was held at their offices on Tuesday, under the presidency of Mr. J. HERBERT TRITTON.

The SECRETARY (Mr. John L. Bethell) read the notice convening the meeting and the auditors' report.

The CHAIRMAN said: Gentlemen, before dealing with the report and accounts, I wish to make a few remarks. The shareholders are, of course, aware that the Director General of Imperial German Telegraphs is, ex officio, a member of our board. Herr Sydow, who, until a few weeks ago, occupied the position referred to, has relinquished it in order to take up the high office of Finance Minister of

the German Empire. To praise Herr Sydow's business capabilities would clearly be a work of supererogation, as the above are facts which speak for themselves, but the directors are desirous not to let this occasion pass without a tribute to Herr Sydow's personal qualities. They have great pleasure in referring publicly to the very friendly nature of their relations with Herr Sydow, and to the unfailing courtesy displayed by him towards the company. The directors wish to place on record their great regret at the severance of these friendly relations, whilst at the same time offering him their heartiest good wishes in his new office (cheers).

Turning to the report, you will observe that the directors are able to speak favourably of the satisfactory working of the company's system. It is always satisfactory to report progress in the right direction, and there has been steady progress in the reduction both of the time occupied in transmission of telegrams, and of the number of errors made on the company's system. In 1906 a telegram to India or the Far East took an average time of transmission between London and Teheran of 40·55 minutes, and in 1907 36·8 minutes, a reduction of approximately five minutes, and this without addition to the number of wires at our disposal, and in the face of an increase in the number of telegrams transmitted. In 1907 the percentage of errors made by our instrument clerks was 0·044 that is, under one error per 2,000 words transmitted—as against 0·045 for the preceding year. These improvements have been attained under the strain imposed upon the staff by the pronounceable-combination-code theory of code formation, upon which the very great majority of codes now in use are based. Every ready to meet the reasonable demands of merchants, the London Telegraph Conference of 1903 admitted as code any words, whether genuine or artificial, formed of syllables capable of pronunciation according to the usage of one of the German, English, Spanish, French, Dutch, Italian, Portuguese or Latin languages. The practical outcome of this concession has been words made up of two- and three-letter permutations, and combinations of the letters of the alphabet, limited in scope only by the necessity of interpolating a minimum of vowels to keep up the appearance of pronounceability. Thus we got code words such as those mentioned in the recent letter of the General Post Office to the London Chamber of Commerce—namely, Bujksroety, Bywrgroebx and Liqraqkper, which it is impossible to consider as pronouceable. The last word looks like "Lipcracker" (laughter). The transmission of combinations such as these presents enormously increased difficulty to the operators, there being no possible check to avoid error such as there was when code words had a real existence in a real language. To the delay in transmission resulting from the above, there must be added the further delay resulting from the enormously increased number of repetitions rendered necessary by the use of the artificial words referred to. It will hardly be believed that repetition telegrams form, on our system, 25 per cent. of the whole number of telegrams carried. The company is now making experiments with the duplex system, applying it to Wheatstone working, and, so far, the results of these experiments have been satisfactory. The object at present aimed at is to make up for the possible temporary loss of one of our two cable wires, in case the relative cable is interrupted, but should a permanent increase in our carrying capacity be rendered necessary by increasing traffics, it may become imperative to make arrangements to introduce duplex working over the whole of our system.

The revenue from message account and other sources amounted to £136,579, as compared with £124,610 for 1906, increase £11,969. The expenses were £73,053, compared with £73,643 for 1906, a decrease of £590. The depreciation of the company's investments during the year is again very heavy, and to meet it £18,144 has been provided out of profit. The directors propose the usual final dividend of £14,875 and bonus of £17,000, leaving £8,558 to carry forward, against £8,974 for the previous year. We have again decided to recommend a distribution from interest on investments of 15s. per share (free of tax). I now move the adoption of the report and accounts, and the approval of the dividend and bonus.

Mr. CHARLES HOLLAND seconded the resolution, which was carried unanimously.

On the motion that Mr. J. Herbert Tritton and Mr. L. Delbrück be re-elected directors,

Mr. G. VON CHAUVIN, in seconding the motion, said: The Indo-European Co. has now completed practically 40 years' term of its existence, and this is somewhat like a jubilee. When the company was originally started with the idea of providing telegraphic communication over the route which the company is now occupying, there were two gentlemen on the Continent who took a particular interest in the enterprise, and who eventually granted the concession to the company. One of them was Gen. Lüders, who was Director-General of Telegraphs in Russia, and the other was my father, who was then Director of Telegraphs in Prussia, and who afterwards became Director-General of Telegraphs in Germany. Even at that early stage I had a certain amount of work to do with the Indo-European Co. I had something to do with some of the preliminary negotiations, and at a subsequent period I went to the Caucasus, and part of the building of the line was entrusted to my charge, so that some of your telegraph poles and telegraph wires or their predecessors were put up by myself. I have seen the company's development, and I can say, from the point of view of an expert, which I claim to be in that respect, that the management of this company has been excellent from every point of view. I therefore desire to put forward a suggestion that we should ask our directors to insert a clause in the notice convening the next annual general meeting that it is the intention of a shareholder to move that a substantial sum of money be voted to the directors in recognition of their past services to this company.

The motion for the re-election of the retiring directors was then carried unanimously. The retiring auditors were also re-elected.

A cordial vote of thanks to the chairman, directors and staff was then adopted.

PRESENTATION TO THE CHAIRMAN.

At the conclusion of the meeting a presentation was made by Mr. Holland to the respected chairman of the company, Mr. J. Herbert Tritton. This consisted of three handsome silver vases, manufactured in accordance with the style peculiar to the James II. period. The stand for the centre and largest vase bore the following inscription: "Presented to J. Herbert Tritton, Esq., by his colleagues on the Board and the senior officials of the Indo-European Telegraph Co., in commemoration of his most successful and kindly connection of 40 years as Director and Chairman of the Company."

Mr. HOLLAND, in making the presentation, said: My dear Tritton, it is my pleasant privilege as senior director to make this presentation to you on behalf of your colleagues on the board and the heads of departments and foreign representatives of the company. We hope you will accept this souvenir as an expression of the very kindly feeling we all have for you, and our appreciation, not only of the able way you have presided over the destinies of the company, but also of your unfailing sympathy for all members of the staff. We wish you every good wish, with the sincere hope—in which I am sure every shareholder of the company will cordially join me—that you may continue to remain our chairman for very many years to come (cheers).

The CHAIRMAN said: Mr. Holland and dear colleagues, both on the board and among the staff of the Indo-European Telegraph Co., I am really overwhelmed at so unexpected a presentation. It is true I have been for 40 years a member of the board—from its inception, in fact, in the year 1868. To use Mr. von Chauvin's words, I may plead in extenuation that I was caught very young (laughter). Forty years ago we had not the present instruments, we had not the present highly trained men, and it was a great venture to attempt to lay a land line of so many thousand miles' length; and if those gentlemen who went out could tell their experiences in the steppes of Russia, in the ravines of the Caucasus, and in the mountainous districts of Persia, there would be many a thrilling story to tell. Perhaps our friend Mr. von Chauvin will one day give us his reminiscences in these matters. It was no light task, but it was successfully accomplished, although financial success was rather slow in crowning our efforts in the early stages of the company. We were fortunate in our two first chairmen, Mr. Grimston and Col. Holland, and were fortunate also in our relationships both with the German and the Russian Governments. A great part of our success has been owing to that fact. I would like to mention a director, Mr. C. W. Siemens, afterwards Sir William Siemens, as having been largely instrumental both in Germany and Russia in bringing about this result. I must not forget also Mr. Henry Weaver, who did so much for us in our first years, nor Mr. William Andrews, who succeeded him, nor his son, Mr. T. W. Stratford-Andrews, who is now our managing director. Nor must I forget to mention the members of the staff generally. We have been well served throughout in this country and abroad by those who are our servants. Far be it from me to think that the chairman's share in the success of the company has been anything but very small indeed, so that I feel overwhelmed at what has been said, and at this mark of esteem, which I very gratefully acknowledge.

West Coast of America Telegraph Co. (Ltd)

The eleventh ordinary general meeting was held yesterday, Sir JOHN DENISON-PENDER, K.C.M.G., presided.

The SECRETARY (Mr. Fredk. L. Robinson) read the notice convening the meeting and the auditors' report.

The CHAIRMAN said: You will see from the report that the gross receipts for 1907 came to £61,854, as against £68,048 in 1906. This shows a decrease, I regret to say, of £6,194. The causes of this reduction, however, I think are satisfactorily accounted for. To begin with, the traffic has not been as good—not only the international traffic, but the local traffic also. Another material cause is that the average of the exchange in 1907 was about 11¾, whereas in 1906, the previous year, it was as high as 14⅛. Then our competitors have opened an office at Antofagasta, and although that has not taken very much traffic from us, at the same time, as you are fully aware when there are two companies the public play off one against the other. The expenses for the year amounted to £34,616, as against £34,173—an actual increase of £443. I have seen this morning a paragraph and an article in a paper with regard to "the very low dividend" we are paying, which is, however, the same dividend as we paid last year. The paragraph complains of the dividend, and says we are perfectly able to increase it and pay very nearly double as much. The article commends the board for their caution in not increasing the dividend. I should like to point out to you the position. You have a preference capital of £170,000—that is, debentures and income bonds. That amount has to be met some day, and at a not very distant time. You have an ordinary capital of £112,520. It is quite true we have the money to pay a larger dividend, but if we use it in that way what are we doing? We are simply depreciating and not increasing the value of your ordinary shares. Because if we can go on as we are, paying, as I hope your Board will be able to do, a very small dividend and increasing your reserve, when the time comes when we have to pay, or, at any rate, to make an arrangement for the continuation of, part of this £170,000, I think you will

agree with me, we are in an infinitely better position to do it if we have a good sound reserve fund at our back. I want to impress upon you this fact that, in paying a small dividend we are increasing the value of your ordinary shares, and not diminishing it. I now move the adoption of the report and accounts.

Sir ALBERT J. LEPPOC CAPPEL, K.C.I.E., seconded the motion, which was adopted without discussion.

Resolutions approving the dividend and re-electing the retiring director (Sir John Denison-Pender) and the retiring auditors were then carried, and after a vote of thanks to the chairman and directors the proceedings terminated.

Marconi's Wireless Telegraph Co. (Ltd.)

The eleventh ordinary general meeting was held yesterday, Col. Sir Charles Euan-Smith presiding.

The SECRETARY (Mr. Henry W. Allen, F.C.I.S.) read the notice calling the meeting, and also the auditors' report.

The CHAIRMAN explained at considerable length the view of the board as to the present situation of the company. He said that their business divided itself into three principal departments: (1) trans-Atlantic wireless telegraphy; (2) maritime or ship-to-ship and ship-to-shore service; and (3) manufacture of apparatus. The board regarded the period of the company's existence so far as having been spent in building up these three main branches of their system, so that they should be permanently placed on a safe and promising commercial basis. This they claim to have now been achieved. The development of the system had to be achieved inch by inch, with a corresponding percentage of failures, which necessitated retracing certain parts of the road which was leading to success. Experience had to be bought; the powerful opposition of those whose interests were regarded as being placed in jeopardy should the Marconi Co. be successful had to be met, as it was, of course, active on every side; and, lastly, the Conferences which were held at Berlin plunged them into a sea of embarrassment. Negotiations had to be initiated and carried out in many countries of the world with public governments and private interests. Subsidiary companies had to be formed, and the general public had to a certain extent to be educated as to the main features of all that is comprised in a world-wide system of wireless telegraphy. As to the cable companies, their opposition to this company's enterprise was, of course, perfectly natural. The board had no grounds for complaint in this respect. Nevertheless, a study of their history in its early stages might afford consolation to their shareholders, who had as yet received no dividends. It was not till 9 to 10 years after the first cable was laid that even a minimum of success was achieved, and at one time it was actually in contemplation to take up and sell at scrap value the cable first laid in the bosom of the Atlantic. The past, with all its difficulties, its obstacles and its disappointments, might now be regarded as finished and done with. The tremendous achievement of regular trans-Atlantic communication was an accomplished fact. Wireless telegraphic communication with the United States of America was now as easy, and when the contemplated improvements are completed would, the directors believed, be as rapid and as easily available as that carried on by the cable companies, the difference being that they hoped to accomplish the service which they rendered to the public at a little more than 50 per cent. of the present cost. The record of the trans-Atlantic wireless service during the past few months carried conviction on these heads, and demonstrated its ensured potentiality. Henceforward all the efforts of the directors would be concentrated on turning to profitable account the enormous advance in all branches and especially in the trans-oceanic service. It was, therefore, in a spirit of confidence that the directors considered themselves fully justified in soliciting the further support of the shareholders and of the general public for the purposes of exploiting the immense resources that had recently been opened up, and of securing substantial returns. The present stage was one that emphatically called for the active and practical development of the world-wide business which they believed to be ensured to the company by reason of its valuable agreements and concessions secured in various parts of the globe. The extent of the benefits which would accrue to the shareholders depended upon the adequacy and even still more on the celerity with which the company was placed in possession of the necessary means to reap the harvest which awaited the sickle, and also to the extent of the area over which their operations could be conducted. As to their general progress throughout the world, the report had made it clear that they were now securing profitable business all over the face of the globe. America, Canada, South America, France, Italy, Russia, Belgium and China all came to them for apparatus and installations, and they felt from the very nature of the business that the field was almost limitless in its profitable opportunities. Indeed, the board was convinced that within a short time the adoption of a system of wireless communication will become obligatory on every recognised state. As they believed their system to be the best, they were sure that they would secure at least a large proportion of the business offered. Their works at Dalston were splendidly equipped and designed as to meet all foreseen demands, and their training school for teaching wireless telegraphy was accomplishing all that they hoped for when it was first established. With regard to Lloyd's, their relations with this great association had now been placed on a satisfactory footing that they hoped to avoid in the future the friction that had been not infrequent in the past. He need not tell them that as regarded Trinity House and the Board of Trade, they trusted that the installations of their system on the Trinity lightships might and should receive great expansion. Mr. Marconi, who was possessed of high abilities as a business man in addition to his scientific attainments, had offered them, until a suitable business manager had been found, to carry on the management of the company, in addition to his own scientific work, in succession to Mr. Cuthbert Hall. So far, he had been singularly successful, and since his assumption of office, had succeeded in effecting considerable economies in the administrative staff. It was not, of course, intended for one moment that Mr. Marconi should be permanently burdened with the conduct of the ordinary business details, as his assistance was most needed in the scientific supervision of the affairs of the company. So soon as a suitable business manager could be found, he would be relieved of his duties as managing director. He was glad to be able to announce that Mr. Marconi had signed a fresh agreement with the company whereby they had secured his services as technical adviser for a further period of three years (cheers). With reference to the new issue of capital, the board believed they had acted on the best advice obtainable as to the form which the new capital issue should take. The amount for which they now asked would, in the opinion of the board, be sufficient to clear off all the company's liabilities to bankers and others, and place the company in sufficient funds to carry out all those improvements, duplications and extensions which it was considered necessary to place them in a position capable of earning the dividends which it was proposed to pay. It was unnecessary to enlarge on the fact that the expenditure of this money must place the ordinary shares in a far more satisfactory position than they held at present. The directors had every reason to believe that the 10 per cent. which it was proposed to allot as dividend to them after the payment of 7 per cent. on the preference shares could be easily realised. The board recommended this issue to the shareholders because they believed that the capital thus acquired would ensure the success of the company. It might, no doubt, weigh with some of the shareholders that the Marconi Wireless Co., as now established and universally recognised, really formed a national asset of national importance, for the success of which England had every reason to be grateful, not only now, but also with regard to the measureless possibilities of the future. He concluded by moving the adoption of the report.

Mr. G. MARCONI (managing director), who was loudly cheered on rising to second the motion, said he agreed with what the chairman had said about the business development of the company. He had not much to add to the statements which had already appeared in the copies of his lectures attached to the report or to what had been already said by the chairman. The transmission of messages between Ireland and America was commenced before the stations at Clifden and Glace Bay were completed. The working of the trans-Atlantic service during the 7½ months since it was inaugurated had in every way confirmed the view he had long held—viz., that wireless telegraphy could furnish, and would furnish a new and economic method of communication with America and other far distant countries. The experience gained in those months of practical working had been sufficient to enable him and his assistants to indicate exactly what modifications and extensions to the present equipment of those stations would be necessary and adequate for the continuous operation of the stations on a 24 hour basis at a high rate of speed. The so-called obstacles, which many thought insurmountable, such as interference with other stations and difficulty of transmission of messages over long distance during the day-time, had been overcome. For some months past, the majority of all their messages and communications had been carried out across the Atlantic during the day-time, and no interference whatever with the working of the ship-to-shore stations had been caused by the operation of powerful long-distance trans-Atlantic stations. No special attempt had been made so far to work at a high rate of speed, although he had recently been informed that a speed as high as 24 words a minute had been touched in communications from Canada to Ireland. He was confident that with slight modifications to the details of the apparatus, at very small cost a speed of at least 30 words a minute could be obtained. He also referred to a recent improvement which made possible duplex working between wireless stations—that was, that every station was able to send at the same time as it was receiving. If this was applied to trans-Atlantic stations, as he had every confidence it would be, it should double their effective rate of telegraphy. With regard to the arrangements with the Italian Government, he could inform them that the high-power station at Coltano was nearing completion, and he thought this important station would be completed by the end of the year. The Italian Government had also entered into agreements or contracts for the construction of high-power stations in Abyssinia, Erithrea and on the Somali coast, which stations would be erected under an agreement entered into between himself, the company and the Italian Government, which Government also, he was able to state, hoped that arrangements might be carried out for an ordinary Post Office or commercial service between England and Italy. He had been made aware that negotiations had been going on with this object between the two Governments. He had the strongest belief that wireless telegraphy was destined to become an indispensable aid to commerce and civilisation.

A long and very miscellaneous discussion followed, in the course of which one or two shareholders made some rather severe criticisms on the "accounts." Mr. Rees, M.P., and Mr. John O'Connor, M.P., however, congratulated the board on their policy in accepting the Government conditions and on the favourable prospects of the company. After the discussion, which resulted in little or no information being elicited, the resolution was carried unanimously.

On the motion of the CHAIRMAN, seconded by Mr. H. JAMESON DAVIS, a resolution approving the proposed increase of the capital to £750,000 by the creation of 250,000 preference shares of £1 each, was passed, and the proceedings terminated.

Great Northern Telegraph Co. (Ltd.)

At the meeting at Copenhagen on Saturday, the chairman and managing director (Commodore E. Suenson, D.R.N.), in rendering an account of the working of the company during 1907, said that their submarine system had not been subject to more frequent interruptions in 1907 than in previous years, although the number of cables in Europe had been increased. There had been 16 interruptions on 8 cables in Europe, and 10 interruptions on 7 cables in the Far East. Their cable steamers, their officers, engineers and electricians had as usual rendered excellent service and had effected repairs with promptitude and ability. The "H. C. Orsted" had been actively employed in Europe for 91 days, and the "Store Nordiske" and "Pacific" had been on active service in the Far East for 151 days, of which 56 were for the account of other administrations. They were glad to report that the working of the important Kiachta route between Europe and the Far East had continued to improve, and the same might also be said of the Wladiwostock route. The new cable between Russia and Denmark had to be laid under great difficulties on account of the intricate nature of the Baltic Sea, and the laying consequently required a great deal of skill. The work was successfully carried out in July by the "Von Stephan" of the Norddeutsche Seekabelwerke, which company also manufactured the cable. The total length of the cable was 791 nautical miles, 472 for the eastern and 319 for the western section. Telegrams between St. Petersburg and England and France could be sent by the new cable with only one re-transmission. The company's Iceland cable had a most propitious inauguration last summer, and the value of the cable for the meteorological service had been satisfactorily proved. The directors had been engaged through the year in complicated negotiations regarding the difficulties in the Far East and the question of the company's exclusive privileges in Japan which necessitated their Shanghai representatives spending nearly the whole of the year at either Peking or Tokio. Although the proposals which were submitted to the Imperial Administrations of China and Japan were, in the directors' opinion, very liberal, still they had been somewhat modified during the negotiations in order to meet their views and appeared now to be satisfactory to the former administration. In Japan they had been less fortunate, although the negotiations were continued right up to the month of February this year, when they were suspended in order to be resumed in Europe, during or after the International Telegraph Conference, where all the interested parties will be represented. Referring to the progress of wireless telegraphy and to the trans-Atlantic service of Marconi's Wireless Telegraph Co., Commodore Suenson said that judging from information obtained from independent and neutral sources, the re-opening of the trans-Atlantic service after four or five years' silence was still far from being a complete success. Although the rates had been fixed at about one-half those of the trans-Atlantic cables, the public, and even the Press, had hitherto made very little use of the new service, which suffered from slowness, uncertainty and want of secrecy. However confident they felt of the absolute and lasting superiority of the telegraph by wire for the transmission from one country to another of political, commercial and private communications, the new invention had in the course of a few years made such remarkable progress that it might, nevertheless, in course of time perhaps become necessary to reckon with it, not only as a supplementary and auxiliary service, but also as a competitor of the telegraph by wire. After giving an analysis of the accounts of the company, Commodore Suenson said that the directors proposed the same dividend and bonus as in the previous year—viz., 20 per cent., of which 5 per cent. had been paid as interim dividends. He concluded by expressing regret for having been obliged on account of failing health to ask for the consent of his colleagues on the board to resign the position of managing director in the course of the present year. The business of the company had developed so that in future it would be impossible for any single person to attend to all the details. The board had, therefore, decided to substitute for the managing director a Board of Management, which would shortly be chosen and organised. Provided, however, he (Commodore Suenson) continued to be honoured with the confidence of the shareholders and also of his colleagues, he hoped to be able, after a much needed rest, to continue to preside over the work and the deliberations of the board and also to supervise the daily business of the company until the new Board of Management became completely organised and consolidated.

BABCOCK & WILCOX (LTD.)—At the meeting last week the chairman (Mr. John Dewrance) said that the nominal capital, owing to the conservative policy which had always been pursued, was very small in proportion to the total assets and to the total transactions of the company; and, therefore, the profit was really not a very large one upon the company's trading. The reason why they were able to make such a good profit was that they had a magnificent organisation throughout the world, that their factory had been extended, and that every detail of the machinery had been perfected to such an extent that the company was able to make a profit on prices which their competitors could not even touch. Much of the business was extremely competitive, and it was only on account of the exceedingly well-organised arrangement of the company that they were able to make a profit in those competitive branches. The factory had been very well occupied for the first three months of the current year, and the directors had every reason to believe that the next accounts would not show any very considerable slump as compared with those now presented. They were threatened with a very serious legislative attempt to restrict the output of coal, which was a highly important factor, and he hoped the legislators would think twice before entering upon so very dangerous a step.

BRITISH ALUMINIUM CO. (LTD.)—The chairman (Mr. John D. Bonner) at the meeting on Friday last stated that the company had contracts concluded for deliveries extending to 1,910, and contracts for further large quantities were on the point of completion on the basis of current prices. The aluminium industry had entered upon a new phase. They should have in the future to be content with a much smaller percentage of profit than hitherto, so that they would have to greatly increase their sales to continue to secure satisfactory financial results. Up to the end of last year their only producing works were those at Foyers, but now the works at Stangfjord and their temporary works at Kinlochleven were in operation their output should be about twice that of last year, and by about the middle of next year their great works at Kinlochleven should at last reach the producing stage. The development of their Orsières power scheme was proceeding very satisfactorily, but they were not expecting to have power available there until after the end of 1909.

BRITISH WESTINGHOUSE ELECTRIC & MFG. CO. (LTD.)—The accounts for 1907 show a trading profit of £92,393, and after providing for depreciation and interest on debenture stock and loans a sum of £11,341 remains to be carried forward. The £250,000 6 per cent. prior lien debentures recently issued have been fully subscribed, and out of this sum the directors propose to pay off bankers' loans and to provide working capital. The balance of £50,000 will be held in reserve to be used as and when required for the general purposes of the company. The important arrangement with the American companies has been carried out, whereby indebtedness amounting to £186,374 has been liquidated by the transfer to the American companies of shares in the Traction & Power Securities Co. at par value. During 1907 there was a substantial increase in the volume of business. At present demand is slack, but the company's improved commercial position, both at home and abroad, will enable it to take advantage of any revival in trade.

CANADIAN GENERAL ELECTRIC CO.—The annual report states that, while operating profits for last year showed a decrease from those of 1906, they were the highest recorded in any other year. After making all provision there was a balance available for dividend on the common shares for last year equal to 7·15 per cent.

CITY OF BIRMINGHAM TRAMWAYS CO. (LTD.)—Mr. E. Garcke stated at the meeting last week that the company lost some of their lines at the end of 1906 and the resultant loss of traffic during the past year had been £124,000. The net profits, however, were only £43,359 less than in 1905. The working of motor omnibuses in Birmingham had not been satisfactory and they were anxious about their investment in the Birmingham & Midland Motor Omnibus Co., but the financial position of their own company was satisfactory, and, having regard to the remaining assets to be realised, he had no misgiving that their original estimate would be borne out.

CITY OF SANTOS IMPROVEMENTS CO. (LTD.)—At the meeting last week the chairman (Mr. D. M. Fox) said the directors contemplated the electrification of their entire tramway system.

COVENTRY ELECTRIC TRAMWAYS CO.—At the meeting on Tuesday the directors' report stated that the gross receipts for 1907 were £29,500. 17s. 3d. and the costs of operation £18,737. 13s., leaving net earnings £10,763. 4s. 3d., an increase of £1,465. 8s. 7d. over 1906. The net profit for the year was £8,505. 5s. 5d. The directors recommended that £3,900 be placed to reserve for depreciation, and that a dividend of 3½ per cent. on the share capital be paid.

CRAIGPARK ELECTRIC CABLE CO. (LTD.)—The net profit for the year ended March 31 was £7,128. 16s. 11d., or, with £604. 1s. 4d. forward, £7,732. 18s. 3d. The directors have written off £1,000 as depreciation on buildings and machinery. Preference dividend absorbed £2,250, and the directors recommend a dividend of 6 per cent. on the ordinary shares (£2,250) and the placing of £1,000 to reserve, leaving £1,232. 18s. 3d. to be carried forward. The cable department shows a satisfactory increase, notwithstanding general depression in trade. Prices of raw materials are more favourable, and the directors look forward with confidence to the business of another year. During the year the company became members of the Cable Makers' Association.

DUDLEY, STOURBRIDGE & DISTRICT ELECTRIC TRACTION CO. (LTD.)—The chairman (Mr. A. C. Miles) stated at the meeting last week that notwithstanding inclement weather and trade depression satisfactory progress had been made. Additional repairs to rolling stock and permanent way had increased the expenses. With regard to the agreement proposed to be entered into with the Shropshire, Worcestershire & Staffordshire Electric Power Co., it was hoped that an economy would be effected. The Power Co. would generate electricity on a much larger scale than the company, and the company would thus be able to purchase current cheaper than they had ever been able to generate it for themselves. The parcels and goods traffic showed a profit of £96.

JOHNSON & PHILLIPS (LTD.)—The report of the directors presented to the meeting on Monday stated that the profit for the year to Dec. 31 last on trading account, &c., after making provision for bad and doubtful debts, and after charging to revenue upwards of £4,300 for maintenance of buildings, plant, &c., amounted to £31,529, making with balance forward (£11,451) £42,981. Deducting depreciation on buildings, plant, &c. (£5,500), debenture interest (£8,498), amount written off investments (£500), &c., there was available £27,123. Out of this the directors propose a dividend of 7 per cent. on the ordinary shares (£12,250), to transfer £8,000 to reserve, and to carry forward £6,873. The business has been well maintained during the year, notwithstanding the general depression in trade and the high prices of

raw material. Business continues to be good and the company are dealing with important contracts.

The chairman (Mr. R. W. Blackwell) said he was glad to be able to say that the business of the company had been sustained—in fact, the turnover had been the largest during any year of their existence. That, however, must be attributed to a considerable extent to the very large increase in the cost of material during the earlier part of the year. After explaining various items in the accounts, he said that the principal matter to which he would call attention was that the business of the company being centred in general telegraphic and submarine work, in the working of indiarubber, and in the manufacture of cables of all varieties, they had, consequently, been sufficiently fortunate to escape the very great troubles which had been met with by those companies who were solely engaged in the manufacture of distinctly electrical engineering apparatus. The new works which were started in the earlier part of last year had been entirely completed. They had been thoroughly and entirely occupied during the whole period under review. In view of the considerable price which they had to pay annually for the supply of motive power, they were glad to note that steps are being taken to obtain such Parliamentary powers as would really provide for something in the nature of a bulk supply for London. He repudiated a circular issued by a firm of brokers offering shares in the company. The directors had no knowledge of the circular, and he considered that that form of advertising was unjustifiable.

The report and accounts were adopted, the retiring director (Sir H. Benbow) was re-elected, and a dividend of 7 per cent. was declared.

KALGOORLIE ELECTRIC POWER & LIGHTING CORPN. (LTD.)—The directors' report for 1907 states that, after paying debenture interest and the 6 per cent. preference dividend, and applying £7,500 to depreciation and renewals, a balance of £5,300 is carried forward. An interim distribution at the rate of 5 per cent. per annum for the first half of the current year is announced on the ordinary shares.

KALGOORLIE ELECTRIC TRAMWAYS (LTD.)—The gross receipts for 1907 were £48,008, compared with £51,380 for 1906, and the net profits were £16,270, against £17,546. During the year the cars travelled 650,530 miles and carried 3,052,241 passengers, compared with 673,544 miles and 3,220,728 passengers in 1906. The number of units consumed in 1907 was 930,231 (value £10,658. 17s. 10d.), against 933,109 (value £10,929. 13s.) in 1906. The earnings per car-mile in 1907 were 17·63d. and expenses 11·17d., against 18·22d. and 11·34d. in 1906.

ORIENTAL TELEPHONE & ELECTRIC CO. (LTD.)—The chairman (Mr. B. St John Ackers) at the meeting on Wednesday, said that although the year witnessed the conclusion of the extensive reconstruction work for which preparations began some five years ago, many important additions had since become necessary in consequence of the increasing demand for telephone facilities on the part of the public. Expenditure would continue in Egypt, where the use of the telephone was being more and more appreciated both by the public and the Government, as well as by the municipal authorities; and not only in the cities and towns but also in a number of outlying districts.

SWANSEA IMPROVEMENTS & TRAMWAYS CO.—At the meeting on Tuesday the directors reported that the gross receipts for the half-year to Dec. 31 last amounted to £27,816. 19s. 5d., an increase of £2,741 on the corresponding period of 1906. Deducting all expenses, there remains £8,731. 1s. 3d. The directors recommended that £2,000 be placed to reserve and depreciation, payment of the preference dividends and a dividend at the rate of 3 per cent. on the ordinary shares. Expenses show an increase of £801. 7s. 10d.

TYNEMOUTH & DISTRICT ELECTRIC TRACTION CO. (LTD.)—The total revenue for 1907 was £12,846. 16s. 9d. Deducting all expenses there remains £4,607. 17s. 4d. The directors recommend that £500 be placed to depreciation and reserve, £500 to capital redemption fund, £1,525 to preference dividend to Dec. 31 and £1,856. 8s. in dividend of 4 per cent. on the ordinary shares to Dec. 31.

WEST COAST OF AMERICA TELEGRAPH CO. (LTD.)—The report of the directors for the year ended Dec. 31 last states that gross receipts were £61,854. 7s. 8d., against £68,048. 3s. 8d. in 1906. Working expenses were £34,616. 11s. 6d., compared with £34,175. 14s 3d. for the previous year. After providing £6,000 for debenture interest and £500 for interest on income bonds and £193. 16s. 5d. for income tax, there remains £20,244. 19s. 9d., added to £1,922. 15s. 9d., brought forward, making £22,167. 15s. 6d. Of this, £10,000 has been placed to general reserve and £2,000 to [illegible] ships reserve. The directors recommend payment of a dividend of 2 per cent., tax free, leaving £1,[illegible] 15s. 6d. to be carried forward.

WM GRIFFITHS & CO (LTD.)—At the meeting of the shareholders on Monday last the directors' report for the year to October 31 last stated that the depression in trade was probably the worst ever experienced. Municipal authorities continued their rigid economy, and the state of the money market seriously curtailed the execution of both public and private works. There was a net loss of £1,[illegible]. 11s. 3d. for the year, but £1,[illegible] of this is accounted for by debts brought forward from previous years found to be irrecoverable. Negotiations now in progress promise, with the improved state of the money market, to place the company in possession of a considerable quantity of contract work. The retirement of Mr. Wm. Griffiths from office as managing director was reported with much regret. The chairman (Mr. A. C. Tupp) said that they still had the benefit of his advice and experience as an ordinary director. They had appointed Mr. Percy Morris, who had been their secretary from the beginning, to be manager pro tem. in addition to his secretarial duties.

NEW COMPANIES, MORTGAGES AND CHARGES.

NEW COMPANIES.

ELECTRIC BATTERIES & CARBONS (LTD.) (97,710.)—Reg. April 24, capital £20,000 in £1 shares, to acquire and turn to account patents, concessions, &c., conferring an exclusive right to use any invention by F. J. Gerard and L. Fiedler, and to carry on the business of engineers, electricians, manufacturers of electric accumulators, electric or other motors, motor cars, locomotives, dynamos and apparatus, &c. Reg. office, 709, Salisbury House, London, E.C.

FERRIE & CO.—Reg. in Edinburgh April 24. Electricians, gas-fitters, &c., 195, Crow-road, Partick. Partnership for 10 years. General partner, R. C. Ferrie, above address. Limited partner, Mrs. J. McDougall, Trees, Barrhead, contributing £150 cash.

HAVANA TELEPHONE SECURITIES CO. (LTD.) (97,712)—Reg. April 21, capital £1,000 in £1 shares, to acquire any bonds, debentures, securities, stock or capital of the Havana Telephone Co.

LANGBEIN-PFANHAUSER WORKS (LTD.) (97,730.)—Reg. April 25, capital £3,000 in £50 shares, to carry on in the United Kingdom and the Colonies the business of electro-metallurgists, electroplaters, electrotypers, manufacturers of and dealers in dynamo machines, electric motors, switches and other electrical apparatus and instruments, chemicals and electrolytic solutions, &c. First directors, Dr. R. Jay and Dr. H. Kissell.

MORTGAGES AND CHARGES.

ST. AUSTELL & DISTRICT ELECTRIC LIGHTING & POWER CO. (LTD.)—Issue on April 10 of £200 5 per cent. debentures, part of series created June 1, 1904, to secure £2,000 charged on company's undertaking and property, present and future, including uncalled capital. No trustees. Previously issued of same series, £1,800.

CITY NOTES.

MEMORANDA (April 30).—Bank rate 3 per cent. (since March 19 1908). Price of silver $24\frac{5}{16}$—$24\frac{7}{16}$d. per oz. Consols $86\frac{3}{8}$—$86\frac{1}{2}$ for money, and $86\frac{7}{8}$—$86\frac{9}{16}$ for account. Consols Pay Day, May 6; Stock and Shares Continuation Days, May 12 and 27; Ticket Days, May 13 and 28; Pay Days, May 14 and 29; Mining Share carry-over Day, May 11.

PRICES OF METALS (London).—*Copper*, cash, $57\frac{1}{2}$—$57\frac{3}{4}$; three months $58\frac{1}{8}$—$58\frac{3}{8}$. *Lead*, English, $13\frac{5}{8}$—$13\frac{3}{4}$; foreign, $13\frac{1}{4}$—$13\frac{1}{2}$. *Spelter*, foreign 21—$21\frac{1}{4}$. *Tin*, English, 143—144; foreign, cash, $142\frac{3}{4}$—$143\frac{1}{4}$, three months, 142—$142\frac{1}{2}$. *Iron*, Cleveland, cash, 50/$10\frac{1}{2}$; three months, 48/1—48/$4\frac{1}{2}$.

CITY OF BUENOS AYRES TRAMWAYS CO. (LTD.)—The directors have declared a dividend of 1s. 3d. per share, less tax, for the quarter ended March 31.

EASTERN TELEGRAPH CO. (LTD.)—This company announce that, subject to final audit, the accounts for the year ended Dec. 31 last show that, after making a contribution to general reserve fund, payment of interest on the 4 per cent. mortgage debenture stock, dividend on the $3\frac{1}{2}$ per cent. preference stock and three interim dividends of £1. 5s. per cent. each on the ordinary stock to Sept. 30 last, there is a balance available, out of which the directors recommend payment of a final dividend of £1. 5s. per cent. and a bonus of £2 per cent., both tax free, payable on May 12, and making, with previous payments on account, a total distribution of 7 per cent. on the ordinary stock for the year. The transfer books of the ordinary stock will be closed from May 5 to 12 inclusive.

EASTERN EXTENSION, AUSTRALASIA & CHINA TELEGRAPH CO. (LTD.)—Subject to confirmation by the shareholders, the directors have declared a dividend for the quarter ended Dec. 31 last of 2s. 6d. per share, together with a bonus of 4s. per share (or 2 per cent.), making a total distribution of 7 per cent. for the year 1907. The dividend and bonus will be paid on the 14th inst. The share register will be closed from May 6 to 13 inclusive.

NORTH-WEST LONDON RAILWAY.—A locally organised committee for the Cricklewood (London) district has presented a memorial to this company on the subject of the proposed tube railway from Victoria to Marble Arch and Cricklewood. The report of the committee intimates that the result of a canvass strictly confined to the district concerned has resulted in a total signature to a memorial of 59,799, each signature being attached to a declaration that the signatory is in favour of the immediate construction of the tube railway on the ground that the signatory regards the railway of personal convenience. Practical unanimity amongst the residents and tradespeople along the entire route of the tube has been expressed in favour of the line. The traffic estimate prepared by the committee is a total of 92,000 passengers per day from local traffic alone. It is stated that the promoters of the bill authorising the construction of this railway have received the support of the Westminster, Paddington, Marylebone, Hampstead and Willesden Councils, and a long list of estate agents, architects, surveyors and others representing owners of property in the district aggregating in value several millions sterling are also warmly supporting the scheme.

ST JAMES & PALL MALL ELECTRIC LIGHT CO. (LTD.)—The amount of electricity sold for the quarter ending Lady Day, 1908, is returned at [illegible] units, estimated to produce £[illegible], against 2,[illegible] units, which produced £36,912 for the corresponding period of 1907.

ELECTRIC TRAMWAY AND RAILWAY TRAFFIC RECEIPTS.

Line	Week ended.	Amount.	Inc. or Dec. (a)	Aggregate. No. of weeks.	Aggregate. Amount.	Aggregate. Inc. or Dec. (a)
		£	£		£	£
Aberdeen Corporation	April 22	1,251	+ 95	47	63,460	– 1,267
Airdrie	,, 17	217	7	15	3,372	+ 53
Anglo-Argentine	,, 22	17,393	– 218	16	224,844	+ 33,622
Ayr Corporation	,, 25	319	+ 106	49	14,066	– 19
Baker St. & Waterloo Ry.	,, 25	3,485	+ 1,015	17	52,450	+ 12,629
Barnsley	,, 17	190	+ 41	15	2,632	+ 138
Barrow	,, 17	284	+ 71	15	3,335	– 10
Bath Electric Trams, Ltd.	,, 22	1,001	+ 281	16	9,705	– 1,082
Birkenhead Corporation	,, 26	1,085	+ 112	...	...	..
Birmingham Corporation	,, 18	6,183	+ 912	4	23,197	+ 1,156
	,, 25	6,816	+ 1,171			
Birmingham & Mid.	,, 10	795	+ 91	14	11,161	+ 401
Blackburn Corporation	,, 22	1,891	+ 919	4	4,962	+ 59
Blackpool Corporation	,, 23	3,339	+ 1,787	§3	4,443	+ 771
Blackpool and Fleetwood	,, 25	883	+ 594	...	...	...
Bolton Corporation	,, 26	2,289	+ 231	4	9,202	– 845
Bombay	,, 2	2,195	+ 629	13	31,506	+ 5,365
Bournemouth Corporation	,, 22	2,533	+ 944	3	5,746	– 323
Bradford Corporation	,, 25	5,591	+ 1,281	4	17,199	– 864
Brighton Corporation	,, 26	899	+ 101	4	3,070	+ 162
Bristol Trams & Carriage	,, 24	5,899	+ 1,217	16	73,878	– 2,241
Buenos Ayres & Belgrano	,, 22	3,550	– 359	16	60,427	+ 395
Burnley Corporation	,, 25	1,195	+ 37	4	5,338	+ 573
Burton Corporation	,, 26	262	+ 2	1	964	– 4
Calcutta Tramways Co.	,, 25	R44,464	– R1,286	..	...	...
Camborne-Redruth	,, 25	115	+ 10	17	2,015	+ 170
Cavehill	,, 17	88	+ 23	15	921	– 151
Central London Railway	,, 25	5,532	– 328	15	101,878	– 3,573
Charing C., Euston & H'stead	,, 25	3,665	...	17	54,065	...
Chatham & Dist. Lt. Rys.	,, 23	1,081	+ 443	§16	10,326	– 423
City & South London Rly.	,, 26	3,432	+ 607	17	56,167	+ 6,225
City of Birmingham	,, 17	2,710	+ 169	15	40,858	+ 134
Colchester Corporation	,, 22	233	+ 59	16	2,572	– 183
Cork Electric Trams Co.	,, 23	168	+ 6	§16	6,156	– 168
Croydon Corporation	,, 24	1,464	+ 152	4	4,703	– 534
Devonport & Dist. Trams	,, 16	519	+ 88	15	6,412	– 174
Dover Corporation	,, 25	212	+ 21	4	694	– 158
Dublin & Lucan Railway	,, 24	176	+ 64	17	1,681	– 44
Dublin United	,, 24	5,603	+ 333	17	78,533	+ 648
Dudley-Stourbridge	,, 14	763	+ 11	15	11,054	– 1,234
Dundee Corporation	,, 22	1,187	+ 157	49	55,837	+ 2,331
East Ham Council	,, 25	870	+ 53	4	3,073	– 121
Exeter Corporation	,, 24	378	+ 67	4	1,028	– 177
Falkirk and District	,, 22	280	+ 22	3	837	+ 41
Gateshead & Dist. Trams	,, 17	1,047	+ 107	15	15,035	+ 291
Glasgow Corporation	,, 25	17,663	– 1,415	47	816,434	+ 15,596
Glossop	,, 25	130	+ 2	17	2,006	– 128
Gravesend—Northfleet	,, 17	205	– 17	15	2,856	– 481
Great Northern & City Rly.	,, 25	1,504	– 219	17	29,828	– 1,712
Gt. Northern, Piccadilly, &c.	,, 25	5,669	+ 1,685	17	91,925	+ 27,541
Greenock & Port Glasgow	,, 17	536	– 95	14	7,177	– 2,055
Hartlepool Tramways	,, 17	218	– 41	15	3,215	– 605
Hastings Elec. Trams Co.	,, 23	1,676	+ 749	17	12,624	– 110
Hong Kong	,, 25	$8,562	+ $1,916	...	...	...
Hull Corporation	,, 25	2,493	+ 277	4	8 924	– 89
Ilford District Council	,, 25	435	+ 12	4	1,559	– 129
Ilkeston District Council	,, 22	161	+ 44	4	543	– 14
Ipswich Corporation	,, 25	365	+ 22	4	1,275	– 77
Isle of Thanet Co.	,, 25	528	+ 173	30	8,253	– 394
Jarrow	,, 17	114	...	15	1,477	– 178
Keighley Corporation	,, 23	216	+ 68	43	6,764	+ 330
Kidderminster & District	,, 17	91	– 1	15	1,260	– 178
Kilmarnock Corporation	,, 25	149	+ 5	49	7,637	– 203
Lanarkshire Trams Co.	,, 23	1 562	+ 309	16	20,325	+ 2,800
Lancashire United	,, 22	2,193	+ 1,118	16	19,628	– 1,037
Leamington	,, 17	137	+ 11	15	2,000	– 71
Leeds Corporation	,, 25	6,797	+ 708	4	23,312	+ 323
Leicester Corporation	,, 25	2,366	+ 343	...	..	...
Lincoln Corporation	,, 25	163	+ 11	4	495	+ 28
Liverpool Overhead Rly.	,, 25	1,477	+ 12	17	23,493	– 230
*London County Council	,, 18	31,984	+ 2,988	‡3	82,134	+ 8,161
London United	,, 25	6,952	+ 1,508	16	89,741	– 2,472
Lowestoft	,, 25	177	+ 38	30	4,664	+ 114
Maidstone Corporation	,, 25	189	...	4	657	...
Manchester Corporation	,, 25	15,494	+ 1,829	4	54,094	+ 4,197
Mersey Railway	,, 25	2,036	+ 218	17	33,671	+ 1,508
Merthyr	,, 17	222	+ 35	15	2,986	– 71
Metropolitan Dist. Railway	,, 25	8,633	+ 911	17	150,932	+ 16,758
Metropolitan Elec. Trams	,, 17	6 033	+ 1,881	15	73 737	+ 12,942
Middleton	,, 17	429	– 129	15	4,748	– 94
Nelson Corporation	,, 25	126	– 3	¶3	539	– 128
Newcastle-on-Tyne Corp.	,, 25	4,300	+ 406	4	14,289	– 1,655
Newport (Mon.)	,, 25	724	+ 121	4	2,401	– 1
Northampton Corporation	,, 24	521	+ 144	¶3	1,472	– 102
Oldham, Ashton & Hyde	,, 17	724	+ 171	15	8,685	– 120
Oldham Corporation	,, 26	2,031	+ 228	5	9,434	– 345
Perth (N.B.) Corporation	,, 22	156	+ 28	49	7,597	+ 31
Perth (W.A.) Elec. Trams	,, 24	1,528	+ 140	¶17	24,113	– 936
Peterborough	,, 17	132	+ 30	15	1,401	– 71
Portsmouth Corporation	,, 25	2,019	+ 358	4	6,525	– 810
Potteries	,, 17	1,751	+ 43	15	27,788	+ 578
Preston Corporation	,, 15	653	+ 2	17	11,477	– 159
	,, 22	889	+ 232			
Rotherham Corporation	,, 23	780	+ 228	§3	2,069	– 15
Rothesay	,, 17	118	+ 20	15	859	– 401
Salford Corpn.	,, 27	4,469	+ 147	4	17,840	– 715
Sheerness	,, 15	19	– 1	15	720	– 29
Sheffield Corporation	,, 26	5,612	+ 198	†5	25,081	– 1,699
Singapore Trams	,, 25	$8,981	+ $627	..	...	...
Southend Corporation	,, 22	491	+ 202	4	1,113	– 25
South Metropolitan	,, 17	821	+ 118	15	10,078	– 525
Southport Tramways	,, 17	265	+ 32	15	3,094	– 466
South Staffs	,, 17	841	+ 18	15	12,931	– 343
Stal'yb'dge, Hyde, &c., Jt. Bd.	,, 25	819	+ 122	‡4	2,990	+ 173
Sunderland Corporation	,, 26	1,091	– 188	4	4,198	– 1,091
Sunderland and District	,, 22	669	+ 262	25	11,359	+ 1,220
Swansea Trams	,, 17	935	+ 110	15	12,863	+ 727
Swindon Corporation	,, 22	158	+ 26	3	445	+ 8
Taunton	,, 17	43	+ 4	15	568	– 32
Tynemouth and District	,, 17	200	+ 39	15	2,192	– 332
Tyneside Trams Co.	,, 24	749	+ 313	17	5,906	– 792
Wallasey District Council	,, 25	939	+ 202	‡3	3,043	– 69
Walsall Corpn.	,, 25	648	+ 241	17	8,678	+ 981
Warrington Corpn.	,, 16	376	+ 25	2	845	+ 22
West Ham Corporation	,, 23	2,474	+ 330	4	8,758	– 899
Weston-super-Mare	,, 15	36	– 19	15	389	– 258
Wolverhampton Co.	,, 17	413	+ 8	15	6,504	– 261
Wolverhampton Corpn.	,, 22	1,045	..	46	32,799	...
*Worcester	,, 17	269	+ 32	15	3,576	– 121
Wrexham	,, 17	156	+ 44	15	1,433	– 30
Yorkshire W.R. Trams	,, 26	1,348	+ 226	17	18,530	...
Yorkshire Woollen District	,, 17	916	+ 39	15	13,101	– 790

(a) These comparisons are with the corresponding period last year. § Plus 2 days. ¶ Plus 3 days. * Partly electrical. † Minus 3 days. ‡ Minus 2 days.

ELECTRICAL COMPANIES' SHARE LIST.

Share.	Last Dividend	Name.	Price Wed., April 29.	Rate % Yielded. £ s. d.	Dividend Due.	Business Week to April 29. Highest.	Lowest.
		ELECTRICITY SUPPLY.					
10	9/0	Bournemouth & Poole Elec. Sup. Ord.	10¾–11¾	5 19 0	Mar, Sept.	..	..
10	4/6	Do. 4½ per Cent. Cum. Pref.	10–10½	4 5 6	Feb, Aug	.	—
10	6/0	Do. 6 per Cent. Cum. Second Pref.	10½–11	5 9 0	Feb, Aug	10½	..
St.	4½%	Do. 4½ per Cent. Deb. Stock (red.)	102–105	4 5 6	Jan, July	..	..
5	3/6	Bromley (Kent) El. Lt. & Power Shares	4¾–5	5 10 0	April, Oct	..	..
St.	4½%	† Do. Do. 1st Debs.	94–97	4 12 9	May, Nov	..	..
5	5/6	Brompton & Kensington Elec. Sup. Ord.	7½–8½	6 1 0	March....	..	..
5	3/6	Do. 7 per Cent. Pref.	6¾–7¾	4 10 0	Mar, Sept	..	..
St.	4%	Central Elec. Sup. Co. 4% Guar. Db. Stock	98–101	3 19 0	June, Dec	..	..
5	2/6	Charing Cross (W. End & City) El. Sup. Co.	3⅝–4⅛	6 1 6	Feb, Aug	..	..
5	2/3	Do. 4½ per Cent. Pref.	4⅜–4⅝	4 17 0	Feb, Aug	4½	..
St.	4%	Do. 4 per Cent. Deb. Stock (red.)	96–99	4 1 0	Jan, July	.	..
5	2/3	Do. City Undertaking 4½% Cm. Pref.	3¾–4¼	5 8 6	Jan, July	3¾	..
5	2/6	Chelsea Electric Supply Ord.	3–3½	6 8 6	March ..	[illegible]	..
St.	4½%	* Do. 4½ per Cent. Deb. Stock (red.)	101–104	4 6 9	June, Dec	.	..
10	7/0	City of London Electric Lighting Ord.	9½–10½	5 14 0	Feb, Aug	9¾	—
10	6/0	Do. 6 per Cent. Cum. Pref.	12–13	4 12 0	Jan, July	..	..
St.	5%	Do. 5 per Cent. Deb. Stock (red.)	123–126	3 19 6	June, Dec	123¾	123¼
St.	4½%	Do. 4½ per Cent. 2nd Deb. Stock (red.)	101–104	4 6 6	Jan, July	..	..
5	1/10	County of Durham Elec. P.D. Ord.	2¾–3	3 9 7	April, Oct	..	..
5	5%	Do. 5 per Cent. non Cum. Pref.	4⅛–4⅜	5 17 8	April, Oct	..	—
10	6/0	County of London Elec. Supply Ord.	7¾–8¼	6 1 3	Feb, Aug	..	..
10	6/0	Do. 6 per Cent. Cum. Pref.	10¾–11¼	4 1 3	Mar, Sept	..	..
St.	4½%	Do. 4½% Deb. Stock (all paid) (red.)	107–110	4 2 6	Jan, July	..	..
St.	4½	† Do. Second Deb. Stock Prov. Certs.	96–99	4 11 0	May, Nov	..	..
5	3/6	Folkestone Electricity Supply Co. Ord.	4¾–5¼	5 7 0	April, Oct	4⅞	—
5	2/6	Do. 5 per Cent. Cum. Pref.	5–5½	4 11 0	Mar, Sept	..	..
St.	4½%	Do. 4½ 1st Deb. Stock (red)	94–97	4 13 0	Feb, Aug	..	..
5	4/6	Hove Electric Lighting Ord.	6½–6¾	6 7 0	April, Oct	..	..
5	5/0	Kensington & Knightsbridge Ord.	7¼–7¾	5 14 0	Feb, Aug	8	..
5	6%	Do. 6 per Cent. 1st Pref.	6½–7	4 5 9	Jan, July	..	..
St.	4%	Do. 4 per Cent. Deb. Stock (red.)	96–99	4 1 0	..	..	—
St.	4%	Kensingtn. & Kngtbg. Co. & Notting Hill Co. (Joint Station) 4% Deb. Stock (red.)	97–101	3 19 0	April, Oct	..	..
St.	4½%	Kent Elec. Power Co.	88–92	4 18 3	Jan, July	..	..
3	1/6	London Electric Supply Ord.	1–1½	5 0 0	Mar, Sept	..	..
5	3/0	Do. 6 per Cent. Pref.	4½–5	6 0 0	Mar, Sept	..	..
St.	4%	Do. 4 per Cent. 1st Mort. Deb.	90–93	4 8 0	Jan, July	92½	..
5	3/6	Metropolitan Electric Sup. Ord.	4¾–5¼	6 4 0	April, Oct	4¾	..
5	2/3	Do. 4½ per Cent. Cum. Pref.	4¾–5¼	4 6 0	Jan, July	..	..
St.	4½%	Do. 4½ per Cent. Deb. Stock 1st Mort.	107–111	4 1 0	June, Dec	..	..
St.	3½%	Do. 3½ per Cent. Mrt. Deb. Stock (red.)	85–90	3 18 0	Jan, July	..	..
100	4½%	Midland Elec. Corp. for P.D. 1st Mort. Db.	96–99	4 11 0	June, Dec	..	..
10	4%	Newcastle & Dist. Elec. Ltg. Ord.	8⅝–8⅞	4 11 5	Feb, Aug	..	—
100	4½%	Do. 4½ per Cent. Deb.	96–98	4 12 9	Jan, July	.	..
5	8%	Newcastle Elec. Supply Ord.	5⅝–5⅞	6 19 3	Feb, Aug	5⅞	5⅞
5	5%	Do. 5 per Cent. non Cum. Pref.	5⅛–5⅜	4 15 3	Feb, Aug	..	..
100	4%	Do. 4 per Cent. Mort. Deb. red. 1907.	96–98	4 2 6	Jan, July	..	..
1	3%	Northern Counties Elec. Sup.	—	..	Mar, Aug	..	..
100	4½%	Do. 4½ per Cent. Deb.	95–97	4 13 9	Jan, July	..	..
10	8/0	Notting Hill Electric Ord.	11¼–12¼	5 14 0	March ..	11⅝	..
5	4/6	Oxford Electric Ord.	5⅞–6⅜	5 10 0	March ..	..	..
St.	4%	Do. 4 per Cent. Deb. Stock	94–98	4 1 6	Jan, July	94	..
5	5/0	St. James' & Pall Mall Elec. Ord.	7½–8¼	6 1 3	Feb, Aug	7½	—
5	3/6	Do. 7 per Cent. Pref.	6¾–7	5 0 0	Feb, Aug	..	..
St.	3½%	Do. 3½ per Cent. Deb. Stock (red.)	85–90	3 17 9	Jan, July	..	..
5	..	Smithfield Markets Electric Sup. Ord.	½–1½	..	Feb	..	..
St.	4%	Do. 4 per Cent. Deb. Stock	70–74	5 8 0	Feb, Aug	..	..
5	4/0	South London Electric Supply Ord.	2⅝–2⅞	6 13 0	April	..	..
1	0/6	South Metrop'n Elec. Lt. & Power Ord.	⅜–⅝	4 0 0	..	..	..
1	0/8⅖	Do. 7 per Cent. Cum. Pref.	1⅛–1⅜	5 2 0	Feb, Aug	..	..
St.	4½%	Do. 4½ 1st Db. Stk. Red.	99–102	4 8 0	April, Oct	..	..
5	2/6	Urban Electric Supply Ord.	1⅞–2⅛	10 18 0	April, Oct	..	..
5	2/6	Do. 5 per Cent. Cum. Pref.	1⅞–2⅛	11 14 0	April, Oct	..	—
St.	4½%	Do. 4½ per Cent. 1st Mort. Deb.	87–90	5 0 0	April, Oct	..	..
5	5/0	Westminster Elec. Sup. Ord.	7½–8	6 5 0	Mar, Sept	7½	7¼
5	2/3	Do. 4½ per Cent. Cum. Pref.	4¾–5¼	4 5 6	Jan, July	..	..
		ELECTRIC RAILWAYS, TRAMWAYS, &c.					
St.	4%	Baker St. & Waterloo 4% Perp. Db. St.	89–92	4 7 0	Jan, July	..	..
1	..	Bath Elec. Trams Pref. Ord.	⅜–⅝	8 0 0	April	..	—
1	0/6	Do. 5 per Cent. Cum. Pref.	$\frac{11}{16}$–$\frac{13}{16}$	6 3 6	Jan, July	..	..
St.	4½%	Do. 4½ 1st Mort. Deb. Stock (red.)	89–91	4 16 0	April, Oct	..	..
St.	4½%	B'ham & Midland Trams 4½ 1st Db. Stk.	93–96	4 15 0	Jan, July	..	..
10	9%	Bristol Tramways & Carriage Ord.	10–10½	8 11 9	Feb, Aug	..	..
10	4%	Do. Cum. Pref. (fully paid)	8–8½	4 14 0	..	..	..
St.	4%	Do. 4 per Cent. Debs.	100–102	3 18 0	Feb, Aug	..	..
10	..	British Electric Traction Ord.	1¼–1¾	..	June, Dec	1½	1½
10	6/0	Do. 6 per Cent. Cum. Pref.	4–4½	12 12 0	Feb, Aug	4¼	—
St.	5%	Do. 5 per Cent. Perpetual Debs.	90–95	5 5 0	April, Oct	92½	90
St.	4½%	† Do. 4½ per Cent. 2nd Deb. Stock	70–74	6 2 0	May, Nov		..
St.	3%	Central London Ordinary Stock	74–77	3 18 0	Feb, Aug	76	75
St.	4%	Do. 4 per Cent. Pref. Stock	84–86	4 13 0	Feb, Aug	84½	..
St.	2%	Do. Deferred Stock	54–57	3 10 0	Feb		..
100	4%	Do. 4 per Cent. Debs.	100–103	3 18 0	Jan, July	101½	101¼
St	4%	Charing X, Euston & Hmpstd Per. Db. Stk.	81–84	4 15 3	Jan, July	81⅝	..
5	2/6	† City of Birmingham Trams. 5% Cm. Pref.	4¼–4¾	5 5 0	April, Oct	..	..
100	4%	Do. 4 per Cent. 1st Mort Debs.	97–100	4 0 0	April, Oct	..	
St.	1¾%	City & South London Rly. Con. Ord.	39–41	4 5 6	Feb, Aug	40½	39⅝
St	5%	Do. 5 per Cent. Perp. Pref. (1891)	113–116	4 6 0	Feb, Aug	..	—
St.	5%	Do. (1896)	112–115	4 7 0	Feb, Aug	..	..
St.	5%	Do. (1901)	110–113	4 8 6	Feb, Aug	..	..
St.	5	Do. (1903)	106–109	4 11 6	Feb, Aug	..	..
St.	4%	† Do. 4 per Cent. Perpetual Debs.	99–102	3 18 0	May, Nov	104	..
10	7/0	Dublin United Trams. Ord	12¾–13¼	4 10 6	Feb, Aug	..	..
10	6/0	Do. 6 per Cent. Pref.	12½–13½	4 9 0	Feb, Aug	..	—
10	..	Gt. Northern & City Rly. Pref. Ord. (4%)	¾–1¼	..	Feb, Aug	..	..
10	4/0	G. Northern, Piccadilly & Brompton Ord.	6–7	5 14 0	Feb, Aug	6½	..
St.	4%	Do. 4 per Cent. Deb. Stock	87–90	4 9 0	Jan, July	87½	..
5	4/0	Hastings & Dist. Elec. Trams. 6% Cm. Pf.	4–4¼	7 5 0	Mar, Sept	..	..
St.	4½%	Do. 4½ Db. St.	94–97	4 12 6	April, Oct	..	..
10	9%	‡ Imperial Tramways Ord.	10½–11½	7 17 0	Mar, Sept	..	..
10	6%	‡ Do. 6 per Cent. Pref.	9½–10	9 5 5	Mar, Sept	..	..
St.	4½%	‡ Do. 4½ per Cent. Debs.	93–94	4 15 9	Jan, July	..	..
5	..	I. of Thanet E. T. & Lt. 5 per Cent. Pref.	⅞–1⅛	..	Mar, Sept	..	—
St.	4%	Do. 4 per Cent. Deb. Stock	58–63	6 7 0	Jan, July	..	—
10	6/0	Lanarkshire Tramways	9¾–10¼	5 13 0	Feb, Aug	9⅞	..
St.	5%	Lancs. Utd. Trams 5% Prior Lien Db. St.	91–94	5 6 0	Jan, July	..	..
10	..	Liverpool Overhead Railway Ord.	1⅛–1½	..	Feb, Aug	..	..
10	5%	Do. 5 per Cent. Pref.	6¼–6¾	7 10 0	Feb, Aug	..	..
St.	4%	Do. 4 per Cent. Deb.	85–87	4 11 0	Jan, July	..	..
10	5/0	London United Trams. 5% Cum. Pref.	6¼–7¼	6 9 0	Jan, July	..	..
St.	4%	Do. 4 per Cent. 1st Mort. Deb. Stock	80–85	4 14 0	Jan, July	80	—
St.	..	Mersey Con. Ord. Stock	2–4	—	Feb, Aug.	..	—
St.	..	Do. 3 per Cent. Perp. Pref.	3–6	—	..	..	..
1	..	Metropolitan Elec. Tramways Def.	¼–⅜	—	April..	¼	..
1	0/6	Do. 5 per Cent. Cum. Pref.	$\frac{11}{16}$–$\frac{13}{16}$	6 3 6	Feb, Aug	¾	$\frac{11}{16}$
St.	4½%	Do. 4½ per Cent. Deb. Stock	94–97	4 12 6	Jan, July	95	..
St.	½%	Metropolitan Railway Consolidated	42½–43½	1 3 0	Feb, Aug	43½	42⅞
St.	2¾%	Do. Surplus Lands Stocks	65–68	4 1 6	Feb, Aug	67½	66½
St.	3½	Do. 3½ per Cent. Preference	86–89	3 19 9	Feb, Aug	86	..
St.	3½	Do. 3½ per Cent. "A" Preference	76–79	4 9 9	Feb, Aug	..	..
St.	3½%	Do. 3½ per Cent. Convertible Pref.	73–76	4 12 0	Feb, Aug	..	..
St.	3½%	Do. 3½ per Cent. Debenture Stock	92–95	3 13 6	Jan, July	..	..
St.	3½	Do. 3½ per Cent. "A" Ditto.	89–92	3 16 0	Jan, July	..	..

* In calculating the yield allowance has been made for accrued interest but *not* for redemption
† Ex Dividend

ELECTRICAL COMPANIES' SHARE LIST.—*Continued.*

ELECTRIC RAILWAYS & TRAMWAYS (*Continued*)

Share	Last Dividend	Name	Price Wed., April 29	Rate Yield £ s. d.	Dividend Due	Business Week to April 29 High-est	Low-est
St.	..	Metropolitan District Railway Ord.	11½–12½	..	Feb, Aug	12½	11½
St.	..	Do. Extension Pref. (5 per Cent.)	20–25	..	Feb, Aug	..	
St.	3½	Do. [illegible] Pref. Ord. (Int. Guar. by Und. Elec. Rys. of London, Ltd.	44–48	7 6 0	Feb, Aug	47	..
St.	..	Do. [illegible] per Cent. [illegible] Rent-charge	73–78	3 17 0	Jan, July	..	..
St.	4	Do. 4 per Cent. Mort. [illegible] Rent-charge	100–104	3 17 0	Jan, July	..	..
St.	3	Do. [illegible]	45–47	3 13 0	Mar, Sept	45	..
St.	4	Do. [illegible] Deb. Stock	108–113	5 6 ..	Jan, July	..	
St.	4	Do. [illegible] per Cent. [illegible]	..	5 7 3	Jan, July	70	65
1	..	New Gen. Trac. [illegible] per Cent. Cum. Pref.	½–1	..	May ...	..	–
1	1/0	Potteries Electric Traction Ord.	¾–1	8 0 0	April, Oct	..	–
1	1/6	Do. 5 per Cent. Cum. Pref.	¾–1	6 13 0	Feb, Aug	..	..
St	4½%	Do. 4½ per Cent. Deb. Stock	93–96	4 13 9	May, Nov	..	..
1	0/7½	S. Met. Elec. Trams. & Ltg. Co. Cm. Pref.	¾–1	6 0 0	Feb, Aug	..	..
St.	4	Do. 4 per Cent. Deb. Stock	76–80	5 0 0	Jan, July	79	..
10	5%	Sunderland Dist. Elec. Trms. 5% 1st Mt. Db.	73–78	6 8 0	Jan, July	..	..
..	5	Underground Elec. Rys. Co. of London...	36–40	12 10 0	June, Dec	38½	38
5	..	Yorkshire (W.R.) Elec. Trams. Ord.	1–1½	–	March	..	..
5	6	Do. 6 per Cent. Cum. Pref.	3½–3½	..	..	..	
St	4½	Do. 4½ per Cent. 1st Debs.	84–87	5 3 6	Jan, July	86½	

ELECTRIC MANUFACTURING, &c.

Share	Last Dividend	Name	Price Wed., April 29	Rate Yield £ s. d.	Dividend Due	High-est	Low-est
1	..	Aron Electricity Meter Ord.	⅛–⅜	..	..	..	..
1	1/2	Do. 6% Cum. Pf.	¾–⅞	7 7 6	April, Oct	..	..
1	2/6	†Babcock & Wilcox Ord. [illegible]	3½–3¾	6 9 0	April, Oct	3⅝	3½
1	1/7½	† Do. Pref.	1⅞–1⅞	3 16 9	..	..	..
5	6/0	British Insulated & Helsby Cables Ord.	6½–6⅞	7 10 6	July, Feb	..	..
5	3/6	Do. 6 per Cent. Pref.	5⅝–6⅛	4 18 0	Jan, July	..	..
St	4½%	Do. 4½ per Cent. 1st Mort. Deb. (red.)	102–105	4 5 6	Jan, July	103½	..
St.	4½%	British Thoms'n-Houst'n 4½% 1st Mt. Db.	95–100	4 10 0	Mar, Sept	99½	..
..	..	British Westinghouse 6 per Cent. Pref.	¼–¾	..	Feb, Aug	..	..
St.	4%	Do. 4 per Cent. Mort. Deb. Stock	46–50	8 0 0	Jan, July	..	..
1	..	Brush Electrical Engineering	⅛	–	March ..	–	–
2	..	Do. 6 per Cent. Pref. non-Cum.	..	..	Mar, Sept	..	..
St.	4½%	Do. 4½ per Cent. Perp. 1st Deb. Stock	74–79	5 11 0	Mar, Sept	..	..
St.	4½%	Do. Perpetual 2nd Deb. Stock	59–64	7 0 0	Jan, July	..	..
5	5/0	Callender's Cable Con. Ord.	10½–11½	6 10 0	Jan, July	..	..
5	2/6	Do. 5 per Cent. Cum. Pref.	5½–6¾	4 7 0	Jan, July	..	..
St.	4½%	Do. 4½ per Cent. 1st Mort Debs. (red.	106½–108½	4 2 6	Nov, May	..	..
1	1/7½	Castner-Kellner Alkali Co.	1⅝–1⅞	8 11 0	May, Nov	1⅞	1⅞
St	4½%	Do. 4½ per Cent. 1st Mort. Deb. (red.).	101–104	4 6 6	Feb, Aug	102½	102
1	0/7	Chadburn's (Ship) Telegraph Ord.	1⅛–1¼	8 8 0	March ..	..	..
1	0/7½	Do. 6 per Cent. Cum. Pref.	1–1¼	5 6 6	April, Oct	..	..
1	..	Consolidated Electrical Co.	..	7 0 0	August	..	..
1	1/0	Consolidated Signal Co.	1¼–1¾	4 5 8	April, Oct	..	..
1	0/7½	Do. 6 per Cent. Cum. Pref.	⅞–1	6 4 0	April, Oct	..	..
3	3/0	Crompton & Co. Nos. 1 to 85,000)	1⅝–1⅞	8 1 0	Jan, July	..	..
10	5%	Do. 5 per Cent. 1st Mort. Debs. (red.).	92–96	5 5 0	Jan, July	..	..
1	0/7½	Davey & [illegible]	⅞–1½	..	Mar, Sept	..	..
5	2/0	Dick, Kerr & Co. Ord.	1½–1⅞	7 5 6	Sept	..	..
1	0/7½	Do. 6 per Cent. Cum. Pref.	1–1¼	4 16 0	Sept ..	..	–
St.	4½	Do. 4½ per Cent. Deb. Stock	100–103	4 7 3	Jan, July	..	–
3	2/6	Ediswan & Swan United "A" Sh.) £3 pd.	¾–1	12 0 0	Feb, Aug	..	..
5	4/2	Do. 4½ [illegible]	1⅝–2⅛	5 0 0	Feb, Aug	..	..
St	4%	Do. 4 per Cent. Mort. Deb. Stock (rd.)	78–81	4 19 3	June, Dec	..	..
St.	5%	Do. 5 per Cent. 2nd Deb. Stock	85–87	5 15 0	Mar, Sept	–	..
..	..	Edmundson's Elec. Corp. Ord.	⅛–⅜	..	Jan, July	..	..
1	..	Do. 6 per Cent. Cum. Pref.	⅜–1⅛	..	May, Nov	54	..
St.	4½%	Do. 4½ per cent. 1st Mort. Deb. (red.)	53–55	7 14 0	Jan, July	54½	52½
1	..	Electric Construction Co.	⅛–⅜		Jan, July	..	..
2	..	Do. 7 per Cent. Cum. Pref.	1½–1¾		July	..	..
St.	4%	Do. 4 per Cent. Perp. 1st Mort. Debs.	64–68	5 17 0	Jan, July	..	..
5	5%	General Electric (1900) 5% Cum. Pref.	7⅛–8⅛	6 1 8	June, Dec	7⅝	7⅝
St.	4%	Do. 4 per Cent. 1st Mort. Debs.	87–90	4 9 0	Mar, Sept	..	..
5	10/0	Henley's Telegraph Works Ord.	10½–11½	6 10 0	Feb, Aug	..	..
5	3	Do. 4½ per Cent. Pref.	4½–5⅛	4 3 6	Feb, Aug	..	..
St	4½%	Do. 4½ per Cent. 1st Mort. Deb. Stock	106–108	4 3 0	Mar, Sept	..	..
10	..	India Rubber, Gutta Percha, &c., Wrks	16½–16½	6 2 0	Feb, Aug	16½	16⅜
100	4%	Do. 4 per Cent. Debs. (red.	98–100	4 0 0	April, Oct	98½	98
1	..	National Elec. Construction Co.	⅛–⅜		April	..	..
1	1	Richardsons, Westgarth & Co., Ltd. Ord.	¼–⅜	7 2 0	Nov	..	..
1	0/7½	Do. 6 per Cent. Cum. Pref.	¾–⅞	6 17 0	May, Nov	..	..
St	4½%	Do. 4½ per Cent. Perp. Deb. Stock	87–91	4 19 0	Jan, July	–	..
1	..	Simplex Conduits Ord.	1⅜			–	–
5	..	Do. 6 per Cent. Cum. Pref.	6⅛			..	..
12	..	Telegraph Construction & Maintenance	30½–31½	6 8 6	Mar, July	32	31
100	4%	Do. 4 per Cent Deb. Bonds (1909)	100–103	3 17 6	Jan, July	..	..
1	2/0	Vickers, Sons & Maxim, Ltd. Ord.	1⅝–1⅞	8 11 0	..	1⅜	1⅜
1	1/6	Do. 5 per Cent. Cum. Preference	1⅛–1¼	4 14 0	..	1	
St.	5%	Do. 5 per Cent. non-Cum. Preferred	101–105	4 15 6			
St.	4%	Do. 4 per Cent. 1st Mort. Db. Sk. (red)	102–104	3 16 6	June, Dec	..	..
100	4½%	Do. 4½ per Cent. 2nd Mort. Deb. (red.)	103½–104½	4 6 0	June, Dec	104	..
10	6/0	J. G. White & Co. 6 per Cent. Cum. Prf.	8–9	6 13 0	Jan, July	..	..
1	1/0	Woodhouse & Rawson [illegible] Ord.	1–1½	3 6 8	Apr, Oct	..	..
5	5/0	Do. 6 per Cent Cum. Pref.	3½–4½	7 15 0	Apr, Oct	3⅞	..
100	4	Do. 4 per Cent 1st Mort. Debs.	72–77	5 4 0	May, Nov	77½	.

TELEGRAPHS.

Share	Last Dividend	Name	Price Wed., April 29	Rate Yield £ s. d.	Dividend Due	High-est	Low-est
10	..	Amazon Telegraph	2–3	–	June, Dec	..	–
100	5%	Do. 5 per Cent. Debs. (red.)	84–87	5 15 0	June, Dec	..	..
St.	15/0	Anglo-American [illegible]	75–78	6 1 0	F, My, Ag, N	.	..
St.	30/0	Do. Preferred	99–101	5 10 0	F, My, Ag, N	100½	99½
St.	1%	Do. Deferred	13½–14	7 3 0	F, My, Ag, N	13½	[illegible]
St	4%	Commercial Cable 4 per Cent. Deb. Stk	84–87	4 12 0	Jn, Ap, Jy, O	86	.
10	[illegible]	Cuba Submarine Ord.	[illegible]	7 5 0	Feb, Aug	8	7⅞
10	10/0	† Do. [illegible] per Cent.	[illegible]	6 19 0	Feb, Aug	..	..
5	2/0	Direct Spanish Ord.	[illegible]–3½	5 13 0	April, Oct	..	..
5	5/0	Do. 10 per Cent. Cum. Pref.	8–9	5 11 0	April, Oct	8½	..
100	4½	Do. 4½ per Cent. Deb.	[illegible]–102½	4 8 0	Jan, July	.	.
20	4/0	Direct United States Cable	13½–14	6 11 0	Ja, Ap, Jy, O	[illegible]	[illegible]
100	4½%	Direct West India Cable 4½% Rg. Db. (red.)	[illegible]–101	4 8 0	June, Dec	.	..
St.	[illegible]	[illegible]	171–180	[illegible] 2 6	Ja, Ap, Jy, O	[illegible]	[illegible]
.	[illegible]	Do. [illegible] per Cent. Pref. Stock	84–87	4 0 6	Ja, Ap, Jy, O	86	[illegible]
St.	4%	† Do. 4 per Cent. Mort. Deb. Stk. (red.)	[illegible]	3 18 [illegible]	May, Nov	10[illegible]	107½
[illegible]	[illegible]	Eastern [illegible]	13–13½	5 4 0	Ja, Ap, Jy, O	13	[illegible]
[illegible]	[illegible]	Do. [illegible] per Cent. Deb. Stock	[illegible]	3 18 6	Feb, Aug	..	..
100	4%	[illegible] Deb. [illegible]	[illegible]–101	3 18 [illegible]	Feb, Aug	..	..
[illegible]	4%	Do. [illegible] Debs. (red.)	[illegible]	[illegible]	May, Nov	..	..
[illegible]	[illegible]	G. N. [illegible]	[illegible]	[illegible]	Jan, July	[illegible]	
100	[illegible]	[illegible] Mt. [illegible] (red.)	[illegible]	[illegible]	June, Dec	..	..
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	May, Nov	..	..
100	$1	[illegible]	[illegible]	6 7 0	Jan, July	.	.
[illegible]	$1	[illegible]	12–16	[illegible]	[illegible]	..	..
1	..	[illegible] W[illegible]	[illegible]	.	[illegible]		
100	[illegible]	[illegible] per [illegible] Deb. [illegible]	[illegible]	[illegible] 19 0	[illegible]	..	–
10	4/0	West African Telegraph Shares...	[illegible]	[illegible]	[illegible]	.	.
[illegible]	[illegible]	West Coast [illegible]	[illegible]	[illegible]	May	[illegible]	[illegible]
[illegible]	[illegible]	Do. [illegible] per Cent. Deb.	[illegible]	[illegible]	Jan, July	.	..
10	..	West India & Panama [illegible]	[illegible]		[illegible]	..	..
10	[illegible]	Do. [illegible] per Cent. [illegible] Pref.	[illegible]	[illegible]	[illegible]	[illegible]	..
10	20/0	Do. [illegible] per Cent. [illegible] Preference	[illegible]	..	[illegible]	[illegible]	..
100	[illegible]	Do. [illegible] per Cent. Deb.	[illegible]	4 16 0	[illegible]	.	..
10	[illegible]	Western [illegible]	[illegible]	[illegible]	Mr, Jn, O, D	[illegible]	[illegible]
[illegible]	[illegible]	Do. [illegible] Deb. Stock (red.)	[illegible]	[illegible]	[illegible]	[illegible]	..
..	[illegible]	W[illegible]	[illegible]		.	..	..

TELEPHONES.

Share	Last Dividend	Name	Price Wed., April 29	Rate Yield £ s. d.	Dividend Due	High-est	Low-est
100	2½	Amer. Teleph. & Telegh. Co. Cap. St.	120–124	6 9 0	..	120	..
..	4%	Do. Coll. Trust $1,000 4 per Cent. Bds	84–87	4 14 9	Jan, July	86	..
St.	5%	Anglo-Portug'se Tel. 5% 1st Mt. Db. Stk.	98½–101½	4 19 0	Mar, Sept	..	–
5	3 0	Chili Telephone	7–7½	5 6 6	August ..	..	..
1	0/7½	†Monte Video Telephone Ord.	..–1	6 16 0	Nov	..	..
1	0/6	† Do. 5 per Cent. Pref.	..	5 3 0	May, Nov	..	..
St.	6%	National Co. Pref. Stock	107–109	5 3 0	Feb, Aug	108	107½
St.	6%	Do. Def. Stock	105½–106½	5 8 6	Feb, Aug	109⅛	108⅛
10	6/0	Do. 6 per Cent. Cum. 1st Pref.	10⅞–11½	4 15 6	Feb, Aug	11⅛	10¾
10	6/0	Do. 6 per Cent. Cum. 2nd Pref.	10⅞–12⅛	4 16 0	Feb, Aug	10⅞	..
5	2/6	Do. 5 per Cent. non-Cum. 3rd Pref.	5⅜–6⅛	4 9 0	Feb, Aug	6⅛	5⅞
St.	3½%	* Do. Deb. Stock 3½ per Cent. (red.)	93–96	3 10 0	June, Dec	99½	99
St	4%	Do. 4 per Cent. Deb. Stock (red.)	101½–103½	3 17 0	Jan, July	102½	102
1	0/7½	Oriental	1⅛–1½	4 13 6	April, Oct	..	..
1	0/7½	Do. 6 per Cent. Cum. Pref.	1½–1¾	4 16 0	April, Oct	..	..
St.	4%	Do. 4 per Cent. Red. Deb. Stock	90–93	4 6 0	Jan, July	..	..
St.	4½%	Telephone Co. of Egypt 4½% Db. Stk. (red.)	99–102	4 8 0	Jan, July	..	..
5	3/9	United River Plate	6–6½	6 3 0	July	6⅜	6¼
5	2/6	Do. 5 per Cent. Cum. Pref.	4½–5½	4 15 0	June, Dec	..	..
St.	4½%	Do. 4½ Deb. St. Red.	99–102	4 8 3	Jan, July	..	..

FINANCIAL, INVESTMENT, &c.

Share	Last Dividend	Name	Price Wed., April 29	Rate Yield £ s. d.	Dividend Due	High-est	Low-est
5	3/0	Elec. & Gen. Investment 6% Cum. Pref.	3½–4½	7 1 0	Jan, July	..	..
10	2/0	Globe Telegraph & Trust	9⅞–10⅜	5 6 0	Sp, De, Mr, Ju	10⅛	9⅞
10	3/0	Do. 6 per Cent. Pref.	13⅜–14⅛	4 4 0	Sp, De, Mr, Ju	14	13⅞
10	6%	Submarine Cables Trust (Cert.)	126–129	4 13 0	April, Oct	..	..

COLONIAL AND FOREIGN ELECTRIC RAILWAYS, TRAMWAYS, &c.

Share	Last Dividend	Name	Price Wed., April 29	Rate Yield £ s. d.	Dividend Due	High-est	Low-est
5	3/0	Anglo-Argentine 6% Cum. 1st Pref.	6½–6⅞	4 13 6	April, Oct	6⅝	6⅝
5	5/0	Do. 10% Non-cum. 2nd Pref.	7⅞–8⅛	6 3 6	Jan, July	8⅛	7⅞
St.	6%	Do. Permanent 6% Deb. Stock	136–141	4 5 0	June, Dec	..	..
St.	5%	Auckland Elec. Trams. 5% Deb. (red.)	104–107	4 13 6	Jan, July	..	..
1	4 0	†Brisbane Electric Trams. Invest. Ord.	3⅛–3⅜	2 12 0	May	4	..
5	2/6	Do. 5 per Cent. Cum. Pref.	4⅝–4⅞	5 2 6	May, Nov	4½	4½
St	4½%	Do. 4½ per Cent. Db. Prov. Certs.	98–102	4 8 0	Jan, July	..	..
St.	8%	†British Columbia El. Ry. Df. Ord.	128–131	6 2 0	Mar, Sept	130½	130½
St.	6%	Do. Pref. Ord. Stock	111–115	5 4 0	May, Nov	112½	112
St.	5%	Do. 5% Cum. Perp. Pref. Stock	107–111	4 10 0	Jan, July	109½	
100	4½%	Do. 4½ per Cent. 1st Mort. Debs.	99–102	4 8 0	April, Oct	..	..
100	4½%	Do. Vancouver Power Debs.	101–104	4 6 6	Jan, July	..	..
St.	4½%	Do. 4½% Perp. Con. Deb. St.	98–101	3 19 0	..	..	..
5	3/0	Buenos Ayres & Belgrano Ord.	4⅝–4⅞	8 1 6	April, Oct	..	..
5	3/0	Do. 6 per Cent. "A" Cum. Pref.	4⅞–5⅛	5 17 6	April, Oct	4⅞	..
5	3/0	Do. "B"	4⅞–5⅜	5 17 6	April	..	..
St.	5%	Do. 5 per Cent. Debs.	110–116	4 6 0	Jan, July	–	..
St.	5%	Do. 5 per Cent. 2nd Debs. (red.)	102–105	4 15 3	Jan, July	..	..
St.	5%	Buenos Ayres Elec. Trams (1901) Ltd. Deb. St.	95–99	5 1 0	Ja, Jul ..	..	–
5	..	Buenos Ayres Grand National Ord.	1⅛–1⅜			..	..
5	2/6	Do. 5 per Cent. Cum. Pref.	3⅛–3½	5 18 0	Feb, Aug	..	..
100	5½%	Do. 5½ per Cent. Pref. Debs.	100–104	5 5 9	Jan, July	..	..
100	6%	Do. 6 per Cent. 1st Deb. Bonds.	98–102	5 17 0	April, Oct	99½	..
St.	5%	Buenos Ayres Lacroze Trams 1st Mt. Db.	91–94	5 6 0	Mar, Sept	..	..
St.	6%	Buenos Ayres Port & City Tram. 1st Mt. Deb. Stock £75 Paid	64–68	6 12 0	Feb, Aug	..	..
5	2/6	†Calcutta Tramways (1 to 137,610)	6–7	5 14 0	Mar, Sept	6⅝	–
10	2/6	Do. 5 per Cent. Cum. Pref.	5–5½	4 13 0	Jan, July	..	..
100	4½%	Do. 4½% 1st Deb. Stock (red.)	103–106	4 5 0	Jan, July	..	..
St	..	Cape Electric Tram Shares	⅛–⅜			..	..
5	1/3	City of Buenos Ayres Tram. Co. (1904) Sh.	5½–5⅞	4 10 0	F, My, A, N	5⅝	5⅝
St.	4%	Do. 4 per Cent. Deb. Stock	98–102	3 18 6	June, Dec	..	..
..	5%	†Colombo Tr. & Ltg. 5% 1st Mt. Db.	85–91	5 10 0	May, Nov	..	–
100	5%	Electric Traction Co. of Hong Kong 5 per Cent. 1st Mort. Debs.	87–92	5 8 6	June, Dec	..	..
1	6%	Havana Elec. Ry. Con. Mt. 5% $1,000 30 year Coup. Bds.	80–85	5 17 6	Feb, Aug	83	..
1	..	Kalgoorlie Elec. Trams Sh.				..	..
100	5%	Do. 5 per Cent. "A" Deb. Stock	87–91	5 8 9	Jan, July	..	–
..	6%	Do. 6 per Cent. "B" Ditto	71–75	7 17 0	Jan, July	..	..
1	1/0	Lisbon Elec. Trams. Ord.	1–1¼	4 0 0	July	..	..
100	7%	Do. 6 per Cent. Cum. Pref.	1–1¼	4 16 0	Jan, July	..	–
St.	5%	Do. 5 per Cent. Reg. Mort. Debs.	90–95	5 5 0	Jan, July	..	..
St.	5%	Madras Elec. Trams. 5% Deb. Stk.	95–98	5 2 0	Jan, July	..	..
..	5%	Manila Elec. Ry. $1,000 Gold Bonds	86–90	5 11 3	Feb, Aug	..	..
100	$1	†Mexico Trams. Co. Com. St.	83–85	4 14 0	..	84½	83
100	5	Do. Gen. Con. 1st Mort. 5% Gold Bds.	84½–87	5 14 6	..	87	86
St	4½%	Montreal St. Ry. Sterling 4½ per Cent. Debs. (1922)	101–103	4 7 6	Feb, Aug	..	..
1	1/0	Perth Elec. Trams Ord.	[illegible]	7 5 6	May	..	..
St	5%	Do. 1st Mt. Db. Stock	103–106	4 14 3	Jan, July	..	..
..	3/0	Rangoon Elec. Trams & Supply Co. Cum. Pf.	5½–5⅞	5 4 0			
St.	4½	Do. 4½ 1st Mort. Deb. Stk.	95–99	4 11 0	..	..	..
.	$4	Sao Paulo Tramway, Light & Power Co. $100 Stock	129–133	6 11 0	..	131	..
..	5%	Do. 5 per Cent. 1st Mt. [illegible] Deb.	[illegible]–98	5 2 6	June, Dec	97½	..
100	4½%	Toronto Ry. Co. 1st Mt. 4½% Ster. Bond	99–101	4 9 0	Feb, Aug	100½	..

COLONIAL AND FOREIGN ELECTRICITY SUPPLY, &c.

Share	Last Dividend	Name	Price Wed., April 29	Rate Yield £ s. d.	Dividend Due	High-est	Low-est
5	3/0	Adelaide Elec. S'ply Co. 6% Cu. Pr.	4⅞–5⅛	5 17 0	Mar, Sept	..	–
10	5/2	Bombay E. S. & T. Co. Cm. Pf.	10–10½	5 14 0	..	..	..
St.	4½	Do. 4½ per Cent. Deb. Stk. (red.)	93–95	4 15 0	Jan, July	..	..
5	3/3	Calcutta Elec. Supply Ord.	6⅞–7⅜	6 8 6	April, Oct	..	..
100	7½	Canadian Gen. Elec. Co. Com. St.	89–95	10 15 0	..	98	96
100	5%	Central Electric [illegible] (S.A.) 1st Mort. [illegible] Debs.	94–99	5 1 [illegible]	Jan, July	..	..
[illegible]	5	Elec. Development Co. of Ontario	75–[illegible]	6 8 0	..	76½	76½
[illegible]	..	Elec. Ltg. & Trac. Co. of Aust. 6 per Cent. Cum. Pref.	[illegible]	..	Feb, Aug	..	..
St.	5%	Do. 5 per Cent. Deb Stock	84–88	5 14 0	Jan, July	..	..
St.	5%	Elec. Supply Co. of Victoria 5 per Cent. 1st Mort. Deb. St.	91–94	5 6 0	Jan, July	..	..
St.	6%	Indian Elec. Sup. & Trac. Co. Deb. St. [illegible]	[illegible]	6 [illegible] 0	Jan, July	..	..
10	..	Kalgoorlie Elec. Power & Ltg. Ord.	–	.	.	..	..
[illegible]	[illegible]	Do. 6 per Cent. Cum. Pref.	[illegible]	8 0 [illegible]	April, Oct	[illegible]	–
St.	6%	Madras E. S. Corp. 6 per Cent. Cum. [illegible] Deb. St.	89–92	5 8 6	April, Oct	..	..
100	5%	Mexican Elec. Light Co. 5% 1st Mort. [illegible]	76–[illegible]	6 8 [illegible]	..	76½	.
St.	[illegible]	Mexican Lt. & Power Co. Cap. St.	[illegible]	..	.	49	47
100	[illegible]	Do. [illegible] 1st Mort. Gold Bds.	[illegible]	5 15 6	..	84	83½
100	[illegible]	Montreal Lt. Ht. & Power Co. Cap. St.	97–100	6 0 0	F, M, A, N	[illegible]	.
1	1/[illegible]	River Plate Electricity Co. Ord.	[illegible]–1	[illegible]	April	1	
1	1/2½	† Do. 6 per Cent. non-Cum. Pref.	[illegible]	[illegible] 0 0	May	..	..
St	5%	Do. 5 per Cent. Deb. Stock	96–99	5 1 0	Jan, July	98½	..
5	3/0	Rosario Elec. Co. 6% Pref. (1 to [illegible])	[illegible]	5 17 6	April, Oct	.	..
100	$1	Shawinigan Water & Power Co. Cap. St.	65–66	6 [illegible]		65	64½
.	5	Do. 5 per Cent. Bds.	102–104	4 15 0	Jan, July	102	..
..	[illegible]	Victoria Falls Power Co. Pref.	½–[illegible]	–	Jan, July		..

* In calculating the yields allowance has been made for accrued interest but *not* for redemption † Ex dividend. ‡ The London Stock Exchange Committee have declined to quote these.

CONTENTS.

THE
ELECTRICIAN
INDUSTRIAL SUPPLEMENT.

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MAY 1, 1908.

The Triumph of the Rotary Pump.

THE examples of rotary pumping machinery to which we give prominence in the present issue must impress upon the engineer the remarkable influence of the electric motor on the design and construction of pumps and pumping plant. Ever since the raising of fluids by mechanical means came to be known the plunger pump has had almost undisputed possession of the field. Indeed engineers could not, for many years, persuade themselves to give approval to any form of rotary pump. The centrifugal pattern progressed but slowly, until the commercial arrival of the electric motor, and the results of its combination with this ideal power agent are to be met with in every mine having any claim to rank as an example of modern engineering practice; they are to be encountered, also, in many other spheres of industrial activity. Although the electrical engineer cannot justly appropriate the honour of introducing the centrifugal pump, he is entitled to claim credit for the extraordinary development of the turbine pump. This machine has without doubt revolutionised the practice of pumping, and placed it upon a more efficient basis, at any rate from a mechanical point of view. Whatever the turbine pump owes to the electric motor it has, however, doubly repaid, and for this reason. Such a pump is naturally only suited for driving by electrical means, that is, if the best results are required. Consequently pump and motor become inseparable. But the motor requires power, and when this is not "on tap" must be generated, hence dynamo-electric machinery is required for the purpose. In the case of mining plants it follows that the electrical operation of the pumps commits the management to wholesale electric driving, a desirable consummation from every possible standpoint. This, however, is aside from the main issue with which we are now immediately concerned. The object of this issue which we have in mind and to which we wish to particularly direct attention, is the new era in rotary pumping which the electric motor has heralded in. Without saying that the rotary electric pump has supplanted the reciprocating pump, we can confidently aver that the development of the centrifugal pump has been marked by continued success from the point at which it was commercially coupled to the electric motor. With many years of fruitful experience behind it the electric rotary pump has established a reputation for flexibility, economy, reliability and durability, which the reciprocating pump has failed to achieve. The greatest successes of the rotary pump are recorded in mining and dock work, to both of which it is now regarded as an indispensable adjunct. In the first mentioned province turbine pumps are introduced without question into the plant and machinery, forming the usual mining equipment. Where difficulties of suction are met with in the use of centrifugal pumps there seems to be no objection to the employment of separate air pumps to raise the water to the rotary pump, when it can immediately deal with it. For the unwatering of mines the vertical electric pump has proved itself to be without rival. Numerous instances are on record where underground workings which have remained flooded for months and even years have ultimately been unwatered by the use of turbine pumps. The essentially practical nature of mining engineers is strongly appealed to by incidents of this kind which are more convincing than the wildest promises of efficiency, or the most elaborately prepared arguments founded on theoretical considerations. A feature of the record we publish of centrifugal and turbine pumps is the large amount of business done with pumps of the rotary pattern having a positive action. These pumps are not suitable for direct connection to the electric motor, but a single reduction gear is usually all that is required for lowering the motor speed to

that of the pump. All these pumps will raise water from a depth of 25 to 30 ft. to the pump itself without the aid of a foot valve or separate air pump. Rotary pumps of this class appear at the moment to fill a distinct want for duty in pipes from ½ in. to 6 in. diameter. They also are noteworthy for their extremely simple construction, a fact which will no doubt explain their popularity for colonial use. The attention now being paid to rotary pumps will without doubt be productive of many improvements in design and construction, if they do not lead to the discovery of some new principle, the application of which will further raise the operating efficiency above its present level, satisfactory though this now is. In conclusion, we may urge upon pump users the value of the electric centrifugal over many forms of reciprocating pump, and commend to their notice both the large amount of practical data with rotary pumps now at the disposal of engineers, and also the many successful plants in operation in different parts of the world.

Allen Turbine Pumps.

FOR some years Messrs. W. H. Allen, Son & Co., of Queen's Engineering Works, Bedford, have been well known as the manufacturers of the "Conqueror" centrifugal pump, and during the last three or four years they have developed a large business in the more efficient type, now usually known as the "Turbine Pump." Their long experience in this class of work has enabled them to produce a highly efficient pump, which is well known for good workmanship, and for the quality of materials employed in its construction.

We illustrate herewith two large turbine pumps which have recently been manufactured by Messrs. Allen, and supplied for some collieries in the Durham district. Each pump in this instance has suction and discharge branches 18 in. in diameter, the casing being of cast-iron. The spindle of the pump is of high-grade nickel steel completely encased with gunmetal sleeves. The disc, which is of the double inlet design, is of bronze and likewise the fixed guide blades in the casing of the pump. The spindle is carried in bearings of the self-oiling type, arranged external to the pump casing, and at one end is provided with a small emergency collar-thrust bearing, which is also automatically lubricated, and efficiently cooled by water circulation, drawn from the discharge branch of the pump.

Each is driven through a flexible coupling by a three-phase motor of 200 B.H.P. of Messrs. Dick, Kerr & Co.'s standard manufacture.

Both pumps have a capacity of 5,000 gallons of salt water per minute, against a total head of 86 ft. when running at 870 revs. per minute. When on trial at the makers' works the pumps developed the guaranteed efficiency of 78 per cent. under these conditions. Water connections are also made between the discharge branch of each pump and the stuffing boxes through which the pump spindle enters the casing, in order to prevent excess of air to the inlet of the impeller.

As the pumps in this instance are situated at a good height above the water supply level, Messrs. Allen have supplied one of their twin air-pumps for the purpose of exhausting the air from the pumps prior to starting up. This air-pump, which is shown herewith, has two barrels 10 in. in diameter, with a stroke of 7 in., and is driven at a

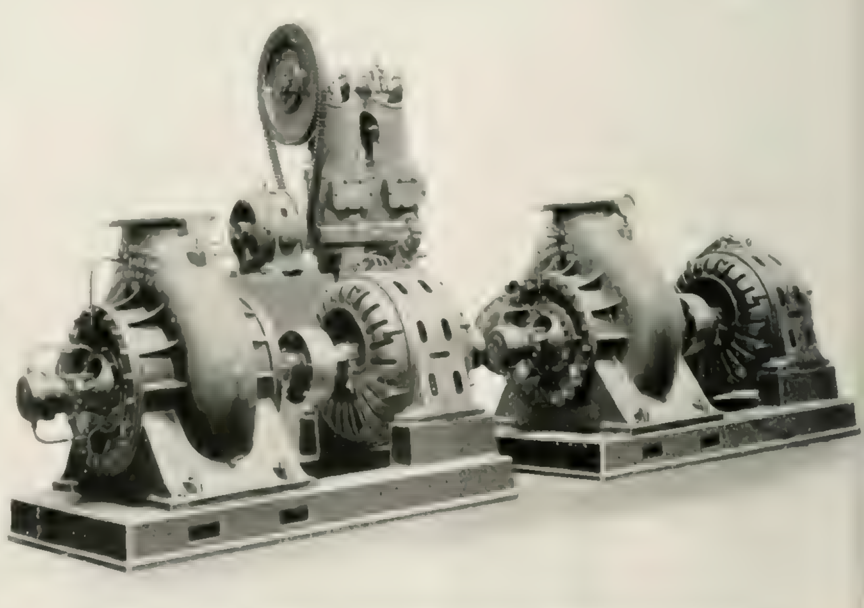


Fig. 1.—Group of Allen Turbine Pumps driven by Induction Motors.

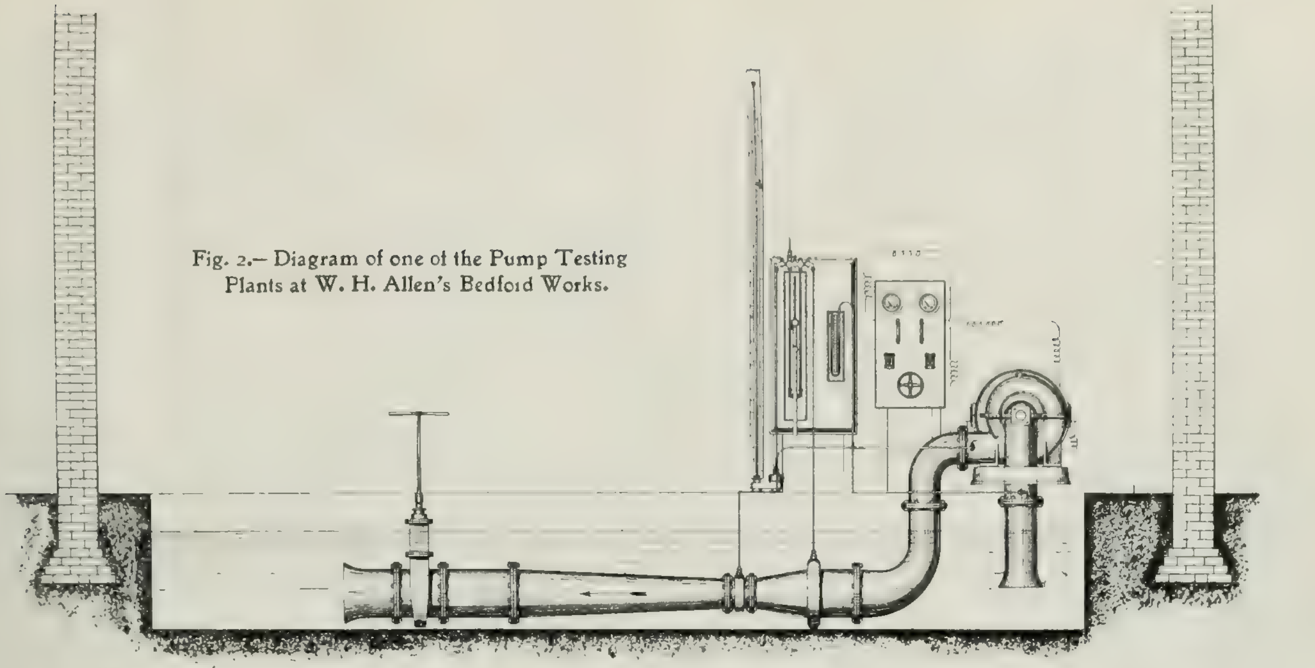


Fig. 2.— Diagram of one of the Pump Testing Plants at W. H. Allen's Bedford Works.

speed of 150 revs. per minute, through chain gearing, by a 7½ B.H.P. three-phase motor. The pump barrels are of gun-metal and the buckets of cast-iron fitted with a gunmetal ring, and the bucket rods of forged naval bronze. All the bearings are lined with whitemetal and are lubricated by means of spring grease cups. Our illustration, which has been prepared from a photograph taken in the makers' works, shows the arrangement of the machinery, and gives a good idea of the compactness of the whole plant, when the large amount of water dealt with is considered.

As to the method of testing Conqueror pumps at Queen's Engineering Works, Bedford, the drawing in Fig. 2 shows a section through the plant utilized for this purpose. The discharged water is measured by a Venturi meter, two sizes of which are installed, the larger one measuring up to 7,000 gallons per min. and the smaller one up to 850 gallons per min. Both meters will stand a total head of 500 to 600 ft. The head is measured by a mercury column which can be connected to the discharge pipe at any desired point. The suction head is measured by an additional U pattern mercury gauge. The "Venturi" meter consists of two parts—the tube and the recorder or register. The tube is arranged to from part of the discharge pipe of the pump, and takes the form of a reducing cone, coupled by a throat piece to a similar, but more gradually expanding, cone with a further short length of pipe and a sluice valve. The registration is guaranteed by the makers of the instrument (Messrs. Geo. Kent, Ltd.) to be within 2 per cent. The "Venturi" law, being a special application of the well-known theory of Bernoulli, may be briefly explained, as being of interest in connection with the use of centrifugal pumps. Water flowing through a pipe of diminishing area loses the pressure which it exerts laterally as it gains in velocity, so that at the throat of the "Venturi" tube, which unites the two truncated cones, it is only a question—within a certain limit of static pressure—of obtaining a sufficiently high speed in order to entirely lose all pressure, and exert a vacuum instead. Conversely, water flowing through an expanding cone loses speed and gains head, consequently a "Venturi" tube produces a great depression in the hydraulic gradient at the throat of the instrument, but restores it practically to its original level at the outlet. An exhaustive series of experiments have been carried out, which have established the reliability of the principle under every conceivable condition. Tubes varying from ¼ in. to 9 ft. in diameter have all answered to exactly the same "Venturi" law. Numerous careful tests against meter, weir and tank measurements have invariably confirmed the truth of the law, and the particulars obtained testify to the accuracy obtained in actual work in the measurement of volumes of water. For this reason it is of great value for the testing of rotary pumping machinery. The tube forms a part of

the ordinary pipe line, and only differs from it in that it presents for a short distance a truncated reducing cone, coupled by a throat piece to a similar expanding cone; there is, therefore, no moving part whatever in contact with the flowing water, and an interruption from such a cause is impossible. The exterior of the tube is provided at the throat and at the inlet, or upstream, end with annular pressure chambers. These communicate with the interior of the tube by small holes, which are bushed with vulcanite to prevent incrustation. The interior ends of these bushes are made perfectly flush with the inside of the tube. The pressures in these respective chambers are, therefore, the same as those at the throat and at the inlet end of the "Venturi" tube respectively. Small pipes convey these pressures to the recording apparatus.

The scale of this column is graduated to read direct in gallons per minute. Another testing plant is also in use by which pumps may be submitted to actual working conditions. For instance in a case in which a pump has to discharge through a closed range of pipes, and with a high suction lift the suction and discharge levels being the same in each case, the suction pipe is submerged in the pond, and the discharge pipe sealed in a rectangular measuring tank fitted with a weir for measuring the quantity of water delivered. Test sheets are filled in recording the results of all pump trials, and from these power and efficiency curves are plotted.

The experience of Messrs. W. H. Allen in the construction of application of centrifugal pumps is both wide and varied. As builders of efficient and economical high-speed steam engines and paraffin engines they are able to supply complete pumping plants where these particular prime movers are required. For fuller details of the construction of the Conqueror pumps we refer our readers to the October (1907) issue of the INDUSTRIAL SUPPLEMENT.

Machine Tools.

WE have constantly advanced the opinion that the machine tool maker is now practically wedded to the electric motor for the individual operation of single tools, as well as for the independent driving of separate motions on large tools. The evidence in support of this contention is cumulative, and is indicated in a striking manner in a large catalogue of machine tools which Tangyes Limited, Birmingham, have just issued. We have recently received a copy of this useful publication which is carefully classified and thumb indexed, and have selected a few typical examples of electric drives as likely to be of interest to our readers.

Fig. 1 represents a 4 ft. high-speed wheel lathe, capable of dealing with railway wheels up to 4 ft. diameter, and to take modern high-speed steels. It will admit $8\frac{1}{2}$ ft. between centres, and turn a pair of railway wheels on their axles, turn two wheels or bore two tyres at the same time independently; turn or bore a tyre on one face plate while boring or bossing a wheel at quick speed on the other. Both headstocks can be driven through treble gear, or the fast headstock can be run through single gear, and the loose headstock through treble gear. The headstocks are bolted to the bed, and have large spindles of cast iron running in hard gun-metal adjustable bearings. The loose headstock is movable along the bed by rack and pinion, and has steel barrel carrying the centre adjustable by hand wheel and screw. The face-plates have spur rings on the back and are driven by pinions which can be thrown into or out of

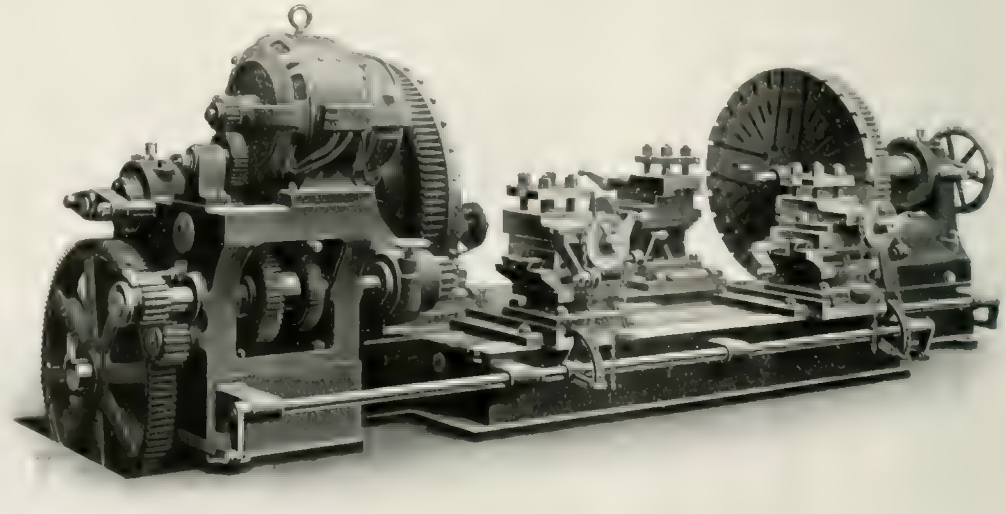


Fig. 1.—Tangye Electrically-driven Railway Wheel Lathe.

gear. Four compound slide rests—two at the front and two at the back—with swivels for turning the treads and sides of wheels at one setting, are provided. They are mounted on pillars and saddles which can be fixed on the

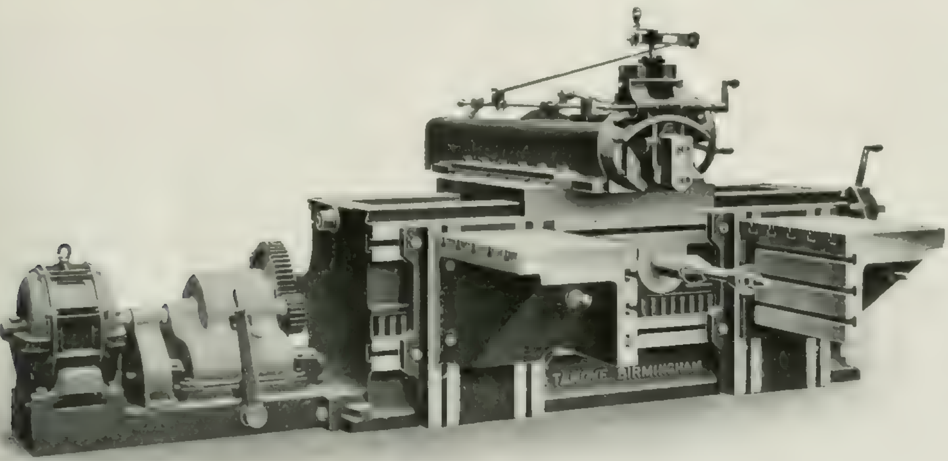


Fig. 2.—Horizontal Planing Machine driven by A.C. Motor.

pockets when turning, or across the bed when boring wheels. A self-acting feed motion is supplied to the rests by ratchets and levers from shafts carried on both sides of the bed.

The lathe is driven from a continuous-current motor, capable of giving 15 B.H.P. as a continuous load, of the variable speed type, having variations obtained by means of shunt control. It is carried on the fast headstock, and drives through gearing giving additional changes of speed, so that the best speed for the work to be operated on can be readily obtained. The pinion on the motor is of raw-hide and the whole of the gearing throughout is machine cut from the solid.

Fig. 2 shows our 24 in. high-speed shaping machine with bed 8 ft. long, and traverse of saddle 5 ft., capable of admitting work 17 in. deep when table is in lowest position. It is specially adapted for heavy cutting, having strong bedplate carried down to the ground level throughout its entire length to ensure rigidity. The driving is through a slotted link, with connecting rod placed in the centre of the ram to avoid twisting under heavy cuts. The machine can be arranged to work at strokes from 0 to the maximum ; the ram, which has square slides, can be adjusted horizontally to shape work on any part of the table. The tool box is arranged to swivel on the face of the ram, with angular index ; it has self-acting vertical or angular feeds, and also a worm and segment for shaping internal curves or setting the tool. The saddle has a self-acting variable feed motion in either direction, which can be instantly adjusted from 0 to the maximum ; it can also be moved along the bed by a hand wheel conveniently placed for the operator, or by a handle at the end of the bed. It has two tables planed on top and side to carry work, can be adjusted vertically by handle and screw, and horizontally along the bed in planed T slots ; they can be firmly bolted in position to ensure rigidity under heavy cuts. The bed has a rack cast on the front for "barring" the table, and is fitted with a mandrel and cones for circular work, which have self-acting motion by worm wheel and ratchet at end of bed.

The machine is driven from an 8 H.P. alternating-current motor from raw-hide pinion through change gear box, carried on an extension of the base, as shown in the illustration. The changes are by means of sliding gears and friction clutches operated by means of the levers shown in the front, so that the changes in speed can be much more readily obtained than would be the case with cone pulley and belt, and the whole of the machine and motor are self-contained.

Fig. 3 depicts a horizontal milling machine having table provided with a cross traverse of 18 in., hand and self-acting feed and stop motions, to also have a cross traverse of 6 in., and is arranged to swivel. The knee bracket supporting the table will admit a maximum of 15 in. from top of table to spindle. The spindle is of steel, and runs in gun-metal bearings, and a top steady arm is provided for supporting mandrel, and the arm can be removed when not required. The machine is fitted with a pair of dividing heads provided with change wheels for cutting spirals. The drive is by means of belt from a 2 H.P. motor of the variable speed type, totally enclosed, so that there is no danger of cuttings getting in the machine. From the pulley on the machine the drive is through a nest of gearing, the changes in which are made by means of levers, one of which is shown on the back of the illustration, the other is not visible, so that all changes are readily made without loss of time. The double pole switch and fuse, starter and the rheostat for varying the speed of the motor as are shown in the illustration, all carried on a separate cast-iron stand

which can be placed in a position convenient to the operator, and at the same time are protected from damage. Much in the same way as the machine tool maker has utilised the electric motor for his particular purpose so also he has

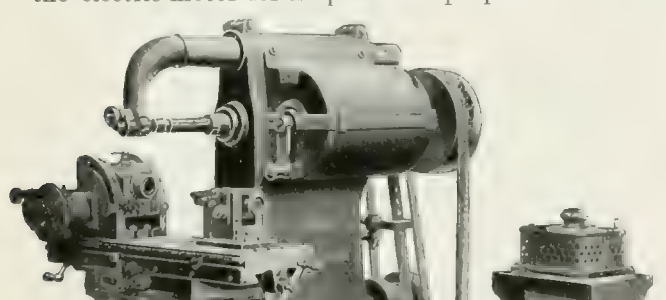


Fig. 3 —Tangye Milling Cutter belt-driven from D.C. Motor.

accepted the latest patterns of starting and protecting devices for mounting directly on the tool or in a position adjacent to it. Iron-clad control gear appears to meet the requirements of machine tools exactly.

Electrically-Driven Fire Pump. . . .

RECENT developments in the transmission of electric power and its increasing use, even in thinly-populated countries, have little by little led to its adoption in all kinds of work, and to its employment for widely different purposes. This method of driving was some years ago applied without success as an auxiliary in fire-engine work, but although exhaustive tests were made they led to no definite results. The Oerlikon Co. have, however, recently succeeded in manufacturing a powerful electrically-driven fire pump fulfilling all necessary requirements.

The geography of a country often prevents the installation of a system of water mains, or on a very extended layout some parts of the pipework may be at such an elevation that the available pressure is too low for effectual employment in case of fire. Formerly the only alternative to a costly steam pump was " man-power," which necessitated a large staff of helpers ; all these difficulties are overcome by the employment of an electrically-driven pump. It can always be used where water is available and an electricity supply network is handy.

Electrically-driven pumps naturally present many advantages over those of the manual description. For an equal weight they possess a much greater power, and require practically no attention. Their advantages over steam-driven pumps are also numerous. In fact for equal power they are cheaper, both in first cost and upkeep. Their operation is simple and to work them requires no special knowledge. While steam pumps require an interval for " getting up steam " electrical pumps can be set to work immediately, and are always ready for use. Their employment is, therefore, both efficacious and economical, either for reinforcing an insufficient hydraulic pressure or for generating a powerful jet of water in cases where mains are not available.

A pump of this description is made by the Oerlikon Co., Oswaldestre House, Norfolk-street, Strand, W.C. It consists of a multiple high-pressure centrifugal pump driven by a 15 H.P. motor to which it is directly coupled. The motor can be adapted for continuous or polyphase currents. In the same manner three-phase motors are provided with either wound or squirrel-cage rotors. In the former case starting is effected by changing the connections from " star " to " mesh." The starter is enclosed in a cast-iron box mounted on the motor. The motor can be connected to the distributing system by a flexible cable which is stowed on a drum fixed to the " chassis " when not in use.

The first pump of this kind turned out by the Oerlikon Co. gave the following results on test. The pump driven by a wound three-phase 15 H.P. motor supplied water through two lines of hose. The first test made was for the purpose of establishing the time taken to put the pump in operation, and it was found, with the pump quite empty, water was delivered in 20 secs. The quantity of water raised in 30 secs. with an internal pump pressure of seven atmospheres was nearly 70 gallons, or 140 gallons per min. The diameters of the orifices through which the water passed were 0·7 in. and 0·8 in. respectively. The current taken was 22·5 amps. at 400 volts, and a frequency rather under 42, the power absorbed being, therefore, 9 k.v.a. The water was projected horizontally to a distance of 132 ft. The total weight of this pump without cables, drum or piping was about 1 ton

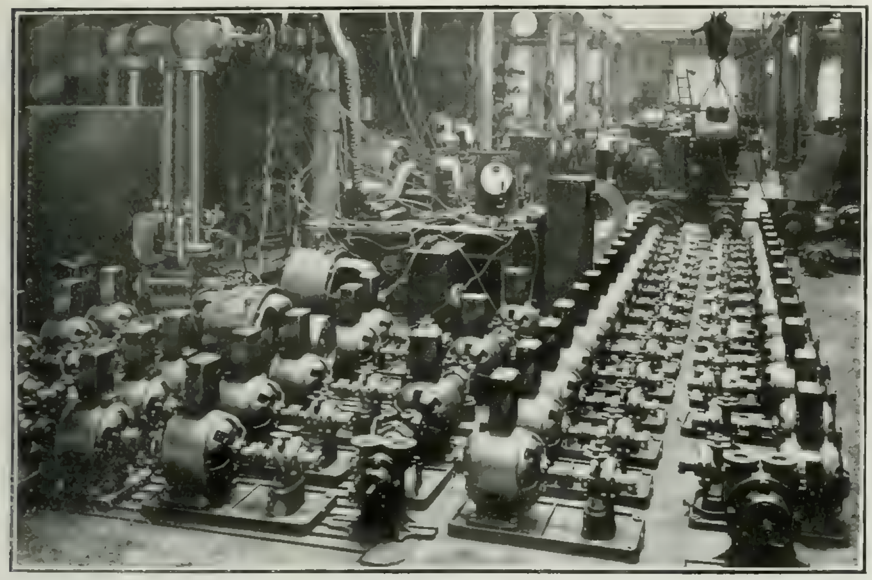
Siemens Rotary Pumps.

THESE pumps are specially suitable when the amount of water available is small or the pressure moderate. They possess the advantage of constant efficiency with varying load through wide limits. Their high working speed adapts them for direct coupling to electric motors and though those of the parallel shaft type require gearing, it is claimed that their working is quiet under all running conditions.

The movable part consists of a phosphor-bronze shaft, fitted with a cylindrical boss. This boss is slotted out along its length, the two slots being at 90 deg. In them are placed two movable slides. The shaft is made in two parts which, after the above arrangement has been fitted, are screwed together. The V-shaped slides, which are of ebonite, are identical in construction, and are fitted together without any screwing being necessary. The stationary part of the pump is made of the ring-shaped casting, fitted with flanges, to which the necessary connecting pipes may be fixed. The upper part of the interior of the casting fits tightly round the shaft, while the lower section is concentric with it, the sides being formed by suitable connecting curves. The two covers are fixed to the main casting by bolts, while their inner surfaces are equipped with cast-iron discs which form the running surfaces for the slides mentioned above. Should the shaft be pressed into the casing the discs then receive a to-and-fro motion, which is increased by the centrifugal force pressing the slides against the lower surface and making a water-tight joint. The difference of pressure causes the slides to be moved from the outlet to the inlet side. During this motion the bosses at the under side act like pistons and force the water from the inlet to the outlet pipe. A safety valve on the inlet side of the pump allows a small volume of air to be drawn in, thus greatly increasing the change in pressure, and reducing any alteration in the speed of the water to a minimum. The shafts, which are very carefully machined, are not provided with the ordinary stuffing boxes, but are packed with leather bands lightly pressed against them by circular brass springs.

Exhaustive tests which have been carried out on this type of pump show that its efficiency remains practically constant when the speed is 400 revs. per min. When running under this speed it is influenced by leakage loss, this, of course, decreasing as the speed rises. In general, this pump works in a most satisfactory manner at a speed which allows it to be directly coupled to an electric motor. A comparison of the combined efficiency of this kind of pump with that of the piston type driven through spur or worm gearing shows that at light loads the losses due to such methods of connection have a considerable effect on the final results.

The sphere of usefulness of such a pump is very wide. The uses to which they can be put are innumerable. They are employed in farming work where a sufficient water supply, which is so necessary in such work, cannot be obtained on the surface. They form a useful part of the auxiliary machinery in country houses, hotels and other places fortunate enough to possess a private well. Their adaptability to the electric drive immediately opens up a large number of spheres of usefulness, for a pump of this type can penetrate where many other kinds not only fear, but find it impossible, to tread. In the adjoining illustration we show a group of these pumps ready for shipment in Messrs. Siemens' works.



Group of Siemens Pumps in Testing Shop.

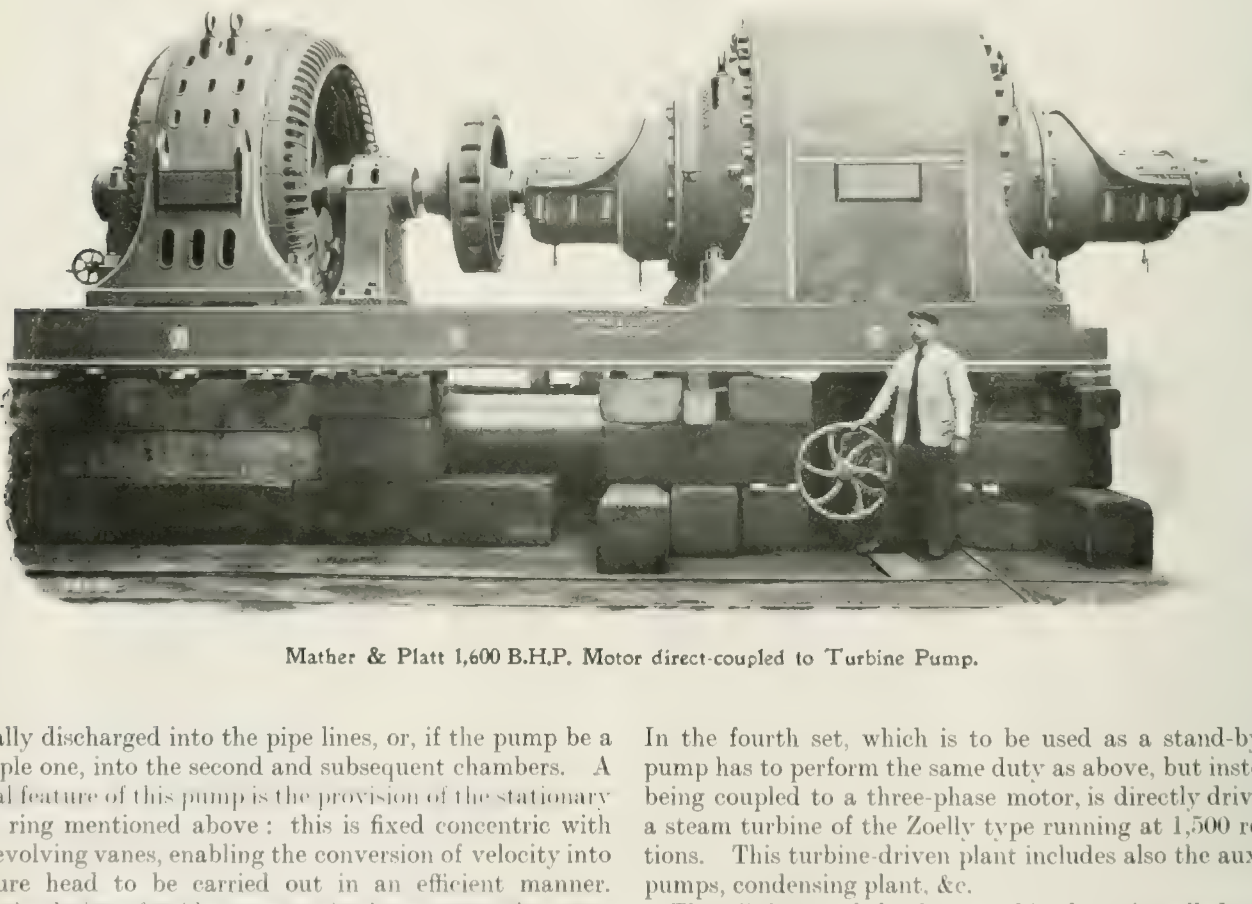
Mather & Platt High Lift Turbine Pumps.

THE feature of the high lift turbine pump made by Mather & Platt, Ltd., is the use of several vanes on a single shaft, each vane running in its own chamber. The delivery pressure of the liquid to be pumped varies directly as the number of chambers used. With a single vane water may be delivered against a head of 30 ft., and four of these operating in series, driven by a common shaft, will discharge the same amount of water against a head of 120 ft.

In the latest type of turbine pump, as now made by Mather & Platt, Ltd., the water enters the revolving wheel axially, traverses the curved internal passages between the vanes, and is discharged tangentially at the periphery into a stationary guide ring of special construction ; this conveys it to the annular chamber in the body of the pump, where the velocity head imparted to the water by the wheel is converted into pressure head. From this chamber the water is finally discharged into the pipe lines, or, if the pump be a multiple one, into the second and subsequent chambers. A special feature of this pump is the provision of the stationary guide ring mentioned above : this is fixed concentric with the revolving vanes, enabling the conversion of velocity into pressure head to be carried out in an efficient manner. With the design of guide passages, in these pumps the water is nowhere forced to undergo a sudden change of direction, or to meet with a sudden difference of cross-section in the passages. The pumps may be driven from steam or gas engines or existing shafting by means of belt or ropes ; but the ideal source of power is the direct coupled electric motor.

In 1905 Messrs. Mather & Platt supplied to the Montreal Water & Power Co., for the supply of water to the town of Montreal, Canada, one of their turbine pumps driven by a polyphase motor. The pump was of the two chamber type, capable of delivering 3,820 gallons of water per minute to a total head of 300 ft. The polyphase motor was designed to work at a pressure of 2,200 volts and 63 cycles per second, and when running at a speed of 740 revolutions per minute developed about 450 B.H.P. Official tests were made of this set after it had been started, and gave an average efficiency of over 70 per cent.

Some little time afterwards a second plant was supplied for delivering 4,500 gallons per minute to the same head as above mentioned ; but in this case, as the pump was coupled not only to a three-phase motor, but also to a steam engine, it had to run at less than half the speed, viz. : 335 revolutions per minute. Consequently the pump was of considerably larger size, and the number of chambers being increased to six. Last year Messrs. Mather & Platt carried out two further contracts for the same company. One of these is for a three chamber high lift pump capable of delivering a maximum of 10,500 gallons of water per minute against a head of 405 ft. This pump is also coupled to a three-phase motor of 1,600 B.H.P. taking its supply direct from the three-phase current at the pressure and frequency above mentioned, and running at a speed of 465 revolutions per minute.



Mather & Platt 1,600 B.H.P. Motor direct-coupled to Turbine Pump.

In the fourth set, which is to be used as a stand-by, the pump has to perform the same duty as above, but instead of being coupled to a three-phase motor, is directly driven by a steam turbine of the Zoelly type running at 1,500 revolutions. This turbine-driven plant includes also the auxiliary pumps, condensing plant, &c.

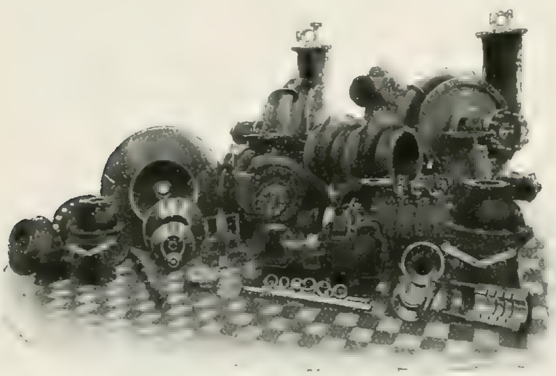
The efficiency of the first combined set installed may be gathered from the subjoined figures of the official test after the plant was started to work, the figures showing the electric power input and the output of the pump :

Revs. per min.	Volts.	Amperes per phase	Gallons per min.	Total head. Feet.	Efficiency. %.
741	2,040	123	4,000	297	69·2
742	2,080	120	3,950	297	69·0
745	2,000	118	4,000	297	70·5
745	2,060	121	4,000	295	69·5
745	2,060	118	4,100	294	70·8

Numerous interesting examples of Mather & Platt combined pumping plants have been installed and are in successful operation in different parts of the world.

Worthington Turbine Pumps.

IN the latest form of Worthington turbine pump the makers have aimed at ensuring as direct a path of the water from the suction point to the discharge pipe as possible. From the suction opening the water enters the first propeller through an annular space of large area, and, directed by the vanes, is discharged at the periphery of the impeller. The velocity of the water is gradually reduced by diffusion vanes so as to convert the velocity head into static pressure with a minimum of frictional loss. It then passes through the intermediate casing into the suction opening of the second impeller, in which the same operation is repeated. This continues through the remaining impellers (where these

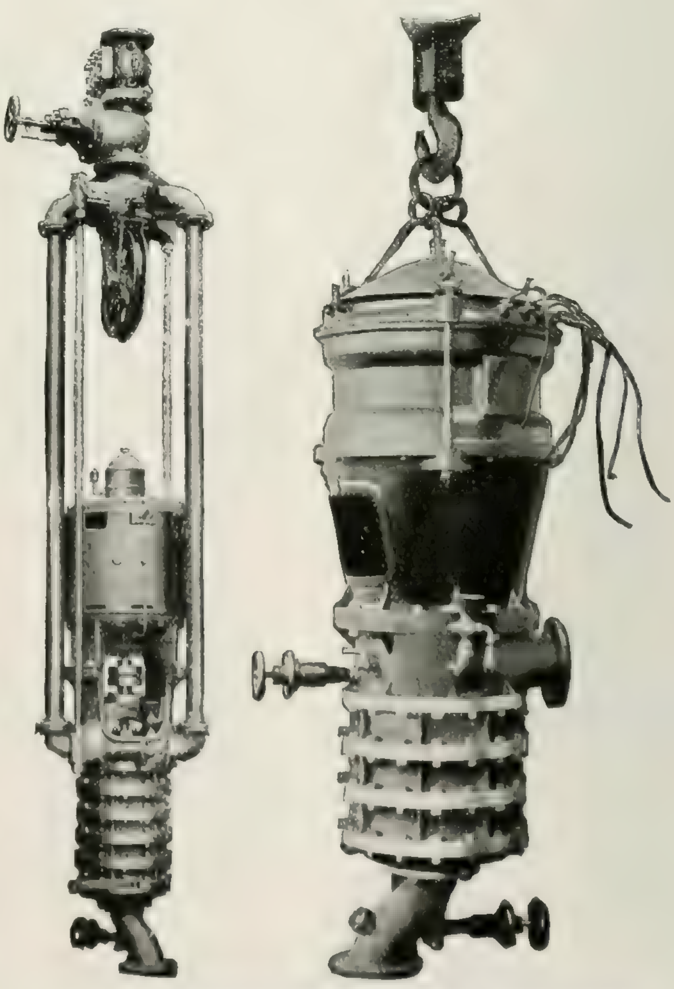


Group of Worthington Turbine Pumps, showing also Working Parts.

are provided), and the water leaves at the delivery pipe at the desired final pressure. The object of the makers has been to embody simplicity in the design without sacrificing any of the operating efficiency of the pump. We understand that tests made with these pumps at work in various parts of the country bear out the makers' claims.

In the construction of the pump the casing is made of cast iron or cast steel, according to the working pressure required. In multi-stage pumps it is built up of sections, the surfaces of which are accurately machined and bolted together, as this construction is most convenient for dismantling the pump for examination purposes. The sections themselves are interchangeable, and the makers stock the various parts so that they can give quick delivery of any size of pump. The impellers are of hard phosphor bronze carefully machined and polished all over, and are secured to the shaft by a feather key. We understand that there is no end thrust, owing to a number of holes being drilled through the impeller boss, these tending to equalise any difference of pressure on each side of the impeller. The fixed diffusion vanes are also of hard phosphor bronze machined all over and secured firmly to the casing. The pump shaft is of nickel steel accurately turned and polished, and runs in bearings of the now familiar ring oiled type. The stuffing boxes are designed to take a special Granal packing, and each gland is adjusted by suitable gearing, which ensures a uniform pressure on the packing. At the suction end of the pump the stuffing box is water sealed. In common with the majority of turbine pumps, the Worthington design is admirably adapted for driving by electric motors, and our illustrations depict a number of electrically driven patterns.

The general utilisation of electric power in mining simplifies the task of the mine manager in dealing with water, both in the workings, during sinking operations, and for unwatering purposes. An electrically driven stationary pump working under fixed conditions as regards quantity and head, forms a marked contrast to the older patterns of reciprocating pumps, especially when such items as quiet running, space occupied, and general efficiency are considered. The adaptability of the turbine pump in conjunction with the electric motor for sinking purposes is being constantly emphasised by continued experience. It is possible to keep the pump working at its normal efficiency against a variable head by only using the number of impellers necessary to cope with the head against which the liquid is being pumped. In the Worthington pump one or more impellers can be cut out by the use of a special byepass, and this method of regulation enables the speed of the motor to be kept constant. The Worthington turbine sinking pump shown herewith is in use in South Africa in the mines of the De Beers Consolidated Co. It will be noted that the pump discharges into two delivery pipes, which, in conjunction with the tie-rods, form the necessary frame for supporting the weight of the pump and motor. By the use of flexible coupling between the motor and the pump, any risk of defective alignment between the two is avoided, and the Worthington Pump Co. make it a practice to employ these couplings in all their direct-connected turbine pumps.



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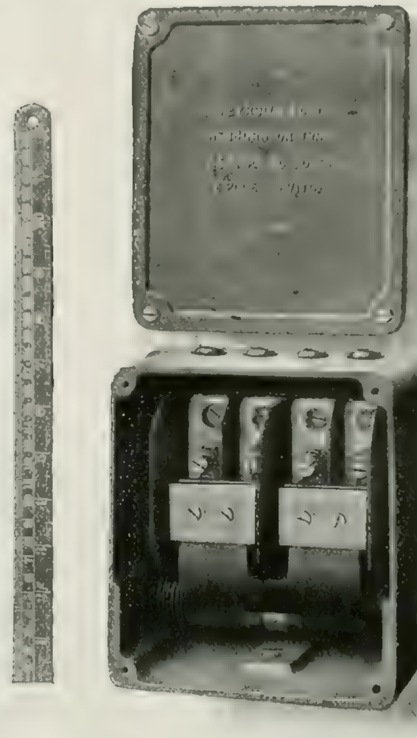

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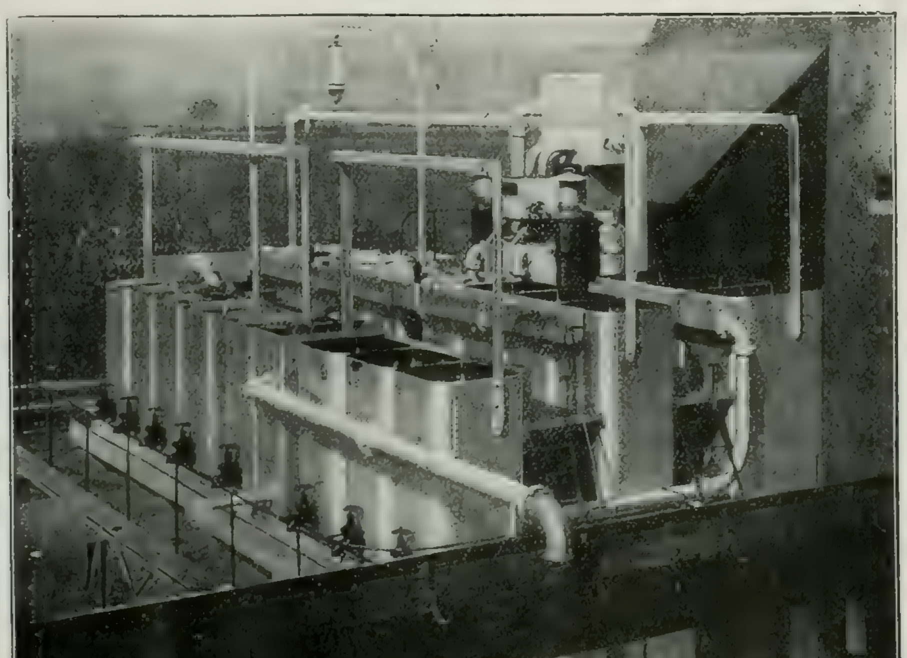

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The "Drum" Rotary Pump.

ROTARY pumping machinery of the positive type has been in general use for many years past, owing to its high efficiency and high range of utility. Pumps of this class are also noticeable for their extreme simplicity, the number of working parts being comparatively few and requiring very little attention in operation. A noteworthy rotary pump of this pattern is that known as the "Drum" pump, which is made by the Drum Engineering Co., Bradford. The main elements of this pump are two in number and comprise a rotating piston and a rotating valve. These are shown in section in Fig. 1, reference to which will explain the operation of the pump. It will be seen that the two vanes, which give the piston its positive action, are so rotated in respect to the valve that they engage with the latter and effectually prevent the passage of liquid through other than the proper channel, namely, by way of the lower vane. The piston is mounted on a horizontal shaft one end of which carries the driving pulley, and the other end is fitted with a small gear wheel which meshes with another wheel immediately above it fixed to the spindle carrying the rotating valve. These gear wheels are outside the case of the pump, and in the larger cases are immersed in an oil bath. It will be clear that by the rotation of the piston in either direction a positive suction effect will be obtained, and the liquid to be dealt with will be rapidly passed through the pump from the suction to the delivery side of the piston. The piston and valve are so shaped that they are always in contact and by this construction a continuous flow of the liquid is assured at all times. It should be noted that there is practically no wear on the gear wheels connecting the piston and valve spindles, as these wheels have no other work to do than that of simply revolving the valve itself.

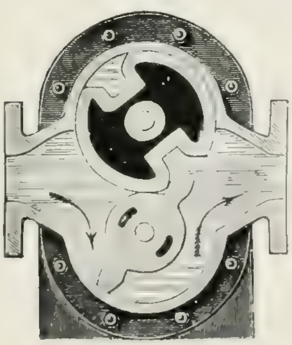

Fig. 1.—Section of the "Drum" Pump.

A pump of so simple a construction as the "Drum" is naturally very adaptable for driving by electric motors, in that the operating principle of each is exactly the same—that is, both are purely rotative devices. We understand that the "Drum" pump has been installed in considerable quantities, coupled through gearing to electric motors, and has proved a very successful combination with this power agent. The pump is manufactured in a variety of sizes varying from 650 to 24,000 gallons per hour capacity. In Fig. 2 we illustrate one of the pumps geared to a direct-current motor, and mounted on the same bedplate. A feature of the construction of the pump is the combined bearings and glands for the shafts carrying the piston and valve. The bearings themselves, as will be noticed in the illustrations, are carried out on brackets at some little distance from the glands, and by this means the makers claim that

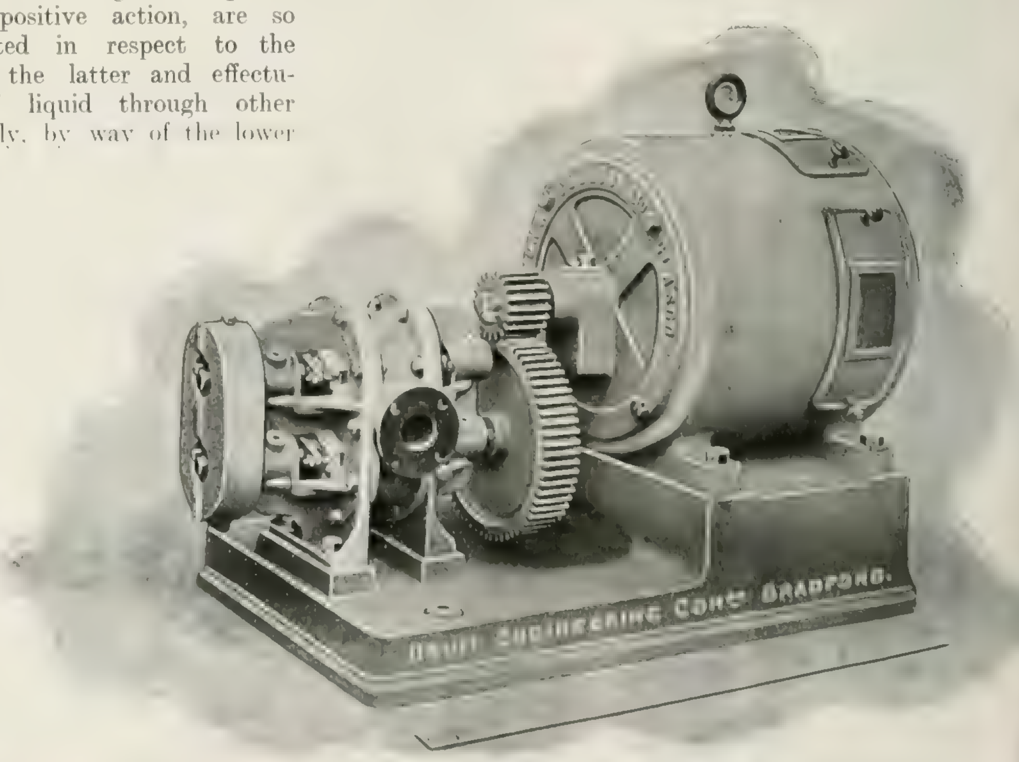

Fig 2. Electrically driven "Drum" Pump.

the lubrication of the spindles is kept entirely independent of the liquid being pumped. There is room enough between the bearing bracket and the stuffing box to re-pack glands at any time should this be necessary. We are informed that this pump will successfully deal with hot water, and may also be employed in refrigerating plants. It is extensively used by brewers, in dye works, sugar refineries, oil mills, water works, and for a large variety of purposes. It is guaranteed to deal with viscous liquids and fluids containing a quantity of solid matter in suspension. As a suction pump we are informed that it is particularly useful, and has been employed in paper mills for attachment to the suction boxes of paper machines. The paper is passed over suitable narrow openings which are connected to the pump, and the vacuum produced is sufficient to satisfactorily draw the moisture from the material. The pump can, of course, be connected to any available power source either by belt or through the medium of gearing. It is also manufactured in a form suitable for operation by hand.

Rees Roturbo Pumps.

In the domain of hydraulics there are certain recognised principles by which the designer of pumping machinery must be guided if he is to produce efficient and serviceable commercial plant. The law now associated with the name "Venturi" is finding practical application in meters and valves, and in a general way is proving of immense value to engineers. One of its most interesting applications is to be met with in the pump invented by Mr. E. S. G. Rees, of Thomas Parker, Ltd., Wolverhampton, and known as the "Rees Roturbo pump." The name was selected as eminently suited to a pump which operates on the turbine principle. The feature of the invention is the employment of a revolving pressure drum into which the suction water is received and from which it is discharged at the periphery. The nozzles are so shaped that the pressure of the water on leaving is converted into velocity. At the point of its discharge from the pressure drum the water is delivered to fixed nozzles which re-convert the velocity into pressure again, prior to the discharge of the water from the pump. In effect the pump employs the "Venturi" principle in a manner which makes one half of the truncated cone revolve and keeps the other half stationary. In consequence there is a minimum of loss at the point where it is most likely to arise, namely the discharge point of the revolving drum. (We refer at some length to the "Venturi" principle as applied to water meters on page 3 of this issue.) The amount of power required to drive the Rees Roturbo pump is claimed by the makers to be a minimum for this class of pump. It has also been shown by experiment that as the head and volume of water is decreased the increase in the power required to drive the pump is not so great as it is with the ordinary centrifugal pattern of pump. In the actual apparatus the water is delivered into the eye of the pump—that is, at the centre of the revolving pressure drum. It is then discharged at the periphery of this drum as already explained, and leaves the pump case at any desired point on its circumference.

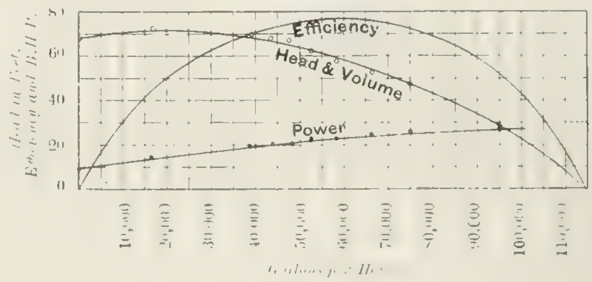

Fig. 2.—Efficiency Curve of Rees Roturbo Pump.

The pump is suitable for direct connection to electric motors, and we illustrate in Fig. 1 a large circulating water pump which is driven by this means. This pump has a capacity of 200,000 galls. per hour, and two are in use supplying circulating water to surface condensers. Fig. 2 is an efficiency curve of the Roturbo pump from which it will be seen that the power required is small, and rises slowly with decrease of the volume and head of water dealt with.

The Ree's Roturbo pump is applicable to any class of pumping duty, and is already in use for dealing with circulating water and boiler feed water. In the latter service it operates directly against the full boiler pressure, and will deal successfully with varying loads at all times. The same principle is employed with the boiler feed type of pump, but a number of pressure drums is mounted on one shaft and the water is carried through these in series, its pressure being increased at each drum until at the discharge the required pressure is reached. We published a detailed description of this interesting pump in *The Electrician* (March 20, 1908), describing its installation at the Wolverhampton Electricity Works extensions.

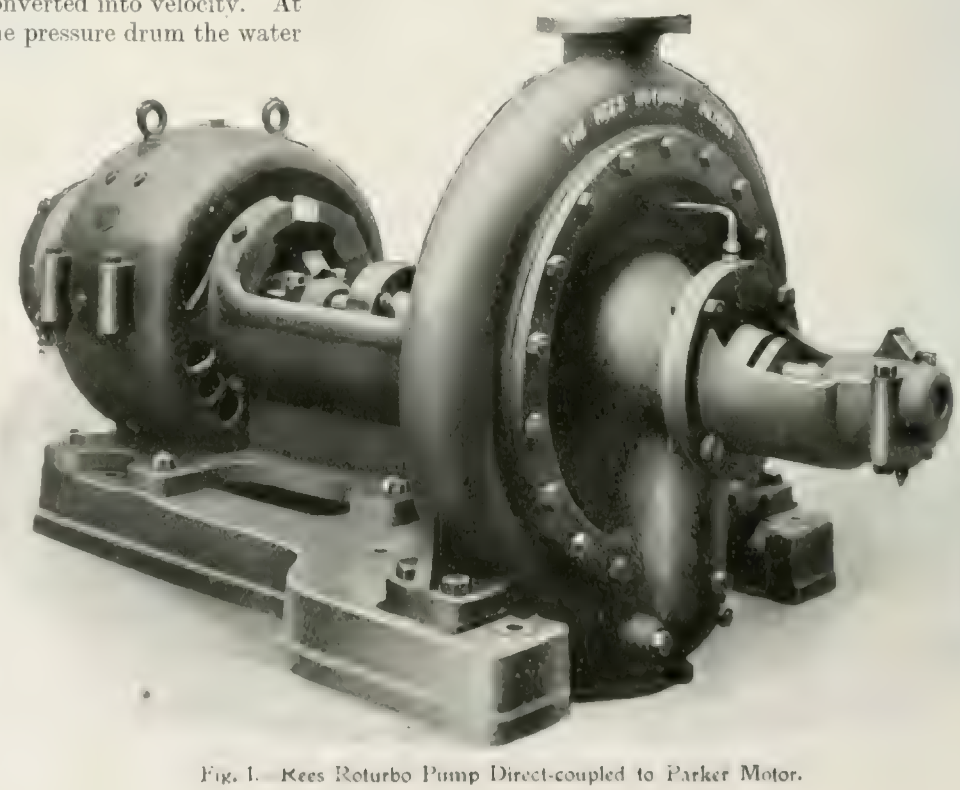
Fig. 1. Rees Roturbo Pump Direct-coupled to Parker Motor.

THE ELECTRICIAN INDUSTRIAL SUPPLEMENT.

ISSUED MONTHLY GRATIS THE ELECTRICIAN 1, 2 & 3, ...

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The INDUSTRIAL SUPPLEMENT is holed for filing, and we are distributing cases which will hold twelve issues. On request a case will be sent to Consulting, Manufacturing, or Contracting firms ; to Chief or Resident Engineers of Electricity Supply, Traction or Power Stations ; to any firm of Merchants or Agents ; to Railway, Tramway, Dock, Harbour, or other companies interested in the applications of Electric Power, &c., to their undertakings ; and to other large consumers of electrical energy, either at home, in the Colonies, or abroad.

A portion of each issue of the SUPPLEMENT is reserved for special circulation oversea.

Editorial.

Another Record.

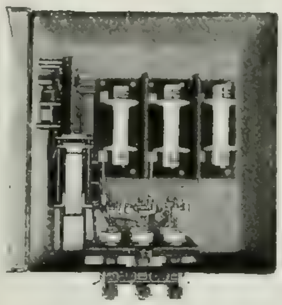
We would specially commend the pages of this issue to the notice of our friends the "gas people," who like to make all the capital they can out of the operating efficiency of suction gas plants and gas engines generally. What will doubtless impress gas engineers in the types of rotary pumping engines details of which we record is the ease with which an electric motor can be coupled to high-speed pumps and the comparative nonchalance of engineers who instal these electric pumping plants and leave them to themselves in all kinds of out-of-the-way places. Let them derive what satisfaction they can from the significance of the development of the rotary pumping engine coincidently with the commercial introduction of the electric motor. It should also be noted that the gas engine is not often selected to drive centrifugal pumps direct. We might reasonably claim a host of things for the electric motor, as witnessed by the remarkable development of the rotary pump. We will, however, remain content with remarking that the passing of the reciprocating pump may be indicative to them, as "the writing on the wall," of the ultimate fate of all inefficient reciprocating mechanisms, among which may be classed the gas engine in its capacity of power agent. We lay stress upon these few items as the outstanding features of electric rotary pump development as they may escape the notice of the zealous advocates of gas power. Gas enthusiasts are apt to pass over too lightly this all important matter of the contrast between rotary and reciprocating mechanisms, and the present occasion serves admirably to call attention to the distinction in as marked a way as possible. We unhesitatingly claim the development of the rotary pump as another record for the electric motor, as an achievement of which it may well be proud. We also express the hope that users of machinery of all kinds will take particular note of the differences which exist between rotary and reciprocating pumping devices on the score of hydraulic and mechanical efficiency. If they have electric power available in their neighbourhood, then they should not hesitate in the selection of the rotary pump as driven by the convenient, reliable and economical electric motor.

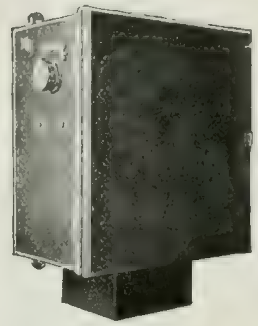
Electric Power from Drainage Canals.

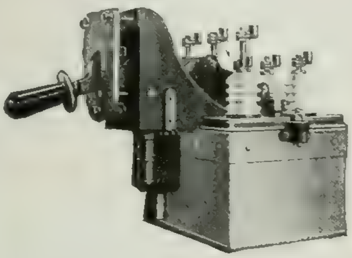
A unique example of the adaptability of certain public utilities to the generation of electrical energy is afforded by the Drainage Canal plant, Chicago. From particulars published recently in the *Western Electrician*, the Drainage Canal scheme, put down for the sanitary relief of Chicago, provided means of power production by the large flow of water in the canal. This, it was considered, could be utilized for electricity generation, and plans were proceeded with at once for this purpose. Upwards of 40,000 H.P. is available and plant for something like 20,000 of this has been put down. The supply of energy to the city has already commenced, and it is anticipated that considerable economies will result from the operation of the plant. The main generators furnish 6,600 volt 60 cycle three-phase current, which is stepped up to 44,000 volts for transmission to Chicago. The system is probably the only one of its kind in which a drainage scheme has been put into service for the production of electrical energy. The distribution of the energy from the plant is undertaken by the Municipal Electricity Department of Chicago. It has often been suggested that the large reservoirs in hill districts should be utilised to generate power for the towns which they supply with water, but unfortunately the flow of water is so small that power cannot be generated from it. In the Chicago Drainage scheme the head is not particularly great, but the flow is large, and for this reason it has been turned to good account. The installation is another striking instance of the flexibility of electrical systems generally, and their value in conjunction with other public utilities.

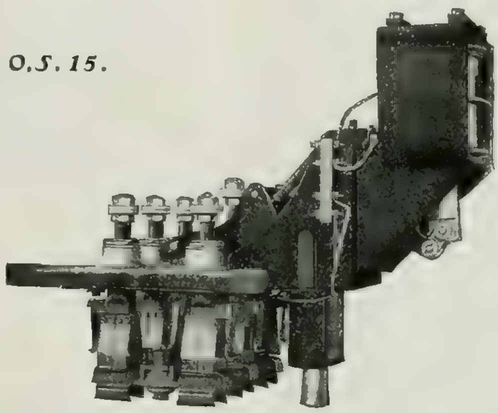
Lancashire Vertical Motors.

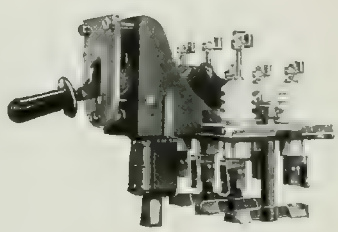
THE almost universal applicability of the electric motor to the driving of industrial machinery is responsible for many modifications in the design of such, and not a few of these have exerted a marked influence on the conduct of certain industrial operations. One of the most noteworthy is that of the development of the vertical motor particularly in the field of pumping on a large scale. The simple process of inverting the electric motor, which is so readily effected, has in the case of the centrifugal pump been responsible for a similar alteration in its design and construction. But for the vertical electric motor industry would not have at disposal the vertical rotary pump, for no other power agent is so convenient or so compact for the purpose as the electric motor. It is instructive to note that although considerable advance has been made abroad with vertical motors British electrical manufacturers are well to the front in this department of electric power development and utilisation. The Lancashire Dynamo & Motor Co., Trafford, have for many years been specialists in the production of industrial electric motors, their works being laid out and organised for the manufacture of nothing but dynamo electric machinery.

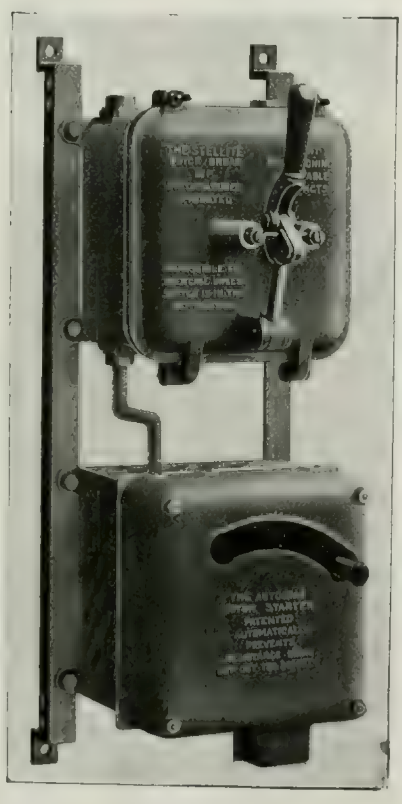












In addition to their standard types of horizontal motors, they have also developed a series of vertical patterns specially suitable for the operation of machine tools and centrifugal pumps. We illustrate in Figs. 1 and 2 typical examples of these motors. Fig. 1 is a standard Lancashire

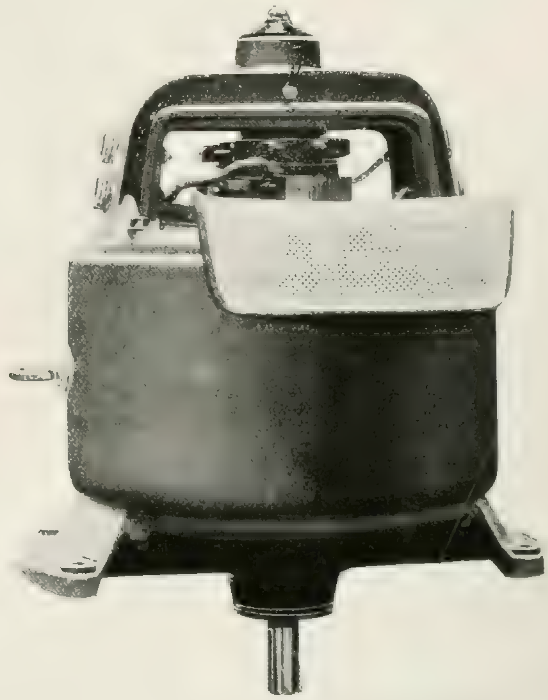


Fig. 1.—Standard "Lancashire" Vertical Motor.

motor of the horizontal type adapted for vertical working. The usual features of the Lancashire motor—namely, laminated pole tips, well ventilated armature, large commutator and compact brush gear—are all retained. The pattern illustrated is of the ventilated type, the end covers being hinged to give access to the commutator and brushes.

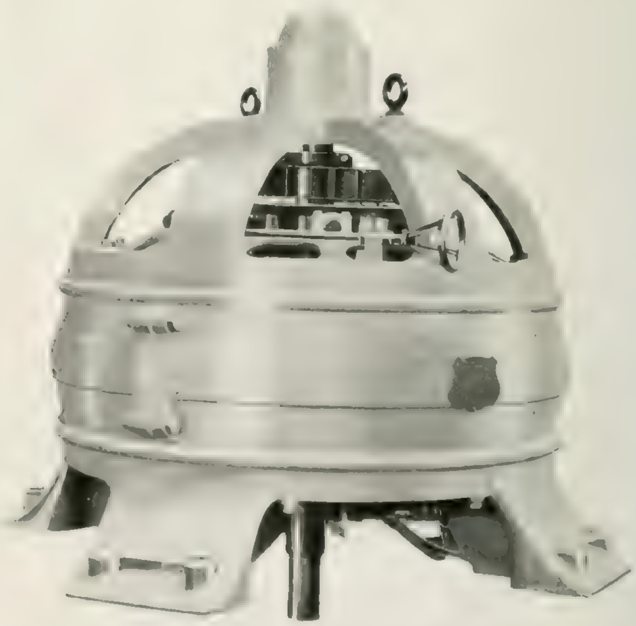


Fig. 2.—"Lancashire" Vertical Motor, fitted with Interpoles for Centrifugal Pump work.

Fig. 2 shows a larger vertical motor of the open type, fitted with interpoles and suitable for coupling to centrifugal pumps. The brush gear is mounted on a rocking frame adjustable from a handwheel which will be noticed in the illustration. The whole weight of the armature is

supported on a special ball bearing of the Hoffman type, fitted in the cap of the end bracket which is clearly shown in the view of the motor. When the pump coupling has been unbolted the armature can be raised bodily by lifting the end bracket by the eye-bolts provided for the purpose. The main terminals are mounted on a marble block under the field frame in a conveniently accessible position. The frame itself is built in two halves bolted together, and the windings of the interpoles are copper strip on edge.

Electric Pumping Plants.

MESSRS. CROMPTON & CO., who are well known as makers of dynamo-electric machinery, have applied their motors for the driving of centrifugal pumps for a variety of duties and for service in all parts of the world. We illustrate in Fig. 1 a combined pumping unit in which a Crompton motor is direct coupled to a centrifugal. The plant is compact and economical, and has been designed to meet the experiences of export and transit in countries where railway facilities are a minimum. Messrs. Crompton & Co. also make a boiler-feed combination of motor and ram pump which is doing service in many electricity works and power stations. We have referred in detail to this plant on a previous occasion, but a few of the main facts are worth recording here. The pump has been introduced to compete with steam-driven direct-acting feed pumps which are now common enough in power station boiler houses. The motor drives the pump through worm reducing gear and the pump is of the duplex double acting pattern. The feed is regulated by varying the speed of the motor. The two pairs of cylinders are contained in a single casting, which is bolted to the main bedplate on which the driving motor is also fixed. The driving gear is enclosed in a cast-iron box partially filled with oil, so that the lubrication is practically automatic. The pumps are made in three sizes and have a capacity of 600, 1,200 and 2,000 galls. per hour, respectively. The motor speeds and horse power for these sizes are: 1,130 r.p.m., 2 H.P.; 1,340 r.p.m., $3\frac{1}{2}$ H.P.; and 1,050 r.p.m. $6\frac{1}{2}$ H.P. The efficiency of the pump is stated by the makers at between 60 and 65 per cent., and the steam consumption for the production of the electrical energy is put at the equivalent of 23 lbs. steam per pump H.P. hour, which compares well with a steam driven pump.

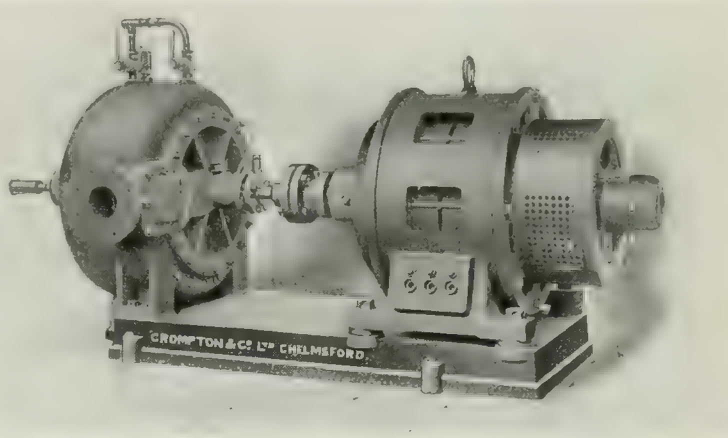


Fig. 1.—Centrifugal Pump Driven by Crompton Motor.

Electric Mining Pumps.

NO better evidence of the value of the electrically-driven rotary pump could be found than that furnished by the experience of mining engineers. This is more particularly noticeable in foreign countries in which mines are situated many miles in the interior, and where transport facilities do not admit of the carrying of heavy loads. The rotary pump driven by an electric motor is the ideal pumping unit for shipment to mines abroad, and mine owners in different parts of the world have appreciated this since the introduction of the electric centrifugal pump. It is interesting to note that a typically British electrical manufacturing firm has carried out numerous installations of this character. Messrs. J. H. Holmes & Co., Newcastle-on-Tyne, have dispatched many interesting electrical pumping plants to foreign mines. Fig. 1 is a typical combination employing a four-pole standard "Castle" enclosed motor of 14 B.H.P. direct coupled to a five-stage turbine pump. The pump is of the series centrifugal type, and when run at 900 revs. per min. has a capacity of 200 galls. per min., against a vertical head of 120 ft. The impellers and guide passages are of bronze, and the shaft is nickel steel, and the whole plant is mounted on a girder bedplate. A flexible coupling is used between the motor and the pump. To comply with the conditions imposed by the restricted transport facilities the weight of the entire plant did not exceed 250 lbs. The pump was supplied to the Bibiani Gold Fields, Ltd., for their Sekondi Mines, and was designed to deal with tailings from the workings.

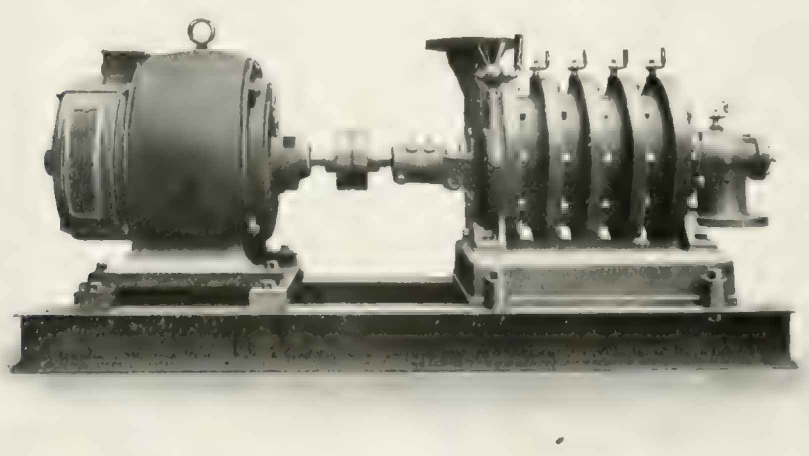


Fig. 1. 14 H.P. Motor coupled to Five stage Turbine Pump.

Fig. 2 is another illustration of a multipolar "Castle" motor, coupled to a Gwynne "Invincible" vertical sinking pump. The pump has 5 in. suction and delivery branches, the capacity being 16,500 gallons per hour against a vertical head of 166 ft. The pump and motor are fitted with ball bearings, the speed of the set being 1,850 revs. per min. The motor is entirely enclosed, but in the illustration the casing has been removed to show the brush gear. It will be noticed that the whole combination is mounted on a substantial steel framing, the upper struts of which are fitted with a large grooved pulley for the slinging rope. This pump is in use in a lead mine in the North of England.

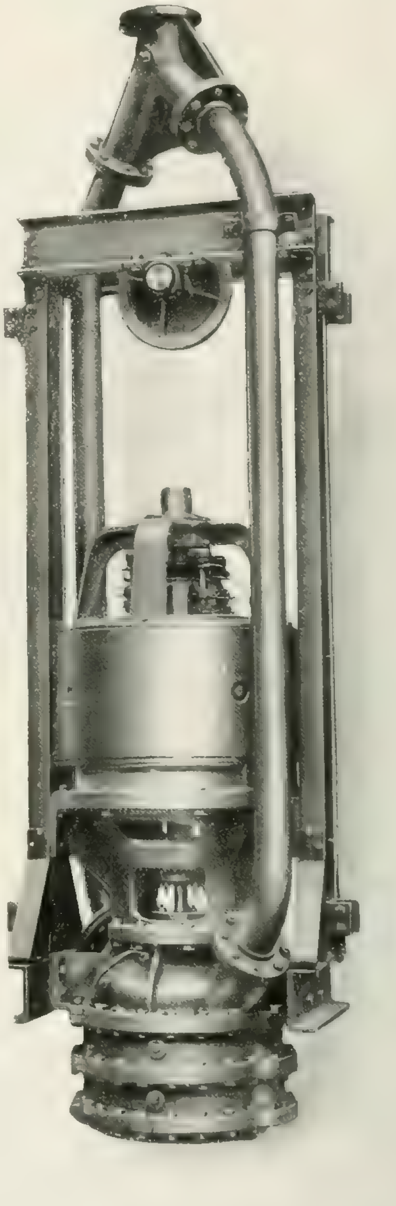


Fig. 2.—Vertical Pumping Equipment for Mine Use.

Messrs. Holmes have carried out many complete electric power installations in mines and collieries, one of the most important of these being that of the Bradford Colliery Co., Manchester, where upwards of 1,100 H.P. of their plant has been in use for some years past.

The pumping plant includes a 75 H.P. direct-current motor driving a three-throw pump discharging 5,000 gallons per hour against a head of 1,680 ft. through 6 in. steel pipes. There is also a 65 H.P. direct-current motor driving a three throw pump discharging 12,000 gallons per hour against a head of 170 ft. At a large colliery near Durham two "Castle" 90 H.P. direct current motors are installed, driving pumps which have a capacity of 12,000 gallons per hour against a 300 ft. head. We understand that J. H. Holmes & Co. are prepared to contract for the complete equipment of collieries and mines with electric power plant of every description.

Tool-Grinding.

SHARP tools not only increase the daily output of machine shops, but also improve the average quality of the work. To keep tools in first-class condition by ordinary means requires the service of an expert; consequently, various methods have been envolved to attain this end mechanically by the use of tool-grinding machines.

To efficiently grind steel tools by means of electrically driven rapid cutting-wheels, according to the *Electrical Review*, N.Y., it is absolutely necessary that the contact between the two should be a line and not a surface. Hence, if it is desired to grind a plane face of a tool, the wheel must have a cylindrical or conical surface, past which the surface to be ground must be moved in a plane. A plane face of the wheel cannot be used for this purpose, because it and the surface being ground would soon coincide, with the results of no cutting and much heating. The tool should be clamped in the holder against its base, or the surface upon which it rests when in use, in order to avoid any errors due to want of parallelism of its sides, and to enable it to be re-ground with a minimum of loss. All of its plane faces should be ground without altering its position in the holder, to insure accuracy of the angles and uniformity in results. This requirement is particularly important in thread tools.

The tool-holder should be capable of presenting the tool to the wheel in such manner that any face can be so ground as to have a definite, predetermined relation to the other faces and to the shank, and the adjustments necessary to accomplish this must be easily understood and quickly manipulated. It must be so mounted as to enable the tool face to be easily and quickly reciprocated past the line of cut of the wheel, and to be reliably fed against it and brought to any part of it. The cuts should be light, quick and frequent, to produce the best results in the shortest time.

Experiments have demonstrated that for roughing-cuts a curved cutting edge is more efficient than a straight one and that different materials and different depths of cut require different degrees of curvature; also that the cut should be a draw-cut and not a gouging-cut, so that the bulk of the metal would be removed ahead of the point of the tool. This adds greatly to its life, the point being the most delicate part. Universal tool-grinding machines, driven by electric motors, have been designed to meet the above requirements.

The Pittler Rotary Pump.

EVER since the first faint impressions of a mechanism for pumping purposes dawned on the mind of man the rotary, as distinguished from the reciprocating device, has been uppermost in his thoughts. To recount the many attempts at constructing a purely rotary machine for pumping and other purposes would be to reiterate almost the entire history of mechanics. Rotary machines,

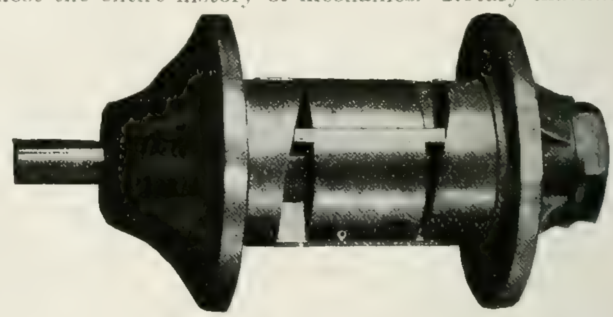


Fig. 1.—Rotor and End Pieces of Pittler Rotary Pump.

their name is legion. The temporary ascendancy of the reciprocating pump has only served to accentuate the need for a more simple unit, and the electric motor is helping to bring this fact home to engineers. The Pittler Universal Rotary Machine is another device which in conjunction with the electric motor should help to add to the list of efficient mechanisms which electric power has been mainly instrumental in introducing. The Pittler machine is the invention of the engineer whose name has been long familiar in connection with the famous universal lathe. Its object is to furnish engineers with a device which would be equally suitable as a liquid and vacuum pump, air compressor, steam engine, and hydraulic motor. In the present article we have to deal with its capabilities as a pump, more particularly for direct driving by an electric motor.

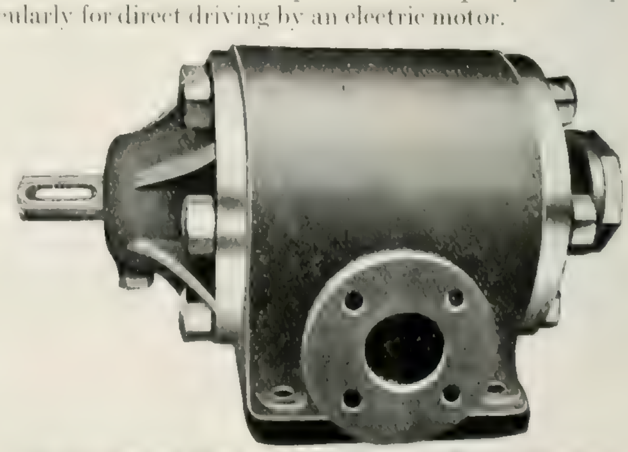


Fig. 2. General View of Pittler Universal Rotary Machine.

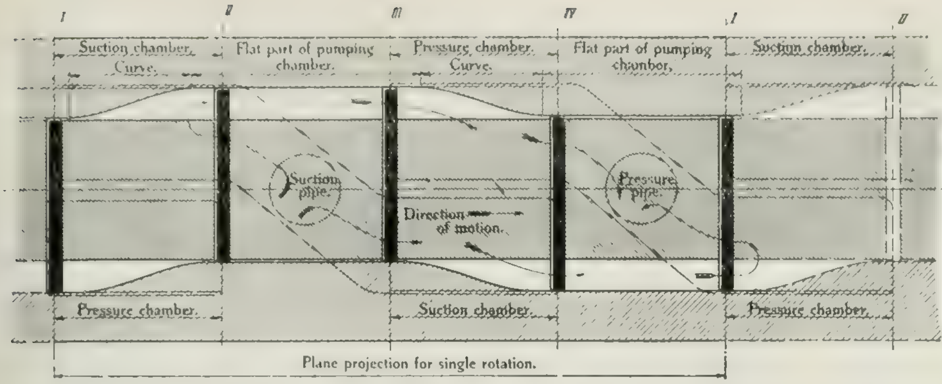


Fig. 3.—Developed Diagram of Rotor and Vanes.

The machine consists essentially of a rotating drum fitted with sliding vanes and a stationary case having suitable guides for the vanes. Reference to Figs. 1 and 2 will make the principle of operation, which we will now explain, quite clear. The rotary member has four or more radial slots cut in it, and steel vanes or slides are dropped into these slots, making a sliding fit. These vanes, on the rotation of the drum are moved to and fro in the direction of the axis, by working against two parallel helical curves formed in the end pieces of the enclosing chamber. The same end pieces form the bearings for the shaft carrying the revolving drum. The casing which encloses the drum and end pieces is provided with inlet and outlet orifices, having suitable flanges, for the working fluid. The operation of the machine as a pump may be best explained by the use of a special diagram. Fig. 3 shows a development of the rotor and vanes, and a portion of the end pieces. The vanes are shown by the heavy black lines, and during one revolution they pass the suction and delivery openings in the enclosing case. In position I. the vane has its right edge just over the suction port, and at this point is commencing to slide outwards. In moving from I. to II. it is surrounded on both sides by the inflowing water, and is not subjected to any one sided pressure, and is sliding out of the drum as the revolution continues to the right. When the end of the suction chamber is reached the vane in front of it passes the edge of the pressure port, forcing the water before it into the pressure port. During this portion of a revolution the vane has to stand the total working pressure, forcing with the front edge and sucking with the back edge; at this time the vane is not sliding in the slot in the drum, so that there are no great friction losses arising. In position III. the pressures front and back of the vane are equalized so that between this and position IV. the vane is free to slide in its slot with a minimum of resistance. Between IV. and I., where the cycle of rotation again commences, the vane is entirely within the width of the drum, its purpose in this position being to tighten the suction chamber against the pressure chamber. The same cycle of events takes place on the other side of the drum only at a difference of 180°. It will be seen therefore

that each vane with each full rotation of the drum sucks and forces a quantity of water which has twice the volume of the space enclosed between two sliding vanes in positions II. and III. From this the quantity pumped can be found, and if the pressure is known the driving power required may be calculated. It should be noted that the movement of the sliding vanes in their slots is quite gradual and that no jerking motion is possible because of the special method of forming the curves in the end pieces against which the vanes press. This construction ensures a gradual increase or diminution of the working chambers in the enclosing case. In Fig. 4 we show end and side sections of the Pittler rotary taken to distribute oil in small quantities to the sliding vanes, though in such a way that, so the makers state, no lubricant finds its way into the working fluid. The pump is suitable for direct coupling to electric motors, and may be placed in any convenient working position. For instance, there is nothing to prevent the pump being coupled direct to a vertical motor and employed as a shaft sinking pump.

At the recent Engineering and Machinery Exhibition the Pittler rotary machine was shown coupled to a small pump which raised oil to a certain pressure and operated a similar rotary machine as a motor. This machine was coupled direct to another Pittler rotary acting as a water pump.

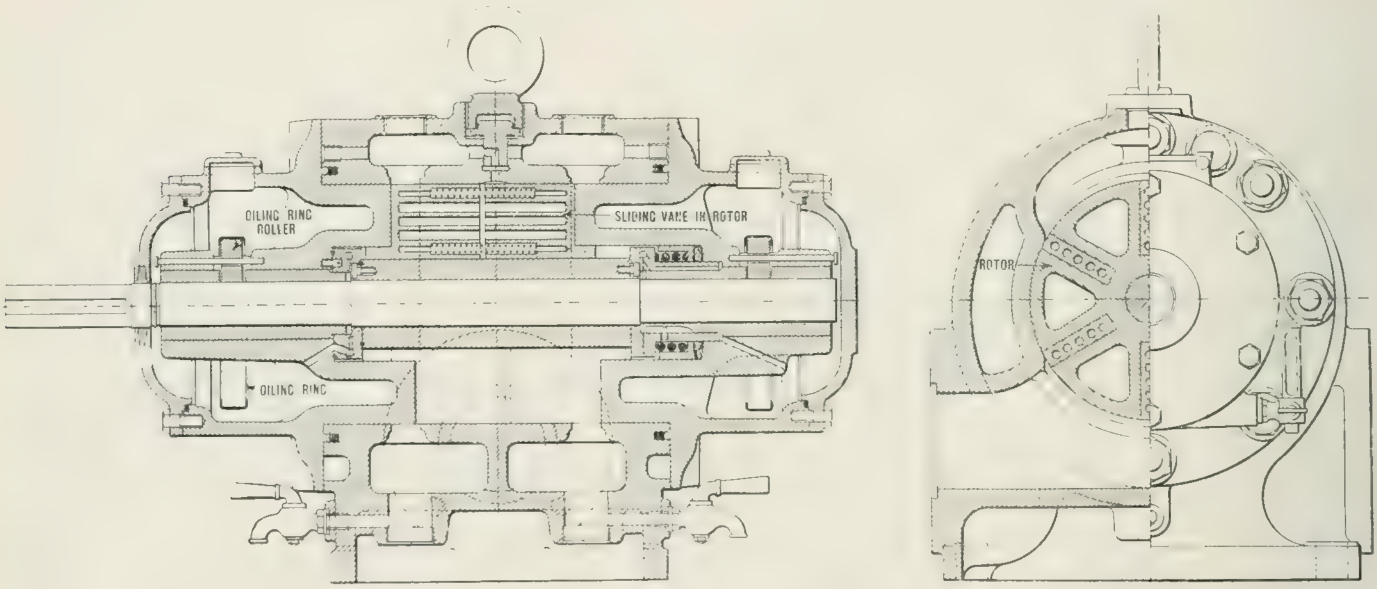


Fig. 4.—End and Side Sections of Pittler Rotary Pump.
Scale: 2 in. = 1 ft.

pump, and these will further assist the reader to understand the unique features of its construction. The method of lubrication is a novel adaptation of the well-known ring lubricator. In place of the flat annulus an internally grooved ring is employed, and this is made to travel round by a small roller pivoted directly above the centre of the shaft, and resting at its lower point upon it. This roller runs quickly round, and carries the ring with it, and as the latter is deeply grooved, it picks up a quantity of oil and distributes it over the shaft. It flows over the journal and returns to the reservoir by a couple of drain pipes. Means are also This use of the Pittler machine for hydraulic transmission is a matter of considerable engineering interest, but space will not admit of our dealing with it in detail in the present article. From the claims of the makers the efficiency of the Pittler rotary as a pump is high, and not only is it capable of working against great pressure, but it possesses the immense advantage of being a suction pump. It will raise water without the aid of a foot valve or any auxiliary vacuum creating device, consequently it should prove of considerable utility in lifting and pumping liquids of all kinds.

Lahmeyer Vertical Motors.

When a shaft-sinking pump is to be installed, high-lift centrifugal pumps are now almost exclusively chosen in preference to reciprocating pumps, over which they have a number of advantages when applied to this class of work. Briefly stated, these are as follow: A much higher lift can be dealt with by a single pump; the

Fig. 1.—Parts of Vertical Moto .

higher speed of the centrifugal pump renders it more suitable for direct-coupling to an electric motor, enabling a smaller motor to be employed than would be necessary with a reciprocating pump; and a considerable saving of space results from the use of a centrifugal pump, especially as it may be constructed equally well with a vertical as with a horizontal shaft.

A water-tight design must be adopted if the motor has at any time to work below the water level, but in the majority of cases this is not necessary, and sufficient protection is afforded by the provision of a drip-proof hood above the motor, which may, therefore, be of the fully-ventilated type, and consequently its size will be as small as possible in relation to its output.

The three-phase slip-ring type induction motor shown dissembled in Fig. 1. constructed by the Felten & Guilleaume Lahmeyerwerke A.G., of Frankfort-on-Maine, for the Mont-Cenis colliery, has an output of 28 h.p. at 120 volts and 1,450 revs. per minute. It has been direct-coupled to a one-stage centrifugal pump, which delivers 26,400 galls. of water per hour against a head of 147 ft. The top bearing of the motor is constructed as a suspension bearing, and supports the rotor, while the lower bearing serves simply to guide the shaft. The pump has its own bearings, and is connected to the motor by a flexible coupling, which takes up any axial thrust. In consequence of the absence of all sliding contacts in them, motors with short-circuited rotors are probably better suited to this class of work than those of the slip-ring type. A Lahmeyer motor of 45 h.p. at 1,000 volts 50 periods per second and 1,450 revs. per min., has been delivered to the Callar Stollen Mining Co., for direct coupling to a sinking pump, the motor being started from an oil-immersed auto-transformer.

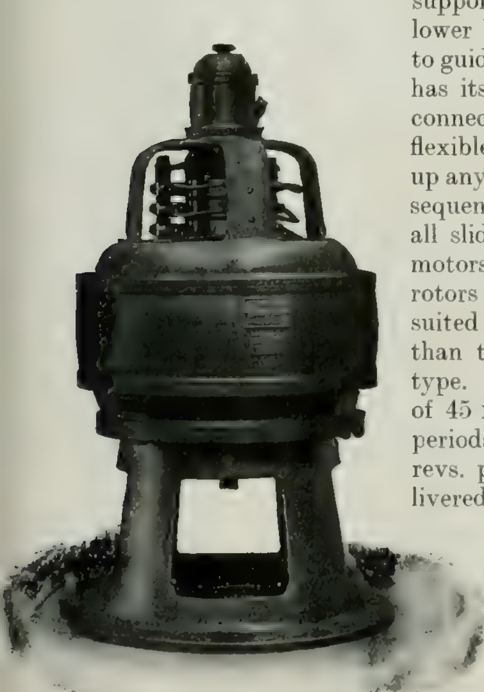


Fig. 2.—Lahmeyer Vertical Motor Complete.

Another motor is at work at the Zeche Ewald pit in Herten, Westphalia. It has an output of 185 H.P. at 500 volts, and 1,500 revs. per min., and drives a high-lift centrifugal pump. The method of lubrication of this motor is worthy of note. A rotary pump in the circular chamber above the top bearing is driven by the motor shaft, and pumps oil from a vessel contained in the base of the motor through a side tube. After passing through the bearing, the oil flows through a channel, arranged between the shaft and the rotor spider, to the lower bearing, and finally finds its way back to the reservoir. The overflow from the top bearing is also conducted to the reservoir through a pipe at the opposite side of the motor. The capacity of the reservoir is about 4½ galls., and thus the oil continually remains cool.

Fig. 3.
Vertical Motor and Sinking Pump.

The motor is ventilated by means of a fan mounted on its shaft. Air is drawn in through circular holes in the motor base, and after passing through ducts provided in the stator and rotor, is expelled through the openings under the drip proof hood.

Fig. 2 illustrates a ready mounted sinking pump delivered to the Gabriela mine, Brandu, Bohemia. The water tight motor is of the short circuited rotor type, and develops 42 H.P. at 500 volts and 2,900 revs. per min. The top of the motor casing is ribbed to present a large radiating surface. At present the pump delivers 6,600 galls. of water per hour against a head of 525 ft., and requires 29 H.P. to drive it; a further stage will eventually be added, which will enable the pump to deal with the same quantity of water against a head of 690 ft., the power consumption then rising to about 38 H.P. The pump is fitted with a suction grid and foot-valve, a hand-operated regulating valve, and a non-return valve, and is, as may be seen from the illustration, mounted together with the motor in a framework suspended from a steel rope. The connection between the pump and the motor is well cushioned with rubber rings, as it frequently happens that the pump has to work entirely under water. The motor terminal box is also made water-tight, and the leading-in cables thoroughly bushed with rubber.

The possibilities of application of the vertical motor are, of course, not exhausted by the driving of sinking pumps. For instance, Fig. 3 shows a slip-ring type vertical induction motor, which develops 20 H.P. at 500 volts and 1,450 revs. per min., and is employed to drive the condenser circulating pump of a 600 kw. steam turbine at the Neuenkirchner Iron Works. In this case a drip-proof construction is naturally unnecessary.

The above description deals with alternating-current motors, as, on account of their simple construction and the possibility of supplying them with current at a high pressure they are particularly suitable for driving the class of machine considered. In some cases, however, and especially when the question of speed regulation arises, as with the driving of hydro-extractors, &c., direct-current motors are to be preferred, and these machines may be equally well-constructed with a vertical shaft.

When laying down electrically-operated mine un-watering plant, it is customary to employ high-lift centrifugal pumps in preference to those of the ram type, on account of the much higher speed at which they run. An electric motor to be coupled directly to a ram pump must be designed to run at a very low speed, and consequently will be of a larger size in comparison to its output, and will occupy a great deal of valuable space. A very compact set, however, is obtained by the combination of a centrifugal pump with an electric motor, and the costs of erection, which mount rapidly with the size of a machine, when installed underground, are substantially reduced.

An un-watering plant installed has been put down by the Felten & Guilleaume-Lahmeyer Werke, in the Wildberg mine, Bohemia. It comprises two high-lift centrifugal pumps, each capable of delivering 330 galls. of water per minute against a manometric head of 755 ft. when running at 1,460 revs. per min., or the same quantity of water against a head of 1,036 ft. when the speed is increased to 1,715 revs. per min. The driving motors are direct-current shunt machines, each developing 175 H.P. Their high speed necessitates a construction similar to that of turbo-dynamos, the armature diameter being only 18·9 in., while the core length is 9·8 in. The peripheral speed of the armature at 1,715 revs. per min. is therefore about 141 ft. per second. The diameter of the commutator, also, has been kept as small as possible, it being 9·8 in. Its peripheral speed is nevertheless about 72 ft. per sec., and it is, therefore, held together by means of two shrink rings. A fan is mounted on one side of the armature to cool the machine.

The motors are mounted on slide rails so that they may be moved in an axial direction to afford easy access to the pumps at any time for the cleaning purposes

Motor-Driven Pumps.

NOW that rotary pumps are largely used for a variety of purposes outside the ordinary pumping installation, such as, for instance, sewage plants, breweries, &c., it naturally follows that an electrical firm, who specialise in the application of motors for industrial purposes, must necessarily have gained considerable experience in the driving of this speciality. Messrs. Electromotors Limited have carried out a quantity of work in this field, and we give a few illustrations of the application of their motors to pump duty.

A very good illustration of the uses to which such pumps can be put in breweries is illustrated in Fig. 1, which shows two inverted motors with pumps connected together on a substantial baseplate, which in turn is provided with runners bearing on the inner flanges of two girders. These pumps are used for the purpose of rousing beer, and being mounted on the runners they can be moved on from one tun to another as desired.

With centrifugal types of pumps it is advisable to make the suction length of as small head as possible, and consequently there has grown up a considerable demand for pumps, suitable for sinking into deep wells, &c. As the area of the bore will not permit of the use of the ordinary type of pump, it has now become a usual practice to fit vertical spindle pumps and motors. Messrs. Electromotors Limited have manufactured a considerable number of such motors, and we

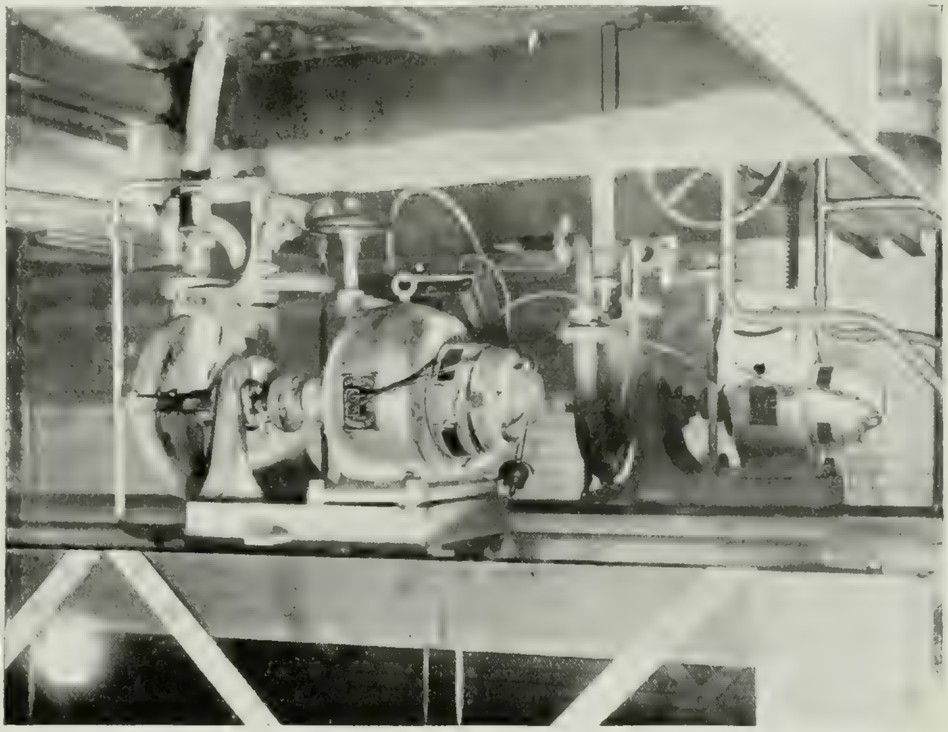


Fig. 1.—Two Electrically-driven Pumps in a Brewery.

Fig. 2.—Vertical Motor for Driving Centrifugal Pump.

give an illustration of one in Fig. 2. which shows their general type. The motor is similar in every respect to their standard horizontal spindle machines with the exception that ball bearings are fitted. Grease is supplied to the respective bearings by means of stauffer lubricators and special precautions have been taken in design to prevent waste grease reaching the windings. The motors are also provided with a ball thrust bearing to take the weight of the armature and pump rotor.

B.E.P. Pump Motors.

IN our issue of September 20th last, we gave some particulars of an interesting pattern of pumping motor which the British Electric Plant Co., of Alloa, had manufactured for a special mining plant. The particular feature of the construction of this machine was the provision of passages around the stator winding, through which the water to be pumped was passed. This exercised a cooling effect on the machine, and also enabled the makers to reduce the size considerably for the amount of work to be done. This motor had an output of 300 B.H.P., and was connected through a flexible coupling to the pump with a capacity of

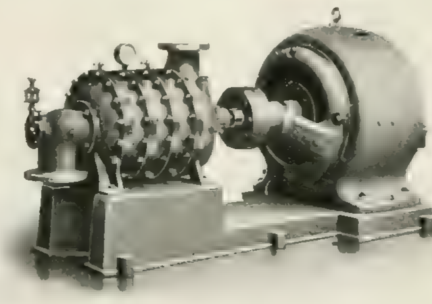


Fig. 1.—General View of B.E.P. Motor Direct-Coupled to 3-stage Turbine Pump.

1,500 gallons of water per minute against a head of 465 ft. The motor was of the induction pattern and with slip rings, and was fitted with suspension ball bearing. Both motor and pump were slung in a special frame, and lowered down the shaft during operation. Fig. 2 illustrates the plant ready for lowering in its frame. The British Electric Plant Co. make a practice of adopting both water and air cooling for pumping motors, as they find that when special precautions are taken to keep the motor at a reasonable temperature, the possibility of moisture condensing on the windings is rendered very remote. The company have also built a large number of motors, both a.c. and d.c. for direct coupling to centrifugal pumps of the horizontal pattern. We illustrate one of these in Fig. 1, and this has a capacity of 500 gallons a minute against a total head of 300 ft. The pump is of the multi-stage type, and is connected with the motor by a flexible coupling, so that each machine is practically free to run in its own bearings, and there is little chance of either being affected by serious want of alignment.

The motor and pump are mounted on the same bed plate, thereby making up a compact pumping unit.

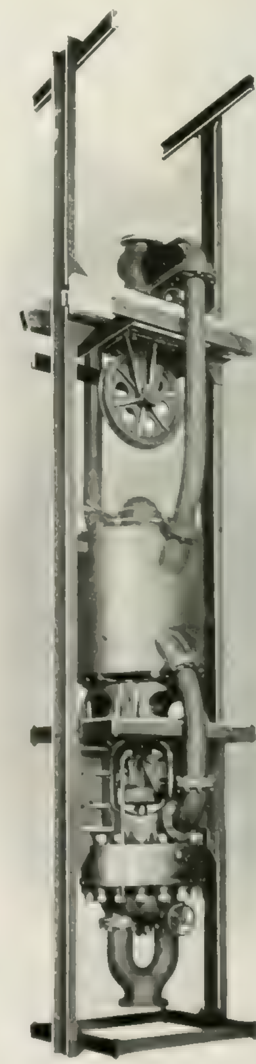


Fig. 2 Water Cooled Sinking Pump Motor.

Westinghouse Pump Motors.

IN the application of motors to the driving of centrifugal and turbine pumps the British Westinghouse Co., has had an extensive experience, many of the important collieries and mines in this country being equipped with their plant. We illustrate in Fig. 1 a view of a Westinghouse polyphase motor, designed for the operation

Fig 1.—Westinghouse Vertical Pump Motor.

of a vertical sinking pump. The design and construction of the windings and frame of the machine are similar to the company's standard C.B. type, the only difference being the provision of supporting feet on one of the end plates, and the fitting of a non-drip hood to throw water off the machine. The rotor is short-circuited, and the stator windings are detained in position by fibre wedges. Fig. 2 shows the complete pumping equipment with which this particular motor is used. The motor has an output of 100 H.P. at 960 r.p.m., and is operated from a 400 volt three-phase 50-cycle circuit. In the illustration may be seen the special method employed for slinging the pump and also the flexible cable for supplying the motor as it is lowered into the shaft.

Another interesting installation of Westinghouse motors is at the Elliott Colliery of the Powell Duffryn Steam Coal Company. A view of this plant is shown in Fig. 3.

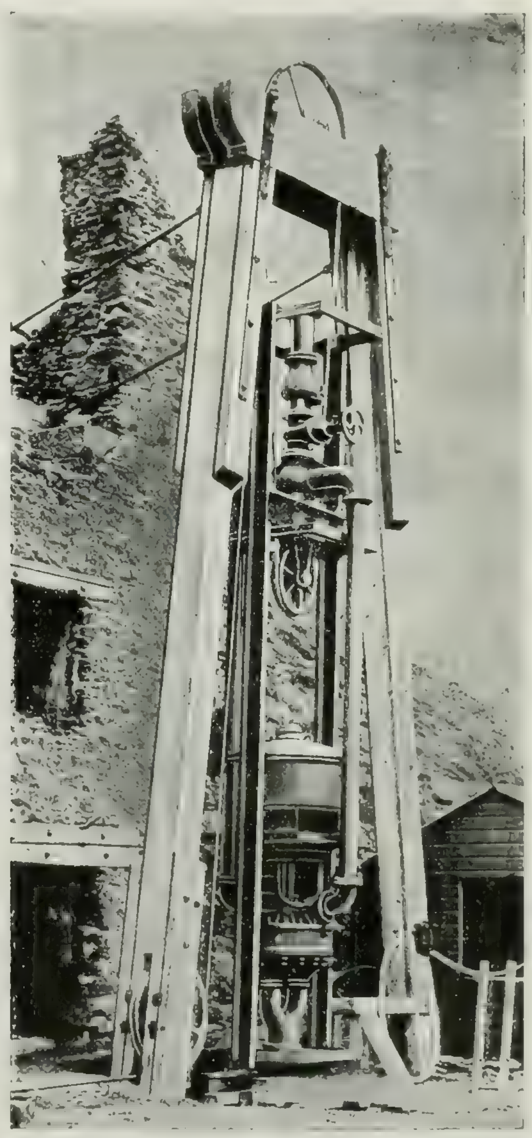


Fig. 2.—Motor attached to Pump in use at Shaft Head.

Here two 950 B.H.P. induction motors are direct-coupled to two Worthington six stage turbine pumps. Motor and pump are run at 1,460 r.p.m., and electrical

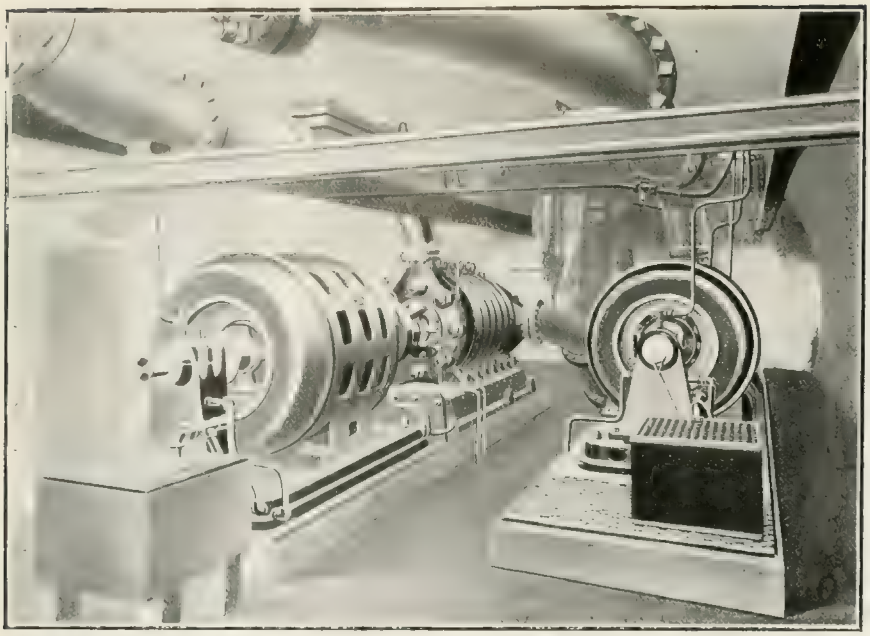


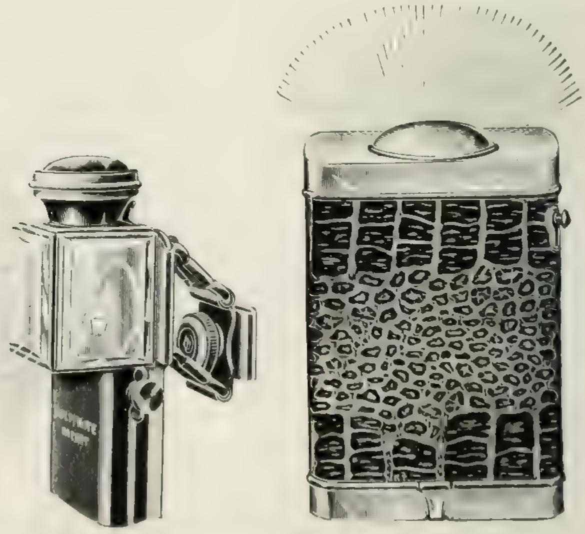
Fig. 3.—Westinghouse-Worthington Pumping Installation, Powell Duffryn Collieries.

energy is supplied at 3,000 volts, 50 cycles, from the central power station of the coal company. Each pump has a capacity of 81,000 galls. per hour against a head of 1,645 ft. This pumping plant, which is the largest of its kind in operation in this country, is erected in a chamber specially built for it at the pit-bottom. Both pumps discharge into a common riser fitted with a gate valve and non-return valve to prevent the water column emptying through the pumps should the motor stop at any time.

The pumps are of Worthington standard construction (as described on page 10), and are connected to the motors through a flexible coupling. It is interesting to note that these pumps take the place of steam pumps which occupied three times the space in which the electrical combination has been put down. The makers also state that in comparison with a horizontal three-throw pump, the weight of the turbine would be about one-third, the floor spaces occupied being respectively 230 sq. ft. and 72 sq. ft. This figure bears eloquent testimony to the compactness of the modern electrically-driven turbine pump.

Pocket Electric Lamps. . . . .

THE introduction of the metallic filament lamp has given a new lease of life to the pocket electric lamp which can, by the use of these lamps, give twice and sometimes three times the number of burning hours. Makers of batteries have also been stimulated to improve the general construction of small cells so as to reduce weight where possible, and at the same time maintain the effective life. We need not dilate here upon the immense value of portable electric lamps in every industry because these are already well known and appreciated. We have recently had an opportunity of testing a small pocket lamp which is made by Ward & Goldstone, Salford, and dubbed by them "Melitilite." Two views of the lamp are shown herewith. The battery



Views of "Melitilite" Lamp adapted for pocket and cycle use.

is a 2 volt cell enclosed in an ebonite case on the top of which are brought out the two terminals formed of lead pillars. By the exclusion of brass all risk of corrosion is obviated. There are no screw terminals as the lamp and switch make pressing contact with the lead posts. The makers claim a life of 10 to 12 hours for the cell when it has been charged once or twice. We have tested a cell, which was handed to us new and just charged. Its life was about eight hours, but we expect to get a full 10 or 12 hours after the next charge. The lamp can be conveniently carried in the pocket, being both light and handy. The makers also supply useful charging accessories comprising flexible cord pole indicator and lamp holder and bayonet plug.

Index to Advertisers.

Motor Sewing Machines.

A WIDE field of utility lies before the small electric motor for the driving of sewing machines. The operation of this useful device has, from an electrical point of view, two distinct aspects. In the one case there is the purely domestic machine driven by its own individual motor. This unit is compact and convenient, and has the advantage of being convertible to foot operation when required. Fig. 1 shows a Siemens motor attached by a special clamp to the table of a treadle machine and driving the same by belt. An adjustable jockey pulley may be fitted to this belt to give control over the speed of the machine by the regulation of the amount of slip. This regulation can be made from the treadle, to which is attached a light rod or cord actuating the lever to which the jockey is fixed. The speed may also be varied by a small rheostat which has an automatic return to normal speed. Messrs. Siemens Bros. Dynamo Works supply these small motors in two sizes, $\frac{1}{16}$ and $\frac{1}{6}$ H.P, the speeds being respectively 2,000 and 1,900 revs. per min. The weight of the $\frac{1}{16}$ H.P. motor is 11 lb. and that of the $\frac{1}{6}$ H.P.) 19 lb. The motors are wound for 12, 110 and 220 volt circuits. The second aspect of the application of the electric motor to sewing machines is the commercial one, in which large numbers of machines have to be driven. Individual and group driving is common for both these, and the selection of either depends on the particular conditions to be met. A whole works employing sewing machines can be driven from a single large motor, or benches fitted with a dozen or more machines can be belted up to a small motor.

Examples of both systems have been put into operation with equally satisfactory results. Experience with sewing machine motors goes to show that when once installed in factories they always remain in service. The management find the turning moment of the electric motor too good a thing to exchange for the speed vagaries of a gas or steam engine.

Fig. 1.—Siemens Motor Clamped to Table of Sewing Machine.

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CONTENTS OF THE CURRENT NUMBER.

NOTES.

The Kelvin Lecture.

ON Thursday evening of last week, before a crowded audience, Prof. SILVANUS THOMPSON delivered the first of the "Kelvin" lectures, taking as his subject "The Life and Work of Lord KELVIN." In such a lecture there was much that was necessarily familiar to his hearers, but there was also much that was unfamiliar, for the lecture teemed with personal notes of a delightful character. Many of these passages we have reproduced verbatim in another column, so that those of our readers who were unable to be present will have an opportunity of appreciating some of the points to which we refer. Of particular interest were the references to the use of numerical values and of models. Lord KELVIN never felt that he had a clear knowledge of a subject unless he could express his results in numbers. There are many mathematicians who are content with mathematics pure and simple, but it would be generally far better for the advancement of physical science if they would occasionally descend from mathematical symbols to simple figures. Similarly, the use of models is almost equally important; or, at least, the actual picturing in one's mind how the physical result is mechanically attained in some form or another. In the words of Lord KELVIN, the test of whether we understand a particular subject in physics is, "Can we make a mechanical model of it?" There would be much less mental fog if people could be induced to make an effort to form models or pictures of what is taking place in any physical change. Such models may be entirely wrong as an actual representation of what is taking place, but they serve to clear the mind, not only of the student, but of the man who has left college days behind him. Another interesting point was the practical applications of science. To a man of Lord KELVIN's genius and intellect it might have been thought that practical applications would have been distasteful, but we all know that this was not the case. On the contrary, he expressed his views strongly on the subject as follows: "There cannot be a greater mistake than that of looking superciliously upon practical applications of science. The life and soul of science is its practical application; . . . . in physical science many of the greatest advances that have been made from the beginning of the world to the present time have been made in the earnest desire to turn the knowledge of the properties of matter to some purpose useful to mankind." Would that the pure scientist always held such a view!

The Bournemouth Tramway Accident.

IT is a somewhat striking coincidence that, on the same day—last Friday—as that on which we published a description of Mr. P. J. PRINGLE's emergency brake, there should have occurred one of the most serious tramway accidents of recent years. The particulars of the accident at Bournemouth are of the usual character—a steep gradient, a sharp curve, excessive speed and an overturned car. The cause of the excessive speed will most probably be ascertained in the course of the Board of Trade inquiry which is being held by Major J. W. PRINGLE. There are other points which, for the time being, we prefer to leave aside for future comment. For the moment the most serious inference to be drawn from the accident is that electric brakes can scarcely be considered sufficiently reliable to be entirely depended upon in all cases of emergency, since they may be rendered inoperative by locked wheels, bad contacts in the controller, or faulty wiring or connections. What appears to be required is a mechanical brake capable of controlling the car at all speeds (the usual wheel and slipper brakes fail in this respect), and that this is being realised is evident from the fact that the two most recent types of brakes which we have described—the Maley electro-mechanical track brake and the Pringle groove skid brake—show a tendency to depart, more or

less, from the usual electrical methods. Since some action must soon be taken by tramway managers if the confidence of the public is not to be seriously shaken as regards the safety of electric traction, we hope that the committees now investigating the question of brakes will lose no time in issuing their reports.

The Franco-British Exhibition.

In our issue of the 17th ult. we noted, with regret, that the idea of electrical manufacturers and supply companies combining to have an exhibit at the Franco-British Exhibition had been abandoned on account of the short time available in which to organise a good exhibit. At that date we expressed the opinion that the shortness of time was scarcely a sufficient reason for such a course. We are glad to state that this view has been adopted by the London Electricity Supply Companies, who have now taken the initiative and have bespoken space for such an exhibit. On Wednesday last a meeting of manufacturers and contractors was called at the offices of the St. James' & Pall Mall Electric Light Co., when Mr. Frank Bailey explained the position. It has been realised that it would be detrimental to the interests of the electrical industry if further efforts were not made to have a collective exhibit. Sufficient funds have been guaranteed by the supply companies to cover the cost of space and a pavilion, to be erected by Messrs. Waring. The general superintendence of the exhibit will be undertaken free of charge. There remains, therefore, only the expense of wiring and current, which is estimated not to exceed £600. It will thus be seen that if not less than 30 firms respond to the invitation the average contribution per exhibitor will not exceed £20, which is a very small sum. The pavilion is to be divided up into six sections, including a suite of furnished rooms, comprising hall, dining room, drawing room, bedroom, nursery and kitchen, designed for the display of electric lighting, heating, cooking and ventilation, besides a reception room, an information bureau, and some general exhibits. We are glad to note that twelve firms decided at this meeting to take space and that there was no lack of enthusiasm. We therefore have every hope that this co-operative exhibit will be carried through to a successful conclusion, and that electrical firms will not fail to take advantage of the occasion. Judging from appearances there is still ample time for a good exhibit to be prepared.

Obituary.—We regret to learn, at the moment of going to press, of the death of Mr. B. H. Thwaite, M.Inst.C.E.

The Late Mr. Tom London.—The Court of Appeal at Mombasa which heard the appeal of the five natives sentenced to death for the murder of Mr. London, has confirmed the sentences on four of the prisoners, and has altered the sentence on the fifth prisoner to 10 years' imprisonment.

Proposed University for Bristol.—At a meeting of the Bristol City Council on Wednesday last, Dr. Cook presented a report from a committee appointed to consider this question. After a certain amount of discussion the report was adopted, and the Council agreed to give financial assistance to the university, provided the arrangements made as to its constitution were satisfactory to them.

Iron and Steel Institute.—It is announced that the Canadian Mining Institute has invited members of the Iron and Steel Institute to take part in their summer excursion. It is proposed that this excursion should start from Montreal on August 24th, proceed to British Columbia and afterwards visit the Nickel-Copper district of Sudbury and the Cobalt district. Receptions will be held at Nelson, Victoria (B.C.) and Toronto.

Wireless Telegraph Notes.—According to a report issued by the Canadian Government the Dominion owns 13 Marconi stations on the Gulf and on the Atlantic seaboard. Three of these are what are known as "low-power" stations and cost £1,000 each; the others are known as "high-power" stations and cost £2,000 each. The Marconi Company receives £500 and £700 per annum respectively for operating them, retaining all the receipts.

New 6,000 kw. Turbo-Alternator for the Manchester Corporation.—On Tuesday last the 6,000 kw. turbo-alternator recently installed in the Stuart-street station of the Manchester Corporation electricity supply department was officially started up by the Lord Mayor of Manchester (Mr. E. Holt). Members of the technical press had been invited to be present, and special cars conducted the party from the Town Hall to the works. In the evening a dinner was held at the Town Hall in honour of the occasion.

Birmingham Section of the Institution of Electrical Engineers.—At the annual general meeting of this section held on Wednesday last the following were elected to serve on the committee during the session 1908-09: *Chairman*—Prof. G. Kapp. *Past Chairmen*—Dr. W. E. Sumpner, Messrs. R. Threlfall, F.R.S., and R. A. Chattock. *Vice-Chairman*—R. K. Morcom. *Committee*—Messrs. V. Bornand, A. R. Everest, A. Lindsay Forster, C. W. Hill, J. P. Kemp, Henry Lea, J. F. Lister, D. K. Morris, A. Pearson, M. Railing, A. M. Taylor and J. C. Vaudrey. *Hon. Secretary*—H. B. Matthews.

Reduction of Accidents by Use of Electric Signalling.—As is well known the ordinary railway signalling in the United States is rather more free and easy than in this country. For this reason the report of the Union Pacific Railroad for January, showing that the number of accidents has been greatly reduced by the use of electrically-worked block signals, is very interesting. The railroad has recently spent £400,000 on the installation of safety appliances, replacing hand and pneumatic signals by those of the electrical type, and under the improved system it is practically impossible for an operator to give two trains "line clear" at the same time.

International Conference on Electrical Units and Standards.—The President of the Board of Trade has appointed a committee—consisting of Mr. G. R. Askwith, K.C., Sir John Gavey, C.B., Dr. R. T. Glazebrook, F.R.S., Major P. A. MacMahon, F.R.S., Major W. A. J. O'Meara, R.E., C.M.G., and Mr. A. P. Trotter—to prepare a programme for the consideration of the delegates to the International Conference on Electrical Units and Standards, which is to be held in London during the coming autumn. This committee will also make arrangements for the reception and assembly of the delegates attending the conference. Mr. M. J. Collins, of the Board of Trade, will act as secretary to the committee.

Faraday Society.—At a meeting of this Society held on Tuesday, April 28th, at the Institution of Electrical Engineers, 92, Victoria-street, the following nominations for the officers and council to be elected at the annual general meeting were announced: *President:* Sir Oliver Lodge, F.R.S. *Vice-Presidents:* G. T. Beilby, F.R.S., R. A. Hadfield, Geh. Reg.-Rat. Prof. W. Hittorf, Prof. A. K. Huntington, Lord Rayleigh, O.M., P.R.S., Prof. A. Schuster, F.R.S., Prof. J. J. Thomson, F.R.S. *Treasurer:* F. Mollwo Perkin, Ph.D. *Council:* Bertram Blount, F.I.C., A. C. Claudet, M.I.M.M., S. Z. de Ferranti, M.I.E.E., F. W. Harbord, F.I.C., R. H. Sutton, D.Sc., T. M. Lowry, D.Sc., H. F. K. Picard, M.I.M.M., James Swinburne, F.R.S., J. F. L. Vogel, M.I.E.E., N. T. M. Wilsmore, D.Sc.

Cable Interruptions and Repairs.

	Date of Interruption.	Date of Repair.
Cadiz Teneriffe	April 22, 1908 ...	May 5, 1908
Alexandria – Larnaca	April 29, 1908 ...	—

Electricity in Cinematography.—An interesting demonstration of coloured cinematograph pictures was given at the new premises of the Charles Urban Trading Co., Urbanora House, Wardour-street, W., on Friday last. The secret as to how these results were obtained was not divulged, though it was stated that the films were not hand-coloured.

The electric installation at this building is very complete. It is ventilated throughout by means of electric fans, and the offices are heated by electric radiators of a new enclosed type, having a high efficiency and low current consumption. All machines are driven by enclosed electric motors with enclosed regulators and switches. The studio is equipped with 14 Westminster photographic lamps, each taking 25 amperes, burning singly on 214 volts, which are separately controlled and regulated from a special D.P. switch fuseboard in the room, and are similar to those used by this company for taking the well-known Urbanora pictures, as shown at the Alhambra and other similar places. The theatre and exhibition rooms are each supplied with two 65 ampere projectors, in addition to the usual apparatus employed in theatres. The lighting is extensive, consisting, as it does, of about 200 5 c.p. ruby lamps, 220 carbon filament lamps and 200 Tantalum patent tubular lamps. The whole of the wires, cables, &c., are contained in heavy gauge Simplex screwed conduit. A very handsome switchboard, mounted on white marble, with tandem knife switches and tubular fuses, in an oak cabinet frame (which swings on a trolley so as to enable the connections, &c., at back to be conveniently reached), controls the whole. The entire work and installation was carried out to the specification and under the supervision of Mr. E. H. Johnson, and all the material, including switchboards, motors, &c., was supplied by the E.M.F. Mfg. Co., 10, Ironmonger-lane, E.C.

International Telegraph Conference.—The conference on telegraphic and allied subjects, which is held from time to time under the terms of the International Telegraph Convention of St. Petersburg, commenced at Lisbon on Monday. The Conference is being held in the Palacio Palmella, and the delegates were welcomed by an address from the Minister of Public Works, Senhor Carnet de Magalhaes, after which the Conference was presided over by the principal Portuguese delegate, Councillor Alfredo Pereira, Director-General of Posts and Telegraphs and Vice-President of the Portuguese Chamber of Deputies. The vice-presidents selected were Councillor P. B. Cabral (Portugal), M. Peter de Szalay (Hungary), and Col. E. Frey (Director of the International Bureau, Berne). It is anticipated that the proceedings will last from five to six weeks. After the inaugural proceedings the delegates elected four committees to deal with (1) Rules and Regulations (chairman, Mr. H. Babington Smith), (2) Rates (chairman, M. Bordelongue, France), (3) Telephones (chairman, M. Pop, Holland); (4) Drafting (chairman, M. Banneux, Belgium). In addition to the above, a special committee has been appointed to consider a number of propositions relating to the revision of the St. Petersburg Convention of 1875, under which all matters relating to International Telegraphy are regulated. On Monday evening a banquet was given in honour of the delegates, the guests numbering nearly 150. On Wednesday the delegates were present at the interesting ceremony of oath-taking by the new King of Portugal.

Institution of Electrical Engineers.—At the meeting of the Institution on Thursday, April 30th, before a large gathering, Mr. H. F. Parshall, representing the American Institute of Electrical Engineers, presented a bust of Benjamin Franklin to the English Institution.

It was, he said, his duty and his pleasure to present, on behalf of the American Institute, this souvenir of the happy remembrances of a trip made by the members of the American Institute to this island about a year and a half ago. It would be recalled by those knowing the circumstances that it was intended to have presented the souvenir on the one occasion that would have been more auspicious than the present—at a meeting when Lord Kelvin was to have been in the chair. That, alas, was not to be. Both Lord and Lady Kelvin had expressed their admiration of the bust. Franklin was regarded, he thought, both in this country and in the United States, as the greatest natural philosopher on the other side, while Kelvin was certainly the greatest on either side. Franklin was to all intents and purposes a British subject, and the same might be said of all the principal American scientists; in fact, there was common ground between all Americans and Britishers. He hoped they would accept the bust as a sincere token of the esteem of the members of the American Institute of Electrical Engineers. The President (Col. R. E. B. Crompton, C.B., R.E.) said, speaking on behalf of the Institution, that they appreciated very deeply indeed the presentation from their American friends and engineers of this token of affection to them, and of respect to their great man, Lord Kelvin. He had to thank Mr. Parshall for the very appropriate and kindly way in which he had spoken, and although they felt that no man could approach their great Kelvin they felt that, if there was any one, it was Franklin. He begged that Mr. Parshall would convey to their brethren in America a message of the warm feeling which the English engineers had for them. The members of the English Institution would never forget the kindly reception and treatment which they received when they visited the St. Louis Exhibition, and they felt that it was but a poor return that they were able to make when the American engineers visited England some time ago. A sincere feeling of friendship existed, a feeling that the two Institutions were one, and he hoped they would have more joint meetings in the future, the present occasion serving to link them still more together.

Royal Institution.—The annual meeting of the members of the Royal Institution was held on Friday last, Sir James Crichton-Browne, F.R.S., treasurer and vice-president, in the chair. The annual report of the Committee of Visitors for the year 1907, testifying to the continued prosperity and efficient management of the Institution, was read and adopted, and the report on the Davy Faraday Research Laboratory of the Royal Institution, which accompanied it was also read. In 1907 41 new members were elected and 63 lectures and 19 evening discourses were delivered. The books and pamphlets presented amounted to about 203 volumes, making, with 693 volumes (including periodicals bound) purchased by the managers, a total of 896 volumes added to the library in the year. Thanks were voted to the president, treasurer and the honorary secretary, to the committees of managers and visitors and to the professors for their valuable services to the Institution during the past year. The following gentlemen were unanimously elected as officers for the ensuing year: *President*—The Duke of Northumberland. *Treasurer*—Sir James Crichton-Browne. *Hon. Secretary*—Sir William Crookes. *Managers*—The Earl of Halsbury, the Earl of Rosse, Sir Thomas Barlow, Sir George Darwin, Sir John Fletcher Moulton, Sir James Stirling, and Sir W. H. White; Drs. D. W. C. Hood, R. Messel and L. Mond, and Messrs. W. A. B. Burdett-Coutts, C. Hawksley, H. F. Makins, G. Matthey and A. Siemens. *Visitors*—Messrs A. N. Butt, Dugald Clerk, C. A. Ballance, J. B. Broun-Morison, E. Dent, J. C. Graham, C. E. Groves, J. List, R. Mond, F. L. Smith and J. Swinburne; Sir Henry Harben, Dr. James Dundas Grant, Lieut.-Col. Sir Frederick Nathan and Major E. H. Hills.

ARRANGEMENTS FOR THE WEEK.

FRIDAY, May 8th (to-day).

PHYSICAL SOCIETY.

8 p.m. Meeting in the Physics Laboratory, Royal College of Science, Imperial Institute-road, South Kensington. Agenda: "A Modified Theory of Gravitation," by Dr. C. V. Burton; "An Examination of the Formulæ for the Grading of Cables," by Mr. C. S. Whitehead; and "Illustrations of Geometrical Optics," by Mr. R. M. Archer.

ASSOCIATION OF ENGINEERS-IN-CHARGE.

8 p.m. Meeting at St. Bride's Institute, Bride-lane, Fleet-street. Annual General Meeting.

ROYAL INSTITUTION.

9 p.m. Meeting at Albemarle-street. Discourse on "Ice and its Natural History," by Mr. J. V. Buchanan.

TUESDAY, May 12th.

FARADAY SOCIETY.

8 p.m. Meeting at 92, Victoria-street. Papers on "Industrial Uses of Ozone, particularly for the Purification of Water," by Dr. F. M. Perkin, and "Determination of Boiling Points of very Small Quantities of Liquids," by Mr. L. O'Dowd and Dr. F. M. Perkin. Mr. V. H. Veley, F.R.S., will exhibit and describe an apparatus for the determination of the dielectric constants of non-conducting liquids.

GLASGOW SECTION OF THE INSTITUTION OF ELECTRICAL ENGINEERS.

8 p.m. Meeting at 207, Bath-street, Glasgow. Annual General Meeting. Paper on "Electric Supply Prospects and Charges as Affected by Metallic Filament Lamps and Electric Heating," by Messrs. H. W. Handcock and A. H. Dykes.

THURSDAY, May 14th.

IRON AND STEEL INSTITUTE.

10.30 a.m. Annual General Meeting at the Institution of Civil Engineers, Great George-street, Westminster.

INSTITUTION OF ELECTRICAL ENGINEERS.

8 p.m. Meeting at the Royal Society of Arts, John-street, Adelphi, W.C. Paper on "Switchgear Control Apparatus and Relays for Alternating-Current Circuits," by Dr. C. C. Garrard.

FRIDAY, May 15th.

IRON AND STEEL INSTITUTE.

10.30 a.m. Annual General Meeting at the Institution of Civil Engineers, Great George-street, Westminster.

SATURDAY, May 16th.

BIRMINGHAM AND DISTRICT ELECTRIC CLUB.

7 p.m. Meeting at the Colonnade Hotel, New-street, Birmingham. Paper on "Electrical Porcelain," by Mr. H. W. Brady

ELECTRIC TRACTION ON RAILWAYS.*

VI.—GENERAL COMPARISON OF CONTINUOUS AND ALTERNATING-CURRENT TRACTION.

BY PHILIP DAWSON.

(Continued from page 743, Vol LX.)

Summary.—The author, having discussed the characteristics of continuous-current and three-phase traction motors in our issues of January 31st and February 28th respectively, now passes on to the consideration of the single-phase motor. After summarising the development of this motor from the historical point of view the author gives particulars of the Westinghouse, Oerlikon, Siemens-Schuckert, General Electric and Eichberg motors.

Having thus briefly considered the principal features in connection with the use of three-phase traction motors we will now consider the latest development which has been

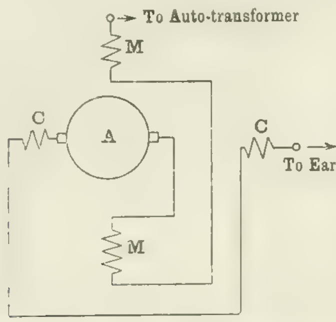

FIG. 19.—DIAGRAM OF CONNECTIONS OF WESTINGHOUSE SINGLE-PHASE SERIES TRACTION MOTOR.

A = Armature or rotor. M Magnetising or field coils. C Commutating or neutralising coils.

brought about by the successful introduction of a practical and effective single-phase motor which possesses all the important features which have heretofore assured the success of the continuous-current series traction motor.

It may be interesting to simply consider the genesis of this motor and the causes which have brought about its

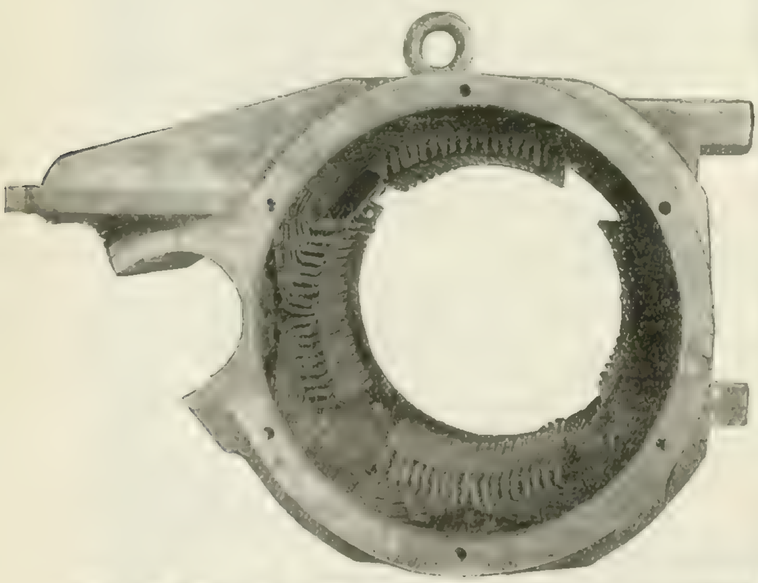

FIG. 20. STATOR OF 100 H.P. WESTINGHOUSE SINGLE-PHASE MOTOR, SHOWING SLOTS INTO WHICH COMMUTATING COILS WILL BE INSERTED.

rapid development. It has been known for a very long time that owing to the fact that the direction of rotation of a continuous-current motor is the same irrespectively of the direction of the current with which it is supplied, ordinary continuous-current motors could be used with single-phase current. The two principal objections which militated against this construction were: (1) The heavy sparking at the commutator, especially at starting and at overloads, which is due to the fact that the armature coils, when short-circuited by the brushes, produced very heavy induced currents; and (2) the very low power factor and large wattless current due to the windings, to the large air-gaps and to magnetic leakage.

In this connection it may be pointed out that shunt motors are practically impossible to operate by alternating currents, owing to the very low weight efficiency, which is principally due to the difference in phase between the field and armature currents, which produces magnetic effects of field and armature to occur at different

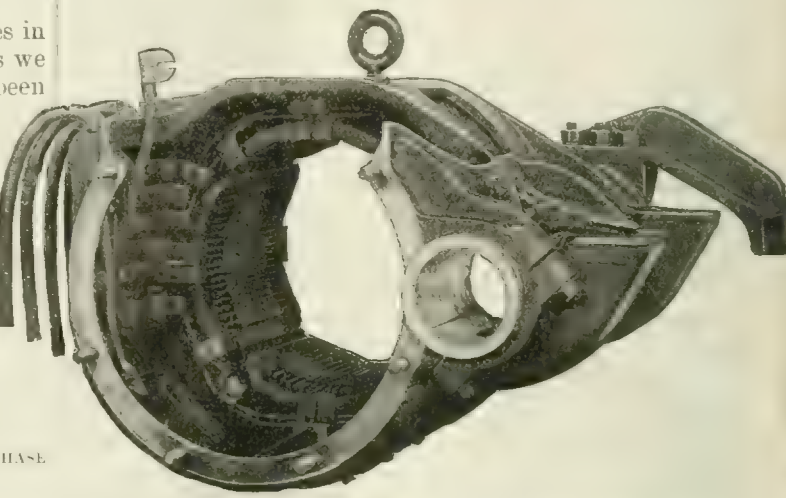

FIG. 21.—STATOR OF 100 H.P. WESTINGHOUSE SINGLE-PHASE MOTOR, SHOWING COMMUTATING COILS IN PLACE.

intervals of time, thus greatly diminishing the torque. Mr. Deri, some 10 years ago, did a great deal to develop the single-phase series motor on a small scale, but nothing came of it, probably owing to the fact that the real want of the single-phase motor had not then made itself felt. In the earlier days, as far as traction was concerned, the continuous-current motor filled all the requirements, and the question of heavy railway electrification had practically not arisen; in fact, it may be said that it is the successful application of the continuous-current motor to tramway and light railway traction, and the immense extensions of these systems as the result of electrification, which has brought about the necessity for our railways to

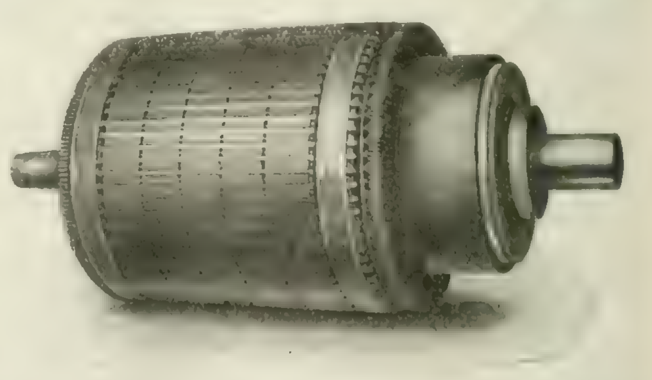

FIG. 22. ARMATURE OF 100 H.P. WESTINGHOUSE SINGLE-PHASE MOTOR.

electrify, and it may, therefore, be said that it is the continuous-current traction motor which is responsible for the development of the single-phase machine.

In the earlier days—*i.e.*, about 1900—there were two forms of single-phase motor, which, from their properties, seemed as if they might lend themselves to modification so as to suit traction requirements—the plain series motor already referred to and the repulsion motor introduced by Prof. Elihu Thomson. To improve the series motor short-

circuited coils were sunk in the pole pieces, and attempts were made to increase the resistance of the armature coils where they were connected to the commutator bars. The repulsion motor consisted practically of a laminated field magnet energised by an alternating current and an armature of the drum type, the brushes of which were given an angular lead and then short-circuited.

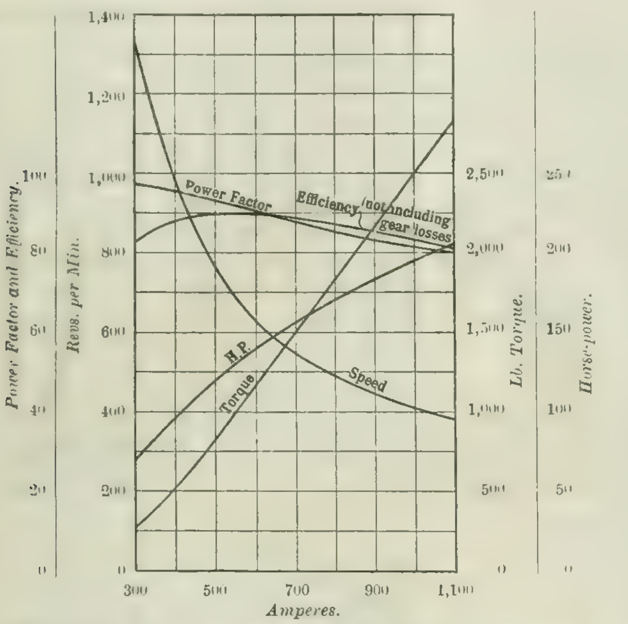

FIG. 23.—CHARACTERISTIC CURVES OF A WESTINGHOUSE 150 H.P. SLOW-SPEED SINGLE-PHASE SERIES MOTOR.

The general theory of these machines will not be considered at this stage, as a separate article is intended to be devoted to them later.

As early as 1892 the Westinghouse Company designed and built two motors of nominally 10 H.P. capacity of the commutator type alternating current, each of which were mounted on a car and tested. These motors were built for a frequency of $15\frac{2}{3}$ cycles per second; but, owing to a number of causes, the operation of this equipment did not prove an entire success. In 1897 the matter was again taken up, and this time on a somewhat larger scale. Motors of 50 H.P. capacity each were built and a long series of tests made.

During the time that the Westinghouse Company were making experiments with single-phase motors, two Austrian engineers, Dr. Friedrich Eichberg and Dr. Winter, were also experimenting with a view to making single-phase traction possible. Work on this basis was started by these two engineers in 1899, and by Christmas, 1900, the results they had obtained were such as to definitely fix the future basis on which they would proceed. The first German patents were taken out in 1901, and the first traction motor was put into service on an experimental line in the works of the Union Elektricitäts Gesellschaft, later amalgamated with the Allgemeine Elektricitäts Gesellschaft. The

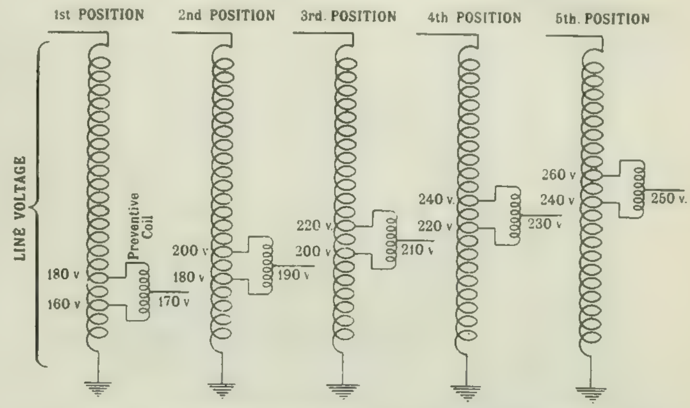

FIG. 24.—DIAGRAM SHOWING RELATIVE CONNECTIONS BETWEEN AUTO-TRANSFORMER PREVENTIVE COIL AND VOLTAGE APPLIED TO MOTORS FOR SEVERAL POSITIONS OF WESTINGHOUSE SINGLE-PHASE MASTER CONTROLLER.

result of this experiment was so successful that Dr. Winter and Dr. Eichberg designed a 100 H.P. machine, the stators of which used high-tension currents at 6,000 volts; these were put into service on the now well-known experimental line at Spindlersfelde, near Berlin, on August 13, 1903. The first actual commercial example of a single-phase system operated by compensated repulson motors above referred to was the Stubaital line near Innsbruck, which was opened for public traffic on Aug. 1, 1904 (see *The Electrician*, Vol. LIII., p. 507).

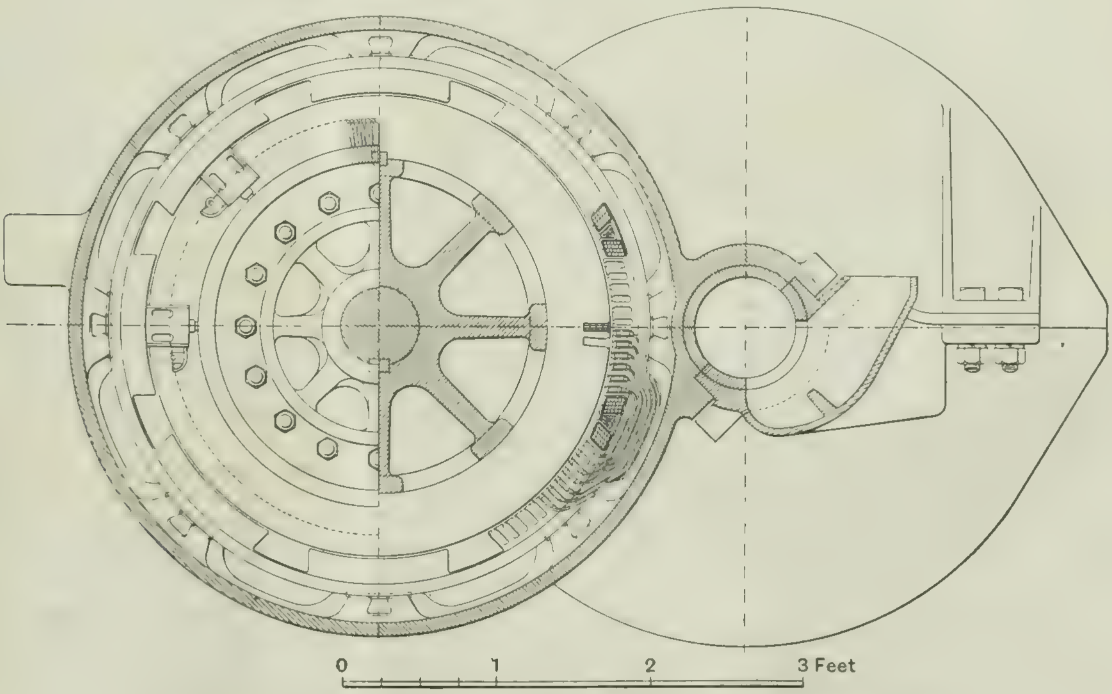

FIG. 25.—CROSS SECTION OF EIGHT-POLE 250 H.P. WESTINGHOUSE SINGLE-PHASE MOTOR.

In 1900 and 1901, when the question of polyphase traction in Europe was so extensively advertised, it became evident to American engineers that there was actually a commercial demand for an alternating-current railway system. It was, therefore, decided by the Westinghouse Company to continue the previous work with motors of the commutator type. Two motors of 100 H.P. capacity each were now built, these also being wound for a frequency of 2,000 alternations per minute, and were tested with a line voltage of from 1,000 to 1,600 volts. The results obtained with these large motors were so satisfactory that on a basis of their performance a contract for a road having 10 cars, each equipped with four 100 H.P. motors, was secured.

In connection with this contract, a number of other details had to be carefully worked out in addition to the motors. It had been found that these motors could not be satisfactorily wound for voltages higher than from 200 to 250 volts. One of the main objects of the system, however, was to permit a higher voltage on the trolley than could be used on direct current. It was, therefore, necessary to provide a transformer on each car for reducing the trolley voltage to a proper value for use on the motors.

out, that advances in single-phase motors were made. Europe was not a bit behind in this problem, for there were several experimenters and designers at work, amongst whom, as already cited, were Dr. Winter and Dr. Eichberg. Mons. Latour and Signor Finzi are names of other well-known investigators in this field. It was in 1895 that Dr. Finzi began to investigate seriously the single-phase moter and to develop it on practically the same lines as those followed by Mr. Lamme in America.

A good example of the ordinary series motor is the latest type of Westinghouse machine, the connections of which are diagrammatically shown in Fig. 19. In this motor the armature is wound like a continuous-current one, except that high-resistance leads connect each armature coil to its corresponding commutator segment; these are frequently placed in the armature slots and at the bottom of them underneath the main armature winding. They are wound non-inductively, and have, therefore, no influence on the torque of the motor. Commutating poles are used, the magnetisa-

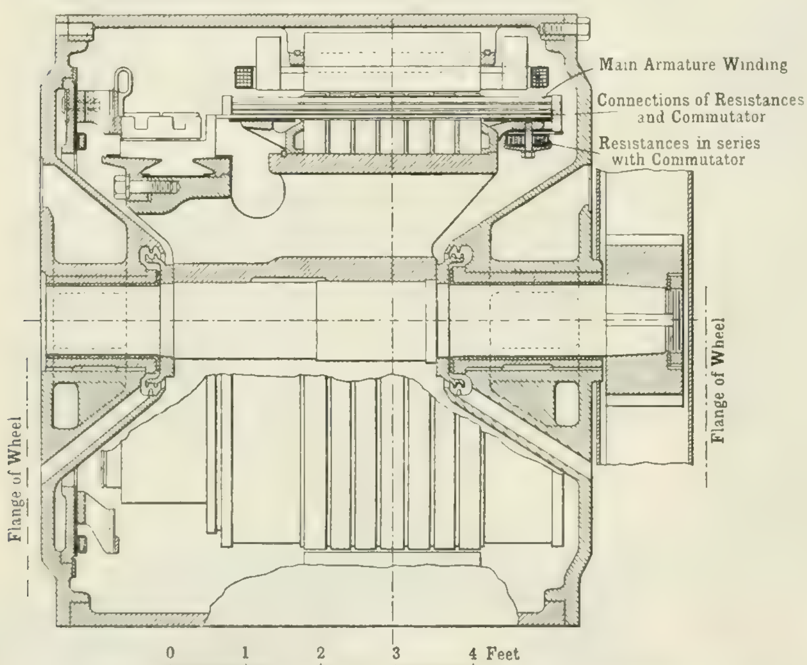

FIG. 26.—LONGITUDINAL SECTION OF 250 H.P. EIGHT-POLE WESTINGHOUSE SINGLE-PHASE MOTOR.

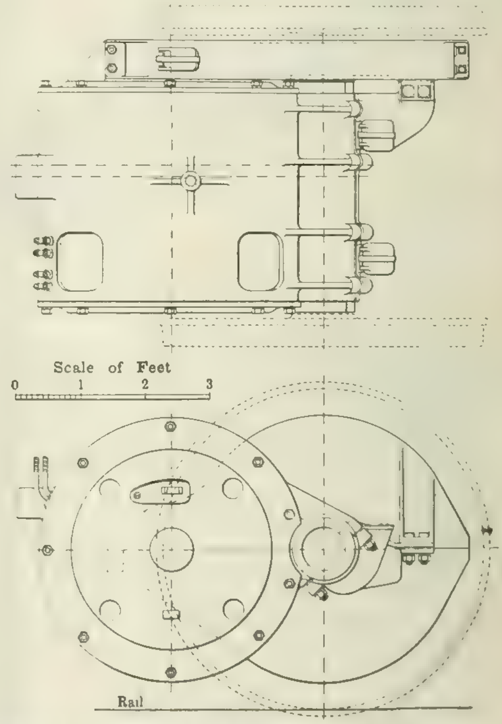

FIG. 27.—OUTLINE DRAWING OF 250 H.P. WESTINGHOUSE SINGLE-PHASE MOTOR.

The next problem to be solved was that of controlling the speed of the car. Owing to the low voltage for which the motors were wound, the current required was rather large, and this made the question of opening circuits carrying these heavy currents a rather serious one.

A long series of further tests was made on motors which had been built with a view of producing a motor for operating on the standard commercial frequency of 25 periods per second. One step taken towards this end was the use of the compensating winding for neutralising the self induction of the armature.

In 1903 experiments had shown that satisfactory motors of the commutator type could be produced for the commercial frequency of 25 periods, and the matter of putting the single-phase alternating current railway system in commercial use was then actively taken up. The present standard line of motors of the Westinghouse Company, ranging from 50 H.P. to 350 H.P., were designed, together with the necessary auxiliary apparatus.

But it was not only in America where Mr. Lamme and the Westinghouse Company's experiments were carried

tion of which is produced by the main current, as shown in the diagram. In earlier types of this motor the commutating or neutralising coils simply consisted of short-circuited coils producing the desired result by their transformer action.

The field or stator winding, instead of consisting of separate coils fitted over pole pieces, as is usual in continuous current practice, is usually distributed and wound in slots similar to the method in vogue in connection with three-phase machinery. This method of winding is clearly shown in Figs. 20 and 21, the former of which shows the field winding before the commutating or neutralising windings have been inserted, while the latter illustration shows these coils in place. Fig. 22 illustrates the armature windings, the high resistance leads being those which are seen soldered to the commutator ends. The characteristic curves for a 150 H.P. Westinghouse motor are reproduced in Fig. 23. The maximum voltage at the terminals of this motor is 250 volts, and it is the total current passing through the armature circuit which has to be dealt with by the switching gear and contactors, a description of which will be reserved

for another article dealing with speed control. The connections between the line, the transformer and the motor are diagrammatically shown in Fig. 24, in which is also shown what the Westinghouse Co. designates as a "preventive" coil, the functions of which are to prevent the short-circuiting of consecutive transformer taps on the auto-transformer during the opening of one switch and closing of the next.

The speed regulation in this type, as in all such types, whether continuous or alternating motor, is effected by varying the voltage at the motor terminals, which in the case of single-phase motors can be done by means of a transformer having taps, whereas, as already stated (in Article V.) in the case of continuous current machines the variable voltage is obtained by resistances with the exception of the series and parallel positions where the voltage is varied by the changing speed of the motors.

Figs. 25 and 26 are respectively cross and longitudinal section and characteristic curves of a 250 H.P. Westinghouse single-phase motor, and are interesting as showing the form of construction adopted. Fig. 27 is a general dimensioned outline drawing of this machine. Further details in this regard, as well as the general form of construction and winding, will not be gone into here, as this question, both as regards continuous and single-phase motors, will be fully dealt with in another article.

(*To be continued.*)

THE KELVIN LECTURE.

On Thursday evening, the 30th ult., Prof. Silvanus Thompson, D.Sc., F.R.S., gave the first of the Kelvin annual lectures inaugurated by the Institution of Electrical Engineers, his subject very appropriately being "The Life and Work of Lord Kelvin."

Prof. Thompson remarked, very truly, that the greatness of a man of such commanding abilities cannot rightly be gauged by his contemporaries, however intimately they may have known him. We have been brought up in modes of thought so largely moulded by him that we cannot adequately realise how much of that which is familiar and commonplace to us is due to his genius. It is difficult for us to realise the prior state of things. But though we may be debarred from rightly estimating his greatness, we at least have the advantage over posterity in having been his students, or disciples, and in having spoken with him face to face.

Space will not allow us to follow Prof. Thompson's words throughout, and, therefore, in what follows we must content ourselves with certain extracts and a comparatively short account of those parts of the lecture where we find ourselves compelled to be more brief.

Born on June 26, 1824, William Thomson had the advantage of being educated by his father, James Thomson, a man of wide accomplishments, who, under disadvantageous circumstances, had risen to be Professor of Mathematics at the Royal Academic Institute of Belfast, and subsequently at Glasgow. As a student at Glasgow (1834-41) Thomson studied the "Mécanique Analytique" of Lagrange, the "Mécanique Céleste" of Laplace, and made the acquaintance of Fourier's "Théorie de la Chaleur." This work of Fourier seems to have produced a very lasting effect on his mind, and in many respects to have dominated much of his scientific career.

Thomson did not take a degree at Glasgow, but in 1841 he entered as a student at St. Peter's College, Cambridge.

Here he speedily made his mark, and continued to contribute—at first anonymously—to the *Dublin* and *Cambridge Mathematical Journals*, Papers inspired by his study of the higher mathematics and by his love for physics. The analogy between the movement of heat in conductors, along lines of flow and across surfaces of equal temperature, and the distribution of electricity on conductors in such a way that the lines of electric force were crossed orthogonally by surfaces of equipotential, led to his Paper entitled "The Uniform Motion of Heat in Homogeneous Solid Bodies, and its Connection with the Mathematical Theory of Electricity." Here was an undergraduate of seventeen handling methods of difficult integration readily and with mastery, at an age when most mathematical students are being assiduously drilled in so-called geometrical conics, and other dull and foolish devices for calculus dodging. It is true he followed the courses of coaching prescribed by his tutor Hopkins, but he could not be kept to the routine of book-work. He also formed a close friendship with Stokes, then a young tutor, and with whom, until his death in 1902, he maintained a continual interchange of ideas and suggestions in mathematical physics. Of Thomson's Cambridge career so much has been written of late that it may be very briefly touched here. How he went up for his Tripos in 1845; how he came out Second Wrangler only, being beaten by the rapid Parkinson; how he beat Parkinson in the Smith's Prize competition; how he rowed for his College to save Peterhouse from being bumped by Caius; how he rowed for Cambridge in the University race of 1844; how he won the Colquhoun Sculls; how he helped to found the Cambridge University Musical Society, and played the French horn in the little orchestra which, at its first concert on December 8, 1843, played Haydn's *First Symphony*, the Overture to *Masaniello*, the Overture to *Semiramide*, the *Royal Irish Quadrilles*, and the *Elizabethan Waltzes* of Strauss! But these things, are they not written in the book of the *Cambridge Chronicle?* Once when Lord Kelvin was in a chatty mood I asked him point-blank how it occurred that he was not Senior Wrangler. His blue eyes lightened up as he proceeded to explain that Parkinson had won principally on the work of the first two days, which were devoted to text-book work rather than to anything requiring analytical investigation. And then he added, almost ruefully, "I might have made up on the last two days, but for my bad generalship. One paper was really a paper that I ought to have walked through, but I did very badly by my bad generalship, and must have got hardly any marks. I spent nearly all the time on one particular problem that interested me—about a spinning top being let fall on to a rigid plane—a very simple problem if I had tackled it in the right way, but I got involved, and lost time on it and wrote something that was not good, and there was no time left for the other questions. I could have walked over the paper. A very good man Parkinson, I didn't know him personally at the time, who had devoted himself to learning how to answer well in examinations, while I had had during previous months my head in some other subjects not much examined upon, theory of heat—flow of heat between isothermal surfaces, dependence of flow on previous state, and all the things I was learning from Fourier." And then he drifted off into a talk of his early Papers and to the mathematical inference (as the result of assigning negative values to the time) that there must have been a creation. "It was," he continued, "this argument from Fourier that made me think that there must have been a beginning. All mathematical continuity points to a beginning—this is why I stick to atoms . . . . and they must have been small; smallness is a necessity of the complexity. They may have all been created as they were, complexity and all, as they are now. But we know they have a past. Trace back the past and one comes to a beginning, to a time zero, beyond which the values are impossible. It's all in Fourier."

After working a short time with Regnault in Paris, Thomson, at the early age of 22, was elected in 1846 to the chair of Natural Philosophy at Glasgow, rendered vacant by the death of Prof. Meikleham. Here he was the youngest of the five Professors Thomson then holding office in the University of Glasgow, and this professorship he continued to hold until he resigned it in 1899, after a continuous service of 53 years. In those days there were no laboratory facilities. Thomson opened the first physics laboratory in Great Britain by making use of some dark, disused rooms, and enlisting the services of a number of keen students. Over earnest students of natural philosophy he exercised an influence little short of inspiration. The next few years were years of strenuous work. At the age of 26 he had published no fewer than 50 original Papers, mostly highly mathematical, and several of them in French. A most important event was the commencement of his friendship with Joule, a Manchester brewer, and honorary secretary of the Manchester Literary and Philosophical Society.

At that date, when there was as yet no doctrine of conservation of energy, when scientific men were not accustomed to distinguish either in language or in fact between force and work, when "caloric" was classed with light and sound amongst the "imponderables," Joule's work was listened to with impatience, and his teachings fell upon deaf ears. Was he not an amateur, dabbling in science, and carried away with strange notions? Joule, too, had prepared a Paper for the Oxford meeting. Its title was: "On the Mechanical Equivalent of Heat evolved by the Agitation of Liquids." It was relegated to an unimportant place, and would have received as little notice as its predecessors, but for Thomson's intervention. Joule himself, in 1885, penned the following account* of the incident:

"It was in the year 1843 that I read the Paper 'On the Calorific Effects of Magneto-electricity or the Mechanical Value of Heat' to the Chemical Section of the British Association assembled at Cork. With the exception of some eminent men, among whom I recollect with pride Dr. Apjohn, the President of the Section, the Earl of Rosse, Mr. Eaton Hodgkinson, and others, the subject did not excite much general attention; so that when I brought it forward again at the Oxford meeting in 1847, the Chairman suggested that as the business of the Section pressed, I should not read my Paper, but confine myself to a short verbal description of my experiments. This I endeavoured to do, and a discussion not being invited, the communication would have passed without comment if a young man had not risen in the Section and, by his intelligent observations, created a lively interest in the new theory. The young man was William Thomson who had two years previously passed the University of Cambridge

* J. P. Joule, "Scientific Papers," Vol. II., p. 215.

with the highest honour, and is now probably the foremost scientific authority of the age. My work with Thomson was chiefly experimental, performed in Manchester and the neighbourhood. We pursued the discussion of the effects of fluids in motion until the experiments were interrupted by the action of the owners of the adjacent property, who, on the strength of an obsolete clause in the deeds of conveyance, threatened legal proceedings, the cost of which I did not feel disposed to incur."

Thomson, in fact, though at first he found some difficulty in understanding Joule's work, threw himself heart and soul into the new and strange doctrines that heat and work were mutually convertible, and for the next six or eight years, partly in co-operation with Joule, partly independently, he set his unique powers of mind to unravel those mutual relations.

Thomson's mind was essentially metrical. He was never satisfied with any phenomenon until it should have been brought into the stage where numercial accuracy could be determined. He must measure, he must weigh, in order that he might go on to calculate. "I often say," he once remarked,* "that when you can measure what you are speaking about, and express it in numbers you know something about it, but when you cannot measure it, when you cannot express it in numbers, your knowledge is of a meagre and unsatisfactory kind ; it may be the beginning of knowledge, but you have scarcely in your thoughts advanced to the stage of science, whatever the matter may be." It was in this spirit that Thomson approached the subject of the transformation of heat.

Another branch of the subject keenly appreciated by Thomson was that developed by Carnot, who introduced the exceedingly useful conception of submitting a body to a reversible cycle of operations, the physical state being the same at the end as at the beginning. Carnot argued, correctly, that at the conclusion of the cycle the body must contain the same quantity of heat as that which it initially possessed, but, incorrectly, that the total quantity of heat lost by the body during one set of operations must be precisely compensated by its receiving back an equal quantity of heat in the other set of operations. Clapeyron, Clausius and Rankine perceived the error. Carnot went so far as to show that, when the extreme temperatures are nearly equal, the efficiency is equal to the product of their difference into a certain function of either of them, called "Carnot's function." Thomson, being dissatisfied with arbitrary scales of temperature, went a step further, and, in a Paper to the Cambridge Philosophical Society in 1848, he showed that an absolute scale of temperature could be obtained in terms of Carnot's theory, each degree being determined by the performance of equal quantities of work in letting one unit of heat be transformed in being let down through unit difference of temperature. Joule, in writing to Thomson in 1848, suggested that probably the values of Carnot's function would turn out to be the reciprocal of the absolute temperature as measured on a perfect gas thermometer, a conclusion independently enunciated by Clausius in 1850. Thomson continued to work at this subject. He verified the prediction of his brother, James Thomson, that pressure would lower the melting point of ice. He formulated the two great laws of thermodynamics, (1) that of Joule, and (2) the law of transformation, which he generously attributed to Carnot and Clausius. He continued to work at the second law, the efficiency of the heat engine, and, with Joule, at thermal effects of fluids in motion. Thus the foundations of thermodynamics were laid.

In 1852, at the age of 28, William Thomson married Margaret Crum, and resigned his Cambridge Fellowship. The happiness of his life was, however, shadowed by his wife's precarious health, necessitating residence abroad at various times. In the summer of 1855 they stayed at Kreutznach, from which place Thomson wrote to Helmholtz, inviting him to come to England in September to attend the British Association meeting at Glasgow. He assured Helmholtz that his presence would be one of the most interesting events of the gathering, so that he hoped to see him on this ground, but also looked forward with the greatest pleasure to the opportunity of making his acquaintance, as he had desired this ever since the "Conservation of Energy" had come into his hands. Accordingly, on July 29th, Helmholtz left Konigsberg for Kreutznach to make the acquaintance of Thomson before his journey to England. On August 6th, he wrote to Frau Helmholtz that Thomson had made a deep impression on him.

"I expected to find the man, who is one of the first mathematical physicists of Europe, somewhat older than myself, and was not a little astonished when a very juvenile and exceedingly fair youth, who looked quite girlish, came forward. He had taken a room for me close by, and made me fetch my things from the hotel, and put up there. He is at Kreutznach for his wife's health. She appeared for a short time in the evening, and is a charming and intellectual lady, but is in very bad health. He far exceeds all the great men of science with whom I have made personal acquaintance in intelligence and lucidity and mobility of thought, so that I felt quite wooden beside him sometimes."

A year later, Helmholtz again met the Thomsons at Schwalbach. Writing to his father he described Thomson as "certainly one of the first mathematical physicists of the day, with powers of rapid invention such as I have seen in no other man." In 1860, after the death of Mrs. Helmholtz, the great German philosopher again visited Britain, staying with the Thomsons for some weeks in the island of Arran. In 1863 Helmholtz, who in the meantime had married again, came to England and visited the chief Universities ; and in writing to his wife gives an amusing picture of his doings.

"My journey to Glasgow went off very well. The Thomsons have lately moved to live in the University buildings (the old college) ; formerly they spent more time in the country. He takes no holiday at Easter, but his brother James, Professor of Engineering at Belfast, and a nephew who is a student there, were with him. The former is a level-headed fellow, full of good ideas, but cares for nothing except engineering, and talks about it ceaselessly all day and all night, so that nothing else can be got in when he is present. It is really comic to see how the two brothers talk at one another, and neither listens, and each holds forth about different matters. But the engineer is the most stubborn, and generally gets through with his subject. In the intervals I have seen a quantity of new and most ingenious apparatus and experiments of W. Thomson, which made the two days very interesting. He thinks so rapidly, however, that one has to get at the necessary information about the make of the instruments, &c., by a long string of questions, which he shies at. How his students understand him, without keeping him as strictly to the subject as I ventured to do, is a puzzle to me ; still, there were numbers of students in the laboratory, hard at work, and apparently quite understanding what they were about. Thomson's experiments, however, did for my new hat. He had thrown a heavy disc into very rapid rotation: he hit it with an iron hammer, but the disc resented this, and it flew off in one direction, and the iron foot on which it was revolving in another, carrying my hat away with it and ripping it up."

But we are anticipating. Hitherto Thomson's work had been mainly in pure science ; but toward the end of the fifties, while still in the midst of thermodynamic studies, events were progressing which drew him with irrestible force toward the practical applications that made him famous. Indeed it could hardly be otherwise, seeing that he was master in whatever he touched.

Early in 1853 Thomson communicated to the Glasgow Philosophical Society a Paper "On Transient Electric Currents," in which he investigated mathematically the discharge of a Leyden jar. He found that when there was a certain relation between the capacity, self-induction and resistance of the circuit the discharge was oscillatory, and thus by a beautiful bit of mathematical analysis he laid the foundation of the theory of electric oscillations. In 1854 he contributed a Paper "On the Theory of the Electric Telegraph" to the *Proceedings* of the Royal Society, in which he investi gated the retardation of signals in cables predicted by Faraday. An application of Fourier's methods showed that the time required for the current at the distant end to reach a stated fraction of its steady value would be proportional both to the resistance and to the capacity, and that the retardation would be thus proportional to the square of its length—the famous law of squares.

Submarine telegraphy was "in the air." John and Jacob Brett had pioneered the project for the Dover-Calais cable ; and in 1851 Crampton successfully united England and France. In 1853 Holyhead and Houth were connected by Mr. (later Sir) Charles Bright. And these were followed by the Dover-Ostend, and longer cables Atlantic telegraphy became the dream of the telegraph engineer. Cyrus W. Field in 1856 negotiated a cable across the gulf of St. Lawrence thus connecting Newfoundland to the American continent. The Atlantic Telegraph Co. was formed, with capital mostly subscribed in England, to promote the great enterprise to join Ireland to Newfoundland. Field, Brett, Bright, Staltham and Wildman Whitehouse were the chief promoters. Bright was engineer, Whitehouse (a retired medical man) electrician. In a pamphlet issued by the company in July, 1857, narrating the preliminary proceedings, the names of John Pender of Manchester, and Prof. Thomson of "2, The College, Glasgow," are included in the list of the directors ; and the statement is made that "the scientific world is particularly indebted to Prof. W. Thomson, of Glasgow, for the attention he has given to the theoretical investigation of the conditions under which electrical currents move in long insulated wires, and Mr. Whitehouse has had the advantage of this gentleman's presence at his experiments, and counsel, upon several occasions, as well as the gratification from his countenance and co operation as one of the directors of the company." This is one side of the matter. The other side is that Mr. Whitehouse had, at the British Association meeting of 1856, read a Paper challenging the law of squares, and declaring if it was true Atlantic telegraphy was hopeless. He professed to refute the law by experiments, the true significance of which was disposed of by Thomson in two letters in the *Athenæum*.

The development of the mirror galvanometer for signalling, and the story of the Atlantic cable of 1857, with its brief success in the following year, are well known. After the failure of the first attempt, Thomson was called upon to take a more active part. Whitehouse was unable to join the expedition and therefore Thomson went as electrician in charge. Of Sir Charles Bright on this occ

* Lecture on "Electrical Units of Measurement," at the Institution of Civil Engineers, May 3, 1883. Reprinted in "Popular Lectures and Addresses," Vol. I., p. 73.

sion, Thomson (in his presidential address to the Institution in 1889) gave the following sketch :

"The first Atlantic cable gave me the happiness and privilege of meeting and working with the late Sir Charles Bright. He was the engineer of this great undertaking—full of vigour, full of enthusiasm. We were shipmates of the "Agamemnon" on the ever memorable expidition of 1858, during which we were out of sight of land for thirty-three days. To Sir C. Bright's vigour, earnestness and enthusiasm was due the laying of the cable."

And Bright has given us the following little silhouette of Thomson : "As for the Professor . . . . he was a thorough good comrade, good all round, and would have taken his turn at the wheel (of the paying out brake) if others had broken down. He was also a good partner at whist when work wasn't on; though sometimes, when momentarily immersed in cogibundity of cogitation by scientific abstraction, he would look up from his cards and ask 'Wha played what ?'"

After various disheartening mishaps success crowned their efforts. Throughout the voyage Thomson's mirror galvanometer had been used for the continuity tests and for signalling to shore, with a battery of 75 Daniell's cells. The continuity was reported perfect and the insulation had improved on submersion. On August 5th the cable was handed over to Mr. Whitehouse and reported to be in perfect condition. Whitehouse at once abandoned the Thomson mirror instruments and began working with his own special patented apparatus, using heavy relays and a special transmitter with induction coils. He sent in no report to the directors for a week while he made ineffectual attempts with bigger induction coils to get his apparatus to work. After more than a week the reflecting galvanometer and ordinary Daniell cells were resumed, and then clear messages were interchanged and international congratulations. News of peace with China and of the end of the Indian Mutiny was transmitted, but the insulation was found to be giving way and on October 20th, after 732 messages had been conveyed, the cable spoke no more. It had been destroyed by Whitehouse's bungling use of induction coils, some of them 5 ft. long, working at some 2,000 volts !

During the next eight years, in preparation for the cables of 1865 and 1866, Thomson was the ruling spirit, and on his return from the last successful expedition he was knighted. During the sixties his activity was extaordinary. Besides all the telegraphic work with which he was connected, he was incessant in research. The conductivity of copper, improved systems of measurement, rational units and the absolute system claimed his attention. He also worked hard at the mathematical theory of magnetism, and to him we owe the terms "permeability" and "susceptibility." In 1859-60 Thomson studied particularly atmospheric electricity, and for this purpose he invented the water-dropping collector and greatly improved the electrometer, which developed into the elaborate forms of quadrant instrument and other types described in the B.A. *Report* of 1867. In addition to this and other physical work, he proceeded to write a text book on Natural Philosophy with Prof. Tait, there being no such book then in existence. The writing of this work led him to devote much attention to the subject of elasticity, and in 1867 he wrote his famous Paper on Vortex Atoms.

In 1870 Lady Thomson died, and in the same year the University of Glasgow was removed to Gilmore Hill, overlooking the river Kelvin.

From his youth Thomson was fond of the sea, and his sailing yacht, the "Lalla Rookh," was for many years conspicuous on the Clyde. He was an accomplished navigator, and thus he was led to teach science in navigation. First he reformed the compass, and, although the Admiralty and Astronomer Royal condemned the new form, Thomson's compass is now all but universally adopted. His sounding apparatus is equally well known. He also invented a tide analysing and a tide predicting machine. Problems on waves fascinated him to the last.

In 1874 Thomson married Miss Francis Anne Blandy, of Madeira, whom he first met on a cable-laying expedition. In 1874 he was elected President of the Society of Telegraph Engineers. Mention must be made of his remarkable controversy with the geologists and biologists as to the age of the earth, which he estimated at not more than 100 million of years. There was much protest, but his view was never really shaken.

With the advent of electric lighting at the end of the seventies, Thomson's attention was naturally attracted to this branch of the practical applications of science. He never had any prejudice against the utilisation of science for practical ends.

"There cannot," he wrote, "be a greater mistake than that of looking superciliously upon practical applications of science. The life and soul of science is its practical application ; and just as the great advances in mathematics have been made through the desire of discovering the solution of problems which were of a highly practical kind in mathematical science, so in physical science many of the greatest advances that have been made from the beginning of the world to the present time have been made in the earnest desire to turn the knowledge of the properties of matter to some purpose useful to mankind."

And so he scorned not to devise instruments and appliances for commercial use. His electrometers, his galvanometers, his siphon-recorders, his compasses, had been made by James White, optician, of Glasgow. In this firm he became a partner, taking the keenest commercial interest in its operations, and frequenting the factory to superintend the construction of apparatus.

He gave evidence before a Parliamentary Committee on Electric Lighting, and discussed the theory of the electric transmission of power, pointing out the advantages of high voltages. The introduction into England in 1881 of the Faure accumulator excited him greatly. In his Presidential address to the Mathematical and Physical Section of the British Association at York that year, he spoke of this, and of the possibility of utilising the powers of Niagara. He also read two Papers, in one of which he showed mathematically that in a shunt-dynamo best economy of working was attained when the resistance of the outer circuit was a geometric mean between the resistances of the armature and of the shunt. In the other he laid down the famous law of the economy of copper lines for the transmission of power.

Helmholtz visiting him again in 1884, found him absorbed in regulators and measuring apparatus for electric lighting and electric railways. "On the whole," Helmholtz wrote, "I have an impression that Sir William might do better than apply his eminent sagacity to industrial undertakings ; his instruments appear to me too subtle to be put into the hands of uninstructed workmen and officials. . . . He is simultaneously revolving deep theoretical projects in his mind, but has no leisure to work them out quietly ; as far as that goes I am not much better off !" But he shortly added, "I did Thomson an injustice in supposing him to be wholly immersed in technical work ; he was full of speculations as to the original properties of bodies, some of which were very difficult to follow ; and, as you know, he will not stop for meals, or any other consideration." And, indeed, Thomson had weighty things on his mind. He was revolving over the speculations which later in the same year he was to pour out in such marvellous abundance in his famous 20 lectures in Baltimore on "Molecular Dynamics and the Wave Theory of Light."

One characteristic of all Lord Kelvin's teaching was his peculiar fondness for illustrating recondite notions by models. Possibly he derived this habit from Faraday ; but he pushed its use far beyond anything prior. He built up chains of spinning gyrostats to show how the rigidity derived from the inertia of rotation might illustrate the property of elasticity. The vortex atom presented a dynamical picture of an ideal material system. He strung together little balls and beads with slides and elastic bands to demonstrate crystalline dynamics. On the use of the model to illustrate physical principles he spoke as follows at Baltimore : "My object is to show how to make a mechanical model which shall fulfil the conditions required in the physical phenomena that we are considering, whatever they may be. At the time when we are considering the phenomena of elasticity in solids I shall want a model of that. At another time, when we have vibrations of light to consider I shall want to show a model of the action exhibited in that phenomenon. We want to understand the whole about it ; we only understand a part. It seems to me that the test of 'Do we or do we not understand a particular subject in physics ?' is 'Can we make a mechanical model of it ?' I have an immense admiration for Maxwell's mechanical model of electromagnetic induction." And again, Lord Kelvin says, "I never satisfy myself until I can make a mechanical model of a thing. If I can make a mechanical model, I can understand it. As long as I cannot make a mechanical model all the way through I cannot understand it." This use of models is, indeed, to be found in the work of every follower of Faraday. Maxwell made free use of models as we have seen. FitzGerald made a remarkable model of the æther. Andrew Gray has liberally employed them. The work of Sir Oliver Lodge teems with models of all sorts. It has become characteristic of the tone and temper of British physicists—of none more than of Lord Kelvin.

Once Lord Kelvin astonished the audience at the Royal Institution by a discourse on "Isoperimetrical Problems," endeavouring to give a popular account of the mathematical process of determining a maximum or minimum, which he illustrated by Dido's task of cutting an ox-hide into strips so as to enclose the largest piece of ground ; by Horatius Cocles's prize of the largest plot that a team of oxen could plough in a day ; and by the problem of running the shortest railway line between two given points over uneven country. On another occasion he entertained the Royal Society with a discourse on the "Homogeneous Partitioning of Space," in which the fundamental packing of atoms was geometrically treated—affording incidentally the theory of the designing of wall-paper patterns !

To the last Lord Kelvin took an active interest in the most recent discoveries. Electrons, or "electrions" as he called them, were continually under discussion. He prided himself that he had read Rutherford's book on radio-activity again and again. He objected *in toto* to the notion that he atom was capable of division or disintegration. In 1903, in a Paper called "Æpinus Atomised," he reconsidered the views of Æpinus and of Father Boscovich from the newest standpoint, modifying Æpinus's theory to suit the notion of electrions.

After taking part in the British Association meeting of 1907 at Leicester, where he entered with surprising activity into the discussions of radio-activity and kindred questions, he went to Aix-les-Bains for change. He had barely reached home at Largs in September, when Lady Kelvin was struck down with a paralytic seizure. Lord Kelvin's misery at her helpless condition was intense. He had himself suffered for 15 years from recurrent attacks of facial neuralgia,

and in 1906 underwent a severe operation. Under these afflictions he had visibly aged, and the illness of Lady Kelvin found him little able physically to sustain the anguish of the stroke. He wandered distractedly about the corridors of his house unable at last to concentrate his mind on work in hand. A chill seized him, and after about a fortnight of prostration he sank slowly and quietly away.

He was buried in Westminster Abbey with national honours on December 23, 1907. The sympathies of all of us go out to Lady Kelvin, who survives him, and who with such assiduous devotion tended him in his declining years.

Honours fell thickly on Lord Kelvin in his later life. He was President of the Royal Society from 1890 to 1894. He was raised to the peerage in 1892. He was one of the original members of the Order of Merit founded in 1902, was a Grand Officer of the Legion of Honour and held the Prussian Order Pour le Mérite.

In politics he was up to 1885 a broad Liberal, but, as was natural in an Ulsterman, became an ardent Unionist on the introduction of the Home Rule Bill. He once told me that he preferred Chamberlain's plan of Home Rule with four Irish Parliaments, one in each province.

In religion Lord Kelvin was an Anglican, at least from his Cambridge days, but when at Largs attended the Presbyterian Church. His simple, unobtrusive, but essential piety of soul was unclouded. He had a deep detestation of spiritualism as a loathsome and vile superstition, and he hated ritualism in all its forms. His profound studies had led him again and again to contemplate a beginning to the order of things, and he more than once professed a profound and entirely unaffected belief in Creative Design.

Kindly hearted, lovable, modest to a degree almost unbelievable, he carried through life the most intense love of truth, and an insatiable desire for the advancement of natural knowledge. Accurate and minute measurement was for him as honourable a mode of advancing knowledge as the most brilliant or recondite speculation. At both ends of the scale his pre-eminence in the quest for truth was unchallenged. If he could himself at the end of his long career describe his own efforts as "failure," it was because of the immensely high ideal which he set before him. "I know," he said on the day of his jubilee, "no more of electric and magnetic force, or of the relation between ether, electricity and ponderable matter, or of chemical affinity, than I knew and tried to teach to my students in my first session." Yet which of us has not learned much of these things because of his work? We of this Institution may well be proud of him, proud that he was one of our first members, that he was thrice our President, and that as our President he died. We shall not look upon his like again.

THE ELECTRICAL EQUIPMENT OF THE PICCADILLY HOTEL (LONDON).

It is interesting to consider the *raison d'être* of the increasing numbers of splendid *caravanserai*—we believe this is the correct term—which have recently been built in London. At first sight it would seem that these palaces could never be commercially successful, and yet their number is constantly receiving additions. It is, in fact, an important social problem, and the search for a solution is interesting. To the electrical engineer, as such, the question is not, however, of extreme importance, and, unless he be intimately connected with the company supplying the necessary electrical energy to the hotel, his concern in its well-being is not very great. On the other hand, while the work of erection is in progress, his interest is somewhat greater. The equipment of a building such as the Piccadilly Hotel brings a certain amount of grist to the electrical mill, while any new features which may be introduced serve to indicate the advance the industry is making.

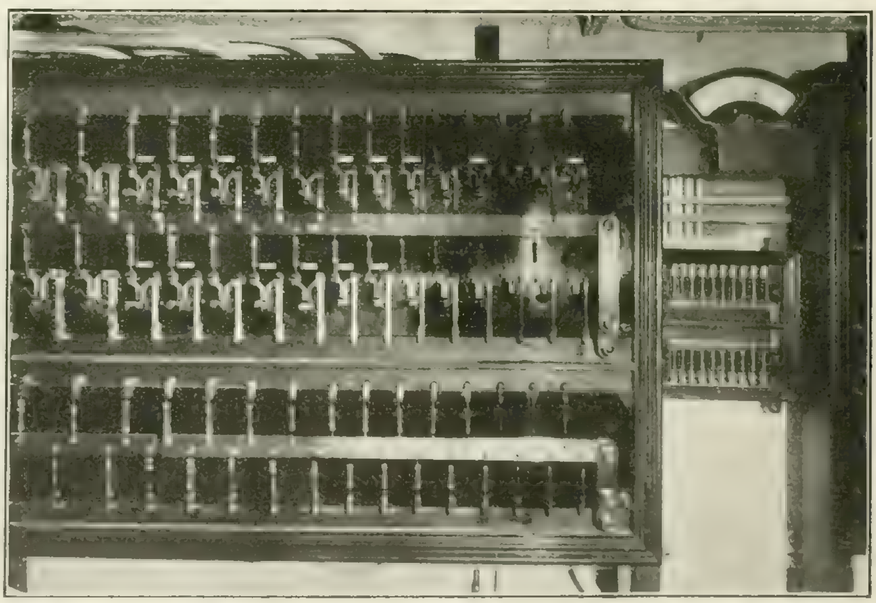

Fig. 1. View of the Regent Street Intake Board of the St. James' and Pall Mall Co., Showing the Power Circuits.

As is well known to those who frequent the West End of London, the Piccadilly Hotel is the latest of these buildings, having been opened only on Wednesday last. As a consequence, it possesses several details in its electrical equipment which have not appeared elsewhere. Before specifically describing these features, some general remarks on the building itself may be of interest.

The new hotel stands on the ground formerly occupied by St. James's Hall, and has entrances both in Regent-street and Piccadilly. Owing to the unusual depth to which the foundations were taken, it has been possible to provide three basements, thus adding considerably to the available space. The architects were Messrs. W. Woodward and W. Emden, while the Office of Public Works was represented by Mr. Norman Shaw, R.A. The engineering plant, including the whole of the electrical equipment here described, was designed and erected under the direction of Mr. E. Wingfield Bowles, while the principal contractors for the electrical work were Messrs. Blackburn, Starling & Co., Gresham Works, Nottingham. In designing the domestic portion, great attention has been paid to making each floor, and even each suite of rooms, complete in itself. The latter are provided with separate kitchens and the necessary domestic offices, and are, therefore, quite independent of the public part of the hotel. The heating is carried out by hot water, the supply of this commodity being exceedingly ample. A hydraulic injector for reinforcing a complete system of fire hydrants is fitted, and a pneumatic message system is also provided. It is outside our province to describe in more detail the arrangement of the rooms and the scheme of decoration. It will suffice to say that these have been carried out with the help of the most modern resources, and are a credit to those responsible for them.

General.—All necessary electrical power is taken from outside, the mains of the St. James' and the London Electric companies being tapped both in Regent-street and in Piccadilly, providing four separate sources of supply. The St. James' and Pall Mall Electric Light Co., whose mains are on the continuous-current system, supply energy for lighting, power and heating, while the alternating supply given by the London Electric Supply Corpn serves for lighting only. In both cases the incoming service cables are led to special fireproof intake chambers. The alternating supply being at 6,600 volts, is stepped down by a special transformer to the required voltage. This has been fixed at 214, the standard of the St. James' Company, and is used throughout the hotel for power as well as lighting purposes. Each service cable, whether

alternating current or direct current, is led to a main intake board situated in an appropriate chamber. The circuits are subdivided, so that 500 ampere supply meters of the Thomson type, made by the Electrical Co., were applicable. A view of one of these boards is given in Fig. 1. From these connection is made to 125 main distributing boards fixed in various parts of the hotel. In the public rooms, where the lights are controlled from one or more central positions, these boards are contained in boxes made in two parts; the upper, which contains single-pole cartridge fuses on both positive and negative leads of each sub-circuit, is inaccessible except to the electrical staff, but the lower, containing single-pole tumbler switches, can be opened by the service staff, and the lights switched on or extinguished as required. These boxes, which are all of similar design, are strongly made of cast-iron and are embedded in the wall. The lids of polished oak are firmly fixed to the iron portion, and are arranged to be just flush with the surface of the plaster. Locks and keys are provided, and, when a box contains both switches and fuses, separate doors are fixed for the reason mentioned above. From these boxes the lighting and power circuits are fed in the usual way. These boxes vary in size, the smallest containing 16 and the largest 50 ways. The internal connections are so arranged that no difficulty is experienced in determining a special circuit, and connections are in all cases on the face of the board. Use has throughout been made of plug connections, and the cross-section of copper provided is most ample. In connection with these boxes it may be noted that a small ivory plate is affixed to each, on which is engraved details as to the company's mains supplying it and to the particular intake room from which it is fed. An arrangement such as this will doubtless be appreciated at its full value by the maintenance staff, and will prevent a great deal of unnecessary work.

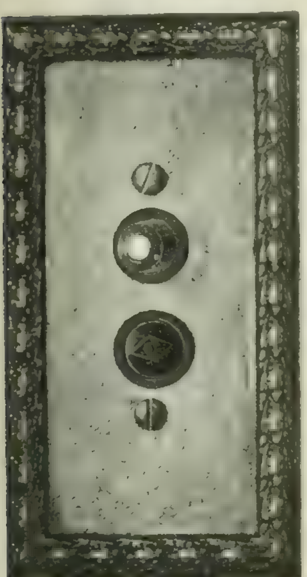

Fig. 2. Cover Plate of Hart Switch.

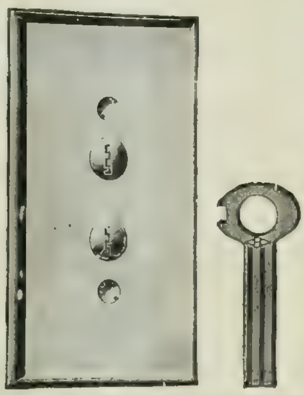

Fig. 3.—Key Pattern Switch.

Lighting.—An equivalent of 10,854 16 c.p. lamps has been installed for lighting purposes. Metallic filament as well as carbon lamps are being used, and the scheme of lighting is exceedingly lavish. A great point has been made of duplication. Each room contains lights fed from both supply companies, and this system is followed throughout, even down to the smallest bedroom. In the corridor, too, the same arrangement prevails, alternate lamps being connected respectively to the St. James' and London Companies' networks. In carrying out the work screwed steel barrel has been used throughout. This was in all cases erected as soon as the walls were in a fit condition; it always preceded the plastering, and in one or two cases was almost in advance of the brickwork. A total of 330,000 ft. of this material has been fixed, which includes that necessary for all electrical purposes, not lighting only. Great care has been taken in planning the pipe work, and attention has been paid to the probability of extensions. These could be made, or even complete re-wiring effected, without disturbing the decorations or necessitating any extensive structural work. The actual lighting equipment, except for the duplication, possesses no special features. A more than ordinary amount of illumination is given in the bedrooms; one of the lights being controlled by the well-known two-way arrangement. The control of the majority of the lights in the hotel is effected by Diamond "H" switches made by the Hart Mfg. Co., Victoria-street, S.W. Upwards of 4,000 of these switches and receptacles are used in the hotel. The switches are distinctive for their positive snap on and off action and also for the employment of two push buttons, one for each of the two motions. The parts of these switches are made by special machinery strictly to gauge and interchangeable. India mica insulation is used and all contacts are of hardened phosphor bronze. A vitrified porcelain box is employed to enclose the current-carrying parts, and the front of the box is closed by a flush-plate, which can be ornamental or plain, as desired. Figs. 2 and 4 show an ornamental cover plate and sectional view of the push-button switch. The same body and mechanism are used for the key pattern switches in the hotel, and one of these is illustrated in Fig. 3. The push buttons are replaced by notched slots, through which a key of the Yale pattern is inserted, and serves to press the plunger movement. The wall plugs and sockets used for radiators, &c., are also of the Hart pattern. These are interesting in that they are self-closing after the withdrawal of the plug. The section in Fig. 5 shows the construction of the receptacle. The plug holes are tightly closed by two brass buttons attached to an arm which is revolved by a thin metal striker entering the receptacle in advance of the plugs. When these are withdrawn the arm turns back and closes the holes. We may mention that the Hart specialities are largely installed in the big hotels in this country and in many continental cities on account of their adaptability to the requirements ruling in these establishments.

In the fittings, utility is the keynote, but nevertheless they are æsthetic. Large size fitting tubes in the service part of the building have been employed, so that the ordinary wire can be run right through into the lampholder, thus avoiding jointing. In this portion of the system water-tight globes are used throughout, and great precautions have been taken to prevent the entrance of damp. In lighting the main rooms lamps of the candle type have been provided in the chandeliers. Use is also made of "Linolite," and in many cases where the cornice projects ordinary glow lamps are placed behind them, and form a very efficient decoration. In the grill room and restaurant table lamps are fed from plugs sunk in the floor, and every arrangement has been made to give sufficient light without glare. The fittings, many of which are very beautiful artistically, have been supplied by Messrs. Elkington & Smith. The various types of lamps have been supplied by Messrs. Siemens for the "Tantulums" and Messrs. Goosens Pope for the "carbons."

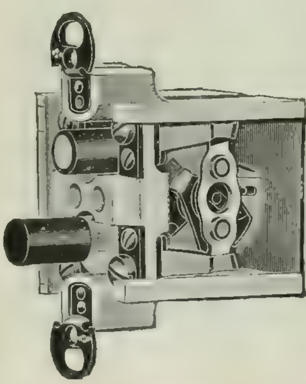

Fig. 4.—Section of Hart Switch.

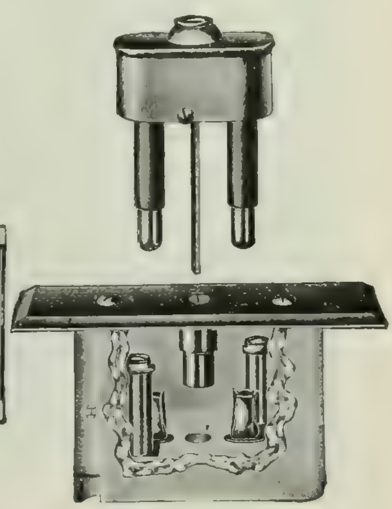

Fig. 5.—Section of Hart Plug.

Power.—There are in all 42 power circuits fed from boards similar to those used for lighting. The total number of motors is 40, ranging in output from 2 H.P. to 25 H.P., the terminal voltage being 214. The most interesting of these are in connection with the water supply of the hotel. A pump driven by a 20 H.P. motor draws water from a private artesian well sunk under the hotel, and delivers it into a reservoir on the ground level. From this position two 10,000 gallon turbine pumps of the Mather & Platt type, driven by 15 H.P. motors raise the water to a number of tanks on the tenth floor, from whence the supply to the hotel is derived. Supplies can also be obtained from the mains of the Metropolitan Water Board. Six passenger lifts account for the same number of 17 H.P. motors, while 2 H.P. luggage lifts and a 20 H.P. goods lift are also provided. There are 13 service lifts driven by motors ranging from 4 H.P. to 8 H.P, and three 7 H.P. motors working wine lifts. Two 20 H.P. and one 12 H.P., by Siemens Brothers Dynamo Works, Ltd., in connection with the main ventilation are erected, and other motors work a brine pump for the refrigerator, a Root's blower, knife cleaning machines, &c.

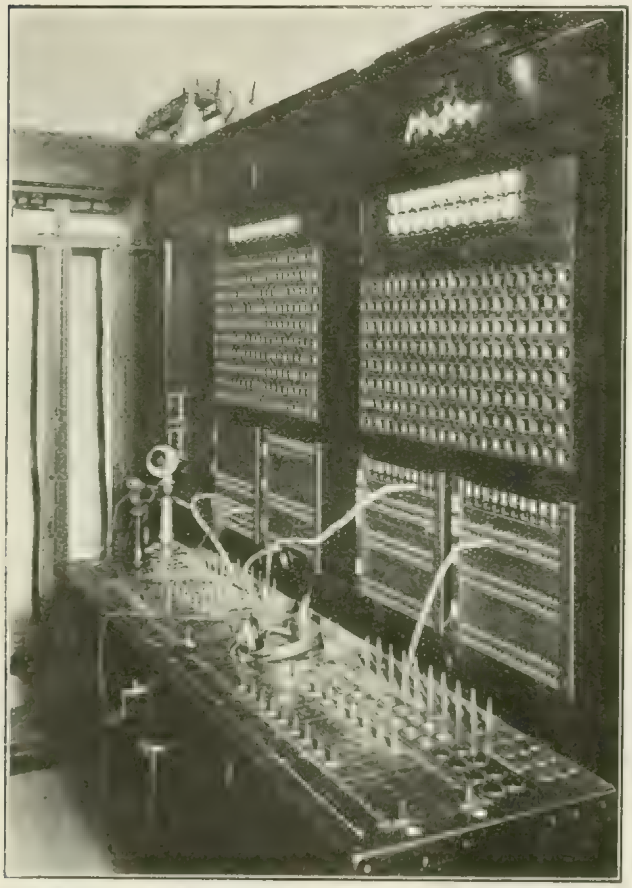

FIG. 6. VIEW OF NATIONAL TELEPHONE CO.'S SWITCHBOARD.

The installation of these machines possesses no special features, the work having been carried out on standard lines, though every precaution against fire or other mishap has been taken. The motors have been supplied by a number of well known firms, among them being Messrs. Mather & Platt, the Lancashire Dynamo Co. and J. P. Hall. Ventilation is effected on the plenum system, the Sirocco fans being capable of supplying 2½ million cubic feet of air per hour, and of completely changing the air in the grill-room and restaurant in less than 15 minutes.

Telephones.—The Piccadilly is the forty-third hotel in London to be supplied with a private branch telephone system—a system that has rapidly become universal among large hotels, so greatly does it add to the convenience of the travelling public. The number of rooms for the use of visitors, including bed and sitting rooms, reaches a total of [illegible], and in each of these a telephone is installed. Over 100 instruments have, besides, been fitted for the use of the management and hotel staff. Chambermaids, landing waiters and porters each have their own instruments, the number fitted thus reaching a total of over 350. These are in communication with the outer world by means of 22 direct lines to the Gerrard Exchange. Operators are provided to give a continuous day and night service, a special room being set apart for the purpose, which, besides containing the switchboard illustrated in Fig 6, is fitted with arrangements conducive to the convenience of the staff. The

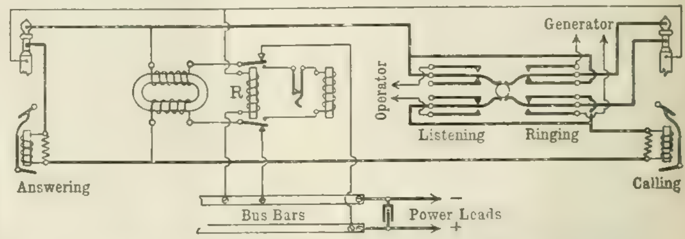

FIG. 7.—CORD CIRCUIT. R RELAY TO CUT OFF LOCAL BATTERY ON EXCHANGE CONNECTIONS.

wiring of the different portions of the building is carried out by means of an external lead-covered, paper-insulation cable, a 500 pair cable being taken from the switch room and run to the different floor levels, where it is joined up to distribution boxes. From these boxes V.I.R. twin wire is run in screwed conduit to the different rooms, draw boxes being fitted at all

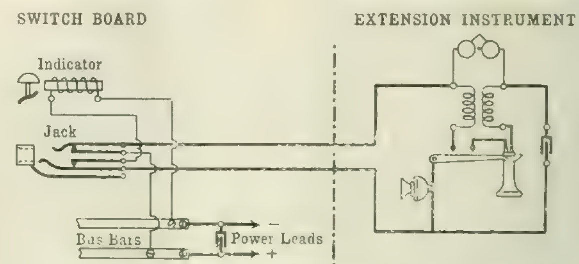

FIG. 8.—DIAGRAM OF CALLING EQUIPMENT.

angles. The switchboard is built to accommodate two operators, the different floors and services being distributed to equalise the traffic. The calling apparatus consists of indicators of the doll's eye type, which, normally invisible, come into sight when the extension calls. Each position is equipped for 13 pairs of cords, the supervisory indicators being fitted im-

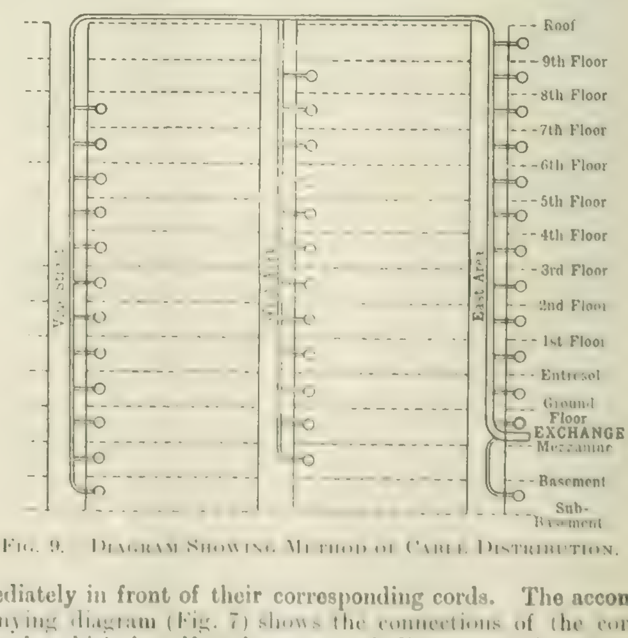

FIG. 9. DIAGRAM SHOWING METHOD OF CABLE DISTRIBUTION.

mediately in front of their corresponding cords. The accompanying diagram (Fig. 7) shows the connections of the cord circuit, which is self-explanatory. A diagram of the calling equipment is also given in Fig. 8, including calling instrument and line indicator, while Fig. 9 shows the method of cable distribution.

Bells.—Probably the most interesting part of the whole equipment is the bell system. Although the idea of employing a comparatively high voltage (about 15) for working the installation is not quite new, having been used at the Ritz Hotel and in ship work, it is certainly at present unusual, and promotes the bell plant to an electrical engineering job instead of it being considered, as was formerly often the case, a piece of work to be done at the last minute by any available handy man. Two motor-generators are provided, each of which is capable of working the system. A 1 H.P. motor is used, which is connected to the 214 volt supply and drives a 1 H.P. generator, supplying the necessary current at 15 volts. By means of a double-pole change-over switch the entire system can be placed on one or other of these machines. The mains are then led to a fuse board, from which 50 bell circuits are tapped off through double-pole fuses. The general arrangement of the system on all floors above the second is shown in Fig. 10 the circuits on the lower floors which serve the public rooms being naturally somewhat different in detail, though the prevailing idea is the same. On each floor there are three local indicators, shown at the top of the diagram, and known as "Local Indicator West," "Local Indicator East" and "Local Indicator North." The pushes in the rooms (C) are in the same way divided into three sections, any depression of them indicating the room on the appropriate board. There is, besides, on each floor, a bellroom containing a three-part indicator, on which any call on that floor is recorded, the number of the room being shown in the proper division. It is also indicated in the service rooms marked "East Section" and "West Section" on the plan, though in this case the part of the floor only is shown, and not the room number. The call is further recorded by means of lamps indicating the floor and section of the floor in the bell porter's room on the ground floor and in the manager's office. A view of these lamp indicator boards is shown on the right of Fig. 12. These last records are made by means of appropriate relays shown in the lower half of the diagram, which close, and keep closed, a small lamp circuit until the attendant, by pressing the restoring button (R) near one of the local indicators, resets all the indicators, and, closing the circuit of the re-setting relays, extinguishes the lights. In this way the manager has a valuable check on the way in which the attendance is being carried out, while the bell porter during the night, when the bell rooms are not fully attended, can see and is kept informed of any calls which are being made. It is also possible from the bell room on each floor, on reception of a certain pre-arranged code of rings, to call up a valet's room, and thus give the required service without much delay. Further, the bell porter can communicate with any of the floors.

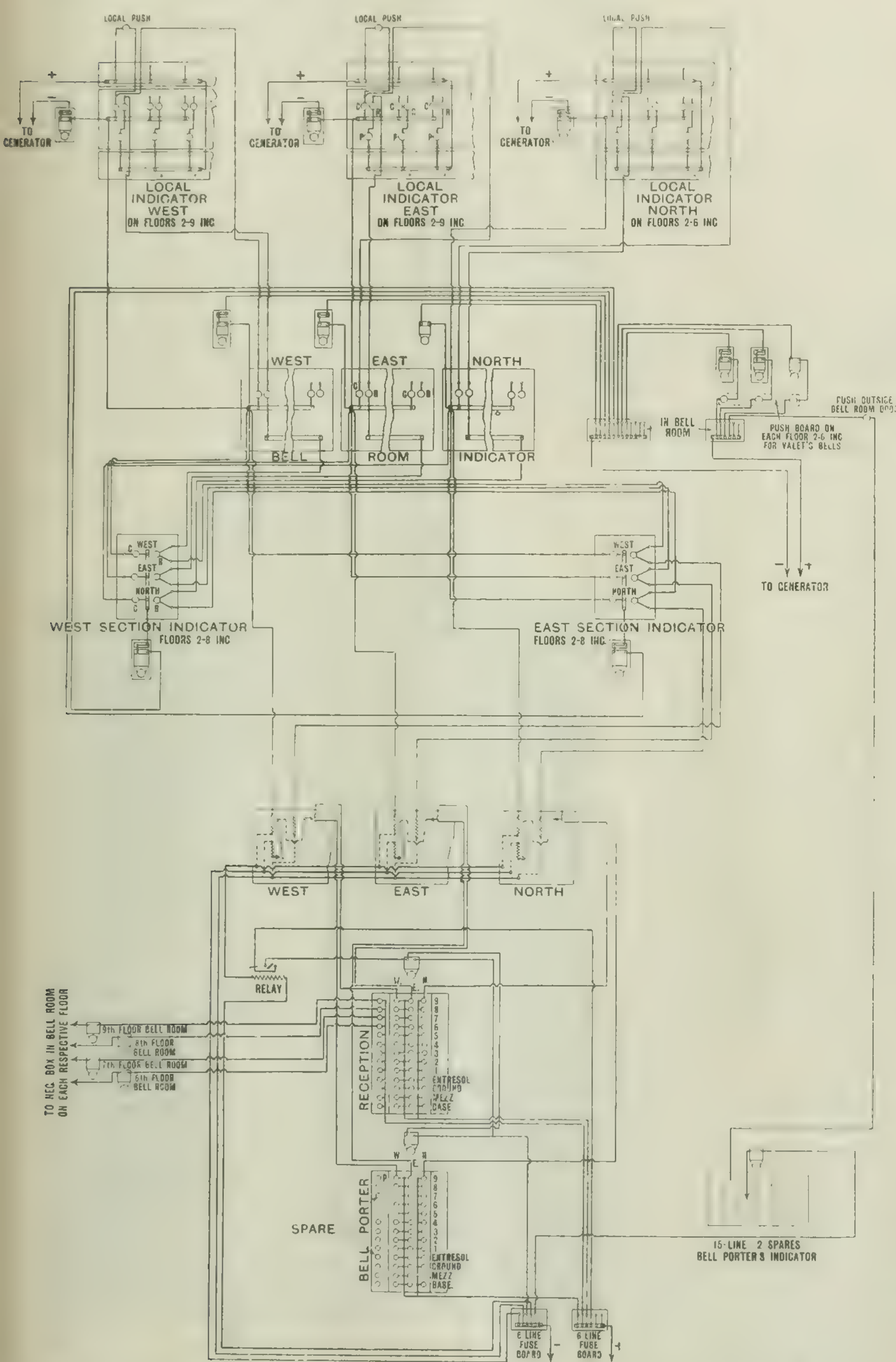

FIG. 10.—GENERAL ARRANGEMENT OF BELL CIRCUITS ON ALL FLOORS ABOVE THE SECOND.

The push at the top of the diagram marked "local push," is situated in the corridors, and is intended to be used either by visitors or attendants when the bell room is closed. A very cursory glance over the above system is sufficient to show that great care has been taken to prevent any complaints arising from defective service, for each ring is indicated in no less than eight places, which to the ordinary man, unused to hotel management, would certainly seem to be rather an *embarras de richesse*.

Heating.—It is now quite the right thing to use electricity to a certain degree for heating purposes. Though seldom used as a main source, it is, however, sometimes employed to the exclusion of the more ordinary methods, but generally finds a place for auxiliary work, such as hot plates, plate warmers and other similar apparatus. In the Piccadilly Hotel 164 plugs

are fitted purely for heating purposes, their sizes ranging from 10 amperes to 25 amperes. They are fitted in the linen and valets' rooms for domestic work, in the dining rooms, restaurant and grill room for hot plates, in the "wing" bedrooms for ordinary heating, and in the American bar and barber's shop for purposes obvious to all. There are, besides, no less than 24 plates in those regions known to house agents as domestic offices. The hot plates have been supplied by Isenthal & Co.

Lifts.—The lift installation, which has been put in by the Otis Elevator Co., comprises six electric passenger elevators, six electric luggage or goods elevators, 16 electric service elevators, and three hydraulic kitchen or goods elevators. The passenger elevators have standard Otis drum-winding engines with the car ropes separate and distinct from the counterbalance weight ropes. Each elevator travels at a normal maximum speed of 250 ft. per minute, and is operated from the car by a two-speed self-centreing lever handle switch, which permits the car being run at fast or slow speed; slow speed being about 150 ft. per minute. The car can, therefore, be started on the slow speed and be brought back from fast to slow speed before reaching a landing, so that an easy start and an easy and accurate stop may be obtained. Provision is also made for slowing down the car speed as the car approaches either extreme of its travel. In addition to the main operating switch in the car, a secondary or emergency switch is provided, which controls the main supply circuit and is intended for use in the event of the regular controlling switch failing from any cause. The luggage elevators vary in speed from 150 ft. to 175 ft. per minute. Each is controlled from the car by a lever handle switch, and Otis standard drum-winding engines are employed. The ordinary full outfit of Otis car safeties, machine safeties, hatchway limits, &c., are employed, and all the landing doors are equipped with an auto-interlocking device. In connection with the car safeties it may be added that the Otis governor or speed regulator is employed, which is designed to prevent unduly excessive speed of the car from any cause. The motors for the majority of these elevators vary from 10 H.P. to 17 H.P. Each of the 16 electric service elevators, which travel at the rate of 150 ft. per minute, are worked by the Otis automatic push-button control device. For each lift, at the main distributing floor, a full set of buttons is provided, one to correspond with each floor served by the car, with an extra button to permit of the lift being stopped, and its destination or direction of travel changed, without the necessity for the car completing the journey upon which it has been started. Momentary depression of a button causes the car to start and to travel to the appropriate floor where it is automatically stopped. The shutters or doors are fitted with electric contacts to prevent any movement of the car unless the doors are closed, and alongside each set of operating buttons a row of electric lamps is provided, one lamp for each floor served by the car. These lamps are arranged to light up by the opening of a shutter and to show the operator at which floor the car is stationary. The motors for the service elevators are 2 H.P. or 3 H.P.

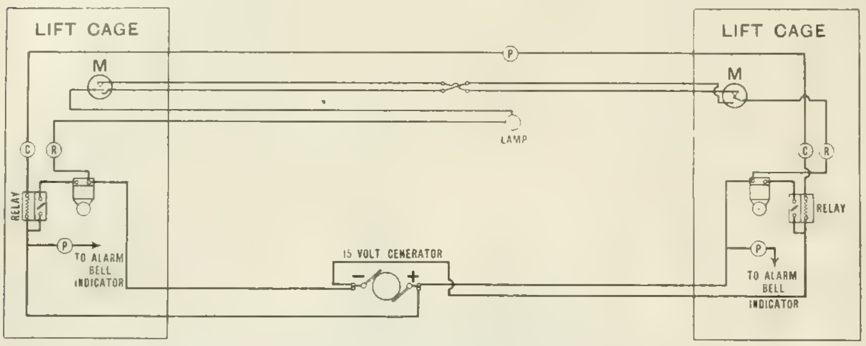

Fig. 11.—Diagram of Calling Arrangement for Lifts (Shown for one Floor) When Two Lifts are Working in the Same Shaft.

A rather important part of the lift installation in this hotel is the calling system, which has been specially designed by Mr. Starling. While in cases where there is only one lift per shaft the wiring is simple, and needs no description, when two lifts are working side by side the conditions are rather different, for through misunderstanding both attendants may reach the calling floor simultaneously, or each may consider attendance on that particular call to be the duty of the other, with much confusion to all concerned. To avoid this playing at cross purposes the arrangement shown in Fig. 11 has been designed. P indicates the calling push, situated on each floor, M the resetting push in the car itself, while C and R are the calling and resetting coils in the indicator showing the calling floor. On the push P being pressed simultaneous indications are given in each car. The attendant in the nearest car will then answer the call, at the same time pressing the Morse key M. This resets both indicators and lights a small lamp situated behind an illuminated dial on each floor, which indicates in both English and French that the lift is coming. In this way the visitor is informed that his call is answered, while the second attendant knows that he need not trouble any further about that particular indication. In case the lift machinery should go wrong, and the cage become fixed between two floors, the push P allows communication with the engineer to be established by means of a special alarm bell.

Clocks.—The system of electric clocks installed in this hotel is unique in many respects, as it is not only one of the largest installations fixed in one building, but the many special conditions and requirements demanded by the large number of dials to be operated necessarily compelled the design of special apparatus. The installation consists of some 300 separate dials of different sizes in the various bedrooms, private sitting rooms, entrances, lounges and other parts of the hotel. The whole of the clocks (a view of one of these is given in Fig. 13) are operated from two master pendulums, which, together with the controlling switchboard, are situated in the basement of the hotel.

Fig. 12.—View in Bell Porter's Room Showing, on the Right, the Bell Indicator Board, and, on the Left, the Master Clock Apparatus.

This interesting piece of work is shown on the left of Fig. 12. The two pendulums are encased in the side panels, each pen-

dulum being of second's beat, specially compensated for temperature variation and carrying an unusually heavy bob. In the centre of the board are the controlling switches for the six clock circuits which are situated in various parts of the hotel. Each circuit is fitted with a change-over switch, so that it can be operated from either master pendulum, and it is interesting to note that, though normally approximately half the clocks are operated from each master, they can if necessary be all controlled from one pendulum. Further, each circuit has a switch, so that it can be connected through an ammeter seen in the middle of the board. Another switch will connect any circuit to a leakage detector, enabling the insulation resistance upon any line to be observed. A pilot dial is also fitted upon each circuit; these are also shown in the photograph. The main circuits for each master pendulum are closed through special solenoid relays. The contacts on the master pendulums close the energising circuits of these relays, and a special device is fitted in each instance to obviate the sparking due to the self-induction of the coils being noticeable at the contacts; in fact, when the whole of the clocks are in operation, there is no visible sparking whatever. The dials in the private sitting and bedrooms of the hotel, although only 6 in. in diameter, can be seen and read from any part of the room on account of the bold figuring and hands used. The backs of these clocks are enclosed in cast-iron boxes, which contain the movement, and are let in flush with the surface of the wall, the conduit tube carrying the circuit wires being screwed into

FIG. 13.—ELECTRIC DIAL.

these boxes, thus making a watertight and workmanlike job. The operation of the dials is absolutely silent, there being not the slightest click or other noise noticeable even in the quietest rooms. The movement used in these dials is extremely interesting, as, in place of the usual ratchet wheel and pawls, there is a small iron armature having a gradually increasing radius, which, with the assistance of a small weight, causes the armature to revolve a complete turn each time the current passes. There are no springs whatever used in the movement, which is so powerful and certain in its action that the same size of fitting is used to operate all dials up to 18 in. in diameter. One of these dials is shown in Fig. 13. The clocks are on a patented system, designed by Mr. G. B. Bowell, of Terminus Chambers, Holborn Viaduct, and were wholly made at his works at Margate.

Lightning Conductors.—The effect of such a building as this being struck by lightning would be a catastrophe both to itself and to its neighbours, and it is, therefore, essential for public safety that adequate means of protection should be provided. There are 45 lightning conductors, supplied and fitted by Messrs. Blackburn, Starling & Co., Ltd.; they terminate in tripod points and are inter-connected by copper strip, which is also run over the more prominent parts of the building. There are in all four earth plates, buried in cinder pits of the well-known pattern, while as an additional safeguard the conductors are also connected to the main water pipe. The presence of so much concrete naturally does not tend to increase the "earth," and it is for this reason that such precautions have been taken.

Water Level Indicators.—Among the fundamental conditions on which the satisfactory working of a place like the Piccadilly Hotel depends the provision of an adequate water supply is one of the most essential. The precautions which have been taken to obtain this have already been described, and it remains to have some method of showing whether everything is in working order. For this purpose four water level indicators have been provided, one in the large tank on the tenth floor, and the other three in three tanks on the third floor. They are on a special system due to Messrs. Blackburn, Starling & Co, Ltd., and are worked off the 15-volt circuit. They consist essentially of a resistance having a number of stops, on one of which the moveable arm rests corresponding to the water level in the tank. By this means an indication is given on an indicator, and allows the engineers to know how matters stand.

Fire Alarms.—Another danger against which it is essential that special precautions should be taken is that of fire. There are in all 48 fire pushes distributed through the hotel, three or four being placed on each floor. If, for any reason, one of these be pressed an indication is made on a special board in the bell porter's room, while the alarm is given by the ringing of an ampled-sized fire bell. In order that necessary testing may be carried out without ringing this bell a special cut-out arrangement is provided on each push. There are also two plug holes on each push, into which a small telephone can be inserted, and the particular circuit adequately tested.

Conclusion.—We could, were not the question of space ever present with us, deal at great length with many features in this hotel which, though not essentially electrical, would be of interest to the engineer. As it is, we have only been able to consider rather briefly such details as are purely electrical, and to leave all others strictly on one side. We have to thank Mr. E. Wingfield Bowles, the consulting engineer, Mr. W. M. Dumaresq, the clerk of works, and Messrs. Blackburn, Starling & Co., Ltd., Gresham Works, Nottingham, for their courtesy in affording us facilities to inspect the installation and for lending us the drawings of the bell system reproduced herewith. The paragraphs dealing with the lifts and telephones have been based on information supplied by the Otis Elevator Co. and the National Telephone Co., while Mr. G. B. Bowell, of Margate, has provided the details of the clock system. The names of many other contractors who have had a hand in making the installation a success are mentioned in the course of the above description. The special bell systems and the general design of the electrical scheme and apparatus throughout are the work of the consulting engineer, Mr. E. Wingfield Bowles, very little alteration having been made in any of the plans or specifications during the progress of the installation.

A NEW METHOD OF OBTAINING POLAR CURVES OF DISTRIBUTION OF LIGHT OF ARTIFICIAL ILLUMINANTS.*

BY W. VOEGE.

During the last few years several successful efforts have been made to devise apparatus by the use of which the mean spherical or mean hemispherical candle-power of a source could be determined by means of a single measurement. The Ulbricht globe and the Matthews integrating photometer serve this purpose, but, on the other hand, tell us nothing of the distribution of light from the sources, the brightness of which they are used to measure. In many practical cases, a knowledge of this distribution is very essential—when, for instance, we are comparing the merits of lamps utilising coaxial or inclined carbons, different varieties of diffusing globes and reflectors, &c.; yet the usual method of obtaining these curves by means of a series of measurements at different angles to the horizontal constitutes at once one of the most tedious and, in the case of somewhat unsteady sources of light, also one of the most inaccurate processes of measurement which can be called to mind.

The process would be considerably simplified if photometric measurements could be replaced by observations of the deflections of

* Abstracted from the *Elektrotechnische Zeitschrift.*

a galvanometer. The use of selenium in this connection naturally occurs to one, but this substance cannot at present be prepared in a sufficiently constant condition. The sensitiveness of the selenium cell is certainly amply sufficient, but the inertia, even of the newest types of cell, is so considerable that it is very difficult to obtain consistent readings; the alteration in resistance caused by a given intensity of illumination also depends on the period during which the cell is illuminated, and the time required for the resistance to settle down to a constant value is very uncertain. An additional objection to the use of selenium is that the alteration in resistance is not directly proportional to the intensity of illumination causing this change.

On all these grounds the author considers it hopeless to attempt the use of selenium for the determination of polar curves of distribution of light. He has, however, succeeded in this aim by another method—namely, by the use of a thermopile. A thermopile, of course, does not react to the luminous rays only, but is acted upon by energy from the entire spectrum, especially the invisible heat rays. In the author's investigations, however, these heat rays were absorbed by means of plates of clear, thick glass placed in front of the face of the thermopile. Even so the greatest effect is produced by the red rays of great wave length, which are, of course, not those which produce the greatest luminous sensation.

we obtain a curve by tracing out the deflections of the galvanometer in the usual way, which resembles the normal curve of distribution of light. It is, therefore, only necessary to ascertain the intensity of the light in any direction by a photometrical method, in order to be able to plot the curve in terms of candle-power.

Whether the method is also applicable to such sources as arc lamps and, in particular, flame arc lamps, is not so evident. For in the latter case the heat rays are obtained mainly from the glowing tips of the carbons while the light is derived principally from the vapour of the arc Hence it is not certain that we should obtain the same curve with the thermopile as by the ordinary photometrical method. By means of the following precautions, however, the author claims to have rendered the method at least sufficiently accurate to be of practical use.

1. In addition to the clear glass a sheet of green glass was placed in front of the face of the thermopile, which absorbs the greater portion of the red rays. In these experiments a thickness of 3 mm. of clear glass and about 1·5 mm. of green glass was utilised. The sensitiveness of the thermopile still remains sufficiently high for the purpose.

2. The thermopile was provided with a suitable focussing apparatus, which concentrated all the rays corresponding to a certain solid angle upon the blackened face presented to the light. The thermopile then registers the mean value of the rays thus concentrated upon the face of it, and these rays come from various points in the light-giving surface of the source or surrounding globe. This corresponds to practical conditions, for in practice an illuminated

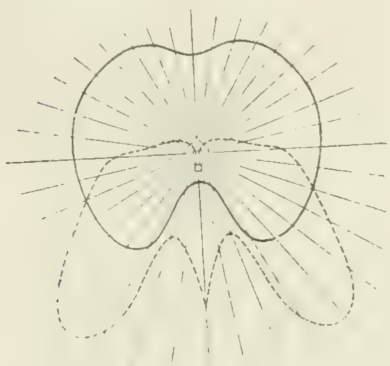

Fig. 1.

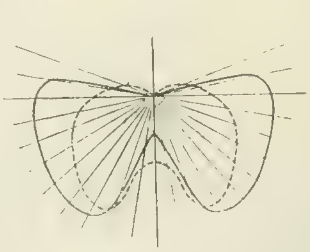

Fig. 2.

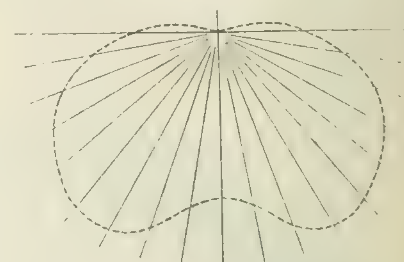

Fig. 3.

Therefore we naturally cannot use the thermopile for absolute light measurements. The method, however, is well adapted to the comparison of the intensity in different directions of the same source, especially if the ratio "luminous energy to total energy radiated" is the same for every portion of the radiating surface.

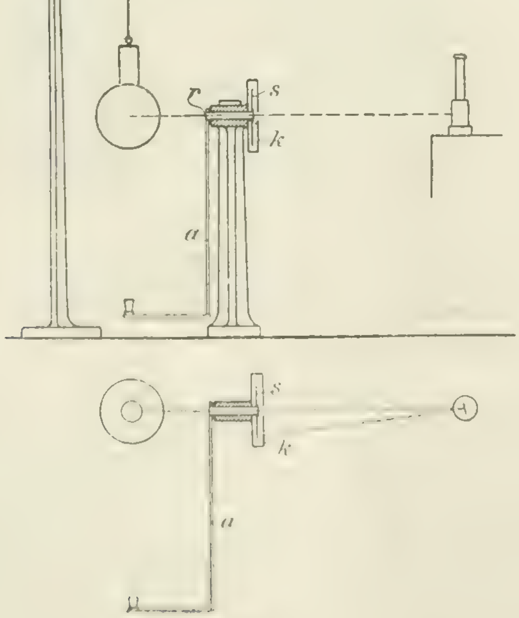

Fig. 4.

This is true in the case of an incandescent glow lamp, for every portion of the filament is in the same radiating condition. It is, however, essential to ensure that the dimensions of the filament itself should be small compared with the distance away of the thermopile As the thermo-electric E.M.F. is proportional to the intensity of the illumination with which it is illuminated,

surface of any extent receives light from different portions of the source of light in just this way.

Numberless experiments have led the author to the conclusion that an adequate representation of the distribution of light from an arc lamp can be obtained in this way, especially if the arc is surrounded by a globe. In doubtful cases a check on the accuracy of the method can be applied by merely repeating the readings, first using a piece of green glass in front of the thermopile, and subsequently a piece of red glass. The curves so obtained should then be very similar, and in the author's experiments this was found to be the case. The author then gives a series of figures to illustrate this point, which, he considers, show very satisfactory agreement.

These results are shown in the table:—

Table.

Angle of inclination to vertical degrees.	Green glass. A_{gr}.	Red glass. A_r.	Ratio $= A_r / A_{gr}$.
0	56·0	66·0	1·18
10	74·0	83·0	1·12
20	74·5	85·5	1·15
30	71·0	87·0	1·22
40	71·5	86·0	1·20
50	69·5	85·0	1·22
60	66·5	78·0	1·17
70	64·5	71·5	1·12
80	49·0	62·5	1·26
90	16·0	46·0	2·88 (?)

In order to apply this method all that is needed is to fix the thermopile at the end of an arm revolving about the source as centre, and note the deflections of the galvanometer corresponding to its successive positions; the process may only take a few minutes. The distance away of the thermopile from the source must be sufficient; in the case of glow lamps, a distance of about 40 cms. to 60 cms., and in the case of arc lamps about 80 cms. to 100 cms., was utilised. A Rubens thermopile and a Siemens & Halske reflecting galvanometer having a resistance of 30 ohms were employed. Then, with a distance of 5 metres between the galvanometer and the scale, a deflection of as much as 1·5 metres was obtainable. The method was, therefore, sufficiently sensitive, and it was found that the deflections due to the thermopile were not erratic, but, on the contrary, very steady and reliable. The zero alteration in the course of an experiment rarely exceeded 2 mm. or 3 mm., and was, therefore, practically negligible.

In order to illustrate the reliability of the method the author then gives a series of curves so obtained, showing the distribution of light from glow lamps, incandescent mantles and arc lamps.

Fig. 1, for example, shows the curve of distribution of light from a carbon filament glow lamp, the curve shown fully indicating the natural distribution from the lamp, and the dotted curve the distribution from the lamp when the upper portion of the bulb was silvered over. In the same way Fig. 2 shows the results of applying the method to an inverted gas light with and without a diffusing globe. Fig. 3 represents the distribution curve of a flame arc lamp with inclined carbons.

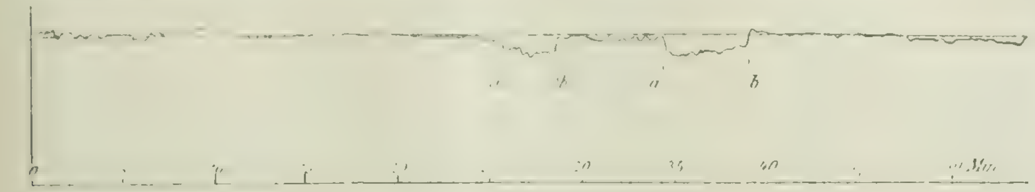

Fig. 5.

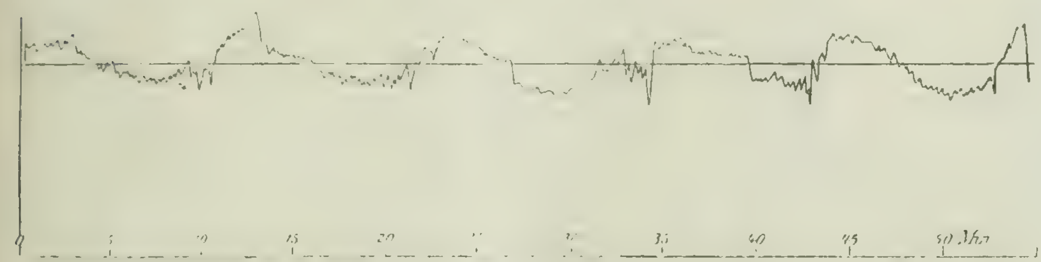

Fig. 6.

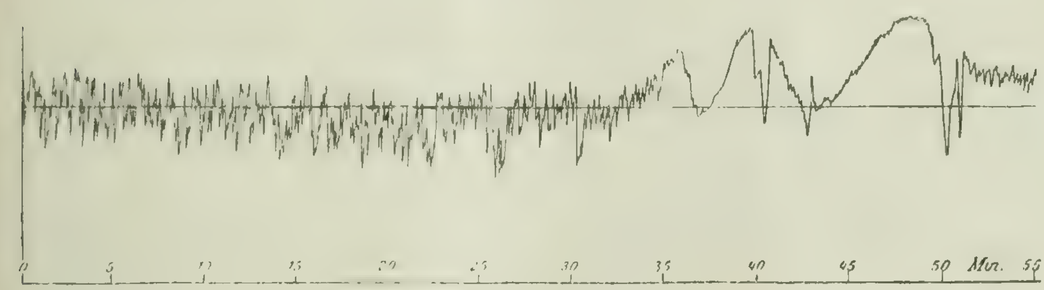

Fig. 7.

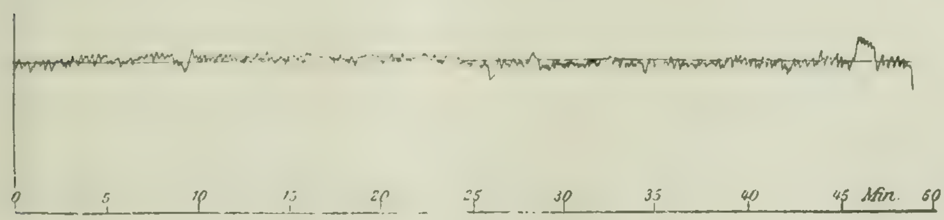

Fig. 8.

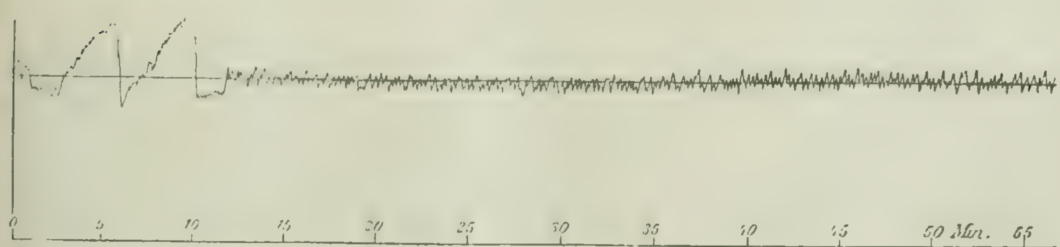

Fig. 9.

The arrangement can be simplified by causing the spot of light from the galvanometer to trace out the curve of distribution of light automatically, as the arm carrying the thermopile is rotated into its successive positions. In order to achieve this object a screen composed of sensitive paper is enclosed in a light-tight box and attached to this arm concentrically with the axis of rotation. The beam of light from the galvanometer mirror, when at rest, falls on the centre of this screen. When the thermopile is acted upon by the light tested, the spot of light travels across the circular screen diagonally, and at the same time the screen is rotated about its axis through the same angle as the arm carrying the thermopile is moved through. The polar curve is thus traced out to scale.

The apparatus is shown in Fig. 4, where *k* is the light-tight box, *s* the screen, and *a* the arm to which the thermometer is attached; *r* is a tube designed to allow a beam from the source of light under test to pass through to the galvanometer mirror, and thus provide the necessary illumination for the production of a spot of light should this be desired.

The optical arrangement described above is also of great service for the purpose of tracing out the fluctuations in candle-power of a source of light. For this purpose it is only necessary to cause the spot of light to fall on a sheet of sensitive paper wound upon a suitable drum, the latter being slowly rotated at a known and fixed rate by means of clockwork. The variations of candle-power on the part of the source under examination are thus automatically recorded. One feature of sources of light which should receive due study is their steadiness, and the author thinks that his apparatus will be specially serviceable for this purpose. For instance, it can be used for studying the fluctuations in candle-power of an arc lamp, the results of the wandering of the arc round the crater, and the effects of using various types of carbons.

The author concludes by commenting on some records of such variations. He shows the fluctuations in candle-power of several arc lamps of different types, and even the variation in the light given out by a glow lamp running on the Hamburg Electricity Supply Co.'s leads. In the case of the latter, it is interesting to observe the drop of P.D. caused by switching on a large induction coil on to the lighting leads shown in Fig. 5.

Figs. 6, 7, 8, 9 represent the performances of arc lamps of different types. In each case the P.D. taken by the lamp was supplied by a battery of accumulators, and the lamp was provided with an opalescent globe. The measurements refer to the ray at 45 deg. to the vertical.

The periodical fluctuations shown in Fig. 6 result from the travel of the arc round the carbons; the figure refers to an ordinary open type of lamp. Figs. 7, 8, and 9 refer to enclosed arcs. Fig. 7 refers to an old-fashioned type of "Lilliput" lamp. Fig. 8, which shows the performance of a newer form of the same make, illustrates the improvement which has recently been made in regulation. Finally, Fig. 9 refers to a Carbone 5 ampere arc, with vertical carbons. The performance of the lamp is very similar to that shown in Fig. 8; it has, however, regulated twice at the beginning of the line.

Royal Society.—At a meeting held yesterday afternoon the following Papers were read: "Helium and Radio-activity in Rare and Common Minerals," by the Hon. R. J. Strutt, F.R.S.; "Seleno-Aluminium Bridges," by Prof. G. M. Minchin, F.R.S.; and "A Tantalum Wave-Detector and its Application in Wireless Telegraphy and Telephony," by Mr. L. H. Walter.

PHYSICAL SOCIETY.

At the meeting held at the Royal College of Science on April 10th, Dr. C. Chree, F.R.S., president, in the chair, a Paper by Prof. W. H. Bragg and Mr. Madsen, entitled

"An Experimental Investigation of the Nature of γ Rays,"

was read by the Secretary. The view that the γ rays are not ether pulses, but are material and consist of neutral pairs of one negative with one positive electron developed in previous Papers (*Phil. Mag.*, October, 1907), appears to be established by the experiments described in this Paper with the secondary radiation produced by the γ rays of radium. On the ether pulse theory, the secondary radiation should be symmetrically distributed, and, from a plate traversed normally by a pencil of γ rays and so thin that its absorption is negligible, should be exactly the same on both sides of the plate in amount, quality and distribution; so that, so far as the secondary radiation is concerned, it ought not to be possible to determine which is the face of entry and which of emergence. As a matter of fact, there is a very great want of symmetry. If an ionisation chamber has its upper and lower ends formed each of plates of two different materials, A and B, and is traversed from end to end by a pencil of γ rays, the current is affected differently when the pairs of plates constituting the upper end are transposed to what it is when the pairs of plates constituting the lower end are transposed, and the difference is the greater the greater the difference in the atomic weights of A and B. On the ether pulse theory there should be no difference. On the neutral pair theory, assuming that the absorption of both β and γ rays obeys the density law strictly, absorption of the γ rays means that a certain proportion of γ particles are stripped of their positives and the negative remainders go on. The emergent secondary cathode radiation from plates of thickness inversely proportional to their density should be the same for all materials. Experiment is in general agreement with this, and the differences promise to be reducible as soon as the difficulties of interpretation have been surmounted. With regard to the incident cathode radiation, if p is the proportion of cathode particles returned to the front face in one plate, and p' the proportion in another plate of different material but similar weight, the incident radiation of the first plate to that of the second is as p to p'. The incident radiation is divisible into two parts, one due to the β particles travelling in the γ stream before incidence, which is scattered, according to McClelland's law, connecting the scattering with the atomic weight, and the other part originating in the plate itself, and the amount of which is regulated by the same law. Hence, as observers have found, the secondary radiation due to γ rays follow a law corresponding to that for β rays, because the secondary radiation is really due to β rays.

The cathode particle due to the γ rays has the same speed, very nearly, as the β particles from the radioactive material producing the γ rays; while, in the case of secondary cathode particles generated by X rays, the velocities are of the same order as the cathode particles inside the X ray bulb. Is it then possible that the cathode particle is first set in motion by the E.M.F. in the bulb, strikes the anti cathode and picks up a positive there, becomes neutral and is now called an X ray, is subsequently stripped of the positive and becomes a secondary cathode particle, the identity of the negative remaining the same throughout and its speed invariable or nearly so? The difficulty comes in when we try to consider the part played by the mass of the positive. Similarly, a γ particle stripped of its positive would be lost to measurement as a γ ray or "absorbed," and become a secondary cathode or β ray, and if a β particle picked up a positive it would disappear as a β particle and be "absorbed."

Dr. R. S. Willows criticised the Paper, and expressed the opinion that the experiments described could all be accounted for by an extension of the ether pulse theory. On the other hand, he instanced phenomena which would be difficult to explain on the neutral pair theory.

A Paper by Miss D. D. Butcher entitled

"Experiments on Artificial Fulgurites,"

was read by Mr. S. Skinner. Fulgurites are tubes formed by lightning striking sand or rock and fusing it. The fact that the tubes formed are of two sorts—strong, rocky, thick-walled tubes, and smooth cylindrical tubes with glassy walls—was pointed out by Dr. Fiedler in 1817, and he suggested the possibility that one sort was formed by positive and the other by negative electricity. This idea seemed to be supported by the fact that the cross section of a thick tube shows a radial structure bearing a marked resemblance to the Lichtenberg figures made by a spark from a positively charged conductor. It was with the view of testing this hypothesis that attempts were made to form fulgurites artificially. The first part of the Paper deals with natural fulgurites, and the second with the production of artificial fulgurites. The results of the experiments may be summarised as follows:—

1. The tubes are formed by fusion of the powder which surrounds the column of air in which the spark passes. The length and thickness of the tube depend on the energy of the spark, and also on the character of the spark—*i.e.*, whether it is unidirectional or oscillatory. This latter is shown by the fact that the same quantity of energy stored in the Leyden jars does not form a tube when the discharge is abrupt and oscillatory, but forms one if the discharge is rendered less oscillatory by the intervention of a wet string resistance, although a large portion of the energy in the latter arrangement is absorbed in overcoming the resistance of the string.

2. There is no appreciable difference in the two ends of a tube provided that the two electrodes are alike. When one electrode is a point and the other a flat plate, any branching that may occur will be towards the plate whichever electrode is made positive. In nature, the flat plate would be represented by the moist lower strata of the soil. Therefore, we cannot say from the character of the tube whether the lightning discharge was from a positive or negative cloud.

3. The difference between thick and thin tubes is due probably to a difference in the sharpness of the flash and the resulting explosive effect. When the explosive effect is great and the quantity of material melted is small, the result will be a large-bored thin-walled tube. Whether this remains circular or becomes pressed together and distorted, depends merely on whether the fused matter has time to cool before the outward pressure of the blowing has been overcome by the inward pressure on the surrounding sand or not. In nature, the damp sand or soil probably acts as the damp string in these experiments, and consequently causes many lightning discharges to be unidirectional. In the experimental tubes the outward pressure was so great and the quantity of fused material so small, that the walls were broken through and left as a mere network.

Mr. Alexander Russell congratulated the authoress on her interesting Paper. Although he had never found a fulgurite he had noticed several phenomena which seemed connected with their formation. Several years ago during a thunder-shower on the sea, he noticed several flashes striking its surface. Where they struck puffs of steam apparently shot upwards. The appearance was not unlike the splash made by a gannet when diving. It was probably caused by the evaporation of the water in the path of the discharge. Now, a striking peculiarity about fulgurites was that they had a hollow core. The material originally filling it had probably been vaporised. It was, therefore, highly probable that when a lightning flash strikes sand, a puff of smoke would be shot out from the end of the fulgurite. When testing insulating materials with high voltages, a puff of smoke from the perforation was often the first indication of the breakdown. Electricians frequently noticed that when a fuse consisting of a thin wire embedded in sand "blows," a tube of siliceous material is formed. When there was considerable power involved, the tube was raised to a very high temperature and, like the glower of a Nernst lamp, it allowed quite a considerable current to pass through it. It would be of interest if the authoress would investigate the conducting power of fulgurites when heated. The difference between thick-walled and thin-walled fulgurites appeared to be only one of degree. If they assumed that the energy to be got rid of was the same in the two cases, then, when a lightning discharge had a long path to traverse before reaching a good conducting stratum, the fulgurite would in general be thin walled, but when the path was short it would be thick walled. It was obvious that a very appreciable amount of energy must have been expended in making some of the fulgurites, parts of which were exhibited.

Dr. C. H. Lees asked if fulgurites, when found, were hollow or filled with sand, &c.

The Chairman asked if there were any changes in the magnetic properties of a material when it was formed into a fulgurite.

Mr. Skinner expressed his interest in the remarks of Mr. Russell on the electrical conductivity of fulgurites, and pointed out that if the sand contained salt the fulgurites would probably be conducting. The suggestion that there might be changes in the magnetic properties was interesting and might be tested by experiment.

A Paper entitled

"Short spark Phenomena"

was read by Mr. Duddell. The Paper deals with two effects which the author has observed in connection with some measurements of the current in the secondary circuit of an induction coil. The apparatus in use consisted of a 12 in. Newton induction coil, which was supplied from the 200 volt direct-current mains. A large resistance was placed in series with the primary of the coil to limit the current, and the current was interrupted by means of a mercury-jet interrupter. The secondary circuit contained a galvanometer to measure the mean current, and a thermo-ammeter to measure the root-mean-squared current. When there was no spark-gap in the secondary circuit and the coil was in action, the mean current, as read by the galvanometer, was zero, and the root-mean squared current about 3·8 milliamperes. If, now, a microscopic spark-gap, say between two aluminium points, was introduced into the secondary circuit, two curious effects took place. Firstly, the R.M.S. current enormously increased in value, and, secondly, a very large deflection was produced on the galvanometer in the direction corresponding to that due to making the primary circuit. The introduction of a spark gap [illegible] mm long caused the R.M.S. current to rise to 3[illegible] milliamperes, and this continued to increase with increasing length of spark gap until it reached a maximum with a gap about 1·4 mm. The author thinks that this effect is due to very high frequency oscillations set up in the wires connected to the secondary circuit of the coil when a spark gap is introduced. He has observed

the effect with brass, iron, zinc, and aluminium electrodes, but the latter metal is the best to use. The large deflection in the negative direction observed on the galvanometer was investigated by recording the wave forms of the potential difference and the current by means of an oscillograph. The author showed a series of curves which he had obtained and gave an explanation of the phenomenon. The effects were shown experimentally at the meeting.

Mr. ALEXANDER RUSSELL thanked Mr. Duddell for his valuable Paper and for the exceedingly interesting and very successful demonstration of short spark phenomena. The author's complete analysis of the phenomena he had discovered would be a great help in elucidating the difficult theory of the action of the induction-coil and would throw light on many still unexplained effects. He believed that the change of sign of the direct current component in the secondary circuit of an induction coil was first discovered by Mr. Duddell, and the Physical Society was to be congratulated on having been the first Society to which this phenomenon was clearly described and demonstrated. He considered that the rise in the value of the effective current when the air-gap was widened was a resonance phenomenon. The capacity between the electrodes was in series with the inductance of the secondary, and hence, as the author pointed out, Kelvin oscillatory discharges were continually taking place. The shape of the curve showing the connection between the effective current and the distance between the electrodes was strong evidence in support of this view. The explanation of the direct current component when the electrodes were at considerable distances apart, might be made by remembering that the wave pulses of E.M.F. round the secondary at "make" and "break" were of different shapes although their integral values were the same. The maximum value of the induced E.M.F. at break was much greater and the consequent rush of electricity was more "impulsive" than at make. Hence, when the electrodes were sufficiently far apart the air-gap was only broken down by the break E.M.F., and so they got a unidirectional pulsating current of triangular shape. When the electrodes were closer together they got an alternating current, the shape of the positive and negative waves being quite different owing to the differently shaped waves of E.M.F. at make and break. When they were very close together, the author's oscillograms showed that they got a pulsating unidirectional current in the direction due to the "make" E.M.F. The reason for this strange phenomenon was by no means obvious.

Mr. S. SKINNER expressed his interest in the Paper, and referred to the experiments on the electrolysis of steam carried out by J. J. Thomson by a modification of Perrot's method. He found that with short sparks the hydrogen appeared at the positive electrode instead of at the negative as in ordinary electrolysis. Perhaps this phenomenon was due to the same causes as the effects shown by the author.

Dr. R. S. WILLOWS asked if the maximum current obtained was connected in any way with the minimum sparking voltage.

Prof. CASSIE pointed out that the minimum sparking voltage occurred at distances very much less than those used in Mr. Duddell's experiments.

Mr. C. C. PATTERSON asked if the author had tried experiments with spark-gaps of different capacities.

Mr. A. CAMPBELL asked if it was possible that the rectifying action of the spark-gap might be similiar to that of an ordinary aluminium electrolytic rectifier.

Mr. DUDDELL said he did not think the effect was in any way connected with the minimum sparking voltage. He had tried varying the materials of the electrodes and using electrodes of various capacities and the effect was the same.

A RESISTANCE CUT-OUT FOR THE PROTECTION OF ELECTROSTATIC VOLTMETERS.

Electrostatic voltmeters are nowadays not so much in favour for use in electrical-control systems as they were some years ago. There is, however, one field of application for such instruments where they are still used very considerably. We refer to their use as earth detectors on high-tension circuits. According to the Home Office Regulations, on every completely insulated system in a coal mine an earth detector must be kept connected up continuously in circuit, so as to indicate the leakage current. As is well known, this regulation cannot be carried out, as no method is known whereby the leakage current of, for example, a 2,000 volt three-phase circuit can be continuously indicated. On such circuits, therefore, an attempt is made to comply with the spirit of the regulation by installing three electrostatic voltmeters connected between phases and ground.

Messrs. Ferranti Limited have brought out an instrument containing three electrostatic voltmeters in one case for this purpose. A rather unfortunate property of electrostatic voltmeters, however, is that they sometimes spark across internally. If some means of protection is not provided, this generally results in the instrument being burned out.

Fuses of the oil type, and of other types, have been used for this purpose, but not very successfully. The amount of current which passes through even the smallest practical fuse is sufficient to burn up the delicate vanes of the electrostatic voltmeter. Fuses in combination with choke-coils and resistances have sometimes been used, but Messrs. Ferranti state that the success of this arrangement is very questionable, and it is also expensive and cumbersome. If the choke-coil be allowed to get dirty or wet it will break down, and is itself then the cause of trouble. The resistance cut-out (Garrard's patent), manufactured by Messrs. Ferranti Limited, has been put on the market as a solution of the problem. The apparatus consists of a small glass tube (Fig. 1) filled with water of a certain con-

FIG. 1.

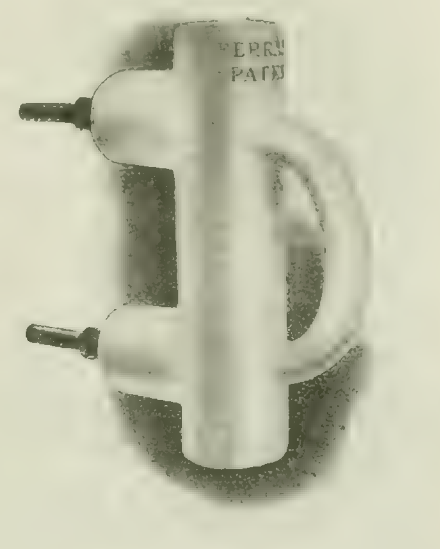

FIG. 2.

ductivity corresponding to the voltage of the supply. A small valve is provided in the glass tube near the bottom, consisting of a hole covered with a piece of rubber tubing. This water-tube resistance is placed in series with the electrostatic voltmeter. The current is led in at the bottom of the glass tube and taken out at the top by means of platinum wires fused into the sides of the tube. The whole is enclosed in a removable porcelain handle (Fig. 2), and the method of mounting is shown in Fig. 3.

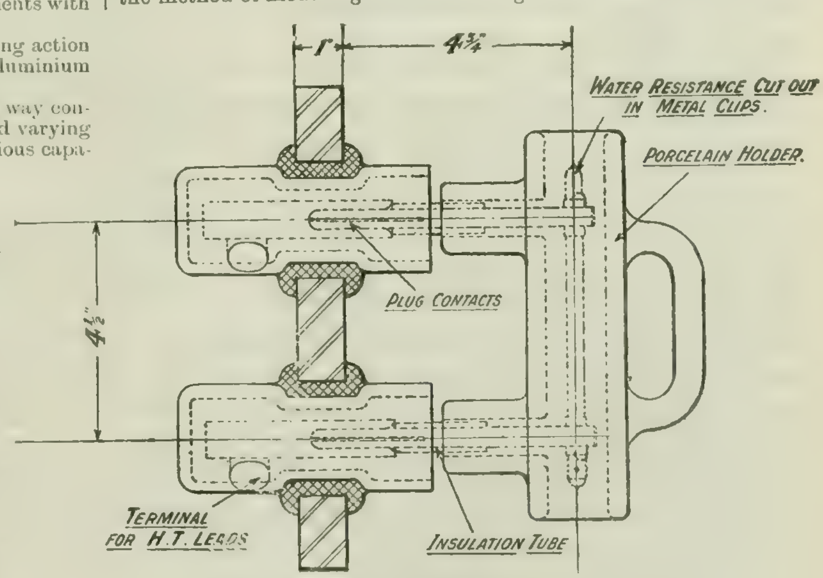

FIG. 3.

The resistance of the water tube is so adjusted that if sparking occurs, for any reason, within the voltmeter the current is limited to such an extent that only a small amount of energy is expended in the water tube. If the current continues to flow the water is heated and boiled, and a slight jet of steam issues from the valve above referred to, interrupting the circuit.

This device has been subjected to very severe tests, such as placing it directly across the terminals of a 3,000 volt alternator, when the circuit was interrupted so quietly as to be scarcely perceptible. The device is now in successful operation in many parts of this country and abroad. It is to be noted that this resistance cut-out is only suitable for protecting electrostatic voltmeters, and is not, for example, intended for protecting synchronising transformers.

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IS THE CONSULTING ENGINEER NECESSARY?

It is well known that customs vary enormously in different countries, and that what is necessary in one country is sometimes considered quite unnecessary in another. Even in engineering matters this is somewhat the case, a very striking example of this fact being the position of the consulting engineer. In Great Britain he has obtained a certain position, but in many countries he is practically non-existent. This, no doubt, is due to the way in which the engineering industry is carried on. In this country there are numerous manufacturers and contractors in almost every line of engineering. On the Continent, on the other hand, most of the work has been in the hands of a few large engineering firms, and there has been a tendency for the large firms to survive and for the smaller firms to die out. Consequently, for many years past, if

an engineering scheme was contemplated, one of these large concerns usually took the matter in hand, prepared a scheme and carried it through. This method was rendered possible because such firms generally obtained concessions or financial interests in projected schemes, so that the engineering work fell to them as a matter of course. We need scarcely remark, however, that the combination of financing with contracting is not a sound way of doing business; it is a method that has led to many failures, and these are familiar enough to our readers without referring to specific instances.

In this country, on the other hand, competition has always been very keen, and engineering work has generally been secured by contractors as the result of tendering. For that reason the specification and the consulting engineer have gone hand in hand as a preliminary to most of the engineering work that has been carried out. We notice, however, that there has been a growing tendency during the last few years for manufacturing firms to be approached by prospective purchasers direct, either without any specification, or with a specification extremely inadequate for the purpose. A glaring example of this kind is the specification recently issued by the Bristol Docks Committee for cables for distributing power and light over the Avonmouth Docks. By far the greater part of the document issued to contractors consists of general conditions and matter irrelevant (from the specification point of view) to the contract in question; indeed, the specification, for work amounting probably to £20,000 or more, is brief and of the most sketchy kind. It gives a general idea of the work required, but extremely little definite information, except length and style of cables, on which a contractor can base a price. For example, we are told that certain groups of motors, amounting in the aggregate to 2,177 B.H.P., together with a large amount of arc and incandescent lighting, are to be supplied from the public supply mains, the position of the supply being indicated. Nothing is said as to the rating of the motors or the extent to which they will be used, but the contractor is expected to derive definite information for all his requirements from the following luminous paragraph:—

> The cables are to be designed to the best advantage of the work which they have to perform, having due regard to the economy in copper on the one hand, and, on the other, a drop in voltage at any part of the system when under different working conditions which shall not, in the opinion of the Engineer, unsatisfactorily affect the working of the motors, the arc lamps, or the incandescent lights.

A specification of this kind necessarily entails a great deal of expenditure to any contractor tendering for the work. Not only so, but when in due time the tenders are received they are on no common basis. Of course, in such cases the tenders are to be accompanied by detailed drawings and full particulars of the whole of the work, and with detailed specifications of the work proposed. In this particular instance "the whole of this information is to be very ample." In other words, the purchaser is to be supplied with a complete scheme worked out in detail by every contractor who tenders, and, moreover, each contractor knows that there is a very good chance that he will not get the work, and will have gone to the trouble and expense for nothing. Of course, other purchasers eventually have to pay for this work, but the purchaser in question gets expert information of this kind from each contractor, and pays nothing whatever for it.

This abuse is liable to become a serious matter; in fact, at the present time in Germany, where competition for engineering work is becoming much more recognised than in the past, the Verein Deutscher Ingenieure considers the matter so important that it has drawn up a memorial on the subject with the object of stopping the practice completely, on the ground that work of this kind should not be done without remuneration.

In the case of Great Britain one is tempted to ask the question—what has brought about this increasing practice on the part of contractors of doing speculative work, for which, in all probability, nothing will be received? We think it is due to want of recognition of the consulting engineer, and to a mistaken idea that it is better to deal direct with the purchaser. At the present time, curiously enough, it is realised that a consulting engineer must be a consultant and nothing more, that he must not be a contractor or manufacturer at the same time; but, on the other hand, the contractor or manufacturer may combine the functions of the consulting engineer at will. This is not logical. It is, no doubt, the result of organisation on the part of the contractor, who feels that he has a right to take up not merely contracting but consulting also, and is free to advertise accordingly. The consulting engineer has little inducement to go outside his proper limits. Yet, according to present ideas on professional etiquette, the consulting engineer must sit down and wait for work to come to him, he must be careful not to suggest that he is well qualified to carry out work of any particular character (unless he be an insurance company), and if the contractor or manufacturer proceeds to undermine his profession he must not complain. We do not suggest the abolition of professional etiquette, but if the consulting engineer is to be so hedged round he should at least be supported, instead of undermined, by his brother engineers in other branches of the profession.

To some extent the idea gained ground during the earlier days of electrical engineering that consulting engineers were undesirable. That, however, was a very false impression as a whole. There have, no doubt, been undesirable consulting engineers, and we have no desire to take up the matter on their behalf. Indeed, we hold no brief for any particular class of engineer. But there is no question (and this opinion has been confirmed by well-known contractors) that nothing is gained by the contractor by working direct with the purchaser, except in the case of inferior contractors. On the contrary, much is lost, for the simple reason that work is liable to go to a very undesirable class of contractor—namely, the one who will cut prices indefinitely, because he has no detailed specification by which he is bound. Such cutting of prices reacts, of course, upon the competent contractor, who gets less work than he otherwise would; not only so, but the purchaser is apt to be dissatisfied, and, in many cases, the work carried out is discreditable to the electrical profession as a whole. A good specification is the surest way of putting a stop to such methods, because the contractor knows much more exactly what he is expected to do. The prices of the good contractor consequently can be kept

down as low as is consistent with profit, whereas the price of the undesirable contractor is necessarily forced up because he knows that he will be bound by the specification. We think it will be readily admitted that wiring, for example, would have benefited materially during many years past if it had been carried out to specification. There would have been less cutting of prices, less cause for complaint on the part of the conscientious contractor that wiring had become "impossible," and, finally, the standard of work would have been higher. As things are at present, the advent of the ironmonger and plumber into the field of electric wiring is a natural consequence.

In many ways the consulting engineer renders the path of the contractor more smooth. He forms the intermediary between the contractor and the purchaser, and, as such, he often stands very much in the position of an arbitrator. He should, in fact, be anxious to see fair play according to the contract, and in that rôle he can render important services to both sides. The purchaser, for example, is often ignorant of technical matters, and thus he not infrequently disputes a point where, through ignorance, he is quite in the wrong, and where the consultant will not hesitate to show the error, whereas the contractor would be regarded with suspicion, as merely biased. Disputes over trivial matters are thus avoided. The contractor benefits by having such matters as ratings put clearly, instead of indefinitely: he deals with a man having technical knowledge, to whom he can appeal, instead of a layman with hazy ideas; and he may even request a certificate of payment without fear of wounding susceptible feelings, for the certificate is issued as a matter of course by the consultant.

We feel strongly, therefore, that all leading contractors should face the position without delay, and should give ready support to the consulting engineer. What would be the position of builders to-day if they did not support the architect? No builder will tender for work without a bill of quantities, because it is not his work to get out quantities, and the latter cannot be got out without the plans and specification of the architect. This is rendered all the more easy by the fact that membership in the Royal Institute of British Architects is generally obtained before practising, and is usually regarded as a necessary qualification. The architect, therefore, has an acknowledged position, and even the man in the street rarely thinks of building a house without engaging an architect. Similarly, the position of the consulting engineer should be recognised, which it certainly is not by the public at the present time, and we submit that it would be for the benefit of the industry generally if contractors were to make a point of refusing to take up work except through the medium of the consulting engineer. At first sight this may seem like a "self-denying ordinance." A little reflection, however, is sufficient to show that this is by no means the case. By following such a course work would not be diminished, non-remunerative work would be avoided, and the standard of good work would be maintained. In fact this course appears to be the only way of preventing unremunerated consulting work on the part of contractors from becoming a serious evil to the contractors themselves and a burden upon every purchaser, rendering competition still more difficult.

REVIEWS.

(Copies, of the undermentioned works can be had from *The Electrician* Office, post free on receipt of published price. Add 5 per cent. for abroad or for foreign books.)

Comparative Electro Physiology. By Jagadis Chunder Bose (London: Longmans, Green & Co.) Pp. xlii.-733. 15s. net.

This book should interest a large circle of scientific readers, dealing as it does with problems of physics, botany, physiology and experimental psychology. The author, when he was in England, acquired a reputation for the skill and ingenuity with which his apparatus was designed, and in the present volume he has given further instances of this. The book contains much that is novel, and the feeling on the part of many will be in reading of his experiments—"This must be tried."

It is, one would imagine, news to the physiologist that a nerve should contract in the act of transmitting a sensation, yet a contraction which may mount up to 14 per cent. should be measurable without Prof. Bose's delicate apparatus.

Then, too, the botanist who has regarded the so-called "nerves" of a stem or leaf rather as veins to convey material to and fro, will be surprised to read that a wave of electrical response runs along them when excited just as in real nerves. Before criticism is possible one must repeat the experiment. We have regarded the nerves of a plant and the heart of a cabbage as mere descriptive expressions, but Prof. Bose implies that these nerves convey stimulus to the plant, and that "a more or less continuous supply of stimulus is essential to the maintenance of the proper excitatory condition of a tissue."

One of his experiments should be interesting to psychologists. It consisted in making a wound 1 centimetre in diameter on the back of the hand of a human being, putting salt solution on it, and sending an electric current through it. A diagram shows how this was done to a dozen different individuals whose ages varied from 18 to 26. When the wound-spot was anode, an E.M.F. of half a volt caused "intense pain," but the effect was "soothing" when the wound was kathode. With two volts the opposite was felt—viz., pain at the kathode, and a soothing sensation at the anode. Other experiments with his sensimeter, less startling to the uninitiated, and demanding somewhat less scientific devotedness on the part of the class, will probably become part of the curriculum of the psychologist.

To the physicist, perhaps the most interesting thing is the magnetic conductivity balance described on p. 607. A primary coil is wound about the middle of a long iron rod, on which are two movable secondaries, one at each end, connected in series with a galvanometer.

One of the secondaries being kept at a fixed distance, the other is moved till the galvanometer is not deflected. If now the molecular condition of one end of the rod is altered by placing a permanent magnet near it, or by sending a steady current through a small coil wound round it, the behaviour of the rod is altered to the magnetic induction of the central coil, and there is a deflection of the galvanometer when currents are sent through it. The author explains this as on all fours with what physiologists call the anelectrotonic or katelectrotonic condition of nerve, which becomes more excitable or less so according as a current is sent along it in one direction or the other.

These experiments are of exceeding interest, but it is doubtful whether the author's interpretation of them will be accepted. The phenomena correspond outwardly, in a way, to some of the phenomena of living matter, but not to all. And there is a still simpler arrangement known in Germany as the *Kernleiter*, that is to say, a body of which the core is a good conductor and the sheath a poor one, such as a piece of cotton covered copper wire soaked in salt solution, with which the phenomena of nerve can be even more closely imitated. But it is only imitation, as the child's toy engine imitates the locomotive, and to lay too much stress on these imitations is dangerous. The frost upon the window panes may look like ferns or moss, but to say that the forms of these are due to no other causes than those which made the water crystallise is to throw away all chances of increasing knowledge, merely that we may contemplate a vast—but very barren—generalisation.

G. J. Burch.

Searchlights: Their Theory, Construction and Applications. By F. Nerz. Translated by C. Rodgers. London: A. Constable & Co. Pp. vi.-134. 7s. 6d. net.

This book is intended to serve chiefly as an introduction to the subject for users of searchlights and more particularly takes the point of view of officers of the Services who have to do with this class of apparatus. It must be said that the object in view has very fairly been attained, the author having handled the subject both from its theoretical and practical sides in a clear and readable manner. The theory of illuminating distant objects is first worked out by simple methods, taking different arrangements of mirrors and lenses as examples; and this section is completed by two tables which embody the results of the formulae worked out and include a number of experimentally obtained constants, whereby the size of searchlight to be used under any given conditions can be readily determined. These tables should be of considerable value in practical work. The book then describes a number of examples of searchlight plant for use in the field, in fortresses and on board ship. The examples given are almost entirely drawn from Continental practice which perhaps detracts somewhat from the value of the work as a handbook in cases where a somewhat detailed description of the apparatus in use here is required. The same remark applies to the employment throughout of the Hefner candle as the unit of light. This perhaps is only to be expected from the fact that the work is a translation from the German. Possibly in a second edition, examples of English practice could be added. Some interesting portable plants driven by petrol and alcohol motors, and steam turbines, are given, including some points as to the working of alcohol motors. The section on searchlight lanterns, lamps and lenses is very full, and with the limitation mentioned above is well brought up-to-date. The book is remarkably free from superfluous matter, and is well printed and illustrated.

Elektromechanische Anwendungen. By Siegfried Herzog. Leipzig: Johann Ambrosius Barth.) M. 20.

This book is a very complete, practical treatise on the application of the electric motor to general industrial purposes. It covers a very wide field and gives full information on the latest methods of electrical driving of nearly every class of machinery. Electric traction is not dealt with, as it does not come within the scope of the book.

A special feature of the work is the large number of excellent working drawings, illustrations and diagrams which it contains, and by means of which the text is rendered very clear. The general plan is to give working drawings and to amplify these, where necessary, by photographic views so as to convey a good idea of the general combination of the motor and machine. There are 700 of these illustrations. Sound judgment has been exercised in the selection of the subject matter, which is well sub-divided, and is arranged in 34 chapters.

The first chapter deals with the different types of motors, methods of speed regulation, the conditions to be complied with, and the methods employed in driving the different classes of machines, discussed in greater detail in the subsequent chapters. In the second chapter, under the heading "Apparatus," controllers, starters, automatic water resistances, and speed-regulating devices are considered. The following seven chapters contain very full information on electrically-driven workshop machines and tools, of which a large variety is given, electrically-driven pumps, air compressors, exhaust and ventilating fans, textile machines, paper and agricultural machinery.

Electric driving in mines and collieries is next treated in six chapters, the subject being exceptionally well handled, especially the two on electrical winding and haulage plants. Numerous examples of typical continental installations are given, and the peculiar features of the problems to be solved are satisfactorily explained. The Ilgner system is given in the greatest detail. Much valuable information will be found in these two chapters, the large number of working drawings being particularly useful. The remaining chapters of this section are devoted to electrical mine locomotives, pumping plants, ventilation, electrical rock drills, and coal cutters.

Electrical driving in foundries, steel works and rolling mills is then explained in detail in seven chapters, which are clear and exhaustive, and also contain numerous illustrations of working plants. Then follow chapters on the electric driving of special winding machinery and capstans, lifting magnets, electrically-operated platforms, turn-tables, elevators, electric hoists, travellers, industrial locomotives, electromobiles, systems of electrical canal haulage, &c., and a final chapter giving miscellaneous industrial applications of the electric motor. Mention should be made here of the electrical equipment of the ship lifting and transporter plant of the Donaw-Moldaw Canal, explained at some length in the penultimate chapter.

The author is to be congratulated on having produced a very comprehensive and valuable handbook of reference on the uses of the electric motor.

MANUFACTURE OF ELECTRICAL CONDENSERS.*

BY G. F. MANSBRIDGE.

Summary.—Consequent, no doubt, upon the newness of the industry, very few reliable physical, electrical and manufacturing data concerning commercial condensers have been published. The author here deals with the subject of the manufacture of condensers from a practical point of view, the numerical data given being obtained from workshop tests, and not from isolated specimens under laboratory conditions.

Electrical condensers are among the oldest electrical devices, but until about 1898 they were only employed to any extent in connection with telegraphy. Since that date, however, the situation has been entirely changed, due to the development of the telephone service, more particularly the common-battery system. With the greatly increased demand manufacturing methods have changed, and instead of building 1 mfd. to 2 mfd. per day, 100 times that amount can now be turned out by a machine hand, resulting in a reduction of the total cost to about one-tenth. Many of the data here given are gleaned from the records of the Post Office factory at Clerkenwell, E.C.

For convenience of description the various types of condensers are considered separately. They fall naturally into four chief classes—namely, mica; glass; paper or other fibrous material impregnated with wax, resin, oil, &c.; electrolytic cells.

Mica Condensers. On account of the very high cost of mica sheet suitable for the work, condensers of this form are but little used. Mica condensers, when well made, retain their capacity and insulation better than those made of paper, and they have also a higher dielectric strength for the same thickness, but the cost per microfarad is approximately 10 times greater than that of paper condensers. Fortunately, the inductive capacity of mica is high (about twice that of paraffined paper), or the labour cost would be excessive, since the size of the sheets is limited to about 4 in. by 3 in., the cost of larger sheets of uniform thickness being prohibitive. A good working thickness is 0·0015 in. to 0·002 in., and if the material is carefully selected there is no necessity, for ordinary purposes, to use more than one sheet between consecutive foils. For purposes where mechanical strength in the condenser plate itself is of special advantage mica is very satisfactory, and for standards it is unrivalled. In standards the chief desiderata are: (1) Constant capacity with efflux of time; (2) constant capacity with varying temperature; (3) high insulation and low absorption.

To obtain (1), it is necessary that the mica and tinfoil sheets be perfectly flat and free from inequalities, so that they will build up under pressure into a solid mass without flexure or mechanical strain; it is also necessary that in assembling the sheets all air-bubbles be excluded. To obtain (2), advantage is taken of the fact discovered by Dr. A. Muirhead† that the mica sheets have a positive temperature coefficient if coated with shellac, and a negative temperature coefficient if coated with paraffin. By building a condenser in two sections, one treated with shellac and one with paraffin wax, the variation of capacity within ordinary limits of temperature can thus be brought practically to vanishing point. To obtain (3) it is necessary to use only selected sheets of the finest clear "ruby" mica, which must be uniform in thickness throughout the sheet, and free from cracks, veins or flaws; spotted or "speckled" mica is useless for the purpose.‡ The shellac employed should be the finest button lac dissolved in absolute alcohol and carefully strained until perfectly free from suspended matter. The building up or assembling of the sheets of foil and mica may conveniently be done on a "hot plate," the greatest care being taken to exclude air bubbles, grit or excess of paraffin or shellac. The desiccation should be slow but

* Abstract of a Paper read before the Institution of Electrical Engineers.

† U.K. patent 15,337, 1891.

‡ An interesting memorandum on mica has recently been published by the United States Department of the Interior.

thorough, and the temperature should not exceed 212°F. The finished condenser should be carefully and not excessively pressed, and should be allowed to cool under pressure in the ordinary way.

Glass Condensers.—The requirements of wireless telegraphy and X-ray work have latterly increased the importance of Leyden jars, and there is now quite an appreciable trade in glass jars for this specific purpose. As is well known to wireless workers Leyden jars, like other condensers, are prone to fail in use if at any point there is imperfect contact between the conductor and the dielectric, and to avoid this difficulty the best plan is to silverplate the glass This may be done by precipitating metallic silver on to the glass in the form of a bright continuous film by the well-known method employed for silvering galvanometer mirrors, &c. An important development of this silver-plated Leyden jar is to be found in the Moscicki high-tension condenser, recently placed on the market by Messrs. Isenthal & Co. In the author's opinion this condenser represents the most satisfactory and practical high tension condenser for commercial work which has been introduced up to the present.* In view of the large number of stations working with a power factor ranging about 0·75, and of the advantages to be gained by improving this power factor, the author would suggest that the question of installing a battery of modern glass condensers at such stations is worthy of more than passing consideration.

Condensers with Paper or other Fibrous Dielectrics.—Although this form of condenser has been employed for many years, there have been but few important changes in the process of manufacture until lately. The standard practice up to the last decade was to use separate sheets of tissue paper and separate sheets of thin metallic foil, and the method employed was to dry the paper by heat, then to transfer it to a bath of hot paraffin wax, and after due soaking to build up the condenser on a "hot plate," the paper being taken sheet by sheet from the bath of hot wax. Obviously, this method of building condenser plates was slow, tedious and expensive, and it had the further disadvantage that as the workmen who handled the material were exposed to a high temperature, the risk of contamination of the wax by emanations from the body was great; indeed, the difficulty was such a serious one that the manufacture of satisfactory condensers in very hot weather was practically impossible. Even in cooler weather it was necessary to select workmen who were not prone to perspire freely. In consequence of this difficulty, the author found it of advantage to build up the condenser plates "dry" in a separate room and to desiccate and impregnate the condensers as a subsequent operation. The slow process of assembling the sheets one by one and of handling about 250 separate pieces to make up a 1 mfd. plate, however, still required improvement. The method adopted was to wind up into the form of a roll long strips of metal foil, two strips of paper being interposed between each foil—that is, six strips in all. This method, which was introduced to the Post Office by Sir John Gavey in 1899, had, however, difficulties of its own. Pure tin foil of the requisite thinness could not at that time be obtained in strips longer than a few feet, and the alternatives were: (1) To feed between the rolls of paper a series of strips of pure tin foil some 4 ft. long, each strip overlapping its predecessor by an inch or two, so as to maintain continuity; or (2) to use an alloy of lead and tin which could be obtained in continuous lengths. The former was an awkward and unmechanical arrangement, and the latter had the disadvantage of producing a heavy and bulky condenser. Both methods also involved a considerable proportion—rarely less than 10 or 15 per cent.—of short circuits in the finished plates brought about by grit in the foil or by defects in the paper. In endeavouring to overcome these difficulties, the author hit upon the idea of using metallised or "foiled" paper of the same character as that sometimes employed for wrapping up packages of tea, &c. Experiments showed that commercial "tin-foiled paper" as then made was not sufficiently reliable as an electrical conductor for the purpose; and even in those samples which gave fair conductivity in the plain sheet very little creasing of the paper sufficed to destroy the continuity. The matter was, however, considered sufficiently promising to warrant careful investigation, and the difficulties in the way of producing a thoroughly reliable conducting surface on such paper were found to be surmountable.†

The process of preparing this foiled paper is as follows: As is well known, metallic tin may be thrown down from its solution either chemically or electrically in the form of an impalpable powder, and the preparation of the finely divided metal is the first process. The ingot tin—previously granulated or "feathered"—is dissolved in nitro-hydrochloric acid, and after all scum and insoluble matter have been removed the solution is diluted, and the tin is carefully precipitated by metallic zinc, or by the action of a weak electric current. After precipitation the powder is repeatedly washed to free it from all traces of acid, and is sifted through sieves of the most minute mesh, so as to eliminate all large particles of tin or any grit with which it may have become contaminated. A suitable adhesive, such as size, is added, and the tin mud is then passed to the coating machines. These are provided with mechanical stirrers to prevent the metal settling, and with rotating brushes and spreaders to distribute the metal evenly over the surface of the paper as the latter passes through the machine. In some machines the paper is passed over heated cylinders so as to dry the coated surface quickly, but as this is liable to reduce the efficiency of the adhesive it is preferable that paper for electrical purposes should be dried more slowly—for instance, by exposure to currents of warm air. The dried paper then presents a dull gray appearance, and microscopic examination shows that the surface is covered by a magma of minute crystalline particles forming a layer of appreciable depth. The paper then passes to the burnishing rolls which consist of heated heavy steel calenders or friction rollers between which the paper is fed. These friction rollers compress the dull magma of tin powder into a coherent thin film having the lustre of the polished metal. During this process any comparatively large crystals of tin or particles of grit which may have escaped untrapped will be driven partly or wholly through the paper, but the effect of this is eliminated by the subsequent electrical treatment, as described later on. The paper is now passed to the slitting machines where it is trimmed and cut to any desired width.

It is interesting to note that prior to the calendering process referred to, the film of tin powder is non-conducting, the conductivity being produced by the action of the steel-burnishing cylinders which so consolidate the coating as to bring the particles into intimate contact. On the foiled paper as usually made for condensers, the quantity of tin averages 25 grains per square foot, and the conductivity is about 25 per cent. of that of pure tin, the resistance of a strip 1 ft. wide averaging 0·3 ohm per foot run. This density of coating gives a surface of 280 sq. ft. to the pound of tin. The average thickness of the tin film is, therefore, as nearly as possible 0·0001 in., or say, 0·0025 mm. Seeing that the material is semi-transparent, the current-carrying capacity of this film is surprisingly high, the fusing current in air being rather more than 1 ampere per inch of width. Bending the paper round even a very small radius does not affect the continuity, but if the paper be very closely folded back on itself so as to put the film sharply in tension or compression, a certain amount of disintegration follows, and the fusing current is correspondingly lower. By using a greater density of coating, say 40 grains per square foot, the effect of creasing is greatly diminished, but there is no necessity for this higher density in condenser work since the creases in the rolled condenser even at the centre of the roll are not very sharp.

The foiled papers may be placed with their metallic sides facing each other, but separated by the two plain papers, in which case the two body papers form the dielectric on the opposite side, or, alternatively, the papers may be arranged so that the dielectric on each side is made up of one body paper and one plain paper. The latter plan is preferable, as it gives a more even distribution of the dielectric strain. Interleaving paper is invariably used for telegraph or telephone condensers, since the insulation otherwise obtainable is but a few megohms. The machine usually employed for the rolling operation accommodates two reels of plain and two reels of foiled paper, and is provided with a set of interchangeable winding mandrels of various diameters.

Mandrels of different diameters for winding the strips are required because of the variously shaped condensers; obviously plates of any desired capacity can be made on any one mandrel by merely varying the number of turns. It is found that, within limits, plates of high capacity require appreciably less area per microfarad than those of low capacity. There is, therefore, a saving in material as well as in labour by building the plates in as large units as possible. Further, it is found that plates built with narrow foiled paper require less material per microfarad than those built with wide paper. This is doubtless due to the wider paper offering greater facilities for trapping the paraffin instead of allowing it to be expressed. The two effects, taken together, indicate that a condenser in the form of a cube would require less material than one in any other shape. The cube is, however, not the most suitable shape for manufacture, and as the conditions of service are often such as to demand the adoption of thin, flat plates, the usual compromise has resulted. The standard sizes adopted by the Post Office are included in an appendix to the Paper. The capacity most in demand for telephone work is 2 mfd., and as plates of this size form a convenient manufacturing unit they are usually taken as the basis on which to frame standard data for manufacturing purposes. Condensers of larger capacity are almost invariably built up by assembling standard units, rather than by direct manufacture in large plates. The usual sizes of paper at present in use are: For interleaving paper, 7½ in. or 4 in. wide, by [illegible] mil thick, giving about [illegible] sq. ft. to the pound; for foiled paper, 6⅝ in. or 3⅜ in. wide by 1¼ mil. thick, giving 100 sq. ft. of conducting surface to the pound and consisting of [illegible] per cent. tin and 6[illegible] per cent. paper.

At one time an unfoiled margin was left on each side of the foiled strip, but since the introduction of the "breakdown process" subse-

* A description appeared in the issue of *The Electrician* of January 4, 1907.

† U.K. Patent [illegible], G. F. Mansbridge.

quently referred to this has been found unnecessary. The substance of the paper is gauged on a ten-fold thickness by means of the usual screw micrometer, as specially made with large contact surfaces for paper gauging. With 1¼ mil foiled paper and ½ mil interleaving paper, the area required for a 2 mfd. plate is about 12½ sq. ft. for each electrode. The volume of the plate, after waxing and pressing, is approximately 7½ cubic in., and the weight 7 oz. The insulation between the electrodes taken at 60°F. with 400 volts after one minute's electrification, usually lies between 1,000 and 2,000 megohms per microfarad.* Any lower insulation than 1,000 megohms per microfarad is an indication of imperfect desiccation, excessive pressure or faulty material. The specific insulation of foiled paper is lower than that of plain paper, because the former is heavily sized. It is, however, only for special purposes that condensers of extremely high insulation are demanded. In such cases, by using the utmost care and material of the very highest quality, it is possible to obtain an insulation of nearly 20,000 megohms per microfarad, and such condensers are invariably built up of sheets.

For certain purposes, such as absorbing the spark across the break of sparking coils, leaky condensers, that is, condensers with specially low insulation, are of advantage, since the high-resistance shunt afforded by the low insulation across the break materially assists in suppressing the primary spark and in thereby lessening the pitting of the contacts. The low insulation necessary may conveniently be obtained by rolling up foiled paper without any interleaving paper. An important detail in the manufacture of condensers for spark suppression is that there must be no appreciable resistance in the condenser circuit, that is, in the electrodes or their connections. The insertion of even 1 ohm in series with the condenser of a high-frequency spark coil markedly increases the sparking at the primary contacts.

The value of the advance made by the introduction of foiled paper for condenser making lies in the fact that in this material the dielectric and the conductors are more correctly proportioned to their work than is possible when solid metal foil is used, resulting in a cheaper, lighter and smaller construction.

When metallic foil is used, short-circuits are very apt to develop, both during manufacture and in subsequent use, due to grit in the foil, pin holes or other defects in the interleaving paper, or disruptive discharges caused by excessive voltage. Condensers made of foiled paper are self-sealing, and consequently are practically proof against short-circuit, and can be subjected to much higher voltages than is permissible with those made from metallic foil. This automatic sealing is brought about in the following way: owing to the extreme thinness of the conducting film the small quantity of heat generated at the point of short-circuit by the sudden discharge of the condenser through that point is sufficient to cause the film of metal immediately surrounding the point of breakdown to be fused into minute globules. The segregation of these globules from each other and from the surrounding metallised surfaces effectually isolates the point of breakdown, and the defect is instantaneously sealed up. So rapid, indeed, is this effect, that if a pin is stuck into an insulated charged condenser so as to produce short circuits between the foiled papers, the short-circuits seal up without fully discharging the condenser, and a dozen or more of such short-circuits may be created one after the other before the condenser becomes fully discharged. The author, therefore, conceived the idea of electrically treating the foiled paper before making it up into condensers in such a way as practically to eliminate all pinholes or defective places by subjecting them momentarily to currents of such strength as to produce a minute non-conducting ring round each defect, thereby isolating it from the surrounding surface.† The apparatus for doing this is of the simplest character. All that is necessary is to pass the paper, foiled side uppermost, over a conducting roller, and to maintain a suitable P.D. between the roller and the foiled surface. The process of isolating or removing these faults is quite automatic, and the apparatus once set requires practically no adjustment; all that is necessary in this respect is to see that the current at the moment of short-circuiting is sufficiently strong to fuse the metallic film in the immediate neighbourhood of the defect, but is not so strong as to burn the paper. If current from lighting mains is employed a series resistance is necessary to limit the short-circuit current. With 100 volts this resistance should be about 15 ohms, and with 200 volts about 150 ohms. Experience shows that the searching effect of the voltage is increased by connecting a condenser of considerable capacity, say 20 mfd., across the potential terminals, but a series resistance of about 50 ohms in the condenser circuit is needed to tone down the suddenness of the condenser discharge. As the process of eliminating these defective places in the paper is largely one of breaking down the weak spots, the operation is generally described as the "breakdown process." As regards the direction of the current there appears to be little to choose; if anything the preference may be given to connecting the positive pole to the plain side of the paper, but the device works quite satisfactorily with alternating current. When the breakdown device is driven by an electric motor it is of advantage to have two rollers making contact with the foiled side of the paper at separate points, preferably not less than 2 ft. apart; the current driving the motor may then be led along this strip of foiled paper between the two rollers, so that should there be any break in continuity in the foiled surface the current driving the motor would be broken when the fault passed the first roller, and the stopping of the machine would call attention to the want of continuity. Fig. 1 shows the necessary connections. If the apparatus is mechanically driven, a suitable relay may be connected between the second and fourth rollers so that a local circuit is completed and a bell rung whenever there is any break of continuity between the two rollers.

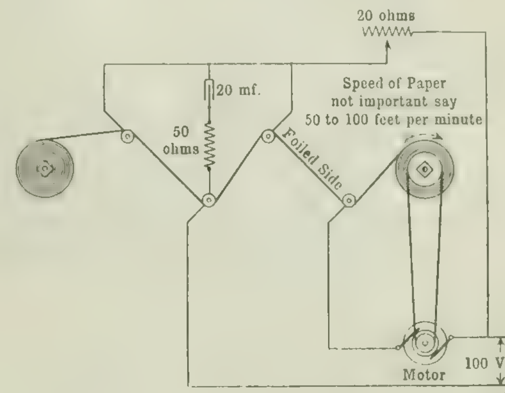


Fig. 1.—Device for Treating Tinfoil Paper.

Joints in the paper must, of course, be made electrically continuous, and a simple way of effecting this is, after the ends have been joined by lapping and pasting in the ordinary way, to paste on to the foiled surface a 6 in. strip of foiled paper placed face downwards, so that part of the foiled surface of the strip makes contact with one side of the break and part with the other. It is not desirable to paste the whole of the surface of the strip, since the continuity of the film may thereby be destroyed; the usual plan is to paste merely the edges on each side, leaving the middle portion clean. Good flour paste is found to give satisfactory results.

(To be continued.)

* The expression "megohms per microfarad," though incorrect, is so generally employed that the custom has been followed throughout this Paper; the phrase should, however, invariably be interpreted as "megohm-microfarads."

† U.K. patent 22,139, 1905.

CORRESPONDENCE.

TRANSATLANTIC WIRELESS TELEGRAPHY.

TO THE EDITOR OF THE ELECTRICIAN.

Sir: With reference to the recent report in your columns of an address given at Liverpool by Mr. Marconi before the Chamber of Commerce, perhaps a few words by an outsider would be of interest to your readers.

In spark telegraphy, as is well known, the wave length is usually regulated according to the distance over which communication is to be effected. Thus, stations intended to communicate over distances of 70 to 75 miles are fitted with transmitting apparatus throwing a wave of approximately 100 metres, and the wave is lengthened with the distance. It is also well known that the liability to atmospheric interference increases with the wave length.

Mr. Marconi, to communicate from Clifden (Galway) to Glace Bay (Nova Scotia) uses a wave of roughly 3,000 metres. With such a wave, reduce the "width" of it as he will, even with the most up-to-date tuning devices for the receivers, it is impossible to cut out all the atmospheric intereference. That this is true can be verified by noting in a recent article by Prof. Fessenden the complaints made by Clifden and Glace Bay of X's. Mr. Marconi denies the accuracy of Prof. Fessenden's statements; but that they are correct I have been careful to verify.

There is, however, a method of combating static disturbances which I have never seen referred to in any scientific journal, though it is used both by Marconi and Fessenden. It is by using a very high-frequency spark discharge. Atmospheric disturbances, except those which invariably accompany a shower of sleet, are always of low frequency, and the note produced by them in the receiving telephones is of very low tone. Formerly Marconi's stations used sparks of extremely

low frequency, such as are still used by Die Gesellschaft für Drahtlose Telegraphie, and when atmospheric disturbances prevailed it was impossible to distinguish, in the receiving telephones, any difference between the sending spark and the disturbances. It was often, indeed, quite impossible to know whether or not a station was sending, even when the ship was well within its range. As a direct result, I have often seen in the papers published on board the liners the statement—"owing to atmospheric disturbances during the night no news has come to hand."

In Jan., 1906, however, Prof. Fessenden built two stations, one at Brant Rock, Mass., U.S.A., and one at Machrihanish Bay, Scotland, and these signalised the advent of high-frequency sparks as a means of combating X's. The notes of the sparks used at these stations sounded in the telephones about high C, and an operator could concentrate his attention on the high note and read messages which, owing to the distinctiveness of the spark from the interference, were easily readable in very bad conditions. I have known operators on ships lying in European ports to read Brant Rock with ease on nights free from atmospheric disturbances. "DDD," as Brant Rock is popularly known among Marconi operators, could be read with ease on occasions when it was impossible to tell whether or not the stations at Cape Cod and Poldhu were sending.

Poldhu in April, 1907, was shut down and Clifden put temporarily into service, transmitting the news to the ships. In June of the same year Poldhu re-opened with a spark of much higher frequency than was formerly used there, but which was still much inferior to the clear, high note of Brant Rock. However, as the atmospheric disturbances are much more prevalent on the American side of the Atlantic than on the European, and as Cape Cod was not fitted with the new apparatus, I noticed little if any improvement in the news service in the summer of 1907. Clifden and Cape Breton are both fitted with sparks of the same frequency as Poldhu, and as they have been suffering from atmospheric disturbances in the winter time I shudder to think how they will fare when the annual summer crop of X's comes on.

As to speed in transatlantic working, a little figuring will show the difficulties to be overcome in that line. CB and CDN are fitted with a power of 300 kw. Thus, a transmission speed of 20 words per minute means that the sending key has to break an alternating current of 300 kw. 300 times in a minute. (For telegraphic averages the word is usually taken as five letters and the number of marks per letter as three.) To attain a speed of 100 words per minute it would be necessary to break the circuit 1,500 times per minute. I am afraid the question of arcing across the key contacts would prove rather a serious difficulty, magnetic blow-outs or no magnetic blow-outs. I am, &c., MORTIMER A. LONDON.

University of California, U.S.A., March 30.

[We think that Mr. London has confused high-frequency oscillations with high frequency in the sparks themselves. There is certainly an advantage in having the sparks themselves occurring so frequently that they give a decidedly high note.—ED. *E.*]

SOME ASPECTS OF THE SCIENTIFIC WORK OF LORD KELVIN.

At the Friday evening meeting of the Royal Institution last week Prof. J. Larmor, secretary of the Royal Society, took the above subject for his discourse, and dealt with the matter almost entirely from a thermo-dynamical point of view.

After referring briefly to Lord Kelvin's early life, the lecturer said that the general impression produced at first sight by the four volumes of his collected scientific papers was a somewhat vague notion of desultory though profound occupation with ideas that were afterwards to be welded by more systematic expositors into our modern theoretical knowledge of mechanical, electrical and optical philosophy. At first glance his exposition in characteristically practical terminology might suggest that these papers were concerned rather with the engineering achievements by which he was most widely known than with new theoretical foundations of physical science. Closer attention, however, compelled the conclusion that the results of his activity in the early period from 1845 to 1856 were perhaps unprecedented in modern scientific annals; at any rate, there could have been few parallels since Newton and Huygens and their great predecessors. His only peer in general physics in those early days was perhaps Helmholtz. They began their careers of investigation about the same time, but at first their paths did not lie much together. For in his early years Helmholtz's profession was that of a physiologist, though in his essay on the Conservation of Energy he revealed in 1847 his true bent as a leader in the exploration of physical principles. By the time this famous essay came into Thomson's hands in 1852 he had himself travelled, with Joule's assistance, not only as far as it had reached, but he had also, on the inspiration derived from Carnot, descended far into the true foundations of the doctrine of energy as available and recognisable to man, evolving from it ideas of revolutionary significance as regards both dynamical science and cosmic evolution, of which no one up to that time had any definite notion. The lecturer then proceeded, with the assistance of Sir James Dewar, to the illustration by experiments of some of the main branches of Lord Kelvin's work. The settlement of practical thermometry on a dynamical basis was effected by his laborious investigation, in conjunction with Joule, on the cooling effect in gases. This was illustrated by the refined apparatus of the Royal Institution, exhibiting the large cooling effect with carbonic acid, the much smaller one with air, and the absence of any noticeable effect at all with hydrogen at ordinary pressures and temperatures, showing that it was then a practically perfect gas. The slight but remarkable influence of pressure in lowering the freezing point of water, predicted by James Thomson, became, when it was verified by his brother's experiments, one of the exciting causes of the development of thermodynamics. This was illustrated by powerful apparatus working up to a pressure of over 1,000 atmospheres, thus keeping water liquid down to −7 deg. C, which illustrated at the same time by its strict reversibility the perfect elasticity and absence of hysteresis that belong to the hydrostatic compression of all kinds of matter. An attempt was made to estimate the share of Lord Kelvin, which was considered by the lecturer to be much larger than is usually understood, in the great modern doctrine of physical and chemical equilibrium, which has more recently been developed in many directions into the application that modern exact data afford, mainly by Willard Gibbs, Helmholtz, van't Hoff, and other investigators. When he was finally converted to accept fully Joule's experimental proofs that all kinds of energy were convertible, and that no energy was ever lost to the universe, by becoming able to reconcile it with Carnot's principle which had dominated his own thought, the acceptance seemed to have carried with it the enduring conviction that all energy was at bottom mechanical, which had coloured much of his work in the science of dynamics. In particular he tried hard for many years to discover some type of material constitution that would fit the luminiferous æther. In this problem, and earlier in the domain of the optical influence of magnetism, discovered by Faraday, he was drawn to a wider grasp of the dynamical effects of rotational momentum. His theory of latent motions developed with practical illustrations from the behaviour of gyrostats, was perhaps the main advance achieved by the science of dynamics in its physical aspect since Legrange. The phenomena of gyrostats were experimentally illustrated by Lord Kelvin's original apparatus, showing their resistance to rotation, their faculty of conferring stability where without the spin there would be none, and finally showing how a suspended gyrostat changes the single period of a conical pendulum into two periods, and thus illustrates the Zeeman magneto-optic effect more closely than its converse, the Faraday effect, in connection with which its theory had been long ago developed. The lecturer also referred to Lord Kelvin's work in evolving the scientific basis for telegraphy in connection with the early Atlantic cables, and to his preparing the way in all directions for the still recent electric transformations of mechanical energy. From one point of view these achievements may, however, be regarded as withdrawing his attention in the time of his greatest fertility from the theoretical problems in which he had no equal, and which will, perhaps, constitute his most lasting fame.

LEA'S WATER RECORDER.

The past few years have witnessed the introduction, into central station practice, of devices for accurately ascertaining the performance of plant and graphically recording the results. By the use of these appliances the efficiency of steam boilers, more particularly, has been raised to an extent which appreciably influences the operating costs of the generating plant as a whole. The CO_2 recorder, the draught gauge, the steam meter and the fuel calorimeter have all contributed to the many improvements which have been noticeable in central station boiler-house working during the past 10 years. It may be said, without fear of contradiction, that the results obtained, have in every way justified the introduction by central station engineers of such apparatus.

With the devices referred to above, it is possible to keep a check upon the work done by the men in charge of the plant to which these recording instruments are attached. Until recently, however, the station engineer has not had at his disposal any very efficient or convenient apparatus for the measurement and recording of boiler feed water, or of the condensed steam discharged from the condensers. In conjunction with his other measuring instruments, one, which will graphically record the rate of flow of water, will enable the engineer in charge, not only to ascertain what

the boilers are doing, but also what is the performance of the generating sets as a whole, and by the measurement of the air-pump discharge, a check can be kept upon the running of either one unit or a number of units, and the amount of steam used per indicated horse-power-hour or per kilowatt-hour can be determined.

Mr. J. E. Lea, of 46, Brown-street, Manchester, has introduced a recording instrument, which is of general application for the measurement of water, when flowing freely over weirs or through notches, but which is especially suitable for the measurement of boiler feed water and the discharges from air-pumps. In connection with the two last-named purposes, where the quantities to be dealt with are comparatively small, the sharp-edged V notch is made use of, in this apparatus, for measuring the flow. The value of this form of notch, for accurate measurement, was first demonstrated by Prof. Jas. Thomson, of Belfast, in the year 1858, in a Paper which he read before the British Association. As the rise and fall of water in a tank fitted with a rectangular or V-shaped notch, is not proportional to the "rate of flow" at any moment, a float with pen attached, would only serve to record the fluctuations in the level of the water. In the "Lea" recorder, however, a mechanical device is introduced, whereby the recording pen is caused to move according to the rate of flow at any instant. This device is shown in detail in Fig. 1. It consists of a drum, mounted

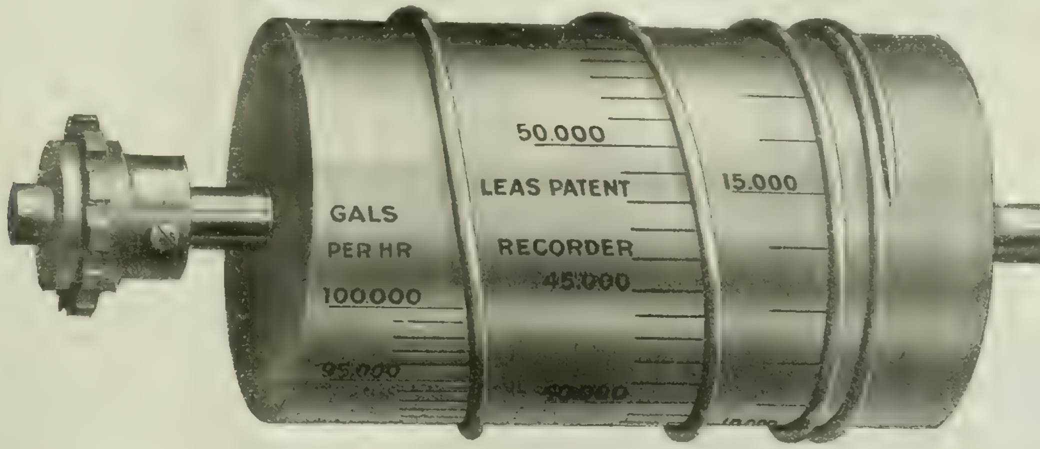


Fig. 1.—Drum and Spiral used in Lea's Recorder.

on a spindle, at one end of which is a pinion, with which a rack, attached to the float rod, engages. Round the drum barrel is wrapped a spiral coil of wire forming a screw thread, the contour of which corresponds with the "curve of flow." It will be noticed that the pitch of this thread is, at first, very small, and that it rapidly increases to the left-hand end of the drum, whilst after the maximum limit is reached it becomes zero again. This arrangement limits the movement of the pen, and prevents its being damaged at either end of its travel. Fig. 2 shows the application of the movement of the drum to the recording pen and chart. This illustration also shows the float rod and rack. As the float rises the drum is rotated, and the motion is imparted to a slider bar, which may be seen above the drum, by means of an arm projecting from it. The lower end of this arm is in engagement with the coil on the drum, already referred to, by means of a small pivoted saddle block. This latter is prevented from leaving its position on the coil by a small guard arm, which comes into contact with a fixed guard bar, should there be any tendency for the saddle to leave the coil. The net effect of this combination of devices is, that, whatever the kind of weir used, or the nature of the diagram representing the ratio between depths of water in the weir and the corresponding rates of flow, the recording pen will move equal distances for equal increases or decreases in the flow, and thus, when a rectangular chart is used upon a cylindrical recording drum, the area of the diagram produced upon it, is a measure of the total quantity passed, and this can easily be deduced by means of a planimeter.

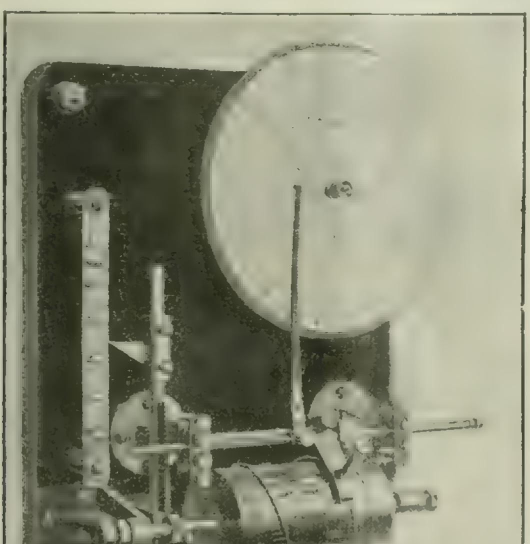


Fig. 2.—Lea's Recording Movement, showing Chart, Height Gauge, and Water Register.

Fig. 3.—Notch Tanks in 3,000 kw. Power Station at Johannesburg.

The circular chart shown in Fig. 2 has the advantage that the whole day's record can be seen at a glance, but the planimeter cannot be used for deducing the total quantity passed. Fig. 4 shows the application of the recorder to a notched tank for either measurement of boiler feed or condenser discharge. The recorder in this instance is mounted directly over the tank, and this is the ideal position for giving the most accurate results.

It might here be mentioned that the apparatus is claimed to possess a compensative action when the water to be measured varies in temperature. This is explained by the fact that if the temperature rises, there is a slight sinkage of the float, owing to the reduced density of the water, and vice versa if the temperature falls the float rises, owing to the increased buoyancy of the colder water. This automatic action of the float tends to the production of true records, by weight, over a large range of temperature. It may be remarked here that scale divisions are marked out on the

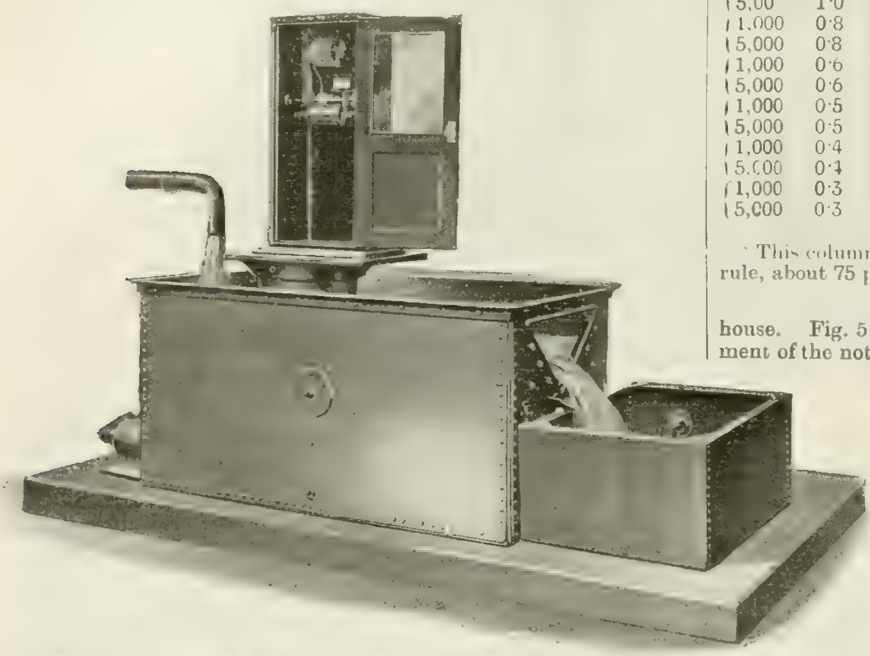


Fig. 4.—Application of Lea's Recorder to Notched Tank, the Recorder being mounted directly over the Tank.

body of the revolving drum, and, by means of a pointer projecting from the saddle arm, the fluctuations in the water level of one $\frac{1}{100}$th part of an inch, or less, are easily discernible. In the instrument illustrated the vertical movement of the float is only $4\frac{1}{2}$ in., while the scale adjacent to the coil on the drum is 20 in. long.

Fig. 3 shows three V-notch tanks as used at a central electric power station near Johannesburg. The plant at this station comprises three 1,000 kw. engine-type units, each having its own surface condenser and Edwards air pump, the discharge from the latter being passed through the notch tank. The recorders are placed inside the engine room, and it is possible, by comparing the readings of the respective instruments, to determine, at any moment, the weight of steam used per kilowatt-hour. Where engines are run non-condensing, it is almost impossible to arrive at the steam consumption, except by the measurement of the feed water.

The recorder itself can be situated at almost any desired distance from the notch tank, although, of course, the nearer it is to its work the better, and the best place for the float (which is the acting element) is in the water of the notch tank, as shown in Fig. 4. In existing stations it should not be a difficult matter to provide space for a small notch tank either for the feed water or for the measurement of the air pump discharge. Space can generally be laid off for this purpose in the foundation basement of the engine room, both with reciprocating and turbine units, or in some part of the boiler

Table *showing "Saving" if Steam Consumption is only reduced 1 per cent., say from 20 lb. to 19·8 lb. per unit.*

Size of plant.	Generating costs per unit.	Cost of steam production per unit.*	Units produced per day of 12 hours.	Saving in £. s. d., assuming that the use of the recorder leads to an economy of only 1 per cent. in steam consumption. Per day.	Per year.
kw.	d.	d.	Units.		
1,000	1·0	0·75	12,000	£0 7 6	£136 17 6
5,000	1·0	0·75	60,000	1 17 6	684 7 6
1,000	0·8	0·60	12,000	6 0	109 10 0
5,000	0·8	0·60	60,000	1 10 0	547 10 0
1,000	0·6	0·45	12,000	4 6	82 2 6
5,000	0·6	0·45	60,000	1 2 6	410 12 6
1,000	0·5	0·375	12,000	3 9	68 8 9
5,000	0·5	0·375	60,000	18 9	342 3 9
1,000	0·4	0·30	12,000	3 0	54 15 0
5,000	0·4	0·30	60,000	15 0	273 15 0
1,000	0·3	0·225	12,000	2 3	41 1 3
5,000	0·3	0·225	60,000	11 3	205 6 3

* This column is based on the fact that boiler house costs are, as a rule, about 75 per cent. of the total generating costs.

house. Fig. 5 illustrates in plan and elevation a typical arrangement of the notch tank and recording instrument for a steam turbine set. The tank in this instance is placed in the basement, and the recording instrument is fixed on the engine-room floor where it can be conveniently handled and readily observed at any time.

We understand that the introduction of this instrument has created considerable interest on the part of central station engineers, and already a number have been put into operation with very satisfactory results. Among these we may mention Manchester, Blackpool, West Ham, Edinburgh; also such companies as the Central Electric Supply Co., South London Electric Supply Corp., the Great Eastern Railway Co., &c. The table above has been recently compiled by Mr. Lea, and we publish it as illustrating clearly the saving to be effected by the use of the recorder. Taking the cost of installing a recorder as £60, this will in many cases be very soon repaid if a saving of merely 1 per cent. is effected. In conjunction with steam-pressure recorders, CO_2 recorders, and the recording instrument at the electrical end of the electricity station, it is possible for the managing engineer to pass constantly in view the operating condition of the whole of the plant. We think that the Lea instrument will be welcomed by all station men, who find it increasingly difficult to keep track of the exact operating conditions of the plant in their charge. It meets the case of both the non-condensing and the condensing station, and in this way should find general application in electric power stations

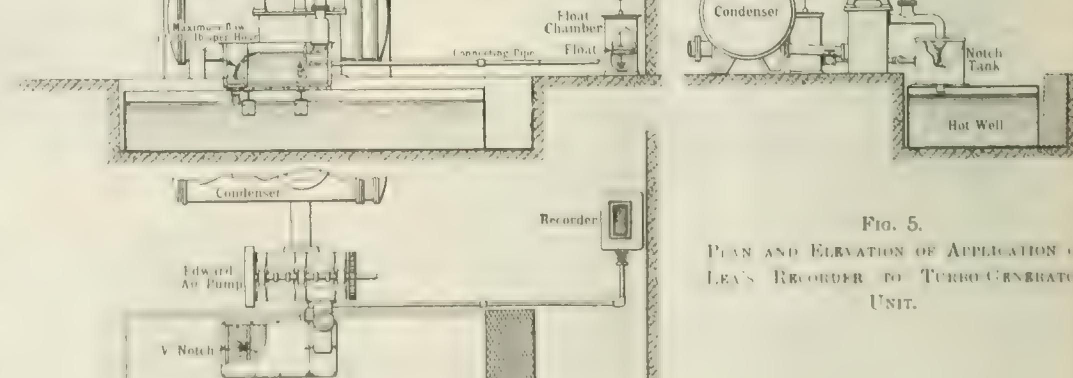


Fig. 5.

Plan and Elevation of Application of Lea's Recorder to Turbo-Generator Unit.

ELECTRICAL EXHIBIT AT THE FRANCO-BRITISH EXHIBITION.

The abandonment of a scheme for getting together a collective electrical exhibit at this Exhibition, which we commented on a short time ago, gave rise to general dissatisfaction, with the result that the Conference of Chief Officials of the London Electric Supply Companies decided, for the benefit of the industry at large, to take definite steps towards securing space at the Exhibition in order that electrical interests might be adequately represented. The secretary of the Conference, therefore, issued the following letter, asking those interested to attend a meeting, and giving details of the form the proposed exhibit is to take :—

Dear Sirs: You are doubtless aware that the steps which were taken to organise a collective electrical display at this exhibition were recently abandoned through lack of sufficient support. The electric supply companies of London are strongly of opinion that, having regard to the magnitude of the Exhibition, the importance of which has not as yet been sufficiently realised, it would be detrimental to the interests of the industry if further efforts are not made to remove the necessity for this decision ; and they have, therefore, resolved to make this appeal to the trade to secure their co-operation in promoting a collective exhibit worthy of the occasion.

With this end in view, and because of the shortness of time at their disposal, my conference have taken upon themselves the responsibility of securing a suitable space in the machinery gallery, and have arranged with Messrs. Waring for the erection thereon of a handsome pavilion. Sufficient funds have been guaranteed by the supply companies to cover the cost of the space and pavilion, and the general superintendence of the exhibit will be undertaken free of charge by my conference ; but there remains the expense of wiring, current and attendance still to be provided for which may be estimated not to exceed £600. If, as is hoped, not less than 30 firms respond to this invitation, the average inclusive contribution per exhibitor would not be more than £20, and, as there is no obligation on exhibitors to provide attendance (though they are, of course, at liberty to do so if they think proper) it will be seen that the cost of participation is extremely moderate. It is proposed that half this contribution should be paid before the opening of the exhibit, and the balance or such amount of it as may be required at a later date. The pavilion will be divided up into six sections as follows :—

1. A suite of furnished rooms comprising hall, dining room, drawing room, bed room, nursery and kitchen designed for the display of domestic lighting, heating, cooking and ventilation.
2. Small machinery worked by motors.
3. Medical apparatus, including baths, high frequency and X-ray appliances.
4 & 5. General exhibits.
6. Reception room and information bureau, which will be available for a few selected exhibits.

I am directed by the Conference of officials to appeal to you to contribute to the success of this exhibit by signifying your intention of participating and informing me what class of goods you propose to show and the approximate amount of space required. I shall be also greatly obliged if you will attend a meeting at this office on Wednesday next, the 6th inst., at 4 p.m., when the subject can be more fully discussed. I would draw your attention to one of the regulations of the Exhibition that all goods exhibited must be of British produce or manufacture. F. J. Walker, Hon. Secretary.

At the meeting held at the offices of the St. James' & Pall Mall Electric Light Co. under the chairmanship of Mr. Frank Bailey (City of London Electric Lighting Co.) a number of gentlemen representing both supply companies and manufacturers attended. The chairman briefly outlined the general idea of the exhibit, and the meeting then resolved itself, as if by magic, into a committee of Ways and Means. Everyone present was unanimous that "something ought to be done," even if only as a counterblast to the "gas people," whose exhibit is to be, we understand, in close proximity. The success of the exhibit will depend to a great extent on the enthusiasm with which the idea is taken up by manufacturers, and if the number attending at yesterday's meeting is any criterion, the whole affair should go with a swing. Among the firms which have already promised support and are willing to take space are the Edison & Swan United Electric Light Co., Electromotors Limited, Gilbert Arc Lamp Co., J. H. Holmes & Co., Rawlings Bros., Rashleigh Phipps & Co., Siemens Bros. Dynamo Works, Stearn Electric Lamp Co., Bergtheil & Young, Berry, Skinner & Co., Dowsing Radiant Heat Co. and R. Waygood & Co.

The Chairman requested each manufacturer's representative to outline his demands. This request was responded to with alacrity, so that some of the later speakers did not conceal the fact that they thought the previous speakers had been greedy, and the general opinion was expressed that if the trade as a whole came forward in the same manner much more space would be needed than had been secured. The committee, however, have the option of extending their area if required, and there need be no fear of cramping. It is also proposed to solicit the aid of municipal electrical undertakings in both London and the provinces, and of provincial electric supply companies.

Further developments have for the present been left in the hands of the committee, and it is to be hoped that things will soon crystallise, for there is no time to be lost if the exhibit is to be ready when the exhibition opens. Though the material profits accruing from an exhibition of this kind may not be very obvious, the harm done by doing nothing would be great, while an exhibit such as that outlined above is likely to appeal very forcibly to the general public.

PARLIAMENTARY INTELLIGENCE.

LONDON ELECTRIC SUPPLY BILLS.

A Select Committee of the House of Lords, consisting of Lord Cromer (chairman) and Lords Welby, Lytton, Lamington and Saunderson, commenced consideration of these bills yesterday (Thursday). The bills to be dealt with were the London and District Electricity Supply, the London Electric Supply and the London (Westminster and Kensington) Electricity Supply Company's Bills.

The Hon. J. D. F. Fitzgerald, K.C. (with whom were Messrs. Talbot, K.C., Clode and Thomas) opened the case for the promoters of the first-named bill. He said the object of the bill was to authorise the promoters to incorporate a company and to construct a large generating station at Barking, on the lower Thames, and to supply electricity in the County of London and adjacent districts in Essex, Middlesex, Kent and Surrey firstly, to authorised undertakers in bulk and to persons or authorities who are entitled to supply the public lighting of their districts, and, secondly, to supply current to consumers for power purposes. The bill was similar to what were known as power bills which had been passed, but no such scheme had yet been passed for London. There could be no doubt (said counsel) of the urgency of the matter. Mr. Fitzgerald then recapitulated the general and special legislation that had been passed regarding electricity supply, and dealt specially with the Kitson clause. The London County Council did not propose to undertake the supply themselves, and had not introduced a bill this session, therefore the way was clear for private promoters to put before Parliament a scheme giving an adequate solution of the question. The scheme now presented would give a cheap supply of electricity for power purposes in bulk throughout the whole of the proposed area. Manufacturers had great inducements to go outside London by reason of cheaper land, lower rates and more healthy surroundings for their workpeople, if they could only get a cheap supply of power. There were at present in the area covered by the bill 66 generating stations, employing 29 different systems of generation and 18 different systems of supply, and in such circumstances cheap supply was out of the question. The elements which were required for cheap supply were cheap coal (which could be obtained and delivered at a very cheap rate by vessels from Newcastle to the proposed Barking works ; an unlimited supply of water for condensing purposes (a generating station on the Thames would provide that condition), and generation on a large scale (the scale on which it was proposed to generate at Barking would be so large that the cost of generation would be reduced almost to a minimum). None of the existing stations were capable of giving the cheap supply required, and such as was proposed by the present bill, and many of them were badly situated with respect to cheap supply of coal and adequate supply of water. The chairman of one of the London companies said at a recent meeting that half or two-thirds of the generating stations in London might with advantage be done away with. Capital cost of construction and equipment of stations was also an important factor in securing a cheap supply. The capital cost per kilowatt capacity in the case of the existing companies appeared to be £47·5, and in the case of the local authorities £34·2, the two classes of station giving an average of £40·85. In the proposed station the capital cost was estimated at from £10 to £12 per kilowatt capacity, which would mean an immense saving when generating on a large scale. The first object of the bill was to be in a position to supply to existing authorised undertakers in bulk, but it was optional for the undertakers to take such a supply or not, and the promoters thought they could give a supply at such a rate that it would pay undertakers to take supply from them. It was not thought, however, that the new supply would lead the present undertakers to abandon their works immediately, but they would probably use a portion of their works to supply certain portions of their areas, and take a supply from the new company for other portions. They would find it more profitable to take a supply from the new company instead of extending their stations or erecting new stations when the demands for current increased, because land was very expensive at many of the places where they were situated, and taking supply from the new company would be specially advantageous to local authorities, who would by that means avoid charging the rates with an increased amount of borrowed money. It appeared that the present companies were in favour of a scheme such as that under discussion, as six of the London supply companies had during the time the Administrative Co.'s bill was before a parliamentary committee, arranged terms with that company, subject to their bill being passed. The promoters also looked forward to being called upon to supply current to tramways, railways and possibly canals. Tramways and railways had been compelled to erect generating stations because there was no company in a position to give them a supply of electricity upon terms profitable to them. The Central London, the City and South London, the Metropolitan and the Metropolitan District and associated companies were instances where this had been done. He

thought they might take it that any of those companies would have been glad to have taken supply from a company such as the one projected. London County Council and the London United Tramways, which had stations of their own, might not for a time at any rate, be tempted to take a supply from the new company, but all the great railways coming into London would, he thought, be glad to entertain the question of working their suburban traffic by electricity if a supply could be got from a large company such as that proposed. The most successful power company at present was that on Tyneside, and they supplied the North Eastern Railway Co. with power for working 37 miles of suburban lines. With regard to the other power users, the third class of consumers, many of them used steam plant or electrical installations of their own, and to get them to do away with their own plant it was necessary to show that they could be given a supply at a price that would make it pay them to do away with it. The experience at Tyneside showed that a large number of power users who did not at present get any supply or only took a limited supply from the present supply authorities would take a supply from the new company. According to the last Board of Trade returns, the prices for power supply by the existing companies in the area covered by the bill varied from 2·47d. to 1d. per unit. The companies which supplied at the lowest rates for power were the St. James' & Pall Mall and the Westminster, but both those companies supplied districts which were not industrial districts, and their demands were mainly for lighting, and the bulk of their income was earned from the supply for lighting in residential areas to wealthy consumers. They supplied power at a rate which would not be remunerative to them if power supply were their business. The St. James' Co. during one year supplied 671,000 units for power against 7,296,000 units for lighting, the latter being charged for at an average of 3·462d. per unit. Those companies could, however, supply current for power in limited quantities at a low price without actual loss, because the power supply was only an adjunct to the lighting supply and was mainly supplied during the daytime when lighting was not much required. The chairman of the St. James' Co. explained that matter in a speech on Feb. 18 this year and said that their power supply was only 12 per cent. of the whole and was in the nature of a bye-product, which involved no addition to capital cost and practically no addition to running costs, except the comparatively trifling cost of coal and water, and under these circumstances the charge for power left a profit. That was also true of most of the companies in London. It was certainly true of the Westminster, who although they supplied a larger quantity for power, also supplied it as a bye-product. They supplied 2,909,000 units for power at 1d. and 11,262,000 units for private lighting at 4½d. per unit, and the income they got from power supply was a very small percentage of their entire income. Local authorities' prices varied from 2·53d. per unit to 0·95d., the latter being the charge at West Ham. In West Ham they gave a very large supply for tramways which were the property of the Corporation, but even their charge was in excess of that proposed to be charged by the new company. The charge proposed to be made to undertakers or consumers whose maximum demand exceeded 250 kw. was £3 per annum per kilowatt of maximum power required and 0·55d. per unit in the case of alternating current untransformed. In the case of a.c. transformed or direct current the charges would be a little higher. Where a person took a supply for power he would be allowed to use a portion of the supply for lighting the premises in which the power supply was used, provided the quantity used for lighting did not exceed 20 per cent. of tht total quantity taken. The Kitson clause had not been very acceptable to undertakers, because under that clause, until a decision had been given by the Board of Trade, undertakers would not know what their exact position was, and therefore in the present bill they had endeavoured to establish a provision that would work automatically and would not require the Board of Trade's intervention. The bill said the promoters were willing to supply to the undertakers at such and such a price, and the latter ought to be able to supply to the consumer at a percentage above that price that would give them a reasonable profit according to the amount of the demand. If the supply taken were as low as 100 kw., the undertaker would be entitled to add 15 per cent. to the price, or, if the demand were only 50 kw., he would be entitled to add 20 per cent.—that was was so say, he would be able to add 1 per cent. to the price the company was charging him for every 10 kw. that the consumer's demand was below 250 kw., and if a consumer could not get a supply from the undertaker on that basis he could come to the Power Co. and get it. But if the committee thought it better to insert the Kitson clause the promoters would be willing to accept it. The bill provided that a consumer or undertaker taking a supply from the new company would have to take or pay for a supply for at least seven years of such an amount that the payment would not be less than 20 per cent. per annum on the capital cost incurred by the company in making provision for such supply. The provisions which the arbitrator would have to regard in case of a dispute were the ordinary provisions inserted in a bill of that kind, and the graduated charges for supply to consumers which it was proposed to insert were meant to guard against hardship to the consumer or undertaker. The power company might otherwise say "We will not give you a supply, you must go to an arbitrator." The terms stated for supplies from 250 kw. down to 5 kw. were put in because there was a difficulty in fixing the prices in the bill. He thought very few questions would arise which would make it necessary to go to the Board of Trade.

There were 17 petitioners against the bill, 14 being represented by counsel. All objections were on the ground of competition. The principal business done by the objectors was the supply of current for lighting, with, perhaps, one exception, in which case a fair amount of power supply was done. Railways and tramways were not supplied by any of the objectors, with the one exception. Under the bill the promoters would not come into competition with suppliers of current for electric light, the principal business would be the supply of current for power to large users. Two of the objections were from promoters of other bills to be considered by that Committee. Neither of these bills offered any solution of the problem of power supply for London. They were both what was known as "linking-up" bills.

At the conclusion of Mr. Fitzgerald's opening the Committee adjourned until to-day (Friday), when the evidence of Mr. H. F. Parshall, one of the engineers to the promoters, is to be taken.

Mr. Parshall is, we understand, followed by Mr. Robert Hammond and Mr. F. H. Pearson.

NEW LONDON BUILDING REGULATIONS.

On Wednesday the House of Commons Police and Sanitary Committee, presided over by Mr. Layland Barratt, approved provisions contained in the London County Council (General Powers) Bill the effect of which is to repeal three sections of the London Building Act, 1894, dealing with the cubical extent of buildings, consent to larger dimensions, and fixing rules as to the uniting of buildings, &c., and giving the County Council discretionary power to extend, under special circumstances, the existing limit of the cubical capacity of buildings allowed and the size of openings between buildings.

Giving evidence in support of the proposed clauses, Mr. Alexander Siemens explained that his firms (Siemens Bros. & Co. and Siemens Bros. Dynamo Works) had extensive electrical manufacturing works at Woolwich and Stafford. On behalf of his own companies, and also of the London & District Association of Engineering Employers, he heartily supported the view that, in the interests of trade, it was highly desirable that the proposals should be passed. The present restrictions undoubtedly interfered with industry in London. Owing to the increased size of engines and machines which now had to be made they had found it quite impossible to carry out certain work at the dynamo works at Woolwich. There, in the case of large machinery, it had to be restricted in several shops on account of the stringent limit as to dimensions. The restrictions as to the size of doors between adjoining shops was a matter which seriously interfered with business; they were obliged to take machines to pieces and re-erect them in adjoining shops because they could not make them in the one shop. As a result of the inconvenient regulations in the Metropolis, witness's firm had had to take work into the provinces for execution, and he mentioned their erection of a large new machine shop at Stafford of something like 2,000,000 cubic ft. capacity. The size of machines was very much larger than in 1894, and large shops were absolutely necessary for making them.

As stated, the provisions asked for by the L.C.C. were accepted by the Committee.

LEGAL INTELLIGENCE.

Ernest Scott & Mountain v. Kent Collieries (Ltd.).

The hearing of this case was resumed on Friday, by the Official Referee (Mr. Muir Mackenzie, K.C.).

Mr. F. S. Highton gave evidence as to tests of the machinery which had been made. He found nothing in the diagrams to suggest faulty design or faulty construction.

Mr. H. W. Ravenshaw had also inspected the machinery on three occasions at Dover. He examined the steam pipes of the boiler, and found a great deal of leakage in the pipes, that the steam pipe from the steam main to the engine came out at the side instead of out of the top, and as a result water and dirt would be more likely to pass through the engine than it would if the pipe came out from the top. He found one of the stop valves leaking badly in No. 2 engine. In that case the engine could not be stopped by that particular valve. The drain pipes from the engine cylinders were leaking badly. The engine room was badly ventilated. He corroborated the evidence of the last witness as to what was shown by the diagrams. He (witness) thought that temperatures of the water which passed through the motor should have been taken. There was a measurement at the colliery of the quantity of water pumped. He considered that the motors supplied by plaintiffs were capable of doing the work they were supplied to do. He thought also that the generating sets were capable of generating what was wanted. He found that engines of those dimensions would readily develop 400 B.H.P. He saw no defective design in the generators, which were not too small to do what they were intended to do. He did not think that the test of what the engine could do was of any value considered in the light of the specification. The test was not an accurate one in the circumstances. There were certain defects in the engine which could be made good, so as to make it comply with the specification. He took the temperature of the water in the shaft when he went there on March 17. He thought he also had taken the temperature of the air in the shaft. The water was 70 F. and the air 61 F. He did not know that the temperature of the water coming into the shaft below the tubbing was a temperature of 75 deg. Overheating under some circumstances would indicate defective design.

Mr. Motley, who was left by plaintiffs in charge of the work, did not agree that the water which gave trouble with the plant was due more to moisture condensation in the motors than to the splashing

caused by the pumps. Referring to the occasion when the motor fused, witness said in his opinion it was due to the following causes. That afternoon they stopped the pumps in order to splice on another length to the cable. The motor had been running for some time at a good temperature, but this operation caused a stoppage of 3½ hours for the motor at a depth of 550 ft. in the shaft. The atmosphere at that depth was very moist, and the condensation took place. As a result, when the motor was started again it fused. He admitted that the machine would not cool down entirely in that time, but thought that it might do so sufficiently to cause a vacuum and thus draw the moist air into the coils. He was under the impression that the Colliery Co. would supply him with anything necessary while working. He asked Mr. Fall (of the company) several times for certain things, but failing to get them, eventually wrote to his own firm in Newcastle for them.

This concluded the case for plaintiffs, and Mr. Bousfield addressed the Referee for the defence and counter-claim. From defendants' point of view the counter-claim was the most serious part of the case. The Kent Colliery Co. had raised some £100,000 in cash in order to take over the Dover Colliery and to continue the work of prospecting for coal, upon which a large amount of money had already been spent. The undertaking presented only ordinary engineering difficulties which would not be difficult to overcome by the use of ordinary skill and with care in the selection of appliances with which to carry out the work. As the result of the failure of these appliances, a very large amount of capital had been sacrificed. Of course they could not expect to get back all that money, but he was anxious to put before the Court what had actually happened and to show that the loss they had suffered arose directly out of the contract with plaintiffs to supply pumps to be capable of doing a certain duty in a certain manner, according to a certain specification. Defendants had done certain work by the use of imperfect appliances. It was quite true they had used these appliances, imperfect though they were, but they did so because by so doing it meant not so great a loss as would have been sustained had they rejected the plaintiffs' machinery in the first instance and waited whilst Messrs. Scott & Mountain supplied plant capable of doing the work required. There was one and only one serious and vital defect in the installation. It was that the motors for the pumps would not carry the full load without overheating and fusing. All the other troubles arose from this fact, and this was the cause of all the delays and undue coal consumption. Throughout the whole time the plant was running the coal consumption was excessive. This was attributable to two causes. First of all, when one pump was doing the work, instead of requiring only 28 lb. of steam to develop a kilowatt of energy it was using 47 lb., and secondly, in order to minimise the delay and damage two pumps were run at half load, which necessitated an extra set of alternators, which, it had been admitted, involved very extravagant coal consumption. Counsel submitted that plaintiffs could not have had any experience of the running of enclosed motors in damp shafts. Their mistake was that they relied upon a water-jacket cooling system instead of upon ventilation in order to keep the motors cool. That meant that there could be very little circulation of air inside the motor, and if there were any moisture there there was little chance of getting it out. It was an experiment upon the part of plaintiffs, and they did not reckon on the serious results of water condensation in the coils of such enclosed motors. There was another point. The water circulated on the outside of the stator, consequently the heat from the rotor had to make its way right through the stator before it could be cooled. It was this lack of air ventilation which caused the motors to break down. During the whole period, from July, 1906, to Dec., 1907, the pumps never had anything like their full load without the motors over-heating and breaking down. The determining factor, in giving the contract to plaintiffs above the heads of those who had quoted a lower price, was their guarantee with regard to steam consumption. It was that the steam consumption on a full-load would not exceed 28 lb. of steam per kilowatt hour. Plaintiffs contended that they did not guarantee that consumption per kilowatt hour, but per kilowatt ampere, which was 15 per cent. less. Mr. Bousfield read the correspondence which had passed between the parties, and said there was no suggestion to be found for putting two pumps side by side into the shaft. It was one compensation arrangement they were working with, and there was no suggestion about two. The first pump was not delivered until two months after the date fixed by the contract for delivery. He submitted that defendants were entitled to something for that delay, seeing that the pumps were a vital part of the delivery. That delay was not caused through anything at the power house. It had been suggested by plaintiffs that there was sufficient available space for a second compensation arrangement. Defendants made the suggestion in one of their letters which was in accordance with the possibility of working the two plants side by side in the pit. The letter rather sat upon the idea. If it was a matter of importance to have the two plants side by side, plaintiffs should have made some counter suggestion which enabled them to have the two things side by side. Of course, that was done afterwards, but it was subsequent to the period when it was a matter of importance. When Mr. Houston took charge there commenced the series of disasters for which defendants sought compensation. Whenever a test was contemplated something broke down, and the test never came off. The working started on July 31 and the thing broke down on Aug. 1. The official referee would see from the letters that the insulation was partly at the bottom of the trouble because, of course, if you got things to an overheat it burnt up the cotton very quickly. There was also trouble of insulation on the question of moisture. One of the reasons why the motors did not go as they should have gone was because the insulation had been swamped. Every detail of the running of the pump was under plaintiffs' control, and it could not be said for a moment that defendants interfered with the order of running or the method of the running, or that defendants were responsible for diverting plaintiffs from what they considered was the best method of running. It was always thoroughly understood that the expense of the experiments which had taken place and of doing what was necessary to put the plant right should fall upon plaintiffs. Defendants' case was that one pump if it had been in proper working order should have got to the bottom of the 620 ft. within about a fortnight. About five months was occupied in getting down to the bottom of the first level. There was no ground for the suggestion that defendants were responsible for any delay which had occurred.

Mr. LANCASTER, a director of defendant company, said that the different incidents which had been referred to in the course of the case were incidents which were always to be met with when pumps have to be made. He received assurances from plaintiffs that notwithstanding those things the pumps would be capable of doing the work required. Plaintiffs' estimate was considerably higher than many of the others who had tendered. It was never suggested that it would be necessary to have two pumps working together in the shaft. Roughly speaking, the breakdowns had a very preducial effect upon the company; in fact, it was absolute ruination to the company. They had raised a large sum from the public (£200,000) and they had very little of it left. His manager might have contemplated before the breakdown having two pumps in the shaft, but it certainly was never contemplated having the pumps at the same level. Witness made up his mind that the engines were not capable of performing their duty with the specified coal consumption from the beginning. They were only doing half load and burning far too much coal. He made up his mind that the motors were not according to contract after the first breakdown occurred in Aug., 1905. It had always been declared by the plaintiffs that the defects were only minor ones, and could soon be put right.

Prof. ED. HALL, another director of defendant company, said he was present at the interview between the parties on Dec. 13, 1905, just before the contract was entered into. To the best of his recollection, nothing was said at that time about having two pumps to deal with a pit 620 ft. deep. He understood that two pumps were to be obtained, one to do the work and the other to be used as a stand-by. At a later interview plaintiffs admitted that the pumps had broken down, and it was decided that a third pump should be obtained.

Mr. WM. THOMAS, certificated colliery manager, also gave evidence. He said he had never known of two pumps being placed in a shaft working alternately. He admitted he had never seen an electric suspended pump working in a colliery shaft, nor did he know the weight of such pumps with motors, &c., nor was any information given him with regard to the matter at the time. Asked how he could form any opinion as to the efficiency of the tackle used for the pumps under such circumstances, witness replied that his own experience told him that the head framing over the colliery shaft would have supported 40 or 50 tons.

The hearing was then adjourned till to-day (Friday).

MUNICIPAL, FOREIGN & GENERAL NOTES.

APPOINTMENTS VACANT AND FILLED.

Applications are invited for the position of assistant professor of physics at Heriot-Watt College, Edinburgh. Salary £225 per annum. Applications by May 23. See advertisement.

Applications are invited for the chair of Civil Engineering at the University of Liverpool, which has recently been established in the Faculty of Engineering. Particulars from the Registrar, to whom applications, with 12 copies of testimonials and references, should be sent before May 15.

A professor of mechanical engineering is required for Poona College of Science, India. Salary R.500, rising to R.1,000 per month. Applications to the Secretary, Public Department, India Office, London, by June 15.

Mr. W. Jackson has been appointed telegraph superintendent of the Buenos Ayres Great Southern Railway, in succession to Mr. J. Brayshaw who is retiring after having held the position 23 years.

EDUCATIONAL NOTICES.

Technological Scholarships.—The West Riding of Yorkshire County Council offer technological scholarships, each of the value of £60, to residents within the administrative area of the West Riding of Yorkshire, and available for courses of instruction in connection with engineering (mechanical or electrical), metallurgy, textiles, dyeing, or other approved industries. These scholarships are intended for young artisans who already have a suitable amount of mill or workshop experience, and the awards will be mainly based on the results of the examinations of the Board of Education and of the City and Guilds of London Institute. In addition to the above, the County Council offer eight minor technological scholarships, value £50 per annum, tenable by persons who have had practical experience at a trade for at least one year, and have con-

currently attended day or evening classes, or by pupils who are about to leave the secondary schools. These scholarships will be awarded on the results of a written, practical and oral examination. Application forms, &c., from the Education Department (Technical Department), County Hall, Wakefield.

Manchester Municipal School of Technology.—A course of six lectures on "The Principles of Electrical Control" will be given by Dr. C. C. Garrard at this school on Thursday evenings (seven to eight), commencing May 7.

Aberdeen.—The Admiralty recently invited the Corporation to quote terms for the supply of electricity for a wireless telegraph station at Stoneywood, and the city electrical engineer (Mr. J. Alex. Bell) recommends the following conditions:—

(1) That the supply be available within six months from the date of the Admiralty agreeing to terms; (2) that supply be three-phase 6,000 volts 50 periods transformed down to three-phase low tension 440 volts in Admiralty premises, the Admiralty to provide accommodation for transformers and switchgear; (3) that the charges be on a flat rate of 4½d. per unit for all supply—heating, lighting and telegraph work—with a guarantee of £550 per annum for five years; (4) that the Corporation lay feeder cables from Ferryhill to Stoneywood, provided Admiralty pay £1,000 towards cost of same, the Corporation to maintain free of cost the feeder cable, which is to remain the property of the Corporation.

Should these terms be accepted steps will probably be taken to give a supply for public and private lighting in Woodside and Old Aberdeen.

The question of the terms upon which the supply of electrical energy is to be continued to the Aberdeen Suburban Tramways Co. is to be referred to a Board of Trade arbitrator.

Aberdare.—The Council have decided to proceed with the scheme for the erection of electricity works, and **Mr. Sellon** has been engaged to prepare plans, &c.

Anglo-French Telephone Facilities.—The president of the British Chamber of Commerce in Paris (Mr. Walter Behrens) waited upon the French Under-Secretary for Posts and Telegraphs (M. Simyan) on Tuesday, in order to urge upon him the necessity of making a reduction in the Anglo-French telegraph charges and in the London-Paris telephone rates. In reply, M. Simyan promised that the subject of the reduction in telegraphic rates should have his immediate attention. He also intimated that the reduction in the Paris London telephone rates would be very considerable. The exact rate was not yet fixed, but the charge would probably be 5 frs. or 6 frs. per conversation of three minutes, instead of 10 frs. as at present.

Argentina.—The "Review of the River Plate" says Siemens-Schuckert Werke, Berlin, have decided to open branches in all the principal South American Republics.

Aston.—The gross profit on the electricity undertaking for the year ended March last was £9,787 (against £6,617 in the previous year), and the net profit £3,127 (£676).

The units sold were 2,942,384 (1,996,364), the income for supply of current being £17,921 (£13,213). 632,250 (513,940) units were supplied for lighting, 1,113,754 (576,874) for power and 1,196,380 (905,550) for tramways. The equivalent of 113,825 8 c.p. lamps is connected, including motors of 2,985 H.P. (increase 57,328 8 c.p.), and applications for the equivalent of 30,733 8 c.p. are in hand.

A report was presented to the Council on Wednesday, that terms had been arranged between Aston Manor, Handsworth, and the British Electric Traction Co. for through tramcar running from Perry Barr to Birmingham, &c. The agreement was approved, but it was decided to reduce the through fare to 2d.

Australasia.—Mr. V. A. E Thomas has submitted to Coburg (Victoria) Council a scheme for lighting Coburg, Brunswick, Kew, &c., by electricity generated by water power to be obtained from the river Yarra, near Warrandyte, about 18 miles from Melbourne.

The outlay is put at £158,000. It is proposed to construct a weir 80 ft. high, a tunnel 600 ft. long, with a 7 ft. fall, and another weir 25 ft. high 3 miles further down the river to utilise the same water again. It is estimated that 1,500 H.P. could be generated, and that this would produce a gross revenue of £[illegible]. Operating costs would be about £8,336. It is calculated that current could be supplied at 3d. for lighting and [illegible] for power. The distributing station would be at Collingwood or Kew. The scheme has been submitted to the Council's engineer, Mr. Murray Fuller.

Birkenhead.—Sanction to a loan of £20,000 for extensions of the electricity supply mains, &c., has been applied for.

Brighouse.—An unopposed inquiry was held last week into the application of the Council for permission to borrow £3,624 for extensions of the electricity undertaking.

On Wednesday the Council decided to apply for sanction to borrow £3,940 for the erection and equipment of a station for transforming the electrical energy to be taken in bulk from the Yorkshire Electric Power Co.

Bristol.—The Electricity department have recently opened showrooms in Colston-street for the display of electric fittings, motors, heating apparatus, &c., and also to demonstrate the numerous advantages of and uses to which electricity may be applied. Two canvassers have also been engaged by the department, and the circulation of suitable literature should also materially assist the new effort of the Electrical department to popularise the use of electricity for light and power.

Burnley.—An inquiry was held here last week into the application of the Council for permission to borrow £26,460 for extensions of the electricity works.

Cardiff.—The borough electrical engineer and tramways manager, Mr. Arthur Ellis, has prepared a report on the running of workmen's cars, &c.

Mr. ELLIS states that the introduction of additional facilities for the conveyance of workmen will be attended with serious results, and he quotes figures to show that, under existing conditions, the limit as regards profit has almost been reached. There is just sufficient to cover depreciation without rendering any assistance to the rates. The profit for the year ended March, 1907, was approximately £4,400. During the past year receipts increased £3,428 and running expenses decreased £3,684, and advertisements brought in £1,500, a total improvement of £8,612; but there had been an increase of £1,835 in loan charges, of £3,764 in track repairs, and £2,000 increase in cost of coal, a total of £7,599. Mr. Ellis thinks that instead of granting further facilities and bringing about a reduction in receipts, still further economies must be effected. A tramway system is a commercial undertaking (Mr. Ellis points out), and must be worked as such, and not as a benevolent institution.

City of London.—According to the annual report of the city coroner (Dr. F. J. Waldo) 145 fires occurred in the City area during 1907. Seven fires were reported as electrical in origin and these were inquired into by Mr. A. A. Voysey, the city electrical engineer, whose expert investigation reduced the number to five. Nine fires were associated with the use of gas. In 30 cases the cause is unknown.

The Common Council have made an arrangement with the City of London Electric Lighting and the Charing Cross, West End & City Electricity Supply Cos. to carry out small side-street demonstrations of electric lighting, and to continue the experimental lighting of certain main thoroughfares for a further period.

Colne.—There was an unopposed inquiry last week into the application of the Council for permission to borrow £4,170 for extensions of the electricity undertaking.

Dartford.—The electrical engineer (Mr. J. D. Pember) has been instructed to obtain tenders for new condensing plant.

Derby.—The salary of Mr. W. C. Pinn, electricity works superintendent, has been increased to £200 per annum.

Electrical Association of Victoria.—At the recent annual meeting Mr. Noel Murray was elected president, and Mr. Harper and Mr. Jackson vice presidents. Mr. Brearley is hon. secretary and Mr. Mountain hon. treasurer. The present membership is 54. The rules had been revised by a sub committee and approved by the Council with the view of making them as far as possible uniform with the rules of the Electrical Association of New South Wales and also of reinstituting the classes of associates and students so as to strengthen the ranks of the association.

Exeter.—Application has been made for sanction to a loan of £8,200 for extensions of mains, &c.

For private lighting the price of current has been reduced from 5d. to 4½d. per unit.

Fire.—An outbreak of fire was discovered on Friday morning in the middle assembling floor at the works of the Foster Arc Lamp & Engineering Co. The cause has not been discovered, but fortunately little damage was done, and this was fully covered by insurance. The hose damaged about 500 enclosed and open-type lamps in course of construction, but steps are being taken to prevent undue delay in completion and delivery.

Heanor.—The Council have instructed the Electric Light committee to obtain particulars regarding electricity supply.

Hull.—The Electric Lighting committee have decided to erect and equip a sub-station in Buckingham-street at a cost of about £10,000.

Maidstone.—Electrical energy will in future be supplied to the light railways department at 1½d. per unit, subject to coal not increasing in price as from April 1 last.

Manchester.—The accounts of the electricity supply undertaking for the past year show £18,177 net profit, after meeting interest and sinking fund charges and placing £10,000 to renewal fund. £10,000 of the surplus is to be devoted to relief of rates. Current has been supplied to the Tramways committee at 1·15d. per unit, compared with 1·26d. in the previous year, representing a saving to the tramway department of £13,520. It is estimated that the loss of income due to reduced charges for current for lighting, which came into operation in December last, will be more than counterbalanced by the accession of business which will result, and the committee promise a further £10,000 in relief of rates from the current year's working. £143,500 will be required for capital expenditure during this year.

The city electrical engineer (Mr. S. L. Pearce) has prepared a report on proposed extensions of plant, &c., at Dickenson-street and Stuart-street stations, at an estimated cost of £[illegible].

The Electricity committee has considered the reports and recommends the Council to make application for sanction to borrow this amount. The extensions at Stuart-street will absorb £128,000, and include two 6,000 kw. turbo-alternators, with condensing plant and foundations (£46,000), and eight water-tube boilers, with economisers and superheaters, flues and foundations (£40,000). Half this work it is proposed shall be done forthwith, and the other half in 1909-10. The water consumption at Stuart-street now amounts to 400,000 gallons daily, the whole drawn from the public service mains of the Corporation, the annual water bill being £3,400. To avoid this heavy expense, and provide for the increased water requirements of the station during the next few years, it is proposed to sink bore holes to accommodate pumping plant capable of delivering some 1,200,000 gallons per day. The cost of this is estimated at £13,500, and a saving of £2,000 per annum is expected.

With a view to further popularising the use of electric light the Corporation seek powers to borrow £5,000 for a short term for wiring consumers' premises. The conditions under which it is proposed to do the wiring are that the tenant or owner shall find the necessary fittings and lamps, that the Corporation shall bear the initial cost of wiring, and that the owner of the premises shall refund, by instalments on the hire-purchase system, the cost of wiring.

On Wednesday the Council considered and adopted the committee's recommendations, but the amount of the proposed loan was reduced to £130,500.

Middlesex.—The Metropolitan Electric Tramways (Ltd.) have suspended the service of cars running between the Eastern and Western Terraces of the Alexandra Palace, as the gross revenue is insufficient to pay working expenses and provide for the rent payable to the Alexandra Park trustees and interest on capital expenditure.

Newcastle-upon-Tyne.—There is a profit of about £20,000 on last year's working of the tramways £19,000 will be absorbed for depreciation. The profits were considerably reduced during the last two or three months of the working year, owing to industrial depression in the city.

Provisional Order Transfer.—Llanelly District Council intend to transfer to the Llanelly & District Electric Lighting & Traction Co. their powers under the Llanelly Electric Lighting Order, 1891, the Council reserving the right to re-purchase the undertaking at the end of 30 or any subsequent seven years.

Reigate.—The Council have applied for sanction to a loan of £4,000 for condensing plant, mains, &c.

Salford.—For the year ended March 31 the total income was £224,048, and the working expenses £147,286, leaving gross profit £96,762.

Payments to local authorities for rent of lines, &c., amounted to £25,985, and interest and sinking fund charges, &c., to £41,971, leaving a net profit of £28,806. In addition there is £1,354 bank interest. The committee have instructed the borough treasurer to apply £15,000 to relief of rates for the past year, and a further £3,000 in accordance with the committee's promise owing to the special circumstances then existing, and that the balance of £10,806 be placed to credit of depreciation and renewals. The increase in gross receipts during the year was about £6,000. Reserve now amounts to £60,000, and the amount paid in relief of rates since the opening of the undertaking is £79,000.

Sittingbourne.—The Council will offer no objection to the electric lighting provisional order (1903) being revoked.

South Shields.—The Council have voted a gratuity of 100 guineas to the borough surveyor for his services in connection with the laying down of the tramways.

Stalybridge, Hyde, Dukinfield and Mossley Joint Tramways and Electricity Board.—The chairman of the Finance committee (Mr. W. E. Wood) has announced that the loss for the past year is a little over £10,000—a considerable reduction on previous losses. Next year they hope for better results.

Stepney (London).—Electric light mains are to be laid in several additional streets.

Swansea.—Mr. R. Borlase Matthews recently offered to submit a scheme for increasing the demand for electricity in the district, the Corporation to pay a percentage on the results. The borough electrical engineer (Mr. C. A. Prusmann), in his report on the offer, points out that the station has been progressive from its start, and that last year there was an increase of something like £2,000 in revenue, and altogether he does not favour the proposal.

Taunton.—An inquiry was held on Tuesday into the application of the Council for sanction to borrow £2,000 for electric lighting extensions.

The town clerk (Mr. G. H. Kite) said that £239 of the amount asked for had already been expended.

The inspector (Mr. H. R. Hooper) asked for particulars, and explained that all expenditure for which prospective loans were granted must be absolutely confined to the purpose for which the money was borrowed.

Mr. Kite stated that up to the present expenditure had commenced before the loan was granted, and the Borough Accountant said they had always been of opinion that the balance from one loan could be used for other purposes.

Mr. Hooper said that was not so, but in order to give the Council the opportunity to start clear, as from April 1 last, he agreed to include the £239 excess of expenditure in the present application. He emphasised that the expenditure sanctioned for a particular purpose, such as mains, meters, house services and transformers, must each be kept quite clear, and that application for a further loan to meet requirements should be made before the whole of either of the amounts for which loans were granted was expended.

Tunbridge Wells.—The question of the control of the electricity undertaking was again considered by the Council on Wednesday, and by 14 votes to 11 it was resolved to revert to the old policy and to place the undertaking under the charge of the Lighting committee.

Wednesbury.—Mr. Griffiths, in presenting a report by the Light and Water committee at the Council meeting on Monday, said the L.G. Board had approved a loan of £7,107 for electrical generating plant, bringing the total sanctioned for electricity supply to £9,926.

Sanction to £800 for extensions into the King's Hill district was to be held over until the question of overhead wires had been settled by the Board of Trade, and three items, amounting to £93, had been disallowed. The committee hoped to be ready to supply current from the Council's own generating station by August. As they were threatened with competition from the Midland Electric Corpn. for Power Distribution, they must be prepared to supply at such a price as would enable them to retain their customers. A new scale of charges, giving favourable terms to customers taking current for both power and lighting, was approved by the Council.

West Bromwich.—The revenue from sale of current for the year ended March 31 amounted to £12,877. 14s. 3d., compared with £12,871. 8s. 5d. in previous year.

Mains are to be laid to Gold's Hill to supply electrical energy to works in that district, under a guarantee of a minimum consumption of 80,000 units per annum for seven years.

Wimbledon.—The salary of the borough electrical engineer (Mr. H. Tomlinson Lee) has been increased from £400 to £500 per annum. The deputy electrical engineer (Mr. R. N. Torpy) and the mains superintendent (Mr. R. W. Klitz) have also had their salaries increased by £25 each per annum.

During the past year 388 new consumers were connected in Wimbledon and 148 in Merton, bringing the totals to 2,677 and 410 respectively. The equivalent number of 35 watt lamps connected for lighting and heating is 128,524, an increase of 16,614.

York.—The Electricity committee recommend the Council to apply for sanction to borrow £7,200 for extensions of mains, &c., during the next two years.

TRADE NOTES AND NOTICES.

TENDERS INVITED.

Bristol Electrical committee invite tenders for supply and erection of (*a*) d.c. works power distribution boards at Avonbank electricity works; (*b*) e.h.t. and l.t. sub-station switchgear for Shirehampton; (*c*) d.c. power switchgear for supply to Avonmouth Docks; and (*d*) extension to galleries at Avonmouth electricity works. Copies of specification and forms of tender, &c., from the city electrical engineer, Mr. H. Faraday Proctor, Temple Back, Bristol. Tenders for (*a*) and (*c*) by May 11 and for (*b*) and (*d*) by May 18. See also an advertisement.

The Electricity committee of *Salford* Corporation invite tenders for supply, delivery and erection at the electricity station, Frederick-road, Pendleton, of cooling towers, tanks, pumps and pipework. Specification and form of tender from the office of the borough electrical engineer, Mr. Victor A. H. M'Cowen. Tenders, addressed to the Chairman of the Electricity committee, must be delivered at the office of the borough electrical engineer before noon Monday, May 25. See also an advertisement.

Melbourne City Council invite tenders for supply and delivery of one 500 kw. motor-generator. Copies of specification, conditions and form of tender from Messrs. McIlwraith, McEacharn & Co. Proprietary (Ltd.), Billiter-square-buildings, London, E.C., agents for the City Council. Tenders, addressed to the Chairman of the Electric Supply committee, Town Hall, Melbourne, must be received by him before 2 p.m. Friday, July 3. See also an advertisement.

Melbourne City Council also invite tenders for supply of 1,003,800 flame and 35,000 ordinary carbons. Copies of specification, conditions and tender forms from Messrs. McIlwraith, McEacharn & Co. Proprietary (Ltd.), Billiter-square-buildings, London, E.C., agents for the City Council, to whom tenders by noon Monday, May 25. See also an advertisement.

London County Council invite tenders for the manufacture and supply of two electrically-driven centrifugal pumps, &c., to be erected at the East Greenwich electricity generating station. Tenders, on official forms, to be obtained from the clerk of the Council (Mr. G. L. Gomme), County Hall, Spring Gardens, S.W., by 11 a.m. Tuesday, May 26. See also an advertisement.

London County Council invite tenders for wiring and fitting for electric lighting of the tramway car shed at Mare street, Hackney. Tenders, upon official forms, to the clerk to the Council (Mr. G. L. Gomme), County Hall, Spring gardens, S.W., by 11 a.m. May 12.

London County Council want tenders by 11 a.m. May 19 for supply of about 2,000 tons (or alternatively for 5,000 tons) of steel girder tram rails and fastenings. Specifications from the Chief Engineer, Spring Gardens, S.W.

London County Council also want tenders by 11 a.m. May 12 for supply of 3,500 31¾ in. and 2,000 21¾ in. steel tyres for electric cars. Forms of tender from the Chief Officer, L.C.C. Tramways, 62, Finsbury-pavement, E.C.

St. Marylebone (London) Council invite tenders for supply and delivery, f.a.s. their wharf at Marylebone, of 16,000 tons minimum, 20,000 tons maximum of double-screened nuts, washed nuts, peas and beans. Tenders to Town Clerk by 4 p.m. May 13.

Portsmouth Guardians want tenders by noon May 13 for wiring the additional blocks and the maternity ward at the workhouse infirmary Specification from Messrs. Rake & Cogswell, Prudential-buildings, Portsmouth.

Southend Corporation require tenders by noon May 28 for supply of traction poles, brackets, overhead line materials and rail bonds for about 1,600 yds. of tramway. Specification from the Borough Electrical Engineer.

Tenders are wanted by 11 a.m. May 20 for lighting three ward blocks and for telephones and fire alarms at the *Croydon* Mental Hospital. Specifications, &c., from the Borough Engineer, Town Hall, Croydon.

Dover Corporation want tenders by May 18 for supply of large and small coal for their electricity department. Forms of tender, &c., from the Borough Electrical Engineer.

Dartford Council want tenders by 4 p.m. June 9 for supply of electric meters, house service cable, jointing material, &c. Forms of tender, &c., from the Clerk.

Derby Electric lighting committee invite tenders for the supply of bitumen cable. Full particulars from the borough electrical engineer, Mr. T. P. Wilmshurst, Full street, Derby.

Bermondsey (London) Council want tenders by noon May 18 for supply and erection of a boiler, steam dynamo, condenser and cooling tower. Specification from the Borough Electrical Engineer.

Edinburgh Corporation want tenders by May 14 for electrical installation for lighting, heating and power at the College of Art, Edinburgh.

Edinburgh Corporation also invite tenders for the supply of arc lamp posts. Tenders to town clerk by May 11.

Harrogate Corporation want tenders for supply of coal (hard steam nuts) for the electricity department. Tenders to the Borough Electrical Engineer by May 18.

The *Metropolitan Asylums Board* want tenders by 10 a.m. May 13 for supply of electrical accessories. Forms of tender, &c., from the Board's Offices.

Ilford Council want tenders by noon May 12 for supply of feeder cable. Specification from the Electrical Engineer.

The representative of the Australian Commonwealth in London has specifications, &c., for the following contracts:—

Extension of common battery switchboards, 200 wall telephones, and 50 receivers and cords for Postmaster General's Department, *Hobart*. Tenders by noon May 11.

Battery glassware, battery material and chemicals, tools, &c., for Postmaster General's Department, *Brisbane*. (Tenders by noon June 1.

Telephone material, instruments and switchboard for Postmaster-General's Department, *Adelaide*. (Tenders by noon June 3.)

The following Australasian Government contracts are also open:—

The Postmaster General's department, *Sydney*, N.S.W., want tenders by May 29 for supplying 8½ tons h.d. copper wire, 3 cwt. copper binding tape and 2,700 porcelain insulators.

The Postmaster General's department, *Melbourne*, Victoria, want tenders by June 9 for 2,800 jacks, one mile 64 wire switchboard cable, 50 cords, 96 3 part plugs and 66 ringing and listening keys.

The Postmaster General's department, *Sydney*, also want tenders by Aug. 12 for [illegible] metallic multiple magneto switchboard for Mosman Telephone Exchange.

Tenders are wanted by June 1 for construction and working of interurban telephone lines in the South and North-West and the extension of the interurban system of the North East of *Spain*, and also for construction and working of an international system connecting with France. The "Madrid Gazette" for April 19 and 23 contains conditions, &c., and can be seen at 73, Basinghall-street, London, E.C.

TENDERS RECEIVED AND ACCEPTED.

Stoke-on-Trent Council have accepted the tender of Willans & Robinson for supply and fixing of a new steam generator and condenser set at £3,26[illegible], and that of Babcock & Wilcox for a new water tube boiler at £[illegible],110. The Council have also placed orders with the British Insulated & Helsby Cables for 150 sets of street box fittings and house service cut-outs, and with the Reason Mfg. Co. for 100 meters.

Wimbledon Electric Lighting committee have accepted the tender of Jas. Howden & Co. for supply and erection of a Zoelly turbine direct-coupled to a Siemens single-phase 1,000 kw. alternator and switchgear, with Worthington condensing plant and the necessary pipework and valves for £7,275.

Paddington (London) Council have accepted the offer of the Metropolitan Electric Supply Co. for supplying and fixing electric motors, &c., at the wharf at a cost of £20. 4s. 7d., and for supplying current to the motors at 2d. per unit, the Council having the option of taking current on a sliding scale.

Fulham (London) Electricity and Lighting committee has accepted the tender of Siemens Bros. Dynamo Works for supply of 100 electricity meters (50 each of 3 and 5 ampere size), and that of F. Pratt & Co. for supply of machines and tools at £140. 5s.

For insulating box compound (1st quality) Bermondsey Council have provisionally accepted the tender of the British Electrical Trade Supply & Bitumen Co. at £1. 10s. 6d. per cwt. There were 16 tenders, varying from £1 to £6. 6s. per cwt.

The tender of G. Weymouth Proprietary (Ltd.) for supply of 200 kw. three-phase 50 cycle generator coupled to Allen high-speed compound engine has been accepted by the Long Tunnel Gold Mining Co., Walhalla, Victoria.

Derby Council have accepted the following tenders:—

Johnson & Phillips, bitumen cable, £84. 6s. 8d.; British Insulated & Helsby Cables, h.t. cable; Geo. Robson & Co., track grinder, £85; Edgar Allen & Co., tramway crossing, £16. 10s.

Southampton Electricity committee have accepted the tender of Crossley & Davenport (Ltd.) for 50 mild steel plates at £7. 5s. per ton, and that of Cochrane & Co. for cast-iron pipes, at £92. 10s.

Southampton Corporation have placed an order with West's Gas Improvement Co. for a coal conveyor for the electricity works at £558.

Kensington Works committee have accepted the tender of Crompton & Co. for supplying and fixing lowering contact gear to 23 arc lamps at £4. 7s. 6d. per lamp.

Bermondsey (London) Council have accepted the tender of E. Green & Son for repairs, &c., to the fuel economiser at the electricity works at £276. 10s.

Bolton Tramways committee have accepted the tender of Edgar Allen & Co. for sole plates, and that of Hadfield's Steel Foundry Co. for points and crossings.

Aberdeen Corporation have accepted the tender of the British Insulated & Helsby Cables for the supply and laying cables at £3,275. 15s.

Bolton Electricity committee have accepted the tender of John Musgrave & Sons for floor engine plates.

Hackney (London) Council have accepted the tender of J. Hudson & Co. for supply of 2,000 tons of Broomhill coal at 12s. 3d. per ton.

Hull Electric Lighting committee have accepted the tender of Siemens Bros. & Co. for mains at £5,929.

Accrington Electricity committee have accepted the tender of the Brush Co. for two single-deck cars at £695 each.

The Postmaster-General's Department, Melbourne, Victoria, have accepted the tender of J. A. Newton & Co. Proprietary (Ltd.) for 50 ringing and listening keys at 12s. 6d. each and 150 ditto at 14s.

The N.S.W. Public Works Department have accepted the tender of C. A. MacDonald for electric plant for the Federal trawler at Cockatoo Island, at £142.

The Société Nationale des Chemins de Fer Vicinaux, *Brussels*, want tenders by May 14 for supply of c. i. rings and head pieces for electric traction standards and by May 26 for supply and laying down of underground electric traction cables. Plans from the offices of the company, 14, Rue de la Science, Brussels.

Electric Driving in Cotton Mills.—Messrs. Marples, Leach & Co. have secured the contract for the complete equipment of the new mill being erected by the Tyne Ring Spinning Co. at Littleborough, near Manchester. The equipment consists of a complete generating plant, including a 1,200 kw. three-phase steam turbo-generator at 50 cycles 400 volts, a pilot lighting set, condensing plant with electrically driven pumps, two 400 H.P. three phase induction motors at 485 revs. per min., two 100 H.P. motors at 360 revs. per min., one 50 H.P. motor at 360 revs. per min. and a number of smaller motors. The larger motors will be direct coupled to the driving shafts on the different floors, while the smaller ones will be connected by ropes or belts to the machine which they have to drive. An elaborate engine-room switchboard is being provided for controlling the whole of the power and lighting circuits in the mill, the main lighting circuits being divided into three sets, being equally balanced over the three phases, and will be at 230 volts. The contract includes the supply, delivery and erection of the whole plant, including the wiring throughout, this section of the work will, however, be sublet to local contractors.

BUSINESS NOTICES.

Correction.—In reference to the paragraph relating to the "Arcoflame" which appeared in our last issue (p. 110), Messrs. J. & H. Grevener, of Eldon-street House, E.C., write :—

TO THE EDITOR OF THE ELECTRICIAN.

Your notice concerning our "Arcoflame" intense flame arc lamp was incorrect. Our "Arcoflame" lamp is an entirely new and improved model, and is only just being placed on the market.

Simplex Conduits (Ltd.) have opened new premises at 16, Corporation-street, Manchester, and 72A, Waterloo-street, Glasgow, where they hold stocks of conduits, cables, fittings, lamps, &c., so that their local customers will be able to draw on them for any requirements. Telephone numbers and telegraphic addresses remain as before.

Mr. S. Thomas Pemberton, Council Chambers, 109, Colmore-row, Birmingham, has been appointed agent for the Midland Counties by Messrs. Evershed & Vignoles. Mr. Pemberton's headquarters will be in Birmingham, and his district will embrace the counties of Warwick, Worcester, Nottingham, Derby, Leicester, Stafford and Shropshire. Inquiries and orders in this district relating to the company's measuring instruments, meggers, bridge-meggers and other manufactures may be addressed to Mr. Pemberton and will receive prompt attention.

Messrs. Marryat & Place, 28, Hatton-garden, London, E.C., have taken over the business lately carried on by Joseph Richmond & Co., engineers and lift makers, 30, Kirby-street, E.C., and the New Sun Iron Works, Bow, E., having purchased the goodwill, together with all drawings and patents, and the premises in Kirby-street.

The British Electric Calibrated Fuse Co. notify that since they obtained the manufacturing rights of the Koolark fuse their increased business has made it necessary to extend their factory and plant at Harpenden. The head office has also been transferred to Harpenden, where all future communications should be addressed. Telegrams, Electrical Harpenden ; Telephone, Harpenden 22.

The death of Mr. S. N. Wolff, the head of the well-known firm of S. N. Wolff & Co., of Beuel-Bonn, occurred on April 9 last. The business is being continued under the same style by his widow, Mrs. Johanna Wolff, and his son, Mr. Oskar Wolff, who have for many years past been identified with the business.

BANKRUPTCIES, LIQUIDATIONS, &c.

At Birmingham Bankruptcy Court last week Archibald F. Mander, electrical engineer, &c., 30, Prestbury-road, Aston, was publicly examined.

Bankrupt traded as Mander Bros., cycle dealers, and as an electrical engineer in his own name at 258, Lozells-road, Aston. Liabilities £258, deficiency £243. Prior to Feb. 1906, bankrupt was employed as an electrical engineer at £2 per week. He then opened a cycle dealer's business with a capital of £30, with an electrical engineer's business in conjunction with it. The work in connection with the latter business increased to such an extent that he transferred it to separate premises in Lozells-road, appointing a manager for the cycle business. At that time he was solvent. Later he was advised to form a limited company to protect the electrical business. The company was registered with a capital of £1,000. There were no shares subscribed for, and the only person interested in the company was himself. A debenture to himself covered all the assets, payable on demand. The stock at that time was worth about £200, and the balance, £750, was goodwill.—Examination closed.

Ernest Noel Owen, electrical engineer, 1, Grove Cottage (lately of 2, Yale-court), Hampstead, London, N.W., has been adjudicated bankrupt. First meeting of creditors, May 11, at Bankruptcy-buildings, London, W.C. ; public examination at same place on June 19.

A first and final dividend of 2s. 6½d. is payable at Bankruptcy-buildings, London, W C., in the failure of Geo. Collier, electrical engineer, &c., 89, Long acre, London, W.C.

A meeting will be held on June 3, at 11, Ironmonger-lane, London, E.C., to receive an account of the winding-up of Benham & Froud (Ltd.).

Plant for Sale.—Mr. E. J. Jennings, West Walls, Newcastle-on-Tyne, has for sale electrical machinery, suitable for isolated generating plants or extensions of existing plants. The machinery constitutes the whole of the generating plant at the Dale End electricity station of Birmingham Corporation, which has been purchased by Mr. Jennings. Photos and full list on application. Further particulars are given in an advertisement.

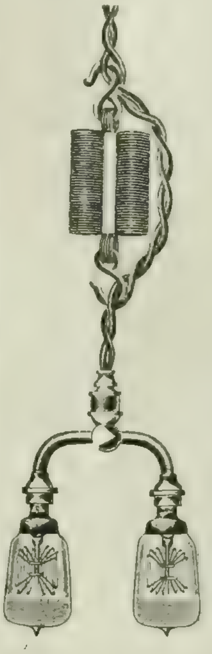
A 6 kw. second hand dynamo, with switchboard, and a quantity of fittings are offered for sale. May be inspected at Pauling's depot, Greenford Station (G.W.R.), Southall. See an advertisement.

A Babcock & Wilcox water-tube boiler is advertised for sale in another column.

Metallic Filament Lamp Patents.—An important firm in the United States advertises that it is open to take licences under patents in that country relating to high-efficiency metallic filament lamps. Applications to Messrs. Lloyd-Wise & Co., chartered patent agents, 46, Lincoln's Inn-fields, London, W.C.

The "Journal."—Part 188 of the "Journal" of the Institution of Electrical Engineers is now ready, price 5s. For particulars of contents, see advertisement.

Anti-vibrator for Metallic Filament Lamps.—The Mills "twin spring" anti-vibrator, which we illustrate herewith, has been introduced with the idea of relieving the suspended patterns of metallic filament lamps from jarring and shock. These lamps are more susceptible to vibration than the carbon variety, so that this device should tend to increase the life of the lamps, while it may also be instrumental in keeping up their efficiency. As will be seen from the illustration, the device consists of a pair of springs to the ends of which two insulated hooks are attached. These hooks are passed between the turns of the flex. The agents for this anti-vibrator are Messrs. Alvey & Bower, Chesterfield. The various springs are made in various strengths to allow for different weights of pendants.



MILL'S ANTI VIBRATOR FOR METAL FILAMENT LAMPS

"McGraw House."—The consolidation of the interests of technical electrical journalism in the United States may in some measure account for the splendid new premises in which the McGraw Publishing Co. have recently housed their staff and plant. Readers of the "Electrical World" and "Street Railway Journal" will doubtless have received a copy of the neat brochure entitled "New Home of the McGraw Publishing Co.," which has been distributed to the four winds of heaven. The "Electrical World" has been in existence under various titles and in various forms some 35 years, and its history tells also the tale of the electrical industry. Of the appointments of the new McGraw building we cannot speak in detail, as space will not permit. They have, however, been laid down on efficient lines, and, in comparison with ideas prevailing over here, may appear lavish to a degree. A building 126 ft. wide by 90 ft. deep and 160 ft. high with 10 storeys, may be expected to effectually accommodate the whole of the plant, machinery and business departments of an establishment which has progressed from small beginnings to its present impressive proportions.

Foster Arc Lamp Works.—A visit to the works of the Foster Arc Lamp & Engineering Co. formed an item of the home district meeting of the Incorporated Association of Municipal and County Engineers, held at Wimbledon on May 2, when a number of municipal engineers and others inspected the works. Much interest was evinced in the company's new electrically-illuminated road sign for motor traffic and the elaborate winding apparatus laid down in the beginning of the year for the rapid execution of metallic filament transformer orders. The various lamps came in for considerable notice, and the numerous inquiries as to cost of running, &c., indicated the deep interest taken by borough engineers in street lighting.

CATALOGUES, &c.

"*Installation News.*"—The literary contents of the April issue of this publication bear a strong resemblance to the weather. They are a strange admixture of advice on heating and cooking and electric fans. The article on the former is reprinted from one of our recent issues. The electric fans described are certainly cool and refreshing to contemplate—on paper, but during this "damp and clammy" weather we prefer that they should remain there. But by the time these lines are in print we may be back in the torrids, and then these fans will be the order of the day.

"*Phoneze.*"—This name suggests at once an idea, and simultaneously impresses it upon the mind. "Phoneze" is a telephone bracket which the General Electric Co. supply to lighten the labours of telephone users. By asking for pamphlet K. 1,234 (with the pretty design on the cover) our readers will get to know what it will cost to "phoneze," or they may turn to our issue of Feb. 7, 1908, for fuller details.

Hart Accumulators.—A leaflet to hand epitomises the advantages of the Hexite separators for storage batteries which the Hart Accumulator Co., Stratford, London, E., is introducing into its batteries. The makers claim that by the use of these separators it is impossible for internal short circuits to occur, there is no need for weekly examination of the cells, and there is an immediate monetary saving

by their use. The separators are equally applicable to stationary, motor-car, portable or any other cells. The list mentioned gives full details and prices.

Water Softening Plant. The Paterson Engineering Co. are issuing very full descriptive details with drawings of their various patterns of water-softening plant. The sections of the water softeners have been worked up in colour, and bring out the main features very clearly. They also show the functions of the various parts of the apparatus distinctively.

"*West Ham Bulletin.*"—The April issue of this particularly virile central station monthly seems to us to eclipse the high standard of its predecessors for generally interesting matter relative to the uses of electrical energy. Two pages devoted to a letter written by Master Bill to Master 'Enery (from a contemporary) will doubtless be read with more than ordinary interest by West Hammers. A photograph of a burst boiler should hasten the decision of steam users in the West Ham District, particularly if th-y feel inclined to hesitate about the introduction of electric motors.

Arc Lamp Lowering Gear.—The specialities of the London Electric Firm, Croydon, in the way of arc lamp lowering gear are now so well known that they hardly require detailed treatment at our hands. We are, however, pleased to note that the company has issued a catalogue in which the fullest details are given of their "one working part" arc lamp lowering gear, and its application for street lighting, interior arc lamps, workshops and yard lamps, &c. Almost every conceivable method of suspending an arc lamp is dealt with. In a letter accompanying the catalogue we are informed that the literature relating to this device previous to the publication of the book before us was confined to a single page list, so that the company may claim a record. A copy of this interesting booklet will be forwarded to any interested engineer.

Fuse Boxes.—Protective devices of the fuse pattern form the subject of the latest list issued by Ernest F. Moy (Ltd.). The apparatus listed and priced is all of the ironclad type, suitable for working pressures up to 550 volts. A feature of the designs is the use of porcelain bases and recesses for the fuse terminals.

PATENT RECORD.

APPLICATIONS FOR PATENTS.

NOTE. *The under-mentioned Applications (except those marked †) are not open to public inspection until after acceptance of Complete Specifications. Those marked † are open for inspection 12 months after the date attached to them, if they have not been published previously in the ordinary course. Names within parentheses are those of communicators of inventions. When Complete Specification accompanies application, an asterisk is affixed.*

January 27, 1908.

1,779 DUDDELL. Vibration galvanometers.
1,797 VON MARDALER. Pocket apparatus for wireless telegraphy.
1,832 SIEMENS BROS. DYNAMO WORKS, & SCHENKEL. Dynamo electric machines.*
1,848 SCHIESSLER. Apparatus for alternative wireless telegraphy and telephony.*
1,850 MERCER. Electric relays.

January 28, 1908.

1,862 JERVIS SMITH. Apparatus for production of electric glow in an exhausted vessel, and modification of said glow by a magnetic field.
1,877 GOVAN. Electrolysis of liquids.
1,918 PARSONS. Turbines.
1,947 CREED & COLLISON. Machines or apparatus for reproducing in ordinary characters, telegraphic or other messages in the form of perforations in a tape.
1,948 B.T. H. Co. (G.E. Co., U.S.) Electric motor control systems.
1,949 B.T. H. Co. (G.E. Co., U.S.) Commutators for dynamo electric machines.
1,950 KREGNAUD(?) (Bell Telephone Mfg. Co., Belgium.) Gravity switches as applied to telephones and the like.

January 29, 1908.

1,980 [illegible]. Lifeguard for tramcars.
1,981 [illegible]. Brakes for tramcars and the like.
1,984 [illegible]. Electric [illegible] apparatus.
2,0[illegible] [illegible]. Electrically controlled lifts, hoists, cranes, &c.
2,082 B.T. H. Co. (G.E. Co., U.S.) Current collectors for electric traction systems.

January 30, 1908.

2,08[illegible] [illegible]. Electrically operated railway switch points and signals.
2,088 [illegible]. Electrical ignition apparatus.
2,094 [illegible] & [illegible] & ROGERS. Devices for [illegible] electric currents.
2,103 [illegible] & Co. & WARREN. Electric lamps.
2,120 [illegible] & [illegible]. Arc lamps.
2,127 [illegible] (G.E. Co., U.S.) Electrically operated switches.*

2,152 TRIVELLI. Obtaining radio-active bodies from uranium or thorium or from compounds of the same.*
2,153 BUCKTON. Incandescent electric lamp caps and couplings.
2,159 PAGE & HARRISON. Electric motors.
2,163 ARCHER. Hauling gear for electric hauling machines.

January 31, 1908.

2,175 MCGREGOR & MOUNTFORD. Switches.
2,195 DERAIN. Dynamos. (Date applied for, 2/6/07.)*†
2,206 AMALGAMATED RADIO-TELEGRAPH CO. Radio-telegraphy. (Date applied for, 31/1/07.)*†
2,214 JUILLE. Trolley heads.
2,222 PHILIPPE MESSIER. Electrical motor.*
2,243 COWPER-COLES. Treatment of copper precipitate.
2,244 B.T.-H. Co. (G.E. Co., U.S.) Dynamo-electric machines.

1906 SPECIFICATIONS.

24,232 B.T. H. Co. (Allgemeine Elektricitats-Ges.) Incandescing bodies for electric lamps.
24,233 B.T. H. Co. (Allgemeine Elektricitats-Ges.) Incandescent lamps having incandescing bodies of refractory metal.

1907 SPECIFICATIONS.

1,947 HANSEL. Electrically operated installation for forwarding postal letters and the like through a tube.
1,963 LOEBL & BRITISH EVER-READY ELECTICAL CO. Switches.
2,132 FLETNER & FELTEN & GUILLEAUME LAHMEYERWERKE A.-G. Controlling motors and other apparatus from a distance. (Date applied for, 27/1/06.)
2,283 MUIRHEAD. Coherers for wireless telegraphy.
2,381 PARSONS, WILSON & FORD. Blading for turbines, compressors and the like.
2,413 BROWN. Electrical block signalling system for railways.
2,416 SUMPNER. Alternating current instruments and appliances.
2,417 CHAMBERS & BENNET. Switches for use with internal combustion engines.
3,116 CUNNINGTON. Electric heaters for bedding, clothing, &c.
3,739 LANCASHIRE DYNAMO & MOTOR CO., WARBURTON & KELSALL. Automatically equalising the power supplied to electric motors subject to an intermittent load.

COMPANIES' MEETINGS AND REPORTS.

BARNSLEY & DISTRICT ELECTRIC TRACTION CO.—At the meeting last week the directors reported that the total revenue for the year was £9,065 and the expenditure £7,455. The available balance was £2,062. Capital expenditure to end of 1907 was £67,403, an increase of £421. Application had been made to the Corporation for a revision in the price at present paid for current, but they had not acceded to the request, and the directors were considering what further steps should be taken.

BRITISH WESTINGHOUSE ELECTRIC & MFG. CO. (LTD.)—At the meeting on Monday the chairman (Mr. J. Annan Bryce, M.P.) said that since their last meeting (Jan., 1907) they had passed through difficult times. In October last the Westinghouse Electric & Mfg. Co. and the Westinghouse Machine Co., the companies from whom in the past they had received financial support, were involved in the sudden financial crisis which paralysed for the time being, the commercial and industrial activity of the United States, at a time when they were in the height of prosperity and doing an increasing and profitable business. The Westinghouse Machine Co. has, as from March 31, been relieved from its receivership, and in the case of the electric company negotiations are proceeding to the same end. The difficulties of the American companies caused embarrassment in the conduct of their own affairs, and it became necessary for them to create £300,000 prior lien debentures at a rate of interest not exceeding 6 per cent., and £250,000 had been placed at 95 per cent. The arrangement under which the indebtedness of the American companies has been cleared off by the transfer of Traction & Power Securities Co. shares at par releases £120,000 of capital hitherto invested in securities. After explaining the items in the balance sheet and referring to the position of the companies in which they were financially interested, the chairman said that a great improvement was shown both in the volume of orders and in the reduced cost of manufacture. The output per £ of pay roll had steadily increased, or, in other words, with a 2 per cent. lower pay roll more than 10 per cent. additional value of apparatus was produced. Further reduction in salary list and general expenses resulted in an additional saving of about £25,000. Selling expenses were rather higher than in the preceding year, owing to an increase in other expenses [illegible]; but the percentage of cost of selling to amount of orders booked was less than in the preceding year. The total amount of shipments for the twelve months, compared with the preceding year, was about 1[illegible] per cent. The business in prime movers—both gas engines and turbines—had been considerable, and the uniform success of their new gas engine encouraged the directors in the belief that that branch of the business would continue to increase and prove profitable. With a view to improved efficiency and economy in manufacture many important lines of apparatus had been re-designed during the year in order to meet the severe competition both at home and abroad. The export business had shown a considerable increase, and new agencies had been established in various quarters of the world. The

arrangement entered into as regards South America had proved satisfactory. Several contracts had been taken on the Continent in co-operation with the French Westinghouse Co., and additional business from that source was anticipated. The orders showed an increase of more than 30 per cent. over the preceding year. Competition was certainly more severe than ever, and prices had been on a descending scale during the year, notwithstanding the high prices of raw materials. At that moment trade was decidedly slack, with little prospect of a revival until after the summer months.

CRAIGPARK ELECTRIC CABLE CO. (LTD.)—At the meeting on Tuesday the chairman (Mr. J. T. Tullis) said the past year's working had been fairly satisfactory—in fact, it had been one of the best years experienced since the formation of the company. At the beginning of the present year their prospects were very bright, the plant in operation was in the highest state of efficiency and the management were very watchful that no hitch should arise in any department. During the year the company had joined the Cable Makers' Association. They were quite able to maintain their independent position, but they thought it advisable to join, as many of the schedules issued stipulated that the wire used should be manufactured by firms connected with the Association.

EASTERN TELEGRAPH CO. (LTD.)—The report of the directors for the half-year ended Dec. 31 states that the revenue for the period amounted to £595,482. 19s. 10d., from which £198,228. 13s. for ordinary expenses is deducted, and £63,526. 19s. 2d. for expenditure relating to maintenance of cables, depreciation of spare cable, sundry differences in exchange and income tax payable abroad, leaving £333,727. 7s. 8d., to which is added £41,651. 3s. 7d. from preceding account, making a total available balance of £375,378. 11s. 3d. After providing for income tax payable in England, interest on mortgage debenture stock and dividends on preference stock, absorbing in all £82,583. 11s. 4d., there remains £292,794. 19s. 11d., out of which the directors have placed £7,000 to reserve for maintenance ships, and £70,000 to general reserve, and have paid an interim dividend of 1¼ per cent. on the ordinary stock (£50,000). The directors now recommend a final dividend on the ordinary stock of 1¼ per cent. and a bonus of 2 per cent., amounting together to £130,000, both payable on 12th inst. (tax free), and making, with the three previous payments, a total distribution of 7 per cent. for the year. It is proposed to carry forward the balance of £35,794. 19s. 11d.

The register of transfers will be closed from 5th to 12th inst., inclusive.

EASTERN EXTENSION AUSTRALASIA & CHINA TELEGRAPH CO. (LTD.)—The report of the directors for the half-year ended Dec. 31 last states that the gross receipts amounted during that period to £304,416. 3s. 11d., against £296,393. 18s. 2d. for the corresponding half-year of 1906. Working expenses (including £26,069. 8s. 10d. for maintenance of cables) absorb £154,203. 10s. 8d., against £139,549. 9s. 7d., leaving £150,212. 13s. 3d. From this is deducted £19,770. 5s. 9d. for income tax payable in England, mortgage debenture interest stock, and other extraordinary expenditure, leaving net profit for the half-year of £130,442. 7s. 6d. Adding £74,947. 9s. 1d. brought forward there is an available balance of £205,389. 16s. 7d. One quarterly interim dividend of 1¼ per cent. has been paid for the half-year, and it is now proposed to distribute another of like amount, making with the interim dividends paid for the first half-year a total dividend of 5 per cent. It is also proposed to pay a bonus of 4s. per share, or 2 per cent., making the total distribution 7 per cent. for 1907. £50,000 has been transferred to general reserve, and the balance (£20,389. 16s. 7d.) carried forward. Several partial renewals of the company's cables have been effected during the half-year, and the cost (£28,848. 19s. 3d.) has been charged against general reserve. Since the close of the year the company's new direct cable between Java and the Cocos Islands has been successfully laid and opened for traffic.

The register of transfers will be closed from 6th to 13th inst. inclusive.

EDMUNDSON'S ELECTRICITY CORPN. (LTD.)—A meeting of the first mortgage debenture holders was held on Wednesday to authorise the creation of prior lien debenture stock not to exceed £200,000, bearing interest at 5 per cent. Mr. P. D. Tuckett deplored the necessity which compelled them to resort to the creation of the proposed debentures, which, in his opinion, was the only practical and satisfactory way of escape from the difficult position that the company found itself in. It did not follow that they would avail themselves of the power to issue the £200,000. The proceedings were adjourned to Thursday next to give dissentient debenture-holders an opportunity of conferring with the directors with a view to seeing whether any modification of the scheme is possible.

GRAVESEND & NORTHFLEET ELECTRIC TRAMWAYS (LTD.)—The total revenue for 1907 was £13,058. 9s. 5d. Deducting all expenses there is a profit of £2,195. Adding £276. 15s. 9d. forward the balance is £2,471. 16s. 3d., of which £1,000 has been placed to reserve and renewals, £1,200 absorbed in payment of preference dividend to June 30, 1906, leaving £271. 16s. 3d. to be carried forward. The year's working showed an increase of £92. 10s. 1d. in receipts and a decrease of £108. 18s. 7d. in expenses.

ISLE OF WIGHT ELECTRIC LIGHT & POWER CO. (LTD.)—At the meeting last week it was reported that at the end of 1907 the equivalent of 20,655 8 c.p. lamps was connected at Ventnor and Bonchurch (against 19,577 8 c.p. in 1906), at Sandown and Shanklin 18,479 8 c.p. (against 16,918), at Newport and Cowes 31,710 (against 29,219), and at Ryde and St Helens 18,456 (against 16,207), making a total of 89,300 8 c.p. against 81,921. With £136. 18s. 11d. from last year, the year's profit was £10,869. 11s. 8d. After paying interest and loans and preference dividend, there remained £3,190. 1s. 10d. The directors recommended that £2,500 be placed to reserve for renewal of plant, an additional £500 to be written off wiring stocks, and £190. 1s. 10d. carried forward.

KALGOORLIE ELECTRIC POWER & LIGHTING CORPN. (LTD.)—Mr. Roger W. Wallace, K.C., who presided at the meeting on Wednesday, stated that the trading account for 1907 was a record one. The plant was in a more efficient condition now than it was before, and the directors proposed to put down a new unit, which would enable them to reduce the expenses still further in connection with the generation of electricity. Their load factor was better than that of any other electric lighting company in the world, and that was entirely due to the management of the works.

LISBON ELECTRIC TRAMWAYS (LTD.)—The result of the company's operations for 1907 shows a net profit of £92,802. 13s. 3d., added to £15,711. 7s. 6d. from last year, make £108,514. 0s. 9d. From this £35,000 has been placed to depreciation and £5,000 to credit of exchange reserve, leaving an available balance of £68,514. 0s 9d., out of which preference dividend (£25,533. 3s. 8d.) has been paid, and the directors recommend a dividend of 5 per cent. for the year (£29,709. 8s.) on the ordinary shares, leaving £13,271. 9s. 1d. to be carried forward. The political unrest and financial depression throughout the country, together with the effect of the abnormally bad weather, combined to check the steady increase of traffic which might otherwise have been expected. Moreover, the operating expenditure also shows a considerable increase due to the enhanced price of coal and other supplies. Capital expenditure of £72,271. 9s. 4d. has been incurred, mainly on additional machinery, rolling stock, cables and the electrification of the lift on the Elevador Do Carmo.

NATIONAL ELECTRIC CONSTRUCTION CO. (LTD.)—The gross profit for 1907 was £29,776. 0s. 8d., and deducting expenses of administration, &c., there remains £18,116. 18s. 8d. added to £2,343. 4s. 7d. from 1906, making £20,460. 3s. 3d. The directors recommend that £3,000 be placed to reserve, £4,487. 17s. be applied to meet expenses of and discount on debenture issue, £1,200 as reserve against capital charges on town lighting installations, £1,550 be transferred to debenture redemption fund, £500 as reserve to cover doubtful debts and £673 10s 9d. as depreciation on free wired installations, furniture, fixtures, plant and tools. In view of the company's large investments in tramway and lighting syndicates, which, owing to delays in construction, are not yet realisable, the directors recommend that the balance (£9,048. 15s. 6d.) be carried forward. The depression which prevailed during the year appears (the report states) to be passing away, and it may now be possible to finance some of the concessions secured before the depression set in. A strike of the employés of the Musselburgh & District Electric Light & Traction Co., which occurred during the busiest months in the year, affected the profits. Powers for the extension of the tramways to Port Seton have been obtained. Considerable and unavoidable delays prevented the completion of the Torquay tramways system; the last part of the route has, however, just been opened, and the receipts are most gratifying. It will be necessary to have additional cars to cope with the traffic. The Mexborough & Swinton Tramways were only completed in August, and the traffic there also calls for additional cars, which are now being made. Important alterations to the system have been found necessary, and these should be completed in the course of the next three months. There have also been unavoidable delays in the completion of the Rhondda tramways system. Owing to financial difficulties, the South Wales Electrical Power Distribution Co. were unable to supply current for the tramways, and it therefore became necessary to erect a generating station. The Rhondda Tramways Electric Supply Co. (Ltd.) was formed, and the capital raised. The work is nearing completion, and it is expected that two sections of the tramways will be opened in the course of a few weeks. The present system at Oxford has to be acquired and satisfactory terms have been arranged with the local horse tramway company. The progress of Bo'ness and Carnarvon electric light undertakings has been maintained.

POTTERIES & DISTRICT ELECTRIC TRACTION CO. (LTD.)—The report for 1907 states that the total revenue for the year was £111,670, increase £2,404. Deducting all expenses there remains £27,874, or with £616 forward the total was £28,491. The directors recommend £3,500 being placed to renewals fund, £2,500 to depreciation and reserve, and to pay a dividend of 4 per cent. on the ordinary shares, carrying forward £441. An application is being made for Parliamentary powers to double the existing lines as the company may require.

RANGOON ELECTRIC TRAMWAY & SUPPLY CO. (LTD.)—The second annual report of the directors states that difficulties were, during the past year, experienced with the machinery, especially the two turbines, causing a delay of several months. It was only recently that those difficulties had been finally overcome, and the company placed in a position to supply a continuous 24 hours' service. The machinery is now working satisfactorily. The electric tramway is now completed and running; the final portion of the track (Poozoondoung route, 1·94 single miles) was opened on March 12. Notwithstanding that traffic was considerably interfered with during the year, the receipts were very satisfactory and show steady improvement. Under the agreement with the municipality there are to be 350 arcs and 1,050 incandescent lamps for street lighting. A portion of the lamps were lighted on Dec. 16 last, and the manager in Rangoon reported that the whole of the street lamps would be completed and in operation at the end of April, 1908. A partial supply over a limited area was commenced in March, 1907, and a 24 hours' supply is now being given. The demand for energy is increasing as rapidly as can be dealt with by the company. The laying of the necessary mains is a tedious process, as this can only be carried on during the dry season. The profits amounted to £7,664. 6s. 10d., or with £1,775. 12s. 8d. from 1906, £9,439. 19s. 6d.

Preference dividend to Dec. 31 absorbed £9,000, leaving £439. 19s. 6d. to be carried forward.

SOUTH METROPOLITAN ELECTRIC TRAMWAYS & LIGHTING CO. (LTD.) Capital expenditure during 1907 was £40,580. 3s. 6d., bringing the total to £480,[illegible] 0. 11s. 1d. The total revenue for the year 1907 was £51,370. 12s. 5d. Deducting expenses (including £6,000 for debenture interest and providing for payments to local authorities under agreements amounting to £1,230), the surplus was £8,477. 1s. 1d., or, with £339. 4s. 11d. from 1906, £8,816. 6s. The directors recommend that £8,385. 16s. be appropriated to preference dividend, leaving £430. 10s. to be carried forward. Traffic receipts from the working of the tramways and light railways amounted to £41,413. 9s., an increase of £23,688. 14s. 7d. The extension of the London County Council system to the company's terminus at Tooting has resulted in increased traffic receipts on the Croydon to Tooting section. The gross receipts from the electricity supply section of the undertaking amounted to £7,371. 17s. 7d., compared with £5,435. 8s. 4d. Deducting depreciation in respect of battery (£469. 17s.) the balance is £2,975. 16s. 5d., compared with £2,671. 9s. 2d. The installations connected to the mains at Dec. 31 represented the equivalent of 43,657 8 c.p. lamps (increase 59 per cent. on the year), and the number of consumers rose from 472 to 603. The company has opened show rooms at 30, High-street, Sutton, for the sale of electrical accessories, and has removed its offices thereto. A department for the wiring of consumers' premises has been instituted, which has been successful.

SOUTH STAFFORDSHIRE TRAMWAYS (LESSEE) CO (LTD.)—The directors' report states that the total revenue for 1907 amounted to £49,786. 19s. 1d., against £43,741. 10s. 1d. for 1906. Expenditure was £45,562. 19s. 3d. The year's profit was £4 223. 19s. 10d. The capital exdenditure during the year in re-constructing the tramways in Tipton, Darlaston and Wednesbury was £34,088. 16s. 8d. All the old steam tramways have now been reconstructed and are working by electric traction, except a quarter of a mile in Wednesbury, which is not worked.

SUBMARINE CABLES' TRUST.—The revenue for the year ended April 15 amounted to £23,941. 13s. 1d. and the expenses to £1,157. 5s. 11d., leaving £22,784. 7s. 2d., to which is added £453. 12s. 2d. from last account, making £23,237. 19s. 4d. After providing £18,378 to meet payment of the coupons £4,810. 18s. has been transferred to redemption fund, leaving £49. 1s. 4d. to be carried forward. During the year 41 certificates have been redeemed by purchase in the open market with the surplus funds of the trust, costing £4,810. 18s., as above.

WESTERN TELEGRAPH CO. (LTD.)—The report of the directors for the half-year ended Dec. 31, 1907, states that the revenue for that period amounted to £353,814. 18s. 2d. and the working expenses to £126,862. 9s. 4d. After providing £16,000 for debenture stock interest and £4,464. 10s. 11d. for income tax, there remains £206,487. 17s. 11d., added to £6,864. 0s. 3d. from June 30, making £213,351. 18s. 2d. First and second interim dividends, amounting to £62,379, have been paid, and after transferring £120,000 to general reserve, £5,000 to maintenance ships' reserve, £10,000 to marine insurance fund and £10,000 to land and buildings depreciation fund, there remains a balance of £5,972. 18s. 2d., which is carried forward. £100,000 has been appropriated from the general reserve fund as a provision to meet the market fluctuations on investments. The directors regret the death of their colleague, Mr. John Coppen, in November last. Mr. John Gordon has been appointed to the vacancy.

NEW COMPANIES, STATUTORY RETURNS, MORTGAGES AND CHARGES.

NEW COMPANIES.

ELECTRIC CONTROL (LTD.) (6,805.)—Reg. in Edinburgh on April 30, capital £6,000 in £1 shares, to carry on the business of electrical and mechanical engineers, and manufacturers of and dealers in appliances and apparatus for the generation, supply and control of electrical power, including electric motors, &c. First directors, J. M. S. Maxwell, C. Macmillan and J. Craig. Reg. office, 177, Reid-street, Bridgeton, Glasgow.

SYLVERLYTE ELECTRIC LAMP CO. (LTD.) (97,716.)—Reg. April 24, capital £2,750 in £1 shares (1,500 preferred ordinary and 1,250 deferred ordinary), to acquire and turn to account any invention relating to the manufacture of electric and other lamps, and any lenses, reflectors or other accessories used in connection therewith, in particular to acquire the benefit of an invention of J. S. Burns, and to carry on the business of manufacturers of electric lamps, reflectors and other articles, &c.

STATUTORY RETURNS.

ANGLO-AMERICAN TELEGRAPH CO. (LTD.)—The return to Feb. 21 gives capital as £7,[illegible] in £[illegible] consolidated ordinary stock, £3,216,[illegible] preferred stock and £3,216,3[illegible] deferred stock, all of which has been taken up and paid for in full. Mortgages and charges, nil.

BRADFORD ELECTRICAL ENGINEERING CO. (LTD.)—The capital in return to Feb. 13 is £3,000 in £1 shares, of which 1,182 have been taken up. £1 per share has been called up on 732 and £482 has been received, leaving £[illegible] in arrears. £450 is considered as paid on the remainder. Mortgages and charges, nil.

CAMBRIDGE ELECTRIC TRAMWAYS SYND. (LTD.)—Return to Feb. 28 gives capital as £5,000 in £10 shares, of which 107 have been taken up. £9 0s. [illegible] per share has been called up on 90, £10 per share on 10, and nil on seven, and £[illegible] has been received. Mortgages and charges, nil.

H. J. CASH & CO. (LTD.)—Return to March 10 gives capital as £10,000 in £1 shares, 6,000 of which have been taken up. 12s. 6d. per share has been called up, and £3,750 has been received. Mortgages and charges, nil.

ELECTRIC WIRING & FITTINGS CO. (LTD.)—Capital in return to Feb. 8 is £5,000 in £1 shares, of which 1,382 have been taken up. £1,375 has been received, leaving £7 in arrears. Mortgages and charges, nil.

GUILDFORD ELECTRICITY SUPPLY CO. (LTD.)—In return to April 8 capital is £55,000 in 25,000 preference shares of £1 each and 6,000 ordinary shares of £5 each, of which 11,276 preference and 2,782 ordinary have been taken up. £1 per share has been called up on the preference and £5 per share on the ordinary, and £25,186 has been received. Mortgages and charges, £25,000.

HARRY W. COX & CO. (LTD.)—Statutory report dated March 9 states that 4,000 shares (class not specified) have been taken up out of a nominal capital of £5,000 in £1 shares (4,000 preferred ordinary). 1,000 shares are considered as fully paid. No mortgages or charges registered.

LONDON ELECTRIC WIRE CO. (LTD)—According to return to Feb. 26 capital is £150,000 in 20,000 ordinary and 10,000 preference shares of £5 each, of which 15,807 ordinary and 5,956 preference have been taken up. £5 per share has been called up on 8,087 ordinary and 5,956 preference, and £70,215 has been received. £38,600 is considered as paid on 7,720 ordinary shares. Mortgages and charges, nil.

MUNICIPAL ELECTRIC LIGHT & POWER CORPN. (LTD.)—In return to March 12 capital is £25,000 in 2,490 ordinary shares of £10 each and 100 founders' shares of £1 each, of which 37 ordinary and 30 founders' have been taken up. £400 has been received. Mortgages and charges, nil.

ST. JAMES' & PALL MALL ELECTRIC LIGHT CO. (LTD.)—Return to March 3 gives capital as £300,000 in 40,000 ordinary and 20,000 preference shares of £5 each, all of which have been taken up. £5 per share has been called up on 39,650 ordinary and 20,000 preference shares, and £298,250 has been received. £1,750 is considered as paid on 350 ordinary. Mortgages and charges, £150,000 3½ per cent. debenture stock, and £163,438 4 per cent. guaranteed debenture stock of Central Electric Supply Co.

TYNESIDE ELECTRICAL DEVELOPMENT CO. (LTD.)—Capital in return to Feb. 26 is £100,000 in 100 shares of £1,000 each, all of which have been taken up. £100 per share has been called up and £10,000 has been received. Mortgages and charges, nil.

MORTGAGES AND CHARGES.

BIRMINGHAM ELECTRICAL CASE CO. (LTD.)—A mortgage dated April 10, and, as collateral security thereto, a debenture of even date, to secure £60, charged on company's undertaking and property, present and future, including uncalled capital, has been registered. Holders, F. E. Bell and P. T. Thompson.

CITY NOTES.

MEMORANDA (May 7).—Bank rate 3 per cent. (since March 19, 1908). Price of silver $24\frac{3}{16}$—24¼d. per oz. Consols $85\frac{11}{16}$—$85\frac{13}{16}$ for money, and $85\frac{1}{16}$—$85\frac{1}{16}$ for account. Consols Pay Day, June 1; Stock and Shares Continuation Days, May 12 and 27; Ticket Days, May 13 and 28; Pay Days, May 14 and 29; Mining Share carry-over Day, May 11.

PRICES OF METALS (London).—*Copper*, cash, 57—57¼; three months 57¾—58. *Lead*, English, 13¼—13½; foreign, 13—13⅜. *Spelter*, foreign 20¾—21. *Tin*, English, 140—141; foreign, cash, 139¼—139¾, three months, 139—139½. *Iron*, Cleveland, cash, 51/6—51/10; three months, 48/1½—48/2½.

BERGMANN ELEKTRICITATS-WERKE A.G. (BERLIN).—A dividend of 18 per cent. for the past year has been declared.

CALCUTTA ELECTRIC SUPPLY CORPN. (LTD.)—The directors have decided, subject to audit, to recommend payment of a final dividend at the rate of 9½ per cent. for the half year ended Dec. 31, 1907 (making 8 per cent. for the year).

COVENTRY ELECTRIC TRAMWAYS CO.—The directors announce a dividend of 3½ per cent. (7s. per share) for the year, carrying £3,900 to reserve for depreciation and £114 forward. £4,000 is to be applied in reducing the company's indebtedness to New General Traction Co.

LONDON ELECTROBUS CO. (LTD.)—Letters of allotment and regret in connection with this company's recent issue of ordinary and deferred shares have been posted.

RIO DE JANEIRO TRAMWAY, LIGHT & POWER CO.—MM. Edouard Quellence and Jean Javal (Paris) and Th. Verstraeten (Brussels) have been elected directors to represent the French and Belgian bankers who have recently taken a large interest in the securities of this company.

STOCK EXCHANGE NOTICES.—The Stock Exchange Committee have appointed May 14 a special settling day in scrip fully paid for £400,000 4½ per cent. sterling debentures of the *[illegible] Railway Co.* and have ordered the same to be quoted. The committee have been asked to appoint a special settling day in and grant quotations to provisional certificates for a further issue of 50,000 £5 ordinary shares (issued at £6) fully and partly (£2 capital and £1 premium) paid and 50,000 £5 fully and partly (£2) paid, preference shares of the *[illegible] Electric Supply Co. (Ltd.)*, and also to grant a quotation to a further issue of 3,176 £5 fully paid cumulative preference shares of the *Calcutta Tramways Co. (Ltd.)*.

ELECTRIC TRAMWAY AND RAILWAY TRAFFIC RECEIPTS.

Line	Week ended.	Amount.	Inc. or Dec. (a)	Aggregate. No. of weeks.	Aggregate. Amount.	Aggregate. Inc. or Dec. (a)
		£	£		£	£
Aberdeen Corporation	April 29	1,209	- 43	18	64,669	- 1,310
Airdrie	,, 24	230	+ 17	16	3,002	+ 70
Anglo-Argentine	,, 29	18,389	+ 1,381	17	313,233	+ 35,003
Ayr Corporation	May 2	252	+ 21	50	14,328	+ 2
Baker St. & Waterloo Ry.	,, 2	3,070	+ 570	18	55,520	+ 13,199
Barnsley	April 24	232	+ 75	16	2,764	+ 213
Barrow	,, 24	273	+ 56	16	3,048	+ 65
Bath Electric Trams, Ltd.	,, 29	624	- 79	17	10,328	- 1,161
Birkenhead Corporation	May 3	1,084	+ 16	...	...	...
Birmingham Corporation	,, 2	6,248	+ 306	5	29,445	+ 1,461
Birmingham & Mid.	April 17	791	+ 85	15	11,952	+ 486
Blackburn Corporation	,, 29	950	11	5	5,912	+ 58
Blackpool Corporation	,, 30	480	- 6	§4	3,819	+ 793
Blackpool and Fleetwood	May 2	503	- 84	...	...	...
Bolton Corporation	,, 3	2,287	+ 75	5	11,489	+ 921
Bombay	April 3	R37,067	+ R8,565	14	R509,698	+ R89,040
Bournemouth Corporation	,, 24	1,526	+ 15	4	7,272	- 308
Bradford Corporation	May 2	4,478	+ 52	5	21,677	- 812
Brighton Corporation	,, 3	825	+ 50	5	3,895	+ 212
Bristol Trams & Carriage	,, 1	4,765	+ 27	17	78,611	- 2,214
Buenos Ayres & Belgrano	April 29	3,667	- 51	17	61,094	+ 344
Burnley Corporation	May 2	1,200	+ 40	5	6,538	+ 613
Burton Corporation	,, 3	278	+ 4	5	1,242	- 120
Bury Corporation	April 26	1,115	+ 181	‡4	4,584	+ 778
Calcutta Tramways Co.	May 2	R15,746	+ R370	..	..	..
Cavehill	April 24	294	+ 227	16	1,215	+ 76
Central London Railway	May 2	5,786	- 303	16	107,664	- 3,876
Charing C., Euston & H'stead	,, 2	3,230	...	18	57,295	...
Chatham & Dist. Lt. Rys.	April 30	719	+ 69	§17	11,045	- 354
City & South London Rly.	May 3	3,121	+ 216	18	59,588	+ 6,441
City of Birmingham	April 24	2,989	+ 412	16	43,627	+ 546
Colchester Corporation	,, 29	164	- 17	17	2,736	- 200
Cork Electric Trams Co.	,, 30	135	- 14	§17	6,891	- 482
Croydon Corporation	May 1	1,323	- 10	5	6,026	- 514
Devonport & Dist. Trams	April 24	473	+ 60	16	6,921	- 114
Dover Corporation	May 2	185	- 7	5	880	- 165
Dublin United	,, 1	5,152	- 11	13	83,685	+ 753
Dudley-Stourbridge	April 24	1,094	+ 332	16	12,148	- 902
Dundee Corporation	,, 29	1,174	+ 104	50	57,012	+ 2,435
East Ham Council	May 2	795	- 82	5	3,867	- 183
Exeter Corporation	,, 1	293	+ 14	5	1,320	- 163
Falkirk and District	April 29	262	+ 4	4	1,099	+ 45
Gateshead & Dist. Trams	,, 24	1,064	+ 115	16	16,099	+ 406
Glasgow Corporation	May 2	17,136	- 134	48	833,570	+ 15,462
Glossop	,, 2	126	- 16	18	2,132	- 138
Gravesend—Northfleet	April 24	232	+ 9	16	3,068	- 473
Great Northern & City Rly.	May 2	1,614	- 191	18	31,472	- 1,903
Gt. Northern, Piccadilly, &c	,, 2	5,495	+ 1,200	18	97,330	+ 28,741
Greenock & Port Glasgow	April 24	598	- 41	16	7,775	- 2,097
Hartlepool Tramways	,, 24	234	- 17	16	3,449	- 623
Hastings Elec. Trams Co.	,, 30	865	+ 77	18	13,489	- 33
Hong Kong	May 2	$5,639	- $1,135	...	...	...
Huddersfield Corpn.	,, 2	1,506	+ 58	[illegible]	8,025	+ 68
Hull Corporation	,, 2	2,363	- 31	5	11,288	- 121
Ilford District Council	,, 2	410	- 39	5	1,969	- 160
Ilkeston District Council	April 29	120	- 1	5	664	- 15
Ipswich Corporation	May 2	339	- 10	5	1,615	- 80
Isle of Thanet Co.	,, 2	398	+ 56	31	8,651	- 338
Jarrow	April 24	120	+ 2	16	1,596	- 176
Keighley Corporation	,, 30	140	- 6	44	6,902	+ 320
Kidderminster & District	,, 24	151	+ 59	16	1,430	- 119
Kilmarnock Corporation	May 2	145	...	50	7,782	- 202
Lanarkshire Trams Co.	April 30	1,272	+ 169	17	21,596	+ 2,969
Lancashire United	,, 29	1,111	+ 31	17	20,742	+ 1,050
Leamington	,, 24	225	+ 94	16	2,225	+ 22
Leeds Corporation	May 2	6,243	- 50	5	29,555	+ 400
Leicester Corporation	,, 2	2,179	+ 40	...	.	...
Leith Corporation	April 25	486	+ 5	‡50	25,335	+ 155
Lincoln Corporation	May 2	111	+ 10	5	606	+ 38
Liverpool Corporation	April 25	10,885	+ 370	17	172,769	- 1,774
Liverpool Overhead Rly.	May 3	1,446	- 79	18	24,939	- 309
*London County Council	April 25	32,110	+ 3,560	†4	114,243	+ 11,720
London United	May 2	6,220	+ 307	17	95,961	- 2,165
Lowestoft	,, 2	159	+ 19	31	4,824	+ 135
Maidstone Corporation	,, 2	174	...	5	831	...
Manchester Corporation	,, 2	14,407	+ 787	5	68,501	+ 5,118
Mersey Railway	,, 2	1,899	+ 43	18	34,570	+ 1,551
Merthyr	April 24	305	+ 120	16	3,291	+ 49
Metropolitan Dist. Railway	May 2	8,632	+ 507	18	159,564	+ 17,265
Metropolitan Elec. Trams	April 24	5,927	+ 1,973	16	79,664	+ 14,915
Middleton	,, 24	485	+ 136	16	5,233	+ 91
Nelson Corporation	May 2	140	+ 8	¶4	678	- 120
Newcastle-on-Tyne Corp.	,, 2	3,501	- 534	5	17,790	- 2,189
Newport (Mon.)	,, 2	646	+ 42	5	3,248	+ 41
Northampton Corporation	,, 1	384	- 2	¶4	1,861	- 105
Oldham, Ashton & Hyde	April 24	745	+ 184	16	9,430	+ 64
Oldham Corporation	May 3	1,805	+ 23	6	11,328	- 321
Perth (N.B.) Corporation	April 29	151	+ 20	50	7,748	+ 51
Perth (W.A.) Elec. Trams	May 1	1,381	- 45	¶18	25,524	- 905
Peterborough	April 24	148	+ 45	16	1,749	- 27
Portsmouth Corporation	May 2	1,849	+ 71	5	8,374	- 769
Potteries	April 24	1,915	+ 146	16	29,704	+ 724
Preston Corporation	,, 24	636	- 48	18	12,113	- 207
Rotherham Corporation	,, 30	528	- 21	§4	2,597	- 36
Rothesay	,, 24	347	+ 245	16	1,906	- 156
Salford Corpn.	May 4	4,500	+ 66	5	22,393	- 656
Sheerness	April 22	67	+ 14	16	788	- 10
Sheffield Corporation	May 3	5,397	- 58	†6	30,478	- 22
Singapore Trams	,, 2	$8,585	- $1,209	.	...	...
Southend Corporation	April 29	311	+ 33	5	1,425	+ 9
South Metropolitan	,, 24	862	+ 172	16	10,940	- 352
Southport Tramways	,, 24	398	+ 156	16	3,492	- 330
South Staffs	,, 24	1,094	+ 257	16	14,025	- 87
Stalyb'dge, Hyde, &c., Jt. Bd.	May 2	688	- 97	†5	3,678	+ 75
Sunderland Corporation	,, 3	1,050	- 335	5	5,249	- 1,426
Sunderland and District	April 29	466	+ 5	26	11,821	+ 1,225
Swansea Trams	,, 24	1,061	+ 291	16	13,925	+ 1,018
Swindon Corporation	,, 29	142	- 11	4	587	- [illegible]
Taunton	,, 24	53	+ 14	16	621	- 18
Tynemouth and District	,, 24	218	+ 46	16	2,410	- 286
Tyneside Trams Co.	,, 29	595	- 113	18	6,291	- 905
Victoria, Elec. Supply Co. of	March 24	1,098	- 183	...	...	...
Wallasey District Council	May 2	844	+ 82	‡4	3,887	+ 13
Warrington Corpn.	April 23	418	+ 53	3	1,162	+ 103
West Ham Corporation	,, 30	1,924	- 254	5	10,683	- 1,152
Weston-super-Mare	,, 22	184	+ 121	16	573	- 137
Wolverhampton Co.	,, 24	615	+ 200	16	7,119	- 62
Wolverhampton Corpn.	,, 29	827	+ 49	47	33,626	...
*Worcester	,, 24	318	+ 69	16	3,894	- 52
Wrexham	,, 24	114	+ 23	16	1,547	- 7
Yorkshire W.R. Trams	May 3	1,159	+ 19	18	19,689	..
Yorkshire Woollen District	April 24	1,198	+ 271	16	11,299	- 519

(a) These comparisons are with the corresponding period last year. § Plus 2 days.
¶ Plus 3 days. * Partly electrical. † Minus 3 days. ‡ Minus 2 days.

ELECTRICAL COMPANIES' SHARE LIST.

Shre.	Last Dividend	Name.	Price Wed., May 6.	Rate % Yielded. £ s. d.	Dividend Due.	Business Week to May 6. Highest.	Business Week to May 6. Lowest.
		ELECTRICITY SUPPLY.					
10	9 0	Bournemouth & Poole Elec. Sup. Ord.	10¾–11¾	5 19 0	Mar, Sept	11¼	..
10	4/6	Do. 4½ per Cent. Cum. Pref.	10–10½	4 5 6	Feb, Aug	10¼	
10	6 0	Do. 6 per Cent. Cum. Second Pref.	10½–11	5 9 0	Feb, Aug	10¾	10¾
St.	4½%	Do. 4½ per Cent. Deb. Stock (red.)	102–105	4 5 6	Jan, July	..	..
5	3 6	Bromley (Kent) El. Lt. & Power Shares	4½–5	5 10 0	April, Oct	..	..
St.	4½%	† Do. Do. 1st Debs.	94–97	4 12 9	May, Nov	..	..
5	5 6	Brompton & Kensington Elec. Sup. Ord.	7–8	6 5 0	March ..	7⅛	7
5	3 6	Do. 7 per Cent. Pref.	6¾–7¾	4 10 0	Mar, Sept	..	..
St.	4%	Central Elec. Sup. Co. 4% Guar. Db. Stock	98–101	3 19 0	June, Dec	..	..
5	2 6	Charing Cross (W. End & City) El. Sup. Co.	3⅜–3⅞	[illegible] 1 6	Feb, Aug	..	..
5	2/3	Do. 4½ per Cent. Pref.	4⅜–4⅝	4 17 0	Feb, Aug	..	..
St.	4%	Do. 4 per Cent. Deb. Stock (red.)	96–99	4 1 0	Jan, July	..	..
5	2 3	Do. City Undertaking 4½% Cm. Pref.	3¾–4¼	5 8 6	Jan, July	.	..
5	2/6	Chelsea Electric Supply Ord.	3–3½	6 8 6	March ..	[illegible]	..
St.	4½%	* Do. 4½ per Cent. Deb. Stock (red.)	101–104	4 6 9	June, Dec		.
10	7 0	City of London Electric Lighting Ord.	9½–10½	5 14 0	Feb, Aug	9¾	9⅝
10	6/0	Do. 6 per Cent. Cum. Pref.	12–13	4 12 0	Jan, July	..	..
St.	5%	Do. 5 per Cent. Deb. Stock (red.)	124–127	3 18 0	June, Dec	126	.
St.	4½%	Do. 4½ per Cent. 2nd Deb. Stock (red.	101–104	4 6 6	Jan, July	..	..
5	1/10½	County of Durham Elec. P.D. Ord.	2¾–3	3 9 7	April, Oct	..	..
5	5%	Do. 5 per Cent. non Cum. Pref.	4⅛–4⅝	5 17 8	April, Oct	..	..
10	6/0	County of London Elec. Supply Ord.	7¾–8¼	6 1 3	Feb, Aug	..	..
10	6 0	Do. 6 per Cent. Cum. Pref.	10¾–11¼	4 1 3	Mar, Sept	..	..
St.	4½%	Do. 4½% Deb. Stock (all paid) (red.)	107–110	4 2 6	Jan, July	10[illegible]½	108
St.	4½%	† Do. Second Deb. Stock Prov. Certs.	96–99	4 11 0	May, Nov		..
5	3 6	Folkestone Electricity Supply Co. Ord.	4¾–5¼	5 7 0	April, Oct	..	..
5	2 6	Do. 5 per Cent. Cum. Pref.	5–5½	4 11 0	Mar, Sept	..	..
St.	4½%	Do. 4½ 1st Deb. Stock (red)	94–97	4 13 0	Feb, Aug	..	..
5	4 6	Hove Electric Lighting Ord.	6¼–6¾	6 7 0	April, Oct	6 7/16	6 [illegible]
5	5/0	Kensington & Knightsbridge Ord.	7¼–8¼	5 14 0	Feb, Aug	8	..
5	6%	Do. 6 per Cent. 1st Pref.	6½–7	4 5 9	Jan, July	..	..
St.	4%	Do. 4 per Cent. Deb. Stock (red.)	96–99	4 1 0	..	..	—
St.	4%	Kensingtn. & Kngtbg. Co. & Notting Hill Co. (Joint Station) 4% Deb. Stock (red.)	97–101	3 19 0	April, Oct	..	..
St.	4½%	Kent Elec. Power Co.	88–92	4 18 3	Jan, July	..	..
3	1/6	London Electric Supply Ord.	1–1½	5 0 0	Mar, Sept	..	..
5	3/0	Do. 6 per Cent. Pref.	4½–5	6 0 0	Mar, Sept	..	..
St.	4%	Do. 4 per Cent. 1st Mort. Deb.	90–93	4 8 0	Jan, July	.	..
5	3/6	Metropolitan Electric Sup. Ord.	4⅝–5⅛	6 6 6	April, Oct	4[illegible]	..
5	2 3	Do. 4½ per Cent. Cum. Pref.	4¾–5¼	4 6 0	Jan, July	..	..
St.	4½%	Do. 4½ per Cent. Deb. Stock 1st Mort.	107–111	4 1 0	June, Dec	..	..
St.	3½%	Do. 3½ per Cent. Mrt. Deb. Stock (red.)	85–90	3 18 0	Jan, July	..	..
100	4½%	Midland Elec. Corp. for P.D. 1st Mort. Db.	96–99	4 11 0	June, Dec	98¼	97⅞
10	4%	Newcastle & Dist. Elec. Ltg. Ord.	8–8½	4 16 10	Feb, Aug	..	..
100	4½%	Do. 4½ per Cent. Deb.	93–98	4 12 9	Jan, July	..	..
5	8%	Newcastle Elec. Supply Ord.	5¾–6	6 16 6	Feb, Aug	..	..
5	5%	Do. 5 per Cent. non Cum. Pref.	5⅛–5⅝	4 15 3	Feb, Aug	..	..
100	4%	Do. 4 per Cent. Mort. Deb. red. 1907.	96–98	4 2 6	Jan, July	..	..
1	3%	Northern Counties Elec. Sup.	—	..	Mar, Aug	..	..
100	4½%	Do. 4½ per Cent. Deb.	95–97	4 13 9	Jan, July	..	..
10	8/0	Notting Hill Electric Ord.	11¼–12¼	5 14 0	March ..	..	..
5	4/6	Oxford Electric Ord.	5⅞–6⅞	5 10 0	March ..	..	..
St.	4%	Do. 4 per Cent. Deb. Stock	94–98	4 1 6	Jan, July	..	..
5	5 0	St. James' & Pall Mall Elec. Ord.	7¾–8¼	6 1 3	Feb, Aug	7¾	7⅝
5	3/6	Do. 7 per Cent. Pref.	6½–7	5 0 0	Feb, Aug	..	..
St.	3½%	Do. 3½ per Cent. Deb. Stock (red.)	85–90	3 17 9	Jan, July	86	..
5	..	Smithfield Markets Electric Sup. Ord.	½–1½	..	Feb	..	..
St.	4%	Do. 4 per Cent. Deb. Stock	70–74	5 8 0	Feb, Aug	..	..
5	4/0	South London Electric Supply Ord.	2⅜–2⅞	6 18 0	April	2[illegible]	..
1	0/6	South Metrop'n Elec. Lt. & Power Ord.	⅜–⅝	4 0 0	..	..	..
1	0 8⅔	Do. 7 per Cent. Cum. Pref.	1⅛–1⅜	5 2 0	Feb, Aug	..	..
St.	4½%	Do. 4½ 1st Db. Stk. Red.	99–102	4 8 0	April, Oct	..	..
5	2/6	Urban Electric Supply Ord.	1⅞–2⅛	10 18 0	April, Oct	..	..
5	2/6	Do. 5 per Cent. Cum. Pref.	1⅝–2⅛	11 14 0	April, Oct	1¾	..
St.	4½%	Do. 4½ per Cent. 1st Mort. Deb.	87–90	5 0 0	April, Oct		..
5	5 0	Westminster Elec. Sup. Ord.	7½–8	6 5 0	Mar, Sept	7¾	7 7/16
5	2/3	Do. 4½ per Cent. Cum. Pref.	4¾–5¼	4 5 6	Jan, July	5[illegible]	..
		ELECTRIC RAILWAYS, TRAMWAYS, &c.					
St.	4%	Baker St. & Waterloo 4% Perp. Db. St.	88–91	4 8 0	Jan, July	90½	89¾
1	..	Bath Elec. Trams Pref. Ord.	⅝–⅞	8 0 0	April	..	..
1	0/6	Do. 5 per Cent. Cum. Pref.	11/16–13/16	6 3 6	Jan, July	.	..
St.	4½%	Do. 4½ 1st Mort. Deb. Stock (red.)	89–94	4 16 0	April, Oct	..	..
St.	4½%	B'ham & Midland Trams 4½ 1st Db. Stk.	93–96	4 15 0	Jan, July	..	..
10	9%	Bristol Tramways & Carriage Ord.	10–10½	8 11 9	Feb, Aug	..	..
10	4%	Do. Cum. Pref. (fully paid)	8–8½	4 14 0	..	..	..
St.	4%	Do. 4 per Cent. Debs.	99–101	3 19 0	Feb, Aug	..	..
10	..	British Electric Traction Ord.	1¼–1¾	..	June, Dec	1 7/16	..
10	6/0	Do. 6 per Cent. Cum. Pref.	3⅝–4⅛	12 12 0	Feb, Aug	4	..
St.	5%	Do. 5 per Cent. Perpetual Debs.	90–95	5 5 0	April, Oct	91	90½
St.	4½%	† Do. 4½ per Cent. 2nd Deb. Stock	69–73	6 2 6	May, Nov		..
St.	3%	Central London Ordinary Stock	74–77	3 18 0	Feb, Aug	76	75½
St.	4%	Do. 4 per Cent. Pref. Stock	85–87	4 12 0	Feb, Aug	..	..
St.	2%	Do. Deferred Stock	54–57	3 10 0	Feb	55⅞	55
100	4%	Do. 4 per Cent. Debs.	100–103	3 18 0	Jan, July	101½	100
St.	4%	Charing X, Euston & Hmpstd Per. Db. Stk.	81–84	4 15 3	Jan, July	..	..
5	2/6	† City of Birmingham Trams. 5% Cm. Pref.	4¼–4¾	5 5 0	April, Oct	..	..
100	4%	Do 4 per Cent. 1st Mort. Debs.	97–100	4 0 0	April, Oct	..	.
St.	1¾%	City & South London Rly. Con. Ord.	39–41	4 5 6	Feb, Aug	40⅝	39¾
St	5%	Do. 5 per Cent. Perp. Pref. (1891)	113–116	4 6 0	Feb, Aug	..	..
St.	5%	Do. (1896)	112–116	4 7 0	Feb, Aug	..	..
St.	5%	Do. (1901)	110–113	4 8 6	Feb, Aug	..	..
St.	5	Do. (1903)	106–109	4 11 6	Feb, Aug	..	..
St.	4%	† Do. 4 per Cent. Perpetual Debs.	99–102	3 18 0	May, Nov	102	..
10	7/0	Dublin United Trams. Ord	12¼–13¼	4 10 6	Feb, Aug	..	..
10	6/0	Do. 6 per Cent. Pref.	12½–13½	4 9 0	Feb, Aug	..	..
10	..	Gt. Northern & City Rly. Pref. Ord. (4%)	¾–1¼	..	Feb, Aug	..	..
10	4/0	G. Northern, Piccadilly & Brompton Ord.	6–7	5 11 0	Feb, Aug	.	
St.	4%	Do. 4 per Cent. Deb. Stock	87–90	4 9 0	Jan, July	87½	..
5	4/0	Hastings & Dist. Elec. Trams. 6% Cm. Pf.	4–4½	7 5 0	Mar, Sept	..	..
St.	4½%	Do. 4½ Db. St.	94–97	4 12 6	April, Oct	..	..
10	9%	‡ Imperial Tramways Ord.	10½–11½	7 17 0	Mar, Sept	..	..
10	6%	‡ Do. 6 per Cent. Pref.	9½–10½	5 17 0	Mar, Sept	..	..
St.	4½%	‡ Do. 4½ per Cent. Debs.	93–94	4 15 9	Jan, July	..	..
5	..	I. of Thanet E. T. & Lt. 5 per Cent. Pref.	⅞–1⅜	..	Mar, Sept	..	..
St.	4%	Do. 4 per Cent. Deb. Stock	58–63	6 7 0	Jan, July	..	..
10	6/0	Lanarkshire Tramways	9¾–10¼	5 13 0	Feb, Aug	..	..
St.	5%	Lancs. Utd. Trams 5% Prior Lien Db. St.	91–94	5 6 0	Jan, July	..	..
10	..	Liverpool Overhead Railway Ord.	1⅛–1½	..	Feb, Aug	..	..
10	5%	Do. 5 per Cent. Pref.	6¼–6¾	7 10 0	Feb, Aug	..	..
St.	4%	Do. 4 per Cent. Deb.	85–87	4 11 0	Jan, July	..	..
10	5/0	London United Trams. 5% Cum. Pref.	6¾–7¼	6 9 0	Jan, July	..	..
St.	4%	Do. 4 per Cent. 1st Mort. Deb. Stock	80–85	4 14 0	Jan, July	82	..
St.	..	Mersey Con. Ord. Stock	1–3	—	Feb, Aug.	1½	..
St.	..	Do. 3 per Cent. Perp. Pref.	3–6	—	..	..	..
1	..	Metropolitan Elec. Tramways Def.	[illegible]—	..	April..	[illegible]	..
1	0/6	Do. 5 per Cent. Cum. Pref.	11/16–13/16	6 3 6	Feb, Aug	¾	[illegible]
St.	4½%	Do. 4½ per Cent. Deb. Stock	94–97	4 12 6	Jan, July	95½	..
St.	½%	Metropolitan Railway Consolidated	42–43	1 3 3	Feb, Aug	43	42½
St.	2½%	Do. Surplus Lands Stocks	63–68	4 1 6	Feb, Aug	67	66½
St.	3½	Do. 3½ per Cent. Preference	86–89	3 19 9	Feb, Aug	88	86
St.	3½	Do. 3½ per Cent. "A" Preference	75–78	4 9 6	Feb, Aug	76	75
St.	3½%	Do. 3½ per Cent. Convertible Pref.	73–76	4 12 0	Feb, Aug	..	..
St.	3½	Do. 3½ per Cent. Debenture Stock	92–95	3 13 6	Jan, July	93½	92
St.	3½	Do. 3½ per Cent. "A" Ditto	89–92	3 1[illegible] 0	Jan, July	90	.

* In calculating the yield allowance has been made for accrued interest but *not* for redemption.
† Ex Dividend

ELECTRICAL COMPANIES' SHARE LIST.—*Continued.*

ELECTRIC RAILWAYS & TRAMWAYS—*Continued.*

Share.	Last Dividend.	Name.	Price Wed., May 6.	Rate Yield-ed. £ s. d.	Dividend Due.	Business Week to May 6. Highest.	Lowest.
St.	..	Metropolitan District Railway Ord.	11½–12½	..	Feb, Aug	12¼	11¾
St	..	Do. [illegible]	25–26	..	Feb, Aug	..	..
St	3½	Do. [illegible] Guaranteed by Underground Electric Railways Co. of London, Ltd.	44 –48	7 6 0	Feb, Aug	..	
St	[illegible]	Do. [illegible] per Cent. [illegible] Rent-charge	75 –78	3 17 0	Jan, July	..	..
St	4%	Do. 4 per Cent. M[illegible] Rent-charge	100 – 104	3 17 0	Jan, July	..	..
St	1	Do. Guar. Stock [illegible]	42 – 47	3 13 0	Mar, Sept	44	..
St	6	Do. [illegible] Stock	105 – 110	5 9 0	Jan, July	109½	105
St	4	Do. 4 per Cent. [illegible]		5 7 3	Jan, July		..
5	..	New Gen. Trams. [illegible] per Cent. Cum. Pref.	[illegible] –1	..	May	..	—
1	1/9	Potteries Electric Traction Ord.	¾–[illegible]	8 0 0	April, Oct	..	—
1	0/6	Do. 5 per Cent. Cum. Pref.	[illegible]	6 13 0	Feb, Aug	..	..
St.	4½%	Do. 4½ per Cent. Deb. Stock	93 – 96	4 13 9	May, Nov	..	..
1	0/7½	S. Met. Elec. Trams. & Ltg. Co. Cm. Pref.	¾–1	6 0 0	Feb, Aug	—	..
St.	4%	Do. 4 per Cent. Per. Stock	79 – 80	5 0 0	Jan, July	..	..
100	5%	Sunderland Dist. Elec. Trms. 5% 1st Mt. Db.	73 –78	6 8 0	Jan, July	—	..
..	5%	Underground Elec. Rys. Co. of London...	36 – 40	12 10 0	June, Dec	..	..
5	..	Yorkshire (W.R.) Elec. Trams. Ord.	1 – 1½	—	March ..	..	..
5	..	Do. 6 per Cent. Cum. Pref.	3½ –3¾	–	..	..	..
St.	4½	Do. 4½ per Cent. 1st Debs.	84 –87	5 3 6	Jan, July	86	..

ELECTRIC MANUFACTURING, &c.

Share.	Last Dividend.	Name.	Price Wed., May 6.	Rate Yield-ed. £ s. d.	Dividend Due.	Business Week to May 6. Highest.	Lowest.
1	..	Aron Electricity Meter Ord.	[illegible]	..	..	..	..
1	[illegible]	Do. 6% Cum. Pf.	[illegible]	7 7 6	April, Oct	..	..
1	2/[illegible]	†Babcock & Wilcox Ord. [illegible] & bonus	3¼–3¾	6 9 0	April, Oct	3[illegible]	[illegible]
1	0/7½	† Do. Pref.	1[illegible]–1[illegible]	3 16 9	..	..	..
5	6/0	British Insulated & Helsby Cables Ord.	6⅛–6[illegible]	7 10 6	July, Feb	..	..
5	3/0	Do. 6 per Cent. Pref.	5⅞– 6⅛	4 18 0	Jan, July	..	..
St.	4½%	Do. 4½ per Cent. 1st Mort. Deb. (red.)	102 – 105	4 5 6	Jan, July		..
St.	4½%	British Thoms'n-Houst'n 4½% 1st Mt. Db.	93 –98	4 12 0	Mar, Sept	..	..
5	..	British Westinghouse 6 per Cent. Pref...	½ – ¾	..	Feb, Aug	[illegible]	..
St.	4%	Do. 4 per Cent. Mort. Deb. Stock	46 – [illegible]	8 0 0	Jan, July	..	..
2	..	Brush Electrical Engineering	¼	—	March ..	—	..
2	..	Do. 6 per Cent. Pref. non-Cum.	[illegible]	..	Mar, Sept	..	..
St	4½%	Do. 4½ per Cent. Perp. 1st Deb. Stock	74 – 79	5 11 0	Mar, Sept	..	—
St	4½%	Do. Perpetual 2nd Deb. Stock	59 – 64	7 0 0	Jan, July	..	..
5	5/0	Callender's Cable Con. Ord.	10¾ – 11¼	6 3 0	Jan, July	.	..
5	2/6	Do. 5 per Cent. Cum. Pref.	5¼ – 5¾	4 7 0	Jan, July	5[illegible]	..
St.	4½%	Do. 4½ per Cent. 1st Mort. Debs. (red.	10[illegible] – 108½	4 2 6	Nov, May	..	..
1	1/7½	Castner-Kellner Alkali Co.	1 – 1[illegible]	8 11 0	May, Nov	1⅜	..
St.	4½%	Do. 4½ per Cent. 1st Mort. Deb. red.	101 – 104	4 6 6	Feb, Aug	102½	..
1	[illegible]	Chadburn's (Ship) Telegraph Ord.	1[illegible] – 1[illegible]	8 8 0	March ..	..	..
1	0/7	Do. 6 per Cent. Cum. Pref.	1 – 1½	5 6 6	April, Oct	..	..
1	[illegible]	C[illegible]	¾	7 0 0	August ...	..	..
1	1/	Consolidated Signal Co.	1½ – 1¾	4 5 6	April, Oct	1½	1½
1	0/7½	Do. 6 per Cent. Cum. Pref.	[illegible]	6 4 0	April, Oct	..	..
3	[illegible]	Crompton & Co. Nos. 1 to 55,000)	1[illegible] – 1[illegible]	8 1 0	Jan, July	..	..
100	[illegible]	Do. 5 per Cent. 1st Mort. Debs. (red.).	92 – 95	5 5 0	Jan, July	..	..
1	[illegible]	Davey & [illegible]	⅞– 1⅛	.	Mar, Sept	..	..
5	2/0	Dick, Kerr & Co. Ord.	1⅝– 1[illegible]	7 5 6	Sept	.	..
5	0/7½	Do. 6 per Cent. Cum. Pref.	1 – 1¼	4 16 0	Sept	1[illegible]	..
St.	4½	Do. 4½ per Cent. Deb. Stock	100 – 103	4 7 3	Jan, July	..	—
5	2/6	Edison & Swan United ("A" Sh.) (£3 pd.)	¾–1	12 0 0	Feb, Aug	..	..
5	1/2	Do. (£5 paid)	1½ – 2½	5 0 0	Feb, Aug	..	—
St	4%	Do. 4 per Cent. Mort. Deb. Stock (rd.)	75 – 81	4 19 3	June, Dec	..	..
St.	5%	Do. 5 per Cent. 2nd Deb. Stock	85 – 87	5 15 0	Mar, Sept	—	..
[illegible]	..	Edmundson's Elec. Corp. Ord.	½– [illegible]	..	Jan, July	..	..
5	..	Do. 6 per Cent. Cum. Pref.	½–1	..	May, Nov		.
St.	4½%	Do. 4½ per cent. 1st Mort. Deb. red.	55 – 60	7 10 0	Jan, July	5t¾	55
2	..	Electric Construction Co.	¼ – ½	..	Jan, July	..	..
2	..	Do. 7 per Cent. Cum. Pref.	1¼ – 1¾	..	July	..	..
St	4%	Do. 4 per Cent. Perp. 1st Mort. Debs.	64 – 68	5 17 0	Jan, July	..	..
10	5/0	General Electric [illegible] Cum. Pref...	7¾ – 8¼	6 1 8	June, Dec	..	..
St	4%	Do. 4 per Cent. [illegible] Debs.	87 – 90	4 9 0	Mar, Sept	..	—
5	1/6	Henley's Telegraph Works Ord.	10¾ – 11½	6 10 0	Feb, Aug	11	..
5	2/3	Do. 4½ per Cent. Pref.	5[illegible] – 5⅝	4 3 0	Feb, Aug	..	..
St	4½%	Do. 4½ per Cent. 1st Mort. Deb. Stock	106 – 108	4 3 0	Mar, Sept	..	..
10	12/6	India Rubber, Gutta Percha, &c., Wrks	19¾ – 16¼	6 2 0	Feb, Aug	..	..
100	4%	Do. 4 per Cent. Debs. (red.	9[illegible] –100	4 0 0	April, Oct	.	..
1	[illegible]	National Elec. Construction Co.	¼ – [illegible]	..	April	..	..
1	[illegible]	Richardsons, Westgarth & Co., Ltd. Ord.	[illegible]	7 2 0	Nov	..	..
1	0/7½	† Do. 6 per Cent. Cum. Pref.	⅞– [illegible]	6 17 0	May, Nov	..	..
St	4½%	Do. 4½ per Cent. Perp. Deb. Stock	87 – 91	4 19 0	Jan, July	—	..
1	.	Simplex Conduits Ord.	1½	..	..	—	—
5		Do. 6 per Cent. Cum. Pref.	5¼	.	..	..	..
12	30/0	Telegraph Construction & Maintenance	50 – 52	6 11 0	Mar, July	51½	31
100	4%	Do. 4 per Cent. Deb. Bonds (1909)	100 – 103	3 17 6	Jan, July	101¼	..
1	2/0	Vickers, Sons & Maxim, Ltd. Ord.	1 – 1[illegible]	8 14 0	..	1[illegible]	1[illegible]
1	[illegible]	Do. 5 per Cent. [illegible] Cum. Preference	1[illegible] – 1[illegible]	4 14 6	..	1	..
St.	[illegible]%	Do. 5 per Cent. [illegible] Cum. Preferred	101 – 105	4 15 6	..	..	..
St.	4%	Do. 4 per Cent. 1st Mort. Db. Sk. red.	102 – 104	3 16 6	June, Dec	104½	104
100	4½%	Do. 4½ per Cent. [illegible] Mort. Deb. red.	103 – 105	4 5 9	June, Dec	104	102⅜
[illegible]	1/0	Willans & Robinson Ord.	[illegible] – 1½	4 0 0	Apr, Oct	[illegible]	..
[illegible]	1/0	Do. 6 per Cent. Cum. Pref.	3⅝– [illegible]	7 15 0	Apr, Oct	3[illegible]	..
100	4%	Do. 4 per Cent. 1st Mort. Debs.	72 – 77	5 4 0	May, Nov	..	..
100	..	Do. [illegible] per Cent. [illegible] Mort. Deb. Perp.	100 – 101	..	..	100½	100

TELEGRAPHS.

Share.	Last Dividend.	Name.	Price Wed., May 6.	Rate Yield-ed. £ s. d.	Dividend Due.	Business Week to May 6. Highest.	Lowest.
10		Amazon Telegraph	2 – 3	—	June, Dec	..	—
100	[illegible]%	Do. 5 per Cent. Deb. [illegible]	84 – 87	6 15 0	June, Dec	..	..
St	15/0	Anglo-American	56 – 58	6 [illegible] 0	F,My,Ag,N	[illegible]	..
St.	[illegible]	Do. Preferred	99 – 101	5 19 0	F,My,Ag,N	100½	99
[illegible]	1/	Do. Deferred	14 – 14½	6 18 0	F,My,Ag,N	14¼	[illegible]
St.	4%	[illegible] Cos. 4 per Cent. Deb. Stk.	84 – 87	4 12 0	Jn,Ap,Jy,O	84½	84¼
10	[illegible]	[illegible] Ord.	[illegible]	7 5 0	Feb, Aug	7½	—
10	[illegible]	† Do. [illegible] per Cent.	1[illegible] – 14¾	6 10 0	Feb, Aug	..	..
[illegible]	2/0	[illegible] Ord.	[illegible] – 3½	5 13 0	April, Oct	..	..
5	5/0	Do. [illegible] per Cent. Cum. Pref.	[illegible]	5 11 0	April, Oct		..
50	[illegible]	Do. [illegible] per Cent. [illegible]	[illegible] – 102½	4 8 0	Jan, July		
[illegible]	[illegible]	[illegible]	[illegible] – 14	[illegible] 11 0	Ja,Ap,Jy,O	[illegible]	13½
100	4½	[illegible] 4½% Rg. Db. (rd.	[illegible] – 101	4 8 0	June, Dec		..
St	[illegible]	[illegible]	13[illegible] – 136	[illegible] 2 0	Ja,Ap,Jy,O	134½	134
St.	[illegible]	Do. [illegible] per Cent. [illegible] Stock	[illegible]	4 0 0	Ja,Ap,Jy,O	[illegible]	..
St.	[illegible]	† Do. [illegible] per Cent. Mort. Deb. Stk. (red.)	[illegible] – 102	3 [illegible] 0	May, Nov	101[illegible]	100¼
[illegible]	[illegible]	[illegible]	[illegible]	[illegible] 4 0	Ja,Ap,Jy,O	[illegible]	13
St.	[illegible]	Do. [illegible] Stock	[illegible]	3 18 0	Feb, Aug		..
100	[illegible]%	[illegible]	[illegible]	[illegible]	Feb, Aug	..	..
[illegible]	[illegible]	† Do. [illegible] Debs. (red.)	[illegible]	[illegible] 10 0	May, Nov	..	..
10	5/0	[illegible]	[illegible]	6 1 0	Jan, July	31	[illegible]
100	[illegible]	[illegible] (red.	[illegible]	[illegible]	June, Dec	101½	
[illegible]	[illegible]	Do. [illegible]	[illegible]	[illegible] 6	May, Nov	[illegible]	[illegible]
100	£1	[illegible]	[illegible]	6 7 0	Jan, July	..	..
100	£1	Do. Preference	[illegible]	6 0 0	Ja,Ap,Jy,O	..	..
1		[illegible]	[illegible]	.	April .		.
[illegible]	[illegible]	[illegible]	[illegible] – 101	3 19 0	June, Dec		—
[illegible]	[illegible]	West [illegible]	[illegible]	3 11 0	May	..	..
[illegible]	[illegible]	Do. [illegible] per Cent. [illegible]	[illegible] – 101½	[illegible]	[illegible]	.	..
[illegible]		[illegible]			[illegible] Nov	..	..
[illegible]	[illegible]	Do. [illegible]	[illegible]	[illegible]	[illegible] Nov	..	.
[illegible]	[illegible]	Do. [illegible]	[illegible]	..	[illegible] Nov	..	..
[illegible]	[illegible]	Do. [illegible] per Cent. Debs.	[illegible]	4 16 0	Jan, July	.	..
10	[illegible]	Western [illegible]	[illegible]	[illegible] 1 0	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	June, Dec	..	..
..		W[illegible]	[illegible]			..	..

TELEPHONES.

Share.	Last Dividend.	Name.	Price Wed., May 6.	Rate Yield-ed. £ s. d.	Dividend Due.	Business Week to May 6. Highest.	Lowest.
100	2½	Amer. Teleph. & Telegh. Cap. St.	120 – 124	6 9 0	.		..
.	4	Do. Coll. Trust $1,000 4 per Cent. Bds	85 –87	4 14 9	Jan, July	..	..
St	5%	Anglo-Portug'se Tel. 5% 1st Mt. Db. Stk.	98½–101½	4 19 0	Mar, Sept	..	—
[illegible]	[illegible]	Chili Telephone	7 – 7½	6 6 6	August ..	.	.
1	0/7½	†Monte Video Telephone Ord.	[illegible]–1[illegible]	6 16 0	Nov	1[illegible]	1[illegible]
1	0/6	† Do. 5 per Cent. Pref.	[illegible] – 1[illegible]	5 7 0	May, Nov	[illegible]	[illegible]
St	6%	National Co. Pref. Stock	107½ – 1[illegible]	5 9 6	Feb, Aug	10[illegible]	10[illegible]
St	6%	Do. Def. Stock	108½ – 110½	5 5 6	Feb, Aug	1[illegible]	10[illegible]
10	6/0	Do. 6 per Cent. Cum. 1st Pref.	1[illegible] – 1[illegible]	4 16 0	Feb, Aug	11[illegible]	.
10	6/0	Do. 6 per Cent. Cum. 2nd Pref.	10¾ – 12½	4 16 0	Feb, Aug	1[illegible]	1[illegible]
5	2/6	Do. 5 per Cent. non-Cum. 3rd Pref.	5⅜ – 5⅝	4 9 0	Feb, Aug	[illegible]	
St.	3½%	* Do. Deb. Stock 3½ per Cent. (red.)	98 – 100	3 10 0	June, Dec	9[illegible]	9[illegible]
St	4%	Do. 4 per Cent. Deb. Stock (red.)	101½ – 103½	3 17 0	Jan, July	10[illegible]	1[illegible]
1	0/7½	Oriental	1[illegible] – 1½	4 13 6	April, Oct	1[illegible]	1[illegible]
1	0/7½	Do. 6 per Cent. Cum. Pref.	1⅛ – 1¼	4 16 0	April, Oct	..	..
St.	4	Do. 4 per Cent. Red. Deb. Stock	90 – 93	4 6 0	Jan, July	..	..
St	4½%	Telephone Co. of Egypt 4½% Db. Stk. (red.)	99 – 102	4 8 0	Jan, July	..	—
5	3/0	United River Plate	6 – 6½	6 3 0	July	6⅜	
5	2/6	Do. 5 per Cent. Cum. Pref.	4¾ – 5¼	4 15 0	June, Dec	..	..
St.	4½%	Do. 4½ Deb. St. Red.	99 – 102	4 8 3	Jan, July	..	..

FINANCIAL, INVESTMENT, &c.

Share.	Last Dividend.	Name.	Price Wed., May 6.	Rate Yield-ed. £ s. d.	Dividend Due.	Business Week to May 6. Highest.	Lowest.
5	3/0	Elec. & Gen. Investment 6% Cum. Pref.	3¾ – 4¼	7 1 0	Jan, July		..
10	2/0	Globe Telegraph & Trust	9¾ – 10¼	5 7 0	Sp,Dc,Mr,Ju	10[illegible]	[illegible]
10	5/0	Do. 6 per Cent. Pref.	13¾ – 1[illegible]	4 4 0	Sp,Dc,Mr,Ju	1[illegible]	13¾
10	6%	Submarine Cables Trust (Cert.)	126 – 129	4 13 0	April, Oct	12[illegible]	..

COLONIAL AND FOREIGN ELECTRIC RAILWAYS, TRAMWAYS, &c.

Share.	Last Dividend.	Name.	Price Wed., May 6.	Rate Yield-ed. £ s. d.	Dividend Due.	Business Week to May 6. Highest.	Lowest.
5	3/0	Anglo-Argentine 6% Cum. 1st Pref.	6½ – 6[illegible]	4 1[illegible] 0	April, Oct	6[illegible]	6[illegible]
5	5/0	Do. 10% Non-cum. 2nd Pref.	7⅞ – [illegible]	6 3 6	Jan, July	[illegible]	7[illegible]
St.	6%	Do. Permanent 6% Deb. Stock	136 – 141	4 5 0	June, Dec	..	..
St.	5%	Auckland Elec. Trams. 5% Deb. (red.)...	104 – 107	4 13 6	Jan, July	105	..
5	4/0	†Brisbane Electric Trams. Invest. Ord....	[illegible]	2 12 0	May	.	
5	2/6	† Do. 5 per Cent. Cum. Pref.	4[illegible] – 4[illegible]	5 2 6	May, Nov	..	—
St	4½%	Do. 4½ per Cent. Db. Prov. Certs.	[illegible] – 102	4 8 0	Jan, July	9[illegible]	..
St.	8%	†British Columbia El. Ry. Df. Ord.	129 – 132	6 1 0	Mar, Sept	131½	1[illegible]
St.	6%	Do. Pref. Ord. Stock‡	111 – 115	5 4 0	May, Nov	..	..
St.	5%	Do. 5% Cum. Perp. Pref. Stock	107 – 111	4 10 0	Jan, July	..	..
40	4½%	Do. 4½ per Cent. 1st Mort. Debs.	99 – 102	4 8 0	April, Oct	..	..
100	4½%	Do. Vancouver Power Debs.	101 – 104	4 6 6	Jan, July	..	..
St.	4½%	Do. 4½% Perp. Con. Deb. St.	98 – 101	3 19 0	.	99½	98⅝
5	3/0	Buenos Ayres & Belgrano Ord.	4[illegible] – 4⅞	8 1 6	April, Oct	..	..
5	3/0	Do. 6 per Cent. "A" Cum. Pref.	4[illegible] – 5½	5 17 6	April, Oct	..	..
5	3/0	Do. "B"	4[illegible] – 5[illegible]	5 17 6	April	..	..
St.	5%	Do. 5 per Cent. Debs.	110 – 116	4 6 0	Jan, July	—	..
St.	5%	Do. 5 per Cent. 2nd Debs. (red.)	102 – 105	4 15 3	Jan, July	..	..
St.	5%	Buenos Ayres Elec. Trams (1901) Ltd. Deb. St.	95 – 99	5 1 0	Ja, Jul ..	..	—
5	..	Buenos Ayres Grand National Ord.	2½ – 2⅞	..		..	..
5	2/6	Do. 5 per Cent. Cum. Pref.	3¾ – 4¼	5 18 0	Feb, Aug	..	..
100	5½%	Do. 5½ per Cent. Pref. Debs.	100 – 104	5 5 9	Jan, July	..	..
100	6%	Do. 6 per Cent. 1st Deb. Bonds.	98 – 102	5 7 0	April, Oct	9[illegible]	..
St.	5%	Buenos Ayres Lacroze Trams 1st Mt. Db.	91 – 94	5 6 0	Mar, Sept	93½	93½
St.	6%	Buenos Ayres Port & City Tram. 1st Mt. Deb. Stock £75 Paid	61 – 68	6 12 [illegible]	Feb, Aug		..
5	2/6	†Calcutta Tramways (1 to 137,610)	6 – 7	5 14 0	Mar, Sept	[illegible]	—
100	2/6	Do. 5 per Cent. Cum. Pref.	5 – 5½	4 13 0	Jan, July	[illegible]	..
1	4½%	Do. 4½% 1st Deb. Stock (red.)	103 – 106	4 5 0	Jan, July	104	..
8	.	Cape Electric Tram Shares	[illegible] – [illegible]	..	.	[illegible]	—
[illegible]	1/3	City of Buenos Ayres Trams Co. (1904, Sh.	5½ – [illegible]	4 11 0	F,My,A,N	[illegible]	5[illegible]
St.	4%	Do. 4 per Cent. Deb. Stock	[illegible] – 102	3 18 6	June, Dec		..
	5%	†Colombo Tr. & Ltg. 5% 1st Mt. Db.	85 – 91	5 13 0	May, Nov	..	—
100	5%	Electric Traction Co. of Hong Kong 5 per Cent. 1st Mort. Debs.	87 – 92	5 8 6	June, Dec	.	..
1	5%	Havana Elec. Ry. Con. Mt. 5% $1,000 50 year Coup. Bds.	80 – 85	5 17 6	Feb, Aug		..
1	..	Kalgoorlie Elec. Trams Sh.		..	..	[illegible]	
100	5%	Do. 5 per Cent. "A" Deb. Stock	87 – 91	5 8 9	Jan, July	..	—
6	6%	Do. 6 per Cent. "B" Ditto	71 – 75	7 17 0	Jan, July	..	..
5	1/0	Lisbon Elec. Trams. Ord.	1 – 1½	4 0 0	July	..	..
100	0/7½	Do. 6 per Cent. Cum. Pref.	1 – 1[illegible]	4 16 0	Jan, July	..	—
St.	5%	Do. 5 per Cent. Reg. Mort. Debs.	90 – 95	5 6 0	Jan, July	.	..
St.	5%	Madras Elec. Trams. 5% Deb. Stk.	95 – 98	5 2 0	Jan, July	..	..
..	5%	Manila Elec. Ry. $1,000 Gold Bonds	86 – 90	5 11 8	Feb, Aug	.	
100	$1	†Mexico Trams Co. Com. St.	87 – 89	4 10 0	..	[illegible]	8[illegible]
100	5	Do. Gen. Con. 1st Mort. 5% Gold Bds.	8[illegible] – [illegible]	5 14 0	..	[illegible]	[illegible]
St.	4½%	Montreal St. Ry. Sterling 4½ per Cent. Debs. (1922)	101 – 103	4 7 6	Feb, Aug	..	..
1	1/0	Perth Elec. Trams Ord	[illegible] – [illegible]	7 5 6	Mar	..	..
St	5	Do. 1st Mt. Db. Stock	103 – 106	4 14 3	Jan, July	.	..
5	3/0	Rangoon Elec. Trams & Supply Co. 6% Cum. Pf.	[illegible] – [illegible]	5 4 0	..	..	—
St.	4½	Do. 4½% 1st Mort. Deb. Stk.	97 – 99	4 11 0	..	..	..
.	$[illegible]	Sao Paulo Tramway, Light & Power Co. $100 Stock	129 – 134	6 11 0	..	132	130½
	5%	Do. 5 per Cent. 1st Mt. $500 Db.	[illegible] – 9[illegible]	5 2 6	June, Dec	97½	97½
100	4½%	Toronto Ry. Co. 1st Mt. 4½% Ster. Bonds	99 – 101	4 9 0	Feb, Aug	..	..

COLONIAL AND FOREIGN ELECTRICITY SUPPLY, &c.

Share.	Last Dividend.	Name.	Price Wed., May 6.	Rate Yield-ed. £ s. d.	Dividend Due.	Business Week to May 6. Highest.	Lowest.
5	3/0	Adelaide Elec. Sply Co. 6% Cu. Pr.	[illegible]	5 17 0	Mar, Sept	..	—
10	[illegible]	Bombay E. S. & T. 6% Cum. Pf.	10 – 10½	5 14 0	..	..	..
St.	4½	Do. 4½ per Cent. Deb. Stk. (red.)	93	4 15 0	Jan, July	..	..
5	[illegible]	Calcutta Elec. Supply Ord.	[illegible]	6 8 6	April, Oct	[illegible]	..
100	7/2	Colonial Gen. Elec. Co. Com. St.	88 – 92	10 17 0	..	10[illegible]	[illegible]
100	[illegible]%	C[illegible] Electricity [illegible] (U.S.A.) 1st Mort. Stg. Debs.	94 – [illegible]	[illegible] 1 0	Jan, July	[illegible]	
100	[illegible]	Elect. Development Co. of Ontario...	76 – [illegible]	6 6 8	..	78	77[illegible]
5	..	Elec. Ltg. & Trac. Co. of Aust. 6 per Cent. Cum. Pref.	2¼ – 2¾	..	Feb, Aug	..	..
St	[illegible]	Do. [illegible] per Cent. Deb. Stock	84 – 88	5 14 0	Jan, July	..	..
St	5	Elec. Supply Co. of Victoria 5 per Cent. 1st Mort. Deb. St.	91 – 94	5 6 0	Jan, July	91[illegible]	..
St	6%	Indian Elec. Sup. & Trac. Co. Deb. St. Ext. Prov. Certs.	95 – [illegible]	6 2 0	Jan, July	..	..
10		Kalgoorlie Elec. Power & Ltg. Ord.	[illegible]	..			
1	[illegible]	Do. 6 per Cent. Cum. Pref.	[illegible]	8 0 0	April, Oct		—
St.	[illegible]	[illegible] E. S. Corp. [illegible] per Cent. Consol. Deb. St.	[illegible]	5 8 6	April, Oct	.	..
500	[illegible]	Mexican Elec. Light Co. 5% 1st Mort. Gold Bonds	[illegible]	6 6 0	..	77	76[illegible]
St		Mexican Lt. & Power Co. Cap. St.	[illegible]	.	..	[illegible]	[illegible]
[illegible]	[illegible]	Do. [illegible] 1st Mort. Gold Bonds	[illegible]	[illegible] 15 6	.	84½	[illegible]
[illegible]	[illegible]	Montreal Lt. Ht. & Power Co. Cap. St.	97 – 101	6 [illegible] 0	F,My,A,N		..
1	1/[illegible]	[illegible] Ord.	[illegible]	[illegible] 0 0	April		[illegible]
1	[illegible]	† Do. [illegible] per Cent. [illegible] Cum. Pref.		[illegible] 0 0			
St.	[illegible]	Do. [illegible] per Cent. [illegible] Stock	[illegible]	[illegible] 1 0	Jan, July	[illegible]	97[illegible]
5	[illegible]	[illegible] Elec. Co. [illegible] Pref. [illegible]	4 – [illegible]	[illegible] 17 6	April, Oct		..
100	$1	S[illegible] Water [illegible] Power Co. Cap. St.	[illegible]	6 1 0	.	6[illegible]	61½
[illegible]		Do. [illegible] per Cent. [illegible]	10[illegible]	4 17 0	Jan, July	.	..
[illegible]	[illegible]	Victoria Falls Power Co. Pref.	[illegible]	—	Jan, July		..

* In calculating the yields allowance has been made for accrued interest but *not* for redemption. † Ex dividend. ‡ The London Stock Exchange Committee have declined to quote these.

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NOTES.

Is the Consulting Engineer Necessary?

IN our Correspondence columns will be found two letters dealing with the subject of the Consulting Engineer, a topic which we discussed at some length in our leading article last week. The letter by "Manufacturer" deals mainly with the causes leading up to the present situation. He points out that in many cases in the past the consulting engineer has not been the ideal intermediary between the contractor and purchaser that he might have been. Frequently he has saddled the trade with his fads, instead of accepting what the trade by long experience has evolved as standard. Consequently there has been much unnecessary expense. The contractor has been put to expense in designing special plant, and the purchaser has had to pay a higher price in consequence. Finally, in many cases the special plant has not given satisfaction, owing to want of experience in its design. Similarly there have been endless schedules of prices to be filled in, and attempts to make the contractor supply single articles at the same rate as per dozen. This, we regret to say, must all be admitted; but we think that this class of consulting engineer is rapidly passing out of existence, if he is not already a being of the past, and the present tendency on the part of the contractor to deal direct with the purchaser is only the substitution of one evil for another that has now practically ceased to exist. The remedy, as "Manufacturer" points out, is that no contractor should quote direct to a purchaser, but only to the specification of a consulting engineer.

THE letter by "Lumen" deals more particularly with the question of how this desirable state of things can be brought about. A great difficulty at the present time is that there is no list of consulting engineers to which a purchaser can refer for guidance. What is required is a list of duly qualified engineers who would be prepared to carry out work according to a certain code of professional etiquette, and who would also have the confidence of the contractor. The latter is as important as the former. As suggested by "Lumen," there is no reason why the Institution of Electrical Engineers should not take action in this matter. It is eminently a case where action should be taken by some independent body who would take account of the interests of all the parties concerned. Otherwise there is a very good chance that nothing will be done, for the simple reason that the electrical industry, unfortunately, is very largely bound up with men who are not prepared to face a situation squarely or to have the courage of their convictions openly. Strong convictions, no doubt, exist, but the statement of such convictions is frequently prevented by the idea that personal loss may ensue unless collective action is taken; and since collective action is always the consequence of expression of individual opinions, and never the reverse, very little is apt to be done. We hope that this unfortunate characteristic of the electrical industry will not result in total inaction in the present instance.

The Rating of Light Railways.

THE decision given by the House of Lords last Friday, and reported elsewhere in this issue, in connection with the rating of the Wakefield & District Light Railway Co., who, it will be remembered, refused to pay the full rate levied by the Wakefield Corporation, is likely to lead to much discussion and many inconsistencies if steps are not immediately taken to put electric tramways and light railways on the same basis as regards the levying of rates. The distinction between the two is obviously in most cases

arbitrary, but the appeal to the House of Lords was decided purely on the legal question—"Is a light railway a railway within the meaning of sec. 211 of the Public Health Act, 1875?" The decision that it is so, and that it is, therefore, entitled to be assessed at only one-fourth of its net annual value, has been arrived at unanimously by the High Court, the Court of Appeal and the House of Lords, although, in the first instance, when the case was tried before the Wakefield justices, the decision was against the company. The important question that now remains is "When is a tramway a light railway?" This depends at present almost entirely on the foresight of the promoters.

A New Electric Locomotive.

THE growth in the use of electric power in mines, collieries and works is leading to a demand for small electric locomotives to perform the necessary operations of haulage and shunting which have been previously carried out by steam locomotives, capstans and horses. Whilst steam locomotives have no doubt given satisfactory service in the past, they are somewhat costly to maintain, and, in some cases, the risk from sparks and cinders is a serious drawback. It is only natural, therefore, that owners who have already installed electric plant for dealing with their manufacturing requirements should turn their attention to extending this plant to other uses. Overhead construction can be erected at very small cost, and the advantage of having an electric locomotive always ready for use, but requiring no attention when it is not at work, is rapidly becoming more widely recognised. The special type of locomotive referred to elsewhere in this issue contains several important features which should make it specially adaptable to this class of service. Amongst these may be mentioned the high centre of gravity, to which Mr. KELLY calls attention. This point is somewhat novel, and has been too often overlooked in electric practice. It is many years now since the London & North-Western Railway Co. built a steam locomotive in which the boiler was placed below the driving axle with the special intention of making the centre of gravity of the locomotive low. The scheme was a failure, and the design was abandoned. Another marked feature of this new electric locomotive is the simplicity and accessibility of its electrical parts, which will go far to reduce the cost of maintenance to a minimum.

Telegraph Code Vocabularies.

IT will be seen from the reports which appear in our present issue of the Eastern, Eastern Extension, and Western Telegraph Companies that the cable and telegraph administrations of the world have found from experience that the extra facilities offered to the mercantile public in the unrestricted use of code vocabularies has been abused by the use of words which do not come within a reasonable interpretation of the clause agreed to by the International Telegraph Conference in London in 1903. The object of the concession to the coding public made by the delegates at the London Conference was to facilitate the general use of code words, and it is well known to those who have full acquaintance with the working of telegraphic systems that neither in submarine cable nor land line working has any obstacle ever been put in the way of the use of code words which the telegraph operator may reasonably be expected to comprehend. The letter which recently appeared in the columns of *The Electrician* from Mr. H. BABINGTON SMITH, of the British Post Office, and the remarks of Sir JOHN WOLFE BARRY at the meetings of the Associated Cable Companies this week, will, we think, convince the public that the telegraphic administrations are only making reasonable protest in calling attention to the abuse of the facilities so readily offered, and in asking the delegates at Lisbon to put this matter on a more equitable basis.

Glasgow Section of the Institution of Electrical Engineers. At the annual meeting of this Section held on Tuesday last the following were elected to serve on the committee during the session 1908-09: *Chairman*, Mr. W. W. Lackie. *Past Chairmen*, Mr. John M. M. Munro and Prof. F. G. Baily. *Vice-Chairman*, Mr. Sam Mavor. *Chairman of Students' Section*, Prof. Magnus Maclean. *Hon. Sec. and Treasurer*, Mr. James E. Sayers. *Members*, Messrs. Chas. Day, Frank Newington, J. S. Nicholson, J. K. Stothert, Wm. M'Whirter, J. Taylor, R. Robertson, E. G. Tidd, J. Robertson.

Hollow Reinforced Concrete Pole.—The *Electrical World* gives a short description of a hollow reinforced concrete pole, due to F. H. Tidnam, which the inventor claims is equal in cost to wooden poles of the same size. The framework or cage for the pole comprises longitudinal wires or rods clamped in place. A core is inserted within the cage before the concrete is poured, and, after the latter has set, the core is withdrawn, thus making a pole light in weight without sacrificing strength. The advantages of concrete poles over wooden poles, apart from strength, are improved appearance and greater durability.

British Science Guild.—At the last meeting of the executive committee of this Guild it was reported that Mr. Deakin, Prime Minister of the Commonwealth of Australia, had been elected vice-president. Reports were presented by the appropriate sub-committees on primary and secondary education, on the practical teaching of science in schools and on the present position of agricultural research in the United Kingdom. A special committee of the Guild has recently been appointed to consider the synchronisation of public clocks in London, and Mr. Buxton, the Postmaster-General, who is in sympathy with the movement, has nominated Major O'Meara, R.E., C.M.G., to be a member of it.

British Weights and Measures Association.—A glance at the current issue of the *Report and Journal* of this Association shows that its objects are still going strong. The *Journal* opens with opinions advanced by various authorities against the metric system, the first being "a good hard knock" at the professor of pure science. It then deals fully with the work of the committee and other business matters of the Association. An abstract of Dr. R. T. Glazebrook's first lecture on "Standardisation in Various Aspects" is given. The last issue of the *Journal* was sent to every British Consular Officer and Commercial Attaché, and the favourable replies received have encouraged the Association to further efforts.

Verband Deutscher Elektrotechniker.—The 16th annual meeting of this society will be held at Erfurt on June 11th and the three following days. Among the Papers to be read are "Recent Conquests in the Sphere of Electric Lighting," by Prof. W. Wedding; "The Influence of Over-running on Metallic Filament Lamps" and "Comparison of the Upkeep of Small Arc Lamps and High Candle power Osram Lamps," by Ober-Ingenieur Remané; "The Fundamental Laws of Heating in Electrical Machines," by Dr. R. Goldschmidt; and "Automatic Synchronising Switches for A.C. Generators," by Herr F. Lux. The ladies of the party will be kept busy with excursions, while the whole of those present will devote the Sunday to this purpose. A reception will be held on the opening evening by the Mayor of Erfurt, and the annual dinner will take place on June 13th.

Cable Interruptions and Repairs.

	Date of Interruption.	Date of Repair.
Alexandria—Larnaca ...	April 29, 1908	May 7, 1908
Cayenne—Salinas	May 12, 1908	...

Wireless Telegraph Notes.—It is announced that the Spanish Government have recently concluded a contract with a French firm for the establishment of 24 wireless telegraph stations. Fifteen of these stations will be on the Spanish coast, seven on the Canary Islands and two on the Balearic Islands. The stations are to be sufficiently powerful to ensure efficient intercommunication between the places mentioned above. By the erection of these stations, it is said that Spain will become independent of the present English and German cable systems, and thus the payment of large subsidies will be avoided.

It is stated that the wireless telegraph instruments specially designed for use on torpedo boat destroyers have proved so successful that similar apparatus is to be installed on the larger types of high-speed war vessels.

It is reported from Washington (U.S.A.) that on May 13, Lieut. Lohm made an ascent in a balloon of the Signal Corps, equipped with a wireless telegraph receiving apparatus, and that messages from Annapolis (Md.) were taken perfectly.

Life of Tantalum Lamps.—A short abstract from a *Bulletin* of the University of Illinois on this subject is published in the *Electrical World*. It is devoted to an account of comparative tests by T. H. Amrine on carbon, graphitised carbon and tantalum filament lamps. The lamps were tested under both favourable and unfavourable conditions, in the first case being connected to a storage battery circuit, and in the second case supplied with badly fluctuating alternating current. Taking as an average life the time in reaching 80 per cent. of the original candle-power, the life in hours under the more favourable conditions was 400 hours for the carbon filament, 780 hours for the graphitised carbon filament and 820 hours for the tantalum filament; with alternating current the figures became 225, 350 and 350 respectively. With widely fluctuating alternating current the tantalum lamps were, therefore, considerably better than those of the carbon filament type.

Corps of Electrical Engineers.—We learn that the movement in connection with the electrical engineers required for the Territorial Army is making satisfactory progress in Birmingham. Three companies are at present being raised by Mr. J. F. Lister, who will be in command with the rank of Lieutenant-Colonel. The three companies are to be known as the "Southern Wireless Company," the "Southern Cable Company" and the "Southern Airline Company." The Wireless Company will be commanded by a Captain and the Cable and Airline Companies each by a Major. These officers will be responsible for their own companies on mobilisation. The companies will be what are known as "Army Troops," and on mobilisation they may not necessarily be attached to the Birmingham Regimental District. The period of annual training is from 8 to 15 days, the August Bank Holiday week being included. The place of training has not yet been fixed, but in all probability it will be Salisbury Plain. We hear that about 150 men have already been attested, and no difficulty is anticipated in raising the required number—namely, 500. Several well-known members of the local section of the Institution of Electrical Engineers have been offered and have accepted commissions in this new unit.

Arc Works Engineering Society.—At the meeting of this Society at Chelmsford on April 30 an interesting Paper was read by Messrs. Wright and Downes on "Pertinent and Impertinent Accuracy." The Society was fortunate in securing the presence of the president (Col. R. E. Crompton, C.B.), who brought with him his measuring machine, of which he gave a most interesting description.

The annual general meeting of the Society was held on the 1st inst. when, after the usual business (including the election of the officers and committee for the forthcoming session), a concert was held.

The apparatus arranged for exhibition by Mr. H. McCullum included: (1) A measuring machine, which has been designed and made by Col. Crompton for extremely accurate measurements of length. (2) The engine from the Bluebell steam car, which was constructed for running on the road with a wagonette body to carry passengers. This was finally worked out and erected by Col. Crompton some 40 years ago, and the exhibit was of interest as being one of the earliest steam engines for road work. It was used for Army service in the Kashmir. (3) An interesting collection of high-tension and X-ray apparatus shown by Mr. Donnithorne (Messrs. H. W. Cox & Co.). (4) Not the least interesting exhibit was a small rectifier, exhibited by Mr. Pochin, a perfect model of beautiful workmanship.

One of the chief events of the evening was the presentation of the Society's apprentices' premium to Mr. H. F. Jefferson for his Paper on "Speed Regulation of Prime Movers." The presentation was made by Mr. Hodgson.

Royal Society's Conversazione.—The exhibits at the Conversazione of the Royal Society on Wednesday evening last were marked by their variety and general interest, appealing largely to the electrical engineer as well as to the pure physicist.

Dr. J. A. Fleming, F.R.S., besides exhibiting a cymometer and oscillation valves, showed photo-electric effects with potassium-sodium alloy. This alloy, which is well-known as resembling mercury in its appearance and mobility, contained a much larger proportion of potassium than of sodium. It was contained in a vacuum tube having one electrode in the alloy, and the other electrode simply of platinum. Upon connecting a galvanometer to these electrodes and illuminating the cell by the light from an electric arc, an E.M.F. of 0·8 volt was created, thus giving a current in the galvanometer circuit. The cell was shown to be very sensitive to a particular wave length of light—namely, that radiated by potassium in a state of incandescence. Other wave lengths produced comparatively little effect. It was also shown that the effect obtained depended upon the plane of polarisation of the light, the effect being a maximum when the electric component of the light was perpendicular to the surface of the alloy. Mr. S. Cowper-Coles showed specimens of pure electrolytic iron, in the form of sheets obtained by electro-deposition direct from pig iron or iron ore without any rolling. The iron so obtained is remarkable for its high tensile strength of 30 tons per square inch, and is free from crystalline structure. Mr. L. H. Walter showed a tantalum wave-detector for wireless telegraphy or telephony, consisting of a tantalum wire point dipping into mercury. This is spontaneously restoring, and at 450 miles, using a power of less than 2 kw., the results obtained are equal to those given by the electrolytic detector. Mr. Walter also showed a signalling key, consisting of aluminium contacts in an electrolyte, these being placed in the primary of the transformer, and actuated electromagnetically. The National Physical Laboratory had a large exhibit, including Mr. A. Campbell's inductance apparatus and vibration galvanometer, and also an apparatus, due to Mr. W. Rosenhain, for the quenching of specimens of metal at any desired temperature. In this apparatus the metal is heated in vacuo in a silica tube, to a red heat if desired, by a coil surrounding the tube; when the required temperature is reached, as indicated by a thermoelectric instrument, water is admitted to the tube, such a course being rendered possible by the remarkable properties of silica. Prof. S. P. Thompson, F.R.S., exhibited an interesting collection of early compass cards and windroses, and Prof. C. V. Boys, F.R.S., showed an ingeniously simple straight-line motion. A small high-frequency alternator, for telephonic experiments, and giving 12,000 periods per second, was shown by Mr. S. G. Brown. Another interesting exhibit was that of the Rev. F. J. Jervis-Smith, F.R.S., who showed that an exhausted bulb became luminous on rotation in an electrostatic field, the glow being displaced by a magnetic field. Other exhibits were apparatus by Prof. H. L. Callendar, F.R.S., and Prof. W. E. Dalby for measuring temperatures in the cylinder of a gas engine; hot-wire oscillographs by Mr. J. T. Irwin; a very complete set of Johansson gauges by Messrs. C. W. Burton, Griffiths & Co.; apparatus for studying graphite at very high temperatures and pressures by Prof. R. Threlfall, F.R.S.; and a copying process by Messrs. B. J. Hall & Co., known as the Ordoverax process, in which a special composition is used capable of taking a rapid impression from an undeveloped blue print, the effect on the composition being that it will take up printer's ink on those parts corresponding to the portion of the blue print not affected by light, and thus any number of prints can be rapidly obtained.

ARRANGEMENTS FOR THE WEEK.

FRIDAY, May 15th (to-day).

Iron and Steel Institute.

10.30 a.m. Annual General Meeting at the Institution of Civil Engineers, Great George-street, Westminster.

SATURDAY, May 16th.

Birmingham and District Electric Club.

7 p.m. Meeting at the Colonnade Hotel, New-street, Birmingham. Paper on "Electrical Porcelain," by Mr. H. W. Brady.

THURSDAY, May 21st.

Institution of Electrical Engineers.

8 p.m. Meeting at the Royal Society of Arts, John-street, Adelphi, W.C. Paper on "Recent Progress in Tungsten Metallic Filament Lamps," by Mr. H. Hirst.

FRIDAY, May 22nd.

Physical Society.

5 p.m. Meeting in the Physics Laboratory, Royal College of Science, Imperial Institute-road, South Kensington. Agenda: "On the Spectrum Top," by Mr. G. P. Sexton; "On the Coefficient of Diffusion," by Mr. B. W. Clack; and "On the Production of Small Alternating Currents of Variable Frequency suitable for Telephonic and Other Measurements," by Mr. B. S. Cohen.

SATURDAY, May 23rd.

Junior Institution of Engineers.

Visit to the Avonmouth Dock Works and Electricity Works, Bristol.

ON PORCELAIN INSULATORS FOR TRANSFORMERS, SWITCHES, &c.

BY CHARLES C. GARRARD.

It is the almost universal practice at the present day to use corrugated porcelain insulators for the bushes of transformers, switches and the like. It has been the fashion to specify that these should have certain minimum leakage distances from live metal to earth. The writer has come across some very pronounced instances of this, in which, in order to obtain the minimum leakage surface specified, extremely deep corrugations have been necessary, resulting in the construction of insulators, which are not only costly but difficult to clean and

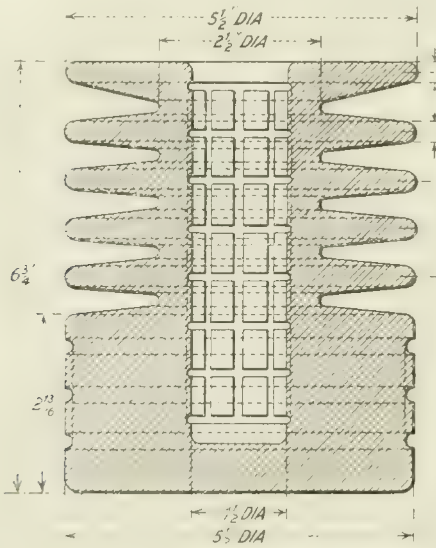


FIG. 1.—10,000 VOLT DEEPLY CORRUGATED INSULATOR.

extremely easy to damage. As an example of this, the 'bus bar insulator illustrated in Fig. 1 may be given, which was for use on a 10,000 volt (line to earth) system, the insulators being specified to have a leakage path of 18 in. It is not difficult to trace the evolution of these corrugated insulators. They have, doubtless, been evolved from the petticoated insulators used for outdoor service. For outdoor service, petticoats are a necessity owing to rain. Bushes and such like for use on transformers, switches, &c., indoors, are not designed to stand up under rainfall, yet they have been as yet practically

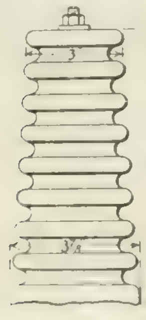


FIG. 2.—H.T. CORRUGATED PORCELAIN BUSH.

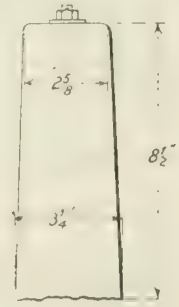


FIG. 3.—H.T. SMOOTH PORCELAIN BUSH.

always made corrugated. The question arises whether these corrugations are necessary. To obtain some information on this point the following tests were carried out, using for the purpose the 100,000 volt testing transformer installed at the Manchester Technical College, and placed at my disposal through the kindness of Principal Reynolds and Prof. Schwartz. Mr. Lustgarten kindly supervised the test, for which I would express to him my best thanks.

A corrugated and a plain insulator having about equal exterior diameters were tested over equal direct distances (see Figs. 2 and 3)—that is to say, the direct jumping distance, through air, not following the surface of the corrugations—was the same in both cases (about 8½ in.). The two insulators were tested in parallel, and the corrugated insulator jumped across first, at 80,000 volts (r.m.s.). The distance on the plain insulator was now slightly shortened, to about 8 in., and it was found that this now sparked across first. The conclusion which was drawn was that, for insulators of about the same outside diameter, the corrugations are of no value, and might as well be left off, as the determining factor of the breakdown point is the length of the shortest air path. Of course, as stated above, this conclusion only applies to indoor insulators. Before the test was made the insulators had been wiped clean with a piece of rag. It was found that if dust, rendered moist by means of a wet rag, was put on the surface of the insulator, a practical short-circuit of the insulator resulted. On keeping the volts low for a little time, the discharge on the surface dried up the moisture and improved the breakdown voltage greatly. This illustrates the fact that porcelain insulators tend to keep themselves dry and to keep their insulation up, for as moisture is deposited the discharge dries it off. It may be thought that the extra length of leakage surface given by a corrugated insulator may be of advantage when the insulator gets dirty. This, however, is counterbalanced by the much greater liability of a corrugated insulator to collect dirt and the greater difficulty experienced in cleaning it. A vertical plain china surface is very much better in both these respects. As, therefore, the above tests show that, when in an ordinary state of cleanliness, the breakdown voltage simply depends on the shortest air distance between poles, it would appear desirable to do away with the usual corrugated insulators on indoor switches, transformers and the like, and replace them with simple cylindrical plain ones, designed to have as long a direct air jump as possible. This will result in an appreciable saving in cost. As, however, the corrugated insulator has become a standardised article, an interchange of opinion on this question might be desired before making the change. It may be mentioned that inquiries made of a Continental firm of electrical porcelain manufacturers elicited the information that they had come recently to similar conclusion as given above, and were now supplying plain, instead of corrugated, bushes for transformers of 60,000 volts working pressure.

THE TANGENTIAL SYSTEM OF SUSPENDING OVERHEAD TROLLEY AND TRANSMISSION WIRES.*

BY ROBERT N. TWEEDY.

"The Council are prepared to receive tenders for about 7½ tons of scrap trolley wire and 12½ cwt. of gun-metal overhead line fittings."

Such is the first of an advertisement which appeared in the technical papers at the end of March, 1908. It had reference to a tramway which was built by a company in 1901, and later on was taken over by the Corporation. There is every reason to believe that this tramway was constructed with the best materials obtainable, and on the standard lines of the period, yet within six years approximately 10 single miles of trolley wire have been reduced to scrap. I do not know when the process of substituting new wire for old was begun, but, judging from experience acquired directly and indirectly, we may assume that serious wear was noticed within the first five years of the lines being opened, and that section after section of wire has been renewed since then. Occasionally no doubt guard wires fell and damaged the trolley wire by causing intense short-circuit currents to pass, and a certain amount of renewals may be debited to errant trolley heads, but almost without exception this 10 miles of wire was spoiled by what we are accustomed to call fair wear and tear. How then are we to reconcile long term loans, or the provision of a minute depreciation fund, with such a rapid destruction of our assets? We may say that the wire is paid for out of revenue and think the question answered.

Logically, therefore, we ought to be prepared to renew the permanent way, the cables, the power station with its equipment and the rolling stock all from revenue, but that is more than we dare face, and we prefer to deal with the heavier and longer lived items by means of a depreciation fund, a renewals reserve fund, or whatever the particular accountant likes to call it.

In the case of a local authority owning a tramway, loans are never extinguishable under 30 years, so that at the present rate of depreciation the whole of the overhead trolley wire and fittings must be renewed at least four times during the period. Nothing that I can

* Paper read yesterday before the Dublin Local Section of the Institution of Electrical Engineers.

say here will alter the general financial policy of local authorities or companies, and the only thing to be done under the circumstances is to suggest some means of reducing this recurring liability to the smallest possible amount.

The first form of overhead construction consisted of copper tubes from which current was collected by a rod or roller. This was not used extensively, and wire soon took the place which it still holds. For a number of years the largest wire used for this purpose was 1/0 S.W.G. of 0·324 in. diameter. This weighed about 1,600 lb. to the mile, and had a tensile strength of 24 to 26 tons per square inch of sectional area.

Two of these wires, in parallel with the usual feeders, supplied ample conductivity for the busiest system, and under ordinary circumstances there was no visible sparking between the trolley wheel and the trolley wire, except at the points of suspension. That was in the days of 7 ton cars, each propelled by two 17 H.P. motors. As time went on the wires were called upon to do a great deal more. Cars have grown since then, their equipment has advanced in power and their speed has increased, while the average number of cars per hour running on every mile of track has had to expand largely to cope with the ever-growing popularity of the service. All these factors have reacted on every portion of the tramway, not excepting the trolley wire, and the result is to be seen in the more serious views which are coming into fashion on the subject of renewal funds. The sufferings of the permanent way have so agonised the observers that the less extravagant but equally morbid throes of the fast perishing overhead construction have excited comparatively little attention.

Diseased trolley wire has been noticed, and without a great deal of inquiry into its environment and habits of life its symptoms have been diagnosed as due to congenital debility, and a new birth of stouter stuff has been prescribed. Single 0 has been succeeded by 2/0, and 2/0 by 3/0, and I am told that 4/0 and even 5/0 S.W.G. wires are becoming common.

That sort of thing is all very well as long as the trolley wire is considered as a feeder pure and simple, and that is the defence put forward most frequently by those who are playing this wild game of "Beggar the Business." Copper they say is a good investment, the more we put up the richer we are, and if we did not put it in the air we should have to bury it in the ground as a feeder, and insulate it into the bargain with something much more expensive than air.

None of which things are as true as they might be.

In the first place, copper is not a good investment. When in a form and position easy to be realised or transferred it may be a good medium for speculation, but it would take a great deal to persuade the people who arrange those matters that it is, in any form whatever, a suitable trustee stock.

Is it a good investment, for instance, to spend, say, £100 in putting up £1,000 worth of copper wire in 1901, to spend another £50 taking it down again, storing it, advertising it, and finally selling it in 1908 for £500, after paying, let us say, 3½ per cent. per annum, or about £280, for interest on the original loan, leaving, after this magnificent transaction, a balance of £500 of capital, now unrepresented by anything at all, to be a burden on the undertaking for the remainder of the term of the loan? This is a rosy picture, because the usual course is to credit revenue account with the sale of scrap, leaving capital account under the open water tap. This process repeated every six or seven years, the present cycle of the "Rake's Progress," will make a very prickly kind of nest-egg for posterity.

The second fallacy can be demonstrated in a similar manner. If the trolley wire were not a wire subjected to wear and tear, and, as we have seen, to renewal every six or seven years, it would be as economical to put extra weight into it, as everyone acknowledges it is economical to use bare overhead feeders rather than insulated underground mains. But the wear and tear reverse the whole aspect of the question, and it becomes cheaper to put down a large underground cable having an expectation of life of 30 years or more rather than constantly to be re-metamorphosing a finished article into raw material.

I hold, and I confidently believe that I have the sympathy of at least the majority of tramway men in so holding, that the most economical section of trolley wire is the smallest which it is possible to use with safety, both with regard to mechanical strength and current density.

I hardly expect or desire to see 1/0 S.W.G. wire in use again, but I am none the less sure that so far as mere strength is concerned 1/0 wire is good enough, so long as it is suspended correctly. 1/0 wire has borne the burden and the heat of the pioneer decade of electric tramways, and its capabilities have been little short of marvellous.

Racked by trapped trolley booms, sagging to the ground under the weight of fallen trees, delivering through a mere line of contact to a dirty trolley wheel currents rising to 200 amperes, it becomes to the older school almost an object for reverence. Nevertheless its day is nearly past, and its noble attributes have added nothing to the output of the melting pot. Heavier currents demand heavier wire, and 2/0 or even 3/0 S.W.G. are not unnecessarily large, but I stand aghast at the budding use of veritable bars of copper. Use of them, too, against all reason even with the usual non-flexible or nearly inflexible systems of suspension, for it seems that the causes which produce fracture and wear at the points of suspension are rather helped than hindered by the introduction of a less flexible wire. For instance, the rate at which deterioration takes place is raised on lines where, panic struck by the heavy cost of maintaining lighter wires, the authorities have installed very much larger wires. I hope that some men who have made such experiments will contribute their criticisms of this point particularly, as it is a most important one.

Circular section wire has been condemned utterly for some years past solely because it wore and weakened at the ears.

The wire was not at fault because the whole trouble arose from two causes, which we will consider. In the first place the upward pressure of the trolley wheel on the wire, the vibrations transmitted from the car through the trolley pole to the wire, and the vibrations due to wind, keep the wire in a state of almost continual motion, and this is concentrated at every point of suspension, which is very nearly rigid. At these points, therefore, a bending action is set up, and crystallisation results sooner or later. No wire, however ductile, will submit to infinitely continued bending, and hard-drawn copper by no means forms an exception to this rule. A slight skin crack appears generally just under one extremity of the ear, and this develops until a fracture occurs.

Clearly in this case the suspension, not the wire, is at fault. Render it more capable of transmitting freely any vibrations in the wire from one length to another, make it so elastic that the trolley wheel will not be able to bend the wire against it, but will lift it and the wire as a whole, and the process of crystallisation will be spread over a longer period. It is too much to hope that it will vanish altogether.

In the second place actual reduction of the section of the circular wire occurs near the ears whenever the ear itself presents a section larger than the wire to the trolley wheel, and this is almost invariably the case, for very few people have had the courage to attach ears to the top semi-circumference only of the wire and of necessity, therefore, trolley wheels have encountered the obstacle presented by the overlapping lips of the ear, and have run off this at the trailing end with a bump on to the wire. Inevitably this produces a depression at the point of impact. Clearly, therefore, this fault does not lie with the circular wire, which now has had its character cleared.

Why then has the use of circular wire been suspended?

Not because any other section suffers less from vibratory troubles, for if anything they suffer more acutely still, but solely, as it seems to me, because the new sections were designed to enable a non-fouling ear to be used. I use the qualification advisedly, as the ears frequently applied to what is known as grooved wire still protrude into the path of the trolley wheel. Strange as it sounds, a new, and in several respects an inferior, form of wire has been brought into general use because the small castings which formed the medium of attachment between the wire and the suspension (bracket arm or span wire) were injurious to the circular wire, the more serious enemy of the wire being left unscathed. Some attempts, more or less ingenious, were made to introduce non-fouling ears for round wire, but they were not received favourably, or, one is tempted to say, given the attention which some of them certainly deserved. A longer lease of life has been given to overhead equipment since the new sections of wire have become fashionable, but we are far from the highest point which can be reached. The non-fouling ear is one step, but it is the shorter of the two which might have been taken.

Perhaps it is the natural order of things that we should go slowly and take small steps first, but it is at least regrettable in this case either that the problem was not tackled as a whole and both steps surmounted at one leap, or that a better suspension was not secured before the ear was touched, for in the suspension lay the major trouble. A trolley wire suspended in mid-air by some magic means perfectly horizontally, without attachments, yet perfectly rigid throughout its length, is the ideal. Can we get anywhere near that in practice? At least we can improve on what we see all around us, and the means are even now at hand.

Let it be granted, in the first place, that the flexible suspension, of which we have heard and seen so much, is an arrant humbug. Alternatively it is called the "bowstring" suspension, and it is by contemplating the probability of the trolley-wheel pressure being adequate to bend the bow that we arrive at the above postulate. Those who talked and those, of less number, who still talk glibly of the flexibility of the bowstring forget that the strung string cannot move unless the bow bends equally, the bow in question being represented by a few feet of 3 in steel tube. Unless the bowstring be slack, as it rarely is, no more give is obtained than were the trolley wire hanger attached in the old way directly to the arm. In the same way, span wire strung taut between two poles "gives" to the trolley wire only by virtue of the lateral movement, equivalent to bow action, of the poles themselves. Let us be honest, then, and admit that span wires and "bowstrings" on bracket arms provide excellent facilities for doubly or trebly insulating the trolley wires, but have little virtue of flexibility.

We are now in a position to discuss Mr. Pringle's new system of suspension. He has the good fortune to be engineer and manager of a tramway which was built just before the murder of circular wire, and the same things happened in due course to the wire and to the ears as happened everywhere else. He took the trouble to ascertain *why* these things took place, and I believe that he set to work first of all to design a mechanical non-fouling ear for his circular wire. This might have been used widely by now, and, indeed, might have averted the introduction of freakish sections of wire, had it not been borne in upon him most forcibly that crystallisation was even a more important factor in the destruction of wire than the bumping and arcing caused by falling ears. He then sought to combine remedies for both diseases in one system, and has evolved what he calls, very happily, except that the words are rather too long, the tangential suspension system.

Full descriptions of this system have appeared in the technical papers. The main points of the system are :—

1. The use of two or more non-fouling ears soldered to circular wire at each point of suspension.

2. The attachment of these ears to a bracket arm or span wire by a length or lengths of flexible steel stranded wire.

3. The use throughout of one-piece porcelain insulators.

With regard to (1) the system is applicable equally well to any form of wire, and to any form of ear, but it is believed that no one will desire to use anything but circular wire and soldered ears if it can be demonstrated that they are at least not inferior to grooved or figure eight wire and mechanical ears. Mr. Pringle has pointed out that the latter forms of wire are more difficult to erect than the older form, and that trolley wheels do not last so long, while the wire itself wears rapidly towards the centre of the spans, a tendency which was not observed with circular wire. These effects are said to be due to the difficulty of keeping the grooves of the wire horizontal, so that the contact between wheel and wire is reduced, leading to wear of both, on account of increased friction per unit of surface and increased current density.

The two ears, which are similar in appearance to the ordinary anchor ear, are set about 5 ft. on each side of the arm, and the forces which suspend the wire are almost in the same plane as the wire itself, instead of being quite at right angles. The result is that the wire approaches the ideal of a freely floating conductor, instead of being held in a kind of vice at intervals of 120 ft. free to move neither vertically nor laterally at every one of these points, any attempt at free movement being translated into a hingeing action at the ends of the ears, as stated above.

The difference is well seen on a line on which one wire is suspended in the old way, and the other by tangential supports. The waves set up by the trolley wheel in the first are partially damped out at the ear and are partially reflected back, this action continuing until the vibrations cease. Practically nothing of the motion is transmitted to the next length of the wire. On the adjacent wire similar waves are seen to travel with very little impediment over the whole line, and this must mean that any injurious effects which are due to vibration, crystallisation to wit, are spread over the whole of the wire instead of being concentrated in great measure at a few points.

The tangential wire is no more than 4½ in. to 6 in. above the trolley pole at its highest point, and critics have suggested that excessive upward pressure on one span—as, for instance, when four or five cars are "banked"—might raise the live wire into contact with the earthed bracket arm. This was a reasonable criticism, but experiments carried out by Mr. Pringle and by the gentlemen who originated the question have proved that there is nothing to be feared on this account, except in the case where a suspension is situated at the bottom of a depression with the trolley wire on each side forming an angle in a vertical plane. To meet this contingency the suspension is modified with entire success. In this relation it should be remembered that the weight of wire to be lifted by any one trolley is considerably in excess of the upward pressure exerted by the trolley pole springs at the wheel.

It cannot be necessary to refer again to the accumulated proofs that ears may be soldered to trolley wire without damaging the latter, and this being taken for granted it is waste of time to enter on a defence of this procedure in the case before us. Let it suffice to repeat that one of the ears used by Mr. Pringle when soldered to rather less than half the circumference of the wire will not release its grip when it is submitted to a tangential pull which fractures the wire. On the other hand, a comparatively small vertical strain, such as would be applied if a trolley head caught between the tangent wire and the trolley wire is sufficient to peel the ear from the wire.

The last sentence suggests that "traps" are not abolished by the tangential suspension, and reminds me that this point was not overlooked by the critics, who, by the way, have been invariably kindly and reasonable. There is no trap whatever on straight-line work, the tangent wires being in the same vertical plane as the trolley wheel, but the construction at curves undoubtedly introduces this element.

"Traps" have been the bane of tramway engineers ever since the first pull-off or the first junction was erected, and it would be indeed a fatal fault in the tangential system if a dangerous trap were to be introduced at every curve. Wherever the course of the trolley wire departs from the straight track by more than a few degrees the tangent wires can be no longer in the same vertical plane as the trolley wheel, and the special curve fittings have to be used in order that the ears may remain vertical and non-fouling. The triangle formed by the trolley wire as its base and the tangent wires as its sides cants over towards the outside of the curve, the degree of cant depending on the radius of the curve. If a trolley wheel de-wires at the leading ear there is a distinct chance of its flying up into the triangle, with the probability of jamming in the trailing angle. The trolley head immediately pulls the tangent wire downwards, cants the ear over until nearly horizontal and exerts a wedging action between ear and trolley wire which strips the two apart. That sounds forceful and not too good for the equipment generally, but it is really done quite simply and without damage to the wire, as actual experiments made under working conditions have proved.

But I have imagined the worst and proceed to remove the doubts as to the utility of the system which must have assailed you, by saying that traps may be set with much greater impunity on this system than on the system to which you are accustomed. The tangential system is its own safeguard, for it smooths out the old angles which used to deflect the trolley suddenly from its path, and makes the course of the wheel over the worst curves almost as sweet as the passage of the car wheels in the still more perfectly-formed curve of the rails. In fact, then, trolley wheels running on tangentially suspended wires are not subjected to the same temptations to leave the wire as they are with vertical and nearly rigid suspension. That this is so is proved by the experience gathered on a large scale at Burton and Derby. In the latter town, for instance, there has been no record of a trolley de-wiring over 3 miles of double track since the new system was put into use at the end of last year, and at Burton continual trouble arising from trapped trolleys was absolutely cured by the adoption of the tangential system at the worst curves. None but a fool or a liar would assert that this system renders de-wiring impossible, but it is most important to realise that such accidents are reduced both in number and effect by its means.

It would seem at first thought that section insulators must topple over if not held directly to the suspending wire as on the old system, but this is not so, even when the section insulators come at curves. To obtain the necessary insulation, an additional porcelain reel is attached at each end of the tangent wire and the difference between the noiseless run of the wheel under the fitting and the hammering and clattering usually associated with the performance is very marked.

The tangential system permits the expansion and contraction of the trolley wire due to varying temperature, as well as any undue momentary tensile stresses at any part of the wire, to be equalised in a way that is not approachable under present conditions, for the tangent wires pass over the lower reel insulators, and need not be bound to it unless that course is considered advisable. Assume, then, that the trolley wire breaks at some point in a span. On the rigid system the two ends fall to the road, or as near it as they can. On the tangential system the same thing happens, but, in spite of the absence of special anchoring, the wire does not run back to the next section insulator on either side, as the tangent ears cannot get past the suspenders. Every span on each side of the break right back to the nearest anchorage takes up its proportion of the sag due to some 5 ft. of wire being slacked off at the two poles, between which the breakage occurred, and that is all.

If the trolley wire should break between the two tangents of a suspension no further damage should happen, as the wire is anchored securely by the ears themselves. If a tangent ear strips from the wire it flies back 5 ft. or so to the insulator, and is there held, the trolley wire itself being lowered but little, as the sag is distributed as in the case above.

To get rid entirely of composition insulators, which we know under the names of hangers, Brooklyn strains, globe strains, turnbuckles and so on, and to replace all these by one form of insulator, and that a single porcelain real or bobbin, is an incident only of the tangential system, but it is an incident which is an event. For some years this insulator has been used by certain of the more enlightened for secondary insulation, and it has conducted itself admirably under the most trying circumstances, but no success has met the few attempts made previously to substitute porcelain for the composite primary "hanger," and doubts have been expressed as to the wisdom of using an unprotected reel for both purposes on the tangnetial system. There is, or there should be at this time, no question of the mechanical sufficiency of the reel, and a glance at one of the tables in the appendix should go a long way towards setting at rest any doubt of the dielectric strength of the reel. There is no chance of dirt staying long on the glazed and wholly exposed surface in our rainy climate, and there is not a great deal to fear from electrolysis, which, on another occasion, I gave reason to believe is a serious enemy to the ordinary form of insulator.

It is obvious from the fact that every trolley wheel has a perfectly smooth and uniform path provided for it, that sparking is not seen on this system; and it is a point worth noting that the conductivity of that path does not vary, as it does when a wheel passes from the copper trolley wire to the brass ear on those lines where the old form of sweated ear is used with circular wire.

Then, again, the tangential suspension reduces the variation in the height of the trolley wire above the rail, which makes for less oscillation of the trolley boom, and, in consequence, less undulation of the trolley wire. That, and the property which it has of halving the angles of the wire at curves in the track, increase the speed at which cars may be run without risk of de-wiring, a feature which is of no little importance where the trolley wires are not approximately central to the track.

The tangential system can be applied with equal facility to old and new lines, and it is not too much to say that trolley wire which has been anchored and re-anchored until it is about to be condemned, may be preserved for a number of years by the adoption of the new suspension, which not only protects the spots where hingeing, bumping and arcing have weakened the wire, but cures those diseases, and makes a repetition of merely palliative and temporising methods unnecessary.

I have refrained from entering into a detailed description of the various parts of the system, and it only remains for one to add that, in my opinion, a great step has been taken towards providing the means for lightening the financial burden, which would continue under present conditions to increase year by year. The liabilities of the overhead equipment are but small in comparison with the liabilities of the permanent way, but they are both factors in a very grave problem, and no opportunity of covering them ought to be neglected.

It is gratifying to observe how in a few months the advantages of the tangential system have been acknowledged in a practical manner by our tramway managers and engineers, and it is with a particularly keen sense of pleasure that I close these remarks by congratulating Mr. Sheardown, the engineer of our magnificent tramways, upon being in the first flight of those who have made already an extensive experiment with the system. He was not quite the first, but I believe he would have been if he had had the chance.

The Paper is followed by three appendixes. Appendix I. consists of part of Mr. Popplewell's remarks on Mr. Trotter's Paper on the "Construction of Overhead Transmission Lines." (*Proc.* Inst.C.E., Vol. CLXIX.)

APPENDIX II.

Results of tests made by Mr. Pringle to determine the effect of soldering on the life of circular and grooved trolley wire of 000 B. & S. section. Each test piece was 10 in. long, clamped tightly at one end and subjected to a hingeing motion of 1 in. at the end of the length, the speed of the operation being 150 alternations per minute.

Circular Wire.

1. Hard	15,658 alternations.
2. ,,	16,487 ,,
3. Soldered—"blackens paper"*	22,225 ,,
4. ,, ,, ,,	27,634 ,,
5. ,, "lights paper"†	7,838 ,,
6. ,, ,, ,,	5,734 ,,

* "Blackens paper" is a dull red heat.
† "Lights paper" is a bright red heat.

Grooved Wire.

1. Hard	12,045 alternations.
2. ,,	5,894 ,,
3. Soldered—"blackens paper"	8,728 ,,
4. ,, ,, ,,	6,272 ,,
5. ,, "lights paper"	3,021 ,,
6. ,, ,, ,,	3,427 ,,

The figures show that when soldering is performed in the usual manner with the iron at a dull red heat the wire is not depreciated, and, secondly, that round wire is superior to grooved wire.

APPENDIX III.

Results of tests made on the porcelain insulators employed on the tangential suspension system to prove their efficiency under the worst conditions. The first test was made on insulators which had been exposed for 18 months to the weather, and to the dirt and dust inseparable from the adjoining electricity station and gas works.

The second tests show the large factor of safety and small current leakage under severe weather conditions.

Table III.—*Tests on 50 Pairs of Tangential Suspension Insulators at 500 Volts Continuous Current.*

Time.	Weather.	Leakage current.
7:8 p.m.	Fine rain just commencing	Insulation approx. infinity
7:10 ,,	Heavy rain	0·002 ampere
7:12 ,,	Very heavy rain	0·005 ,,
7:13 ,,	Heavy rain	0·002 ,,
7:14 ,,	Light rain	0·0015 ,,
7:16 ,,	Drizzle	0·0015 ,,
7:18 ,,	Drizzle	0·0015 ,,
7:20 ,,	Fine rain	0·001 ,,
7:25 ,,	Rain stopped	0·005 ,,
7:30 ,,	Rain stopped	Insulation approx. infinity

(b) Tests on 50 Pairs of Insulators at 2,000 Volts, Alternating Current.

—	Weather.	Leakage current.
Taken over a period of half an hour	Light rain	0·019 ampere
	,,	0·019 ,,
	Very heavy rain	0·033 ,,
	,, ,,	0·0437 ,,
	Light rain	0·0192 ,,
	Rain stopped	0·0137 ,,
...	One hour later	0·006 ,,

THE FRANCO-BRITISH EXHIBITION.

Never has the electrical engineer in this country had such an opportunity for demonstrating what can be done in the way of effective illumination as is provided by the Franco-British Exhibition at Shepherd's Bush, London, which was opened yesterday by T.R.H. the Prince and Princess of Wales. The Great Exhibition of 1851, which was held in Hyde Park, is often referred to as one of supreme importance, but the present Exhibition (as is only natural) completely dwarfs that earlier effort, and is said to cover no less than eight times the area—*i.e.*, about 200 acres, if the various approaches, &c., are included. Altogether it comprises about 28 palaces and halls, whilst the grounds abound with smaller buildings, all providing an unlimited source of education and pleasure for the visitors who will doubtless congregate there daily from all parts of the globe, notwithstanding the fact that the Exhibition is entirely devoted to the industries and products of two countries and their respective colonies.

Since the success of the Exhibition will depend so largely on its accessibility from all parts of the metropolis, it is gratifying to notice the great efforts which have been made by the various railways and tramways to deal with the expected unprecedented traffic. The Central London Railway have extended their line from the Shepherd's Bush terminus to a station in Wood-lane adjacent to the main entrance of the Exhibition, as will be noticed in Fig. 1, which shows a plan of the grounds, whilst the Hammersmith & City Railway have erected a special station at the very edge of the Exhibition grounds. The London County Council are busy completing a route in Wood-lane on the overhead system, which will bring passengers from the Harlesden and Harrow-road districts, and the London United Tramways (Ltd.) provide access, from an extensive area in the west and south-west, to Uxbridge-road, from which a special covered approach has been constructed leading into the Exhibition grounds. It is expected that these railways and tramways will be able to convey about 70,000 passengers per hour, if necessary, so it is evident that the transport facilities leave little to be desired, particularly if allowance is made for the motor omnibuses and other vehicles which will congregate round that area now that the Exhibition has opened.

Fears have from time to time been expressed that electricity would be somewhat under a cloud, and we were, therefore pleased to see that electric lighting is conspicuous in all parts; in fact, less than a week ago we had difficulty in finding any traces of gas lighting, and it was very gratifying to observe that practically the whole of the exterior lighting of the buildings and the illumination of the grounds is by electricity, whilst arc lamps also play the most prominent part as regards the interior lighting of halls and palaces. The general public can scarcely fail to realise to what a great extent the success of the Exhibition, from a spectacular point of view, is due to the adoption of electrical fittings. There is certainly

little doubt that never before has there been such an extensive system of decorative lighting of buildings in this country, and when it is known that the lamps employed for decorative purposes on most of the buildings run into many thousands, there need be little surprise that it is claimed that, from some positions, as many as 100,000 electric lamps may be seen illuminated at the same time.

These figures, of course, give only a very indefinite idea of the electric power required, but it will be obvious that the maximum demand will far exceed that of most provincial towns, and it is very fortunate that this demand will occur during the summer months, when the plant of the supply authorities concerned is usually but lightly loaded.

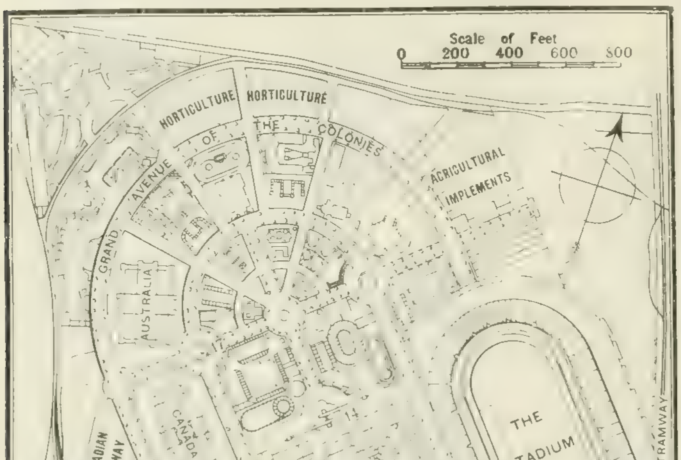


Fig. 1. Plan of the Franco-British Exhibition.

Arrangements have been made for obtaining a supply of nearly 3,000 kw. from external sources, whilst generating plant installed by the Exhibition authorities will provide a few thousand kilowatts, and numbers of private plants have been erected, to which reference will be made later.

The Exhibition lies in the area controlled by the Hammersmith Borough Council, with whom all arrangements for a supply of electrical energy have been made. Three feeders have been laid from the Council's electricity works in Fulham Palace road, and also from the generating station of the Notting Hill & Kensington Electric Supply Co., whose works are adjacent to the Exhibition in Wood-lane. In the latter case, however, the company are sub contractors to the Hammersmith Council, who have found it convenient to obtain in this manner half the supply demanded. It is interesting to learn that the price being paid by the Exhibition authorities for the supply of current is 1d. per unit from sunrise to sunset, and 2d. per unit from sunset to sunrise, with a guaranteed minimum payment of £10,000, whilst the Hammersmith Council obtain current from the Notting Hill & Kensington Company at 0·8d. per unit for a guaranteed minimum consumption of 1,000,000 units, and 0·75d. for all units supplied after this amount.

The current supplied from the Hammersmith Council's generating station is single phase, at 2,200 volts and 50 periods, and that obtained from the Notting Hill and Kensington Company is three phase, at 5,000 volts and a frequency of from 45 to 50 cycles per second, the value expected being about 46½. The feeders from these works, consisting of three 0·25 sq. in. concentric lead-covered cables in the case of the single-phase supply, and of 0·125 sq. in. three-core cables for the three-phase supply, are laid in 3½in. earthenware ducts, and we are informed that the Hammersmith Council arranged for the London County Council to lay these ducts at the same time as the latter body were laying mains in Wood-lane in connection with the tramways. In this way considerable expense was saved, due to one opening of the ground only being necessary, to say nothing of less inconvenience to traffic. This co-operation between the two Councils deserves more than passing notice.

A small sub-station, containing a 100 kw. transformer, has been fitted up near the Exhibition entrance in Uxbridge-road, but the main feeders run to a sub-station near the Wood-lane entrance to the Exhibition as indicated by "A" on the accompanying plan (Fig. 1). From this sub-station feeders also run as indicated by the dotted line in Fig. 1 to a sub-station adjacent to the Machinery Hall and marked "B" on the plan. Each of these two sub-stations is divided into two sections, for single-phase and three-phase supply respectively, and are constructed in a permanent manner, since it is expected that they will be in use for possibly 10 years. The high-tension switchboards are in all cases of Messrs. Cowans' manufacture, and are fitted with that firm's well-known high-tension oil circuit-breakers with Andrews' discriminating release, the only instruments fixed being one Everett Edgcumbe ammeter on each feeder. By arrangement with the Exhibition authorities the current is metered at the entrance to the grounds, and Siemens' double tariff meters are fixed in sub-station "A." These meters have to be read twice daily—at sunset and sunrise as given by Whitaker's Almanack—by representatives of the Hammersmith Council and the Exhibition authorities.

The low-tension boards have been supplied by the Universal Electrical Mfg. Co. (London agent, Mr. Brittain) and serve to control the various distributing circuits. The capacity of the largest switch on the six boards supplied by this firm is 3,000 amps., and the smallest 200 amps., the total capacity of all the switches on the above boards being about 30,000 amps. A view of one of these low-tension switchboards is given in Fig. 2. The main 'bus bars are fixed in front of the switchboard, whilst the earthed 'bus bar is placed behind. In all cases the low-tension 'bus bars are arranged in sections, connected by switch fuses, so that any section can easily be isolated, if necessary. The switches are of standard type with easily renewable flickers and sparking contacts, whilst the switch fuses are of the shunted type, no porcelain being used on the whole of the boards. The fuses themselves are of tin strip in parallel with 25 ampere enclosed dust fuses. We may mention as an instance of smart delivery, that the order for the first four switchboards was received by The Universal Electrical Mfg. Co. on the afternoon of February 26th, and the boards were ready for delivery on March 28th, notwithstanding the fact that the boards had to be specially designed, all the work being carried out in the above firm's shops. The specification and design for all these boards were got out by Messrs. W. B. Esson and A. W. Money.

For reducing the pressure of supply, Berry transformers, manufactured by the British Electric Transformer Co., of Hayes, are used. In the case of the single-phase supply, the transformation is from 2,200 to 440 volts, and a tapping is taken from the centre of the transformer winding, so that a three wire supply at 220 volts is obtained, the neutral wire being earthed at the sub-stations. In the case of the three phase supply three 220 volt circuits are obtained to the neutral point of a "star" arrangement.

Three 200 kw. Berry transformers are installed in both the single-phase and three phase sections of sub-station "A"; but, as these transformers were not designed specially for the purpose of the Exhibition supply, it has been found necessary in some cases to instal also small booster transformers to raise the pressure by 12 volts. In sub-station "B," adjacent to the Machinery Hall, in addition to three 200 kw. single-phase transformers for yielding a low-tension alternating-current supply, a 150 kw. General Electric Co.'s motor generator is installed, consisting of an induction motor, with slip rings and a liquid rheostat for starting purposes, and a 500 volt continuous-current dynamo with interpoles. The liquid rheostat, the main switches for the motor generator and the switchboard controlling the supply from this machine and that from the 500 k.w. direct-current plant in the Machinery Hall, referred to hereafter, are seen in Fig. 3. In addition to two 250 kw. transformers, two 400 kw. Bruce Peebles–La Cour Cascade motor converters are also installed in the three-phase section of this substation for delivering continuous current at 500 volts. The main switches, for the converters and motor generator, which are of a reverse-current type, are fixed on separate switchboards manufactured by Messrs. Cowans.

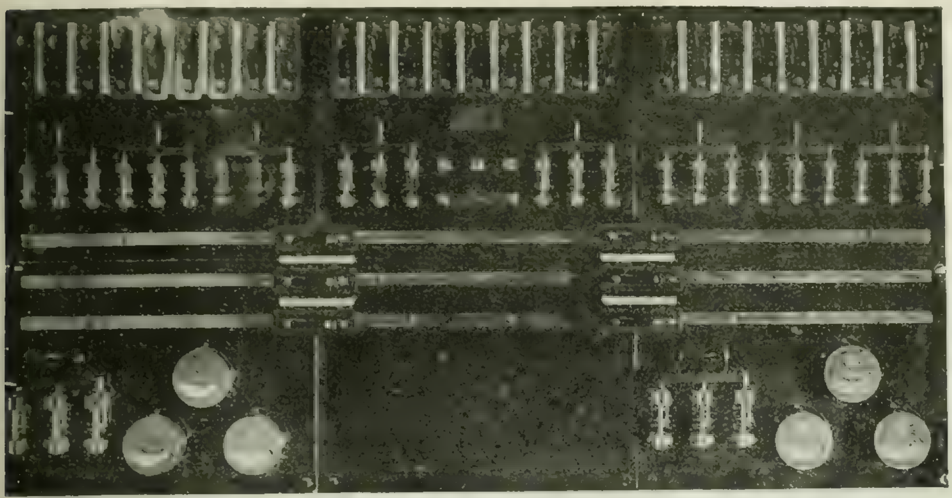


Fig. 2.—Low tension Three phase Switchboard at Substation "A."

It was originally intended to keep one converter as a spare, but owing to the enormous demand for current, it is expected that it will be necessary to make use of both. Although all these machines have been installed by the Hammersmith Council so as to deliver continuous current, it was arranged that the energy should be metered on the high-tension side in the previously described sub-station at the Wood-lane entrance to the Exhibition. As the Council supply the continuous current at only 500 volts, the Exhibition authorities have installed a 25 kw. motor balancer, manufactured by Messrs. Laurence, Scott & Co., to deal with 100 amperes out of balance current, and maintain 250 volts on each side of a three-wire continuous-current system.

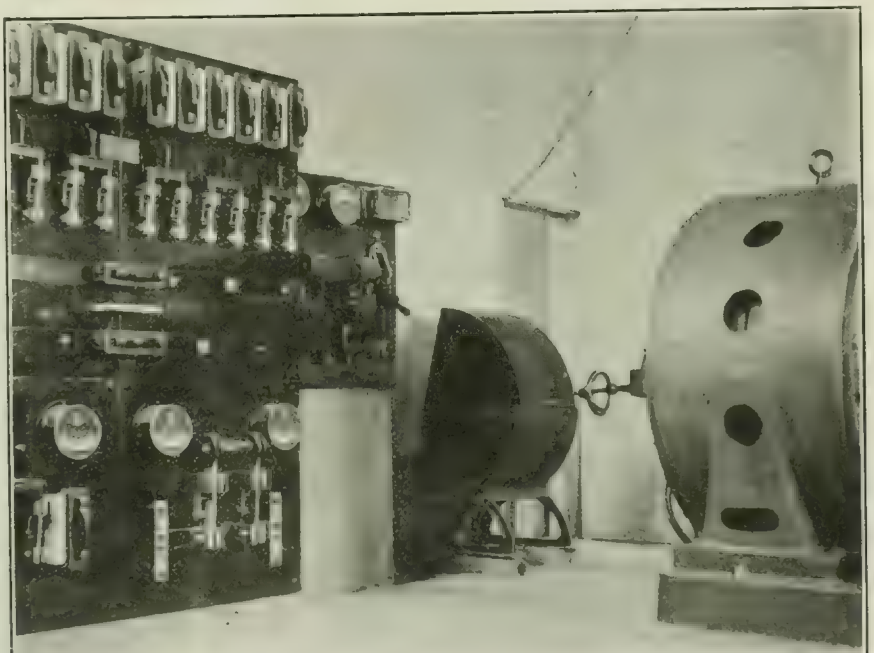


Fig. 3.—View in Single-Phase Substation, showing the Switchboard for the 500kw. Generating Plant and Small Switchboard for G.E.C. Induction Motor.

In this sub-station are also erected the switchboards manufactured by The Universal Electrical Mfg. Co. for controlling the supply from the generating plant installed in the Machinery Hall. As it is intended to run this plant in parallel with the external supply, arrangements are made on these switchboards for paralleling the two sources of current through switch fuses. The present arrangement is to run the generating plant only during the evening, the external supply alone being used at other times, and as large refrigerating plants, &c., are installed, it is expected that a considerable load will be required at all periods, so that a very good load-factor should be obtained by the Hammersmith electricity supply station. These switchboards are constructed in a similar manner to those previously described, except that the circuits are connected together by heavy copper links instead of switch fuses.

It will be seen from what has been said above that single phase, three phase and continuous currents are supplied from the sub-stations. For the external decorative lighting of the buildings continuous current is in all cases used, whilst the arc lighting is mainly carried out from the alternating-current supplies, careful attention being paid to the balancing, as far as possible, of the various circuits in connection with the 3-phase supply.

As regards the wiring of the buildings, &c., this has been carried out by a large number of contractors, who have been engaged for many months in this by no means easy task. The firms mainly concerned are as follows:—

Armstrong, Power & Co.	W. J. Furse & Co.
H. J. Cash & Co.	Hampton & Sons.
Wm. Coates & Son.	Geo. Hopkins & Sons.
S. G. Cozens.	Shalders & Davis.
J. Defries & Sons.	Stegmann & Co.
The Electrical Co.	

A considerable amount (approximately 250 lamps) of the arc lighting in the grounds—namely, all that in the Court of Honour section—has been carried out by S. G. Cozens, 63, Queen Victoria-street, London, E.C., the arc lamps employed being of the Maxim enclosed pattern for alternating current, wired two in series for 220 volt circuits. Some of these lamps are seen in Fig. 4. The conduit system for these exterior lamps is heavy gauge screwed tube throughout, and each circuit of four lamps is run back to the distributing centre. Circular

screwed draw-in junction boxes of a special heavy pattern with recessed watertight lids are used for all underground work, the covers being packed with red lead and securely fastened with six bolts to each box. The conduit is generally laid in the ground at a depth of 2 ft. to 2 ft. 6 in., and we are informed that the above firm installed 17,000 ft of conduit and 700 junction boxes before any cable was drawn in. The cable employed for external use is 7/20 S.W.G., with a special rubber dielectric of 2mm. thickness, and about 12 miles of this cable has been used in connection with the arc lamps installed by S. G. Cozens.

Fig. 4. View in the Court of Honour Section, showing part of the Installation carried out by S. G. Cozens.

It is interesting to learn that during a period of three days over 9 miles of cable were drawn into these conduits, and on a test being taken only one fault was located, this being caused by a bad burr in one of the cast-iron arc-lamp bases. These arc lamp standards have been supplied by the Exhibition authorities and have been erected by the contractors. This firm has also erected 150 "Santoni" flame arc

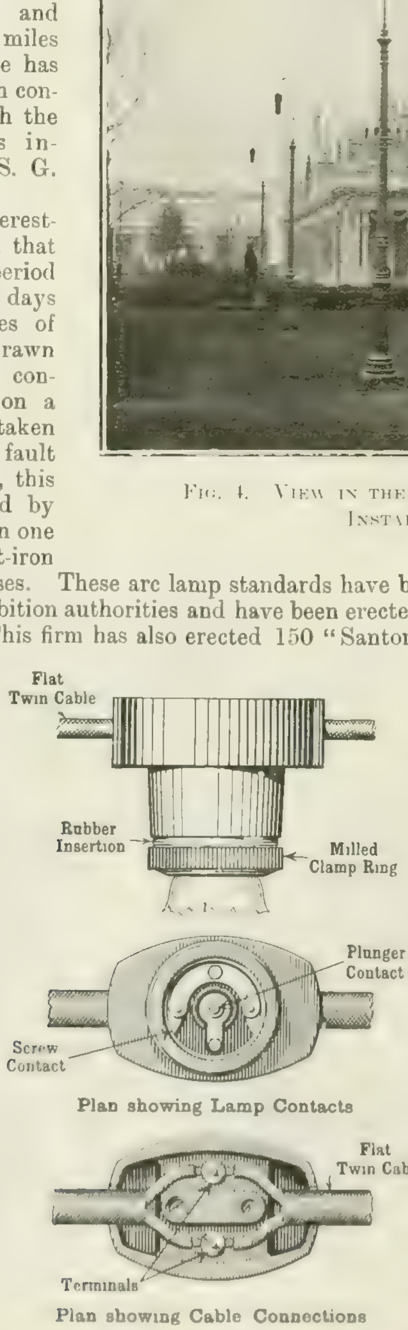


Fig. 5. Diagrams showing the Methods of attaching Lampholders on the "Fairyland" System.

lamps for the interior lighting of the buildings in the Court of Honour section, the lamps being wired four in series on 220 volts alternating current circuits and fitted with substitutional resistances. To comply with the L.C.C. requirements every arc lamp is suspended in duplicate, so that in the event of one suspension being detached or broken the lamps would still be suspended by a seven-strand galvanised iron wire sling. For the interior arc-lamp wiring, 7/20 S.W.G. cables of 600 megohm grade are used, the leads being attached to the tie rods and girders by means of porcelain insulators securely fastened to karri wood, the karri wood being bolted to the ironwork by galvanised iron hook bolts; for the interior lighting of this Court of Honour section approximately 7 miles of cable have been used. The incandescent lighting carried out by S. G. Cozens comprises 5,000 lamps in the Decorative Arts Palace, 2,000 lamps in the Louis XV. Pavilion, 3,000 lamps in the Palace of French Applied Arts; 500 lamps for the Indian Court Kiosks and permanent logia lighting on various buildings and also 150 incandescent lamps and 16 arc lamps in the administrative offices of the Exhibition.

The major portion of the exterior incandescent lighting is carried out on the patent "Fairyland" system of the Imperial Lighting Co., Gate-street, Holborn, W.C. In this system a special twin rubber-covered cable is used, to which special lampholders are fixed about every 12 in. These lampholders are of a special watertight pattern, and are connected, as seen

Fig. 6. View in Passage leading to Uxbridge Road.

in Fig. 5, without cutting the conductors, so that a bad contact only affects the lampholder in question. As the lamp contacts are watertight, the lamps can be fixed vertically or in any position, which is, of course, a great convenience for external lighting; also no metallic parts are exposed to the atmosphere.

The back of the lampholder, where the connections to the terminals are made, is sealed with special compound so that all moisture is absolutely excluded. The strip just mentioned is fed in the centre of a 200 lamp length, each 200 lamps of 5 c.p constituting one circuit, the complete circuits being run to a distributing centre, where they are separately controlled by a "Berry Skinner" ironclad push-and-pull D.P. switch and fuse. Upwards of 20 miles of this strip have been used for the decorative lighting of the buildings; this strip can be seen in Fig. 4. We understand that something like 100,000 lights have been affixed to the various Exhibition buildings, and in each case the "Fairyland" system is employed. The Imperial Lighting Co. also adapt their patent holder for use with bayonet socket lamps, and this pattern is suitable for interior lighting. To comply with the rules of the insurance companies, the back of the holder is fitted with a metal plate which was introduced with the idea of preventing a fire starting in case of short-circuit. This holder is not watertight but is very effective for interior work

Undoubtedly, one of the most difficult pieces of wiring was in connection with figures holding lights on the top of the towers of the British Applied Arts Palace. One of these figures holds a 100 c.p. lamp, and the other 24 16 c.p. lamps round a wheel, and an idea of the labour involved in installing these lamps may be gathered from the fact that the cost of this wiring was £20. However, notwithstanding the fact that the decorative lighting of the various buildings involved many risks to those concerned, it is gratifying to learn that only one accident, and that of a minor character, occurred on the staff of S. G. Cozens, who had a large number of men engaged in this work.

The Stadium will undoubtedly prove one of the greatest attractions at the Exhibition. Its artificial lighting has been carried out by Messrs. Shalders & Davis by means of 114 "Santoni" flame arc lamps and 32 "Maxim" enclosed ditto, the wiring for same being 600 and 2,500 megohm grade cable run on insulators and clips securely fixed to the girders on the underside of the Stadium, all wiring in exposed positions being carried in iron tubes. The switchboards are four in number, two for the flame arcs and two for the enclosed, each switch being double pole and encased in a cast-iron box. The wiring is arranged so that the lamps are controlled alternately, and the failure of a single fuse would not seriously affect the general lighting. The lamps fitted at the exits are also independently controlled.

Mention has already been made of the covered passage leading from Uxbridge-road to the Exhibition; this passage has been lighted throughout the whole length by nearly 400 "Sunshine" flame arc lamps, which have been supplied and erected by the Electrical Co. The wiring for the lamps is run on porcelain insulators fixed near the roof, and as the arrangement is very simple, we need not comment further with regard to it. A view showing some of the arc lamps in this passage is given in Fig. 6.

Messrs. Stegmann & Co. have just completed the exterior illumination of the Grand Restaurant, one of the principal buildings in the Exhibition. The number of lamps fitted for decorative purposes is nearly 5,000, and these are controlled in groups of between 150 and 200 lamps by double-pole fuses and switches, all ironclad, the corresponding lines of lamps at each end of the building being switched on together. The amount of cable used is approximately 5 miles, and china cleats and insulated staples have been absorbed by the thousand.

We propose to describe other points of interest in connection with the wiring, and also the various exhibits, in our next issue.

(*To be continued.*)

Single-Phase Traction in America.—The *Street Railway Journal* gives a short description of a new single-phase railway between York and Hanover, a distance of about 18½ miles. Three-phase current is supplied by a private company at 2,300 volts and a frequency of 60, but is transformed to 6,600 volts and a frequency of 25 in a special sub-station whence it feeds the trolley wire. The cars are fitted with four 75 H.P. motors and with both trolley and pantagraph collector.

ELECTRICAL INSTALLATION AT TRIBLEY PIT.

The introduction of electricity for colliery purposes is proceeding with considerable vigour in the north-east area of England, due largely to the facilities offered by the widely extended network of the County of Durham Electrical Power Distribution Co. One of the most interesting examples of this movement is to be found in the Tribley Pit, which is within 1½ miles of the well-known Pelton Collieries, and belongs to the same owners.

It was at first intended to equip this new pit with steam-driven plant, but fortunately arrangements were made enabling the change-over to be effected before a considerable amount of work had been done. The installation at present consists of a winding gear supplied through an Ilgner converter set, a surface haulage gear for transporting tubs of coal from the new pit head to the old colliery at Pelton, an electrically driven fan for providing ventilation in the mine and a certain amount of lighting on the surface and in the workings. There is, further, in working order, an underground haulage along one of the main roads, although in two or three directions the work of bringing the coal tubs to the pit shaft is accomplished by means of gravity owing to the natural dip of the seam.

A pump is also to be installed for dealing with any water that may prove troublesome in the mine, although at the present time, owing to the geological formation of the ground, there is not much trouble. The mine shaft passes first of all through 7 fathoms of dry sand, then through 2 ft. of running sand, again through 3 fathoms of boulder clay and then into the shales above the five quarter main seam of coal, the total depth of the shaft being 22 fathoms. Water is found, but it percolates through the strata underneath the present workings into lower seams through which it penetrates to the lower level workings of the older mine, and is then pumped out. Provision, however, has to be made for any accession of water, and a motor-driven pump of a capacity of 250 gallons per minute operating against a head of 170 ft. is being installed.

There is also a small haulage to be installed for carrying waste stone to the refuse tip. The most important and interesting part of the equipment to electrical engineers is, however, the installation of the Ilgner converter set. This, together with the greater part of the electrical equipment of the mine, has been supplied by the Electrical Co., Newcastle branch (A.E.G., Berlin), and has resulted in a most remarkable steadying of the demand upon the electricity network. The converter set (Fig. 1) consists of two main machines direct coupled, one being an alternating current, 440 volt, three-phase motor, running at a synchronous speed of 1,200 revs. per min. At a full load of 55 H.P. it takes 65 amperes, and the average speed of rotation is about 1,100 revolutions. The dynamo to which this is coupled is of the interpole type, and is capable of giving a voltage ranging from zero to 300 and an amperage of 167. It is constructed to run at 995 to 1,130 revs. per min., and to give a continuous output of 50 kw. without exceeding heating or sparking limits. At the outer end of the shaft is mounted the exciter for the field of the direct-current machine, and the whole of the control of the winding motor is regulated by the strength of excitation given to the dynamo of the Ilgner set. This reduces the amount of switchgear necessary to a very inexpensive and compact arrangement, and involves a considerable saving of capital cost. The other end of the shaft is finished by means of a half-coupling, which is secured to a similar half-coupling on the flywheel of the set, giving the necessary kinetic energy to overcome the fluctuations in the power required for winding purposes by means of a special flexible device, which is worthy of attention. The usual bolts which are employed to secure such half-couplings together are replaced by means of cylinders of compressed leather, roughly 1¼ in. in diameter and 4 in. long; six of these lie with one-half of their length in one coupling and half in the other, and are held in position by means of the pressure of the spiral springs against their free ends. This flexible arrangement is at once both simple and very strong, and gives the necessary freedom on the plant to avoid undue strains along the shaft

due to the sudden and extensive torques on the direct-current generator.

The flywheel which supplies the kinetic energy weighs 900 kg., and has a diameter of 4 ft. 11 in. When revolving at 1,200 revs. per min. it will, therefore, be seen that the stored energy is considerable. The time required to start the set up from rest and bring it to practically full synchronous speed is about two minutes, and a brake gear is fitted to the set for the purpose of bringing it quickly to a standstill when shutting down. That this is necessary is evidenced by the fact that on the test it took 26 minutes for the set to come to rest when running free.

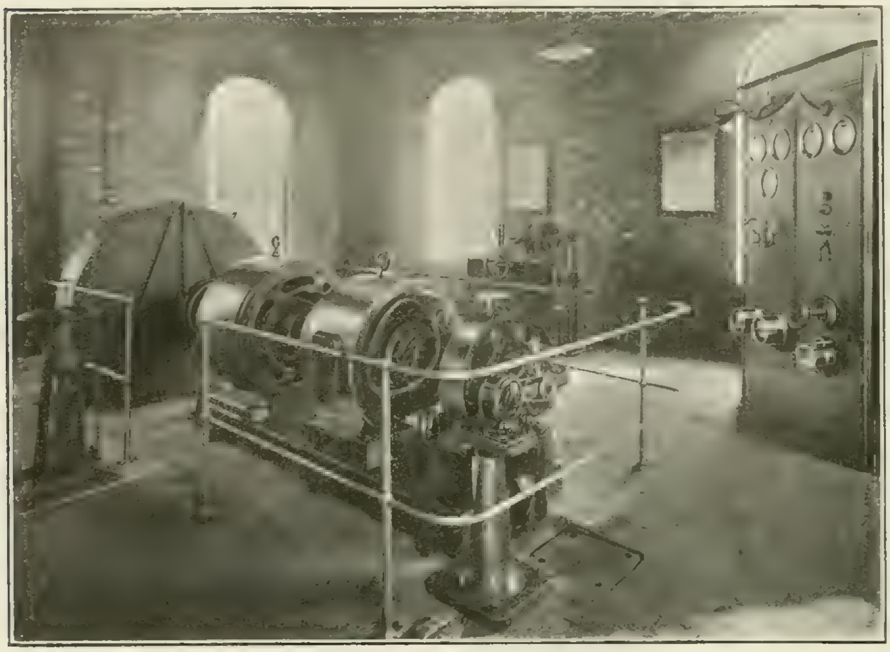


FIG. 1.—VIEW OF ILGNER SET.

The winding gear (Fig. 2) consists of a single drum winder 8 ft. in diameter, geared to a direct-current shunt-wound motor of the Electrical Co.'s manufacture, designed to carry 167 amperes at a voltage of zero to 300 volts. It is a 12-pole shunt-wound machine, with field coils specially arranged in sections, so as to give large heat radiating area; when taking full current it develops 60 H.P. There is no regulating resistance in the field of this motor, and the Ilgner set generator and this motor are connected up solidly together by means of cable with only an overload circuit-breaker in series. The duty of the winder is to lift 800 tons of coal per shift of eight hours, or rather, it has to draw that amount of coal in seven hours, and to allow one hour for changing men. As a matter of fact, it is at present running from 4 a.m. to 11 p.m. each day. The same speed is maintained on the lift for men and trucks, and the average time of wind is 20 seconds. The winding shaft being 11 ft. 6 in. in diameter permits of two ordinary tubs in each cage, each tub containing 10 cwt. The gross weight, including the weight of the cage, is, therefore, something in the nature of 4 tons. The very slight effect which is noted on the supply system when the magnitude of the tractive effort put on the plant is taken into consideration is a very strong testimony of the steadying efficiency of the Ilgner set.

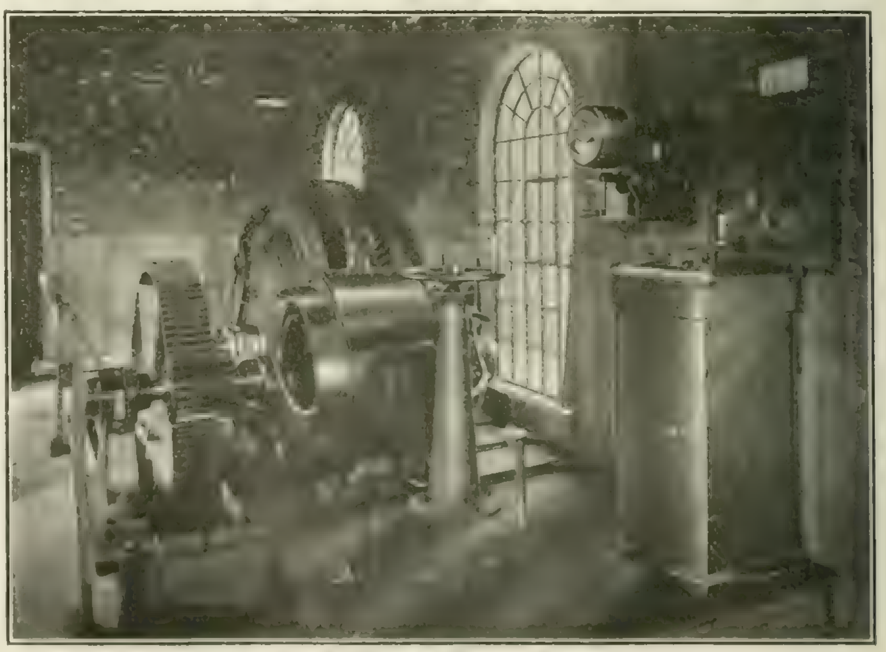


FIG. 2.—VIEW OF WINDING MOTOR.

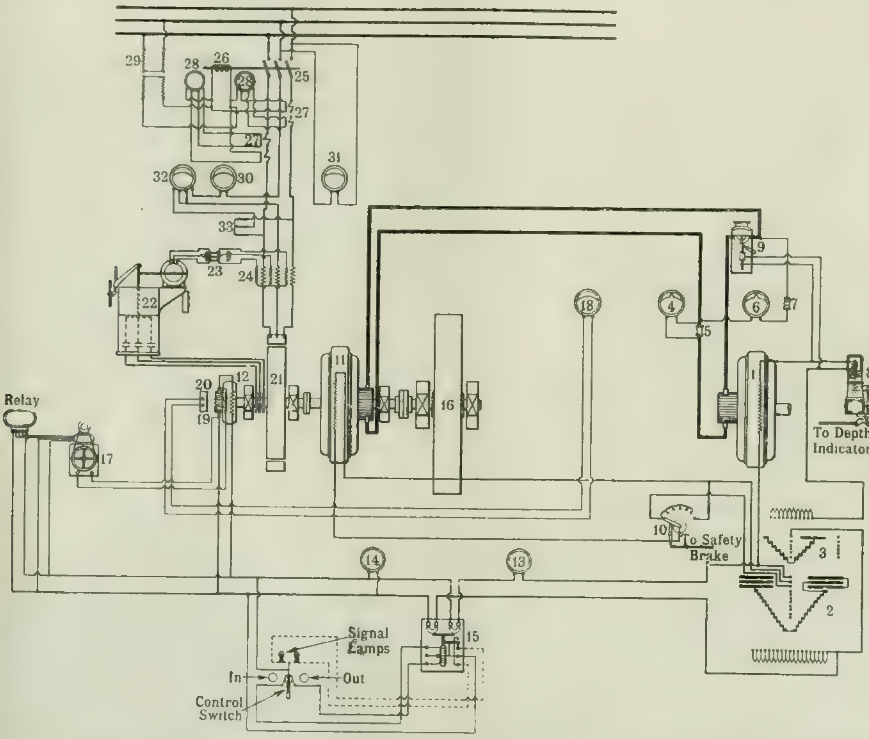
The method by which this closeness of regulation is obtained is by means of a slip regulator placed in series with the stator of the Ilgner set motor. This slip regulator consists of a liquid resistance in each phase of the supply, the position of whose moveable plates is determined by the balance of what is virtually a torque dynamometer. This consists of a squirrel-cage induction motor giving 1·4 kg.-metres when taking 3·8 amperes and 190 volts, whose spindle is attached to an arm on which depends the gear holding the moveable electrodes of the liquid resistance. Adjustment is made by means of counterweights. Should the current through the stator of the squirrel-cage motor exceed a specified amount it operates against the weight of the electrodes and raises them, thereby inserting resistance in the stator circuit of the motor. The current passing through the squirrel-cage dynamometer is at all times proportional to the energy passing through the motor of the Ilgner set. It follows, therefore, that directly the demand on this motor becomes excessive its speed and output are dropped by the insertion of stator resistance and an opportunity is given to the flywheel to take up the work by giving out its stored energy. In this way a consistent balance is kept up between the demand of the winder motor, the stored energy of the fly-wheel and the demand on the mains.

The switchboard, which is also supplied by the Electrical Co., presents as its chief feature of interest the method by which the winding motor is started and stopped by means of long distance control on the exciter circuit. This will be seen by examination of the diagram of connections (Fig. 3). In order to keep the voltage of the exciter constant at 110 with the varying speeds of the Ilgner set, the shunt regulator is operated by means of a small motor actuated by relays. As the speed of the Ilgner set rises resistance is put into the field, and, therefore, at any speed of the Ilgner set the position of the controller in the hands of the engine man corresponds to the fixed excitation passing to the generator of the Ilgner set.

As far as the main current is concerned 110 volt mains pass from the switchboard to isolated switches (opened by hand

when required by means of an insulated pole) on each phase. The current then passes through current transformers and relay coils to a 100 ampere high-tension main switch immersed in oil. It then passes through the series measuring transformers of 1·25 kw. capacity to the stator of the Ilgner set. The current transformers are utilised in connection with the slip regulator transformer by means of which resistance is inserted in the stator.

course, in proportion to the speed. He is also given two other dials, showing the voltage on the winding motor and the amperes taken by it. By this means he can at all times tell when he is putting too heavy a strain either upon the motor itself or upon the Ilgner set. The braking of the winder is effected mechanically by means of a foot brake, but there are connected with the indicator of the cages contacts which operate an electric brake for the prevention of over-winding.



1. Winder Motor.
2. Controller (Field Regulator).
3. Field Switch.
4. Winder Ammeter.
5. Winder Ammeter Shunt.
6. Winder Voltmeter.
7. Winder Voltmeter Resistance.
8. Brake Magnet.
9. Maximum Cut out.
10. Field Breaking Switch.
11. Generator.
12. Exciter.
13. Exciter Ammetor.
14. Exciter Voltmeter.
15. Max. Automatic Field Break Switch for distant control.
16. Flywheel.
17. Automatic Field Regulator.
18. Speed Indicator.
19. Speed Indicator Dynamo.
20. Centrifugal Switch for 19.
21. Three-phase Motor
22. Starter and Slip Regulator.
23. Short-circuiting Switch.
24. Transformer for Starter and Slip Regulator.
25. Three-pole Oil-switch.
26. Max. Cut-out Coil for three-pole Oil-switch.
27. Current Transformer.
28. Relays.
29. Transformer.
30. Three-phase Motor Ammeter.
31. Three-phase Motor Voltmeter.
32. Three phase Motor Wattmeter.
33. Neutral Point.

FIG. 3.—DIAGRAM OF CONNECTIONS FOR ELECTRIC WINDER ON THE ILGNER SYSTEM.

The Ilgner set is started by raising the plates of the slip regulator as high as possible, closing the main switch of the motor and lowering the plates gradually into a solution of caustic potash, which is kept cool by means of water circulation in the tanks. Should the rate of lowering be too rapid

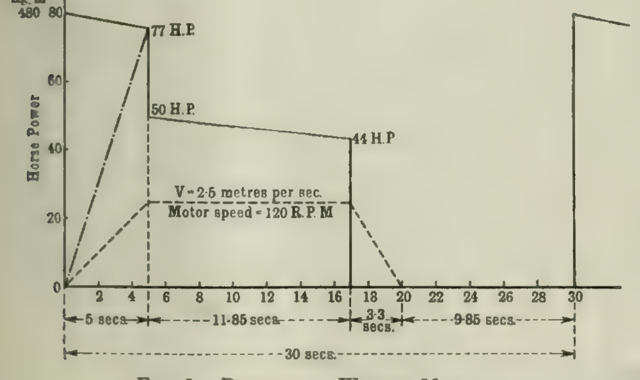


FIG. 4.—DIAGRAM OF WINDER MOTOR.

Net Load=21 cwt. Depth of Shaft=132 ft. Output=120 Tons per Hour.

the torque dynamometer comes into action and lifts the plates slightly to give the motor time to get up speed.

Coupled by means of a small belt to the main shaft of the Ilgner set is a very small dynamo for the purpose of giving pressure to a voltmeter in the winding house, which virtually intimates to the man in charge of the winder the speed of the Ilgner set, inasmuch as the volts generated are, of

Figs. 4 and 5 show typical winding diagrams obtained on the winder motor.

The ventilation of the pit is effected by means of a single inlet Sirocco fan, 8 ft. 6 in. in diameter, capable of giving 40,000 cubic ft. of air per minute when running at a speed of 465 revs. per min., at a pressure corresponding to 2½ in. water gauge, or 25,000 cubic ft. when running at 227 revs. per min. This fan is belt-connected to a British Thomson-Houston two-speed motor, taking 34½ amperes and giving 25 H.P. at the higher speed, and 24·5 amperes and giving 12½ H.P. at the lower speed.

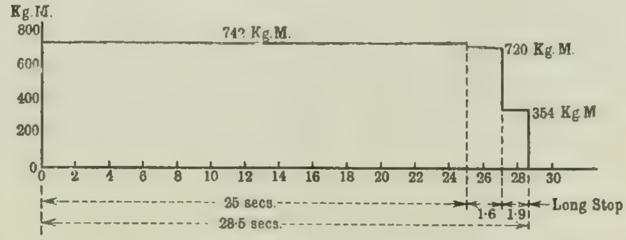


FIG. 5.—DIAGRAM OF MAXIMUM OCCASIONAL OVERLOAD.

The surface haulage of the tubs obtained from Tribley Pit is along a length of 1¼ miles (the endless rope drive producing a total length of 2½ miles.) The tubs are run in sets of three at every 60 yds. along the rope, and each tub contains 10 cwt. of coal when full, the weight of the tub itself being 5 cwt. For 200 yds. from the Tribley Pit there is a rise in gradient of 6 in., but beyond this point the gradient is down, until the drop from

Tribley to Pelton is 70 ft. The rope moves at a rate of $2\frac{1}{2}$ miles per hour, and a 60 H.P. three-phase motor of the Electrical Co.'s manufacture is installed to drive this gear, running at 575 revs. per min. and taking 70 amperes at 440 volts.

The haulage in the underground workings, mentioned previously, is accomplished by means of a 12 H.P. Electrical Co.'s motor, running at 770 revs. per min. and taking 16·7 amperes at 440 volts, operating through a gearing on a single drum 2 ft. 6 ft. diameter horizontal type winder, which will run at a speed of 20 yds. per minute on the rope. The starting gear for this underground haulage plant consists of a combination of three-pole switch fuses and an ammeter, totally enclosed in a cast-iron case of a special design made by the Electrical Co. The fuses are of the screw-socket type, and, in order to prevent fuses of different capacities being interchangeable, the sockets for each capacity of fuse are of a different size. On the cover is a lock, operated by means of a key which cannot be inserted while the switch is in. Moreover, the switch must be opened in the process of locking up the case, as otherwise it is impossible to take the key out. In this way there is no danger of unauthorised persons tampering with the electrical equipment, and all gear likely to come in contact with explosive gases are hermetically sealed when in operation.

The main distributing board for the lighting circuits is placed in the winding house. The installation at present consists of 25 16 c.p. lamps, which number will shortly be doubled. The supply of the whole installation is effected by means of a static transformer supply station at present of 300 kw. capacity, erected by the County of Durham Electrical Power Distribution Co. on the land adjacent to the colliery, in which their pressure of 6,000 volts on the overhead transmission is reduced to a working pressure for the pit of 440 volts at a frequency of 40 cycles per second.

The main switchboard for the colliery installation, manufactured by Messrs. Reyrolle & Co., of Hebburn-on-Tyne, is of polished slate mounted in angle iron framing, and comprises a separate panel for each of the following circuits—winding, haulage, ventilating, pumping and lighting. Each panel is furnished with an oil-break switch, fuses of the tubular type, and an ammeter. The switchboard is placed in a compartment specially set apart for it in the transforming station. From each panel the circuits are carried by means of bare overhead wires to the various motors, and in the case of the underground circuit the overhead wires are carried to the top of the shaft, where they are jointed to a three-core paper lead-covered and armoured cable for transmitting power to the underground plant.

A NEW ELECTRIC LOCOMOTIVE.

BY A. C. KELLY.

Electric locomotives for slow-speed haulage on mineral railways, and for use in other places where large tractive efforts are required at moderate speeds, have hitherto been constructed more or less on the lines of tramway practice, that is, with direct-current motors geared by single-reduction gearing to the driving axles. When, as is usually the case, these locomotives have to run on narrow gauges, the difficulties of making a really satisfactory locomotive are considerably increased, since the space available for the motors between the wheels becomes very restricted.

The locomotive shown in the illustration has been designed especially for use on a 30 in. gauge mineral railway. It contains a single direct-current, series-wound motor geared, by double reduction gearing, to a countershaft placed between the axles. Both the countershaft and the axles are provided with crank discs, and the former drives the latter by coupling rods. The principal advantages of this construction are as follows:

1. By the use of double reduction gearing the motor may be run at conveniently high speeds, whilst the speed of the locomotive is kept within the ordinary requirements of this class of work.

2. The electrical equipment being placed on the deck of the locomotive is accessible from all sides and can overhang the wheels of the locomotive. This permits far larger motors to be used than has hitherto been possible.

3. The whole of the locomotive, with the exception of the wheels and axles only, is completely spring supported. This ensures easy riding even on light permanent way.

4. The centre of gravity of the locomotive is higher than usual, thus improving the riding properties of the machine and reducing the cost of upkeep and maintenance. A heavy machine with low centre of gravity subjects the permanent way and the locomotive itself to severe shocks and vibration.

The following are the principal particulars of this locomotive:—

Class 1:—Four-coupled, slow-speed, narrow gauge.

Weight in working order	11 tons.
Gauge	2 ft. 6 in.
Wheel base	5 ft.
Diameter of wheels	33 in.
Electrical equipment	One 95 H.P. motor, 500 volts, direct current.
Full-load speed	6 miles per hour.
Maximum speed	20 ,, ,,
Tractive effort at 6 miles per hour	5.000 lb.
Maximum tractive effort	6,500 lb.

With favourable conditions of rail, even greater tractive efforts than the above have been developed, and this locomotive has easily started and pulled a train of coal waggons totalling 145 tons.

The locomotive is constructed throughout according to steam locomotive practice. The frames, buffer plates, &c., are of heavy mild steel plate, the wheels have steel tyres shrunk on, and are keyed and pressed by hydraulic pressure on to their axles. Lubrication of all bearings, &c., is effected by syphon wick lubricators placed in convenient positions close to the driver, and communicating with the bearings by copper oil pipes. Whilst in the present instance it was necessary to provide a locomotive of greater capacity than those already in use on this narrow gauge, which naturally led to this type of construction, locomotives embodying the same general principle can be built for other gauges and for other powers. The construction is not restricted to direct-current locomotives, but can be employed for working on single-phase systems, and in some cases for working on three-phase systems.

WESTINGHOUSE ELECTRIC LOCOMOTIVE.

The illustration shows the locomotive on the experimental track at the Westinghouse works. The side, top and end doors of the locomotive are open, showing the accessibility of the electrical apparatus; the trolley pole has been removed from its socket. In the foreground is an insulated third rail, which almost screens the 30 in. gauge railway on which the locomotive stands.

The locomotive has been designed and constructed by the British Westinghouse Electric & Mfg. Co., Manchester, and will shortly be at work on the Oakbank Oil Co.'s private railway at Mid Calder. This is the third Westinghouse locomotive supplied to this company, the first two having been of 50 H.P. each, with single-reduction geared motors.

HIGH-TENSION SWITCHBOARDS WITH REMOVABLE SWITCH CARRIAGES.

In the design of modern high-tension switchboards the following considerations must be borne in mind: Firstly, all parts should be made inaccessible to the operator while under pressure, without, however, interfering with his freedom of action; and secondly, means should be provided for rendering such parts dead and open to inspection for the purpose of testing, adjusting and renewing, without necessitating the total shut-down of the installation. Where the necessary space is available, these conditions may be fulfilled by the adoption of switchgear of the remote control type, the high-tension switches being operated from a control board either electrically or mechanically. All measurements are then made by means of low-pressure instruments, used in conjunction with small transformers; and the actual high-tension switches are located in switch

chambers, quite apart from the control board, and separated from one another by insulating partitions. Section switches are provided, by means of which any part of the high-tension gear may be de-energised in readiness for inspection.

Such an arrangement is, however, impossible when the switchboard must be installed in a limited space. It is frequently necessary to erect the high-tension gear immediately behind the control

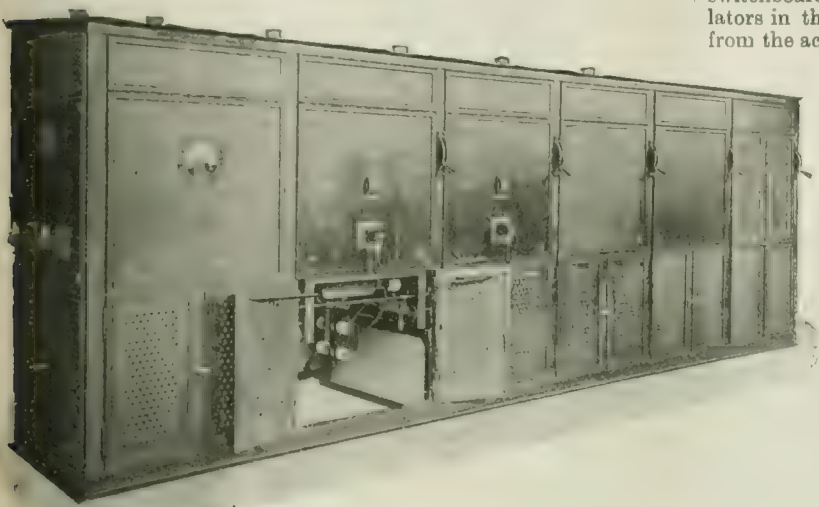


Fig. 1.—H.T. Switchboard, with Inspection Doors Open.

board, all switches, measuring transformers, &c., being mounted close to a wall, and consequently quite inaccessible from behind. Considerable ingenuity has been displayed in combining safety with ease of inspection in the design of boards of this type, of which an interesting example is afforded by the system adopted by the Felten & Guilleaume-Lahmeyerwerke A.-G., of Frankfort-on-Main.

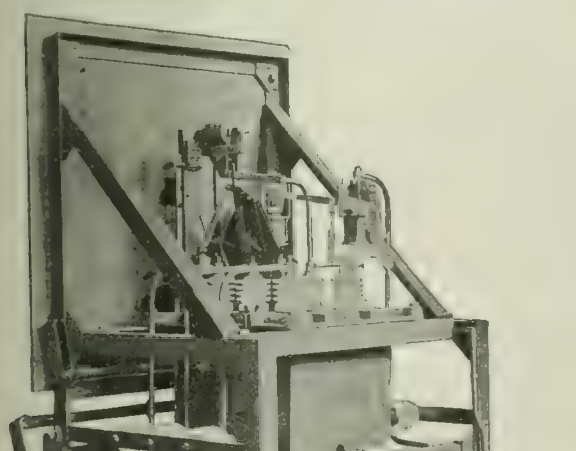


Fig. 2.—Removable Switch Carriage on Truck.

Fig. 3.—H.T. Switchboard, showing Method of Withdrawing Switch Carriage.

The several panels of the switchboard are separated from one another by brickwork partitions, and each is divided horizontally into three chambers. The middle chamber contains an oil-break switch and all necessary relays and measuring transformers and instruments As shown in the accompanying figures, this part of the board is constructed in the form of an angle-iron framework mounted on wheels, and may be withdrawn from the switchboard on to a truck provided for the purpose. If necessary, the switch carriage may then be wheeled right away from the board for testing or adjusting. The connection of this removable portion of the panel to the 'bus bars on the one side and the feeders or machine cables on the other is made by means of plug contacts carried on the lower part of the frame. The corresponding fixed contacts at the back of the board are connected to the 'bus bars through isolating switches, the operating levers of which are attached to the fixed part of the switchboard frame. The 'bus bars are mounted on porcelain insulators in the top enclosed division of the board, and are separated from the actual switchgear by an insulating partition. The jaws of the isolating switches are in direct connection with the 'bus bars, and, being thus continually under pressure, they are mounted in the 'bus-bar chamber. Their blades pass through slots in the insulating partition, and are provided with earthing contacts at their lower end. When one of the isolating switches is opened, therefore, all parts of the switchgear below the partition are in direct connection with the earth, and there is consequently no possibility of danger from a residual charge when the panel is opened up for inspection.

Doors of ornamental sheet iron are fitted below that portion of the panel forming the front of the removable switch carriage, so that the plug contacts may be inspected without opening up the panel. This is an important point, as it is of advantage that the contacts may be examined when the switch carriage is in position, to obviate the possibility of their becoming displaced, and to ensure that they make good contact.

The isolating switch is interlocked with the switch carriage and the lower inspection doors in such a way that the latter cannot be opened, and the switch carriage cannot be withdrawn, as long as the plug contacts and main switch are under pressure. Neither can the isolating switch be closed while the doors are open or the switch carriage is withdrawn. The isolating switch is further interlocked with the main oil switch, so that the former can be opened or closed only when the latter is open, and there is thus no possibility of the isolating switch being opened while carrying current. All eventualities are thus provided for, and contact with any part while under pressure is entirely prevented.

For machine panels, or panels controlling independent feeders, the outgoing cables may be connected directly to one set of the plug contacts in the lower chamber, as there is no danger of such cables remaining under pressure when the switch is opened. Where two or more feeders supply current to a sub-station, and may consequently be paralleled at the sub-station end, or where the switchboard is connected to a network or ring main, however, there is always a possibility that the cable will remain under pressure even though the main switch be opened. In this case, the cable ends are taken to the 'bus-bar chamber and connected to the plug contacts through isolating switches in the same manner as the 'bus bars. The two sets of isolating switches are then mechanically coupled together, and are simultaneously operated by a single lever.

By the adoption of this system a switchboard can be erected in a very limited space, and the greatest possible safety combined with easy accessibility to all parts demanding attention is attained. A further advantage is that a spare switch carriage may be provided, so that in the event of extensive adjustments or repair to any part

of the board becoming necessary the panel concerned may be re placed by the spare switch carriage, and the machine or feeder connected to it will not be put out of operation for any serious length of time.

The switch carriage and other parts of the switchboard are of particularly strong construction to fulfil the requirements of mining and other industrial installations. The use of steel springs has been avoided in the interlocking gear, owing to their liability to rust, and so becoming deranged. The interlocking is in all cases accomplished by means of simple but effective catches, operated either directly by the respective switch handles, or by the force of their own weight. The photographs reproduced here are of a 5,000 volt board installed underground in the Franziska pit, Gelsenkirchen, Westphalia. Similar boards have been constructed for pressures up to 10,000 volts.

PARLIAMENTARY INTELLIGENCE.

LONDON ELECTRIC SUPPLY BILLS.

The House of Lords Select Committee (presided over by Lord Cromer), appointed to consider three bills relating to electricity supply in London resumed consideration of the first of the bills (the London and District Electricity Supply Bill), on Friday last.

Mr. Talbot, K.C. (one of the Counsel for the promoters), explained in answer to a question by Lord Welby, that in the event of the purchase of the Company's undertaking by the local authority the auditor would not be called up to decide whether any of the plant was obsolete, with a view to deducting the cost of such obsolete plant from the purchase price, but merely to decide whether its cost was properly capital expenditure.

Mr. H. F. Parshall, one of the consulting engineers to the promoters, then submitted and explained a set of tables which had been compiled on behalf of the promoters. These tables showed

(1) The different districts covered by the scheme, the names of the authorised distributors in the specified districts, and the systems and pressures of the supplies.

(2) The capital expenditure of the various authorised distributors, the total in the case of local authorities being at March 31 last £8,197,556, and in the case of companies at December, 1906, £13,353,238, the average total capital expenditure per kw. of plant capacity being: Local authorities £89. 2s., Companies £99. 6s.

(3) The present cost of generation by authorised distributors per annum, the total in the case of local authorities being £515,605 (including interest and provision for depreciation at 6½ per cent.) for 96,246,481 units distributed, and by companies £872,384 (with the same allowance for interest and depreciation) for 137,013,688 units distributed.

(4) A list and statistics relating to bulk supply undertakings within the area of supply.

(5) Details of the estimated output of the proposed undertaking (stage A), putting the total plant capacity at the commencement of of the company's operations at 72,000kw. normal rating and at 90,000kw. overload rating, the total maximum load expected to be reached by individual consumers at some time during the year at 81,000kw., and the resulting load factor at 41·2; (stage B, a later stage of the company's operations), after extension of the plant, 144,000kw. normal rating, 180,000kw. overload rating, maximum load reached by consumers at some time during the year 180,000kw. and resulting load factor 53·3.

(6) Capital expenditure at stage A, with maximum load on works of 60,000kw., £2,600,000, and at stage B, with maximum load 120,000kw., £4,270,000.

(7) Estimated revenue, at stage A, for 190,530,000 units at average price of 0·616d., £488,597, net profit £196,151.

(8) At stage B, for 492,750,000 units at average price of 0·556d., revenue £1,141,217, net profit £489,788.

(9) Maximum prices scheduled in the bill for undertakers or users taking more than 250kw., at varying numbers of average hours' use of maximum demand and at varying load factors for a.c. and d.c. and calculated at £3 per annum per kw. for a.c. with 0·25d. per unit added, £3. 10d. per kw. for transformed a.c., and 0·3d. per unit, and £4. 10s. per kw. for d.c. with 0·33d. per unit.

(10) Estimated average prices for bulk supply and for supply to large power users for various numbers of hours' use of maximum demand and with various load factors.

(11) Comparison of present cost of generation with cost incurred by taking current from the power company at the rates contemplated by the bill. Local authorities £515,605 per annum, companies £872,384, total £1,387,989. Total cost at which it is stated a similar quantity of energy could have been supplied to the authorised distributors by a bulk supply undertaking at the estimated prices of the projected London and District Electricity Supply Co., £747,917, showing an estimated saving on the latter of £640,072.

(12) A comparison of the present generating costs of 26 local authorities in the proposed area with the costs to which they would be put if they closed their works and took supply from the company. Present cost, including capital charges and less sinking fund on land, £419,181, estimated total cost of bulk supply £362,796, estimated saving £56,385.

(13) Similar figures relating to 13 companies. Present total costs £483,566, bulk supply £387,019, estimated saving £96,547.

(14) Advantages to local authorities of obtaining bulk supplies instead of extending their works. Total future generating cost if works were extended to deal with increased load £777,276, cost of combined supply if bulk supply were taken from the power company and present undertaker, own works only used to deal with peak loads £667,707, estimated annual saving £112,569.

(15) Similar figures relating to companies. With present stations extended £1,024,335, combined supply £912,308, estimated annual saving, £112,027.

(16) Growth of demands on local authorities and companies in kilowatts from 1900 to 1907, the average total increase per annum being 13,056kw.

(17) Prices to be charged by authorised distributors on the basis of the maximum prices scheduled under the present scheme for transformed a.c. supply to consumers with various demands below 250kw., the maximum being £4. 10s. per kw., plus 0·5d. per unit.

(18) Prices to be charged by authorised distributors on the basis of the estimated prices scheduled under the present scheme, for transformed a.c. supply to consumers with various demands below 250kw. and with varying loads.

(19) Maximum prices under the bill compared with prices proposed in other bills.

(20) Comparison of maximum prices to be charged for untransformed supply under the present bill and under the London Electric Supply Bill, 1908 (one of the other two bills to come before the present Committee), for various numbers of average hours of maximum demand and with varying loads.

(21) Summary of the estimated output of the proposed undertaking, at stage A, units sold 218,314,620, works load factor 46·3.

(22) Estimated capital expenditure at stage A, £1,930,000.

(23) Estimated revenue account relating to bulk supply to authorised distributors at stage A, for 218,314,620 units at an average of 0·479d., £437,350; working expenses £276,880, net profit £160,470.

Mr. Parshall, examined by Mr. Talbot, said he was one of the engineers called in to advise on the L.C.C. bill put forward last year. He considered the condition of electric supply in London was far from up-to-date. None of the present suppliers could be of much use to their neighbours because of the difference of the systems and the pressures. Continuous current was supplied at 19 different pressures and alternating current was supplied in the form of single-phase, two-phase and three-phase and at nine different frequencies and 14 different pressures. If full use were to be made of the present steam plants, apart from the purely electrical conditions, material modifications would have to be made in the generation, so that the different kinds of electricity required at different points could be supplied at those points. To link up the present supplies it would require a new system of transformers. Mains of different frequencies could not work together, so that motor-generators would have to be provided, and continuous and alternating current could not work together, and many kinds of linking up machinery would be required to connect them. In the case of a.c. the difference in frequency was more important than the difference in phase, because by the use of intermediate transformers it was possible to make single-phase work with three-phase. By linking up instead of adopting the proposed bulk supply there would be no saving of capital. It would cost as much to provide a system which would be inefficient and not comprehensive as it would to put down a bulk supply from a single central source. A great many of the existing steam units were obsolete and were burning twice as much coal as a modern up-to-date plant would. Cheap generation by linking up the existing stations would not be the final result. There were 66 generating stations, and it was obvious that with electricity generated at so many points the waste of labour and coal must be very considerable, and many of the existing stations could not get a good supply of condensing water or sea borne coal, whereas the proposed station on the banks of the Thames would be able to coal from sea going steamers and would have an abundant supply of condensing water. The idea of linking up the whole of the 66 stations was hopeless, and in the present bill they had taken in their estimates only the stations that might reasonably be included in one of the other bills to come before the Committee. He did not suggest that the old stations should be at once scrapped. They could be used for peak-load stations and would also be useful for a stand-by until the present suppliers were satisfied that the new company's supply was reliable and cheaper than their own.

Witness explained to the Committee the meaning of the term "peak load," and gave the hours during which the peak load lasted on the electric railways and on the lighting circuits of certain companies. The linking up would not, in his opinion, provide efficiently for a bulk supply, and it would take a great deal of capital, but there was only £1,000,000 provided for in the linking up bill, and that would not give an installation generally useful for the supply in London. He thought £5,000,000 would be nearer the mark. In the present bill they asked for 4½ millions capital and borrowing powers bringing the amount up to £6,000,000.

Mr Balfour Browne, K.C. (for the London Electric Bill), remarked that it was only fair to say that the bill under consideration provided for the areas of all the existing authorities and the other bill did not.

Mr. Parshall went on to say that the great portion of their capital was for the area comprised in the other bill. The additional area in

the present bill would not take more than £1,000,000. He thought the reason for the discrepancy was that the companies who wished to take such limited powers under the other bill were prepared to do very little. He estimated that there was between 300,000 and 400,000 H.P. used for industrial purposes in London that had not been provided for by electricity, and they would be able to prove that a great many of those power users had not taken electric power because it was too expensive. Most of the present companies were hampered with a purchase clause and they were not in a position to put down new plant. The promoters asked for capital and borrowing powers of £6,000,000, but £4,500,000 would be sufficient to take them through the first stage. When the Administrative County of London Co.'s bill was under consideration a number of the present supply companies agreed provisionally to enter into arrangements to take power from the Administrative Co., and his company was willing to enter into similar arrangements, the charges being similar to those offered by the Administrative Co. The arrangement was not that the companies should be bound to take current from the bulk supply for the peak load, but that would be the natural consequence of such an arrangement.

By Mr. TALBOT: The cost of the land and buildings required for extending the present stations so as to give a supply such as they contemplated (without any machinery at all), would be enough to cover the whole cost of their bulk supply scheme. The capital involved in the land and buildings of the present stations was £3,500,000 and the total expenditure on the stations was about £9,000,000. Centralisation of the source of supply was absolutely the right principle. The extension or increase of the present stations would involve a considerable nuisance. There had already been complaints regarding the Bankside station—as good a station as any in London—and if a bulk supply were put there with about 10 stacks there would be so much smoke and general nuisance that the station would be objected to altogether, and every one of the stations trading in the same way would become more or less a nuisance. The diversity in the demands in the case of a large supply would improve the load factor. There was no intention to interfere with the business of the present undertakers. The promoters said: "We will give you a supply equal to that you now have and save you £640,000, and you can apply that towards redeeming the $9\frac{1}{2}$ millions capital expenditure or to other purposes." It had been suggested that it was unwise to trust in one station, but it would be seen from the plans that the units were self-contained and failure of one would not affect the others, and the mains were duplicated. There were many large towns in the Kingdom which were supplied from single stations. He had designed stations for Glasgow Corporation tramways, Dublin United Tramways, Central London Railway, and the London United Tramways, where the service was dependent on a single source of supply and failure of that source would preclude the continuation of the service, but although some of these had been in operation 10 or 12 years, they had never failed. The first installation of plant at the proposed station would be five sections of 24,000kw. each. About 127,000 kw. were now supplied in London, and they proposed to provide for supplying 157,000 kw. In estimating the probable demands it was taken that the railways would be electrified to a sufficient extent to take 60,000 kw. from the bulk supply. They anticipated that in the initial stage 30 per cent. of the 140,000 kw. now produced by present distributors would be asked for from the new undertaking, and they anticipated that the direct power users would take 15,000 kw. at the outset, but they expected that would get much larger. Although they expected an ultimate demand of 60,000kw. from railways, they had only estimated for a demand of 25 per cent. of that at the commencement, as they could not expect people to set aside 51,000kw. of existing plant, but as their business grew they would ultimately require 51,000 kw.

By LORD LYTTON: The site at Barking was considered better than a site on the south side of the river, as it was better situated for dealing with the whole of the demand and it would not interfere with any residential neighbourhood.

By Mr. TALBOT: It was proposed to generate 3 phase current, which was almost universally used to-day for transmission of power. It was proposed to transmit at 13,000 volts, as it was found that with transmission at about 15,000 volts the best results were got from the capital employed. The periodicity had been settled at 50 cycles. That would suit the smaller class of power users because motors were cheaper for 50 cycles than for a lower frequency, although for heavy work, such as railway work, a low frequency was desirable. A better system of generation was obtained at 50 cycles than at 25 cycles. In the Administrative bill the frequency was taken as 25 cycles, but that was a matter in which they had now the advantage of greater experience. To save the second opening of the streets they had provided for manholes at a distance of about 100 yards, where cables could be drawn in. It was intended to have 14 control stations connected to the transformer stations. There were 43 of the present authorised distributors whom he thought their supply would benefit, and 37 of these would benefit to a greater extent than the others. These 37, consisting of 11 companies and 26 public bodies, would benefit to the extent of £208,000, or nearly 14 per cent of present cost. The cost of production by these 37 distributors was 1d. per unit, and the promoters were prepared to give them bulk supply at 0·866d. This included in both cases $6\frac{1}{4}$ per cent. for capital charges.

The CHAIRMAN asked why the company's offer was not made to the remaining 13 out of the 50 distributors.

Mr. PARSHALL said some companies (like the City of London Co.), were in a more advantageous position than the smaller companies, and the same offer could not be made to them with expectation of acceptance, but the new company proposed to supply the large power consumers throughout the whole area. He supported Counsel's statement that the Kitson Clause had given rise to general discontent. The maximum prices for current fixed in the bill were lower than in any previous bill. The new company's dividends were to be limited to 8 per cent.

When the Committee met again on Monday, the CHAIRMAN asked what would happen if anything occurred to stop supply from the projected station at Barking, and how would London be situated if it were entirely dependent upon that supply? He was assuming that the distributors had taken advantage to the full of the facilities it was proposed to offer. Mr. Parshall had mentioned that there would be several installations, but he (the Chairman) had in his mind some more general cause, external or internal, which would stop the whole of the supply. Suppose we were engaged in a naval conflict, he did not know how far it would be possible for a foreign ship of war to steam up the Thames and shell the Barking station, but in the event of such a thing occurring would the whole supply be cut off or could some temporary arrangement be made to mitigate the evil? And what would happen in the event of a strike? He understood there was provision in one of the Criminal Law Amendment Acts which made it a penal offence to join a combination which might cause the cutting off of a general supply of a town. Then anarchists might place bombs to destroy the installation, and he wished to know whether that would destroy the whole supply of London?

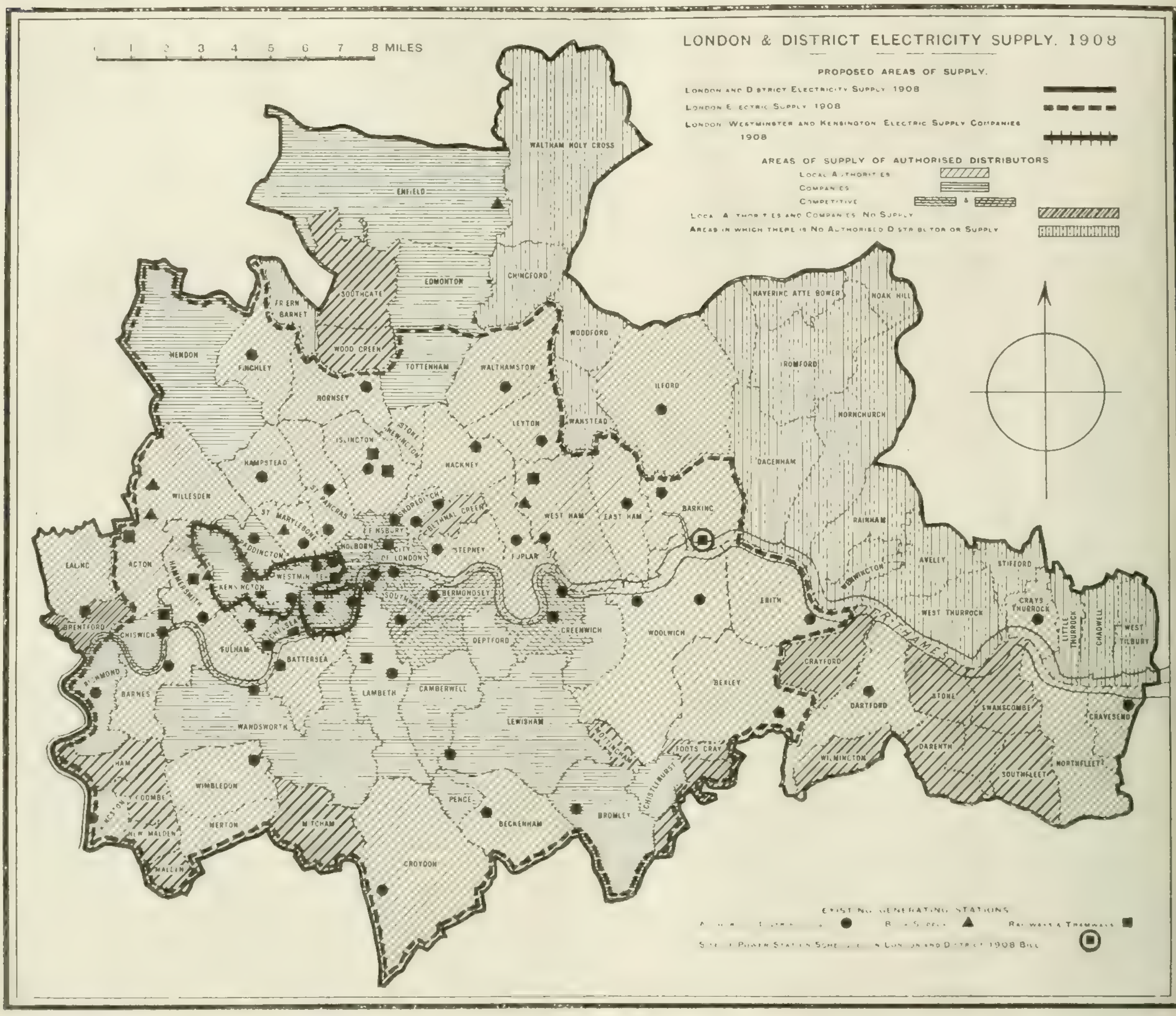
Mr. FITZGERALD said, as Mr. Parshall had explained, the units would be separate units of 24,000kw. each, and that method of working would provide against any ordinary contingency of machinery breaking down, but when one came to ships of war coming up the Thames and taking possession of the station he was afraid in that case they could stop the work and the whole of London would be deprived of electric light and electric power, but as it was desirable that the station should be on the Thames, so that it could get a good and cheap supply of coal and water, the question of having one or two stations would not make any difference; if a ship of war could destroy one it could probably destroy two. The same argument, he thought, almost applied to the case of disturbances by anarchists. With regard to strikes, if a company had one, two, three, or four stations, a strike might affect them all. The number of men employed in a generating station was not very large. It was not like a factory.

Mr. BALFOUR BROWNE said New York, Paris, and Berlin did not rely upon single stations. With regard to strikes affecting several stations, they knew distinctly there had been a strike in the South Metropolitan Gas Co.'s works, and that there was no strike either in the Commercial or the Gas Light & Coke Co. The provision in the Criminal Law Amendment Act mentioned by the Chairman did apply to gas and water, but not to electricity.

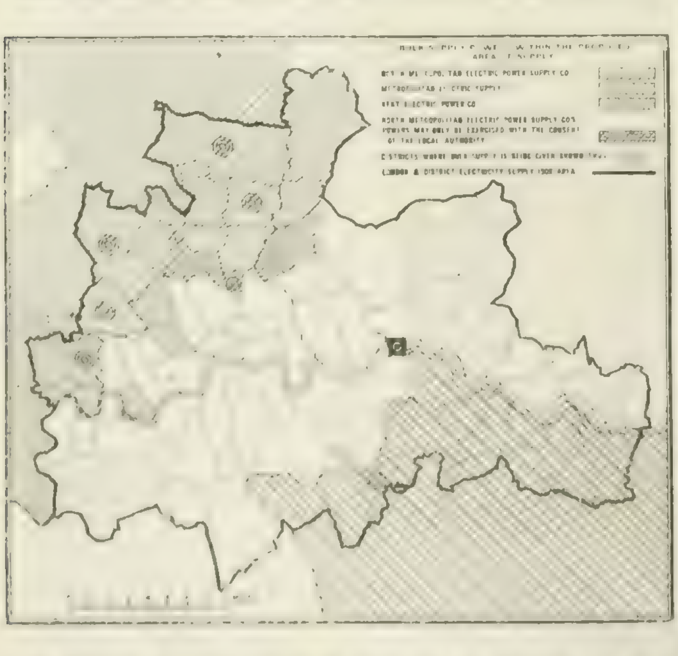
The cross-examination of Mr. PARSHALL then proceeded by Sir Ralph Littler, K.C., who with Mr. Rigg, K.C., represented the Corporation of London. Mr. Parshall said his company did want to go through the City of London, although they could carry on their scheme without doing so. He thought the effect of clause 3 of the Bill would give them the power to go through, but with an appeal to the Board of Trade as to the route. He knew there were a great number of pipes and other mains under the streets of the City, and he accepted Sir Ralph's statement that the Corporation had obtained special Parliamentary powers to limit the breaking up of the streets. He should say it was practically true that there was no other place where the breaking up of the streets was so serious a matter as in the City of London. The Charing Cross Co. and the City of London Co. were supplying in competition in the City. The City had the right to purchase the undertakings in 1914. He did not think that, supposing his company bought up one or both of those companies, the Corporation's right to purchase would be postponed for 42 years. He admitted that the demand for power in the City might be from comparatively small consumers, as there were no big factories.

By Mr. BALFOUR BROWNE: There would not be any saving of capital if the supply were provided by a combination of the companies. He took it that in such a scheme the big stations would generate, and the small ones would use their plant only for peak load. There would have to be motor-generators put in and linking up cables laid. It could not be done under £40 a kilowatt. The London Electric Supply (Joint Committee) could only obtain the machinery as cheaply as the promoters of the present bill if they bought units of similar size, and he was not quite satisfied that they had buildings satisfactory for the purpose. He had based his estimates of the cost of the Joint Committee scheme upon the assumption that the object was to provide a general power supply for London, and in his opinion, if they did not do it upon the method he had indicated, and at the cost he had estimated, they would not effect that object. He agreed that interest must be paid on the 20 millions that had been spent upon plant by the companies and local authorities in London and his company did not propose to put six million on the back of that. They were going to spend a million and a half upon plant, &c., compared to what the old undertakers had spent nine millions upon. With regard to his statement that most of the companies were handicapped by a purchase clause, they only had until 1931 to run, and in the bill 42 years were asked for. The old companies were handicapped to that extent.

MAP SHOWING THE AREAS COVERED BY THE THREE LONDON ELECTRIC SUPPLY BILLS, 1908.



Bulk Supply Powers within the Proposed Area of Supply.



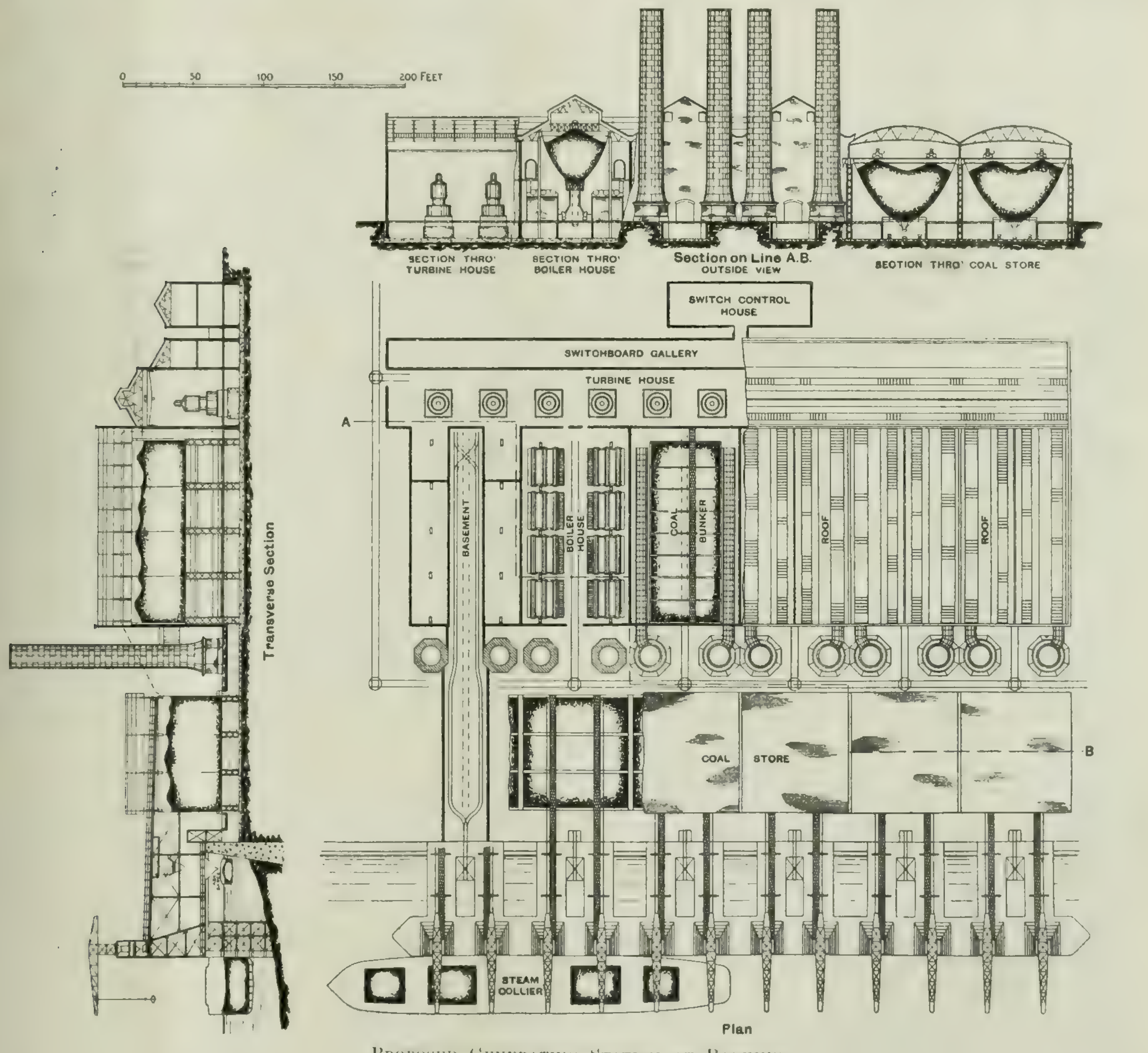
Mr. Balfour Browne then cross-examined Mr. Parshall at great length on the accuracy or otherwise of the estimates that had been made on behalf of the promoters of the amount and probable demand of the potential power users in the London area. Mr. Parshall said they had a report which was issued by the Home Office in January last and gave the number of factories in the area, and the number of persons employed therein, and the trades in which they were engaged; he also got last year, in connection with the L.C.C. Bill, information on the subject from Mr. Rider, the electrical engineer of the L.C.C. tramways. He had since then confirmed the figures he then obtained. He had gone to individual factories and heard from the occupiers themselves about their own conditions. The L.C.C. representatives found last year that there were in Shoreditch 42 factories employing steam and 181 gas power. Since then he had been to about a dozen factories. Messrs. Bryant & May were using producer gas to the extent of 200 H.P., and they did not seem to be quite satisfied with it. The H.P. he allowed in his estimates per head of the workers employed in factories differed according to the class of work in which they were engaged. In the case of printing works it was as low as 0·25 H.P., but in the builders' materials trades it was as high as 3 H.P. Assuming that the Joint Committee Bill would meet every demand and that the cost under their scheme was a great deal less than Mr. Parshall estimated—although it was, he thought, an erroneous supposition—there would still be a case for the London and District Bill because it was going to take the undertakers' old stations or save them enough to enable them to scrap their stations and give their customers the benefit of £100,000 a year. He did not agree that anything his company could do could also be done by the existing companies. It would take his company a year and a half to two years to establish their works and lay their mains. He gave evidence on behalf of the City of London Co. in 1905 on a bill which was thrown out by Lord Camperdown's Committee because the proposals were not satisfactory. The City of London Co. proposed to equip a power station at Bankside, in addition to their present works, to supply the whole of the area covered by the Administrative Co.'s bill. In reference to the remark by Mr. Balfour Browne that on that [illegible] witness was of opinion that the City of London Co. could raise capital more easily than the Administrative Co. because it was a going concern, witness said he had a statement from some of the companies that with purchase in 1931, they found

it rather difficult to find capital. The finance in this particular case was assured. He did not believe the City of London Co. could obtain new turbines now in nine months. When he said they could do so in 1905 he believed they had some very special offers as to delivery. He said in 1905 it did not matter how well engineered a company was, there was experience to be bought and paid for, but experience was impossible in a case of the character they were now discussing.

By Lord Lamington: The present company was not the same company that had had a bill on several previous occasions. It was a new company.

In further reply to Mr. Balfour Browne, Witness said with regard to the table showing the increase that had taken place in the output of the authorised undertakers in London during the last eight years metallic filament lamps would cause an alteration in the rate of increase, because carbon filament lamps took about three times as much current, but that would be in favour of the tables. The facts from which the tables were compiled were largely supplied to him by Mr. Hammond, who would give proofs as to their accuracy, but the figures were not all Mr. Hammond's. They worked together. In Chicago, New York, and Boston turbo-generators were at work, so that the estimated generating costs had been ascertained from the actual results of practice. In regard to Mr. Balfour Browne's statement that Mr. Merz based his evidence on those machines, witness said they were not in existence in 1905. His Company were satisfied to take the same terms as Mr. Merz's Co., viz., that the other Companies did not undertake to take anything but if the power company did not supply them at what Mr. Balfour Browne described as a ridiculously low figure their powers in the distributing company's area were to cease. The loss in transmission would not be 16½ per cent. The £2,600,000 in the tables covered all the mains shown on the map, which went to every part of the district. They could not tell how many miles they would have to lay until the load came. He did not know that 30 power bills had been passed through Parliament, and that not one of them, independent of a distributing company, had ever paid a dividend except the North Metropolitan.

By Mr. Seymour Bushe (who appeared for the promoters of the London (Westminster and Kensington) Electricity Companies Bill: The nearest point of the area in the London (W. & K.) Bill was eight miles from Barking, and the power company's mains would be brought to one point on the boundary. The price charged by the Westminster Co. was 5·58d. in 1892, and it had been continuously reduced until to-day it was 1d. Under his company's scheme in some circumstances consumers might pay more than 1·519d. if their demands were below 250kw. If none of the distributors took a supply they would still go on with their general power scheme. It would practically mean that they would have to look elsewhere for custom. If distributors would not take a supply the power company would be able to use the Act so that customers could get a cheap supply. The clause authorising the company to deal direct with railways and with individuals was in substitution for the Kitson clause, and they hoped it would be considered more favourably by the authorised distributors than that clause. Those two forms of dealing with individuals were, he thought, absolutely new. If a man were refused a supply by the distributing company, the power company would supply him. They did not lay a distributing main for the first customer. They had provided themselves in the larger scheme with capital for running a network of mains for distribution. They did not intend to compete for public lighting, but they asked for powers to supply the authorised distributor, which would include current for public lighting. He was surprised that the companies represented by Mr. Bushe looked upon the new company's arrival at their boundaries with apprehension. He thought they would look upon it with considerable pleasure. He admitted they were asking for powers practically for perpetuity.



Proposed Generating Station at Barking.

Parliamentary Intelligence *continued on p.* 184.

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THE ENGINEER IN PUBLIC LIFE.

It is often regretted that the engineer takes very little part in public affairs. For example, on municipal councils, although municipal work is largely concerned with engineering, he is seldom found. Similarly, there are comparatively few Members of Parliament who are engineers, and consequently the committees and commissions which are appointed from time to time to consider engineering questions consist generally of members who are more or less ignorant of the subject under discussion. As an instance of this fact we need only mention the committees which have considered the problem of power supply in London, and in whose hands the fate of the numerous Bills which are brought up from year to year to solve this question is placed. If only a fair proportion of the members of such committees and commissions were engineers much time would

be saved which is at present wasted in instructing the layman upon engineering details, and in all probability the conclusions reached would be more sound.

This want of prominence in public affairs on the part of the engineer is doubtless due to a variety of causes. There are probably few subjects which differ so materially as politics and engineering. Unfortunately, even in municipal life politics play a considerable part, and demand a sacrifice of far more important principles. In Parliament this is still more the case. The average engineer is not a keen politician, and his sense of proportion is probably outraged by the usual run of political statements. It is sometimes thought that the outlook of the engineer is too narrow, and that he is unable to appreciate any questions beyond technical matters. This view, however, can scarcely be supported. Mr. HENRY FLOY, in a Paper read recently before the American Institute of Electrical Engineers gives other possible reasons. For example, the engineer may be so keenly interested in the scientific aspect of his work as to be absorbed in his profession, and the irresponsibility of the politician may clash with his ideas of engineering accuracy. Generally the engineer is not a fluent speaker —we often wish that he were—and as a result he is not particularly good at making out a strong case for his own views, more particularly in public. The politician, on the other hand, must see his own side of the question and no other. Then, again, according to Mr. FLOY, the engineer is often lacking in a broad and general education, particularly along the lines of history, political economy and business engineering.

Mr. FLOY gives some instances of decisions reached by commissions that might have been, and probably would have been, beneficially modified if engineers had been more in evidence. For example, in the case of an amalgamation between a gas company and an electricity company, the commission decided that the cost of consolidation should not be met by issuing new securities, and that the low prices reached through competition should not be raised after consolidation. The public were thus protected, but there was a very good chance of bankruptcy. Benefits do not necessarily result from consolidation of this kind. Thus the Massachusetts Gas and Electric Light Commission found that the benefits of consolidation of gas and electricity companies in cities of considerable size do not compensate for the disadvantages to the public arising from such consolidations. To the layman it may appear strange that it should cost more per unit to deliver gas or electricity to the small consumer than to the larger consumer, and probably on that account the New York Commission of Gas and Electricity fixed a maximum charge per unit to be made by the Rookland Light & Power Co. in Orange Town. The result of this regulation was that out of 112 consumers served at a loss under the rate formerly charged, 75 would receive a service under the new rate at a still greater loss to the Company, while out of 26 served at a profit 19 must be served at an increased profit to the Company in order to make good the losses incurred by the reduction of price to the 75 consumers just mentioned.

Points of this kind would appeal much more readily to the engineer than to men without an engineering training. It would be considered absurd to refer questions of appeal to the House of Lords if the judgment depended upon the views of the Peers as a whole, yet the layman does not consider it absurd that he should express authoritative opinions upon engineering subjects, and we are generally content to allow large engineering questions of a legislative character to be settled by men who are devoid of engineering training.

OBITUARY.

BENJAMIN HOWARTH THWAITE.

We regret to record, as briefly announced in last week's issue of *The Electrician*, the death of Mr. B. H. Thwaite, which occurred on Wednesday, May 6th. He was in his 51st year.

Mr. Thwaite was born at Brighouse, Yorkshire, in 1857, and received his early education in that town. In 1887 he introduced C. E. L. Brown's dynamo, then being manufactured by the Maschinenfabrik Oerlikon, into England, and in the same year invented and patented a method of electromagnetic concentration of iron ores. He was the author of the pioneer project for transmitting combustible generator-produced gas (from a coal field generating station) at high pressures for supplying gas-driven dynamos.

In 1892 Mr. Thwaite explained his pioneer project for the electrical transmission of power from a coal field generating station before the Manchester Association of Engineers, and later (1894) in the "Nineteenth Century." The Manchester Paper contained specifications for a 110 miles transmission of 10,000 H.P. at 20,000 volts (prepared by Mr. Thwaite in collaboration with Mr. James Swinburne). In 1892 he publicly demonstrated in Manchester the stimulating effect of the actinic rays of an electric arc light on plant life, and in 1893 developed a process for generating gas from semi-bituminous and peaty coal, and applied the gas, which he designated "power gas," to the driving of electrical machinery.

A year later he developed a scheme by which the waste gases from blast furnaces could be utilised for generating power in internal combustion engines, and explained how the future rôle of the iron-making blast furnace might include the generation of cheap electrical energy for distribution to areas within a radius of 30 miles. In connection with this important subject he in 1895 applied the blast-furnace method for the electric lighting of a Scottish ironworks with great success. Mr. Thwaite in 1896 described the application on a practical scale of static discharges of electricity for effecting the deposits of suspended dust from blast furnace gas by electrical coherence, and tested it practically. Mr. Thwaite, at this time, contributed to the "Engineering Magazine" of New York an article demonstrating the economic rationale of main railway electrification, and invented, in conjunction with Mr. George Cawley, a process for canal electrification. In later years he did a good deal towards the industrial advancement of electrochemistry, especially in connection with the manufacture of calcium carbide, and invented a process for effecting the decarbonisation of cast iron with electricity as a heating agent.

He was the author of a work, published in 1902, on the "Generation and Transmission of Electric Energy at and from Coal Pit Centres," which also appeared in the *Annalen für Gewerbe und Bauwesen*, under the title of "Die Erzeugung und Ubertragung elektrischer Energie in und von Kohlen distrikten."

At the time of his death Mr. Thwaite was keenly interested in the application of electricity to horticulture, and one of the glasshouses in the Royal Botanical Gardens, Regent's Park, London, had for some time been placed at his disposal in which to carry out systematic experiments.

THE REV. EUGENE LAFONT.

We also regret to record the death of the Rev. Eugene Lafont, S.J., C.I.E., D.Sc., chairman of the Calcutta Section of the Institution of Electrical Engineers, which occurred on Sunday last at Darjeeling, India. The deceased was among

the leading physicists in India, and for 40 years did much towards propagating that science among both Europeans and Eurasians.

Father Lafont was born in Belgium in 1837, and was educated at St. Barbara's College, Ghent, and at the Jesuits' Seminary. After some years of educational work in his own country he proceeded to Calcutta in 1865, being appointed science professor in St. Xavier's College. He founded the well known solar observatory of his college, and was one of the most active members of the Indian Association for the Cultivation of Science. He was always intimately associated with the work of the College, and was appointed its rector a few years ago. He received the honorary degree of Doctor of Science on the occasion of the celebration of the University's jubilee in March last, was a Companion of the Indian Empire, and a Chevalier of the Order of Leopold.

MANUFACTURE OF ELECTRICAL CONDENSERS.*

BY G. F. MANSBRIDGE.

(*Concluded from page 111.*)

Summary.—Consequent, no doubt, upon the newness of the industry, very few reliable physical, electrical and manufacturing data concerning commercial condensers have been published. The author here deals with the subject of the manufacture of condensers from a practical point of view, the numerical data given being obtained from workshop tests, and not from isolated specimens under laboratory conditions.

The condenser plates having been wound then pass to the drying oven, and subsequently to the vacuum pans and screw-presses. The desiccation of the plates prior to waxing must be very complete and thorough if the highest insulation is required. Ovens heated by gas, steam and electricity are in use for this purpose, but the last named is infinitely preferable. For an oven of about 25 cubic ft. capacity which will accommodate 500 2 mfd. plates, a power consumption of 2 kw. suffices. The temperature permissible is limited by the necessity to avoid scorching the paper, since cellulose suffers adverse physical changes if heated much above 212°F. for any considerable time. Consequently the practice at one time was to dry the condensers at a temperature of 212°F. to 220°F., but this involved from three to four days stoving unless the plates were composed of only a very few sheets or layers, and were disposed in such a way that the heat could readily permeate, and the moisture readily leave, the innermost layers. Since this in commercial work is impracticable, the author tried the plan of utilising the resistance of the strip of foiled paper to generate heat in the interior of the condenser when a current of suitable strength was passed along it. To this end, all that was necessary was temporarily to short-circuit the plate by means of the connecting lugs at the commencement of the roll, and to pass the current in at another pair of lugs at the end of the roll. It was found, in this way, that with an oven temperature of 212°F., and an additional expenditure of 4 watts per 2 mfd. plate, thorough desiccation could be effected in 8 to 12 hours, without any scorching of the paper, although the temperature inside the rolled condenser reached 270°F. Although fairly simple in manipulation, this method did not lend itself very readily to commercial manufacture on the large scale, but it served to point the way to the possibility of using higher temperatures without scorching, and it eventually led to the use of a simple process which has been found most satisfactory and efficient—namely, the vigorous churning of the heated air inside the oven by means of a fan. This rapid circulation results in a great number of particles of heated air being brought into contact with the paper in a given time, and as a result of numerous trials it is found that the use of a fan in this way permits of temperatures as high as 290°F. or 300°F. being employed without scorching the paper, and satisfactory desiccation can be obtained in as short a time as eight hours. Fig. 2 shows the insulation of various batches of foiled-paper condensers which were subjected to different periods of drying under the conditions indicated above.

One point calling for attention as regards the drying of condensers is the shrinkage in length which takes place with many papers during desiccation. In the case of plain paper newly come from the mill this may amount to [illegible] per cent after 24 hours' drying at 212°F., and there is a further shrinkage on waxing. In the case of foiled paper the shrinkage on drying is much less, and the whole of this occurs prior to waxing. If perfectly fresh and undried interleaving paper is wound up tightly with foiled paper, and the compound roll is then dried and waxed, there will be a tendency for the great shrinkage of the interleaving paper to cause the foiled paper to crinkle or crease when pressed. To guard against this the plain paper should either be matured for a few months in stock, by which time it will have shrunk considerably, or it should be oven dried for some hours before use.

After being effectively desiccated the plates have to be impregnated with paraffin wax. The function of the paraffin is threefold: (1) To increase the inductive capacity of the dielectric; (2) to prevent moisture from again reaching the highly hygroscopic paper; (3) to retain the condenser in the closely compacted form into which it is compressed while the wax is hot. The inductive capacity of the layers of paper and air which separate the electrodes before the plate is impregnated is approximately 1·2, and on the air being replaced by paraffin this increases to approximately 3·2. Obviously the more thoroughly the air is replaced by the paraffin the greater will be the gain, and to facilitate this it is advantageous to impregnate the condensers in vacuo. A suitable

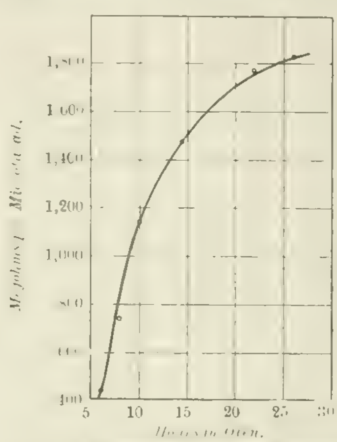


FIG. 2. FOILED PAPER CONDENSERS.

Average insulation (300 volts, 60 secs. and 60°F.) after various periods of drying. Electrical oven. Fan in use throughout. Average temperature 280°F.

vacuum pan was illustrated and described by the author. Two hours impregnation at 212°F. is sufficient if a thoroughly good vacuum is obtained. After full impregnation the vacuum is broken and the condensers are left subjected to atmospheric pressure for 10 minutes, and are then removed from the hot wax and at once pressed. No advantage can be traced from the employment of more than atmospheric pressure in the pan after evacuation is complete. The method of pressing and the manipulation at this stage are of considerable importance. In the first place it will be obvious that the greater the pressure the greater, within limits, will be the capacity obtained, and with this object it is the practice in certain factories to employ hydraulic machinery and to compress the plates to the utmost limit. The objections to this course are, however, considerable. First, there is a great tendency to drive the paraffin out of the pores of the paper and so to

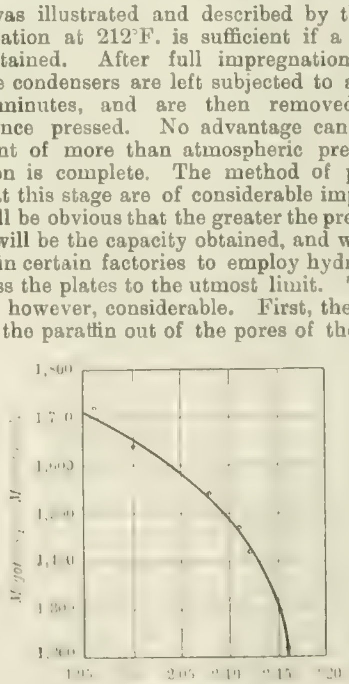


FIG. 3. FOILED PAPER CONDENSERS.

[illegible]

leave the paper readily penetrable by moisture, unless the plates are at once hermetically sealed. Secondly, the enormous pressure greatly increases the liability to short circuits, and although this is of little importance with foiled paper condensers owing to the automatic sealing, it is better to avoid it since such breakdowns after the paper has been waxed are always accompanied by a fall in insulation. Thirdly, the excessive pressure results in lowering the insulation to an extent which is out of proportion to the increased capacity. This effect is shown in Fig. 3. A further objection is that, for commercial reasons, it involves the simultaneous pressing of a vertical pile of plates, and this procedure is to be deprecated, since the cooling of such a pile is necessarily slow, and the wax continues to drain out of the inner condensers to

* Abstract of a Paper read before the Institution of Electrical Engineers.

such an extent that when cold there is comparatively little left in them. For this reason the pressing of even two plates one above the other is not permitted at the Post Office factory. The same objections do not, of course, apply to the pressing of a number of plates side by side; indeed, this is the current practice. With the same object—namely, that of retaining a sufficiency of wax in the plate—the presses are water cooled both on the top and on the bottom. With cooling water at a temperature not exceeding 60°F., five minutes' cooling in the press suffices for a condenser ¼ in. thick. The presses are of the screw type, since experience shows that more uniform results can be obtained with them than with levers and dead weights. As soon as the plates are fairly cold they should be placed aside to settle down in temperature before being tested, and, in the meantime, they should be protected from atmospheric moisture, since paraffin is markedly hygroscopic.

In addition to, or in substitution of, paraffin, beeswax, resin, shellac, ceresine, stearine, lead stearate, &c., have all been suggested, and for each some special advantage has been claimed in the way of higher inductive capacity, greater dielectric strength or less affinity for moisture as compared with paraffin. The author has, however, been unable to find that any one of these substitutes possesses the all-round advantages of good paraffin. For use in tropical countries paraffin of a specially high melting point is desirable, but for use in the temperate zones wax, with a melting point of about 130°F., answers most requirements. The author ascertains the melting point, or, more correctly, the "setting" point, by inserting a calibrated thermometer with a small bulb into a vessel of hot wax, and as the wax cools noting the well-defined period during which the temperature becomes stationary; this temperature represents the setting point. Some typical curves showing the result of this

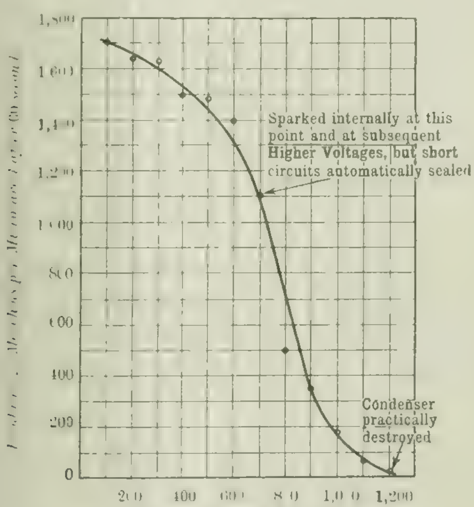


FIG. 4.—FOILED PAPER CONDENSERS.
(Relation between test voltage and observed insulation (test taken at 62°F., insulation corrected to 60°F.).

method are given in the Paper. A convenient quantity of paraffin is about 2 oz., contained in a test tube or beaker 1½ in. in diameter; the thermometer generally used has a bulb of ¼ in. diameter by ¾ in. long.

As a rough approximation, it may be said that with ordinary paraffined paper at 60°F. the breakdown point is approached when the pressure reaches the equivalent of 150,000 volts per centimetre. With foiled paper, however, the result of the automatic sealing is practically to double the effective dielectric strength. Fig. 4 shows graphically the results obtained on subjecting an ordinary telephone condenser, made from foiled paper, to steadily increased pressure. As the voltage rose above the normal point of dielectric strength the paper broke down, possibly at several places, but each short-circuit sealed up as fast as it was formed, and not until the pressure reached 1,200 volts was the condenser rendered useless.

For telegraph work separate condensers of suitable capacity are selected, and are assembled between a pair of sheet iron plates which are then bolted together. The batch of plates so assembled is built up into a solid mass with plastic paraffin, and is then hermetically sealed in a tinned iron case, the opening where the wires are brought out being sealed with a non-contracting mixture of gutta percha, resin, stearine pitch and Stockholm tar. For telephone work nothing more is necessary than a hermetically sealed metal case, since the condenser is usually covered up and protected by the telephone apparatus. On the Continent papier-mâché cases have been adopted to some extent, but their use cannot be recommended.

In speaking of the insulation resistance of a condenser it is necessary to be most precise as to exactly what is meant. The insulation is usually expressed either in terms of the percentage loss of charge after the charged condenser has been insulated for a certain time or as so many megohms per microfarad. The "percentage-loss-of-charge" method is used chiefly for standards and for submarine cable condensers; for ordinary telegraph and telephone condensers the insulation is more often reckoned as "megohms-per-microfarad." Neither expression is a precise specification of the insulation value unless certain datum lines are assumed or stated. The first of these necessary data is the temperature at which the test is taken, the second is the value of the voltage applied, and the third is the time which is allowed to elapse between the first application of the voltage and the moment at which the leakage is measured.

The behaviour of a condenser in respect to electrification is an important indication of its quality, as incipient defects give the first indication of their existence by producing unsteady or "negative" electrification. Fig. 5 shows typical insulation and electrification curves of foiled-paper condensers when tested with various voltages.

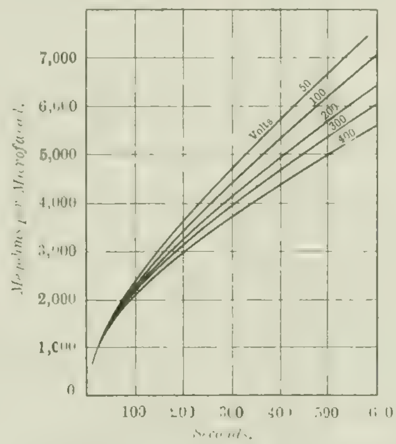


FIG. 5.—FOILED-PAPER CONDENSERS.
Insulation and electrification with various voltages. Temperature 61°F.

Fig. 6 shows similarly the variation of insulation with constant voltage and varying temperature, the tests being taken after one minute's application of the voltage, the temperature in each case being maintained for a period long enough to allow the condenser thoroughly to take up the new temperature. As may be deduced from the curve, the correcting coefficient for foiled paper condensers is as nearly as possible 3·50 per cent. per degree F.

From general considerations, one may state the relation—$\Omega \propto \frac{s}{vt}$, where Ω = megohms per microfarad, s = seconds after application of voltage, t = temperature in degrees F., v = applied voltage.

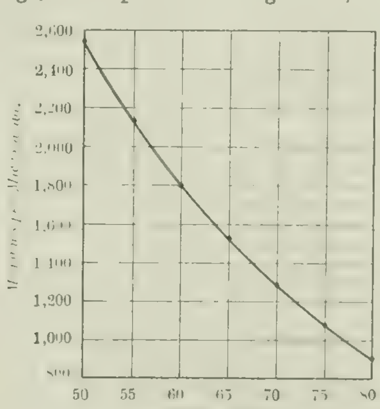


FIG. 6.—FOILED-PAPER CONDENSERS.
Variation of insulation with temperature (curve plotted from calculated results) 100 volts, 60 seconds.

For foiled-paper condensers the following approximate empirical formula is obtained: $\Omega = 400 \frac{s^{0.5}}{v^{0.1} \times 1{\cdot}035^{t-60}}$. For metallic-foil condensers the expression becomes $\Omega = 4{,}000 \frac{s^{0.5}}{v^{0.1} \times 1{\cdot}035^{t-60}}$.

A special development of the paper condenser is the "inductive-resistance" form introduced by Dr. Alexander Muirhead for the balancing of long submarine cables. This differs only from the tinfoil condenser in that one set of electrodes consists of plain sheets bunched together, while the other set consists of sheets of foil cut into the form of a grid. The strips forming the grid are joined in series and serve as a resistance. The width of the strips may be chosen so as to give, within a considerable range, any desired ratio between resistance and capacity. The insulation and electrification

constants are not so easily matched with accuracy, but, fortunately, the insulation and electrification of high-class condensers made from thoroughly desiccated paper impregnated with paraffin are of the same order as those of a gutta-percha submarine cable, and an exact match of these constants is not essential. The question of maintaining the conductor resistance of such a condenser constant under varying temperatures is a more difficult problem, and is one which, so far as the author is aware, has not been successfully solved. The manufacture of such artificial cables is very expensive, owing to the difficulty in handling the thin grid of tinfoil; this may, however, be overcome by the use of foiled paper, since, owing to the thinness of the conducting film, the strips are much wider than if made of metal, and they are, consequently, more easily handled.

The workshop apparatus required for testing condensers during and after manufacture depends, to a certain extent, upon the conditions of service. Assuming that the condensers are required to comply with the requirements of the Post Office specification, the most satisfactory testing set will be found to be a good strained-suspension reflecting galvanometer, carefully calibrated for proportional throws and deflections, together with the usual universal shunt box, short-circuit and reversing keys, and a primary or secondary battery giving at least 400 volts. The galvanometer and other testing instruments must be carefully "guard-wired," otherwise the tests will be more or less vitiated by leakage. The specification of the National Telephone Co. provides for tests of a less simple character. These tests involve the use of sinusoidal alternating currents of speaking and ringing frequencies, and require apparatus of special construction. The author gives in an appendix the technical details of this specification.

Electrolytic Cells.—These have not been received with much favour in this country, but they were at one time used to a considerable extent in Germany for common battery telephone work. The only advantage which these "polarisation cells" possess over condensers is with respect to size, a cell, or a set of cells capable of stemming back a direct current of 25 volts having a volume of only about 5 cubic in. On the other hand, the cost of such a set of cells is from three to four times that of a condenser of equal effectiveness. The cells used appear to be of three classes—viz., "acid cells," consisting of two small electrodes of platinum dipping into an acid solution; "sodium cells" (natronzellen), in which the electrolyte is a solution of a sodium salt; and aluminium cells, in which the electrodes consist of aluminium, and the electrolyte is some kind of basic solution. The acid cells have a damming effect of about 1·8 volts each, the sodium cells about 2·7 volts and the aluminium cells as much as 30 or more volts. The disadvantage of the polarisation cell is that it is more or less leaky, both electrically and mechanically. The permanent polarisation current passing through each cell is small, but on a system of many thousand subscribers the aggregate leakage becomes considerable. The mechanical difficulty is, however, the more serious one. If the cells are hermetically sealed they are liable to burst owing to the gradual accumulation of gas. To avoid this difficulty some forms are provided with a simple release valve. This is particularly necessary with aluminium cells.

We hope to give an abstract of the discussion in our next issue.

CORRESPONDENCE.

IS THE CONSULTING ENGINEER NECESSARY?

TO THE EDITOR OF THE ELECTRICIAN.

SIR: When I saw the above heading to the leader in your issue of last week, I began to wonder whether you had added yourself to the list of those who sit in judgment on the consulting engineer, or whether a certain department had decided that, owing to the extended scope of its inquiries, consulting engineers were no longer necessary for the schemes it is called upon to investigate.

Happily it was neither of these, and I soon found myself interested in the very clear and concise article, which to the best of my recollection is the first that I have seen in print which attempts to deal fairly with the question.

I venture to think that after a somewhat prolonged attempt to dispense with the consulting engineer the time is not far off when he is coming into his own again, more firmly established than ever now that experience has taught both the purchaser and the seller that his function can be exercised with considerable advantage to both.

A rumour is but a rumour at the best, but certain firms are said to have come to the conclusion that fortune was within their grasp despite these hard times if only they could short circuit the consulting engineer and get to the purchaser direct. The consulting engineer was short-circuited, they got to the purchaser direct, but if increased gains have accrued to them on that account they are certainly very quiet about it.

Then, again, what about lamps sold on the basis of wattage per Continental candle, instead of per British candle? What about motors made abroad and rated for higher output than for the same size of motor made at home? Is it of no advantage to the home manufacturer that the consulting engineer should insist on the British rating, instead of the foreign one; and is it of no advantage to the purchaser and to the electrical industry generally to have an intermediary who knows sufficient to insist that there is a proper relation between the goods supplied, the work they have to do and the price paid for them?

Then, again, from the point of view of the Institution of Electrical Engineers, the consulting engineer is a sheer necessity. Where else can the Council find arbitrators when invited to select them? The contractor, who, impartial as he doubtless would endeavour to be when called upon to perform duties of this kind, still has interests which tend to disqualify him *quâ* arbitrator.

Having regard to what one has seen and heard during the last few years, there is no doubt that the burden of unprofitable competition, as far as the manufacturers are concerned, would be greatly lightened if they would come to an understanding and refuse (as builders do) to tender, except on a document stating concisely what is wanted, drawn up by a competent and impartial person. It is probably no exaggeration to say that if this were done the costs of their estimating departments would be reduced by anything from 50 to 75 per cent., with corresponding advantages both to them and to the purchaser.

Many of the difficulties that have arisen are due, I believe, to a cause beyond the control of most of the parties concerned, and the remedy lies with the Institution of Electrical Engineers, who would doubtless move in the matter if only someone would draw their attention to it. At the present moment the purchaser has no means of ascertaining who is a qualified consulting engineer, and who is not. If he desires to find an architect or a surveyor, he has only to refer to the lists of the respective institutions.

Cannot our Institution in a similar way decide what shall be the qualifications and restrictions to be imposed on a consulting engineer, and afford all those who are prepared to subscribe to them the opportunity to be put on a list to be compiled, and to consist of consulting engineers only?

Would-be clients would thus immediately have available the information they require, while if any member found that the restrictions imposed did not tend to his advantage or further his interests he could immediately meet the situation by removing his name from the list.

Failing some such basis of operation, professional etiquette is a hollow sham which will continue in the future, as it has done in the past, to serve simply as a wreath to the brow of the gentleman of independent means who has adopted the profession as a pastime.

The mere ordinary mortal, however, who has to work for his living, will, if he be wise, treat with scorn a professional etiquette that brings him no compensating advantages. He will lose no opportunity, provided only that it is right and honourable, to turn his energies and business abilities to the best account. He will thus further the primary object for which he engages in his profession—that is to say, the securing of a competence for the present, and some assurance for the future, when, on account of advancing years, he may reasonably ask for rest from his labours.

With apologies for troubling you at such length, I am, &c.,

London, May 12. LUMEN.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: I have read the leading article in your current issue with much interest, because it seems to me that the subject, which is one of great importance to the electrical industry, could not have been raised at a more opportune moment or (adequately) by a journal of less standing than *The Electrician*.

The consulting engineer is necessarily suffering from the depression in trade, which is felt by the manufacturers to a larger extent. But he, as a class, is also suffering because of his sins of commission (and omission). Theoretically, the consulting engineer is the ideal intermediary between the contractor and the customer; by means of a lucid specification, easily understood by both sides, he puts all the manufacturers on the same footing, causes the work of preparing estimates to be reduced to a minimum, and so saves time and money to the contractor, and indirectly benefits the customer. Afterwards he sees to the proper carrying out of the contract, protecting the customer's interests whilst securing payment at reasonable intervals to the contractor. Finally, he passes the work and receives his own commission, all sides being pleased and everyone lives happily ever afterwards.

But what has happened in actual practice in many cases is that the consulting engineer, feeling himself in a position of power, has proceeded to saddle the trade with his fads instead of accepting what the trade, by long experience, has evolved as standard. Consequently the manufacturer has been put to the expense, when quoting, of preparing plans of special apparatus, and, if he secures the order, of making patterns which may, perhaps, never be used again. The customer has to pay extra for these luxuries, and often, in the end, the special apparatus has failed, owing to the contractor's want of experience in the particular and special design. Again, the specifications have often been badly drawn, nebulous and full of legal quibbles. Consulting engineers have also put manufacturers to the trouble of filling up endless schedules of quantities, giving rates each and per dozen, and in the end squeezing the contractor to supply single articles at the dozen rate. These, and many other things, caused one of our humourists in the old days to propose the opening of a night school for consulting engineers.

Naturally the manufacturers have become somewhat tired of these methods on the part of the "goats"; and, unfortunately for the "sheep," he has classed them all as one species. Similarly, also, the customer, being on the saving tack and perhaps once bitten, tends to approach the manufacturer direct. You thus have two mutually attractive bodies. Now, having tried to short-circuit the bad consulting engineer for some time, both parties feel the want of the ideal intermediary. The manufacturer cries out because he has to prepare expensive estimates, and the customer is not satisfied because he fears all along that he is being "had" owing to his want of technical knowledge.

The remedy, Sir, is obvious. No manufacturer should quote direct to a customer, but should point out that in the interests of both it would be best to employ a consulting engineer. And he might ask the customer to agree with him on one name from a list of consulting engineers that he would submit. Needless to say, the "goats" should be omitted from this list. To make the position still more secure, it should not be impossible for manufacturers to agree on a common line of action in this respect.—I am, &c.,

London, May 13. MANUFACTURER.

THE SO-CALLED "CONTRACTILITY OF NERVE."

TO THE EDITOR OF THE ELECTRICIAN.

SIR: The statement by Prof. Bose, in his book on "Comparative Electrophysiology (reviewed in your last issue), that nerves contract when stimulated by electric discharges, has been tested experimentally by Prof. A. D. Waller and Miss H. P. Kemp, who demonstrated before the Physiological Society, on March 21st, that the phenomena are simply due to the heating effects of the current and may be obtained equally well with a fiddle string.

A piece of nerve taken from the leg of a dead frog—or a piece of fiddle string—is suspended from a suitable support, and to its lower end is attached a light lever so arranged as to magnify any movements of extension or contraction. The end of the lever is in the field of a lantern objective, so that the total magnification of the movements amounts to some 400 times. When the discharge of a small induction coil is passed through the nerve—or the fiddle-string—for about half a second, it instantly stretches slightly, rapidly returning to its original length. This may be repeated quite a number of times. With a longer closure of the key the initial lengthening is followed by a contraction which may be partly recovered from several times, but ultimately if the current is continued becomes suddenly very great. And the fiddle-string shows these phenomena as well as the nerve.

The explanation is extremely simple. The first effect of the heat generated by the induction currents is to render the substance more extensible, and it accordingly stretches under the weight of the lever. The next effect is to dry it so that it shrinks momentarily, expanding again in the moist atmosphere of the experimental chamber. And the final effect of the heat evolved is to cook the nerve or frizzle the fiddle string, causing the large visible contraction. Calorimetric measurements by Mr. W. Waller gave data from which it could be shown that the rise of temperature might well be about 1·35°C. per second.

The so-called "contractility of nerve" has, therefore, nothing to do with its physiological properties, but is simply an effect of heating and drying.

Moreover, it requires to produce it a strength of discharge about 10,000 times greater than the currents in ordinary use for physiological purposes, and some 365,000,000 times as great as the smallest electrical stimulus that will produce the true response of nerve.—I am, &c.,

Oxford, May 11. GEORGE J. BURCH.

PRINGLE'S GROOVE SKID EMERGENCY BRAKE.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: I have been very interested in reading your descriptive article on this and also your Note dealing with same in your issue of the 1st inst. In the latter you refer to the fact that in this particular form the brake cannot be graduated, and that it is either on or off, or at maximum or nothing.

I should like to be able to state some of my reasons for adhering to this principle in relation to the brake problem. This particular form of brake has been designed with the main object of reducing the liability of failure in the personal element to the minimum. It appears to me, given that an emergency condition exists, that the only call on the motorman or conductor should be the exercise of the most simple and elementary of motions, and that the brake, when once applied, should not be capable of being graduated or removed, but be instantaneously at its maximum and remain so until the car comes to rest. In other words, given that an emergency condition has arisen, all further responsibility after this one action should, if possible, be removed from the motorman or conductor.

The mental and physical strain on them in the event of a runaway is exceptionally severe, and it seems to be that providing this brake with a means of graduating its power at once places considerably more responsibility on the motorman or the conductor, and by this means increases the liability of failure in the personal element, a failure which has been present at, and contributable to, nearly every tramway accident recorded.—I am, &c.

Electricity and Tramways Department, P. J. PRINGLE.
Burton-on-Trent, May 11.

THE THEORY OF ALTERNATE-CURRENT TRANSMISSION IN CABLES.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: It is very satisfactory to notice from Mr. Cohen's letter in your issue of the 1st inst. that there is comparatively little difference between his measurements of the effective insulation of cables at telephone frequencies, and those of Herr Gáti. We are therefore justified in concluding that this effective insulation is of the order of 0·1 megohm per mile, and we have Mr. Cohen's own authority that loading coils can be made giving an inductance of 0·4 henry per mile without appreciable effect on the effective conductor resistance. As this is sufficient to produce a distortionless circuit with the above leakance, we may take it that there is no objection to the realisation of this condition in practice. Of course, if it had not been possible to use so much inductance, I quite agree that it would be inadvisable to reduce the insulation to a very low value for the sake of strictly fulfilling the distortionless condition.

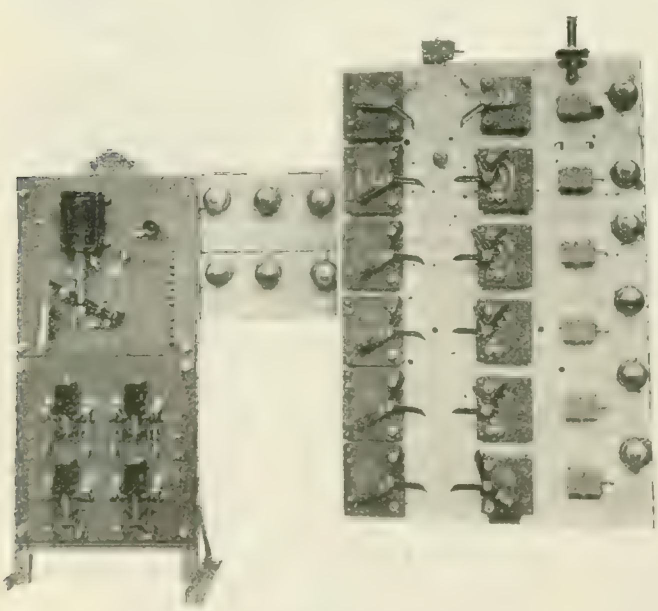
The only point now in question is Mr. Cohen's statement that "the probability is that the insulation as measured by alternating current varies to about the same extent as the insulation measured by direct current." If this is to imply that there is approximate proportionality between the insulation measured in these two ways, and that therefore the direct-current insulation may be taken as a criterion of the effective alternate-current insulation, it appears to me somewhat surprising. It is quite possible that Mr. Cohen may have found this to be the case with certain cables, but I do not think that it can be a general rule, and it would be very unfortunate if this idea were accepted and acted upon without certain evidence. The dielectric losses appear to be so much more important than the actual leakage, that attention ought to be concentrated principally on reducing them.

I am much obliged to Mr. Cohen for his information concerning the oscillograph test, but am sorry that it was not made on a cable rendered distortionless by inductance coils, as it would have been most interesting to see if the theory was confirmed.—I am, &c., CHARLES V. DRYSDALE.

Northampton Institute, E.C., May 12.

PUSH-BUTTON LIFT CONTROLLER.

The accompanying illustration shows a complete push-button controller which has been constructed by Messrs. Adams Mfg. Co. for a six-floor lift. The apparatus is shown all together, mounted roughly on a board for testing purposes, and it will be seen that it consists of a control panel, mounted in a convenient form so



ADAMS' PUSH BUTTON LIFT CONTROLLER.

as to stand upon the floor, six patent magnetic push buttons which are intended to be mounted inside the car, six patent magnetic push buttons which are intended to be mounted one upon each floor at each entrance to the lift, and also six tappet reversing switches and six tappet switches to insure accuracy of stopping. There are also seven gate switches, one for each gate giving access to the lift and one for the gate of the car itself, as well as a floor switch and a small emergency push button, which can be used by the passenger to stop the lift instantly at any position in case of emergency. The tappet reversing switches, as well as the tappet switches for accurate stopping, are operated by the travel of the car itself, so that the operation of this lift is entirely automatic and does not require the intervention of an attendant at all.

By this system the attendant is dispensed with and released for other work. The passengers operate the lift themselves, and their time is not wasted waiting for the attendant. The method is so simple that even a child can work it, and accidents are said to be impossible, because the human faults of carelessness and forgetfulness have no chance of operating. To call the car the passenger presses a button just as if ringing a bell. If not already in use, this causes the car to come to the passenger, stop opposite to him, and unlock the gate for him to enter. Having entered and closed the gate behind him, he presses a button inside the car which is labelled to correspond with the floor to which he wishes to travel. This causes the car to travel to that floor, where it stops and unlocks the gate for the passenger to alight. When he has alighted and closed the gate, the lift is at the disposal of any other passenger.

The advantages of this method of control are briefly summed up by Messrs. Adams Mfg. Co. as follows: Always available day or night; no attendant required; the lift cannot be started while any gate is open; no gate can be opened unless the car is opposite to it; cannot be operated from outside while a passenger is in the car; passenger has sole control; in case of emergency the passenger can stop the lift instantly by pressing the emergency button, and can start it again at his pleasure, but it will not start again until he starts it.

SEARCHLIGHT PROJECTORS.

In addition to their use for naval, military and mercantile purposes, there is an extensive field for searchlight projectors in connection with the navigation of canals and rivers by night, locomotive head-lights, &c.

Considerable attention is now being paid by Messrs. Johnson & Phillips to this branch of their manufactures, and they have recently brought out new designs. The Admiralty pattern of projector, as manufactured by this firm, is shown in the accompanying

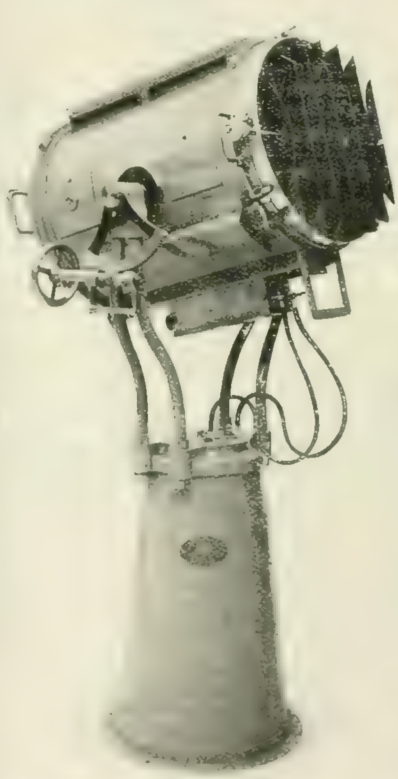


FIG. 1. MESSRS. JOHNSON & PHILLIPS SEARCHLIGHT PROJECTOR (Admiralty Pattern).

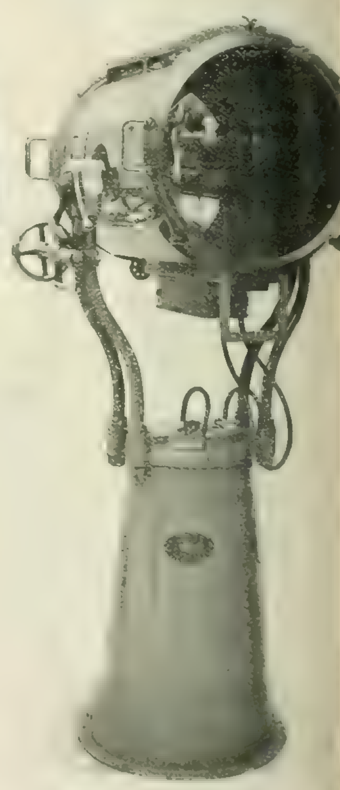


FIG. 2. END VIEW OF PROJECTOR.

illustrations. It will be seen that the projector is carried by a stout sheet iron conical pedestal, having brass or gunmetal fittings. The gunmetal turntable revolves freely upon large balls fitted in carefully designed races, the barrel itself being carried by bent steel tubes, thus combining strength and lightness. Gearing is also provided, if necessary, for both horizontal and vertical movements, with suitable locking arrangements, and switches can, if desired, be inserted in the pedestal.

The yacht-pattern projector is mounted upon a cast-iron base, having a cast-iron fork, revolving on ball bearings, to carry the barrel. Concentric connections are arranged between the barrel and the fork, so that the barrel can be swung completely round without disturbing the connections.

In all cases the lamps are of a special horizontal pattern, and are arranged to operate automatically or by hand, as desired, in the former case very sensitive regulation being obtained. The operation of changing from one condition to the other consists merely of turning a small knob. The standard sizes of projectors made by Messrs. Johnson & Phillips range from 7 in. to 36 in. in diameter, but larger sizes can, of course, be supplied if desired. Ordinary dispersing lenses are provided, and also special lenses giving the dark interval required for canal navigation.

THE FARADAY SOCIETY.

The 34th ordinary meeting of the Faraday Society was held on Tuesday, April 28, 1908, at the Institution of Electrical Engineers, 92, Victoria-street, S.W. Prof. A. K. Huntington, vice-president, was in the chair

A Paper by Prof. A. K. Huntington and C. H. Desch, D.Sc., Ph.D., on

"The Planimetric Analysis of Alloys and the Structure of Phosphor-Copper"

was read by Prof. Huntington. Dr. T. M. Lowry occupied the chair during the reading of the Paper, which was illustrated by means of lantern slides.

The authors discuss the conditions under which it is possible to estimate the relative proportions of the constituent metals of an alloy by means of a planimetric measurement of the areas of the solid phases exposed in a polished and etched micro-section. Details of the method are given, and its accuracy is shown by a series of measurements of analysed alloys. The method has been most fully studied in the case of phosphor-copper, of which a number of photo-micrographs were shown. In the case of alloys containing less than the eutectic proportion of phosphorus, however, the area of the copper crystals is found to be considerably greater than that calculated from the composition determined by analysis. The origin of the discrepancies was traced to the segregation of the eutectic, the copper crystals which separate at first drawing to themselves a portion of the copper of the surrounding eutectic. The crystals are, therefore, surrounded by a belt of copper phosphide. By measuring the area of this belt, and thence calculating the amount of segregated copper, a correction may be applied to the area of the crystals, and a very satisfactory agreement with the analytical results is thus obtained.

Prof. W. W. Haldane Gee communicated suggested that the method might be used to compare the relative losses of the constituents of an alloy after prolonged etching with different reagents, or after electrolytic corrosion, and so throw light on the method of corrosion.

Dr. C. H. Desch stated, in reply to a question, that the method could not be of quite general applicability, it being useless, for example, in cases where the alloy was homogeneous. It was also necessary for the alloy to be in a state of physical equilibrium.

Prof. A. K. Huntington added that the method would probably be usefully extended to the case of the phosphor-tin alloys.

A Paper on

"The Interaction of Aluminium Powder and Carbon,"

by Frank E. Weston, B.Sc., and H. Russell Ellis, B.Sc., was read in abstract by Mr. Weston. Very little work has been done on the combination of Al and C at temperatures lower than that of the electric furnace. Franz Fichter (*Zeits. f. Anorg. Chem.* 1907, 54), using a mixture of soot and aluminium, produced an impure aluminium nitride; Matignon (*C. R.*, CXLV., No. 17, 1907), using a mixture of lampblack and aluminium, obtained a product, on heating in a Perrot furnace which yielded a gas with water consisting of 96·36 per cent. CH_4 and 3·36 per cent. H. The authors have shown that the Al powder and carbon can be made to react at temperatures much below that of the electric furnace. Mixtures of Al powder and carbon, wood charcoal, sugar carbon and graphite have been prepared, in which reaction takes place in starting with a fuse of Mg powder and BaO_2 as in Goldschmidt's reaction; other mixtures have been made which only react when heated at temperatures varying from 400°C. to 1,000°C. In all cases the products of reaction were found to be aluminium carbide (9·12 to 65·91 per cent.), aluminium nitride (3·67 to 42·16 per cent.), alumina (11·07 to 55·4 per cent.), aluminium and carbon. The carbide produced is most probably that described by Moissan as Al_4C_3, since the gas obtained on treating the product of reaction with either water or hydrochloric acid was found to consist of CH_4 and H, the latter coming from (1) the action of HCl in unaltered Al, (2) action of NH_3 on Al, the NH_3 being formed by the action of water on the aluminium nitride. The authors are of opinion that the chief cause of the reaction is to be found in the initial oxidation of the carbon, by atmospheric (and occluded) oxygen to CO and CO_2 the heat of this reaction causing the oxidation of some of the Al to Al_2O_3, and the heat of this reaction causing the combination of the Al with carbon and atmospheric (and occluded) N. (See Matignon.) This view is supported by the fact that very little action took place in a mixture of Al and wood charcoal when heated to bright redness, in vacuo, in a steel tube, whilst the same mixture reacted energetically when heated in an open basin to just visible redness.

Dr. F. Mollwo Perkin did not agree with the authors' view as to the cause of the reaction. There was no evidence that at 1,100 deg. CO could be reduced. Possibly the reaction was started by superficial oxidation of the aluminium.

Mr. Charles Weiss referred to the aluminium carbides found at the bottom of the furnaces in which aluminium is made. As a rule these carbides were entirely enclosed in a coating of alumina.

Mr. H. R. Ellis gave some further particulars regarding the nitride produced, probably by the action of nitrogen at a high temperature on the aluminium carbide. As crude aluminium carbide can be made by heating clay and carbon in the electric furnace, this method might be as economical a one for the fixation of atmospheric nitrogen as the combination of calcium carbide and nitrogen to form cyanamide.

Prof. A. K. Huntington suggested that perhaps the author's reaction was a triple one, brought about by the presence of a gas (CO_2 or CO) between two solids which would not react alone. The gas, unlike the carbon, might be able to permeate the film of oxide surrounding the aluminium, getting at the actual metal, and so start the reaction.

A Note on

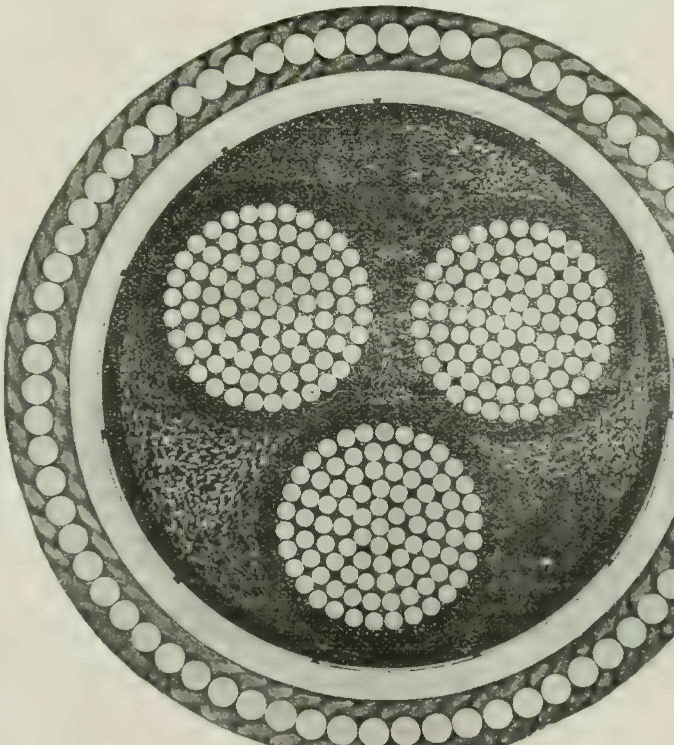
"Technical Chemistry in Russia"

was communicated by Prof. N. Piltschikoff.

The Paper refers to copper-refining works at Moscow and St. Petersburg and the Laschinsky electrolytic method of copper recovery from its ore which is used at Boleslav. The special feature of the process is to prevent oxidation of iron at the anodes, and consequent waste of current, by coating these with lead. The Gorbov and Mitkievitch arc furnace for the fixation of atmospheric nitrogen is about to be worked on a technical scale. In this the current of air draws the arc (the voltage across which is 600-1,500 direct or alternating) into a worm, in whose mouth is formed a "bunch of fire," through which all the air has to pass. The products of combustion are subsequently cooled in the further part of the worm. In an experimental 14 kw. furnace an output of 56 gr. HNO_3 per kilowatt-hour has been attained. The furnace is stated to be simpler and more economical than the Birkeland-Eyde furnace. Other processes mentioned are the late Prof. Kloboukoff's method of electric tanning, which prevents fermentation in the bath, and Dr. Danilevsky's process for depositing copper on leather. The purification of water by ozone is being experimented with at St. Petersburg, and at Moscow Prof. Sokotoff's powerful and economical ozoniser is being tried.

A LARGE CABLE FOR MINING WORK.

It has always appeared to us that the lot of the cable maker is a varied one (about its happiness we know nothing, and, therefore, will pass no opinion), for not only has he to make quite small wires



Full Size.

suitable for winding instrument coils, but he also soars to great heights in the manufacture of cables suitable for large power transmission schemes. Again, the processes by which his results are arrived at are very different, for the methods of manufacture employed in turning out a cotton-covered wire and a lead covered and armoured cable cannot by the most elastic stretch of the imagination be called the same.

The employment of electricity in mining work naturally makes for the use of cables of large size. The great demand which is concentrated within a comparatively small area of supply, even

when a fairly high voltage is used, makes an ample cross section of copper necessary, while the almost obligatory employment of three-core cable in three-phase work increases the area of copper covered by one armouring. A firm who are making a speciality of this kind of work are Messrs. W. T. Henley's Telegraph Works Co., of Blomfield-street, London, and among their products may be mentioned a three-phase cable of 0·8 sq. in. section for a working pressure of 3,000 volts, recently manufactured by them for the Powell Duffryn Steam Coal Co. of Aberaman, near Aberdare, which we illustrate in the accompanying figure.

This cable is, it is claimed, the largest ever installed in a colliery; it is one of the largest ever made for any purpose, the total weight being 65 tons per mile, the overall diameter 4¼ in., and the breaking stress 40 tons. It is of the three-core type, the conductors being composed of 91 plain copper wires, each 0·104 in. in diameter, equivalent in sectional area to 0·8 sq. in. These are insulated with paper impregnated with special insulating compound to a diameter of 1·34 in. The three cores are then laid up with specially prepared wormings and a further covering of impregnated paper to a diameter of 3·06 in., making a total insulation thickness of 0·190 in. The cable is also sheathed with a Board of Trade earth shield composed of copper strips, covered with a continuous seamless tube of lead 0·16 in. in thickness, served with a heavy coating of tarred yarn and armoured with 70 galvanised-steel wires each 0·160 in. in diameter. It is then finally served with another heavy coating of tarred yarn and waterproof compound to an overall diameter of 4·25 in.

Messrs. Henley's are to be congratulated on the successful manufacture of such a cable, which is a very Forth Bridge in its way, and even if, as we are told, the days of the three-core cable are numbered, it will remain as a monument to the skill of this well-known firm of cable makers.

PARLIAMENTARY INTELLIGENCE.

(Continued from page 175.)

LORD WELBY asked why perpetuity had been spoken of, and Mr. Bushe explained that under the Bill a body would have to be authorised by Parliament to acquire the undertaking at any time.

By Mr. ERSKINE POLLOCK, K.C. (for Middlesex C. C.): Several of the districts in Middlesex for which they wished to take powers were supplied by the North Metropolitan or by the Metropolitan Co., with the local authorities as distributors. The North Metropolitan Co. also supplied current to Middlesex C. C. tramways. The power company there might under some circumstances take supply in bulk from the new company. The loss in transmission from Barking would not be more than 5 per cent. Stage A of their scheme provided for expenditure in Middlesex, and the expenditure for the second stage practically included £1,527,000. He certainly objected to striking Middlesex C. C. area out of the scheme. He was not sure that they would not get the tramway supply.

By Mr. FREEMAN, K.C. (for London C. C.): The area of the present bill was the same as the L.C.C. bill of last year. The system and the site for the station were also the same as in the L.C.C. bill. It was not intended that the bill should give them power (which Mr. Freeman said it gave in its present form), to pay 8 per cent. dividend from the very beginning if the money were earned. The Administrative people accepted a purchase clause in the later stages. He thought that clause gave power to purchase at the value of the undertaking without value of goodwill. In regard to the provision in the present Bill that they should receive, in the event of purchase, an additional amount that would raise their dividends up to 6 per cent. per annum, they thought power companies should not be purchasable, and that as they traded on a very small margin of profit and would give the public the best possible service, there should be some certainty for their capital.

In reference to the purchase clause LORD WELBY remarked that it appeared to be an open question whether obsolete plant might not have to be included in the purchase price, and Mr. Freeman said it was obvious that if the plant had not been kept perfectly up to date some of it would be obsolete at the end of the 42 years.

Mr. PARSHALL, further cross-examined by Mr. Freeman, said he did not think it unreasonable that a public body who wanted to purchase all the electricity undertakings in their area in 1931 should have to pay his company such an amount for goodwill as would represent their earnings until the end of the 42 years, provided the value were properly ascertained. Such a provision was necessary to induce people to finance such an undertaking. He thought "their value" should be the money that had been spent on plant, provided it had been kept in good working order.

Mr. FREEMAN said what his clients wanted was that at the end of the period they should not have to pay for machinery which, although properly bought, was then obsolete.

Mr. FITZGERALD said Lord Cross's Committee laid it down that there should not be a purchase clause in power companies, and there had been none in previous power bills. The promoters of the present bill would have no objection to being put on the same terms as gas and water companies as to purchase, but if they were put on the ordinary terms of the Electric Lighting Acts there might be considerable difficulty in raising capital. Owing to the terms of purchase under the Electric Lighting Acts the ordinary electric lighting undertaker was not limited in the amount of dividend. Some of them in London paid 10, 12, and even 14 per cent. In the present case the dividend was to be limited, and there was a purchase clause as well, and if the undertaking was to be successful the purchase clause should be one that would not prevent capital being raised. They were making a concession that had not been asked from the promoters of any power bill that had been passed. The Administrative Bill as introduced did not contain any purchase clause, but after it had passed Lord Camperdown's Committee and when it got to the House of Commons and was passed on second reading, a member authorised to speak for the promoters said they would assent to a purchase clause being inserted, and a purchase clause was brought up and settled by the committee. That was not the same as in the Electric Lighting Acts nor the same as that proposed in the present bill.

When the Committee met on Tuesday Mr. FITZGERALD said he found that, as Mr. Balfour Browne had said, the provision in the general law making it a penal offence for employes of contractors or bodies supplying gas or water under statutory authority to join in strikes did not apply to electricity undertakings, but the statute was the Conspiracy and Protection of Property Act, 1879, and not a Criminal Law Amendment Act. The promoters had no objection to its being extended to electricity, but he did not think it could be done in the present bill, but would have to be made the subject of a public bill. With regard to the method by which the statistics of the power in use in London which was not supplied by electricity had been compiled, one source was a Home Office return showing the number of factories and the number of hands engaged. Other information was obtained by Mr. Parshall from the L.C.C., and was compiled for another purpose, viz.: in connection with the Council's powers as to providing means of escape from fire in all factories employing over 40 hands. That information was not intended for publication, but it served to assist the Council with their estimates put before Parliament in their Electricity Supply Bill of last year.

Mr. PARSHALL, in further cross-examination by Mr. Freeman, said one third of the surplus profits of the new company, after payment of 8 per cent. dividend, would go to sinking fund, which would benefit the purchasers at the end of 42 years. He did object to the insertion of a sliding scale of dividends and prices for current, because a load factor might develop which would reduce their receipts although their expenses would not be any less.

By Mr. WEDDERBURN, K.C. (for Croydon Corporation): Croydon was a residential district. He did not agree that the ratepayers would suffer from competition by his company if it entered the district. He declined to agree that his company should be precluded in its Bill from seeking to get provisional orders in districts where Corporations already had orders. It was a matter for argument by counsel. He did not agree that if his company and the present undertakers worked in combination they would not share alike, because the latter supplied only for the peak load. They would get the benefit of the company's 40 per cent load factor.

By Mr. BLENNERHASSETT, K.C. (for Westminster City Council): He believed Westminster Corporation could buy the seven electricity supply companies undertakings which supplied the district in 1931 without anything for goodwill. He also accepted the statement that under the Central Electric Supply Co.'s Act, 1905, the Corporation could buy that company's Marylebone station on the same terms. It was not correct to say that an undertaking could not be successful without a demand for power purposes, as a great many companies got on without it, although a power demand was a valuable adjunct to an electricity supply undertaking. There was no precedent for the powers they proposed to take which would enable them to come into Westminster (amongst other places), to supply electrical energy to railways and tramways, but they bound themselves by certain terms. If a decision of any body had to be sought before the company could acquire and alter an existing undertaking he would suggest the Board of Trade in preference to the City Council.

By Mr. EDWARD MORTEN (for West Ham): Mr. PARSHALL said: There was nothing to prevent his company coming to West Ham and cutting rates to get a footing, but he did not think it likely they would do so. According to the bill, consumers with a demand over 250 kw., with load factors of 25, would have to be supplied by the Corporation at 0·5836d. (which Mr. Morten said was exactly their works cost). Unless they were content to supply to consumers of that description at that price the Company could come in provided they could offer a better price. As Mr. FitzGerald had said, West Ham supplied for power at 0·95d. in 1907.

Mr. FITZGERALD offered to insert in the bill the same provision as had been inserted for the protection of the London United Tramways, but Mr. Morten said that would not be of any use to West Ham, as their undertaking stood on a different footing.

By Mr. A. B. CANE (for Marylebone): Despite the price paid by the Council for the Metropolitan Company's undertaking in that area, he thought it fair for his company to compete with Marylebone Council, who would be given the benefit of the Company's low prices. Local authorities costs were on the average cheaper than the companies because they were more recent. The reason electrical plant could now be installed at a cheap rate was not merely because electrical invention had advanced, but particularly because it had advanced on such lines that it would be beneficial to create a big

central undertaking. The saving to Marylebone Council by taking their day load from the company was estimated at £3,435. The fact that the works costs at Marylebone were only £23,000 (as stated by Mr. Cane) instead of £28,870 (as stated in Table 3), although the load had been increased, would not wipe out the proposed saving entirely, because the saving would be the difference between the works cost and the cost of the combined supply. If the company charged the Council the maximum price the saving would doubtless disappear, but if the maximum price was charged the company would not expect to do business with the Council.

In reference to Mr. Cane's observation that as all distributors would have a separate source of supply the Company would not (by the terms of clause 57 of their bill) be bound by their schedule prices, Mr. FitzGerald said that was a usual clause in such bills, and was known as the stand-by clause. It had been passed by a Committee of the House of Lords, and was intended to avoid the difficulty supply companies had to meet in cases where, after the company had gone to expense in providing a supply, a consumer who had a separate supply only used the public supply in emergencies. Under the stand-by clause he was obliged to take current up to a certain amount or in any case to pay that amount. It was passed by the Sir James Kitson's and Lord Camperdown's Committees.

By Mr. Courthorpe Munro (for St. Pancras Council): He agreed that if the Committee found that the company were not going to confer any substantial benefit on a material portion of the rate payers they would be justified in saying they should leave St. Pancras alone. He supposed there would be few power users over the 250kw. limit in St. Pancras. His company's prices would work out better for the consumers than the prices in Mr. Merz's bill. The higher the load factor the better it worked out. He was not surprised that in instances which Mr. Munro mentioned of people who had taken advantage of the Council's offer to supply at the prices in Mr. Merz's bill (£4 per kw. and ½d. per unit), in preference to the Council's previous charge of 1d. flat rate, the consumers had found the charges work out higher and afterwards asked to be put on the 1d. rate, because their load factors were very low—10·2 and 6·7.

In reply to Lord Saunderson Mr. Cane said most people in London had low load factors, and he was endeavouring to show that the company's charges were more than St. Pancras was now charging for power.

By Mr. Williams (for Stepney Council): They reason they asked for five years to carry out their work was not because they were doubtful of their finance. The new company did not propose to take the Councils' undertaking from them. They might compete with them, but they would give them the opportunity of taking advantage of the Company's prices.

By Mr. Gerald Sanders (for Islington Council): Islington supplied current for power under certain conditions, at a flat rate of 1d. He did not know that he would quite say that the Islington undertaking had been an improving one. If the company supplied the Council at 0·8d. the latter would not necessarily have to add something for distribution, as they would buy the current at a better load factor than they would sell it at. He would not bind himself to accept a clause to the effect that if the company commenced to supply in a district they should be bound to continue to do so. They were taking 11,800 B.T.U. per pound as the result of the fuel combustion, and 15½ lb. as the steam consumption per unit at the generator. They would have to make a separate calculation for the steam consumption per unit sold.

This concluded Mr. Parshall's cross-examination, and the Committee then adjourned till Wednesday.

Mr. Parshall, re-examined by Mr. Fitzgerald on Wednesday, said that in regard to the suggestion that they could, under clause 52, get into a district by quoting a ridiculously low price, and might afterwards raise the price, under the terms of that clause they must give the local authority the option of taking current from them at the price quoted. If they quoted an absurdly low price, the local authority had the first call upon cheap electricity. As to Mr. Blennerhassett's suggestion that under the provisions of clause 73 of the bill they might buy up the seven companies supplying Westminster, what clause 73 enabled them to do, was by agreement with any authorised undertaker and with the approval of the Board of Trade, and on such terms and conditions as the Board of Trade sanctioned, to take over the undertaking of the authorised undertaker. In certain circumstances they might take over undertakings, but of course, not undertakings doing well, as these would require a large amount of capital. The seven companies supplying Westminster represented the most prosperous companies in London. He agreed that if they were foolish enough to follow the example of Marylebone Council and were to proceed to purchase the seven Westminster companies, their case would be seven times worse than that of Marylebone They were not interfering with Marylebone except for a very small power portion of their business. In regard to other large bulk supply schemes, witness said in addition to Chicago, there was New York, which, so far as the lighting was concerned, relied now on one bulk supply station. Then the various traction companies had their own stations.

Mr. Robert Hammond was the next witness, and was examined by Mr. Clode. The feature he had always considered a most important one was the fact that, in consequence of the parcelling out of London into districts, with the idea that the local authority should only operate in its own particular district, had led to one generating station one district. The outcome was no less than 66 generating

Estimate of Power Requirements in Area of Supply made by London County Council Officials in 1907, as quoted by Mr. Hammond

	Number of Factories.		Total number of persons employed.		Power requirements in proposed area estimated in H.P.
Administrative County of London, and City of London	9,332	...	361,287	...	293,887
Essex	661	...	35,721	...	35,976
Kent	320	...	19,402	...	18,971
Surrey	321	...	5,158	...	5,921
Middlesex	349	...	14,862	...	16,240
	10,983	...	436,430	...	370,995

Trades in H.P.	
Chemical	24,711
Brewing	18,811
Mills	71,325
Engineering	114,866
Printing	22,155
Builders' Materials	12,137
Textile	1,593
Ordnance	32,269
Laundry	5,003
Miscellaneous	68,125
Total	370,995

stations. In addition, there were eight stations for railways, and two stations for tramways, making practically 76 stations within the London area. The idea of linking up only perpetuated this evil.

Mr. Hammond proceeded to give the Committee a technical description of the process of linking up. This was followed by a clear exposition by Mr. Hammond of the set of 23 tables compiled by the engineers for the Bill, and the titles of which are set out on page 172 *ante*.

In the course of his explanation of the tables, Mr. Hammond said in table 3 he had debited to cost of generation only 25 per cent. of the management charges, presuming that the heaviest cost of management was that connected with the distribution and collection of accounts. In regard to interest and depreciation, some of the London authorities had obtained loans for 42 years, but, as the equation of the plant over 42 years was outside the question, he had adopted the Local Government Board period of 25 years throughout. The number of units distributed, by both local authorities and companies, totalled 233,260,109, at a cost of £1,387,989. This worked out at close upon 1·43d. per unit, which was extremely high for the production of that enormous amount of electricity, and if this continued they would not get cheaper electricity. The mistake that had been made in the past was decentralisation. The supply should be centralised. The same mistake was made years ago in the case of the gas companies, when they had little gas companies in every district, but gradually amalgamations took place, until they got aggregation into two works only for London. Centralisation of electricity supply was taking place all over the world, and should also take place in London. He cited the case of the Niagara Falls scheme, and coming nearer home that of the Tyneside. It had been found that great railway companies went to the large bulk supply stations rather than put down their own stations. Only by aggregation could they get low prices. Table 5 showed the kind of installation he thought would solve the problem, and set out in two stages a description of the undertaking they proposed for London. Stage A showed that even with only a maximum load of 60,000 kw. the scheme would be a success. The aggregation permitted putting down the very largest sets; they wanted less plant because the supply was from one centre, and they got the advantage of the diversity factor. Coming to table 9, witness said that under the Bill the distributor was allowed to demand from the bulk company a supply of electricity of the kind he wanted, either alternating-current untransformed, transformed alternating-current, or direct-current. Hence the difference shown in the charges. In order to show how these charges worked out, witness had prepared a table of "Specimen Calculations and Prices" (this was put in). He particularly wished to state that table 11 was purely illustrative. It showed that if the bulk idea had been adopted years ago, the annual amount of energy would only cost in a bulk supply undertaking £747,917, against the present cost of £1,387,989, a difference of £640,072. The table illustrated the difference between the cost of generation at the present time and what the costs would have been had a bulk supply prevailed. It would be unsound policy to perpetuate this uneconomical state of things by adding to the generating plant in the various stations. From tables 13 and 14 they would see what would actually take place in each case, and the benefits that would accrue to those works utilising the supply instead of adding to their works. Taking Barking as an instance, here they would use their own plant until the time came when fresh plant was required. Instead of getting fresh plant, Barking would come to the company. In regard to table 16, which showed the growth of the demand for electricity supply, witness mentioned that at the present time the industry was passing through a keen crisis in reference to the "wire"

lamp, the first effect of which would no doubt be that the consumption of electricity in London and other places would not have such rapid growth for lighting as it had had in the immediate past. The "wire" lamp would at first be adopted by those now using the carbon lamp) whose electricity bills would come down because the amount of electricity consumed would be less. While this was the immediate effect, however, he felt strongly that the ultimate effect would be to greatly benefit the industry. In regard to tables 17 and 18, Witness handed in the above table giving "An estimate of power requirements in area of supply made by London County Council officials in 1907."

In any power bill dealing with this matter conscientiously the benefits should be shared by consumers. They did not think it wise to put in the Kitson clause, which brought in arbitration. Having offered the authorised distributor supply at the prices set out in table 10, each distributor would know exactly what price he would have to pay. The authorised distributor would get the benefit of the diversity factor. For instance, supposing the sum of the maxima of a number of consumers were 1,000 kw.; no two of these would synchronise, and the distributor would find that he would only have to call upon the Company for something very much less. He would, therefore, get a double profit. With a diversity factor of 2, he would only call for 500 kw. He would buy the 500 kw. at a load factor of 50 per cent. and sell 1,000 kw. at a load factor of 25 per cent. Witness considered, therefore, that the distributor was splendidly protected. In regard to consumers beyond 250 kw. big lots of power were more the subject of a power company than a lighting authority, and were therefore put in the same category as railways and other large consumers.

Mr. HAMMOND resumes his evidence this (Friday) morning.

PACIFIC CABLE.

Last week Mr. BELLAIRS asked the Under-Secretary for the Colonies whether the estimated loss to the British taxpayers (£62,590) on the Pacific cable for 1908-9 was mainly due to the faulty route selected, to the barren rock called Fanning Island, and whether it was practicable, and if so, would the question be considered in conjunction with the Colonial Governments, to under-run and re-lay the cable to Honolulu, so as to benefit British shipping, afford alternative routes by the American cables, and give a fresh route to the Far East?

Col. SEELY said the estimated loss on the cable for 1908-9 was £69,000, of which only five-eighteenths would fall on British taxpayers. The route via Fanning Island was adopted in accordance with the desire of the Colonial Governments that the cable should touch only British territory. In the absence of suggestions from those Governments H.M. Government did not propose to consider the question of re-laying the line so as to touch at Honolulu.

Burnley Corporation Bill.—The Police and Sanitary Committee of the House of Commons have passed the tramway portion of this bill, which authorises the construction of the existing tramway in Manchester-road to the boundary of the borough, the extension of the Rose-grove branch and also a branch tramway from the Duke Bar to Harlesdyke.

Tramway Brakes.—Replying to a question in the House of Commons on Thursday last week, Mr. Kearley said that the whole question of tramway brakes and their efficiency was now being investigated by a committee appointed by the Municipal Tramways Association, and another by the Tramways and Light Railways Association, and when their conclusions were received as to the best form of brake the question of legislation would be dealt with.

BOOKS RECEIVED.

(Copies of the undermentioned works can be had from *The Electrician* office, post free, on receipt of published price. Add 10 per cent. for abroad or for foreign books

"Elementary Manual on Applied Mechanics." By Andrew Jamieson. 8th edition. (London: Charles Griffin & Co.) 3s. 6d.

"The Evolution of Forces." By Dr. Gustave Le Bon. (London: Kegan Paul, Trench, Trübner & Co. 5s.

"Die Berechnung elektrischer Anlagen auf wirtschaftlichen Grundlagen. By Dr. Ing. F. W. Meyer. (Berlin: Julius Springer.) M. 7.

"Thermoelemente und Thermosaulen." By Prof. Dr. Franz Peters. Vol. XXX. of "Monographien uber angewandte Elektrochemie." (Halle a. S., Wilhelm Knapp.) M. 10.

"Die Messtechnik." Part IV.—"Wechselstrommessungen, Wellenstrommessungen und Magnetische Messungen." By Dr C. Heinke. Part V.—"Die Technischen Messinstrumente." By R. O. Heinrich and D. Bercovitz: Part VI.—"Die Electrizitätszähler. By [illegible]. (Leipzig: S. Hirzel.) M. 24.

"Collected Researches of the National Physical Laboratory." Vol. III. and IV. 1908.

"Proceedings of the Royal Society. Vol. LXXX. No. A. 539. Series A—Mathematical and Physical Sciences. (London: Harrison & Sons.)

"Science Abstracts." April, 1908. Vol. XI. Part IV. Section A—Physics. Section B—Electrical Engineering. (London: E. & F. N. Spon.) 1s. 6d. each.

LEGAL INTELLIGENCE.

Ernest Scott & Mountain (Ltd.) v. Kent Collieries (Ltd.)

The hearing of this case was resumed on Friday, when Mr. JAMES FELL, manager of defendants' colliery, said that it would have been possible to get to the bottom of the 620 ft. level with an ordinary pump in about a fortnight. He was not an electrician and could not say what was the cause of the breakdown they experienced. He came to the conclusion after the breakdowns in September and November that the power of the pumps was not such that they could take a full load. No test could show better the actual working of the pump, as to whether it was capable of taking the full load, than that which took place on Nov. 17, under the best conditions the No. 3 pump at full load took from 25 to 30 tons of coal. As the pump went down into the pit they had to put on new lengths of pipe, and to enable that to be done taps had to be put into the shaft. That was not completed until August or the middle of Sept. On July 31 they had not even commenced the work for the second stage because it was covered with water. Between Oct. 1 and 12, the No. 1 motor was rewound again at the Colliery, and it was ready to go on working in the shaft on Oct. 12. There was some pumping going on between Oct. 1 and 12 however. On Oct. 25 they were not ready with the winch rope for the second pump so that Morley was unable to erect the second pump at that time. He could not say that Morley often pressed him to complete arrangements in order to have both the pumps in the shaft at the same time. The arrangements for lowering the second pump were completed on Nov. 3, but they had no time to get it down in the shaft before the other pump failed. On Nov. 17 arrangements were made for working the pumps in series, one on the tangye level and one on the shaft bottom. He denied that when they proceeded to lower No. 2 pump into the shaft it was found that defendants had not supplied a long enough wire rope to enable the pump to reach the water level.

Mr. W. J. HORNER, a director of defendant company, had never heard a suggestion that both pumps were to be kept in the sinking shaft at the same time. Mr. Lancaster and he both came to the conclusion that the pumps singly would not do the work they were intended to do.

Mr. H. M. SAYERS said he inspected the machinery at Dover and made a report to defendants on Oct. 31. With regard to the motors he was of opinion they were not capable of carrying the full guaranteed load. He made calculations from the dimensions of the motors and the probable extent of heat loss, comparing the probable amount of loss with surface by which the heat had to escape, and he found that the quantity of heat lost per unit of surface was about four times as great as that usually allowed. The usual limits of the rise in temperature were 70°F, but in this case the temperature was 1½ to twice the usual limit. He attributed the breakdown which took place on Oct. 17 at a depth of 550 ft. to faulty construction and overheating. A motor of that kind required something in the nature of forced ventilation, and that difficulty could be got over by ventilating arrangements. That difficulty was successfully overcome when the alterations were made in No. 3 motor. Witness said that when cotton got charred that was not good insulation, this affected the breakdown because there were leakages of current through charred cotton which set up sparking, and caused rapid local deterioration of short-circuits at the turns. The pumps were not in a state efficient enough to submit to a test. As to the coal consumption he said he had no figures of the actual coal consumption from August, 1906, to December, 1907. The mere arithmetical capacity of the cylinder of the engine did not give conclusive indication of the power of the engine. With regard to the drying of the motor witness said he was sure that 10,000 volts had never been applied to the two terminals of the machines. What plaintiffs meant when it was stated that the motors were subjected to that test before leaving their shops was that the voltage was applied between the windings and the iron of the motor, which was a test of the insulation between the windings and iron of the motor; but was no test of the terminals. The moisture in the windings came from internal condensation for in the examination he found the presence of copper salts on the wires which pointed to the fact that the windings had not been properly dried. The circumstances of the breakdown of the motor also pointed to internal condensation as the cause. The presence of copper salts showed that the moisture must have been in contact with the wire for some time, and then again, if the water came from without, directly the moisture reached the live wire a path of conductivity would have been set up, and a breakdown occurred immediately. In two of the three motors which he examined there was insufficient cooling. The main cooling factor in motors of this character was the amount of surface for radiation. In the two machines in question the surface radiation was much smaller than the usual practice. This was an element distinctly connected with the breakdown. Plaintiff had undoubtedly relied upon water cooling and had not taken necessary steps to make the air radiation effective.

Mr. W. M. MORDEY, M.I.C.E., president designate of the Institution of Electrical Engineers, said he was called in to make a test of generating plant and one of the electrical pumps supplied by plaintiffs, and to ascertain whether the plant complied with the specification

and tender as regarded the output, the temperature of the alternators, and the steam consumption of the engine; also to find whether the electric pump worked under the specified conditions and was a satisfactory piece of machinery. Witness described in detail the results of his tests, &c. According to the specification the generating plant had to be capable of giving 300 kilo. volt. amperes as a normal full load with a maximum rise of temperature above the surrounding air of not more than 70 F. at the end of six hours normal full load run, each set to be capable of an overload 25 per cent. above normal load, or 375 kilo. volt amperes, to be sustained for half an hour, without excessive heating. With regard to the steam consumption the specification in the contract was that the engine should not consume more than 28 lb. of steam per kw.-hour, at a pressure of 100 lb. per sq. in. on the stop valve, the engine being non condensing. The power of each motor was to be 300 H.P. at 1,440 revs., and each pump to be capable of raising 1,000 gals. of water per min. against a head (including friction), of 640 ft., which was equal to a pressure of 277 lb. per sq. in. In order to get a steady, unvarying run for testing the output of steam consumption and the temperature of the alternators, witness ran the machinery on an artificial load consisting of water resistance, this method being more favourable to the contractors, and at the same time making it easier to determine the actual electrical output in kilowatts. The steam consumption was determined by carefully measuring the water fed into a set of boilers which had no other duty than to supply the engines; all auxiliary apparatus which required steam was provided for by other boilers. The governors were removed and the engine run with the valve throttle fully open. These were normal conditions as far as testing was concerned. Witness took all precautions to avoid leakage and to measure any leakage which did occur. The water was pumped into the boilers from a large iron tank which had been carefully measured, and the water level in the boilers was also carefully registered on the guages. He also put a guage on the exhaust and ascertained that there was no back pressure there. The steam gauges on the boiler and engine varied a good deal, there being a difference of as much as 15 per cent. None of the safety valves blew during the test; the pipes from the cylinder cocks were disconnected from the drains and led into buckets, and the steam separators were treated in the same way. The glands were tight, practically no water coming through whilst very little water leaked through the cylinder drain cocks. This showed exceptional dryness of steam. The test lasted $6\frac{1}{4}$ hours, and readings were taken every 15 minutes of all electrical quantities, of pressures of steam, of the temperature of the alternators, and of the engine room, &c. Readings were also taken from the boiler house of the water consumption, very carefully calibrated instruments being used. The results of the test were as follows:—Maximum kilowatts obtainable, as an average of 10 readings at 100 to 102 lb. pressure, 375 revs., 250 kw.; maximum kilowatts obtainable as average of all readings during $6\frac{1}{4}$ hours, at pressures ranging from 97 to 108 lb., 256. Maximum temperature rise attained at $6\frac{1}{4}$ run on above output, on artificial load, 90°F. He also tested the electric pump and generator. The generator ran on a load for which it was provided by the contractors, the load on the motor being arranged by throttling the pump to represent slightly less than the specified full load of the motor. The test enabled the temperature of the alternator to be ascertained under working conditions as well as the temperature of the motor. In the case of the generator and electric pump the test lasted $5\frac{1}{2}$ hours, and then he had to stop as the motor was getting hot, and it would not have been safe to run longer. On an average of 254 kilo. volt amperes the maximum temperature attained in $5\frac{1}{4}$ hours was 111·5 F. The steam consumption per kilowatt-hour on an average load of 250 kw. was 44, and the electric pump temperature rose to 117 F. as already stated after $5\frac{1}{4}$ hours running. At the time of stopping the temperature was still rising rapidly, and air was issuing from the motor. This corresponded to a mean internal temperature of 212°F. That, of course, was an average; at times during the test it was higher, and at times lower. Such a temperature was not safe and no insulating material that he knew of would stand it for long; also the expansion and contraction of the parts did great damage to the machine.

Questioned by Mr. HUTCHINSON as to asbestos windings witness criticised them adversely, declaring that they were inflammable owing to the mucilage and cotton stuff used in the composition. After he had made the above tests and presented his report plaintiffs had an opportunity of repeating them and objecting to the arrangements. Mr. Ravenshaw, for plaintiffs, did make a test, but according to witness, that gentleman used inaccurate appliances and generally failed to arrive at any correct results. The engines were not capable of doing any more than his test showed, and he had heard nothing to alter his opinion. The alternators were clearly over loaded, and the question of the 25 per cent over load was never approached, as there was no possibility of getting it upon the engines.

Mr. RUSSELL, K.C., cross-examined witness at some length as to the results of his tests.

Mr. ERNEST G. PINK, electrical engineer in charge of the plant, on behalf of defendants, said he had co-operated with Mr. Mordey while he was there on behalf of the plaintiffs. He (witness) was personally under the manager, Mr. Fell. His first entry in the log book was dated March 31, 1907. The readings of the current and voltage were obtained from the engine man. Witness had to work out and record the daily averages. He had no knowledge of any tests being made on Dec. 24 and 31. On Dec. 24 he had a note that the motor was burnt out at 3.40 p.m., and there was no opportunity of making a test after 3.40 p.m.

On Tuesday Mr. J. H. ROSCOE, secretary of defendant company, also gave evidence.

Further evidence was given on behalf of defendants in support of the counterclaim, and the case had not concluded when we went to press.

Bourne and Hollingsworth v. Marylebone (London) Council.

On Wednesday the Court of Appeal (Sir Gorell Barnes and Lord Justices Farwell and Fletcher Moulton) concluded the hearing of an application by defendants for judgment or new trial in this action, which was tried before Mr. Justice Ridley and a special jury. The action was brought by plaintiffs to recover damages for alleged breach of contract to supply electrical energy to plaintiff's premises. The facts were given in our issue for Feb. 14 last.

Mr. MONTAGUE SHEARMAN, K.C., and Mr. MCCARDIE, who appeared for appellants, contended that there was no evidence of any contract, and that if there was, there was no evidence of any authority in Mr. A. Wright or Mr. F. A. Wilkinson (the engineers to the defendant Council) to make such a contract.

Mr. MONTAGUE LUSH, K.C., and Mr. J. D. CRAWFORD, for respondents, submitted that upon the evidence and correspondence there was evidence upon which the jury could find that there was a contract, and that Mr. Wright and Mr. Wilkinson had implied authority to make the respective contracts.

Sir GORELL BARNES, in giving judgment, said it seemed to him there was no evidence which the learned judge ought to have left to the jury entitling them to give the answer they did to the first question. (Did Mr. Wright make the alleged contract in June?—Yes.) There was a verbal conversation in May which was to be considered by Mr. Wright, who then wrote a letter. The construction to be placed on that letter was one entirely for the judge and not for the jury, and the letter was not capable of the construction which plaintiffs sought to place upon it. The letter contained no binding promise that the work would be done on Sept. 1. As to the second contract he could find no trace of any authority for Mr. Wilkinson to make such an exceptional contract. The result, therefore, was that there was no evidence to support the finding upon which the jury arrived as to the alleged first contract, and if there was a second contract then there was no evidence which could reasonably be submitted to the jury that Mr. Wilkinson could himself make it, or had been held out by defendants as having authority to make it.

Lords Justices MOULTON and FARWELL concurred.

The appeal was accordingly allowed, and judgment entered for appellants, with costs.

Assessment of Light Railways—Wakefield Corporation v. Wakefield & District Light Rlys. Co.

On Friday last the House of Lords (the Lord Chancellor, Lords Macnaghten, James of Hereford, and Atkinson) dismissed this appeal of Wakefield Corporation from a decision of the Court of Appeal affirming an order of the King's Bench Division. The facts were given in our issues for April 13, 1906, and March 22, 1907. The point to be decided arose on a special case stated by justices for the City of Wakefield, and was whether certain lines of rails constructed and laid in certain public streets within the City of Wakefield should, for the purposes of the general district rate, be assessed at their full net annual value, or whether they should be assessed in the proportion of one-fourth only of such net annual value pursuant to sec. 211 (1b) of the Public Health Act, 1875. The justices held that respondents were liable to be assessed and to pay on the full net annual value and ordered accordingly. The King's Bench reversed this decision, and held that respondents were liable to be assessed in the proportion of one-fourth only of the net annual value.

After hearing counsel (Mr. Macmorran, K.C., and Mr. W. M. Mackenzie) for appellants (Mr. Danckwerts, K.C., and Mr. Ryde, for respondents, were not called upon),

The LORD CHANCELLOR, in delivering judgment, said, I think it is clear that the Light Railway Company was here the occupier. It is clear, too, that the structure was a railway and that it was constructed under the powers of an Act of Parliament. The only point upon which there can be any difficulty is upon the question whether the land is used only as a railway. I think the user is the user by the occupier who is to be rated, and that under those circumstances the view of the Court of Appeal should prevail. I am, therefore, for affirming the judgment.

Lord MACNAGHTEN, Lord JAMES and Lord ATKINSON concurred, and the appeal was dismissed.

Electric Railway Rating Appeal.—Liverpool Overhead Railway Co. v. Liverpool Parish Assessment Committee.

At the Liverpool City Sessions recently the Deputy Recorder delivered judgment in this rating appeal in respect of two assessments in the parish of Liverpool, the total ratable value of which is £5,066. It was said that on Jan. 27, 1908, the solicitors for respondents gave notice that only £4,200 would be supported by evidence and their first witness (Mr. A. L. Ryde), estimated the figure at £4,414. As against the £4,200 appellants contended that the "ratable" should stand at only £1,433. During the hearing the

parties agreed upon a figure for the gross receipts of the undertaking, and also upon many of the deductions which are to be made towards arriving at the ratable value. Where they finally differed the witnesses for appellants had (the Deputy-Recorder said) more accurate sources of knowledge as regards the several items of expenditure, what chattels were in use on the undertaking and what were their respective actual values in 1905. That date was taken because it was agreed between the parties that the basis of assessment was to be the position in that year. Appellants were fortunate in that as regards many of the heavier chattels which required valuation they were able to put in actual valuations arrived at upon inspection of each article by Mr. Ingram and Mr. Cottrell, whilst respondents' witnesses sometimes valued from types without inspecting all the articles, and arrived at their values by taking the original price and making certain theoretical deductions therefrom in respect of age, probable wear and tear, changes in price, &c. The latter valuations had been mainly useful in affording checks upon the correctness of the former. The Court had decided upon figures in respect of the deductions, &c., which remained in dispute, but there were only two which, on account of the amount or the principle involved, needed to be mentioned. As regarded the number of motors said to be in excess of what a hypothetical tenant in 1905 would have reasonably estimated as necessary to be purchased in order to carry on the undertaking, the court had taken into account that in that year the Lancashire and Yorkshire Railway Co. had not begun to run their trains upon appellants' line, so that appellants required more motors in 1905 than they did now. While the court considered that those working the line in 1905 were in a better position to judge of the number of motors actually necessary than were experts who made theoretical estimates in 1908, yet the conclusion the Court had come to was that there was an "excess," which was to be calculated out at £1,440. A question of principle was involved in the claim on Mr. Cottrell's statement of £3,127 for "twelve months' depreciation of tenant's capital." Appellants' counsel (Mr. Ryde) submitted that that came under "working expenses." Were an allowance for this suggested depreciation to be sustainable, it would appear to the Court to come rather more fitly under "repairs and renewals," and particularly under the latter. Sums for "repairs and renewals" had been agreed upon between the parties, and in the opinion of the Court those sums were sufficient, and it seemed to the Court that the claim for £3,127 was based upon a misapprehension. No suggestion was to be found in any of the cases that the capital of the hypothetical tenant was to be assumed to have depreciated by 25 per cent. during the twelve months. The hypothetical tenant was imagined as entering upon the occupation in 1905, when the tenant's capital was supposed to be invested at actual values in articles which might be viewed as at that time probably depreciated from their original cost price. If the depreciation were 25 per cent. then 75 per cent. remained, and that 75 per cent. was the capital invested by the hypothetical tenant and by the sums allowed for repairs and renewals. The stock represented by that capital was apparently maintained at a standard level for that year, and so on from year to year, and the Court was not satisfied that in 1905 a further 25 per cent. of the capital was in fact lost as suggested. The ratable value of the whole undertaking having been ascertained, the valuation of the generating station became the subject of a very marked difference of opinion between the parties. Its value had to be ascertained in order that it might be deducted from that of the whole undertaking, so that the resulting balance might be distributed among the various parishes in proportion to their respective receipts. For the whole undertaking, including the generating station, appellants suggested a valuation upon the proportion of capital expended in construction in each parish. That method the Court was unable to accept. The age of the undertaking, the fact that extensions at either end were not coeval with the original line, the alterations at Dingle, and also the fact that he was not satisfied that the line (including the stations) did not depreciate by nature, exposure and age more quickly than the generating station, led the Court to regret that method. Having quoted decided cases the Deputy Recorder said that, applying those principles to the calculations placed before him as to the structural value of the generating station, he had estimated its rental value, and the final result was that the values in the parish of Liverpool worked out at (a) gross £2,490, net £1,660; (b) gross £2,790, net £1,860. Respondents must pay appellants' costs of the appeal.

MUNICIPAL, FOREIGN & GENERAL NOTES.

APPOINTMENTS VACANT AND FILLED.

Applications are invited for the position of head of the electrical engineering department of the Halifax Technical College. Salary £200 per annum. Applications to the secretary (Mr. W. H. Ostler), Education Offices, Halifax, by June 1. See an advertisement.

Applications are invited for the position of assistant professor of physics at Heriot Watt College, Edinburgh. Salary £225 per annum. Applications by May 23.

A professor of mechanical engineering is required for Poona College of Science, India. Salary R.500, rising to R.1,000 per month. Applications to the Secretary, Public Department, India Office, London, by June 15.

Mr. Geo. Thomson, chief assistant electrical engineer at Swansea, has been appointed electrical engineer at Neath.

Mr. Benson has been appointed chief mains superintendent at Swansea.

Mr. D. M'Coll, jun., has been appointed general manager of the Shanghai electric tramways.

Accrington.—The Council have applied for sanction to a loan of £1,400 for a water-cooling tower.

Ayr.—The Council have decided not to proceed with the order for the extension of the electric lighting area to Alloway and Prestwick on account of the onerous conditions attached by the Councils of those districts to their consent to the order.

Bath.—The provisional agreement entered into in Feb., 1907, between the Corporation and Mr. E. Schenk (acting for a syndicate) for the sale of the electricity undertaking was not completed, owing to the syndicate not having complied with the conditions laid down. As a result of further negotiations with Mr. Schenk fresh proposals have been submitted to and adopted by the Electric Light committee.

The main features of the original terms included the payment to the Corporation in cash before the 31st Oct., 1907, of the purchase money, representing the actual capital cost to the Corporation of the undertaking with a further £2,000 expenses of obtaining the provisional electric lighting order, together with a cash bonus of £10,000 to be paid on or before 31st Dec., 1908, and a further bonus of £10,000, or a free supply in perpetuity of electric energy to the value of £450 per annum, as soon as the undertaking became vested in the company in perpetuity. Instead of the purchase money being paid down in cash the amount is now to be paid by an instalment of £22,500 on the signing of the agreement and the balance by annual sums extending over 30 years. The transfer is to be carried out by a lease to the purchaser for 30 years from 31st March, 1908, with a covenant by the Corporation to convey the property absolutely if all the instalments are duly paid and the covenants performed, with power for the lessee to pay in advance sums not less than £5,000 each in reduction of the rent. The lease shall be executed immediately after the Board of Trade consent to the transfer. Current contracts shall be assigned to the purchaser with the lease, and the lessee shall indemnify the Corporation against the same and any other liabilities, except only capital liabilities on loan account, in respect of which the Corporation shall indemnify the lessee. If the lease is not taken up within one month from the date of the consent of the Board of Trade, or if the consent of the Board is refused or is not obtained within three months of the date of the agreement, the Corporation may rescind the contract and may retain as forfeit out of the sum deposited £5,000 if the assent of the Board of Trade has been obtained and £2,500 in any other contingency. The Corporation shall carry on the business from 31st March, 1908, on behalf of the purchaser until the lease has been taken up. A further agreement is to be entered into between the parties defining the terms for supply of energy to the Corporation for lighting and other purposes. If the Board of Trade refuses consent to transfer in perpetuity the company may promote a bill at their own expense to authorize the Corporation to convey the undertaking, and the Corporation undertake (if such bill is promoted within two years) to support its promotion. If the transfer in perpetuity is not obtained either by sanction of the Board of Trade or by bill the purchaser will be discharged from his liability to give free energy to the extent of £500 per annum.

The third schedule to the proposed agreement contains the provisions of the lease and includes a covenant by the lessee to give the free supply of energy to the Corporation for lighting public buildings and other property or for power, heat and other purposes.

The present charges shall be the maximum scale to private consumers and all surplus profits after payment of 4 per cent. on the ordinary shares shall be applied in reducing charges until the cost of private lighting has been reduced from 5d. to 4d. per unit. The company shall not transfer to or join with any other company supplying light other than electric light in the City. The company will spend at least £30,000 during the next 18 months on additions to the undertaking, of which at least £20,000 shall be expended on works within the City.

Schedule four provides that the price for street lighting shall be for the same amount of light, for the same number of lamps, burning for the same hours as during the year ending March 31, 1908: For one year commencing 1st April, 1908, £4,390; from 1st April, 1909, and thereafter, £3,512 per annum; from the date when the company shall have paid a dividend of 4 per cent. on their ordinary shares £2,634 per annum. For lighting public buildings and other property belonging to the Corporation, the prices shall be the same as to ordinary consumers. The Corporation undertake to take from the company all electricity used by them for seven years from date of agreement, and to use for street lighting during each of those years such an amount of energy as will give the same amount of lighting for the same number of lamps burning the same hours as during the year ending the 31st March, 1908. The price shall include repairs, renewals, maintenance, attendance and other expenses.

Bexhill.—The Electric Light committee reported on Monday that the electricity department had made good progress during the

year. The gross profit was £4,451. 9s. 3d., and, after paying interest and sinking fund, the net profit was £1,017. 15s. 9d.

Brazil.—Mr. G. Campbell, British Vice Consul at Rio de Janeiro, in reporting upon the mining industry in the States of Minas Geraes, refers to the abundant supplies of water which are available at Minas Geraes, and which are being used for working the mines, and for generating electricity for lighting the towns. Mr. Campbell continues :—

There is a great future for electricity in the country, and it is already developed to a considerable extent. Small towns of 4,000 inhabitants have electric light and some have tramways. Add to this that there are numbers of small factories whose existence must depend on economy, that butter and cheese are made in large quantities, and that Brazil is ambitious to become a manufacturing country, and there should be many opportunities for electrical engineers. There is, in particular, one industry still undeveloped smelting. The whole of the elevated region constituting the centre of Minas Geraes is notably rich in iron ores, whose purity is remarkable, but the difficulty remains that the fluid iron cannot be converted on the spot into commercial products until some economical method of smelting is discovered. It is said that electricity would be too expensive, but, with the existing water power, it seems that this would be the best solution unless the price of coke is considerably reduced. The School of Mines at Ouro Preto is shortly going to make some experiments in smelting. The State of Minas Geraes is 221,894 square miles in area with a population of about 4,000,000, and its known minerals are gold, diamonds, precious stones, manganese iron, cinnabar, platinum, galena, graphite, palladium associated with gold, asbestos, mica, talc, molybdenum, monazite. About 2,000 H.P. of electric power is already employed at the mines in the district. A firm of electricians might be able to obtain some small orders and could use this opportunity to study the country and the abundant water supply with a view to eventually installing a plant for smelting purposes. The development of the mining industry will afford an opening for machinery and implements, and if the shortage of labour continues, electrically worked tools will be used as far as possible.

Brighton.—It is reported that there was a deficit of about £2,500 on the past year's working of the electricity undertaking, against £976 in 1906-7, and a profit of £5,381 in 1905-6.

British Chamber of Commerce (Paris).—The 1907 annual report of the British Chamber of Commerce, Paris, a copy of which we have received, contains much commercial information, statistics, &c., which should prove useful to firms doing business with France.

Burslem.—The Council have agreed to give a supply of electric current to Messrs. Doulton & Co.'s works and to Messrs. Meakin, but, in view of the federation of the Potteries, the Electric Lighting committee want a clause inserted in the order providing that the clause as to revision sh ll n ɔt affect contracts entered into prior to the date on which the order shall come into force.

Camp Lighting.—The annual camp of the Royal Bucks Hussars (Buckinghamshire Imperial Yeomanry) opened on Tuesday. The regiment, which is commanded by Col. the Hon. H. Lawson, will encamp in Stowe Park for 15 days. A feature of the camp will be the fact that it will be lighted throughout by electricity. The plant has been constructed by Messrs. Cooper & Co., under the direction of Messrs. O'Gorman & Cozens-Hardy. The engine and dynamo for generating the current are of special pattern, mounted on an artillery gun carriage, and are of a type which is being used for the first time.

Chili.—In a valuable report by Mr. Consul-General Leay on the trade of Chili in 1907, the following notes occur :—

Machinery for the new nitrate works has been imported mainly from the United Kingdom and Germany, the United Kingdom securing the larger share of these orders, the chief portion of which consist of boilers, tanks and piping. British work in this department is well known and gives satisfaction. In the case of electrical goods, however, America and Germany appear to be ahead of the United Kingdom and, as there is a growing tendency towards an extension of the use of electricity, it is to be regretted that British makers are not competing more successfully.

The town of Pisagna is still lighted by oil, but efforts are being made to re-establish electric lighting.

At Talcahuano a company has been promoted to connect the port with Concepcion by an electric tramway both for passenger and goods traffic.

Chislehurst.—The Chislehurst Electric Lighting Co. have extended their mains to Summer Hill.

Dudley.—It was reported to the Council last week that for the year ended March 31 last 2,203,097 units were generated, against 1,991,904 in 1906-7.

1,050,910 units were supplied to the tramways, an increase of 84,666; 42?,333 for private lighting, increase 30,471; 413,727 for power, increase 94,000; and 135,237 for public lighting, increase 806. The units sold showed an increase of 210,014. The total revenue was £12,792; the expenses were £6,807, against £6,461, and the charges on capital account £5,641, against £5,176, making altogether £12,448, and leaving a net profit of £344, compared with £68.

Dumbarton.—The first section of the Dumbarton tramways was opened for traffic on Thursday last. The contractors were Messrs. J. G. White & Co. (Ltd.), London, and the Dumbarton Burgh & County Tramways Co. are running cars from Dumbarton, through Dalreoch and Renton to Alexandria. This tramway line will ultimately link Glasgow with the banks of Loch Lomond. The contractors are busy with the extension from Alexandria to Jamestown and Balloch, while on the other side of Dumbarton the work of connecting the town with the junction of the Glasgow Corporation tramways at Dalmuir is proceeding rapidly. It is expected the whole line will be open for traffic in June.

Dunfermline.—The Council considered on Monday a communication from Sir Alex. Kennedy on the electricity supply question, and Sir Alexander was instructed to continue his negotiations with the Fife Electric Power Co. in order to arrive at a definite agreement with the company before the expiry of the Burgh provisional order.

East Ham.—The Board of Trade have sanctioned the borrowing of £8,000 for the purchase of the tramway in Romford-road. Application has been made for sanction to borrow £1,000 for roof coverings to tramcars, £1,620 for cooling plant at the electricity works and £2,000 for extension of mains

Electric Driving in Railway Works.—The North-Eastern Railway Co. have decided to substitute electric power for the steam plant at their waggon building and repairing shops at New Shildon. Electrical energy will be taken from the Cleveland and Durham Electric Power Co.

Electricity in Docks.—Swansea Harbour Trustees have decided to erect two electricity stations at the new King's D ck, at a total estimated cost of from £25,000 to £30,000.

Elland.—The Council have applied for sanction to a loan of £3,000 for additional generating plant.

Erith.—The Council have appealed against the assessment of the electricity undertaking for income tax at £1,142.

Erdington.—It was reported to the Council last week that the working of the tramways from their opening on April 22, 1907, to March 31 last, had resulted in a profit of £1,960. 1s 1d. £600 of this sum has been placed to reserve and the balance (£1,360. 1s. 1d.) applied in aid of current rates.

Gillingham.—On Monday the Council authorised various extensions of the electric lighting mains.

Glasgow.—Last week the Corporation decided to increase the salary of the manager of the tramways (Mr. J. Dalrymple) from £1,000 to £1,100 per annum. An advance of £75 was also granted to Mr. E. T. Goslin, electrical engineer, whose present salary is £475. Recommendations to grant increases of £25 each to three other officials were rejected.

Hackney (London).—The Electric Lighting committee has decided to lay a new concentric feeder cable (0·4 sq. in. section) in Homerton at an estimated cost of £1,515.

Halifax.—Major P. Cardew, R.E., and Mr. H. Graham Harris, who were recently instructed by the Corporation to inquire into and report on the working and management of the tramways, more particularly in regard to the safety of the public, have issued their report.

Generally speaking, it may be said that the Halifax tramway routes are bordering upon the limit of possible safe working by electric cars fitted with ordinary flanged wheels runing on grooved rails; for not only are the gradients steep, but the hills are long and with many curves, and the exudations from the soil and deposits from the air and from other traffic frequently produce a greasy surface on the rails. Safety can only be secured, even with every possible mechanical safeguard and with the most careful regulations, by constant and unremitting attention to the maintenance of the efficiency of every working part of the cars and stock, including also that of the human element of drivers and conductors. Attention is drawn to an increase in consumption of energy per car mile shown in a previous report, also to the increase in the number of accidents. In this respect, the report says, "it appears your tramway undertaking in the past has not been maintained to the 'level of perfection' which, having regard to the physical difficulties inherent to its construction and working, is essential to economy and to safety. The best construction, equipment, supervision and manipulation are no whit too good for your requirements, and this standard of excellence, once reached, should be carefully maintained." Several recommendations are made as to cars, a rather longer wheel base with less overhang would conduce to safety on the steep grades, on which single-deck cars would give greater security. Single-deck cars with open sides might be used as workmen's cars, but it is strongly urged that no cars with covered upper decks be allowed on the routes with steep grades, as the increased height of the centre of gravity is prejudicial to the efficiency of the brakes. All controllers should be absolutely similar and ample brake power should be provided in view of the exceptionally steep gradients.

The report concludes : "We would most strongly impress upon the Committee the necessity for more careful attention to the upkeep and cleaning of the motors and all accessories than appears to have been exercised in the past. Numerous motors under repair were shown us in which there was evidence of damage caused by the motor having been allowed to run too long without attention. These remarks also apply to the rheostats, cut-offs, wirings, and electrical and mechanical equipment generally."

Heckmondwike. It was reported to the Council last week that the expenditure on the electricity undertaking had exceeded the borrowing powers by about £17,000, and that application had been made to the L G. Board for sanction to the outlay more than a year ago, but that that body had not yet arranged for the holding of an inquiry. A revised scale of charges for current for power, as recommended by the Electricity committee, was approved.

Inquest.—The Bournemouth coroner resumed on Wednesday the inquest on the seven persons killed in the tramway accident on May 1.

The coroner (Mr. LEFROY) remarked that the inquiry would simply be a general one into the cause of death ; so far as he knew there was no criminal negligence. They had the assistance of a Board of Trade assessor (Major Pringle) on that occasion, and any recommendations as to safeguarding the public in future or affecting tramway construction would be dealt with in the report of the Board of Trade.

One witness (TOM WHITE) said he was on the car when it left Poole Hill. It did not pull up at the first stopping place, and as the speed increased he made up his mind to jump off. The car was going at 30 miles an hour down Avenue-road, when it left the track and toppled over the embankment.

Replying to Major Pringle, Witness said the car was going 8 miles an hour round the first corner, 18 round the next, and quite 30 when it went off.

Mr. F. W. LACEY, borough engineer, gave evidence as to the construction of the line in 1902. The track was still in very good condition, and he should think a car could go round in safety at 10 or 12 miles an hour.

Replying to Major Pringle, Mr. LACEY said the rails were worn, but there was a guard rail on the inner side, which was a most important factor in preventing the car going off. That particular line had been relaid about two years ago, and would have been relaid again in six months or so.

Mr. IGNATIUS BULFIN, electrical engineer, stated that he was at the scene of the accident about an hour after it occurred. He carefully inspected the outer and inner rails where the car came off, and found them in good condition for the scheduled speed round the curves—6 miles an hour. Witness described the brakes on the car, consisting of the ordinary hand brakes, which could be put on either by the driver or the conductor, and the magnetic brake, coupled with that being the rheostatic brake. He examined the car the day after the accident, and found the whole of those brakes intact, with the exception of No. 1 left-hand magnetic shoe, which was missing.

Replying to Major Pringle, Witness said the hand brakes were in working order at the time of the accident. The handles of the controllers of the electric brakes were not in the right position to use. The magnet brake and the magnets would not be working. The magnetic brake was not working when the car came off, judging from the position of the handles. There was no other brake available at the time of the accident but the hand brake.

Major PRINGLE: What had the driver to depend on for the brake power ?—The hand brake only. It was sufficient if the speed was not allowed to get too high. The conductor might have used the hand brake at the rear end of the car, but if two persons used the hand brake at the same time the wheels would probably become locked. He believed the driver did all he could to put on brake power and used his utmost resources. In so doing he might have put the handles of the controller in the position in which they were found. He did not think the loss of the fourth brake shoe would have any material effect upon the other three, and he would not have hesitated to allow a car to go down the hill with three instead of four shoes. He agreed with Major Pringle that the absence of the fourth shoe reduced the drag by 25 per cent.

Mr. CECIL BARBER, traffic manager, said the ill-fated car came into use about two years ago. It had been in the shops for six weeks from Nov. 7 to Dec. 14, and was then generally overhauled. The men were instructed to endeavour to make up lost time, but in doing so to keep to the Board of Trade scheduled speed. Witness corroborated the other witnesses as to the position of the brakes. The driver could only have had the hand brake to use when the accident happened. He had once made an experiment with an unloaded car down the gradient of 1 in 12 and at a speed of 15 to 20 miles an hour. The car, with only a hand brake, pulled up in less than 40 yds. Driver Wilton's record was a good one, and he was absolutely a sober man. On May 1 he had done about 5½ hours work before the accident happened.

Replying to Major Pringle, Witness said he was responsible for the upkeep of the cars, and the depot superintendent and staff were responsible to him. The car had not a bad record. Many men had a liking for it. There were regular men at each depot to examine the controllers. They were examined twice a week. The hand brakes were examined on the night previous to the accident at Parkstone. The controllers were examined the previous Wednesday, and no report as to anything wrong was made. His instructions to the men were that no car was to go out with less than three shoes operative, as a car was absolutely safe with three shoes. He could not trace when that particular shoe was disconnected, but he knew their stock of shoes at the depot was short. He did not agree that the absence of the fourth shoe reduced the drag 25 per cent

Yesterday (Thursday) further evidence was given by Mr. Barber, and other witnesses stated that the brakes of the car had previously been out of order.

The inquest was then adjourned until the 27th inst.

Leeds.—The associated firms who recently waited upon the Council in reference to the charges made for electrical energy for lighting and power have written asking for a reconsideration of the subject.

Leeds Bradford Tramways.—The Board of Trade have given permission for a through service of electric tramcars between Leeds and Bradford. The necessary alterations for a junction of the lines midway at Stanningley are in progress, and it is stated that there will be a complete through service.

Leyton. For the year ended March 31 the total number of units generated by the electricity department was 3,604,513, against 2,366,907 in 1906-7.

3,303,631 units were sold (against 2,052,545 in 1907), including 880,392 (against 871,971) for private lighting, 718,158 (683,319) for public lighting, and 1,705,808 (497,255) for traction. The equivalent of 63,815 8 c.p. lamps is connected for private lighting, against 59,726 8 c.p., and there are 1,900 consumers against 1,778. The maximum lighting load was 944 kw. against 948 kw.

Light Railways.—The Light Railway Commissioners have granted the application of the Blackburn, Whalley and Padiham Light Railway Co. for a revival of powers and an extension of time for the construction of the line.

Llanelly.—On Tuesday the Council decided to affix their seal to the agreement with the Llanelly & District Electric Light & Traction Co. for the transfer of the Llanelly provisional order to the company.

London County Council.—On Tuesday it was agreed to lend £12,301 to St. Marylebone for electricity supply.

Tramways.—The Highways committee recommended capital expenditure to the amount of £179,450 for 175 bogie truck double deck electric cars. Postponed.

For the electrification of the tramways from Loughborough Junction to Norwood the Highways Committee recommend capital expenditure of £45,330. Postponed.

Anchoring of Truck Rails. It was reported by the same Committee that when the first portion of the Council's tramways were reconstructed for electric conduit traction no measures were taken to anchor the truck rails; but in the case of lines dealt with later extended yokes were used for the purpose. Various sums had been expended for dealing with the loosening of the rails, and it was recommended that capital expenditure of £7,000 be authorised for work required in connection with the anchoring of truck rails. Postponed.

Feeder Pillars. Capital expenditure of £635 was authorised for the provision of additional feeder pillars along the route of the electric tramways from the Elephant and Castle to St. George's Circus.

Metropolitan Electric Tramways. It was agreed to offer no opposition to the Metropolitan Electric Tramways Bill, provided that clauses are inserted to the effect that the powers for the tramway along Harrow road and Edgware road shall not be exercised until the Council gives its consent ; and for the protection of the Council's interests.

Surface Contact System.—Capt. Hemphill asked the Chairman of the Highways Committe whether he would report to the Council at an early date his proposal for the construction of new tramways this year, and also, in view of the possible failure of the surface contact system, if he would consider the desirability of making the lines in the Mile End road suitable for the conduit or overhead system.

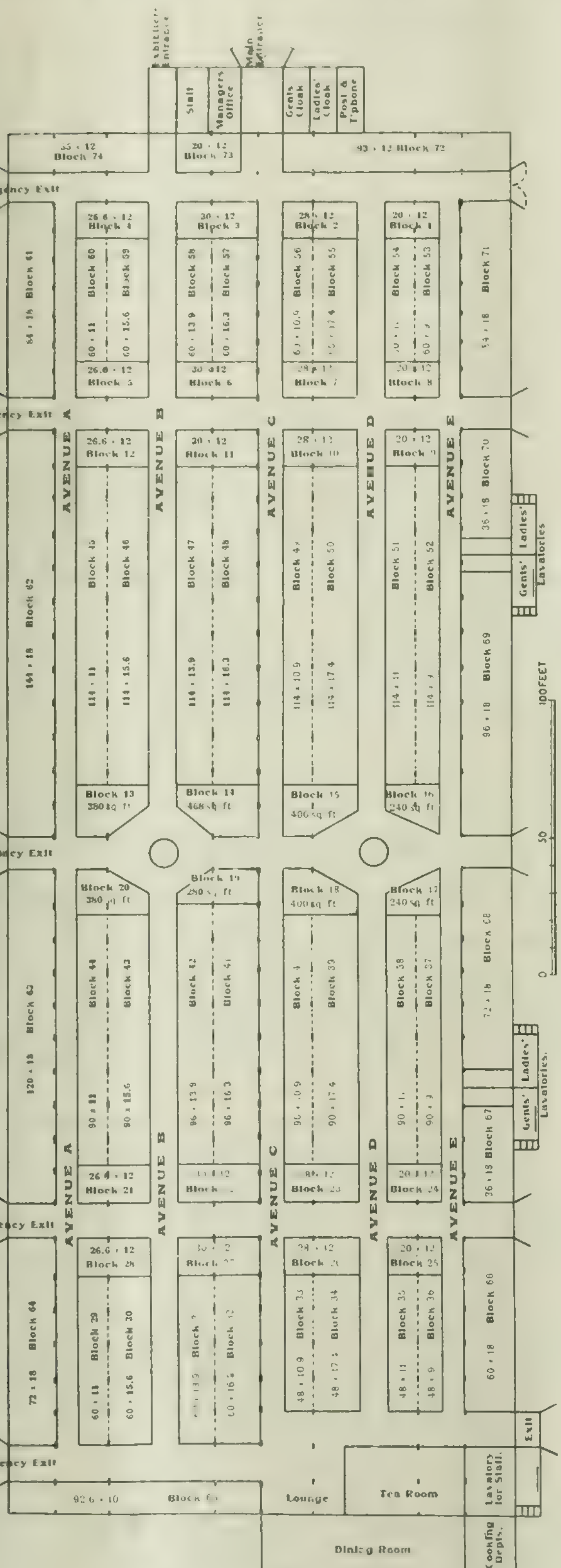
Mr. Whittaker Thompson said he had not sufficient information to lay before the Council with regard to the experiment with the surface contact system in the Mile End-road. A certain number of cars were being equipped by the Highways Committee, as the contractors had to some extent failed to carry out the work as speedily as was hoped. As soon as the cars had been run with a certain amount of regularity on the route he would be in a position to make a report. Upon the development of that system undoubtedly depended the carrying out of their progress this year. Many lines in the north of London had been put into their programme to be reconstructed on the G B. system, but if this system proved to be more or less a failure—and he hoped that nothing of the kind would occur—then it would be the committee's duty to bring before the Council further recommendations with regard to the reconstruction of the lines.

Newcastle-under Lyme. The Council have applied for sanction to borrow £700 for cable extensions.

Newport (Mon.). 27 Osram lamps are to displace gas lamps in five thoroughfares. The Council have decided against the running of tramcars on Sunday.

Obituary. The death occurred at New York, on May 5, of Mr A. Manthorpe, late manager at Spennymoor for the Northern Counties Electricity Supply Co., who recently left for America to take up a position with Lloyd's Shipping Co.

Manchester Electrical Exhibition (1908).—Excellent progress is being made with the scheme for holding an electrical exhibition in Manchester from Oct. 3 to 31 next. The building is progressing rapidly, and everything points to the exhibition being on a large scale. Forms of application for space, with particulars as to cost



FLOOR PLAN OF THE ELECTRICAL EXHIBITION, MANCHESTER.
COVERING AN AREA OF OVER 100,000 SQUARE FEET

and ground floor plan of the exhibition, can be obtained from the Organising Managers, 2, Queen Anne's-gate, Westminster, London, S.W. Applications will be dealt with in order of receipt, and firms who wish to secure good positions should make prompt application for space. A plan of the floor space at the Exhibition is given above.

Palestine.—Among the public works under consideration in this country is the introduction of electricity for lighting, power and traction. The river Aoudja enters the sea about 10 miles north-east of Jaffa, and may be utilised in the generation of electric current.

Patent Amendment.—The British Westinghouse Electric & Mfg. Co. (Ltd.), 2, Norfolk-street, Strand, London, W.C., seeks leave to amend the specification of Letters Patent No. 23,946 of 1896 granted to Reginald Belfield for improvements in electric switches and cutouts or circuit breakers. Particulars of the proposed amendment are set out in the "Illustrated Official Journal (Patents)" of the 13th inst., and notice of opposition must be given within one calendar month from that date.

Presentation.—On his marriage, Mr. E. J. Walsh, of the York electricity staff, has been presented with a case of fish knives and forks.

St. Annes-on-the-Sea.—The electrical engineer (Mr. J. H. Clothier) has issued his annual report, which shows that good progress was made during the past year. 131 new consumers were connected, a greater number than in any previous year, and there was an increase in the units sold to private consumers of 38,456 (against 36,999), but the average number of units sold per customer was 425, against 457.

School Lighting.—Hornsey Education committee has decided to wire the North Harringay School at an estimated cost of £154. 6s. Tantalum lamps will be used.

Sheffield.—The experimental electric lighting of Pinstone-street and the Moor has proved so successful that the Electric Lighting committee recommend the extension of the system by the erection of 23 arc lamps from the Town Hall to Blonk-street.

South Shields.—The income of the tramways department for the year ended March was £30,762 and the working expenses £18,003. The gross profit was £11,700, a decrease of £141 on 1906. After paying £5,651 interest and £3,223 sinking fund charges, the net balance was £2,884.

Stockport.—An unopposed inquiry was held last week into the application of the Corporation for sanction to borrow £10,500 for extensions of the electricity undertaking.

The town clerk (Mr. R. Hyde) explained that the money was required for an additional generating set, extensions of mains, &c., and for new offices. The electricity undertaking was started in 1898, and had been progressive from the start. Last year the revenue was £17,128, and from the profits £2,000 was applied in relief of rates. The capital expenditure had been kept at the lowest possible figure and the outstanding debt was only £34,606.

Sutton Coldfield.—At March 31 last the net capital expended on the electricity undertaking was £34,879, increase £1,204 during the past year.

There are 484 consumers, increase 26, and the maximum load recorded was 908 kw., a reduction of 23. The total output was 347,820 units, increase 24,919. For public lighting there was a reduced consumption of 5,342, and for private consumption an increase of 30,261 units. The sale of current produced £4,128, against £3 642. Gross revenue from public lighting was £823, and after deducting cost of labour, maintenance and repairs, £562, the price for both public and private lighting working out at an average of 3·24d. per unit. The cost of generation was 1·51d. per unit. The gross profit amounted to £2,691, or 6·61 per cent. on the capital expenditure, and after deducting the amount repaid in respect of loans, &c., there is a net profit on the year of £100. 10s., against a deficit of £99. 4s. 5d. last year.

Tonbridge.—At last week's meeting of the Council complaint was made by two local wiring contractors that certain employés of the Council were carrying out installations privately. The Electricity committee, which had investigated the matter, recommended that no action be taken. Discussion took place on the question of principle, several Councillors dissenting from the recommendation, including the chairman (Mr. Race), and an amendment to refer the matter back to the Council in committee was carried.

Tramways in the City.—The Improvements and Finance committee of the City Corporation recommend, in connection with the proposed improvement of Bishopsgate street between Angel-alley and the City boundary that, on the London County Council's contributing half the cost of widening the thoroughfare, no opposition be offered to the construction of a tramway from the City boundary to Middlesex-street. The recommendation was adopted by the Corporation yesterday (Thursday).

Watford.—The Council has received 210 applications for the post of electrical engineer. Before the final selection is made, the Electric Lighting committee is to visit six electricity undertakings where certain of the candidates are engaged.

West Ham.—East Ham Corporation having come to an arrangement with the North Metropolitan Tramways Co. for the purchase of the Green street and High-street line (the electrification of which is to be proceeded with at once), the West Ham Tramways committee has decided to carry out the overhead equipment of 336 yds. of the northern line belonging to West Ham. The tramways manager (Mr. H. E. Blain) has been in conference with the managers of East Ham (Mr. W. C. Ullmann) and Ilford (Mr. A. H. Shaw) so that an elaborate system of through-running may commence as soon as the electrification is completed. The committee has also approved the proposed appointment of Mr. J. B. Hamilton, tramways manager of Leeds, to act as arbitrator to settle the through-running basis, conditionally on the other authorities agreeing to abide by his award for seven years.

The chairmen of the Electric Lighting and Tramways committees and Mr. Blain will represent the Council at a conference of tramways authorities on "Mutual Insurance against Third-Party Risks" to be held in London this month. West Ham's experience has shown (says Mr. Blain) that the risk in question may be borne by the undertaking at a cost below the premiums demanded by insurance companies.

The L.G. Board have sanctioned the borrowing of £64,317 for the electricity supply undertaking, including additional plant £17,076, extensions to Silvertown £17,212, prospective expenditure on mains £14,300, transformers £6,000, and meters £3,000, the balance being for excess expenditure at Abbey Mills and Canning Town stations.

The electrical engineer (Mr. A. Hugh Seabrook) is to proceed with the erection of two of the five chain-grate stokers provided for in the loan at an estimated cost of £700.

The salary of the resident engineer (Mr. G. Lloyd Jones) has been increased to £280, with a further increase to £300 per annum at end of year. The salary of the station foreman (Mr. W. McKenzie) has also been increased.

York.—On Monday the City Council resolved to apply for sanction to borrow £7,200 for mains extensions, &c.

TRADE NOTES AND NOTICES.

READY NOW.

"THE ELECTRICIAN" ELECTRICAL TRADES' DIRECTORY AND HANDBOOK.—The 1908 Edition of the Big Blue Book, price 15s., or post free in the United Kingdom, 15s. 9d. The new and enlarged volume brings a great mass of statistical and technical data quite up to date, and the Directorial Division has been thoroughly revised and amplified.

All branches of Electrical Engineering and Industry are fully treated, and Electro-Financial matters have received every attention in the new volume, which aggregates more than 2,000 pages. The Directory Division is complete and thoroughly accurate, and has been completely revised. All mere lists of members of Societies and Institutions (so easily and cheaply available) are excluded, as quite unreliable for Manufacturers' and Dealers' purposes. The full set of valuable Statistical and Engineering Tables, &c., have been very carefully revised and extended, and remodelled into handy book form; these are included in the 1908 Blue Book, making it the most complete book of the kind ever published.

TENDERS INVITED.

Walsall Electric Lighting committee invite tenders for supply and erection of condensing plant, including surface condenser, air pumps, cooling tower and water purifier. Specifications from the borough electrical engineer, Mr. A. S. Barnard. Tenders to the town clerk (Mr. John R. Cooper), Council Office, Walsall, by noon 29th inst. See also an advertisement.

Rawtenstall Corporation invite tenders for supply and erection at the electricity works of two track boosters and l.t. d.c. and h.t. a.c. switchboards. Copies of general conditions, specifications, &c., may be seen at the offices of Messrs. Lacey, Sillar & Leigh, 2, Queen Anne's Gate, Westminster, and 78, King-street, Manchester, and may be obtained at the former office only. Tenders to the town clerk, Mr. James Whalley, by May 29. See also advertisement.

Bristol Electrical committee invite tenders for supply and erection of (*a*) d.c. works power distribution boards at Avonbank electricity works; (*b*) e.h.t. and l.t. sub-station switchgear for Shirehampton; (*c*) d.c. power switchgear for supply to Avonmouth Docks; and (*d*) extension to galleries at Avonmouth electricity works. Copies of specification and forms of tender, &c., from the city electrical engineer, Mr. H. Faraday Proctor, Temple Back, Bristol. Tenders for (*a*) and (*c*) by May 11 and for (*b*) and (*d*) by May 18.

London County Council invite tenders for the manufacture and supply of two electrically-driven centrifugal pumps, &c., to be erected at the East Greenwich electricity generating station. Tenders, on official forms, to be obtained from the clerk of the Council (Mr. G. L. Gomme), County Hall, Spring Gardens, S.W., by 11 a.m. Tuesday, May 26.

The Electricity committee of *Salford* Corporation invite tenders for supply, delivery and erection at the electricity station, Frederick-road, Pendleton, of cooling towers, tanks, pumps and pipework. Tenders, addressed Chairman of the Electricity committee, to the office of the borough electrical engineer before noon May 25.

The Penrikyber Navigation Colliery Co., *Penhiwceiber*, Glam., want tenders by June 4 for 12 months' supply of stores, including electric lamps and fittings, castings, ironmongery, oils, &c. Forms of tender from the Secretary.

Manchester Tramways committee want tenders by 10 a.m. May 19 for supply and delivery of steel girder tramway rails, tie bars and rail bonds.

Leeds Tramways committee want tenders for construction and reconstruction of tramway track. Specifications, &c., from Mr. J. B. Hamilton, Standard-buildings, City-square, Leeds.

Worthing Corporation invite tenders for supply and erection of elevated barometric counter-current jet condensing plant, air and circulating pumps and piping. Tenders by noon May 26.

Handsworth Council want tenders by noon May 25 for supply of l.t. distributor cables. Specification, &c., from the generating station.

Leith Corporation want tenders by 25th inst. for supply of coals to their electricity works. Schedules, &c., from the Burgh Electrical Engineer.

Dartford Council want tenders for 12 months' supply of lubricating oils, electric meters, house service cable, jointing material and accessories. Tenders by 4 p.m. June 9.

Southend Corporation want tenders by noon May 28 for laying about 1,500 yds. of single tramway track, with loops. Specification, &c., from the Borough Engineer.

Hanley Corporation invite tenders for lamp columns and arc lamps. Specifications from the Borough Electrical Engineer.

Melbourne City Council invite tenders for supply and delivery of one 500 kw. motor-generator. Copies of specification, conditions and form of tender from Messrs. McIlwraith, McEacharn & Co. Proprietary (Ltd.), Billiter-square-buildings, London, E.C., agents for the City Council. Tenders, addressed to the Chairman of the Electric Supply committee, Town Hall, Melbourne, must be received by him before 2 p.m. Friday, July 3. See also an advertisement.

Melbourne City Council also invite tenders for supply of 1,003,800 flame and 35,000 ordinary carbons. Copies of specification, &c., from Messrs. McIlwraith, McEacharn & Co. Proprietary (Ltd.), Billiter-square-buildings, London, E.C., agents for the City Council, to whom tenders by noon Monday, May 25.

The Postmaster-General's Department *Perth* (W. Australia) want tenders by Sept. 7 for supply of nine-section common battery switchboard with frames, racks, power plant, &c.

Tenders for erection and equipment of an electric power station for the supply of light and power to the Government coal mines at *Pernik*, Bulgaria, will be received until June 7 by the Direction des Mines, Carrières et Eaux Minérales, Sofia. Deposit of about £1,200 required. Specification (in German) from the Board of Trade, 73, Basinghall-street, London, E.C.

TENDERS RECEIVED AND ACCEPTED.

Marylebone (London) Council have accepted the following tenders: W. H. Willcox & Co., vaseline and best white rags; T. & W. Farmiloe, oil, turpentine and lead; Naylor Bros., varnishes; Pryke & Palmer, whiting, resins, chamois leathers, dexine manhole gaskets, hacking knives, paraffin, soap, enameline, &c.; Croager Bros. and F. Bird & Co., sash tools, &c.; Witty & Wyatt, asbestos tubing; J. Knox & Co., brass back and hand saws; J. F. & G. Harris, meter boards, banjo boards and battens; H. W. Talbart, creosoting troughing, brackets, &c.; W. McGeoch & Co., black adhesive tape; St. Helens Cable Co., rubber gloves, rubber mats; British Insulated & Helsby Cables, pure tin fuse wires; Tully & Straker, mica; Baxter & Caunter, ceiling roses; Pope's Electric Lamp Co., radiator lamps (120 volts 24s. per dozen, 240 volts 25s. per dozen); General Electric Co., steel conduit (45 per cent. discount off list).

West Ham Council has provisionally accepted the following tenders for annual supplies:—

Indiarubber covered wires: Liverpool Electric Cable Co., Platte, Scheele & Co., and Armorduct Mfg. Co.; flexible wires, single vulcanised. Electrical fittings: Evered & Co., Electrical Co., Armorduct Mfg. Co., G. Straus & Co., G. Binswanger, British Insulated & Helsby Cables, Verity's Limited and General Electric Co. Engine room stores: Geo. Angus & Co., James Gibb & Co., H. Edmunds & Co., Manufacturers' Agency Co., Fredk. Bird & Co., Middleton Bros., Pryke & Palmer and Wreems & Rhall. For chemicals only one tender was received, and this is not to be accepted, but the various articles are to be obtained at following prices: F. W. Berk & Co., sulphate of alumina, £4 5s. per ton; Middleton Bros., carbonate of soda, £5 5s. per ton; caustic potash, £1 8s. per ton; glycerine, 6s. 9d. per gallon; calcium chloride, 10s. per cwt.

Berwick Council have accepted the tender of the local electric supply company for lighting the main streets by flame arc lamps, the contract being for 10 years.

Hammersmith (London) Council have accepted the tenders of John Spencer (Ltd.) for steam piping at £230 (there were eight tenders varying from £230 to £320); of Mechan & Sons for iron flues, air heaters and hot-air ducks at £710 (four tenders from £710 to £1,350); of J. Hopkinson & Co. for boiler mountings, &c., at £189. 11s. plus £4 for fitting same to two boilers (three tenders from £181. 10s. to £212. 4s.); of the Premier Accumulator Co. for battery boosters and switchboards at £939. 5s. (11 tenders, three being only portions of contract, varying from £939. 5s. to £1,192. 17s.); and of the Main Colliery Co. for three months' supply of Craigola and Victoria coal at 15s. per ton.

Hammersmith (London) Council received seven tenders from six firms for supply of main switchgear, and that of Switchgears Limited at £2,014. 10s. has been accepted. The lowest tender was £1,951. 5s. and the highest £2,981.

Tonbridge Council have accepted the tender of Siemens Bros. Dynamo Works for dynamo with spare armature and condenser at £976, that of Körting Bros. for pipework and pumps at £314 and that of the Walsall Electrical Engineering Co. for switchboard, &c.

Eccles Council have accepted the tender of E. Heaton & Son for a Lancashire boiler and superheater at £601, and that of Browett, Lindley & Co. for a 210 kw. steam alternator and exciter at £1,266. 12s. 6d.

L.C.C. have agreed to extend the contract with Hadfield's Steel Foundry Co. to include the special track work required for the "lay-by" to be constructed at the Franco-British Exhibition for £570.

Stockport Corporation have accepted the tender of J. & W. S. Bri coe for re-laying permanent way, paving, &c., for repairs and renewals of tramway track.

Newcastle-under-Lyme Council have accepted the tender of Bagguley & Wood for supplying and laying 1,010 yds. of three-wire cable at £579. 10s.

The Metropolitan Asylums Board has accepted the offer of the Magneta Co. to instal 30 clock dials at the head office which will be synchronised by electricity. The annual cost will be £19.

The Bastian Meter Co. have secured the contract for the supply of 2½ ampere meters to the Edinburgh Corporation for the ensuing year.

Messrs. Pinching & Walton have been instructed to carry out some repairs of the electric lighting installation at the City of London Infirmary at Poplar.

Devonport Electric Power committee have accepted the tender of the Underfeed Stoker Co. for mechanical stokers at £1,375.

Colchester Council have accepted the tender of J. Yates & Co. for tramcar-wheel tyres.

Pease & Partners have placed an order with the British Thomson-Houston Co. for a 120 H.P. haulage motor and other plant.

Malvern Council have accepted the tender of the Reason Mfg. Co. for meters, and that of Callender's Co. for cables.

Leek Council have accepted the tender of Mather & Platt for a steam dynamo at £2,650.

Middlesbrough Council have accepted the tender of Callender's Co. for cables at £1,642.

Stalybridge, Hyde, &c., Tramways and Electricity Board have accepted the tender of Bolckow, Vaughan & Co. for fish-plates.

Surface Condensing Plant Contracts.—The surface condensing plant department of Messrs. Willans & Robinson has during the past month or two received many orders for surface condensers of either the "Contraflo" or "Vacuum Augmenter" types. Among others may be mentioned:—

Condenser for dealing with 12,000 lb. of steam per hour, for a mine near Johannesburg; condenser for dealing with a 300 kw. exhaust steam turbine, for Messrs. Crompton & Co; condenser for dealing with a 250 kw. reciprocating engine, for Stoke Corporation; condenser for dealing with 2,000 lb. steam, for Sydney (N.S.W.) University; condenser for dealing with a 1,000 kw. turbine, for Southampton Corporation; two condensers for dealing with 4,000 kw. each, for Glasgow Corporation; condenser for dealing with a 1,500 kw. turbine, for Islington (London) Council; and condenser for dealing with 30,000 lb. of steam per hour, for Durban Corporation.

"Tantalum" Lamps.—The "Tantalum" lamp is rapidly coming into favour for street and rain ligh ing. Siemens Dynamo Works (Ltd.) have recently received an order from Brighton Corporation for the supply of 15,000 16 c.p. "Tantalum" lamps for series burning in the majority of side streets in lieu of the carbon filament lamps. The company have also recently fitted up two trains on one of the London underground electric railways with "Tantalum" lamps, the result being highly satisfactory.

BUSINESS NOTICES.

We are informed that Messrs. Max Schorch & Co. (Ltd.), Rheydt, Germany, manufacturers of dynamos, alternators and motors (d.c. single, two and three-phase), have opened a branch at 35, Basinghall-street, London, E.C., where the business will be carried on under the style of the Schorch Electrical Co. Mr. Walter R. Rothenberg has been appointed general manager for England and the British Colonies. Among the special features to be introduced are complete electrical outfits for mines and collieries, high-efficiency a.c. loom motors, high-voltage switchboards and oil switches and general plant for central stations. The Rheydt works have been established since 1881, and the company state that during the past few years about 6,000 installations, totalling 250,000 H.P. have been supplied by them.

Hy. Fras. Joel and Richd. Pape (trading as "Fors" Accumulator), 110, Strand, and 15, Dyott-street, New Oxford-street, London, W.C., have dissolved partnerhsip.

BANKRUPTCIES, LIQUIDATIONS, &c.

A meeting will be held on June 15 at 1, Oxford court, Cannon-street, London, E.C., to receive an account of the winding-up of the South-Western Electrical Co. (Ltd.).

A meeting will be held on June 12 at 35, New Broad-street, London, E.C., to receive an account of the winding-up of the Pioneer Gas, Electric Light & Power Co. of South Africa (Ltd.).

Sale by Auction.—Messrs. Horne & Co, 8, Delahay-street, Storey's Gate, London, S.W., will sell by public auction at the Royal Arsenal, Woolwich, on Thursday, 21st instant, obsolete and unserviceable stores, including iron and steel, brass ingots, copper, gun-metal, lead, aluminium, white metal, tin, zinc, &c., one Cornish boiler, 5 lathes, 3 machines (boring and drilling), 4 pumps, 54 cwt. electric cables, telegraph instruments, rheostats, ship and signalling lamps, ebonite, indiarubber, &c. May be viewed on the Monday, Tuesday and Wednesday previous to and on morning of sale. Catalogues at the War Office, Whitehall; the Ordnance Office, Tower; and the Ordnance Office, Royal Arsenal, Woolwich. See also an advertisement.

Sale by Tender.—Tenders are invited for the purchase of heating and generating plant at the Nottingham Post Office. Forms of tender from the Controller of Stores, Stores Department, G.P.O., 17-19, Bedford-street, London, W.C. Tenders by 10 a.m. May 25. See also an advertisement.

Plant for Sale.—A modern steam plant, including two 350 H.P. Willans vertical compound engines with air pump and three high-class Lancashire boilers, are advertised for sale.

Incandescent Lamps for Sale.—The Wenham Company 90, Great Russell-street, London, W.C., have 20,000 incandescent electric lamps for sale. See advertisement.

Premises to Let.—Messrs. Rolleston, Greyfriars, Leicester, and 5, Waterloo-place, London, S.W., advertise to be let two-storey water mill buildings and premises at Lower Mitcham, on the river Wandle, with water wheel, driving tackle and accessories, two cottages, &c

Metallic Filament Lamp Patents.—An important firm in the United States advertises that it is open to take licences under patents in that country relating to high-efficiency metallic filament lamps. Applications to Messrs. Lloyd-Wise & Co., chartered patent agents, 46, Lincoln's Inn-fields, London, W.C.

Patent Licences.—The proprietors of Pollak & Virag's English Patents relating to telegraphy, are desirous of selling the patent rights or of granting licences to British manufacturers. Particulars of the Patents are given in an advertisement, and further information can be obtained from Messrs. W. P. Thompson & Co., Chartered Patent Agents, 6, Lord-street, Liverpool.

The owners of Patent No. 25,191 of 1904, relating to the application of coherers to electrical transmission, are desirous of arranging for the grant of licences to manufacturers upon royalty, or to dispose of their rights under such Patent. Particulars from Messrs. Allison Bros., Chartered Patent Agents, 52, Chancery-lane, London, W.C.

Polyglot Stenocode.—The subject of code vocabularies and coding systems is very much to the front at the present time, due, doubtless, to the meeting at Lisbon of the delegates of the Contracting States at the International Telegraph Conference, under the terms of the St. Petersburg Convention. The opportunity has been taken by Mr. A. C. Baronio, who is a specialist of the first order in coding systems, to circulate some particulars concerning his latest system of coding, which he has styled the "Polyglot Stenocode." It is claimed that this system increases the speed and accuracy of telegraphic transmission by enabling everything that can be written in any language to be put into a cipher which is economical to use and to transmit. The subject is one which is best explained by reference to Mr. Baronio's circular (which can be obtained from the author, at 20, Copthall avenue, London, E.C.), but we may say that Mr. Baronio's extensive and peculiar acquaintance with everything that appertains to the creation and elaboration of telegraphic code systems has been concentrated upon this particular development, and he claims that very nearly the last word concerning this intricate and rather fascinating subject is said in the "Polyglot Stenocode" system, which, summarised, is "the employment of biliteral combinations of a

consonant followed by a vowel so selected as to be transmissible in the Stenocode alphabet by electric currents of uniform strength but varying direction or duration, after the manner of the common Morse system." The "Polyglot Stenocode" is in the printer's hands, and will be ready for publication soon after the close of the proceedings of the International Conference at Lisbon now sitting.

CATALOGUES, &c.

Voltmeters.—List No. 8,005 A of the Union Electric Co. contains particulars and prices of type Se of the "Union" electrostatic voltmeter. These instruments can be used on direct or alternating-current circuits of any frequency or current curve, but on pressures above 13,000 volts are intended for a.c. only in series with condensers, and in this case the readings are consequently affected by the frequency.

Electrical Fittings.—The Electrical Co. have ready a neatly printed pamphlet containing some excellent illustrations of electrical fittings, cooking and heating apparatus, &c. The pamphlet contains some chaste specimens of cut-glass lustre fittings, and French. Old English, modern and other styles of metal fittings. It is difficult to do justice to the publication in a brief note, and we would advise readers interested in artistic fittings to pay a visit to the company's show rooms at 162, Shaftesbury-avenue, London, W.C., where a comprehensive selection of the best productions of English and foreign manufacture will be found attractively displayed.

Electrical Plant.—We have received from the English branch of Max Schorch & Co. (the Schorch Electrical Co., 35, Basinghall-street, London, E.C.) a pamphlet giving illustrated particulars of some of their manufactures, which include continuous-current dynamos, single and three-phase generators, motors (d.c., single, two and three-phase), transformers, starters, switches and switchboards, arc lamps, instruments, &c. The company are specialists in mining plant works, driving, &c., and the pamphlet gives a long list of firms for whom electric power plants have been installed. Catalogues and prices list can be obtained on application at the London office.

"Kalkos" Wiring System.—The Sun Electrical Co., 118-120, Charing Cross-road, London, W.C., forward us section K of their catalogue, which gives illustrated particulars and prices of the "Kalkos" patent tinned tube wiring system. A full description of this system appeared in *The Electrician* INDUSTRIAL SUPPLEMENT for March. In the section of the catalogue just issued a great variety of tubes and sockets, junctions, bends and adaptors, component parts of standard boxes, junction, ceiling and switch boxes, wall plugs, watertight fittings, distribution boards, main switches and fuses, &c., are listed and priced. Some useful "Hints on Estimating" and instructions for erecting are included.

Small Self-contained Lighting Plants.—Ideal Plants (Ltd.), Macdonald's-lane, Corporation-street, Manchester, who recently acquired the business of R. J. Nicholson & Co., send us their new lists descriptive of small petrol-driven self-contained electric lighting plants. "Light in the Country," now in its fifth edition, explains the particular feature which, it is claimed, differentiates the "Ideal" electrical outfits from any other plant offered for country house lighting. The booklet is well printed, with illustrations of the generating set, storage battery, switchboard, a general view of an "Ideal" engine room, and small sectional drawings showing the manipulation of the gases in the "Ideal" engine. Publications 84 and 85 accompany "Light in the Country," the former giving prices of 16 complete plants—engine, dynamo, switchboard and storage battery—suitable for various sized houses, the latter detailed particulars and prices for each component of these plants.

Switches and Switchgear.—W. F. Jones, Rosoman & Co., 5, Castle-street, City-road, London, E.C., have sent us a copy of a new price list of switches, cutouts and ironclad switchgear. Several types of switches and fuses are illustrated, and on sheet 16 particulars are given of ironclad motor panels specially designed for use in collieries, factories, shipyards, &c., where totally enclosed apparatus is essential. It is claimed that these are gas and watertight and foolproof, and suitable for 600 volt circuits.

Silent Electric Clock.—In our last issue we gave a short account of the electric clock system due to Mr. G. B. Bowell, of London and Margate, which has been installed in the Piccadilly Hotel. We have now received an illustrated catalogue from Mr. Bowell, which gives information about the various types of clocks manufactured by the firm. The point that has most taken our fancy is that they are silent and are, therefore, specially suitable for bedroom use.

Fire Alarms.—Pearson Fire Alarm (Ltd.) send a copy of their new catalogue, giving illustrated particulars of the Pearson automatic fire alarm. Among recent installers are Messrs. Rylands & Sons, Bradbury, Greatorex & Co., and the "Daily Mail."

Imports.—The following are official values of electrical machinery, material, and apparatus imported into this country (*a*) during April 1908, and (*b*) during the current year from Jan. 1 to April 30, with the increases or decreases compared with the corresponding periods of 1907:—

Electrical machinery (*a*) £45,112 (decrease £5,065); (*b*) £226,125 (increase £31,755); telegraph and telephone cables (*a*) £12,995 (decrease £31,953); (*b*) £47,694 (decrease £73,976); telegraph and telephone apparatus (*a*) £14,753 (decrease £6,495), (*b*) £74,749 (decrease £8,308); other electrical wires and cables, rubber insulated (*a*) £7,965 (decrease £4,208), (*b*) £26,795 (decrease £8,633); with other insulations (*a*) £14,764 (increase £11,185), (*b*) £42,477 (increase £11,027). The following were not separately enumerated last year: Carbons (*a*) £12,795; (*b*) £60,828; glow lamps (*a*) £16,870, (*b*) £76,827; arc lamps and electric searchlights (*a*) £65, (*b*) £1,201; parts of arc lamps and searchlights (other than carbons) (*a*) £4,737, (*b*) £19,104; primary and secondary batteries (*a*) £6,395, (*b*) £16,769. Total of electrical goods and apparatus, other than machinery and telegraph and telephone wire (*a*) £102,680 (decrease £21,991), (*b*) £401,745 (decrease £44,731).

Exports.—The exports of electrical machinery, material, &c. (*a*) during April, 1908, and (*b*) during the current year from Jan. 1 to April 30, and the increases or decreases compared with the corresponding periods of 1907, are as follows:—

Electrical machinery (*a*) £101,762 (increase £7,394), (*b*) £460,733 (increase £157,752); telegraph and telephone cables (*a*) £34,625 (decrease £8,357), (*b*) £191,475 (decrease £68,854); telegraph and telephone apparatus (*a*) £10,615 (increase £2,537), (*b*) £50,748 (increase £6,543); other electrical wires and cables, rubber insulated (*a*) £17,641 (decrease £4,429), (*b*) £92,988 (decrease £4,574); with other insulations (*a*) £28,113 (increase £5,693), (*b*) £87,738 (increase £25,619). The following were not separately enumerated last year: Carbons (*a*) £544, (*b*) £2,165; glow lamps (*a*) £4,718, (*b*) £14,591; arc lamps and searchlights (*a*) £1,789, (*b*) £5,319; parts of arc lamps and searchlights (other than carbons) (*a*) £1,581, (*b*) £5,283; primary and secondary batteries (*a*) £8,787, (*b*) £17,388. Total of electrical goods and apparatus, other than machinery and telegraph and telephone wire (*a*) £124,176 (increase £1,268), (*b*) £583,782 (decrease £54,863).

COMPANIES' MEETINGS AND REPORTS.

Eastern Telegraph Co. (Ltd.)

The seventy-second ordinary general meeting of this Company was held on Tuesday, under the presidency of Sir JOHN WOLFE BARRY, K.C.B.

The SECRETARY (Mr. A. R. Hardie) read the notice calling the meeting and the auditors' report.

The CHAIRMAN said: The meeting will doubtless take the report as read. In consequence of the alteration in the period covered by our financial year, to which I referred at previous meetings, we are unable to offer the customary detailed comparison of income and expenditure, as we have no accounts for the corresponding period of 1906 with which to compare those now before you. I am, however, pleased to inform you that the aggregate receipts for messages during the half-year under review compare favourably with those for the corresponding period for 1906. The receipts from messages exchanged with South Africa, however, continue to decline, there being a considerable falling off in all classes of that traffic. On the other hand, the traffic with India shows a slight improvement, and there is again a steady increase in the message receipts from traffic with South America, so that on the whole there is an increase in the message receipts of about £5,000.

As regards the expenditure side of the revenue account, it may, perhaps, be convenient, as we cannot make a comparison with the corresponding half year in 1906, to make some comparison with the accounts for the preceding half year to June 30, 1907, and, in doing so, I may state that the total expenses, exclusive of repairs to cables, for the half-year we are now considering show a decrease of about £3,600 as compared with the previous half-year. Some of the items of expenditure show a small increase, while others show a decrease, but in the aggregate the expenses, as I have stated, are slightly less. When, however, we turn to the abstract showing the expenses attending maintenance of cables, we find that the cost for the half-year under review is nearly £22,000 more than it was for the preceding half year. As I have so often stated at these meetings, the expenditure under this heading is, and must be, extremely variable, being dependent upon the number of interruptions of our cables, and to the extent of the consequent repairs, in addition to which the credit to this account in respect of charters of our repairing steamers by foreign Governments and other telegraph administrations may, of course, be more or less than that received for the corresponding period. In the present instance both of these factors tell against the present half year, as not only have we been obliged to lay in nearly double the quantity of new cable on repairs to our own lines, but the credits in respect of charters, &c., are nearly £9,000 less than they were for the half year to June, 1907.

When I last had the pleasure of addressing you, I pointed out that in view of the fact that the accounts for the intermediate or June half year included the most productive quarter's receipts—viz., those for March—we must not expect so satisfactory a balance in the final half year's accounts. In view of the present lack of elasticity in the revenue and the continued depression in South Africa, which is adversely affecting our receipts, the Directors consider it advisable to carry forward to next account a larger balance than is usual at the end of our financial year. You will see that we, therefore, decided to carry a sum of £70,000 to the general reserve fund this half year and to carry forward to next account a balance of about £35,000.

The general reserve fund now amounts to £1,144,730. This is satisfactory as far as it goes, but we trust that the traffic will improve so as to enable us to raise our contributions to this fund, while maintaining the moderate dividend and bonus which have remained so constant for so many years. With a cable system such as ours now amounting to a total length of 41,069 miles, it is absolutely necessary that our reserve fund should be sufficient to provide, not only for important renewals of the various sections as they deteriorate through age and other causes, but also to enable us to increase our carrying capacity from time to time as the traffic grows from the development of the world's commerce or other causes which stimulate the volume of telegraphic business. It is by reason of our reserve fund that we can from time to time meet all the requirements of the telegraphing public, and the best interests of the public are to be found in the financial strength of the Company, because this alone has made it possible for us to adopt reductions in the tariff and to grant improved facilities to those interested. I may here mention that very important renewals have been recently completed on one of our cables in the Indian Ocean, the cost of which will be charged against our reserve fund account next half-year.

During the half-year our cable steamer "Duplex" has undergone extensive overhaul in England, and has been furnished with a new boiler, and, in accordance with our usual custom, a portion of the cost has been applied from the maintenance ships fund.

You will see from the report of the Directors that the International Telegraph Conference is now sitting at Lisbon, where this Company is ably represented by the Managing Director, Sir John Denison-Pender, Mr. F. A. Johnston, one of our Directors, and some of the officials of the traffic department. As you may be aware, nearly all the countries in the world are represented at this Conference by officials appointed by the various Governments, and although delegates of the telegraph companies are invited to express the views of their companies upon the different questions under discussion, they are not permitted to vote on any subject, even though it may be one of vital interest to them. In debates on future action we have, therefore, to depend upon the justice of our case and the arguments which we are able to bring forward combined with the submission of facts and figures which our representatives, owing to their great experience in such matters, are able to submit to the deliberations of the Conference. These, together with the support of our own Government representatives, ought, I hope, to result in solutions of questions affecting cable telegraphy in a manner fairly satisfactory to the companies, as also to the interests of the public, because, after all, the interests of the State and of the telegraphing public should be indentical with those of the cable companies, and it is our constant endeavour to work with this aim in view. Although your Directors have always been prepared to meet the reasonable demands of the public for reductions in tariff, it must be borne in mind that the carrying capacity of cables is limited, and that if tariffs are reduced beyond a certain point, the work not only becomes unremunerative but would actually entail a loss to the Company. Therefore, in the event of future demands on us to make any further reductions of tariff, we must look to the Governments concerned to assist us either by the extension of the standard revenue system which has been found to work satisfactorily for Indian and South African traffic, or by some other method which may be mutually beneficial. We have every confidence in our representatives at the Conference, and also in the justice of the numerous delegates from the various Governments, that nothing will be done to impair the present efficient working of our cable system, which is all important to the welfare of the world. I now move the adoption of the report and accounts, and the declaration of the dividend and bonus therein set out.

The MARQUESS OF TWEEDDALE, K.T., briefly expressed his pleasure in seconding the motion.

Mr. STACEY said that he desired to make a few remarks on one item in the revenue account respecting the pension and superannuation funds and the retiring allowances. As these funds had only been in existence 15 years it was obvious that they had not sufficiently accumulated to provide adequately for the older members of the staff, who were, perhaps, approaching middle age when these funds were instituted. Doubtless the younger men would be suitably and even liberally provided for by the maturing of these funds, but the case of the older men required special consideration. They had done good work, and in the earlier days of the Company they had to be contented with lower salaries than were now paid. He understood that it had been the practice of the Directors to augment the amounts at present produced by these funds in individual cases, but he thought that the shareholders generally would agree with him that there should be some scale by which a man should receive a retiring allowance based upon the number of years of his service. Long service in foreign climates must to a certain extent deprive a man of his full usefulness, and in such cases he thought that long service should be the governing factor. It was therefore important—and he believed that those on both sides of the table would agree with him—that there should be a scale by which a man should receive, say, as many sixtieths as he put in years of service—that was, a man would have to put in 40 years' work—his whole working life—before he could receive two-thirds of his pay as a pension.

Mr. J. NEWTON inquired whether the telegraph companies represented at the Conference at Lisbon had not some sort of influence to prevent undue reductions in the tariff. It seemed to him that if the telegraph companies had no influence they were at the mercy of an unknown power called Governments, and he desired to know if the companies had not the power to resist undue reduction. The Chairman had said nothing about wireless telegraphy. He (Mr. Newton) wanted to know whether those who were concerned in the latter were represented at the Conference, and whether an attempt would be made to reduce their rates. With reference to the remarks of the last speaker, the shareholders were greatly interested in the point raised, for the stability of the company could not but be benefited by their having an attached staff.

The CHAIRMAN: With respect to the remarks that have fallen from the last speaker, we have, as I said in my speech, a considerable amount of influence at the Conference upon all matters, from our knowledge of the business and the support which we receive from the British delegates, but over and above that the Conference has no actual power to reduce our tariffs. They can, of course, urge various considerations in that direction. No doubt every one is moving in the direction of lower tariffs, but so far as regards making reductions, that must be done by the various companies, who will need to be convinced that it can be done with propriety before a reduction is made. The delegates may probably try and induce us to see that reduction will be the right policy, but we shall have our own views on the subject, and, although the views of the delegates may influence our decision, the final decision as to a reduction of our tariffs rests with the Directors. With respect to wireless telegraphy, I do not think that those concerned are represented at the Conference; they do not seem to have arrived at the position which appears to justify representation. Turning now to the other matter which was referred to by the first speaker, I am sure that all the Directors of this Company are gratified to hear the remarks which fell from the body of the room on the subject of the treatment of the retiring staff. I am bound to say that everything seems to us to be working satisfactorily. Naturally the pension fund cannot arrive at its full amount in so short a number of years, but it is approaching its capital value of £500,000, and it is continually growing. The valuation of the securities and the position of the funds has to be gone into once every five years, and the next quinquennial period is this year, in the month of June. We hope that a considerable addition may, as in former years, then be made in the valuation of the liabilities and assets of the pension fund. But with respect to the incidence of the fund on the older members, I think that the shareholders may remember that we have a superannuation fund for the very purpose of dealing with this subject of the older members. As the pension fund continues to grow, the necessity for the superannuation fund will tend to decrease, and we are using the superannuation fund to deal with those pensions which have to be given to the older members of our retiring staff. It will also be remembered, I dare say, that the retiring age is now 55 years, which we considered was a high enough age for people who have served us well in the tropics, and I think that that was the right policy; and, in order to deal with the matter at 55 years of age, the Company voted a very considerable sum of money, which has been applied to that purpose. I am bound to say that, as far as I know, we have not met with any case which the Directors have been obliged to deal with in a parsimonious manner on account of want of funds, and we shall bear in mind what has been said from the body of the shareholders in dealing with the subject in the future as we have in the past. I should also like to say that from time to time, when neither the superannuation fund nor the pension fund appeared to meet the case adequately, the Directors have voted sums of money to redress any inequality which seemed to be one which should be dealt with. I hope that that will be satisfactory to the shareholders. He then put the resolution to the meeting, and it was carried unanimously.

On the motion of Mr. NEWTON, a cordial vote of thanks was afterwards passed to the Chairman and Directors.

The CHAIRMAN, in reply, said: Gentlemen, I am sure that all the Directors and myself are very much obliged to you for your kind vote of thanks, which I shall accept also on behalf of the staff.

The proceedings then terminated.

Eastern Extension Australasia & China Telegraph Co. (Ltd.)

The sixty-ninth half-yearly ordinary general meeting of this Company was held on Wednesday under the presidency of Sir John Wolfe Barry, K.C.B.

The GENERAL MANAGER AND SECRETARY (Mr. F. E. Hesse) read the notice calling the meeting, the minutes of the sixty-eighth ordinary general meeting, which were confirmed and signed by the Chairman, and the report of the auditors.

The CHAIRMAN then said: The gross revenue for the half-year under review amounted, in round numbers, to £304,000, against £296,000 for the corresponding period of 1906, an increase of £8 000. This result may be considered satisfactory, having regard to the general depression in trade that has recently prevailed in the Far East and elsewhere, and to the keen competition that still continues between the Government Pacific cable and our system for the Australasian traffic. I am, however, happy to say that we continue to hold our own in this competition, notwithstanding the strong pressure brought to bear upon the commercial community by the local authorities to forward their telegrams by the Pacific route, and the fact that nearly all Government telegrams are sent by the latter route. I cannot but think that this is very unfair to us, and that as a great British Company we are entitled to an equal share of Government business. (Hear, hear.) The working expenses amounted, in round numbers, to £154,000, against £139,000 for the corresponding period of 1906, showing an increase of £15,000. Of

this increase, over £13,000 is due to cable repairs having been far more numerous during the past half-year than in 1906, when they were exceptionally light, costing only £12,854, or about one-half of the normal amount. The rest of the increase is accounted for by the natural growth of salaries and wages. We have also had to spend over £1,000 in connection with a claim made upon the Company by the owners of the s.s. "Agincourt" for consequential damages arising out of the loss of that steamer's anchors and chain when she fouled one of the Company's cables in the Yang-tsze kiang river. The claim being a very wide one, involving far-reaching consequences, your Directors had no alternative but to resist it, especially as it had always been understood that the International Convention for the Protection of Submarine Cables limited the Company's liability to making compensation to the value of the material actually lost. Unfortunately this view was not accepted by the Court of First Instance, which held that although the claim of the plaintiffs went too far, the owners of the "Agincourt" were entitled to a larger measure of compensation than that admitted by the Company. Your directors appealed against Mr. Justice Bray's decision, and obtained a unanimous decision from the Lords Justices of Appeal altering the learned Judge's order, and declaring that the liability of the Company was to make compensation for the sacrifice of the anchors and chain lost, but not further to pay damages resulting from such sacrifice. The action was eventually settled on this basis. It is needless to say that any other result might have been most damaging to the interests of all those who had laid and were working telegraphic cables.

The net profit for the half-year amounted, in round numbers, to £130,000, and after adding £75,000 brought forward from the previous half-year, there remained an available balance of £205,000. The usual quarterly interim dividends of 2s. 6d. per share were paid during the past year, and it is now proposed to distribute a final dividend for the year of like amount, making a total dividend of 5 per cent. It is also proposed to pay a bonus of 4s. per share, or 2 per cent., making a total distribution for the year 1907 of 7 per cent. The usual additions have been made during the past year to the maintenance ships' insurance and depreciation funds, and after applying £50,000 of the revenue balance to the general reserve fund, £20,339 is carried forward.

During the past half-year several partial renewals of the company's cables have been carried out. The lengths of new cable inserted for these purposes have aggregated 330 nautical miles, and the cost of such renewals, amounting to £28,848, has been debited to the general reserve fund. The laying of the Company's new direct cable between Java and the Cocos Islands, to which I have made reference at previous meetings, has been successfully accomplished and the line opened for traffic since the close of the year. The length of the cable is roundly 778 nautical miles, and the cost will be charged against the general reserve fund during the current half-year. This new communication will form a useful alternative route for our Far East traffic, and had it been in operation when the recent strike occurred amongst the Indian Government telegraph employees, it would have assisted in relieving the congestion occasioned during the early days of the strike. The Indian Government authorities shortly after the outbreak, fortunately for the cable communications passing in transit through India, arranged with the Eastern and Eastern Extension Companies to work two of their landlines from the cable stations at Bombay and Madras, and in this manner we were able to transmit the trans-Indian traffic across India with satisfactory results to the telegraphing public and to the Indian Government. When the strike was over, the landlines were again worked by the Government, but we are in communication with the Indian authorities with a view to obtaining, if satisfactory terms can be arranged, the permanent working across India of the trans-Indian traffic by the Eastern and Eastern Extension Companies, as we are convinced that such an arrangement would be for the advantage in speed and accuracy of all the countries which we serve.

Another quinquennial meeting of the International Telegraph Conference is now being held at Lisbon, and two of your Directors are attending it to look after the Company's interests. Judging from what appeared in the newspapers a few weeks ago, considerable misapprehension appears to have existed on the part of the Chambers of Commerce and telegraphing public generally as to the action of the Governments and Cable Companies at the Conference in regard to the use of artificial words in code telegrams; but the publication of the Postmaster-General's letter to the Chambers of Commerce on the subject will have made it clear that it is not proposed to withdraw the privilege, but only to endeavour to have more clearly defined the condition as to the "pronounceability" of artificial words. When the concession of admitting any pronounceable artificial words on the footing of code at 10 letters to the word was granted, it was assumed that the privilege of making up codes on this basis would be used in a reasonable manner, so that the telegraph service, whether by cable or landline, might not unduly suffer, while the public would be benefited. This expectation has not been completely fulfilled. Before the new Regulations came into force the British Post Office found it necessary to issue a circular to the Chambers of Commerce as well as to the principal code makers, directing attention to the fact that codes were being compiled of artificial groups of letters which in many cases could not be regarded as "pronounceable," and that such words would be difficult to transmit and would lead to errors. In many cases code makers have recognised the importance of avoiding combinations which are of doubtful pronounceability, but in some cases an unreasonable use of the concession has been made. As an instance of this, such words (and I must spell them, for I cannot pronounce them) "[illegible]," "[illegible]" and "[illegible]" may be mentioned as words which appeared in a code recently submitted (laughter). It will be readily understood that a telegraphist can deal more rapidly and easily with a pronounceable word, which can be more quickly grasped and remembered while it is being transmitted, as compared with an arbitrary combination of letters requiring a separate effort of attention for each letter. Thus greater speed and accuracy, which are what the public require, are obtained, and there is less need for repetitions and corrections. It is desirable and to be hoped that the condition as to pronounceability will at the Conference be more clearly defined, in order to put some limit for the future to this tendency, which, if unchecked, cannot fail to produce results highly injurious to the telegraph service and, consequently, to the public and commerce. There is, however, no intention of adopting other than a wide and even generous interpretation which would cover the great bulk of the codes at present in use.

Speaking generally of our present report, I think we may consider it as fairly satisfactory, though I wish that I could see greater signs of commercial development in the Far East, and fairer treatment of our Company by the Governments concerned in the State-aided competitive cable in the Pacific. I now move the adoption of the report and accounts, and the declaration of the dividend and bonus therein set out.

The MARQUESS OF TWEEDDALE seconded the resolution.

Mr. JOHN NEWTON said some years ago a system was adopted by the telegraph companies enabling social messages to be sent at a much cheaper rate than would have been charged to the general public for the ordinary kind of telegrams, and he would like to ask whether the Company had improved on that Social Code in such a way that messages could be sent by the general public at a moderate cost.

The CHAIRMAN: The Company most cordially support coding under all reasonable conditions; 95 per cent. of all the work of this Company is coded and only about 5 per cent. is uncoded. That 5 per cent. may be divided again into business messages and social messages, but even if they were all social messages, they would not amount to more than 5 per cent. Some few years ago the Boards of all the Companies realised that some effort should be made to put those who wished to telegraph social messages somewhat on the same basis as those mercantile firms who have codes of their own, and who are able to send their messages at a price which, if written out in long-hand, would probably not amount to more than 2d. or 3d. a word. Following that idea, the "Eastern" Social Code was prepared, and is purchasable by any member of the public for 5s., and is also placed for the free use of the public at all our stations, on all the great lines of steamers, and in other places where social messages might originate. Of course, in addition to that, there are a good many other social codes, and some of them are in constant use. Then, again, we have a principle of registering, free of all fee, the name and address of anyone who likes to come and who is likely to use the cables when away from home. Therefore, with the use of the Social Code and with the use of free registration of addresses, social messages can be transmitted very cheaply. If the public would only take advantage of the opportunities that exist, very few social messages need come in what I may call long-hand.

The resolution was then put and carried unanimously.

The retiring Directors, the Hon. Arthur G. Brodrick and Sir Albert J. Leppoc Cappel, K.C.I.E., were then re-elected, as were the retiring auditors, Messrs. Deloitte, Plender, Griffiths & Co. and Messrs. Welton, Jones & Co.

Mr. LANE suggested that in declaring the quarterly dividends the Directors might be disposed to consider the distribution over the four quarters of the year of the amount now regularly paid as bonus, so that instead of receiving 2s. 6d. per share quarterly the shareholders would receive 3s. quarterly.

The CHAIRMAN said the suggestion should receive the Directors' full consideration, but he could give no more precise answer at that moment.

A cordial vote of thanks to the Chairman, Directors and staff brought the proceedings to a close.

Western Telegraph Co. (Ltd.)

The sixty-ninth ordinary general meeting of the shareholders in this Company was held on Wednesday, under the presidency of Sir John Wolfe Barry, K.C.B.

The SECRETARY (Mr. E. Steer Hodson) read the notice convening the meeting.

The CHAIRMAN said: I have once more the agreeable privilege of submitting for the approval of the shareholders a satisfactory statement of accounts and balance sheet of the Company. Although the message revenue has only increased by an amount slightly under £2,000, it must be remembered that during the period under review we have been working under normal business conditions, and that the receipts have not been inflated by exceptional circumstances, such as to some extent prevailed in the latter part of 1906. In South America generally, political, financial, and commercial matters appear to be steadily and surely advancing towards the still greater prosperity which undoubtedly awaits that great continent, so richly endowed by nature and possessing statesmen eminently qualified to administer its resources. The revenue since the 1st January this year is also so far satisfactory. It is with much regret we have to report the death in November last of our late colleague, Mr. John Coppen, who was a Director of this and the Western & Brazilian Co. for [illegible] years. Mr. John Gordon has been appointed to the vacancy.

He was until lately a member of the important firm of Messrs. Edward Johnston & Co., of Rio de Janeiro and Santos, and is exceptionally qualified to assist in furthering the interests of the Company, having resided for many years in Brazil, and possessing an intimate acquaintance with that country and its requirements. Mr. Gordon is at present in Rio de Janeiro, and among other affairs necessitating his presence there is engaged on important business for this Company. The deputy chairman, Sir John Denison-Pender, and Mr. F. A. Johnston, one of our Directors, I may mention, are attending the Conference in Lisbon, and so are also attending to the affairs of the Company. The total expenses under the various abstracts show a decrease of £1,232 compared with the corresponding period of 1906, resulting from increases and decreases under the different headings. Other expenses show a net decrease of £5,020, due chiefly to there being no expense corresponding to that incurred in 1906 in connection with concessions for new cables. The expenses attending the maintenance of cables were increased by £2,580, 42 more knots of cable, valued at £4,300, were used during the half-year, otherwise a reduction would have appeared under this head. After providing £16,000 for debenture stock interest and £4,464 for income tax, there remains a balance of £206,487, to which is added the sum of £6,864 brought forward from June 30 last, making a total of £213,351. First and second interim dividends, amounting to £62,379, have been paid, and after transferring £120,000 to the general reserve fund, £5,000 to the maintenance ships reserve fund, £10,000 to the marine insurance fund, and £10,000 to the land and buildings depreciation fund, there remains a balance of £5,972 which is carried forward to the next account. With regard to our reserve fund investments, the directors have decided, in view of the depreciation of our securities, to provide a sum of £100,000 on account of investment fluctuations whenever it may be found necessary to realise portions of the reserve fund. I now move the adoption of the report and accounts.

The Rt. Hon. Lord BALFOUR OF BURLEIGH seconded the motion.

Mr. NEWBY said he thought the £100,000 put to reserve was hardly sufficient.

Mr. ENNIS expressed his entire concurrence with the action of the Directors in making provision to the extent of £100,000 on account of investment fluctuations. They had also placed £120,000 to reserve and therefore the fund was really £20,000 more, after allowing for the £100,000 referred to. At their last meeting he suggested that when the Company had a period of prosperity (and he considered that the result of the past half year's working was magnificent), the shareholders might be allowed—in the Directors' discretion—to share in such prosperity.

The CHAIRMAN: With respect to what Mr. Newby said about the £100,000, I may tell him that that amount was arrived at by taking the bottom prices of the day, but we do not wish to be writing up and writing down our reserve fund. (Hear, hear.) We adopt a round figure, and really the reserve fund is not depreciated to that extent until we want to sell. As a matter of fact, we are selling very small portions, and I do not see when we shall have to sell until we have to carry out some very important renewals, which, no doubt, will come about, and which are, at any rate, now in prospect. When that time comes, we shall have £100,000 to provide for investment fluctuations, and we have the advantage of not stating our reserve fund in public at a higher price than is fairly represented by the investments. I think everyone will agree with that, and that the round figure of £100,000 is sufficient, and I think that Mr. Newby, if he figures out all his fluctuations, will agree with us. He pointed out one or two cases where the depreciation is more in proportion, but over the broad result £100,000 represents the depreciation. With respect to the remarks of Mr. Ennis, I am bound to say that whatever falls from him always receives attention, but I cannot myself fairly hold out the prospect to the shareholders of an increased dividend, and I think it would be a pity that the meeting should think that is likely to happen. We see before us very large expenditure in the way of the renewal of some of our cables. Some of them are 35 years old, and although they have been wonderfully preserved, yet we cannot expect that they will go on for ever, and I do not think—and the Board do not think—that the reserve fund now is at all greater than it ought to be. (Hear, hear.) In fact, we want to build up more, in order to make the dividend of this Company a stable dividend, which the shareholders can, humanly speaking, rely on subject to any eventualities which might arise. It is also necessary to bear in mind that in these days most telegraph cable companies are threatened with competition, and I think it would be a great mistake myself to think or suggest that the Directors would be able to declare a larger dividend than they are now doing, having regard to what they hold to be the permanent interests of all the shareholders.

The Chairman said, in further reply, with reference to wireless telegraphy, and the Marconi system, he had nothing to add to what he had said on previous occasions, and nothing had since occurred to make him alter the views he had expressed. He then put the resolution, and it was carried unanimously.

On the motion of Mr. NEWBY, seconded by Mr. LYTH, a cordial vote of thanks to the Chairman, the Directors, and the staff was passed.

The CHAIRMAN acknowledged the compliment, and the proceedings then terminated.

Submarine Cables Trust.

The thirty-seventh ordinary general meeting was held on Tuesday, the MARQUESS OF TWEEDDALE, K.T., presiding.

The SECRETARY (Mr. Sidney Collett) read the notice calling the meeting and the auditors' report.

The CHAIRMAN said the revenue for the year being dividends on stocks and shares, together with interest on deposit, amounted to £23,942, against £25,278 in the preceding year, a decrease of £1,336. This decrease is explained by the fact that owing to the change in the date of the Eastern Telegraph Co.'s financial year, and the consequent alteration in the dates of payment of its dividends, we had to exclude from our receipts of last year one of that company's quarterly dividends and, to balance our accounts, to include a quarter's dividend of the Anglo-American Telegraph Co. which properly belonged to this year—that is to say, the dividend was declared, but was not received during the year. Consequently the receipts in our present accounts include only three quarters' dividends from the Anglo-American Co., reducing our receipts as compared with those of last year by the sum mentioned. It is satisfactory to know that, although the figures show this decrease, our actual receipts, had the conditions been normal, would have been slightly better than last year, for, while our income from the various companies in which we hold investments is practically unchanged, we have received during the year 125 bonus shares from the Central & South American Telegraph Co., the interest on which has gone to swell our dividends from that company. There remains, after paying 6 per cent. interest to our certificate holders, a balance of £4,859. 12s. 4d., which enabled us to acquire and cancel 41 certificates during the year, against 43 last year. We have now cancelled 1,158 certificates, out of 4,200, and we carry forward £49 to next account. You will be glad to learn that our securities show an appreciation over capital of £156,288. I now move the adoption of the report and accounts.

Sir ALBERT J. LEPPOC CAPPEL, K.C.I.E., seconded the resolution, whichrwas carried unanimously.

The retiring auditors were then reappointed, and a vote of thanks to the Charman and his co-trustees brought the proceedings to a close.

AUCKLAND ELECTRIC TRAMWAYS CO. (LTD.)—The total revenue for 1907 was £140,451. 19s. 9d., compared with £132,364. 17s. 1d. for 1906. Traffic receipts (£137,718. 9s.) show an increase of £7,381. 9s. 9d. Deducting expenses (including £14,255 debenture interest) and providing for rental and percentage of profits to Auckland City Council (£3,567. 11s. 1d.), and setting aside £10,000 to depreciation, there remains £29,722. 7s. 9d. Expenses amounted to £20,350. 10s. 8d., compared with £16,915. 6s 5d. for 1906. In addition, £18,726. 7s. 7d. has been expended on renewals and charged to depreciation account. Including £3,101. 10s. 9d. brought forward, there is £32,823. 18s. 6d. The directors propose that £10,000 be placed to reserve, and after payment of the preference dividend recommend a dividend of 6 per cent. on the ordinary shares, leaving £2,165. 9s. 7d. to go forward. Capital expenditure during the year amounted to £71,398. 6s., bringing the total to £664,390. 14s. Expenditure during the year included a new 600 kw. generating set and two new boilers installed, and the purchase of large additions to the rolling stock. At the end of the year the company had 71 cars in stock, an increase of 11. The number has been further increased by delivery of 10 cars from this country and the construction of six in Auckland, bringing the total to 87.

CALCUTTA ELECTRIC SUPPLY CORPN. (LTD.)—5,487,883 units of electrical energy were sold during 1907, against 4,578,380 in 1906. Gross revenue was £103,360. 8s. 11d., compared with £89,242, and working costs £46,084, against £39,065, the increase in working costs being chiefly due to the large increase in the cost of coal. Capital expenditure at Dec. 31 amounted to £604,347. 18s. 8d., an increase of £59,994 on the year. There are 3,721 houses wired (against 3,060), with the equivalent of 320,863 8 c.p. lamps (against 262,893 8 c.p.) connected. The net revenue was £57,275, against £50,176. During the year £19,016. 0s. 9d. was expended on the renewal of mains. The directors have determined the agreement of the managing agents as at Dec. 31 last, and offices have been opened at 8, Dalhousie-square, Calcutta. Mr. Frank Rawson, C.M.G., has been appointed agent and manager of the company. Since the close of the financial year the number of applications from new consumers has largely increased. The new comprehensive licence was granted by the Government on July 31 last, and by its terms the company's statutory powers are continued until determined by purchase of the undertaking either by the Government or the local authority, which purchase can be effected on Oct. 20, 1918, or at any recurring period of 10 years thereafter. Adding to the net profits the balance from last year (£4,230. 0s. 10d.), and deducting the interim dividend at the rate of 6½ per cent., &c., there remains an available surplus of £44,850. 19s. 11d., and the directors recommend that £17,000 be placed to depreciation and renewals, and a final dividend at the rate of 9½ per cent. for the half-year be declared on the ordinary shares (making 8 per cent. for the year), £5,305. 3s 3d. being carried forward.

CALLENDER'S CABLE & CONSTRUCTION CO. (LTD.)—The report for 1907 states that the profit (after providing for income tax) was £60,453. The balance forward from 1906 was £56,722, but from this the extra remuneration voted to the directors in respect of 1906 had to be deducted, leaving the balance from 1906 £55,522, making together £115,976. It is proposed to pay a dividend on the ordinary shares at the rate of 10 per cent. per annum (tax free), being 10s. per share, whereof 5s. was paid on the 1st Nov., 1907; and a bonus of 5s. per share; to place to suspense account £10,000, and to carry forward £45,107. The most pronounced factor in restricting busi-

ness in heavy mains has been the abnormal price of copper which prevailed in the first eight months of last year, leading to the temporary abandonment of nearly all new enterprise in electricity supply, and to the curtailment of extensions of existing networks in every direction. This was not confined to the home trade, as diminished orders were observed in almost every area throughout the world in which the company carries on its business. The continuing downward trend of the market offered no inducement to consumers to undertake new work or to fill up their depleniished cable stocks. The recent return of copper to its average price came after the season was at an end, and it may, therefore, be said that practically the whole of the company's business during the past year consisted of extensions which were absolutely necessary in connection with electric supply stations already in existence. The subsequent stringency in the Money Market has delayed that improvement in business which might otherwise have been expected, and has caused difficulties in other directions, one large firm with which the company has had dealings for some years past having been forced into liquidation. Their business is in course of reorganisation, but, in order to provide against any possible loss, the directors have placed £10,000 to suspense account. The directors refer with deep regret to the loss which the company has sustained through the deaths of Sir David Evans and Mr. W. O. Callender. Mr. W. O. Callender was the founder of the business and the originator of the process which had brought success and fortune to the company. Although he retired from active management some years ago, he maintained until a few months before his death a keen interest in everything concerning the company and its affairs. By his passing away the country had lost one of the pioneers of the electric lighting industry. The directors desire to put on record their appreciation of the great and invaluable services which he rendered to the cable-making industry as well as to the company ever since its formation. The directors have appointed Mr. John Varley to fill the vacancy caused by the death of Sir David Evans.

NATIONAL ELECTRIC CONSTRUCTION CO. (LTD.)—At the meeting on Monday the chairman (Mr. L. B. Schlesinger) said that during the past year it had been practically impossible to raise capital for industrial enterprises, particularly those connected with the electrical industry. Having regard to all the circumstances, the directors did not think the results of the past year could be considered unsatisfactory. The balance was sufficient to pay a 5 per cent. dividend, and they had indicated the possibility of an interim dividend being declared later. The *Musselburgh* strike resulted in a loss of profit estimated at £1,200, and in the dividend on the preference shares being reduced from 6 to 2 per cent. When the Port Seton extension was built he was confident that the ordinary shares would be of considerable value. The *Torquay* contract had been completed, and the Torbay-road line was opened for traffic just before Easter. The receipts on the completed system had so far been excellent, averaging about 12·18d. per car-mile. Given reasonably good weather, the undertaking should earn a large revenue. With regard to the *Mexborough and Swinton* tramways, the results to date had satisfied them that there was a large travelling population and that the investment should be a profitable one. Unfortunately, however, they had had a great deal of trouble with the Dolter surface-contact system and they had decided to have the overhead installed. Orders for materials had been placed and the work would be put in hand at once, a considerable portion of the system equipped and ready for the Whitsuntide holiday. That was the first line equipped on the Dolter surface-contact system in this country, and, as a result of the experiments there, the systems at Hastings and Torquay had been considerably improved, so that in both those towns the system appeared to be a success. The *Rhondda* undertaking, the largest one in which they were interested, would have been completed some months ago had not unforeseen obstacles arisen which delayed its completion. A satisfactory agreement has been come to with the Rhondda Council. As the South Wales Power Co. were not in a position to supply current to the tramways owing to financial troubles, the Rhondda Tramways Electric Supply Co. was incorporated. Capital was raised by the issue of debentures, and the tramway company guaranteed the working expenses of the company and the interest and premium on the sinking fund policies on the debentures issued. Last year they obtained a bill for the electrification and extension of the tramways in *Oxford*, and also to acquire the present horse tramway undertaking. Satisfactory terms had been arranged with the existing company, under which they take, in satisfaction of the purchase price, shares in a tramway syndicate which is now being formed. The construction of the tramway between *Dewsbury and Ossett* was in hand.

PERTH (W. AUSTRALIA) ELECTRIC TRAMWAYS (LTD.)—The gross receipts for 1907 were £75,031 17s. 10d., compared with £75,542 12s. 1d. for 1906, and the net profit amounted to £31,176 19s. 11d., against [illegible] 16s. 5d. Out of the £14,445 18s. 3d. available, the year's preference dividend absorbed £6,000. £1,560 has been expended in respect of new car barn, machine shop, &c., £1,000 is to be placed to reserve, a dividend on ordinary shares at 5 per cent. absorbed £5,000, leaving [illegible] to be carried forward. A contract has been entered into with the owners of the Nedlands Park estate to operate a tramway now being built to connect with the company's system. Mr. E. [illegible], M.Inst.C.E., has been elected to fill the vacancy on the board caused by the death of Mr. E. C. Ogilvie.

POTTERIES & DISTRICT ELECTRIC TRACTION CO. (LTD.)—At the meeting on Tuesday the chairman (Mr. G. F. M. Cornwallis West) said that, notwithstanding the unfavourable weather, their traffic receipts (including parcels) had increased by £2,539 without any increase in route mileage. The number of passengers carried showed an increase of 517,309, the total being 19,665,634. Power and running expenses showed a reduction of over £700. Repairs and maintenance were £18,216, against £16,250 in 1906. £13,700 had been expended on permanent way, of which £6,300 is charged to the year's revenue. Considerable increase in expenditure on repairs and maintenance of rolling stock has also been incurred, the increase being from £7,810 in 1906 to £9,324 in 1907.

SOUTH METROPOLITAN ELECTRIC TRAMWAYS & LIGHTING CO. (LTD.) Mr. C. G. Tegetmeier stated at the meeting on Monday that the past year's operations had realised a net profit of £8,477, compared with £4,717 for 1906. The traffic receipts from the tramways amounted to £41,847, against £17,820. Weather conditions had unfavourably affected their receipts, but the extension of the L.C.C. trams to Tooting Junction had had the effect of forming an improved link in the tramway system of the South of London. They had carried during the year nearly 7,000,000 passengers. The gross receipts of their electrical supply and power section were £7,391; against £5,435, but expenses had increased, chiefly due to the enhanced price of coal. The introduction of the new metallic filament lamps would, he thought, benefit them considerably in the long run.

UNDERGROUND ELECTRIC RAILWAYS CO. OF LONDON (LTD.)—An extraordinary meeting was held on Monday to consider resolutions for winding up the company with the view of carrying out a scheme for the conversion or exchange of the profit-sharing secured notes of the company and for other purposes, and also for altering the articles of association. A resolution in favour of adopting the scheme proposed by the directors was carried unanimously.

NEW COMPANIES.

RICHARD PAPE (LTD.) (97,901).—Reg. May 8, capital £10,000 in £1 shares, to acquire benefit of a contract relating to an electric storage battery known as the "Fors" accumulator, together with the business of manufacturing and selling same, to adopt an agreement with R. Pape, and to carry on the business of electrical engineers, manufacturers of and dealers in accumulators, storage batteries and electrical appliances of all kinds, &c.

GREYSTONES ELECTRIC LIGHT & POWER CO. (LTD.) (3,311.)—Reg in Dublin May 8, capital of £3,500 in £1 shares, to carry on the business of electrical engineers, electricians, practical engineers, contractors, &c. First directors, C. L. Matheson, K.C., H. M. Fitzgibbon, A. L. Figgis, F. Batchelor, A. M. Archer, E. S. Dashwood and R. M. Tweedy. Reg. office, 5, Leinster-street, Dublin.

TEWKESBURY ELECTRIC LIGHT CO. (LTD.) (97,848.)—Reg. May 4, capital £5,000 in £1 shares (2,000 preference), to acquire the interest of J. Parker under the Tewkesbury Electric Lighting Order (1805), to adopt an agreement between Tewkesbury Council and J. Parker and a provisional contract between the same parties whereby the company will acquire a lease of a site for the generating station, and to carry on the business of an electric light and power company, &c. First directors, J. Mitchell, A. Johnson, J. Parker and J. H. Edwards.

CITY NOTES.

MEMORANDA (May 14).—Bank rate 3 per cent. (since March 19. 1908). Price of silver 24¼d. per oz. Consols 86 1/16—86 3/16 for money, and 86 [illegible]—86¼ for account. Consols Pay Day, June 1; Stock and Share Continuation Days, May 27 and June 10; Ticket Days, May 28 and June 11; Pay Day, May 29; Mining Share carry over Day, May 26.

PRICES OF METALS (London). *Copper*, cash, 58 [illegible]—58 [illegible]; three months 58[illegible]—59[illegible]. *Lead*, English, 13 [illegible]—13 [illegible]; foreign, 13 [illegible]—13 [illegible]. *Spelter*, foreign 20—20¼. *Tin*, English, 134½—135½; foreign, cash, 134—134½, three months, 133½—134. *Iron*, Cleveland, cash, 55/0; three months, 48/4—48/6.

CALCUTTA ELECTRIC SUPPLY CORP. (LTD.)—The number of units delivered to consumers during the four weeks ended March 27 were 407,925, compared with 305,049 units in the corresponding period of 1907.

DIESEL ENGINE CO. (LTD.)—A dividend of 10 per cent. has been declared on the ordinary and preference shares for the year ended March 31.

HADFIELD'S STEEL FOUNDRY CO. (LTD.)—Lord Claud Hamilton has joined the board of directors of this company.

MARCONI'S WIRELESS TELEGRAPH CO. (LTD.)—An extraordinary meeting will be held on 13th inst., at the company's offices, to confirm the resolution passed on 30th ult., increasing the capital to £750,000 by the creation of 250,000 7 per cent. cumulative preference shares of £1 each.

STOCK EXCHANGE NOTICES.—The Stock Exchange committee have ordered a further issue of £75,000 4½ per cent. first mortgage debenture stock of the [illegible] to be quoted. The committee have been asked to appoint a special settling day in and grant a quotation to scrip (fully and partly paid) for [illegible] 6 per cent. prior lien debentures of the [illegible] (Ltd.), and also to grant quotations for a further issue of 20,000 £5 fully paid ordinary and 20,000 £5 fully-paid 7 per cent. cumulative preference shares of the [illegible].

ELECTRIC TRAMWAY AND RAILWAY TRAFFIC RECEIPTS.

Line	Week ended.	Amount.	Inc. or Dec. (a)	Aggregate. No. of weeks.	Amount.	Inc. or Dec. (a)
		£	£		£	£
Aberdeen Corporation	May 6	1,340	- 45	19	16,010	- 1,355
Airdrie	„ 1	2,9	+ 1	17	3,821	+ 70
Anglo Argentine	„ 6	19,634	+ 2,269	18	332,807	+ 37,272
Ayr Corporation	„ 9	232	+ 10	51	14,061	+ 12
Baker St. & Waterloo Ry. .	„ 9	3,410	+ 650	19	58,500	+ 13,849
Barnsley	„ 1	147	- 12	17	2,411	+ 200
Barrow	„ 1	213	- 19	17	3,821	+ 46
Bath Electric Trams, Ltd...	„ 6	442	+ 29	18	11,071	- 1,132
Birkenhead Corporation ..	„ 10	1,117	+ 81	..	..	..
Birmingham Corporation .	„ 9	6,,06	+ 66	6	35,702	+ 1,528
Birmingham & Mid	April 24	1,023	+ 316	16	12,378	+ 803
Blackpool Corporation	May 7	551	+ 20	§5	4,351	+ 804
Blackpool and Fleetwood ..	„ 9	354	+ 49	..	..	..
Bolton Corporation	„ 10	2,318	+ 73	6	13,808	+ 994
Bombay	April 16	R38,2,6	+ R10,1,5	15	R547,924	+ R99,195
Bournemouth Corporation.	May 6	1,5,6	- 88	5	8,859	- 396
Bradford Corporation......	„ 9	4,487	- 182	6	26,164	- 1,970
Brighton Corporation	„ 10	,75	- 136	6	4,670	+ 76
Bristol Trams & Carriage..	„ 8	4,910	- 33	18	83,551	- 2,247
Buenos Ayres & Belgrano...	„ 6	1,0,0	+ 328	18	68,164	+ 672
Burnley Corporation	„ 9	1,201	- 56	6	7,739	+ 557
Burton Corporation	„ 10	2,5	- 17	6	1,508	- 137
Bury Corporation	„ 3	1,112	+ 125	‡5	5,697	+ 103
Calcutta Tramways Co....	„ 9	R15,310	+ R1,0	..	..	...
Camborne Redruth	„ 9	115	+ 12	19	2,219	+ 182
Cardiff Corporation	„ 9	2,09	+ 121	...	...	...
Cavehill........	„ 1	70	+ 11	17	1,286	+ 87
Central London Railway .	„ 9	5,,00	+ 75	17	113,663	- 3,801
Charing Cross, Euston & Hampstead	„ 9	3,2,0	...	19	60,535	...
Chatham & Dist. Lt. Rys. ..	„ 7	8,8	+ 1,8	§18	11,853	- 216
City & South London Rly...	„ 10	3,000	+ 306	19	62,588	+ 6,747
City of Birmingham	„ 1	2,765	+ 63	17	16,592	+ 609
Colchester Corporation	...	...	...	...	...	...
Cork Electric Trams Co. ...	„ 6	186	+ 37	§18	7,377	- 115
Croydon Corporation	„ 8	1,395	- 37	6	7,420	- 551
Devonport & Dist. Trams...	„ 1	416	+ 11	17	7,367	- 102
Dover Corporation	„ 9	179	- 50	6	1,060	- 214
Dublin United	„ 8	5,363	- 637	19	89,048	+ 391
Dudley Stourbridge	„ 1	717	- 79	17	12,865	- 981
Dundee Corporation	„ 6	1,168	+ 63	51	58,181	+ 2,4,5
East Ham Council	„ 9	780	- 125	6	4,667	- 301
Exeter Corporation	„ 8	3,1	+ 5	6	1,622	+ 158
Gateshead & Dist. Trams...	„ 1	898	- 84	17	16,996	+ 321
Glasgow Corporation........	„ 9	17,463	- 939	41	851,033	+ 14,523
Glossop	„ 9	136	.	19	2,258	- 138
Gravesend & Northfleet......	„ 1	185	- 33	17	3,273	- 505
Great Northern & City Rly..	„ 9	1,503	- 136	19	33,065	- 2,039
Gt. Northern Piccadilly, &c	„ 9	5,765	+ 1,515	19	102,895	+ 30,256
Greenock & Port Glasgow...	„ 1	513	- 151	17	8,288	- 2,251
Hartlepool Tramways	„ 1	181	- 77	17	3,651	- 629
Hastings Elec. Trams Co....	„ 7	952	+ 43	19	14,411	+ 10
Hong Kong	„ 9	...	- $509	...	.	...
Huddersfield Corpn.	...		.			...
Hull Corporation	„ 9	2,402	- 1	1	13 813	- 122
Ilford District Council	...	...	...	...	.	...
Ilkeston District Council ...	„ 6	111	+ 4	6	815	- 11
Ipswich Corporation	„ 9	351	- 40	6	1,967	- 100
Isle of Thanet Co.	„ 9	300	- 29	52	9,650	- 367
Jarrow	„ 1	82	- 38	17	1,679	- 214
Keighley Corporation	„ 7	156	- 9	45	7,058	+ 310
Kidderminster & District...	„ 1	81	- 9	17	1,515	- 128
Kilmarnock Corporation ..	„ 9	150	- 1	51	7,932	- 204
Lanarkshire Trams Co. ...	„ 7	1 235	+ 32	18	22,831	+ 3,000
Lancashire United........	„ 6	1,247	+ 21	18	22,003	+ 1,018
Leamington	„ 1	113	+ 13	17	2,367	+ 35
Leeds Corporation	„ 9	6,226	- 334	6	35,781	+ 111
Leicester Corporation	„ 9	2,164	+ 234	...	.	...
Leith Corporation	„ 2	503	+ 25	‡51	25,839	+ 180
Lincoln Corporation	„ 9	108	+ 2	6	714	+ 40
Liverpool Corporation	„ 2	10,872	+ 71	18	183,641	- 1,703
Liverpool Overhead Rly. ...	„ 10	1,399	- 76	19	26,338	- 385
*London County Council ...	„ 2	32,807	+ 3,062	†5	147,050	+ 14,782
London United	„ 9	6 365	- 479	18	102,326	- 2,644
Lowestoft	„ 9	160	+ 4	32	4,985	+ 139
Maidstone Corporation......	„ 9	181	...	6	1,014	...
Manchester Corporation ...	„ 9	14,469	- 160	6	82,970	+ 5,359
Mersey Railway	„ 8	1,837	- 61	19	36,407	+ 1,490
Merthyr	„ 1	199	+ 1	17	3,490	+ 51
Metropolitan Dist. Railway	„ 9	8,970	+ 1,211	19	168,534	+ 18,476
Metropolitan Elec. Trams..	„ 1	5,650	+ 880	17	84,715	+ 15,795
Middleton	„ 1	292	- 15	17	5,525	+ 76
Nelson Corporation	„ 9	135	- 11	¶5	811	- 134
Newcastle-on-Tyne Corp. ...	„ 9	3,805	- 315	6	21,595	- 2,504
Newport (Mon.)	„ 9	625	- 5	6	3,876	+ 16
Northampton Corporation .	„ 8	476	+ 26	¶5	2,337	- 79
Oldham, Ashton & Hyde ...	„ 1	525	- 11	17	9,955	+ 20
Oldham Corporation	„ 10	1,950	- 10	6	13,278	- 331
Perth (N.B.) Corporation ...	„ 6	110	...	51	7,889	+ 51
Perth (W.A.) Elec. Trams...	„ 8	1,379	+ 20	¶19	26,903	- 21
Peterborough	„ 1	100	+ 1	17	1,853	- 26
Portsmouth Corporation ...	„ 9	1,880	+ 15	6	10,255	- 751
Potteries	„ 1	1,659	- 182	17	31,373	+ 542
Preston Corporation	„ 6	720	+ 2	19	12,815	- 205
Rotherham Corporation ...	„ 7	507	- 10	§5	3,165	- 46
Rothesay	„ 1	117	+ 32	17	1,323	- 124
Salford Corpn........	„ 11	4,659	+ 57	6	27,030	- 599
Sheerness	April 29	53	- 1	17	841	- 12
Sheffield Corporation........	May 10	5,741	+ 42	17	36,219	- 1,715
Singapore Trams	„ 9	$9,517	- $70	..	...	...
Southend Corporation	„ 6	312	+ 17	6	1,767	+ 25
South Metropolitan	„ 1	725	+ 68	17	11,665	- 284
Southport Tramways........	„ 1	229	- 7	17	3,722	- 338
South Staffs........	„ 1	781	- 61	17	14,810	- 148
Stalybridge, Hyde, &c., Jt. Bd.	„ 9	713	- 97	18	1,391	- 22
Sunderland Corporation ...	„ 10	1,126	- 232	6	6,375	- 1,658
Sunderland and District ...	„ 6	408	- 24	27	12,232	+ 1,201
Swansea Trams	„ 1	871	+ 61	17	14,796	+ 1,082
Swindon Corporation	„ 6	118	- 10	1	735	- 13
Taunton	„ 1	38	- 5	17	653	- 23
Tynemouth and District ...	„ 1	115	- 22	17	2,556	- 308
Tyneside Trams Co.	„ 6	327	- 97	19	6,618	- 1,003
Wallasey District Council	„ 9	828	+ 49	15	4,718	+ 63
Walsall Corpn.	„ 9	530	+ 47	19	9,,13	+ 1,091
Warrington Corpn.	„ 7	380	+ 1	5	2,008	+ 81
West Ham Corporation......	„ 7	2,136	- 162	6	12,819	- 1,314
Weston-super-Mare	April 29	73	+ 13	17	646	- 124
Wolverhampton Co.	May 1	420	- 7	17	7,518	- 68
Wolverhampton Corpn......	„ 6	896	+ 53	48	34,622	...
*Worcester	„ 1	259	+ 1	17	4,153	- 50
Wrexham	„ 1	95	+ 1	17	1,642	- 6
Yorkshire W. R. Trams	„ 10	1,374	+ 86	19	21,064	..
Yorkshire Woollen District.	„ 1	817	- 118	17	15,116	- 639

(a) These comparisons are with the corresponding period last year. § Plus 2 days. ¶ Plus 3 days. * Partly electrical. † Minus 3 days. ‡ Minus 2 days.

ELECTRICAL COMPANIES' SHARE LIST.

Share.	Last Dividend	Name.	Price Wed., May 13.	Rate % Yield. £ s. d.	Dividend Due.	Business Week to May 13. Highest.	Lowest.
		ELECTRICITY SUPPLY.					
10	9/0	Bournemouth & Poole Elec. Sup. Ord...	$10\frac{1}{2}$—$11\frac{1}{2}$	6 ? 0	Mar, Sept,	..	..
10	4/6	Do. $4\frac{1}{2}$ per Cent. Cum. Pref.	10 —10½	4 6 6	Feb, Aug	..	..
10	6/0	Do. 6 per Cent. Cum. Second Pref. ...	$10\frac{3}{4}$—11	5 9 0	Feb, Aug	10½	$10\frac{1}{2}$
St.	$4\frac{1}{2}$%	Do. $4\frac{1}{2}$ per Cent. Deb. Stock (red.) .	102 —105	4 5 6	Jan, July	105	104
5	3/6	Bromley (Kent) El. Lt. & Power Shares	$4\frac{1}{2}$—5	5 10 0	April, Oct	..	..
St.	$4\frac{1}{2}$%	† Do. Do. 1st Debs.	94 —97	4 12 9	May, Nov	..	..
5	5/6	Brompton & Kensington Elec. Sup. Ord.	7 —8	6 5 0	March....	7	..
5	3/6	Do. 7 per Cent. Pref........	$6\frac{3}{4}$—$7\frac{3}{4}$	4 10 0	Mar, Sept	..	..
St.	4%	Central Elec. Sup. Co 4% Guar. Db. Stock	98 —101	3 19 0	June, Dec	..	..
5	2/6	Charing Cross (W. End & City) El. Sup. Co.	$3\frac{1}{4}$—$3\frac{3}{4}$	6 13 0	Feb, Aug	3½	3½
5	2/3	Do. $4\frac{1}{2}$ per Cent. Pref.	$4\frac{1}{8}$—$4\frac{5}{8}$	4 17 0	Feb, Aug	4½	..
St.	4%	Do. 4 per Cent. Deb. Stock (red.)	96 —99	4 1 0	Jan, July	$97\frac{1}{2}$	..
5	2/3	Do. City Undertaking $4\frac{1}{2}$% Cm. Pref.	$3\frac{3}{4}$—$4\frac{1}{4}$	5 8 6	Jan, July	..	..
5	2/6	Chelsea Electric Supply Ord.	$3\frac{1}{4}$—$3\frac{3}{4}$	6 4 0	March ..	..	..
St.	$4\frac{1}{2}$%	* Do. $4\frac{1}{2}$ per Cent. Deb. Stock (red.) ...	101 —104	4 6 9	June, Dec	..	..
10	7/0	City of London Electric Lighting Ord...	$9\frac{1}{4}$—$10\frac{1}{4}$	5 17 0	Feb, Aug	9½	9½
10	6/0	Do. 6 per Cent. Cum. Pref.	12 —13	4 12 0	Jan, July	..	..
St.	5%	Do. 5 per Cent. Deb. Stock (red.)......	124 —127	3 18 0	June, Dec	..	..
St.	$4\frac{1}{2}$%	Do. $4\frac{1}{2}$ per Cent. 2nd Deb. Stock (red.)	102 —105	4 6 0	Jan, July	..	..
5	1/10½	County of Durham Elec. P.D. Ord........	$2\frac{3}{4}$—3	3 9 7	April, Oct	..	..
5	5%	Do. 5 per Cent. non Cum. Pref.	$3\frac{7}{8}$—$4\frac{1}{8}$	3 9 7	April, Oct	..	..
10	6/0	County of London Elec. Supply Ord......	$7\frac{3}{4}$—$8\frac{1}{4}$	6 1 3	Feb, Aug	7½	..
10	6/0	Do. 6 per Cent. Cum. Pref.	$10\frac{3}{4}$—$11\frac{1}{4}$	4 1 3	Mar, Sept	10½	..
St.	$4\frac{1}{2}$%	Do. $4\frac{1}{2}$% Deb. Stock (all paid) (red.)...	107 —110	4 2 6	Jan, July	$108\frac{1}{2}$	108
St.	$4\frac{1}{2}$%	† Do. Second Deb. Stock Prov. Certs....	96 —99	4 11 0	May, Nov	97½	..
5	3/6	Folkestone Electricity Supply Co. Ord.	$4\frac{3}{4}$—$5\frac{1}{4}$	5 7 0	April, Oct	..	..
5	2/6	Do. 5 per Cent. Cum. Pref.	5 —$5\frac{1}{2}$	4 11 0	Mar, Sept	..	..
St.	$4\frac{1}{2}$%	Do. $4\frac{1}{2}$ 1st Deb. Stock (red).....	94 —97	4 13 0	Feb, Aug	..	..
5	4/6	Hove Electric Lighting Ord.	$6\frac{1}{4}$—$6\frac{3}{4}$	6 7 0	April, Oct	..	..
5	5/0	Kensington & Knightsbridge Ord.........	$7\frac{1}{2}$—$8\frac{1}{2}$	5 17 9	Feb, Aug	..	..
5	6%	Do. 6 per Cent. 1st Pref.	6 —$6\frac{1}{2}$	4 12 0	Jan, July	..	..
St.	4%	Do. 4 per Cent. Deb. Stock (red.)......	96 —99	4 1 0	..	..	—
St.	4%	Kensingtn. & Kngtbg. Co. & Notting Hill Co. (Joint Station) 4% Deb. Stock (red.)	97 —101	3 19 0	April, Oct	..	..
St.	$4\frac{1}{2}$	Kent Elec. Power Co.	88 —92	4 18 3	Jan, July	..	..
3	1/6	London Electric Supply Ord.	1 —$1\frac{1}{2}$	5 0 0	Mar, Sept	..	..
5	3/0	Do. 6 per Cent. Pref....	$4\frac{1}{4}$—$4\frac{7}{8}$	6 3 0	Mar, Sept	..	..
St.	4%	Do. 4 per Cent. 1st Mort. Deb.	90 —93	4 8 0	Jan, July	..	..
5	3/6	Metropolitan Electric Sup. Ord.	$4\frac{1}{2}$—$4\frac{3}{4}$	6 16 6	April, Oct	4½	$4\frac{1}{2}$
5	2/3	Do. $4\frac{1}{2}$ per Cent. Cum. Pref.	$4\frac{1}{2}$—5	4 10 0	Jan, July	..	..
St.	$4\frac{1}{2}$%	Do. $4\frac{1}{2}$ per Cent. Deb. Stock 1st Mort.	107 —111	4 1 0	June, Dec	..	..
St.	$3\frac{1}{2}$%	Do. $3\frac{1}{2}$ per Cent. Mrt. Deb. Stock (red.)	85 —90	3 18 0	Jan, July	..	..
100	$4\frac{1}{2}$%	Midland Elec. Corp. for P.D. 1st Mort. Db.	96 —99	4 11 0	June, Dec	..	..
10	4%	Newcastle & Dist. Elec. Ltg. Ord.	$7\frac{1}{4}$—$8\frac{1}{4}$	5 0 0	Feb, Aug	..	—
100	$4\frac{1}{2}$%	Do. $4\frac{1}{2}$ per Cent. Deb.	95 —98	4 12 9	Jan, July	..	..
5	8%	Newcastle Elec. Supply Ord.	$5\frac{1}{4}$—$5\frac{3}{4}$	6 19 2	Feb, Aug	..	..
5	5	Do. 5 per Cent. non Cum. Pref.	$5\frac{1}{2}$—$5\frac{3}{4}$	4 15 3	Feb, Aug	5½	$5\frac{5}{8}$
100	4%	Do. 4 per Cent. Mort. Deb. red. 1907.	96 —98	4 2 6	Jan, July	..	..
1	3%	Northern Counties Elec. Sup.	—	..	Mar, Aug	..	..
100	$4\frac{1}{2}$%	Do. $4\frac{1}{2}$ per Cent. Deb.	95 —97	4 13 9	Jan, July	..	..
10	8/0	Notting Hill Electric Ord........	$11\frac{1}{4}$—$12\frac{1}{4}$	5 14 0	March ..	..	..
5	4/6	Oxford Electric Ord.	$5\frac{7}{8}$—$6\frac{3}{8}$	5 10 0	March ..	..	..
St.	4%	Do. 4 per Cent. Deb. Stock	94 —98	4 1 6	Jan, July	..	..
5	5/0	St. James' & Pall Mall Elec. Ord.........	$7\frac{3}{4}$—$8\frac{1}{4}$	6 1 3	Feb, Aug	..	..
5	3/6	Do. 7 per Cent. Pref.	$6\frac{1}{2}$—7	5 0 0	Feb, Aug	..	..
St.	$3\frac{1}{2}$%	Do. $3\frac{1}{2}$ per Cent. Deb. Stock (red.) ...	85 —90	3 17 9	Jan, July	..	..
5	..	Smithfield Markets Electric Sup. Ord...	$\frac{1}{4}$—$\frac{3}{4}$	..	Feb	..	..
St.	4%	Do. 4 per Cent. Deb. Stock........	70 —74	5 8 0	Feb, Aug	..	..
5	4/0	South London Electric Supply Ord.......	$2\frac{3}{8}$—$2\frac{7}{8}$	6 13 0	April	..	..
1	0/6	South Metrop'n Elec. Lt. & Power Ord.	$\frac{1}{8}$—$\frac{3}{8}$	4 0 0	..	..	..
1	0/$8\frac{3}{8}$	Do. 7 per Cent. Cum. Pref........	$1\frac{1}{16}$—$1\frac{3}{16}$	5 6 0	Feb, Aug	..	..
St.	$4\frac{1}{2}$%	Do. $4\frac{1}{2}$ 1st Db. Stk. Red........	99 —102	4 8 0	April, Oct	..	..
5	2/6	Urban Electric Supply Ord.	1 —2	12 10 0	April, Oct	..	..
5	2/6	Do. 5 per Cent. Cum. Pref.	$1\frac{5}{8}$—$1\frac{7}{8}$	11 14 0	April, Oct	..	..
St.	$4\frac{1}{2}$%	Do. $4\frac{1}{2}$ per Cent. 1st Mort. Deb........	87 —90	5 0 0	April, Oct	..	..
5	5/0	Westminster Elec. Sup. Ord.	$7\frac{1}{2}$—8	6 5 0	Mar, Sept	$7\frac{3}{4}$	$7\frac{1}{2}$
5	2/3	Do. $4\frac{1}{2}$ per Cent. Cum. Pref.	$4\frac{3}{4}$—$5\frac{1}{4}$	4 5 6	Jan, July	5	4½
		ELECTRIC RAILWAYS, TRAMWAYS, &c.					
St.	4%	Baker St. & Waterloo 4% Perp. Db. St.	88 —91	4 8 0	Jan, July	89	..
1	..	Bath Elec. Trams Pref. Ord.	$\frac{3}{8}$—$\frac{5}{8}$	8 0 0	April....	..	..
1	0/6	Do. 5 per Cent. Cum. Pref........	$\frac{11}{16}$—$\frac{13}{16}$	6 3 6	Jan, July	..	..
St.	$4\frac{1}{2}$%	Do. $4\frac{1}{2}$ 1st Mort. Deb. Stock (red.) ...	86 —91	4 19 0	April, Oct	87	..
St.	$4\frac{1}{2}$%	B'ham & Midland Trams $4\frac{1}{2}$ 1st Db. Stk.	93 —96	4 15 0	Jan, July	94	..
10	9%	Bristol Tramways & Carriage Ord.	10 —$10\frac{1}{2}$	8 11 9	Feb, Aug	..	..
10	4%	Do. Cum. Pref. (fully paid)........	8 —$8\frac{1}{2}$	4 14 0	..	..	..
St.	4%	Do. 4 per Cent. Debs.	99 —100	4 0 0	Feb, Aug	..	..
10	..	British Electric Traction Ord........	$1\frac{1}{4}$—$1\frac{1}{2}$	..	June, Dec	1½	..
10	6/0	Do. 6 per Cent. Cum. Pref........	$3\frac{3}{8}$—$4\frac{1}{8}$	12 12 0	Feb, Aug	3½	3½
St.	5%	Do. 5 per Cent. Perpetual Debs.	88 —92	5 8 6	April, Oct	90	$88\frac{1}{2}$
St.	$4\frac{1}{2}$%	† Do. $4\frac{1}{2}$ per Cent. 2nd Deb. Stock	67 —71	6 7 0	May, Nov	..	..
St.	3%	Central London Ordinary Stock	74 —77	3 18 0	Feb, Aug	$75\frac{3}{4}$	74½
St.	4%	Do. 4 per Cent. Pref. Stock	87 —89	4 10 0	Feb, Aug	..	..
St.	2%	Do. Deferred Stock	54 —57	3 10 0	Feb	56	55
100	4%	Do. 4 per Cent. Debs.	100 —103	3 18 0	Jan, July	$101\frac{1}{2}$	100
St.	4%	Charing X, Euston & Hmpstd Per Db. Stk.	81 —84	4 15 3	Jan, July	83	$81\frac{1}{2}$
5	2/6	† City of Birmingham Trams. 5% Cm. Pref.	$4\frac{1}{4}$—$4\frac{3}{4}$	5 5 0	April, Oct	..	..
100	4%	Do. 4 per Cent. 1st Mort. Debs........	97 —100	4 0 0	April, Oct	..	..
St.	$1\frac{3}{4}$%	City & South London Rly. Con. Ord. ...	40 —42	4 3 6	Feb, Aug	$40\frac{1}{2}$	$39\frac{1}{2}$
St.	5%	Do. 5 per Cent. Perp. Pref. (1891) ...	113 —116	4 6 0	Feb, Aug	..	..
St.	5%	Do. (1896)	112 —115	4 7 0	Feb, Aug	..	..
St.	5%	Do. (1901)	110 —113	4 8 6	Feb, Aug	..	..
St.	5	Do. (1903)	106 —109	4 11 6	Feb, Aug	107	..
St.	4%	† Do. 4 per Cent. Perpetual Debs.	99 —102	3 18 0	May, Nov	..	..
10	7/0	Dublin United Trams. Ord	$12\frac{1}{2}$—$13\frac{1}{2}$	4 10 6	Feb, Aug	..	..
10	6/0	Do. 6 per Cent. Pref........	$12\frac{1}{2}$—$13\frac{1}{2}$	4 9 0	Feb, Aug	..	..
10	..	Gt. Northern & City Rly. Pref. Ord. (4%)	$\frac{3}{4}$—$1\frac{1}{4}$	..	Feb, Aug	..	..
10	4/0	G. Northern, Piccadilly & Brompton Ord.	6 —7	5 11 0	Feb, Aug	..	..
St.	4%	Do. 4 per Cent. Deb. Stock	87 —90	4 9 0	Jan, July	$87\frac{1}{2}$	..
5	4/0	Hastings & Dist. Elec. Trams 6% Cm. Pf.	4 —$4\frac{1}{2}$	7 5 0	Mar, Sept	..	..
St.	$4\frac{1}{2}$%	Do. $4\frac{1}{2}$ Db. St.	94 —97	4 12 6	April, Oct	..	..
10	9%	‡ Imperial Tramways Ord........	$10\frac{1}{2}$—$11\frac{1}{2}$	7 17 0	Mar, Sept	..	..
10	6%	‡ Do. 6 per Cent. Pref.	$9\frac{3}{4}$—$10\frac{1}{4}$	5 17 0	Mar, Sept	..	..
St.	$4\frac{1}{2}$%	‡ Do. $4\frac{1}{2}$ per Cent. Debs.	93 —94	4 15 9	Jan, July	..	..
5	..	I. of Thanet E. T. & Lt. 5 per Cent. Pref.	$\frac{7}{8}$—$1\frac{3}{8}$	..	Mar, Sept	..	..
St.	4%	Do. 4 per Cent. Deb. Stock........	58 —63	6 7 0	Jan, July	..	—
10	6/0	Lanarkshire Tramways	9 —$10\frac{1}{2}$	5 12 0	Feb, Aug	..	..
St.	5%	Lancs. Utd. Trams 5% Prior Lien Db. St.	91 —94	5 6 0	Jan, July	..	..
10	..	Liverpool Overhead Railway Ord.........	$1\frac{3}{8}$—$1\frac{1}{2}$	..	Feb, Aug	..	..
10	5%	Do. 5 per Cent. Pref.	$6\frac{1}{4}$—$6\frac{3}{4}$	7 10 0	Feb, Aug	..	..
St.	4%	Do. 4 per Cent. Deb	85 —87	4 11 0	Jan, July	..	..
10	5/0	London United Trams. 5% Cum. Pref. ...	$6\frac{3}{4}$—$7\frac{1}{4}$	6 9 0	Jan, July	..	..
St.	4%	Do. 4 per Cent. 1st Mort. Deb. Stock	80 —85	4 14 0	Jan, July	..	—
St.	..	Mersey Con. Ord. Stock	1 —3	—	Feb, Aug.	..	—
St.	..	Do. 3 per Cent. Perp. Pref.	3 —6	—	..	..	..
1	..	Metropolitan Elec. Tramways Def.	$\frac{1}{2}$—	—	April.. .	½	..
1	0/6	Do. 5 per Cent. Cum. Pref.	$1\frac{1}{8}$—$\frac{1}{4}$	6 3 6	Feb, Aug	$\frac{3}{4}$	..
St.	$4\frac{1}{2}$%	Do. $4\frac{1}{2}$ per Cent. Deb. Stock	94 —97	4 12 6	Jan, July	95½	..
St.	$\frac{1}{2}$%	Metropolitan Railway Consolidated	41 —42	1 2 6	Feb, Aug	41½	$41\frac{3}{4}$
St.	$2\frac{3}{4}$%	Do. Surplus Lands Stock	65 —68	4 1 6	Feb, Aug	67½	$67\frac{1}{4}$
St.	$3\frac{1}{2}$	Do. $3\frac{1}{2}$ per Cent. Preference	86 —89	3 19 9	Feb, Aug	..	..
St.	$3\frac{1}{2}$	Do. $3\frac{1}{2}$ per Cent. "A" Preference	75 —78	4 9 6	Feb, Aug	..	..
St.	$3\frac{1}{2}$%	Do. $3\frac{1}{2}$ per Cent. Convertible Pref.......	73 —76	4 12 0	Feb, Aug	$74\frac{1}{2}$	..
St.	$3\frac{1}{2}$%	Do. $3\frac{1}{2}$ per Cent. Debenture Stock	91 —94	3 14 6	Jan, July	$92\frac{1}{2}$	$91\frac{7}{8}$
St.	$3\frac{1}{2}$	Do. $3\frac{1}{2}$ per Cent. "A" Ditto........	89 —92	3 16 0	Jan, July	..	..

* In calculating the yield allowance has been made for accrued interest but *not* for redemption.
† Ex Dividend

ELECTRICAL COMPANIES' SHARE LIST.—*Continued.*

ELECTRIC RAILWAYS & TRAMWAYS *Continued.*

Share	Last Dividend	Name	Price Wed., May 13.	Rate % Yield. £ s. d.	Dividend Due.	Business Week to May 13 High-est.	Low-est.
St.	..	Metropolitan District Railway Ord.	12 – 13	..	Feb, Aug	12⅝	11¾
St.	..	Do. Extension Pref. (5 per Cent.)	20 – 25	..	Feb, Aug	..	..
St.	3½	Do. 3½ per Cent. Ext. Pref. (Int. Guar. by Und. Elec. Rlys. Co. of London, Ltd.)	44 – 48	7 6 0	Feb, Aug	44½	
St.	3	Do. 3 per Cent. Consolid. Rent-charge	73 – 78	3 17 0	Jan, July	74	..
St.	1½	Do. 4 per Cent. Midland Rent-charge	100 – 104	3 17 0	Jan, July	100⅛	..
St.	1	Do. Guar. Stock 4 per Cent.	42 – 47	3 13 0	Mar, Sept	44½	43
St.	6	Do. 6 per Cent. Perp. Deb. Stock	105 – 110	5 9 0	Jan, July	105½	105½
St.	4	Do. 4 per Cent. Ditto		5 7 3	Jan, July	65½	
5	..	New Gen. Trac. 6 per Cent. Cum. Pref.	½ – 1	..	May	..	..
1	0/9½	Potteries Electric Traction Ord.	½ – ½	8 0 0	April, Oct	..	..
1	0 6	Do. 5 per Cent. Cum. Pref.	¾ – ¾	6 13 0	Feb, Aug	..	..
St.	4½%	Do. 4½ per Cent. Deb. Stock	93 – 96	4 13 9	May, Nov	..	..
1	0 7½	S. Met. Elec. Trams. & Ltg. 6% Cm. Pref.	⅝ – 1	6 0 0	Feb, Aug	..	..
St.	4%	Do. 4 per Cent. Deb. Stock	76 – 80	5 0 0	Jan, July	..	..
100	5%	Sunderland Dist. Elec. Trms. 5% 1st Mt. Db.	73 – 78	6 8 0	Jan, July	..	..
..	5%	Underground Elec. Rys. Co. of London...	36 – 40	12 10 0	June, Dec	..	..
5	..	Yorkshire (W.R.) Elec. Trams. Ord.	1 – 1¼	–	March ..	..	..
5	..	Do. 6 per Cent. Cum. Pref.	2½ – 3½	–	..	..	..
St.	4½	Do. 4½ per Cent. 1st Debs.	84 – 87	5 3 6	Jan, July	..	..

ELECTRIC MANUFACTURING, &c.

Share	Last Dividend	Name	Price Wed., May 13.	Rate % Yield. £ s. d.	Dividend Due.	High-est.	Low-est.
1	..	Aron Electricity Meter Ord.	⅛ – ⅛	..	..	..	..
1	1 5?	Do. 6% Cum. Pf.	1⅛ – 1⅛	7 7 6	April, Oct	..	..
1	2 4½	†Babcock & Wilcox Ord ......xd & bonus	3⅛ – 3⅜	6 9 0	April, Oct	3⅜	3⅛
1	0 7½	† Do. Pref.	1⅛ – 1⅛	3 16 9	..	..	..
5	6 0	British Insulated & Helsby Cables Ord.	6¼ – 6⅝	7 10 6	July, Feb	..	..
5	3 0	Do. 6 per Cent. Pref.	5⅝ – 6⅜	4 18 0	Jan, July	..	..
St.	4½	Do. 4½ per Cent. 1st Mort. Deb. (red.)	102 – 105	4 5 6	Jan, July	..	..
St.	4½%	British Thoms'n-Houst'n 4½% 1st Mt. Db.	93 – 98	4 12 0	Mar, Sept	..	..
5	..	British Westinghouse 6 per Cent. Pref.	⅛ – 1½	..	Feb, Aug	½	..
St.	4%	Do. 4 per Cent. Mort. Deb. Stock	45 – 50	8 0 0	Jan, July	48	..
2	..	Frush Electrical Engineering	¾	–	March ..	¾	..
2	..	Do. 6 per Cent. Pref. non-Cum.	⅛ – ⅛	..	Mar, Sept	..	..
St.	4½%	Do. 4½ per Cent. Perp. 1st Deb. Stock	70 – 75	6 0 0	Mar, Sept	..	..
St.	4½%	Do. Perpetual 2nd Deb. Stock	55 – 60	7 10 0	Jan, July	..	..
5	5 0	Callender's Cable Con. Ord.	10¼ – 11¼	6 3 0	Jan, July	..	..
5	2/6	Do. 5 per Cent. Cum. Pref.	5⅝ – 5¾	4 7 0	Jan, July	..	..
St.	4½%	Do. 4½ per Cent. 1st Mort Debs. (red.)	106 – 108½	4 2 6	Nov, May	..	..
1	1/7½	Castner-Kellner Alkali Co.	1⅞ – 1⅞	8 11 0	May, Nov	1⅞	..
St.	4½%	Do. 4½ per Cent. 1st Mort. Deb. (red.)	101 – 104	4 6 6	Feb, Aug	102½	..
1	0 9?	Chadburn's (Ship) Telegraph Ord.	1⅛ – 1⅛	8 8 0	March ..	..	..
1	0/7½	Do. 6 per Cent. Cum. Pref.	1 – 1⅛	5 6 6	April, Oct	..	..
1	0 8?	Consolidated Electrical Co.	¾	7 0 0	August ..	¾	..
1	1/0	Consolidated Signal Co.	1⅛ – 1⅜	4 5 6	April, Oct	..	..
1	0/7½	Do. 6 per Cent. Cum. Pref.	⅞ – 1⅛	6 4 0	April, Oct	..	..
3	3/0	* Crompton & Co. (Nos. 1 to 85,000)	1⅛ – 1⅛	8 2 0	Jan, July	1⅛	1⅛
100	5	Do. 5 per Cent. 1st Mort. Debs. (red.).	92 – 95	5 5 0	Jan, July	..	..
1	0 7½	Davis & Timmins	⅞ – 1⅛	..	Mar, Sept	..	..
5	2/0	Dick, Kerr & Co. Ord.	1⅛ – 1⅜	7 5 6	Sept	..	..
1	0/7½	Do. 6 per Cent. Cum. Pref.	1 – 1⅛	4 16 0	Sept	..	..
St.	4½%	Do. 4½ per Cent. Deb. Stock	100 – 103	4 7 3	Jan, July	..	..
3	2/6	Edison & Swan United ("A" Sh.) (£3 pd.)	⅝ – ¾	..	Feb, Aug	..	..
5	3/2	Do. (£5 paid)	1⅛ – ⅞	5 0 0	Feb, Aug	..	..
St.	4%	Do. 4 per Cent. Mort. Deb. Stock (rd.)	78 – 81	4 19 3	June, Dec	..	..
St.	5%	Do. 5 per Cent. 2nd Deb. Stock	85 – 87	5 15 0	Mar, Sept	..	..
5	..	Edmundson's Elec Corp. Ord.	⅛ – 1	..	Jan, July	..	..
5	..	Do. 6 per Cent. Cum Pref.	½ – 1	..	May, Nov	¾	..
St.	4½%	Do. 4½ per cent. 1st Mort. Deb. (red.)	53 – 58	7 15 0	Jan, July	57	54
2	..	Electric Construction Co.	½ – ¾	..	Jan, July	½	..
2	..	Do. 7 per Cent. Cum. Pref.	1½ – 1⅜	..	July	..	..
St.	..	Do. 4 per Cent. Perp. 1st Mort. Debs.	64 – 68	6 17 0	Jan, July	64½	64
10	1 0	General Electric (1900) 5% Cum. Pref.	7⅞ – 8¼	6 1 8	June, Dec	..	..
St.	4%	Do. 4 per Cent. 1st Mort. Debs.	87 – 90	4 9 0	Mar, Sept	..	..
10	10/0	Henley's Telegraph Works Ord.	10¼ – 11¼	6 10 0	Feb, Aug	..	..
5	2/3	Do. 4½ per Cent. Pref.	4⅞ – 5⅜	4 3 6	Feb, Aug	..	..
St.	4½%	Do. 4½ per Cent. 1st Mort. Deb. Stock	106 – 108	4 8 0	Mar, Sept	..	..
10	15/0	India Rubber, Gutta Percha, &c., Wrks.	16¼ – 16¾	6 2 0	Feb, Aug	16⅛	15⅞
100	4%	Do. 4 per Cent. Debs. (red.)	98 – 100	4 0 0	April, Oct	..	..
1	2/0	National Elec. Construction Co.	⅝ – ¾	..	April	..	..
1	0 9	Richardsons, Westgarth & Co., Ltd. Ord.	⅛ – ⅛	7 2 0	Nov	..	..
1	0/7½	Do. 6 per Cent. Cum. Pref.	1⅛ – 1⅜	6 8 0	May, Nov	⅞	..
St.	4½%	Do. 4½ per Cent. Perp. Deb. Stock	87 – 91	4 19 0	Jan, July	..	..
1	..	Simplex Conduits Ord.	1¾		..	..	..
5	..	Do. 6 per Cent. Cum. Pref.	5¾		..	..	..
12	30/0	Telegraph Construction & Maintenance	29 – 31	6 11 0	Mar, July	31	30
100	4%	Do. 4 per Cent. Deb. Bonds (1909)	100 – 103	3 17 6	Jan, July	..	..
1	2 0	Vickers, Sons & Maxim, Ltd., Ord.	1⅛ – 1⅜	8 14 0	..	1⅜	1⅛
1	0/6	Do. 5 per Cent. non-Cum. Preference	1⅛ – 1⅛	4 14 6	..	1	..
St.	5%	Do. 5 per Cent. non Cum. Preferred	101 – 105	4 15 6	..	..	..
St.	4%	Do. 4 per Cent. 1st Mort. Db. Sk. (red.)	102 – 104	3 16 6	June, Dec	..	..
St.	4½%	Do. 4½ per Cent. 2nd Mort. Deb. (red.)	104 – 106	4 5 9	June, Dec	105	104½
100	..	Do. 4 per Cent. 2nd Mort. Debs. Scrip	100 – 102			100¼	100¼
5	1/0	Willans & Robinson Ord.	½ – 1½	4 0 0	Apr. Oct	..	..
5	3/0	Do. 6 per Cent. Cum. Pref.	3⅞ – 4⅛	7 15 0	Apr, Oct	3⅞	..
100	4	Do. 4 per Cent. 1st Mort. Debs.	72 – 77	5 4 0	May, Nov	..	..

TELEGRAPHS.

Share	Last Dividend	Name	Price Wed., May 13.	Rate % Yield. £ s. d.	Dividend Due.	High-est.	Low-est.
10	..	Amazon Telegraph	2 – 3	..	June, Dec	..	..
100	5%	Do. 5 per Cent. Debs. (red.)	84 – 87	5 15 0	June, Dec	..	..
St.	1/0	Anglo American	35 – 38	6 1 0	F,My,Ag,N	..	..
St.	30/0	Do. Preferred	98 – 100	5 19 0	F,My,Ag,N	100	99¼
St.	1%	Do. Deferred	14½ – 15½	6 18 0	F,My,Ag,N	15	14½
St.	4%	Commercial Cable 4 per Cent. Deb. Stk.	84 – 87	4 12 0	Jn,Ap,Jy,O	..	..
10	6 0	Cuba Submarine Ord.	7½ – 8½	7 5 0	Feb, Aug	7⅞	7½
10	10/0	Do. 10 per Cent. Pref.	15¾ – 16¾	6 19 0	Feb, Aug	16	..
5	2/0	Direct Spanish Ord	3½ – 3¾	5 13 0	April, Oct	..	..
5	6/0	Do. 10 per Cent. Cum. Pref.	8 – 9	5 11 0	April, Oct	..	..
St.	4%	Do. 4 per Cent. Deb.	99 – 102½	4 8 0	Jan, July	100	..
20	4 0	Direct United States Cable	13⅝ – 14	6 11 6	Ja,Ap,Jy,O	13⅞	13⅝
100	4½%	Direct West India Cable 4½% Rg. Db. (rd.	99½ – 101½	4 8 6	June, Dec	..	..
St.	2 0	Eastern Ordinary	131 – 136	5 2 6	Ja,Ap,Jy,O	134	133
St.	17/6	Do. 3½ per Cent. Pref. Stock	84 – 87	4 0 6	Ja,Ap,Jy,O	86	85
St.	4	Do. 4 per Cent. Mort. Deb. Stk. (red.)	100 – 102	3 18 6	May, Nov	..	..
10	5 6	Eastern Extension	13 – 13½	6 4 0	Ja,Ap,Jy,O	13	13
St.	4%	Do. 4 per Cent. Deb. Stock	101 – 104	3 18 6	Feb, Aug	..	..
100	4%	Eastern S. African Mort. Deb. 1900	99 – 101	3 18 6	Feb, Aug	..	..
25	4%	† Do. 4% Mauritius Sub. Debs. (red.)	98½ – 101½	3 19 6	May, Nov	..	..
10	6	G. N. of Copenhagen [illegible]	29 – 31	6 1 3	Jan, July	..	..
100	4½	Do. 4½ per Cent. Mt. Deb. (red.)	99½ – 101½	4 8 6	June, Dec	..	..
3	2/6	Indo-European [illegible]	53 – 55	5 12 6	May, Nov	53	..
100	£1	Mackay Companies Common	68 – 73	6 7 0	Ja,Ap,Jy,O	..	..
100	£1	Do. Preferred	72 – 75	5 0 0	Ja,Ap,Jy,O	..	..
1	..	Marconi's Wireless Tel. Co.	⅞ – ⅞	..	April	..	..
100	4	Pacific & European Tel. 4% Guar. Deb. (red.)	98 – 101	3 19 0	June, Dec	..	..
24	1/3	West Coast of America	1 – 1¼	8 11 0	May	..	..
100	4	Do. 4 per Cent. Deb.	99 – 101	3 18 6	Jan, July	..	..
10	..	West India & Panama	⅝ – ⅞	..	May, Nov	..	..
10	1/0	Do. 6 per Cent. 1st Pref.	5⅝ – 6	6 17 0	May, Nov	..	..
10	0/6	Do. 6 per Cent. 2nd Pref.	5 – 6	..	May, Nov	5⅞	5½
100	5	Do. 5 per Cent. Debs.	101 – 104	4 16 0	Jan, July	..	..
10	8	Western Telegraph	13 – 13½	6 1 0	Mr,Jn,S,D	13⅛	13⅛
St.	4	Do. 4 per Cent. Deb. Stock (red.)	100 – 102	3 18 6	June, Dec	..	..
..	..	Western Union [illegible]	75 – 80			..	..

TELEPHONES.

Share	Last Dividend	Name	Price Wed., May 13.	Rate % Yield. £ s. d.	Dividend Due.	High-est.	Low-est.
100	28	Amer. Telephn. & Telegh. Cap. St.	118 – 122	6 14 6	..	..	..
..	4%	Do. Coll. Trust $1,000 4 per Cent. Bds	85 – 87	4 14 9	Jan, July	..	..
St.	5%	Anglo-Portug'se Tel. 5% 1st Mt. Db. Stk.	98½ – 101½	4 19 0	Mar, Sept	..	..
5	3 0	Chili Telephone	7 – 7½	5 6 6	August ..	7¼	..
1	0/7½	†Monte Video Telephone Ord.	⅞ – 1⅛	6 16 0	Nov	..	..
1	0/6	† Do. 5 per Cent. Pref.	⅞ – 1⅛	5 7 0	May, Nov	..	..
St.	6%	National Co. Pref. Stock	107½ – 109½	5 9 6	Feb, Aug	108½	108
St.	6%	Do. Def. Stock	109 – 111	5 8 0	Feb, Aug	110	109½
10	6 0	Do. 6 per Cent. Cum. 1st Pref.	10⅝ – 12½	4 15 0	Feb, Aug	..	..
10	6 0	Do. 6 per Cent. Cum. 2nd Pref.	10⅞ – 12½	4 16 0	Feb, Aug	..	..
5	2/6	Do. 5 per Cent. non-Cum. 3rd Pref.	5⅝ – 5⅞	4 9 0	Feb, Aug	5¾	..
St.	3½%	* Do. Deb. Stock 3½ per Cent. (red.)	98 – 100	3 10 0	June, Dec	98½	98
St.	4%	Do. 4 per Cent. Deb. Stock (red.)	101½ – 103½	3 17 0	Jan, July	103	102
1	0/7½	Oriental	1⅛ – 1¼	4 13 6	April, Oct	1⅛	..
1	0 7½	Do. 6 per Cent. Cum. Pref.	1⅛ – 1¼	4 16 0	April, Oct	..	..
St.	4%	Do. 4 per Cent. Red. Deb. Stock	90 – 93	4 6 0	Jan, July	..	..
St.	4½%	Telephone Co. of Egypt 4½% Db. Stk. (red.)	99 – 102	4 8 0	Jan, July	99	..
5	3/0	United River Plate	6 – 6½	6 3 0	July	..	..
5	2 6	Do. 5 per Cent. Cum. Pref.	4⅜ – 5⅛	4 15 0	June, Dec	5⅛	..
St.	4½%	Do. 4½ Deb. St. Red.	99 – 102	4 8 3	Jan, July	..	..

FINANCIAL, INVESTMENT, &c.

Share	Last Dividend	Name	Price Wed., May 13.	Rate % Yield. £ s. d.	Dividend Due.	High-est.	Low-est.
5	3/0	Elec. & Gen. Investment 6% Cum. Pref.	3⅜ – 4½	7 1 0	Jan, July	–	..
10	2 0	Globe Telegraph & Trust	9⅜ – 10½	5 7 0	SpDcMrJu	9⅝	..
10	3/0	Do. 6 per Cent. Pref.	13⅛ – 14	4 5 8	SpDcMrJu	13⅝	..
10	6%	Submarine Cables Trust (Cert.)	126 – 129	4 13 0	April, Oct	128	..

COLONIAL AND FOREIGN ELECTRIC RAILWAYS, TRAMWAYS, &c.

Share	Last Dividend	Name	Price Wed., May 13.	Rate % Yield. £ s. d.	Dividend Due.	High-est.	Low-est.
5	3/0	Anglo-Argentine 6% Cum. 1st Pref.	6⅛ – 6⅜	4 13 0	April, Oct	6⅛	..
5	5 0	Do. 10% Non-cum. 2nd Pref.	7⅞ – 8⅛	6 3 6	Jan, July	8	..
St.	6%	Do. Permanent 6% Deb. Stock	135 – 140	4 5 9	June, Dec	..	..
St.	5%	Auckland Elec. Trams. 5% Deb. (red.)	104 – 107	4 13 6	Jan, July	–	..
5	4 0	†Brisbane Electric Trams. Invest. Ord.	3⅜ – 4	2 10 0	May	3⅝	..
5	2 6	† Do. 5 per Cent. Cum. Pref.	4⅛ – 4⅛	5 1 0	May, Nov	..	..
St.	4½%	Do. 4½ per Cent. Db. Prov. Certs.	98 – 102	4 8 0	Jan, July	100½	100
St.	8%	†British Columbia El. Ry. Df. Ord.	129 – 132	6 1 0	Mar, Sept	131	..
St.	6%	Do. Pref. Ord. Stock	111 – 115	5 4 0	May, Nov	..	..
St.	5%	Do. 5% Cum. Perp. Pref. Stock	107 – 111	4 10 0	Jan, July	110½	..
100	4½%	Do. 4½ per Cent. 1st Mort. Debs.	99 – 102	4 8 0	April, Oct	..	..
100	4½%	Do. Vancouver Power Debs.	101 – 104	4 6 6	Jan, July	..	..
St.	4½%	Do. 4½% Perp Cons. Deb. St.	98 – 101	3 19 0	..	99	..
5	3/0	Buenos Ayres & Belgrano Ord.	4⅛ – 4⅜	8 1 6	April, Oct	..	..
5	3/0	Do. 6 per Cent. "A" Cum. Pref.	4⅝ – 5⅛	5 17 6	April, Oct	..	..
5	3 0	Do. "B"	4⅝ – 5⅛	5 17 6	April	..	..
St.	5%	Do. 5 per Cent. Debs.	110 – 116	4 6 0	Jan, July	–	..
St.	5%	Do. 5 per Cent. 2nd Debs. (red.)	102 – 105	4 16 3	Jan, July	..	..
St.	5%	Buenos Ayres Elec. Trams (1901) Ltd. Deb. St.	95 – 99	5 1 0	Ja, Jul ..	..	..
5	..	Buenos Ayres Grand National Ord.	2⅛ – 2⅝	..	..	..	..
5	2 6	Do. 5 per Cent. Cum. Pref.	3⅛ – 4⅛	5 18 0	Feb, Aug	..	..
10	5½%	Do. 5½ per Cent. Pref. Debs.	100 – 104	5 5 9	Jan, July	..	..
100	6%	Do. 6 per Cent. 1st Deb. Bonds.	98 – 102	5 17 0	April, Oct	..	..
St.	5%	Buenos Ayres Lacroze Trams 1st Mt. Db	92 – 95	5 5 0	Mar, Sept	..	..
St.	6%	Buenos Ayres Port & City Tram. 1st Mt Deb. Stock £75 Paid	64 – 68	6 12 0	Feb, Aug	..	..
5	2/6	†Calcutta Tramways (1 to 137,610)	6 – 7	5 14 0	Mar, Sept	..	..
10	2/6	Do. 5 per Cent. Cum. Pref.	5 – 5⅜	4 13 0	Jan, July	5⅛	..
1	4½%	Do. 4½ 1st Deb. Stock (red.)	103 – 106	4 5 0	Jan, July	105	..
St.	..	Cape Electric Tram Shares	⅛ – ⅛	..	..	..	..
5	1/3	City of Buenos Ayres Trams Co. (1904) Sh.	5⅛ – 5⅛	4 10 0	F,My,A,N	5⅛	..
St.	4%	Do. 4 per Cent. Deb. Stock	98 – 100	3 18 6	June, Dec	..	..
..	5%	†Colombo Tr. & Ltg. 5% 1st Mt. Db.	85 – 90	5 11 0	May, Nov	..	..
100	5%	Electric Traction Co. of Hong Kong 5 per Cent. 1st Mort. Debs.	87 – 92	5 8 6	June, Dec	..	..
1	5%	Havana Elec. Ry. Con. Mt. 5 $1,000 50 year Coup. Bds.	80 – 85	5 17 6	Feb, Aug	..	..
1	..	Kalgoorlie Elec. Trams Sh.	–	..	..	..	..
100	5%	Do. 5 per Cent. "A" Deb. Stock	87 – 91	5 8 9	Jan, July	..	..
100	6%	Do. 6 per Cent. "B" Ditto	71 – 75	7 17 0	Jan, July	..	..
5	1/0	Lisbon Elec. Trams. Ord.	1 – 1¼	4 0 0	July	..	..
100	0/7½	Do. 6 per Cent. Cum. Pref.	1 – 1⅛	4 16 0	Jan, July	..	..
St.	5%	Do. 5 per Cent. Reg. Mort. Debs	90 – 95	5 5 0	Jan, July	..	..
St.	5%	Madras Elec. Trams. 5 Deb. Stk.	95 – 98	5 2 0	Jan, July	..	..
..	5%	Manila Elec. Ry. $1,000 Gold Bonds	86 – 90	5 11 3	Feb, Aug	..	..
100	$1	†Mexico Trams Co Com St.	88½ – 90½	4 8 6	..	89½	89
500	5	Do. Gen. Con. 1st Mort. 5 Gold Bds.	87⅛ – 88⅛	5 13 0	..	88⅛	87⅛
St.	4½%	Montreal St. Ry. Sterling 4½ per Cent. Debs. (1922)	101 – 103	4 7 6	Feb, Aug	..	..
1	1 0	Perth Elec. Trams Ord.	⅞ – 1⅛	7 5 6	May	..	..
St.	5	Do. 1st Mt. Db. Stock	103 – 106	4 14 3	Jan, July	105	..
5	3/0	Rangoon Elec. Trams & Supply Co. 6 Cum. Pf.	5⅛ – 5⅜	5 1 0	..	..	..
St.	4½	Do. 4½ 1st Mort. Deb. Stk.	97 – 99	4 11 0	..	..	..
..	$2½	Sao Paulo Tramway, Light & Power Co. $100 Stock	127½ – 129½	6 11 0	..	..	..
..	5	Do. 5 per Cent. 1st Mt. $500 Db.	100½ – 98½	5 2 6	June, Dec	98½	98
100	4½	Toronto Ry. Co. 1st Mt. 4½% Ster. Bond.	99 – 101	1 9 0	Feb, Aug	..	..

COLONIAL AND FOREIGN ELECTRICITY SUPPLY, &c.

Share	Last Dividend	Name	Price Wed., May 13.	Rate % Yield. £ s. d.	Dividend Due.	High-est.	Low-est.
5	3 0	Adelaide Elec. S'ply Co. 6% Cu Pr.	4⅞ – 5⅛	5 17 0	Mar, Sept	..	..
10	5/0	Bombay E. S. & T. 6% Cm. Pf.	10 – 10½	5 11 0	..	10	..
St.	4½	Do. 4½ per Cent. Deb. Stk. (red.)	93 – 95	4 15 0	Jan, July	94	93
1	3/3	Calcutta Elec. Supply Ord.	6 – 6½	6 6 0	April, Oct	6½	..
100	7/2	Canadian Gen. Elec. Co. Com. St.	88 – 92	10 17 0	..	90½	89½
100	5%	Castner Electrolytic Alkali Co. (of U.S.A.) 1st Mort Stl. Debs.	94 – 99	5 1 0	Jan, July	..	..
500	5	Elect. Development Co. of Ontario	76 – 79	6 6 6	..	78½	77½
5	..	Elec. Ltg. & Trac. Co. of Aust. 6 per Cent. Cum. Pref.	2½ – 2¾	..	Feb, Aug	..	..
St.	5	Do. 5 per Cent. Deb Stock	84 – 88	5 14 0	Jan, July	..	..
St.	5	Elec. Supply Co. of Victoria 5 per Cent. 1st Mort Deb. St	90 – 93	5 7 6	Jan, July	91½	91¼
St.	6%	Indian Elec. Sup. & Trac. Co. Deb. St. Rd. Prov. Certs.	95 – 98	6 2 0	Jan, July	..	..
1	..	Kalgoorlie Elec. Power & Ltg. Ord.	⅛ – ⅜	..	..	..	..
1	1/7½	Do. 6 per Cent. Cum. Pref.	⅞ – ⅞	8 0 0	April, Oct	..	..
St.	5	Madras E. S. Corp. 5 per Cent. Constn Deb. St.	89 – 92	5 8 6	April, Oct	..	..
500	5	Mexican Elec. Light Co. 5% 1st Mort Gold Bonds	76 – 78	6 8 0	..	77½	77
St.	..	Mexican Lt. & Power Co. Cap. St.	48 – 50	..	..	49½	49
100	5	Do. 5% 1st Mort. Gold Bnds	84 – 86	5 16 0	..	85½	85
100	4	Montreal Lt. Ht. & Power Co. Cap. St	98 – 101	5 19 0	F,My,A,N	98½	..
1	1/7½	†River Plate Electricity Co. Ord.	1 – 1	6 8 0	April	1	..
1	1 2½	† Do. 6 per Cent. non Cum. Pref.	⅞ – 1	6 0 0	May	..	..
St.	5%	Do. 5 per Cent. Deb. Stock	96 – 99	5 1 0	Jan, July	98	97½
5	3/0	Rosario Elec. Co. 6% Pref. (1 to 20,000)	4⅞ – 5⅛	5 17 6	April, Oct	..	..
100	$1	Shawinigan Water & Power Co. Cap. St.	64 – 66	6 1 0	..	65	64
..	5%	Do. 5 per Cent. Bds.	102 – 104½	4 17 0	Jan, July	103½	..
..	7 3/4	Victoria Falls Power Co. Pref.	–		Jan, July	..	..

* In calculating the yields allowance has been made for accrued interest but *not* for redemption. † Ex dividend. ‡ The London Stock Exchange Committee have declined to quote these.

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CONTENTS OF THE CURRENT NUMBER.

NOTES.

Is the Consulting Engineer Necessary?

IN our Correspondence Columns this week will be found some further opinions upon the subject of the Consulting Engineer. The sins of the consultant, his desire for fads, and his avoidance of standard plant form the subject of many complaints, though it is generally agreed that the consultant now recognises the desirability of reform in such matters; we might even say that the leading consulting engineers recognised it long ago. One of our correspondents suggests that the ways of the architect might be followed further with advantage. The builder when tendering has something very definite in the shape of a bill of quantities on which to base his price, and it is suggested that the consulting engineer should similarly work out sizes and lengths of all cables, steam pipes, &c. In the case of main cables we agree with this view, though we do not think such a course can be followed completely. In this connection it is worth while to remember that a bill of quantities is not such a very definite document after all; the quantities are estimated partly from drawings, and in many cases cannot be quite exact. The bill of quantities is the basis of the tender, but the amount paid for any item is not necessarily that mentioned in the bill of quantities; payment is frequently according to the schedule rate therein mentioned, and the work must be measured up before the payment can be determined. Such a course is an essential accompaniment of a specification giving lengths, and if this system were extended to cover house wiring, then wiring would have to be measured up, which would not be an easy matter. Moreover, the architect does not provide the bill of quantities, nor does he measure up the work. Would the purchaser be prepared to pay a further fee to the equivalent of the quantity surveyor? We think not.

THE effect of the contractor dealing direct with the purchaser is well put by Mr. MERVYN O'GORMAN. In Germany the contractor's interests are brought into line with those of the purchaser by making the former finance the latter. "A man, chiefly or only, versed in electrical matters, is suddenly called to have an opinion (and back that opinion with money advances) upon the value of a factory which makes plum puddings, or glass bottles, or the prospects of a colonisation scheme among the Thibetians." Obviously this cannot be a satisfactory system. Consideration of the whole subject leads to the conclusion that consulting engineers and contractors have mutual interests, and any course that may be taken to draw up a list, or to form an institute, of consultants, should be the result not merely of action on the part of consultants alone, but of *co-operation* between consultants and contractors. A process of elimination is desired by the former and of protection by the latter; the contractor knows better than anyone else if the methods of Mr. A, B or C are undesirable, and he could place information in regard to their methods at the hands of a committee. Such information would not be easily obtainable otherwise, though highly desirable if the contractor is to be protected, as he should be. In a question of this kind, which is essentially one for *joint* action, we welcome views from contractors and consultants alike, even if anonymous, though we hope that in future more of our correspondents will follow the lead of Mr. O'GORMAN, and will drop the veil of anonymity, thus rendering their remarks of still greater value.

The Saving of Daylight.

IF the Daylight Saving Bill, which is at present being considered by a Select Committee of the House of Commons, is approved by Parliament, one more trouble will be added to those already besetting the central station engineer. For although the consumption of electrical energy for power and street lighting would not be affected

the number of units used for private lighting during the summer time would be very much reduced. In fact, it is claimed that there would be a saving of as much as £2,500,000 in artificial lighting. That so large a saving will be brought about is unlikely, for in many cases such a reduction would necessitate an increased price per unit. Not only would there be a reduction in the quantity used, but the power factor would be reduced, there being no compensating increase in the winter. The passing of the bill, which appears to be receiving much greater support in commercial circles than might have been expected, presents one of those cases in which an industry may suffer to some extent for the general good. There is no question that the arrangement of time so as to utilise an extra hour of daylight per day during the summer time would be universally appreciated, and would be productive of good from the point of view of *mens sana in corpore sano;* there would be greater inducement to take more physical recreation, from the lack of which most of those troubled with business occupations suffer. But, with such legislation in view, it behoves the station engineer to look still more actively for other means of disposing of electrical energy, and to look upon electric lighting as a poor part of the business.

London Underground Electric Railways.

THE extraordinary general meeting of the shareholders of the Underground Electric Railways Co. of London, held recently, although primarily summoned in connection with the proposed readjustment scheme, provided the Chairman, Sir EDGAR SPEYER, with the opportunity of again drawing attention to the present unsatisfactory condition of the companies catering for the conveyance of passengers in London. He did not ignore, however, the fact that the expert advisers of the Underground Electric Railways Company had been influenced too much by the conditions prevailing in American cities, and consequently had been too sanguine concerning the development of London traffic, but we agree with him in thinking that the foundations have been laid for providing London with the best transportation facilities of any town in the world. In order, however, that this may eventually come about, it is essential that the various companies concerned should work together, for the present policy of carrying passengers at unremunerative rates cannot continue indefinitely. Unity of action, however, will be difficult to secure. It is not unlikely that companies running petrol omnibuses would view an increase in the fares with favour, but the Electrobus Co. would probably decline to adopt such a course for obvious reasons, apart from the fact that such fares are stated by the company to be remunerative at present, whatever they may prove to be in the future. The advent of more of these electric omnibuses on the streets is, therefore, likely to complicate the situation from the general financial point of view.

Registration of Wiring Contractors.

THERE appeared recently in our advertisement columns a notice that the Birmingham Electric Supply Department had decided to draw up a list of wiring contractors who would be authorised to carry out work in the city area, and that all installations to be connected to the department's mains after June 30th should be carried out by such authorised contractors. This action by Mr. R. A. CHATTOCK, the city electrical engineer, undoubtedly marks a new era in electric wiring, and should receive the support, not only of other central station engineers, but of all electrical engineers who are interested in the welfare of the industry. Much has recently been said about cheapening the cost of installations, but it is essential that a distinction should be made between cheap wiring carried out on existing systems and cheap systems of wiring. It is the former class of work which eventually leads to breakdowns and to consumers becoming dissatisfied, and which it is so difficult to prevent being connected to the mains provided it satisfies the Board of Trade requirements, since consumers are apt to look upon further requirements of the supply department as rather in the nature of "red tape." This feeling is, perhaps, fostered by the signing of application forms and other procedure in connection with the installing of a service and the connecting up of the wiring. If it were possible to reserve the term "electrical engineer" for such authorised contractors, considerable benefit would result as regards the standing of the industry; but we fear that this is beyond the bounds of present expectations. Nevertheless, the action taken by the Birmingham Electric Supply Department is certainly a step in the right direction, though there may be some interesting legal questions involved.

University of London, King's College.—We are informed that the forty-eighth annual dinner of this college will be held at the Hotel Cecil, on Wednesday, June 3rd. The chair will be taken by Viscount Milner.

Institution of Electrical Engineers.—At the meeting last week, the chairman announced that arrangements had been made for holding the annual conversazione on Thursday, June 25th, and the annual dinner on October 22nd. It will be noticed from the "Arrangements for the Week," in another column of this issue, that the Annual General Meeting is to be held on Thursday next.

Iron and Steel Institute.—At the annual general meeting of this Institute held on Friday last, the president (Sir Hugh Bell) presented the Carnegie gold medal for research to Dr. C. A. F. Benedicks, of the University of Upsala, Sweden, and the Bessemer gold medal to Mr. B. Talbot, inventor of the continuous open hearth process. Carnegie scholarships were awarded to Messrs. T. Baker, R. F. Bohler, W. Gresson, E. Preuss and L. P. M. Revillon.

Post Office and National Telephone Staffs.—The following official notice has been issued by the Postmaster-General:—

As the staff of the Post Office is aware, the staff of the National Telephone Company will, with a few exceptions, be transferred to the Post Office on January 1, 1912, and the Postmaster-General thinks it well to warn officers of all grades of the Post Office service who may be promoted hereafter that, while every care will be taken to prevent hardship, their seniority may possibly be affected by officers transferred from the service of the National Telephone Company.

Deutsche Bunsen-Gesellschaft. The annual meeting of this Society will be held from May 28th to 31st in Vienna. Among the Papers down for reading are: "Electrochemical and Electromagnetic Theories of Photo-chemical Processes," by Dr. Byck; "On the Theory of Electrical Nerve Irritation," by Dr. Nernst; and "The Law of Mass Action with Silent Electric Discharges," by Prof. Le Blanc. The festivities include visits to the Opera House and other places of interest in Vienna, while excursions in the neighbourhood will also be made.

Cable Interruptions.	Date of Interruption.
Cayenne–Salinas	May 12, 1908
Las Palmas–Arrecife	May 18, 1908
Angleterre–Guernsey	May 20, 1908

L'Association Française pour L'Avancement des Sciences.—The annual meeting of this society will be held this year during August at Clermont-Ferrand. Sir William Ramsay has accepted an invitation to lecture before the Society on some of his important researches.

Mordey-Fricker Prepayment Meter.—The Board of Trade have approved of the pattern and construction of the Mordey-Fricker electricity meter (No. 2,513, which was known as the Mordey-Fricker Electrolytic Prepayment Meter) deposited with them on May 23, 1907. The Board have also approved the means provided for fixing and connecting such meters described in the specification and instructions deposited on April 24, 1908 (H. 5,470).

Institution of Mechanical Engineers.—The annual Conversazione was held last Friday evening at the Institution, St. James's Park, the guests being received by the President (Mr. T. Hurry Riches). The customary excellent entertainment was provided, the band of H.M. Scots Guards playing throughout the evening, whilst a selection of vocal and instrumental music was given in the library. By means of electrophones a large number of the guests were enabled to be audibly present at the Covent Garden Opera, and further entertainment was furnished by a lecturette delivered by Mr. L. N. Reddie on "Sound Waves and Sound Reproduction," illustrated by lantern slides and gramophone records of Tetrazzini, Caruso and others.

Association of Teachers in Technical Institutions.—The second annual conference of this Association will be held in London at Whitsuntide, on Saturday, Monday, Tuesday and Wednesday, June 6th, 8th, 9th and 10th. Meetings will take place at St. Bride's Institute, Fleet-street, on the opening day, at Anderton's Hotel, Fleet-street, the Regent-street Polytechnic and the London Day Training College on the Monday, and at St. Bride's Institute on the Tuesday. A conversazione will be held at St. Bride's Institute on Saturday, June 6th, and the annual dinner at Anderton's Hotel on Tuesday June 9th. An excursion will be made to Windsor and Hampton Court on Wednesday, June 10th. A cordial invitation to attend the meetings is extended to all those interested in technical education.

Stray Current from Tramway Lines.—A consideration of this subject, which has long been receiving the attention of electric tramway and railway authorities on the Continent, has culminated in the following regulations, recently issued by the Minister of Public Works in Paris.

1. The conductivity of the track must be maintained in the most efficient manner possible, especially at the rail joints, the resistance of which must in no case exceed that of 10 metres of the normal rail. The owner is bound to test the conductivity periodically and to keep records of the results obtained. These shall at all times be available for inspection by the official charged with the supervision of the undertaking.
2. The drop of pressure in the track, measured over a length of 1 km., selected arbitrarily at any part of the line of rail, must not, on the average, exceed 1 volt during the interval between the passing of the cars.
3. The feeders connected to the track must be effectively insulated.
4. At those points on the track where switches are in use, or where the track is broken, special arrangements must be made to ensure sufficient conductivity.
5. Where the track passes over a metallic structure it must, as far as possible, be electrically insulated from the metal work at the place of crossing.
6. In those cases where no heavy masses of metal work exist in proximity to the track a loss of pressure in excess of that permitted in paragraph 2 may be sanctioned, on the condition that no inconvenience is thereby caused, more particularly as regards telegraphic or telephonic communications or railway signalling.

"The Central."—The principal article in the current issue of *The Central* is an abridgement of Profs. Callendar and Dalby's Paper on "The Measurement of Temperatures in the Cylinder of a Gas Engine" recently communicated to the Royal Society, which gives a very clear idea of the work that has up to the present been done on this important subject. Mr. L. Calisch's article on "Some Remarks on the Electrification of Railways" first deals with the subject from the cost point of view, comparison being made between the running expenses with steam and electric traction, together with details of the profits that may be expected to accrue under the newer system. The writer is of the opinion that electrical working in termini and their surroundings will shortly become a necessity, and considers the direct-current system most suitable for this purpose. An article by Mr. D. Jaffé on the "City of Victoria and Hill District Waterworks (Hong Kong)" is very interesting, and contains some excellent photographs. As mentioned in our last notice, Old Students still seem to be going strong in spite of the summer weather. Dr. G. T. Moody's features are handed down to posterity in this issue, and in this connection may we suggest that the separate issue of these photographs might be a way of increasing the funds of the Old Students Association; means for doing this are, we notice, under consideration by the committee. It is interesting to note that though the college is to form an integral part of the Imperial College of Science and Technology it will still preserve its own entity, and will not be absorbed by the new body as the Royal College of Science and School of Mines are to be.

The Corps of Electrical Engineers.—This corps, whose name has recently been before the public in connection with the formation of the London Balloon Company, is now devoting its attention to raising the telegraph companies allotted to it under the Territorial scheme. A nucleus of N.C.O.'s and men are transferring from the present corps to the new field units, but there are vacancies for a good number of men, such as wireless experts, linesmen, wiremen, telegraph operators, experienced drivers, and others who are prepared to devote the necessary time to learning the special duties of the corps. There will also be room for a few special men, such as students from the technical colleges, polytechnics and similar institutions, and practical engineers, to complete the Electrical Engineers Coast Defence Companies. The qualifications for joining and the terms of enlistment are as follows:—

Period of enlistment	4 years.
Age limit	17 to 35 years.
Height, drivers	5 ft. 3 in. to 5 ft. 6 in.
,, sappers	5 ft. 4 in. and upwards.
Chest measurement	33 in. minimum.

The men will go to camp for a training of eight days (or 15 days optional) in the summer, and will receive regimental and engineer pay at army rates during this period. Recruiting is very brisk at present, and men wishing to join any of these units should apply personally on Tuesdays at 7 p.m., or by letter to the Officer Commanding, London Division Electrical Engineers, Regency-street, Westminster, S.W. Ex-military men of the R.E., R.A. and A.S.C. branches of the service, and ex-volunteers with practical experience of driving, and a few men with practical training in military cooking, will receive special consideration.

Electric Traction on the New York, New Haven and Hartford Railway.—We have recently (see *The Electrician*, Vol. LIX., pp. 907, 1,023, and Vol. LX., p. 87) given some details of the equipment of this line. A recent issue of the *Electrical World* contained some notes on its operation. At present there are 83 trains operated by electricity on week-days, between New York and Stamford, and 33 on Sundays. By July 1 additional electric locomotives will be in commission and then all trains between the two points will be run by electricity. The power house at Cos Cob is now working at its full capacity, but a fourth unit is to be added to furnish power in case of emergency in the operation of the service. All the repeated and complicated difficulties encountered in installing the electric service, the company says, have been overcome. Electrically-operated trains have been running on the New York Central lines since last July and are considered successful from the operating, engineering and financial standpoints. With the electric system it is possible to use the "air-rights" of the corporation; that is, to build office buildings over the terminal yards. The Railway Company's property at the Grand Central terminus is worth £10,000,000 more, now that the road is to be operated throughout by electricity, taking into account this possibility of erecting revenue-producing buildings on it. Money is also saved in the lighting of yards and terminals, since with the present facilities it is easy to provide current for other purposes, and in this way the railway will save £40,000 a year. The power house is designed to take the

peak loads, and electric power will be used in the operation of bridges, unloading machinery, &c. Switching will be done largely by electricity, and by the use of electrical automatic stops, so that the presence of more than one man at the front of the train will be unnecessary.

Submarine Cables and Trawlers.—It is reported that the Commercial Cable Co. has made representations to the State Department at Washington requesting diplomatic correspondence with Great Britain on account of the alleged depredations of British fishing trawlers, who are stated to have frequently destroyed the company's submarine cables between America and Europe, so continually causing interruptions in cable communication. The company state that during the past three months it has been put to an expense of over $100,000 in repairing cables within 50 miles of the Irish coast on account of the acts of these trawlers, two and even three of the cables having been injured and broken at one time. On May 16th all the broken cables were repaired, but on May 18th two of them were again broken, and on May 19th a third was broken by the trawlers. Other cable companies are (the report continues) also in trouble from the same causes.

The officials of the companies point out that the interruptions affect not only communication between Europe and America, but also between Great Britain and Canada, and consequently between Great Britain and Australia. Great Britain collects a tax on all cable messages passing to or through that country, and it is contended by the companies that no injury to the fisheries would result from excluding the trawlers from the narrow cable zone, but that, on the contrary, such a fish preserve is needed, just as seal preserves are defined and protected. There are 13 submarine cables in the particular locality off the Irish coast, 10 serving America, two serving England, and one serving France. The value of these cables is stated to be $100,000,000.

On March 14, 1884, a convention was signed by 26 States (including Great Britain and the United States) by virtue of Art. II.* of which it was agreed to make the wilful disturbing or injuring of a submarine cable a criminal offence. The United States enacted such a criminal statute in 1888. While the difficulty in enforcing such a statute is recognised, owing to the fact that the offence is committed on the open seas, where there are no police, the Commercial Company maintains that Great Britain is obliged by international law to prevent its citizens destroying the property of American citizens, even on the high seas. A precedent for exercising such authority is found in the Act of Congress and Proclamation of a President of the United States, which in 1886 prohibited American citizens from killing seals in the Pacific Ocean north of the 35th deg. of latitude.

Manufacture of Tungsten Lamps.—In connection with the Paper on "Recent Progress in Tungsten Metallic Filament Lamps," which appears in this issue, the following facts put forward by Dr. C. H. Sharp in a lecture before the American Electrochemical Society will be of interest to our readers. There are a number of difficulties in producing a filament from a material like tungsten, due to the fact that it is brittle and unites readily with oxygen and carbon. Hence it is the practice to produce filaments from tungsten in the form of a very fine powder which is held together by some sort of binder that can be removed after the filament has been squirted; this removal must leave the filament free from oxygen and carbon. In the Kuzel process a colloidal solution of tungsten is formed by making an arc between tungsten terminals under water. This solution when of the proper consistency is squirted into filaments which consist entirely of pure tungsten and water. When the water has been driven out, the tungsten particles can be sintered together by heating the filament in an atmosphere containing no oxygen. In Welsbach's process, an organic binder is used to make a paste, which can be squirted through a die. The binder is removed by heating in an atmosphere which will oxidise the carbon and which contains at the same time sufficient hydrogen to reduce any tungsten which may have been oxidised. For the Just-Hanamann process, a very fine filament of carbon is heated in an atmosphere of chloride of tungsten and hydrogen. This results in a deposit of tungsten upon the filament or the substitution of tungsten for carbon. The carbon must afterward be removed by some such process as indicated above. In the "Z" process, a binder of collodion is used which can be made to burn itself out entirely. It has been found possible also to use binders of paraffin, which material can be removed simply by heat; or a low melting metallic alloy may be used as a binder, the foreign metals being driven off by heat. An account was given of the result of a manufacturer's test on 15 series tungsten lamps in which the average candle-power did not change during 2,135 hours' burning. Of these lamps, five survived at the end of the test and only three actually burned out.

The Waste of Daylight.—At a meeting of the London Chamber of Commerce on Tuesday last, Mr. W. Willett read a Paper on the above subject. Mr. Willett, it will be remembered, is the originator of the scheme for providing the worker with a larger share of daylight than he at present possesses. A bill dealing with the question is now before Parliament, and its author is strenuously soliciting support from all parties. The scheme has for its foundation the adjustment of clocks six times a year; setting them forward 20 minutes on three Sundays in the spring and back for equal intervals on three Sundays in the autumn. By this means it is claimed that more daylight will be secured, thus increasing both the physical and mental capacity of the nation. On one point neither electrical engineers nor gas people can be expected to see eye to eye with Mr. Willett, for one of the chief advantages of the scheme is said to be a saving of £2,500,000 per annum on artificial lighting. On Tuesday afternoon, after briefly summarising the working details, the author dealt with the objections that had been raised. After the first derisive stage was passed, the damage to clocks by such alterations was considered disadvantageous. This damage was shown to be imaginary, and electrically worked clocks were specially indicated as being suitable for this purpose. It had also been suggested that the change should take place all at once—*i.e.*, one alteration of 1 hour instead of three of 20 minutes at weekly intervals. But Mr. Willett considered a predominant factor should be for the workman's day always to begin about 6 a.m., and after sunrise. With reference to railway working, although Mr. Gooday of the Great Eastern Railway opposed any alteration, many other railway officials had given the scheme their support, believing it would mean increased receipts and lessen the risk of accidents. Mr. Willett concluded by appealing to his hearers to do all they could to cultivate public opinion and thus strengthen the demand for the bill to be made law. At the close of the lecture Mr. Hope Jones exhibited some electric clocks and showed that it was possible by simple arrangements to alter the time of a whole building without difficulty.

ARRANGEMENTS FOR THE WEEK.

FRIDAY, May 22nd (to-day).

PHYSICAL SOCIETY.

[illegible] p.m. Special General Meeting, to be followed by Ordinary Meeting as detailed below.

5 p.m. Meeting in the Physics Laboratory, Royal College of Science, Imperial Institute-road, South Kensington. Agenda: "On the Spectrum Top," by Mr. G. P. Sexton; "On the Coefficient of Diffusion," by Mr. B. W. Clack; and "On the Production of Small Alternating Currents of Variable Frequency suitable for Telephonic and Other Measurements," by Mr. B. S. Cohen.

SATURDAY, May 23rd.

JUNIOR INSTITUTION OF ENGINEERS.

Visit to the Avonmouth Dock Works and Electricity Works, Bristol.

TUESDAY, May 26th.

FARADAY SOCIETY.

8 p.m. Meeting at the Institution of Electrical Engineers, 92, Victoria-street. Presidential Address on "Some Aspects of the Work of Lord Kelvin," by Sir Oliver Lodge, F.R.S.

THURSDAY, May 28th.

INSTITUTION OF ELECTRICAL ENGINEERS.

[illegible] p.m. Annual General Meeting at 92, Victoria-street.

* Art. II of the Convention is as follows:—"*Art. II.* It is a punishable offence to break or injure a submarine cable, wilfully or by culpable negligence, so as to interrupt or obstruct telegraphic communication, either wholly or partially, such punishment being without prejudice to any civil action for damages. This provision does not apply to cases where those who break or injure a cable do so with the lawful object of saving their lives or their ship, after they have taken every necessary precaution to avoid so breaking or injuring the cable."

ELECTRIC TRACTION ON RAILWAYS.*

VI.—GENERAL COMPARISON OF CONTINUOUS AND ALTERNATING-CURRENT TRACTION.

BY PHILIP DAWSON.

(*Continued from page 123.*)

Summary.—The author, having discussed the characteristics of continuous current and three phase traction motors in our issues of January 31st and February 28th respectively, now passes on to the consideration of the single phase motor. After summarising the development of this motor from the historical point of view the author gives particulars of the Westinghouse, Oerlikon, Siemens-Schuckert, General Electric and Eichberg motors.

The Maschinenfabrik Oerlikon have constructed a single-phase motor on the series principle, which is used in connection with an electric locomotive in regular operation on the Wettingen line near Zurich, a line constructed at the instance of the Swiss Government with a view to thoroughly testing single-phase traction, which it expects at an early date to introduce on the St. Gothard and many other mountain railways, and which may possibly eventually be extended to the whole of the Swiss railway system. The connections of this motor are diagrammatically shown in Fig. 28, on which the various numbers represent

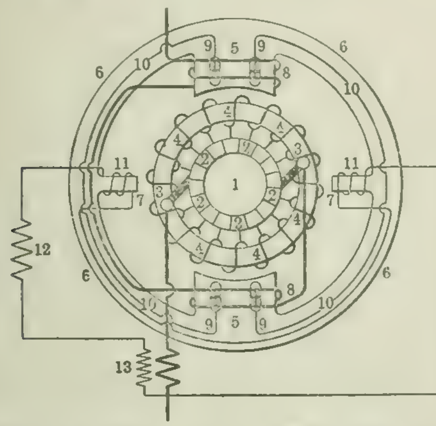


FIG. 28.—DIAGRAM OF CONNECTIONS OF 200 H.P. OERLIKON SINGLE-PHASE SERIES MOTOR.

1. Commutator. 2. Commutator segments. 3 Brushes. 4 Armature winding. 5. Magnetising poles. 6. Magnet Yoke 7. Commutating or neutralising poles. 8. Magnetising coil. 9. Slots for compensating coils. 10 Compensating coils then can either be short-circuited or placed in series with the main circuit. 11. Commutating winding in series with each other are fed from separate transformer. 12. Inductive resistance in series with commutating coils. 13. Series exciting transformers.

the different portions as indicated by the explanatory note below the drawing. It will be noticed that this machine is very similar to the Westinghouse motor already described, except that, by using a very low voltage between commutator segments and by the introduction of an additional commutating winding fed from a separate series exciting transformer, the resistance between the commutator bars and the armature windings have been left out. At the same time it should be mentioned here that the Oerlikon Company have found it necessary, under certain conditions, to add the resistance between the armature winding and the commutator, although they are not shown on the diagram. It will be noted, therefore, that the only essential difference between this motor and the Westinghouse machine is the absence of these resistances and the introduction of compensating as well as commutating windings.

Figs. 29 and 30 give the efficiency and other characteristic curves of this type of motor. The motor is fitted with eight poles, and the normal speed of the motor is 650 revs. per min., and the gear ratio adopted was 1:3·14, the periodicity adopted being 15 periods per second.

Messrs. Siemens, Shuckert are also responsible for what may be called a modified type of series motor; the original motor as constructed by them for the Murnau Oberammergau line was practically nothing but a plain series motor, nearly in every way similar to those constructed by the Westinghouse Company, whereas their most recent motor is in many ways similar to the Oerlikon motor which has just been described. Although of the series type it has several special points about it which really very materially differentiate it from the other types of single-phase series motors.

Fig. 31 shows one of the windings adopted by this firm. It will be seen that they are, leaving the rotor out of account,

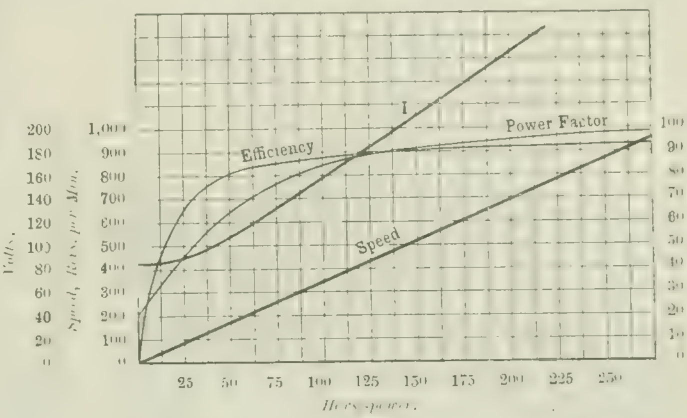


FIG. 29.—CHARACTERISTIC CURVES OF 200 H.P. OERLIKON SERIES SINGLE-PHASE MOTOR, 15~.

for a number and respectively designated in the diagram by the letters E.C.H. and A., this latter is in the present case composed of two sets of shunt windings, one for each direction of rotation. This shunt coil may be called an excitation coil, and as the arrangement shows, only one of the coils is used at a time; a modified arrangement, probably adopted to introduce some method of regulation into the shunt coil so as to keep the auxiliary field created by it always at right angles to the main field, has been introduced and is represented in Fig. 32, from which it will be seen that in this

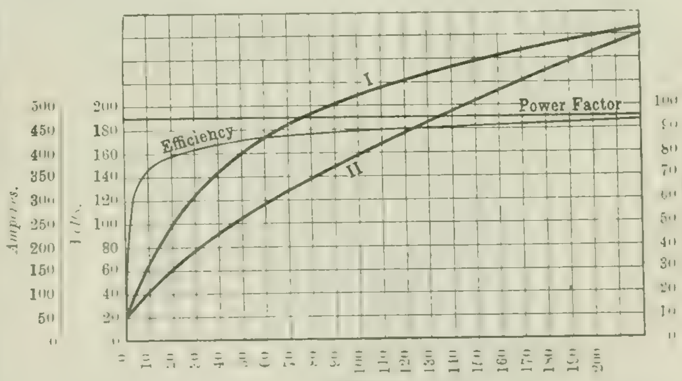
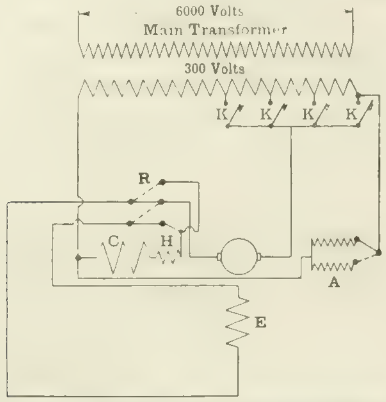


FIG. 30.—CHARACTERISTIC CURVES OF 200 H.P. OERLIKON SERIES SINGLE-PHASE MOTOR.

case a separate exciting transformer is introduced. One or more taps from a special auxiliary so called exciting transformer, together with the other terminal of this shunt transformer, supply this auxiliary excitation coil. These coils A can be wound on the stator teeth lying exactly in the neutral zone, and need embrace but one tooth as shown in Fig. 33 at A, but it is preferable to spread it out in several slots, at the same time taking care to keep the axis of the coil in the neutral zone. In other words the shunt coil may be spread out as in the case of the compensating

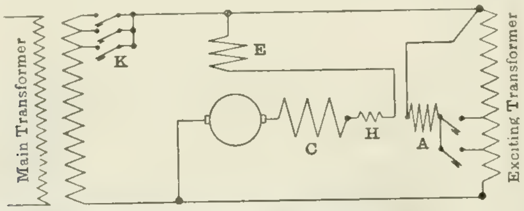
series windings shown in the diagram Fig. 31, and as shown for these coils designated by C in Fig. 33. Windings A constitute the commutating series coils, and their position is clearly indicated in Fig. 33, these coils being those which supply the necessary reactance voltage in the coils of the



E Excitation. C Compensating series coils. H Commutating coils. A Auxiliary shunt windings. K Contactors. R Reversing switch.

FIG. 31.—DIAGRAM SHOWING CONNECTIONS ADOPTED BY SIEMENS-SCHUCKERT FOR SINGLE-PHASE RAILWAY MOTORS.

rotor undergoing commutation during running. The object of coils C, or so-called compensating coils is to neutralise as far as possible the distortion so far as magnetism and inductance are concerned in the rotor windings. Whilst



E Excitation. C Compensating series coils. H Commutating coils. A Auxiliary windings. K Contactors.

FIG. 32.—LATER METHOD OF SIEMENS-SCHUCKERT SINGLE-PHASE RAILWAY MOTOR CONNECTIONS.

coils E, which have their axis normal to the common axis of the three other windings, supplies the useful magnetising stator current. An alternation arrangement whereby it is claimed greater simplicity in the stator windings result, is windings (Fig. 34) is obtainable by using a uniformly distributed equi-pitch winding. By the device shown of connecing A to the transformer at both terminals, it is claimed that the winding A exercises the functions of the coils A, C and H shown in Fig. 32.

This motor, as is usual with modern single phase traction plant, has a stator with distributed winding placed in the

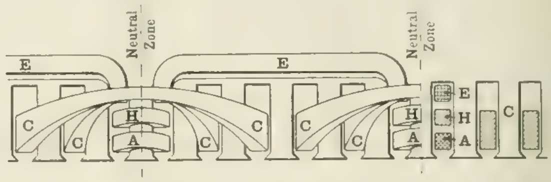


FIG. 33.—ARRANGEMENT OF THE FOUR-STATOR WINDINGS IN EQUAL AND EQUI-SPACED SLOTS OF SIEMENS-SCHUCKERT SINGLE-PHASE MOTOR.

slots in the stator, and without any salient poles. A cross and longitudinal section through this motor is given in Fig. 33. This motor possesses four stator windings, namely, the series field, a commutating field in series with the main field, a compenstating winding excited from a separate variable series transformer, and two compensating shunt fields, one

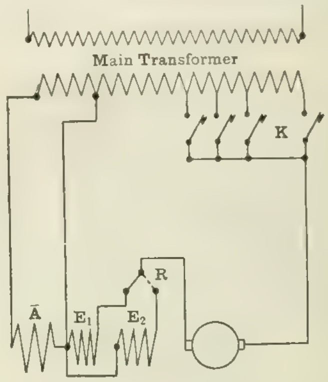


FIG. 34.—ALTERNATIVE METHOD OF CONNECTIONS FOR SIEMENS-SCHUCKERT SINGLE-PHASE RAILWAY MOTOR.

used for forward and the other for the reverse movement. The connections of this motor are diagrammatically shown in Fig. 3.4 The armature is of the driven type wound in every way like an ordinary continuous current machine,

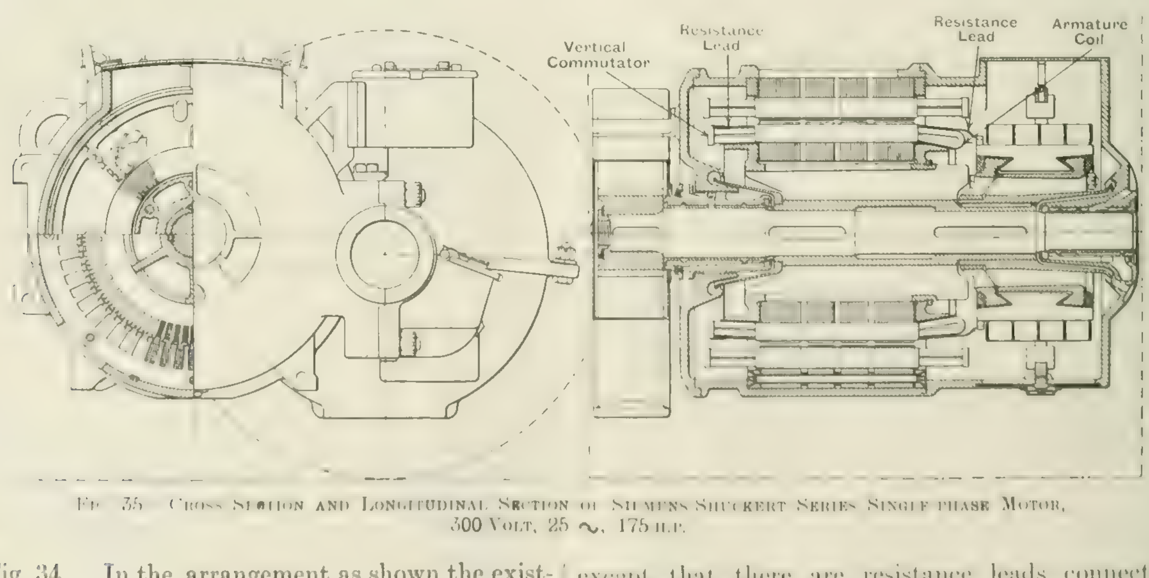


FIG. 35. CROSS SECTION AND LONGITUDINAL SECTION OF SIEMENS SHUCKERT SERIES SINGLE PHASE MOTOR, 300 VOLT, 25 ∿, 175 H.P.

shown in Fig. 34. In the arrangement as shown the existing current is taken off the secondary of the main transformer, instead of using a separate exciting transformer. Experience has shown that the equivalent of these four stator except that there are resistance leads connecting each armature coil to the commutator segments. For this purpose each armature coil is connected to what might be designated as a vertical commutator situated at the back of

the armature at the opposite end to that at which the collecting horizontal commutator is fixed. Each of these vertical commutator segments is connected by resistance wires to the commutator collecting segments, these high resistance leads being fixed in the slots on the top of the ordinary armature coils; these windings are clearly shown in the illustration of the motor. Special ventilation is provided by means of ducts through which ventilating air is thrown tangentially into the commutator and over it, through the armature, and out at the other end.

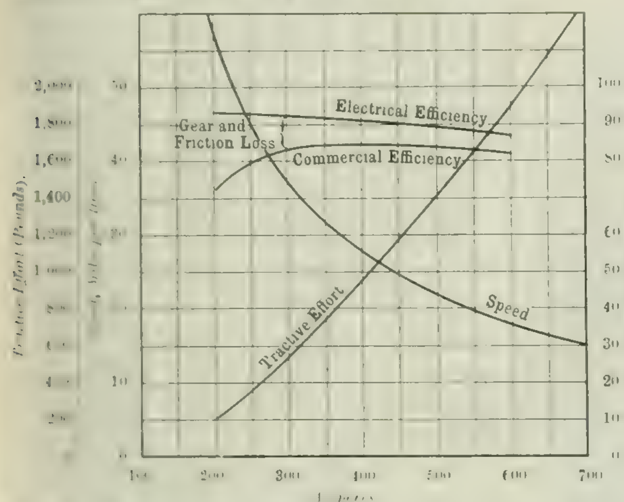


FIG. 36.—CHARACTERISTIC CURVES (CALCULATED) OF G.E.—A 603 COMPENSATED 100 H.P.—B.T.H. SERIES SINGLE-PHASE MOTOR.
Gear reduction 71/19 3·74. 42 in. Wheels. 175 volts. 25 ∼.

The General Electric Company of America, after having first decided to build a traction motor of the plain repulsion type, have now abandoned it in favour of what practically amounts to a plain series motor. As with all the other single phase motors already described, the field or stator winding of this machine is distributed in slots, and there are no salient poles. The motor as at present constructed on American light railway or interurban lines, is of the plain series type with commutator coils in series with the main magnetising coils, and in some cases resistances are inserted between the armature coils and the corresponding commutation blades. This motor has been specially constructed to operate both on continuous and alternating current, so as to be able to run over existing tramway systems in large towns, and then run over a country line for a considerable distance over its own right of way with alternating current, until approaching another town, when it will again change over to continuous current and run over the existing continuous current system. Curves of such a motor rated at 100 H.P. are given in Figs. 36 and 37, the maximum voltage at motor terminals being 200 volts, and, as in all plain series motors, as well as those variations of this type so far described, the whole current passing through the armature at a pressure never exceeding 200 volts (usually nearer 175 volts), has to be dealt with by the controlling gear and contactors; it will be noted that the motor characteristics given in Figs. 36 and 37 have been calculated, and are not from actual test results, but notwithstanding this they are quite accurate enough for the purpose of these articles to enable comparisons between different types of motors to be made. Figs. 38 and 39 are characteristic curves of a 50 H.P. motor of the same type and make. Fig. 40 gives a general dimensioned design of this motor as proposed by the British Thomson-Houston Company in their tender for the electric equipment of the South London portion of the London, Brighton & South Coast Railway.

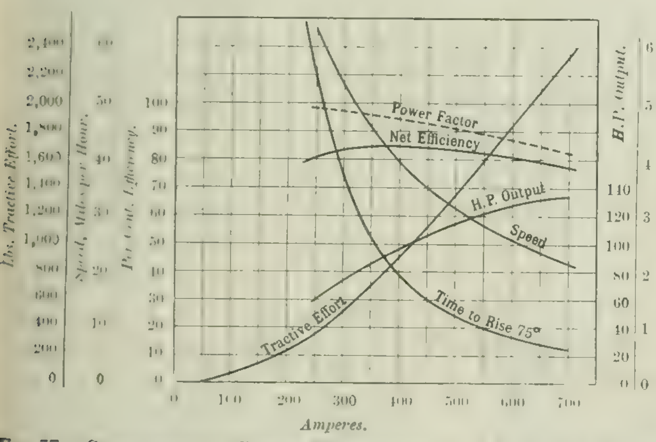


FIG. 37.—CHARACTERISTIC CURVES CALCULATED OF G.E. A. 603 225 VOLT B.T.H. SINGLE-PHASE MOTOR.
Gear 63. Pinion, 27. Ratio, 2·33 Diam o wheels, . 25 ∼.

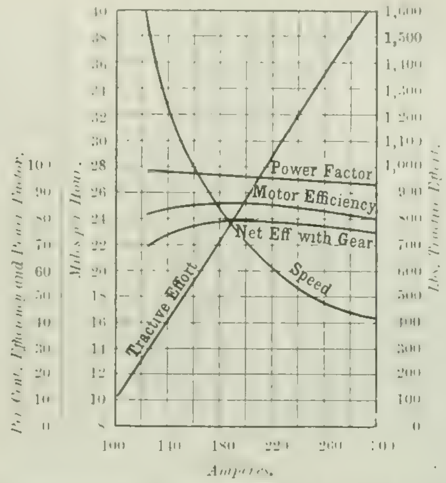


FIG. 38.—CHARACTERISTIC CURVES OF G.E. A. 605 A 50 H.P. RAILWAY MOTOR.
Alternating Current, 25 ∼, 250 volts. Diam. of wheels, 33 in. Pinion, 17. Gear, 73. Ratio, 4·3. Fields in multiple.

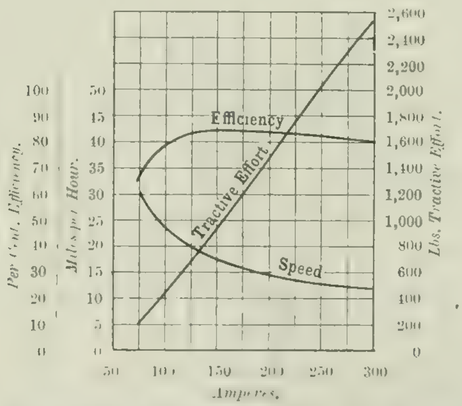


FIG. 39.—CHARACTERISTIC CURVES OF G.E. A. 605 A 50 H.P. RAILWAY MOTOR.
Direct Current at 250 volts. Diam. of wheel, 33 in. Pinion, 17. Gear, 73. Ratio, 4·3. Fields in series.

Diagram Fig. 37 represents the characteristic curves of a single-phase motor constructed by the General Electric Company of America, and rated at 100 H.P. on the one hour basis with a temperature rise not exceeding 75 degrees centigrade. It will be seen that the continuous load which this machine can bear with the same temperature rise corresponds to about 49 H.P., or a ratio between hour and continuous-rating of 2·6 as compared to 1·92 in the case of the Winter-Eichberg motor referred to in another part of this article, and that the speed of this motor is at rated load

under normal conditions 800 revolutions as compared to 600 in the case of the Winter Eichberg 51 German motor. A careful comparison of the characteristic curves of this

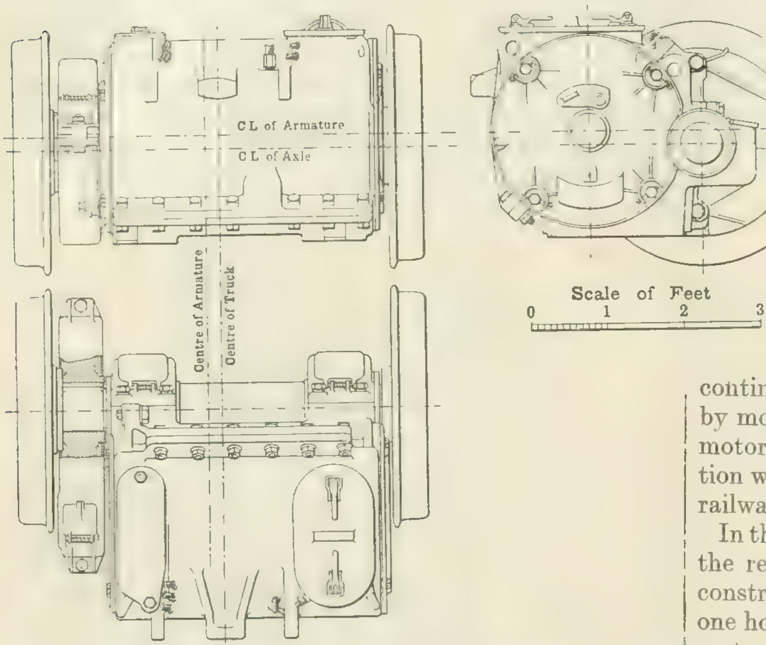


FIG. 40. OUTLINE DRAWING OF 100 H.P. B.T.H. SINGLE-PHASE MOTOR.

motor which is called the G.E.A. 603 motor with the W.E. 51 is most interesting. In making such comparison it must not be overlooked that the problem to be solved appears to be looked at differently in America and in Europe. In the former country apparently, it seems to be the opinion of many engineers that single-phase motors are more especially suitable for long distance traffic on interurban roads, and that it is essential that the single-phase motor should be so designed as to be able to be worked efficiently also over continuous-current lines. The result of this point of view is the production of a machine which gives better results as a continuous-current motor than as an alternating-current one. In Europe on the contrary, it has been generally assumed that single-phase motors should be primarily designed to give the best results as single-phase machines, it being more or less immaterial what sort of results are obtained from the machine when operated by continuous currents. Furthermore, it is generally admitted by most European railway engineers that the single-phase motor will, in the near future, be largely employed in connection with the conversion of the suburban lines of existing railways from steam to electric traction.

In this connection Figs. 38 and 39 are instructive which give the relative characteristic curves of a single-phase motor constructed by the General Electric Co., of America, of 75 H.P. one hour rating and designated on the G.E.A. 605 A railway motor, when operated by continuous and single-phase currents.

The last motor of the plain series type to be mentioned is that manufactured by Messrs. Brioschi Finzi, of Milan, and designed by Dr. Finzi, who has already been referred to previously in this article. These motors were rated at 30 H.P. each.

(*To be continued.*)

THE FRANCO-BRITISH EXHIBITION.—II.*

Summarising the work which has been carried out by the various wiring contractors, it may be said that over 2,000 arc lamps have been erected, whilst the incandescent lighting will probably be nearly half-a-million lamps; but it is, of course, difficult to estimate exactly the figures, since many parts of the wiring are not altogether completed, and also the lighting of the stands is not in all cases definitely decided upon.

In addition to its use for lighting, electricity will be extensively employed for power, but it is not possible to give a detailed description of this application until most of the stands are fully equipped and other machinery in the grounds is in a more finished state. At present it must suffice to mention that two motors have been installed in connection with a moving staircase at each end of the passage leading from Uxbridge-road, to which reference has been previously made, and a 125 H.P. motor for the "flip-flap," whilst several electrically driven pumps are also being fitted up.

For distributing the current throughout the grounds an extensive system of lead-covered cables has been laid down by Messrs. Reed's Electrical Co., and an idea of the size of this undertaking can be gathered from the fact that over 34,000 yds. of lead-covered cables have been laid within the last few months. Owing to the state of the ground, due partly to the building operations, it will be understood that the conditions have been rather severe, but we learn that, although no less than 27 high-pressure tests have been carried out on the various networks of cables, in only *one* case has a fault been indicated. The cables are of the Western Electric Co.'s (28,000 yds.) and Johnson & Philips' (6,000 yds.) manufacture, and have been drawn into earthenware ducts supplied by the Albion Clay Co. These ducts, which vary from 1 to 17 ways, run between the various draw-in pits, in which are fixed the disconnecting boxes. Single-phase, three-phase and continuous-current lead-covered services are taken into most of the buildings, three-core cables being used for the single-phase and continuous-current supplies on the three-wire system, as previously described, and four-core cables for the three-phase

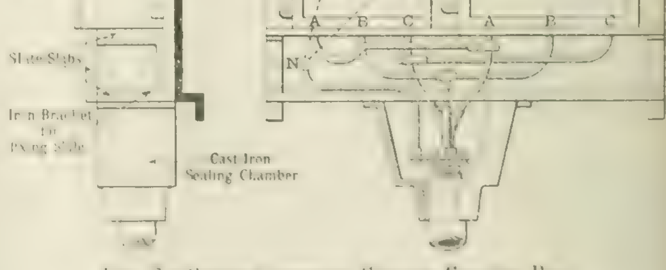


FIG. 7.—SECTION THROUGH SERVICE SEALING BOX.

supply. The main distributing cables are 0·36 sq. in. by 0·36 sq. in. by 0·18 sq. in. in the former cases, and 0·24 sq. in. by 0·24 sq. in. by 0·24 sq. in. by 0·12 sq. in. in the latter case, so that it will be seen from these particulars that the network of cables is comparable with that of many large towns, and

* The first part of this article appeared in our last issue.

when it is remembered that this extensive network has been laid in such a short time, great credit reflects on Messrs. Reed's Electrical Co. for the satisfactory way in which the work has been carried out.

The services into the buildings terminate in sealing boxes, above which are fixed, as will be seen from Fig. 8, the main switches, &c., all of which have been supplied by Messrs. Berry, Skinner & Co. A section through one of these sealing boxes is shown in Fig. 7.

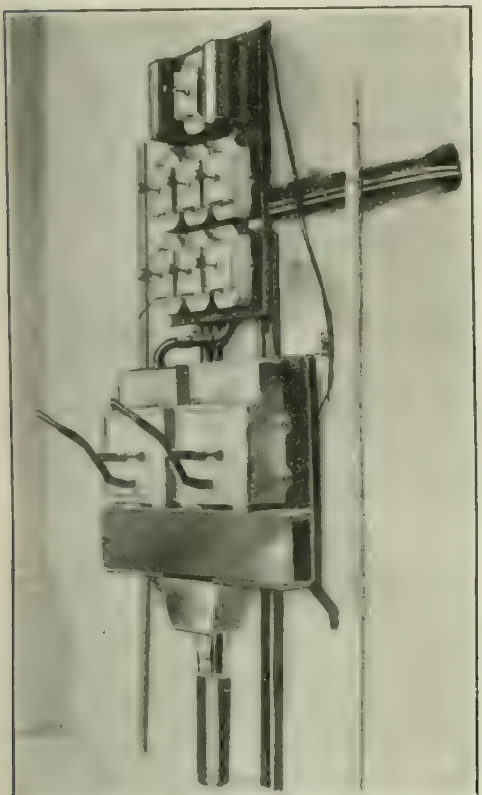


Fig. 8.—View Showing Group of Switches at Point of Entry of a Service.

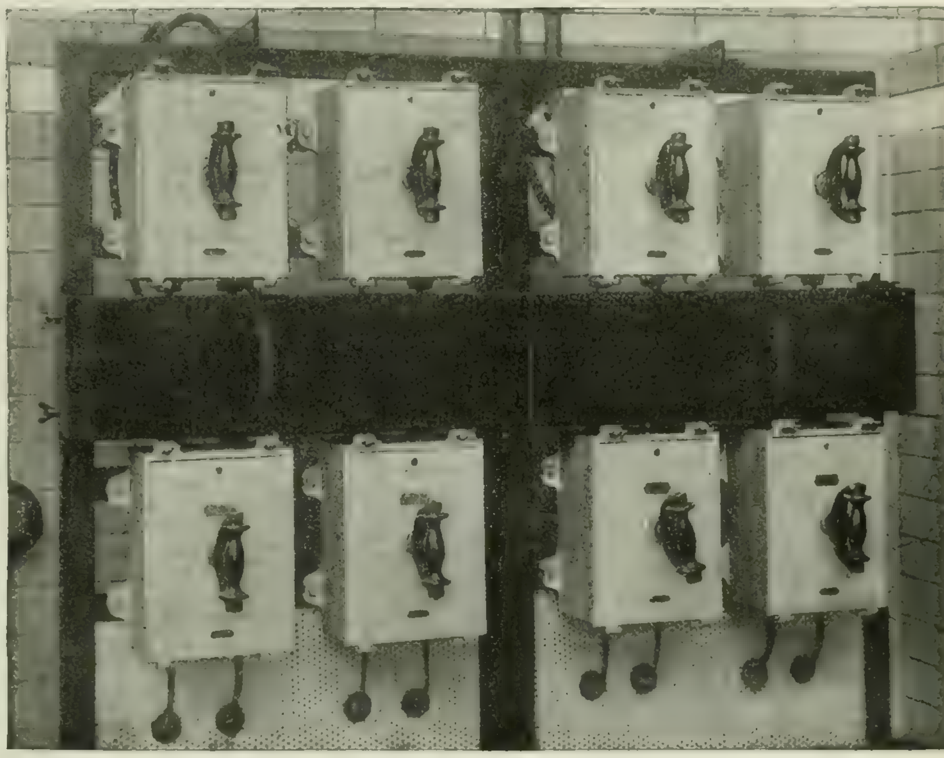


Fig. 9.—Group of Berry Skinner Switches.

The control of the main feeding points at the various buildings throughout the Exhibition is effected by Berry Skinner ironclad switches. These have been erected on suitable supports either of slate or steel frame and attached directly to the walls of the buildings. Both arc and incandescent circuits are fed from boards on which small ironclad switches of the same pattern are mounted. We illustrate in Fig. 8 a group of these switches, showing the main switches for the service and the switches controlling some of the arc-lighting circuits. It has been possible by the employment of a combined double-pole switch and fuse to ensure absolute safety in the control of the main circuits. The Berry pattern of switch has proved extremely useful in this respect, in that it saves space and enables the connections to be brought in to both the switch and fuse without the exposure of loose ends. Electrical engineer visitors to the Exhibition will notice these groups of switches at various points, though there are many installed within pillars and behind partitions. The Berry Skinner switch is too well known to need description here, but we may refer readers to the December issue of our Industrial Supplement for full particulars. We illustrate in Fig. 9 a group of these switches mounted on a special board and arranged to distribute energy from a set of 'bus bars which are mounted between the two groups of switches. The connections are entirely enclosed at the front of the board, so that it is impossible to receive a shock, and couplings at the back are adequately shut off from other than official inspection. The principal advantage of the controlling device of the Berry type is that when a fuse is required to be renewed, as will naturally be the case in an installation where overloading of the circuits is all too common, this renewal can be effected with the fuse contacts absolutely dead. Our readers will recall the fact that with the Berry Skinner switch the lid

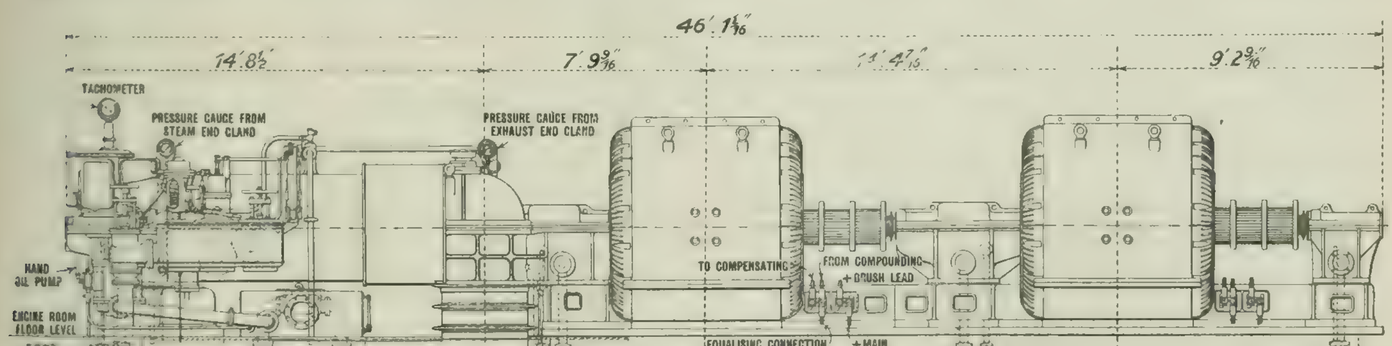


Fig. 10.—1,800 kw. Parsons Turbo-C.C. Tandem Set Installed in the Machinery Hall.

of the enclosed iron box swings forward and carries with it the switch mechanism and the fuse bridge contacts.

The generating plant in the Machinery Hall consists of a 500 kw. Westinghouse gas engine set and a 1,800 kw. Parsons continuous-current turbo set. The latter is of Messrs. Parsons' standard type, embodying all the latest improvements, and an idea of its size can be obtained from Fig 10. It consists of a turbine arranged for driving dynamos arranged in tandem, each dynamo giving an output of 900 kw. The turbine is of the latest improved parallel compound type, adapted for the full range of expansion from the initial to the condenser pressure, and is also arranged to give load when running non-condensing. The plant will also maintain an overload of 25 per cent. for two hours, and 50 per cent. momentarily. The machine will run at a speed of 1,800 revs. per min., and at a voltage of 460/560. The turbine has been designed for a steam pressure of 150 lb. per square inch and a superheat of 100°F. The turbine is fitted with a mechanical governor, arranged for a permanent speed variation of $2\frac{1}{2}$ per cent., and a temporary speed variation of 5 per cent. The dynamos are of the latest construction fitted with Messrs. Parsons' patented compensating winding, which enables sparkless commutation to be obtained at all loads without moving the brushes.

A 2,000 H.P. Mond gas plant has been installed to supply power for the Westinghouse gas engine set in the Machinery Hall, and consists of two of the well-known Mond producers of 7 ft. internal diameter, one patent mechanical washer, one gas-cooling tower, two centrifugal cleaners, two scrubbers and a governor. The fuel to be gasified is delivered by means of an elevator into the bunker above each producer, which in turn delivers the fuel into a cast-iron charging hopper at the top of the producer. The fuel on entering the producer from the charging hopper goes into a cylindrical bell which has for its chief object the maintaining of a constant level of fuel. The gas producer consists of two cylindrical steel shells one within the other, the inner shell being lined with firebrick, the annular space between them forming an air jacket in which the air and steam blast is superheated on its way to the space beneath the grate, which consists of specially designed fire-bars set radially in the form of an inverted cone. The producer is of the water-luted type with lutes all round, and is so constructed that ashes may be removed at all times without interruption of the operation of the producer. In other words, the producer is absolutely continuous in operation. The air blast is supplied by a Roots blower. The gas leaving the producer passes into a rectangular steel washer in which it is brought into intimate contact with water sprayed up into the form of rain by quickly revolving dashers or paddles. By this means the gas is here freed from dust and partially from tar and is at the same time considerably cooled down. On leaving the washer the gas enters at the bottom of a gas-cooling tower packed with short earthenware tubes which effectually distribute over the whole area of the tower the water which is supplied at the top. The gas passes upwards and on its way comes into intimate contact with the water trickling down. In this tower the gas is much cooled and a large amount of tar is removed. The gas then passes into a pair of specially designed centrifugal cleaners into which a small amount of water is introduced. Herein the gas is still further cooled down and freed from tar, and when it leaves this apparatus only contains a small trace of tarry matter which is removed as the gas passes through the scrubbers which are rectangular steel boxes fitted with a number of trays on which are placed simple wood planings or shavings and sawdust. The gas then passes in a thoroughly clean state to the gas engine. One of the chief points of advantage in this type of plant is that a very cheap fuel can be used; also as the gas production is automatically controlled to give only the amount required by the gas engine, even under variable load, all waste of gas is prevented. The stand by losses are extremely small, and after remaining idle for a fortnight or more, the producer may be brought into proper working condition in about 20 minutes, while after ordinary night stoppages it is only necessary to turn in the blast for about five minutes before the gas is actually required at the gas engines.

The gas engine set for which this producer has been installed consists of a 750 H.P. vertical three-crank six-cylinder Westinghouse gas engine direct-coupled to a 500 kw. Westinghouse continuous-current dynamo. As we have previously mentioned, gas engines coupled to dynamos are installed in many buildings for supplying current for lighting purposes. Thus, in the Canadian Palace two Westinghouse gas engines are to drive two 130 kw. direct-current generators; in the Australian Section two Westinghouse gas engines drive a 100 kw. and a 130 kw. generator respectively; whilst in the *Daily Mail* building a Diesel oil engine is used to drive a small direct-current generator.

The steam for the Parsons turbine is obtained from a battery of three Babcock & Wilcox boilers, working at 160 lb. steam pressure, and a Körting ejector condenser has also been installed. A switchboard is also being supplied by Messrs. Crompton & Co. in connection with the generating plant, but as it is not yet completed we will make further reference to it at a later date.

Current is supplied by the Exhibition authorities to exhibitors for use on their stands at the following rates: For power purposes, $2\frac{1}{2}$d. per unit; for lighting, 3d. per unit; for 16 c.p. lamps alight from dusk until the hour of closing, during the period of the Exhibition, 20s. per lamp; ditto for 8 c.p. lamps, 15s. per lamp.

Regulations were issued for the carrying out of all electrical installations in connection with exhibits, and from these regulations we have taken the following extracts, which are interesting as showing the conditions under which this class of work has been carried out:—

The wiring of the exhibitor's space must be carried out by the exhibitor at his own expense, and subject to the rules of the London County Council, London Fire Brigade, local and other authorities, as well as of the engineer to the Exhibition.

Each exhibitor shall supply and erect securely on his stand a hardwood board, having mounted thereon two main single-pole fuses in iron boxes, and a linked double-pole main switch enclosed in a hardwood or metal case; and in addition to this, where the number of incandescent lamps on the stand exceeds 15 lamps (5, 8 or 16 c.p.) a distribution board with a double-pole main fuse way for each circuit of 15 lamps. (For electric signs and motors see regulation in connection therewith.)

If the total number of lamps on a stand does not exceed 15, two single-pole encasing-type porcelain cut-outs may be used, but the double-pole main switch shall be as specified above. Where conductors enter the back of distribution fuse or switchboards, which are mounted on woodwork, a sheet of asbestos, uralite or other similar fireproof material shall be placed behind the conductors.

Cut-outs shall be of the high-pressure cylinder type, with tin fuse wire, having a margin of not more than 50 per cent. capacity.

No bare conductors will be allowed.

Wires and cables shall be adequately and firmly fixed, and in all cases where wires are within reach of the public they must be enclosed in wood casing or other approved covering. All joints must be soldered, and covered with pure rubber and proof tape. On circuits to carry more than 5 amperes clamped joints must be used.

Unencased conductors must be out of reach of the public, securely supported on insulators, and tappings to lamp-holders must be made by insulated conductors other than flexible cord, with properly taped joints.

Unencased conductors must not be in contact with bunting, gauze, cloth or other covering material.

Fairyland strips are allowed, but unless the holders are fitted with metal backs must be securely mounted on uralite or similar board or insulators out of reach of the public.

No "E.L.B." flexible strip or boards will be allowed, unless in iron cases with glass fronts.

Wiring at the back of wood sign boards must be encased.

Wood casings with batten holders will be allowed.

Exhibitors proposing any system of lighting not included in the above will please send full particulars to the engineer of the Exhibition, as otherwise it will not be possible to connect their stand installation.

No imitation candles, shades or other accessories made in celluloid will be allowed on fittings connected to the circuit, to accumulator batteries or other source of supply.

If metal tubing be used, both lead and return wires must be in the same tube, and the tubes must be earthed unless exemption be granted by the Exhibition Executive. No socket connected tubes will be allowed; all tubes must be screw connected and electrically and mechanically continuous, and must not contain an open seam.

Where externally lighted signs are above 10 ft. from the floor, or in positions inaccessible to the public, they may be wired in circuits of not more than 30 lamps of 5 c.p. or 8 c.p. Signs lower than 10 ft. will be treated as part of a stand, and must not have more than 15 lamps (5, 8, 16 c.p.) on a circuit.

No sign must be fixed direct on woodwork, or within 12 in. horizontally or vertically of wood or cloth work, unless effectively protected by asbestos, uralite or similar material.

Internally lighted signs must be of fireproof construction, and each contain not more than eight 5 c.p. or 8 c.p. lamps; they must be open at the top, and have a number of 1 in. holes in the bottom or sides to permit of thorough ventilation. These lights must not be lighted from the inside without the special written consent of the above-mentioned authorities.

No arc lamps will be allowed unless the written consent of the Exhibition Executive has previously been obtained.

Motors exceeding $\frac{1}{4}$ H.P. must be of the enclosed or enclosed ventilated type. Such motors must be controlled through double-pole cut-outs, linked switches and fireproof starting resistance, with "no-current" automatic release.

If the "starting" current of any motor be excessive in the opinion of the Executive of the Exhibition, it may be necessary to arrange certain times for starting up; and the motor may have to be kept running between certain times, or be run only during certain times as may be arranged.

Neither live transformers nor charged accumulators will be allowed unless special permission be granted by the Exhibition Executive.

The names of proposed contractors must be submitted for approval, and no work in connection with the connecting up of the stand will be undertaken by the Exhibition Executive until the installation upon the said stand is complete, and tested to the satisfaction of the Exhibition Executive.

The Exhibition Executive reserve the right of supplying and fixing at the expense of the exhibitor a meter for the purpose of registering current which may be consumed by the exhibitor.

The whole of the electrical work at the Exhibition, including the three-phase and single-phase wiring, the planning of the sub-stations and arrangement of the lamps for the general illumination of the buildings and grounds, was carried out to the specifications of Messrs. W. B. Esson and A. W. Money.

A visit paid to the Machinery Hall last week after the opening of the Exhibition showed that a large number of the exhibits had not yet left their packing cases, especially in the French section. This section will naturally attract a large amount of attention from English engineers. Close to the entrance is an interesting group of motors manufactured by the Société Alsacienne de Constructions Mécaniques of Belfort, to which we will refer at a later date. Dinin accumulators for central station and for ignition purposes were also displayed. The most striking exhibit, however, in this line was a 6,000 ampere hour (at 10 hours' discharge) Tem accumulator. Carbon brushes, dry cells, arc lamp carbons and lightning arresters were conspicuous on the stand occupied by Le Carbone, whilst radiographic apparatus, testing instruments, voltmeters, &c., small accumulators and magnetos were shown by the Société d'Electricité, Nilmelior. The most imposing exhibit in the French section was, however, an erection showing a gas condensing apparatus, and pipe work by the Pont-à-Mousson Blast Furnaces Foundry Society, the exhibit being carried out by J. Jauncey & Co. A Niclausse boiler of 200 H.P., for working at a pressure of 12 kg. per square centimetre, or up to 16 kg. per square centimetre was also noticeable.

In addition to a stand in the Machinery Hall, the British Mannesmann Tube Co. have erected a number of poles in the grounds outside, their main exhibit consisting of tramway poles, arc lamp columns, telephone poles, steam pipes, &c., many of these being not at first noticed on account of their height. The smaller poles are in one length tapered, and a 10 in. U steam bend 45 ft. 6 in. long is also in one piece. The United Flexible Metallic Tubing Co. also have an attractive stand.

As an example of their work, Messrs. D. Colville & Sons show four steel plates 69 ft. long by 87 in. wide and 1 in. thick, each weighing $9\frac{1}{10}$ tons. Messrs. Babcock & Wilcox, in addition to their boilers used for the power supply, have a small boiler on their stand in the Machinery Hall, and also a conveyor, &c.

Many stands were still covered up, but we noticed that among the exhibitors were:—

Messrs. W. H. Allen, Son & Co. (pumps, &c.),
Messrs. Crossley Bros. (gas and oil engines),
Messrs. J. Hetherington & Sons,
Messrs. T. Broadbent & Sons (electrically-operated crane),
Messrs. Royles, Ltd. (valves, condensers, radiators, &c.),
Messrs. J. Holroyd (electrically-driven machine tools),
Messrs. Jones & Horsfield (covering for steam pipes),
Messrs. J. Stirk & Sons (electrically-driven tools),
Messrs. A. Herbert, Ltd. (machine tools),
Messrs. Vickers, Sons & Maxim (armour plate, &c.),
Messrs. Selig, Sonnenthal & Co. (machine tools),

and we shall have another opportunity of referring to these in detail. Messrs. Waring & Sons were busily engaged on the pavilion of the electric supply companies, whilst Messrs. Mather & Platt were putting the finishing touches to their exhibit, which consists of a 800 H.P. twin-cylinder, 2 cycle gas engine, with a three-phase generator mounted on the crank-shaft between the two cylinders; a 210 H.P. Zoelly steam turbine running at 3,000 revs. per min., and coupled direct to a high-lift turbine pump; a pair of high-lift turbine pumps direct coupled to a direct-current steel-clad motor placed between the two pumps; a direct-acting steam pump for boiler feeding against pressures up to 250 lb. per square inch; and a large tank constructed of standard-sized cast-iron plates.

A branch telephone exchange has been fitted up at the Exhibition by the Post Office, and will be designated "Franco." It will enable those exhibitors who become subscribers to communicate with one another and with subscribers in London or other towns. It is stated, also, that special attention has been paid to providing a good service to Paris and other French towns.

MANUFACTURE OF ELECTRICAL CONDENSERS.

We give below an abstract of the discussion which took place at the meeting of the Institution of Electrical Engineers on May 7th when Mr. G. F. Mansbridge read his Paper on the above subject. An abstract of this Paper appeared in our last two issues.

Sir JOHN GAVEY mentioned, with reference to the introduction of the roll method at the Post Office works at Mount Pleasant, that the method was not his (the speaker's), but he owed it to a hint given him by the Western Electric Co., of New York and Chicago. Mr. Mansbridge's improved method, known as the foil paper method, was very interesting, particularly the self-sealing of faults. Many of them could remember in the early days when the plate lightning arrester was first introduced. Those arresters certainly protected the instruments they were intended to protect, but generally put the line to earth and caused interruptions of considerable duration. He confessed that when condensers were first introduced on a large scale in telegraph circuits for quadruplex and other methods of working he rather anticipated a good deal of trouble. He had, however, been mistaken and it was found that a lightning discharge was harmlessly absorbed by the condenser. The use of condensers had considerably increased, and he thought that they were within measurable distance of having condensers on every telegraph circuit, as they had on every telephone circuit. Their use had allowed the introduction of central battery circuits, whereas before independent batteries had to be used. It was obvious therefore that anything which tended to facilitate the manufacture of condensers, to reduce their price, and to render them more serviceable would be of very great advantage to both the telegraph and telephone services.

Mr. J. E. KINGSBURY said that the practical nature of the author's Paper was obvious to them all. One of the earliest uses of condensers was shown in a patent deposited in the United States Patent Office in 1878 by Black & Roseburgh, but was not issued until Feb. 1879. This was a patent for the use of condensers in place of a type of apparatus which had been mentioned in a previous specification of Roseburgh, and it was interesting to note that the type of apparatus described in the patent specification was practically of the same nature as the type which Mr. Mansbridge had brought to their notice. The patent filed in May, 1878, and issued in February, 1879, by Roseburgh, was for a glass tube filled with glycerine and water, or other suitable liquid, and provided with airtight fitting caps connected with platinum points, forming a high resistance medium, capable of offering high resistance to the galvanic current and comparatively little resistance to the induced current. Only a few days after depositing that patent, however, Roseburgh had apparently found a condenser that was far more suitable for the purpose he had in view. On June 4, 1878, he deposited a patent for an improvement in electric telephony. The claim made in that patent was:—"At any station on a telegraph or telephone line, and on a desired line of the same, the combination of a telephone, with or without other secondary current apparatus, and a condenser, so that the secondary current apparatus may be used without interfering with the action of the galvanic circuit, and so that the galvanic circuit may be broken between the points where the two ends of the derived line are attached without breaking the secondary current circuit." There might, he said, have been some earlier patents, but those were about the earliest he had been able to find. It was interesting to note that in a specification of a U.S. patent issued to Lee Westcott & Robes in January, 1897, a condenser was described:—"Constructed of alternate layers of tin foil and thin plates of mica, gutta percha or paper saturated with paraffin arranged like the leaves of an interleaved book. Each alternate metal plate is connected so as to form a distinct series, and each series is insulated from the other, one of which should in this case be connected with the line and the other with the earth, the telephone being inserted above or below

the condenser as may be most convenient but forming part of the same circuit." That description, he thought, would apply to almost any condenser. It was singular that even as late as 1896 condensers were used to only a very small extent. In that year, however, the central battery system was being practically developed and created a demand for a cheap and efficient condenser, the condensers of the period being costly and difficult to make. It was evident, therefore, that the invention of a cheap and practical condenser was as much the outcome of necessity as any other invention they had.

Mr. A. Whalley remarked that the experience of his firm, one of the earliest workers in that line, had led to their using condensers made of foil paper, having only a single interleaving paper of a thickness only one-half that of the metal paper. Mr. Mansbridge had referred only to his own pattern of condensers for telegraph and telephone work, but the subject was also of some interest to electric lighting engineers. The use of condensers with the small transformers installed for metallic filament lamps would help to solve the problem raised in connection with Messrs. Handcock & Dykes paper. Condensers could be used at 200 volts for a long time without serious rise in temperature, and could no doubt be made to stand 500 volts, and would raise the power factor at very small cost. As regards the breakdown point, the practice at Helsby was to strain the condensers on direct current up to 500 or 600 volts, and to sort out such as showed damage at that pressure.

Major O'Meara gave a few figures as to the use of condensers in the Post Office. During 1906 there were installed for telephonic use 14,130 condensers, representing 32,200 microfarads. In 1907 14,800 condensers were installed, representing 33,550 microfarads. At the present time they had in their telephone circuits some 80,000 condensers, representing 0·182 farads. Sir John Gavey had referred to the increasing use of condensers for telegraphic purposes. In 1906 they installed 2,130 condensers, representing 15,270 microfarads, and last year installed 2,470 condensers, representing 12,130 microfarads. He had not the exact figures relating to the number in use in telegraphic circuits, but he understood that they had in use something like 6,000 condensers. The figures he had given referred to paper condensers manufactured as described by Mr. Mansbridge. They had had his condensers in use now for seven years, and they were found satisfactory from all points of view.

Mr. B. S. Cohen said there was one very important point to which Mr. Mansbridge had not referred and that was the effect of alternate currents on condensers. It would be seen that in the specification of the National Telephone Co. for condensers attention was called to the effects of alternate currents and alternate discharge. Many forms of commercial condensers possessed considerable dielectric losses, which in some cases had resulted in a reduction in capacity when measured by alternating current to such an extent as to cause serious trouble. The necessity for testing condensers in practice with alternating-current was, he thought, first pointed out by the engineering staff of the Western Electric Co. A few years ago an investigation was carried out by the National Telephone Co. to determine the capacity of various types of commercial condensers at telephonic speech frequencies, and perhaps a few of the results might prove of interest :—

	D.C.		A.C.		Per cent. Var.
A batch of 15 condensers of one pattern	2·16	...	1·99	...	10·85
A batch of 21 " " "	2·09	...	1·76	...	18·8
A batch of 7 " " "	2·43	...	1·81	...	34·2

Given an alternating current of about 800 periods the workshop capacity test of a condenser with that current was, if anything, simpler than the direct current test, as all that was required was a standard condenser, slide wire bridge and telephone receiver. The question of insulation resistance variation of commercial condensers with alternating current did not appear to have been studied to any great extent. He referred those interested to a paper by F. W. Grover, on the "Simultaneous Measurement of Capacity and Power Factors," read before the American Physical Society in 1907, and abstracted in *The Electrician* for September 27, 1907. As to the artificial cables for telephone work mentioned by the author, whilst it was probable that they would be of great use for general educational work, he thought it possible such cables might prove dangerous in use. An artificial cable for telephone work should have capacity and resistance limited to such an extent that the result was the same as in a properly distributed system, and it was possible that trouble would be caused by variations in capacity.

Mr. H. Oppenheimer said it was two years since his firm had taken up the manufacture of condensers. He could congratulate the author on the progress made during the past two years, since he first saw the condenser Mr. Mansbridge was making. The elementary stage had now been passed by Mr. Mansbridge, and even at the start the relative results had been very satisfactory. He remembered that when his firm first made condensers they had about 7 per cent. wasted. In the second lot the percentage wasted came down to 3·8 in the next to 1·6, then to 0·36, and to-day the percentage of waste was only 0·2.

Mr. J. E. Taylor said he had taken a great interest in high-tension work, and the use of silvered leyden jars for wireless telegraphy. One was limited very often in using leyden jars for wireless work, as contact would fail if the silvering was not protected by some means, since in sparking across the silvering was rapidly burnt away. Insulating varnish over the silvering was found unsatisfactory. A further difficulty to overcome was the well known brush discharges. These caused a certain amount of burning away of the silvering, and rendered the jars useless. Such discharges were a source of serious loss, and he had been carefully considering the matter, as he was not satisfied with the usual explanation. As to the author's condensers, he could support some of the results claimed. Such condensers could be used to a considerable extent for shunting electromagnets and for preventing sparking when lamp filaments got broken. Any ordinary condenser of about 100 mfds. capacity would not stand for a moment the discharge which occurred when a circuit was broken in the ordinary way, but Mr. Mansbridge's condensers would withstand a number of discharges before they became incapacitated, in fact they had become so cheap that it did not pay to use them long enough to thoroughly exhaust them. The author had referred to the advantage under certain circumstances of leaky condensers. He was rather inclined to think that it was better to have a good condenser than a leaky one.

Prof. S. P. Thompson asked, with reference to the method of testing the foil strip, since the number of sparks seemed to indicate a great number of faults, what would happen if the strip were put through the machine a second time ? Did the once running through really find out all the faults ? Also could the paper before being callendered, be used as a coherer ?

Mr. W. M. Mordey thought that the author had shown the close connection there was between telegraphy and telephony. It would be interesting if the author could give them some particulars as to power factors and losses in cables. He was surprised to find that the losses in condensers were less than represented by the power factor. He would like to get what many of them had tried for—a condenser that would be of practical use in power distribution work. As to the use of condensers and transformers, he thought it would be found that the losses in the condensers would be as great or even greater than the losses in the transformer systems.

The Chairman (Col. R. E. B. Crompton) said that during the South African War they had had a very interesting experience of the advantage of using condensers in connection with portable telephones, since they were enabled to signal although their circuits might be broken, sometimes getting speech through gaps of several feet of broken circuit, and in telegraph work they got across gaps of several yards.

Mr. G. F. Mansbridge, in reply, said Mr. Whalley had raised the point as to the use of these cheap condensers for increasing the power factor on lines fitted with small house transformers. He presumed that Mr. Whalley intended that the consumer who paid for the transformer should also pay for the condenser. If that could be arranged it would be a very happy solution. With regard to Mr. Cohen's remarks, he, the author, had intended dealing with the alternating-current problem, but Mr. Cohen had intimated some time ago that he intended to discuss the Paper, and the alternating-current points had been purposely left out, because he, the author, expected to hear from Mr. Cohen the answer to the points he had raised. At the Post Office they found very little difference between alternating and continuous-currents, but there the conditions were rather different to outside, as they made practically the whole of their condensers. With regard to Prof. Thompson's inquiry, there were in the machine actually two rollers connected to the positive and two to the negative mains, and there was always a small amount of sparking on the second roller. The first roller, however, found all the real faults and weak places that would give trouble, and those were burnt out. In addition to such places there would be small places not necessarily bad which were also burnt out by the second roller, where the paper had to be dragged against the friction of the preceding roller, and was consequently subjected to a more serious strain. He had found by experience that there was no advantage in carrying the paper through four or five times, but possibly if it was taken through a dozen times some weak places would be found. He had tried a strip of the callendered paper so creased as to become practically non-conductive, and had found it to act like a coherer. With regard to Mr. Mordey's remarks, the tests in the Post Office were practically confined to those carried out in the regular course of the work. He wished that they had facilities for making other tests.

Mr. C. L. Addenbrooke, in a written communication, mentioned that some recent work of the writer's on the behaviour of dielectrics under high alternating stresses bore on points dealt with by the author and alluded to by Mr. Mordey. For convenience of experiment some of the writer's work has been done with condensers having tinfoil electrodes and he had come across and employed the interesting self-sealing property to which the author alluded. The writer had found it convenient chiefly because in breaking down insulation its use prevented such serious arcs as when solid metal plates were employed. The author's work did not appear to have led him, so far, to seriously consider the losses in the dielectric, when submitted to alternating pressures over considerable periods, and the consequent heating which, as well as the cost of manufacture, had hitherto been the chief deterrent to the use of condensers in connection with the transmission and use of alternating currents for power supply ; but they might undoubtedly now look for developments in this direction. It would, however, be a condition that such condensers must have small dielectric losses. The writer had found considerable difficulty in measuring these losses. He was glad to say that by the use of the electrostatic wattmeter which he brought out some time ago, with certain modifications, it was possible to measure the losses to 0·001 mfd., and at any voltage from 500 upwards, and at very low power factors. With this apparatus he had been able

to secure some interesting results which he hoped shortly to make public. One or two points, however, might be mentioned. There were, as had already been hinted in the discussion, great differences in the losses which occurred in condensers and cables, depending on their construction. For instance, in a paper condenser kindly lent to the writer by Dr. Muirhead, the loss was as low as ⅞ of 1 per cent. of the apparent loss, which meant a loss of about 3·5 watts in a 1 mfd. condenser submitted to an alternating current of 63 periods and 1,000 volts. This was the best result the writer had come across so far, but in most cases the losses were much larger and with bad construction might amount to 30 to 40 per cent. The charge of a condenser depended on the shape of the wave and with a high peak the current flowing in and out of the condenser was larger than would be deduced from the voltmeter reading; possibly some of the discrepancies in Mr. Cohen's results could be accounted for in that way. The writer was convinced that the testing of condensers and cables by taking their losses at different pressures would before long become a recognised method.

Dr. Alexander Russell (communicated) said that the data given in the Paper threw light on some curious phenomena which he had noticed in connection with the use of condensers in laboratory work. It followed from Kelvin's criterion for an oscillatory discharge that when the resistance of the ballistic galvanometer used to measure the discharge of a condenser was sufficiently small the discharge would be oscillatory. In that case it would be expected that the galvanometer would act in a curious way. He had found, for example, with some of the galvanometers that, if the needle be at a dead point, it would remain stationary however great the discharge that passed through the galvanometer coil. If the resistance in series with the condenser were diminished a large throw in one direction was obtained, but if the resistance were increased a throw resulted in the other direction (*Phil. Mag.* 6 Vol. 12, p. 202, 1906). In some positions of the needle the throws on charge and discharge were in the same direction, whilst in others they were in opposite directions. The phenomena, although fairly complicated, could be explained easily and satisfactorily if it was assumed that an ordinary condenser acted like an ideal condenser with a non inductive resistance of a few ohms in series with it. So pronounced was this effect that the writer found it useful to classify condensers according to the magnitude of this "effective" internal resistance. In some condensers this effective resistance was large, and they were not suitable for measuring inductance in terms of capacity and resistance, or for producing Duddell currents. Probably those unknown causes, which were generally classified under dielectric hysteresis and absorption, had something to do with this effect, but the writer had always held that it was mainly due to the resistance of the sheets of foil used in making the condenser, and a perusal of the Paper confirmed him in that opinion. He thought that if efforts were made to have the conductivity of the foil as great as possible, a thoroughly satisfactory condenser suitable for measurements with high-frequency currents could be produced. He also showed how the effect of the resistance of the foil could be discussed mathematically, and that the mere fact that the capacity of condensers must be regarded as distributed capacity sufficed to explain some of the phenomena observed in practice. It also pointed out a serious limitation to the use of condensers with high-frequency alternating or pulsating current for testing purposes, when the highest accuracy was desired.

Mr. A. W. Ashton (communicated) thought the method of specifying the insulation resistance as the ratio of the testing voltage to the current entering the condenser after one minute's electrification was convenient in practice, yet the figure so obtained was certainly not the resistance. The current from which the true resistance of a dielectric might be calculated should represent the energy converted into heat in the dielectric, which energy was not recoverable on discharge. From experiments which the writer had made on foil paper condensers he often found that the current entering the condenser after charging had been continued for 72 hours was only about 5 per cent. of the current after one minute's electrification; also after charging for a long period the curve of discharge current became approximately the same as the curve of charge current. That was an important effect and showed that nearly the whole of the energy entering the condenser during the electrification represented recoverable energy. The writer had shown elsewhere (*Phil. Mag.*, Nov., 1901) that for certain dielectrics the current representing the absorbed energy might be represented by an expression of the form Kt^{-x}, where K = a constant, t = time since commencement of charge and the exponent x varied from 0·43 to 0·78. With foil paper condensers he had found it was only approximately true, and the exponent then varied from 0·53 to 0·58. The author's equations confirmed this figure. With regard to the discrepancy noticed by Mr. Cohen between the values of the capacity as measured by alternating and direct currents, there was no doubt that the quantity discharged from the condenser was a function of the time of discharge. Thus, the capacity calculated from a discharge lasting, say, 1,000 seconds, must differ considerably from that determined by means of a ballistic galvanometer.

Dr. W. E. Sumpner (communicated) said that there was no doubt that the applications of condensers to power installations using alternate currents would be both numerous and important if the condensers could be made sufficiently small, cheap and safe. In those three respects the Mansbridge mode of manufacture was a decided step in advance, but he would like to emphasise the matter of safety, which, he thought, had not been sufficiently dwelt on by the author. The self-sealing property of those condensers was closely analagous with that of oil insulation for high-tension transformers and switches. The high resistance of the metal films prevented serious currents passing, and such condensers seemed safer than choking coils, for if a fault developed in the latter a serious short easily occurred. During the last two years he had used such condensers largely for voltmeters and phasemeters of the type recently described by Mr. Record and himself, and there had been no case of a short-circuit due to the subjection of such condensers to alternating voltages. He had not, however, used pressures above 400 volts. Several cases had occurred in which the capacity had considerably fallen off, but such cases could fairly be attributed to faulty manufacture resulting in the formation of cracks in the thin metal films, such cracks ultimately becoming ruptures under the action of the current. The better condensers had in no case altered their capacity in the slightest degree, owing to the action of alternating-currents for a period of 18 months. Some of the time-honoured methods of testing and specifying the properties of condensers needed revising now that Thomson galvanometers and electrometers were no longer the only, or the best, instruments for making condenser measurements. The capacity could now be quickly tested by a non-reflecting instrument, and the insulation could as easily be tested by permanent magnet voltmeters and micro-ammeters. He called attention to a Paper on condensers by F. W. Grover (Washington Bureau of Standards, Vol. III., part 3). The tests there recorded showed that the power factor for 47 out of 54 mica condensers was less than 0·0175, for two others it was less than 0·005, for one other it was less than 0.0011, while in one case the power factor was as low as 0·0002. Similar diversity was shown by paraffin paper condensers, and could hardly be attributed to differences in the dielectric; they were much more likely to be due to the conducting surfaces. The power factor, however, in reasonably well-made condensers was so low that the loss of power was negligible for engineering purposes; size, price and safety were the only important matters.

Mr. A. J. Stubbs (communicated) was disposed to think that the "breaking down" effect was probably due to the presence of metal foil perforations rather than to sparking over simple air-gaps and subsequent fusion of the surrounding metal. He thought that perhaps the idea of conducting flaws in the paper might be strengthened by recent experience with paper-insulated cable. In one case a whole delivery from the paper mills was found after manufacture of about 9 miles of main cable to be speckled with conducting particles which, under favourable circumstances, broke down the insulation of the cable. An equally satisfactory and much more speedy method of determining the melting point for wax was to place a small tube partly filled with wax against a thermometer and heat the two in water, observing the temperature at which the wax began to rise in the tube. Recent experience showed that the telephone acted as a sort of spark-gap for the oscillatory currents of aerial telegraphy, resulting in the breakdown of the telephone. With cheap condensers the telephone engineer might view the installation of a wireless station by the Admiralty in the heart of London with comparative complacency when he knew that the 5 farads, which, according to Mr. Mansbridge, could be manufactured in a year, would suffice to protect 100 miles of telephone circuits from this latest and most insidious enemy, as a condenser of only 0·05 mfd. put across the circuit was found to prevent sparking.

Mr. J. W. Record (communicated) thought the word "foiled" paper was not sufficiently comprehensive and was likely to cause confusion, and, as the paper was actually coated or painted with a metallic film, the term "coated" paper would be more applicable for the metallic painted type, and tin foil condensers for the foil plate pattern. He was not in agreement with the author regarding the pressure to be applied to a particular plate. With a tin foil condenser the foil, being laid on separately, could not be in such perfect cohesion with the dielectric as with coated paper, therefore the increase of pressure in the former would have far more effect than in the latter. He had measured the resistance of a 2 mfd. condenser of the coated type containing 50 ft. per plate 3½in. wide, and found it to be about 90 ohms. A smaller length of tin foil paper had a resistance of 3·75 ohms. The question of resistance was of great importance when the condensers were required for the suppression of sparks of high speed tremblers, such as induction coils, and he had found that a coated paper condenser must either have several contacts on each plate for reducing its resistance or else a condenser of larger capacity must be used. With regard to the testing and specifying of condensers, it was of little avail to have a condenser marked 4 mfd. if it was no more effective than one marked 2 mfd., and evidently the National Telephone Co. were alive to that fact, as their latest specification provided for a test approaching working conditions. By far the most satisfactory means of measuring capacity known to the writer was a device by Dr. Sumpner described in his recent Paper before the Institution.* The a.c. voltmeter method enabled a far more searching voltage to be applied during the test and a greater frequency than could be obtained without ordering a special alternator, and gave the current that would effectually burn out weak portions of the plate due to creases and other causes. If the condenser was leaky, either intentional or otherwise, true capacity was still registered on the instrument. He gave particulars of tests made on some 2 mfd. coated paper condensers, and it was noticeable that in all cases the a.c. voltmeter method showed lower capacity than the ballistic galvanometer test.

* *The Electrician*, Vol. LX., pp. 875, 924.

THE OVERLOAD CAPACITY OF STEAM TURBINES.

[COMMUNICATED.]

Not least of the advantages to be derived from the installation of steam turbines is the comparative ease with which provision can be made for heavy overloads at a comparatively small increase in first cost only, assuming provision is made for this in the first instance. The present article deals with two turbines which have recently been installed in a textile mill in Lancashire, where a total power of 1,000 kw. was required for electrically driving the mill. Those responsible for the installation of the plant specified—rightly or wrongly—that if departure was made from the slow-speed Lancashire type of engine, and either turbines or high-speed reciprocating engines were installed, that these would have to be in duplicate, so as to allow a complete unit of plant as reserve in the event of failure.

It goes without saying that if a normal rating of 2,000 kw. were installed in either turbines or high-speed reciprocating engines, where in reality only 1,000 kw. was required for daily operation, that these two types of prime mover would be handicapped in capital cost in comparison with the slow-speed Lancashire type of engine. To meet the particular circumstances of the case, a special type of turbine was designed and built which, whilst retaining the advantage of low capital cost, at the same time gave an ample reserve by means of the overload capacity. In fact, the plant installed will give greater security against breakdown than it is possible to obtain with any other form of prime mover without actually duplicating the plant.

In the present instance, as already mentioned, 1,000 kw. was required for ordinary every day working, and instead of putting down one unit of 1,000 kw. the plant has been divided into two sets of 500 kw. each, which are each arranged to give an overload up to 1,000 kw. continuously, if necessary, by means of the pass valves. The alternators are rated so that at the normal full-load capacity of the sets—namely, 500 kw.—there is an ample margin in their capacity, and they are capable of working continuously at 1,000 kw. if necessary. In other words, the alternators are large in comparison to the normal rating of the turbines.

For ordinary working the necessary 1,000 kw. will be obtained by working the two units at 500 kw. each, but in the event of one of the units being out of commission the full 1,000 kw. is obtained from the second unit by making use of its overload capacity.

The first cost of a turbine plant rated on the above lines is but slightly in excess of plant rated on ordinary lines, for the reason that the overload on the turbine is obtained by means of pass valves, and consequently the size of the turbine is but slightly increased. The additional cost of the alternator, on the other hand, is a small matter, when considered as an increase on the total cost of the complete unit.

Relative Steam Economy.—It will at once be asked whether the steam consumption of two units is not necessarily higher than the steam consumption possible with one unit of double the capacity. This would be the case but for the fact that a unit of 1,000 kw. would have to run at a speed of approximately 1,500 revs. per min., whereas the smaller units of 500 kw. can safely be run at double this speed—namely, 3,000 revs. per min.—and this increased speed fully makes up for the difference in consumption between the larger and the smaller units. It is true that the large alternator is not working at its best efficiency at 500 kw., but the difference is a comparatively small one, and need scarcely be taken into account on a commercial basis.

When these 500 kw. units are working at 1,000 kw. their consumption is necessarily not as good as when working at the lighter loads, but here, again, the difference is not very great, as will be gathered from the steam-consumption curve shown in Fig. 3, which was obtained at the official trial.

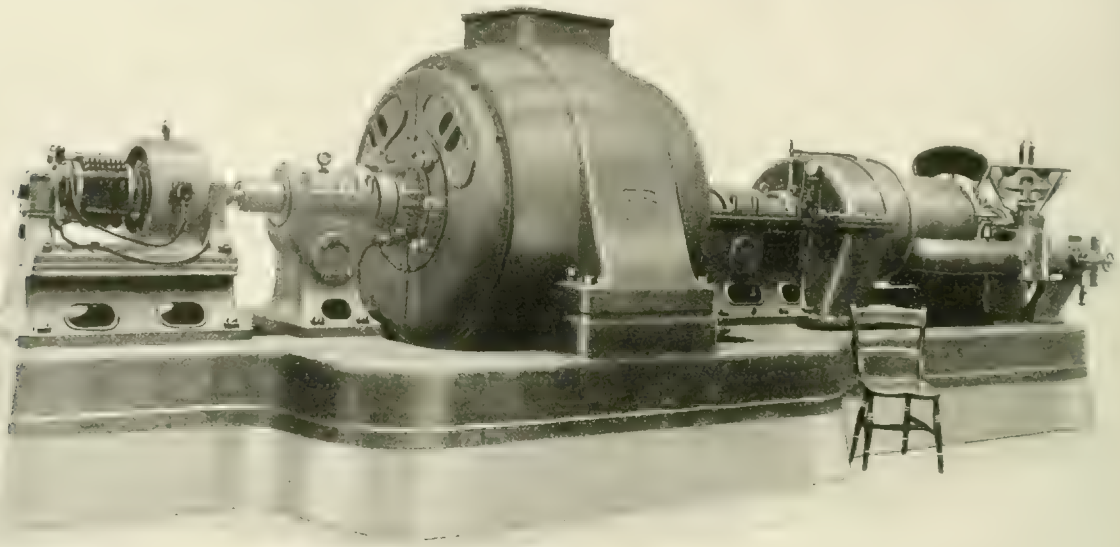


FIG. 1.—VIEW OF WILLANS-SIEMENS TURBO-ALTERNATOR.

500 kw., 3,000 R.P.M., 50 ~, 500 volts, overload capacity 1,000 kw.

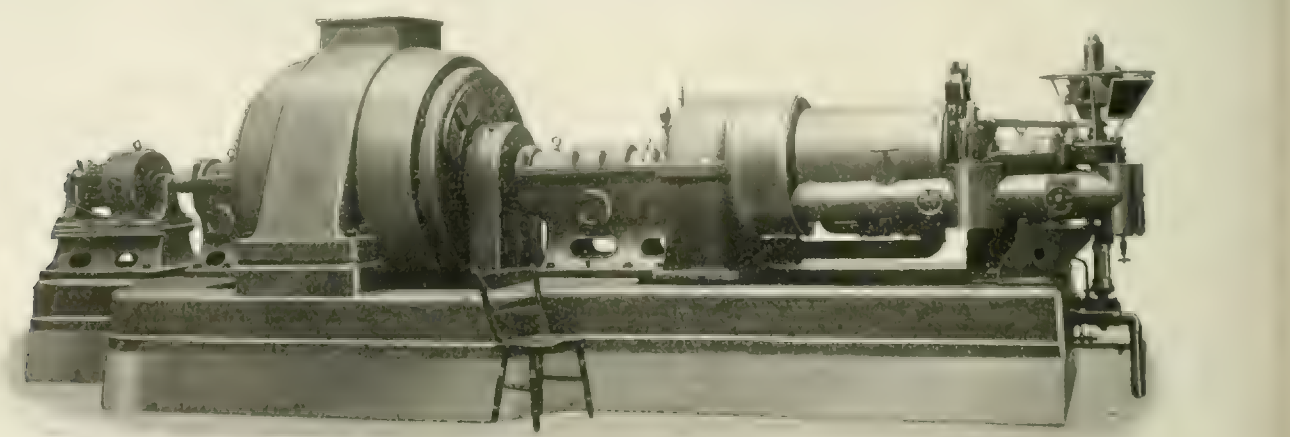


FIG. 2. ANOTHER VIEW OF WILLANS SIEMENS 500 KW. TURBO-ALTERNATOR.

It will be noticed from the curve that the most efficient point of working is in excess of the normal full load, but this was specially provided for in the present instance due to a knowledge that the turbines would be run in excess of their full load for a greater portion of the time.

Turbines and Alternators.—As already mentioned, the turbines shown in the illustrations (Figs. 2 and 3) accompanying this article are arranged for a normal load of 500 kw. and for giving an overload capacity of 100 per cent. continuously if necessary by means of pass valves and when running at a speed of 3,000 revs. per min. The turbines run with a steam pressure of 150 lb. superheated by 200°F. and exhaust into a single condenser fixed between the two turbines, and which is arranged for maintaining a vacuum of 28 in.

Particular attention may be drawn to the comparatively short length of the Willans-Parsons turbine in comparison with turbines of the ordinary Parsons type. It was appreciated, when designing these turbines, that unless the length of the ordinary Parsons turbine could be materially shortened there would probably be little scope for turbines of so small a capacity. By shortening up the turbines, as has been done in the present instance, the first cost has

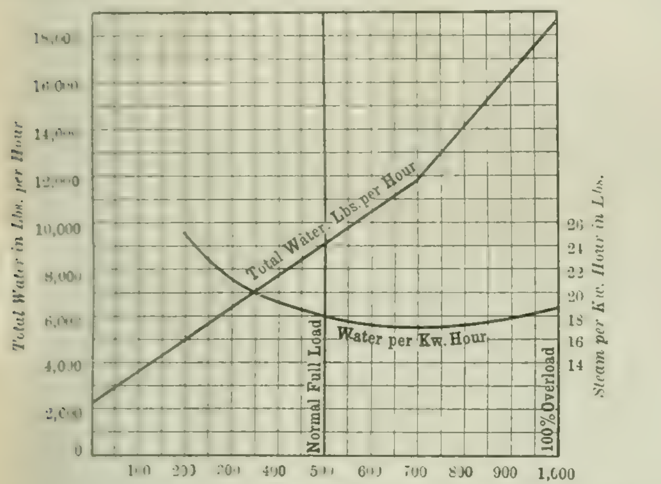


FIG. 3.—STEAM CONSUMPTION OF WILLANS-SIEMENS TURBO-ALTERNATOR
Normal full load 500 kw., overload capacity 1,000 kw., 3,000 R.P.M., superheat 200 F., vacuum 28 in.

been materially reduced, and, what is of greater importance, the reliability has been considerably increased, due to the unsupported length of the rotor between the bearings being so much diminished.

The alternators are of the three-phase type, and are arranged for giving their output at 50 cycles per second, and at a voltage of 500.

Condensing Plant.—The condensing plant is of the ordinary surface type, and is capable of maintaining a vacuum of 28 in. when the two 500 kw. turbines working at full load are exhausting into it. When either of the turbines, working at 1,000 kw. load, is exhausting into the condenser, the normal vacuum of 28 in. will be somewhat reduced—say to 27 in. or 27½ in.—due to the larger volume of steam to be dealt with.

The steam turbines and condensers were manufactured by Messrs. Willans & Robinson, of Rugby, whilst the alternators were built by Messrs. Siemens Dynamo Works, of Stafford.

RECENT PROGRESS IN TUNGSTEN METALLIC FILAMENT LAMPS.*

BY H. HIRST.

Summary.—A historical *résumé* is given of the development of metallic filament lamps up to the present time. Particulars of typical tests of osram, wolfram, tantalum and carbon lamps are recorded in the shape of curves, and finally the author shows the effectual saving to be obtained by employing auto-transformers and low-voltage lamps, although he believes that the supply companies will not be disadvantageously affected.

It may be news to a large number of electrical engineers of the younger generation that the metallic filament lamp is one of the oldest forms of electric lighting, platinum being the incandescent body. These lamps, were, however, never a commercial success, because the melting point of platinum is only slightly higher than that temperature to which it has to be raised for the economical production of light. In consequence the life of the filaments was short, and the slightest increase in the voltage was sufficient to melt the filament. Attempts were made to overcome this defect by automatic arrangements to cut out the lamps should the voltage rise to a point likely to melt the filament. The arrival in 1881 of the carbon filament lamp, however, stopped the researches. Its immediate success was due to (1) that the filament could not be melted, (2) its high specific resistance.

The necessity of reducing the cost of distributing networks brought about lamps for 200-250 volts. Although these lamps were not as efficient as those for the lower voltages, they saved so much in the cost of distribution that the supply companies were able to reduce the cost of electrical energy to those consumers using them, and they were officially recognised by the Board of Trade Regulations of 1901, which enabled the supply undertakers to enforce their use on all consumers.

The success of the oxides of the rare earths in gas lighting led to their application to electric lighting, as has been done in the Nernst lamp (patented 1897). The first commercial metallic filament lamp was the osmium lamp, invented by Auer von Welsbach in 1898, and its regular commercial supply commencing in 1902, but only at low voltages. In January, 1905, the tantalum lamp appeared on the market suitable for a 110 volt circuit, but it already had a serious competitor in the tungsten filament. In 1904 Siemens & Halske endeavoured to extend their drawing process, which had been successful with tantalum, to tungsten, thorium, &c., but the brittleness of tungsten and its want of ductility rendered the process inapplicable. In 1904 Drs. Just and Hanaman also applied for a patent for incandescent bodies consisting of pure tungsten, and this is the first English patent describing the manufacture of pure tungsten filaments. In their process tungsten or molybdenum or their compounds are mixed with organic binding media, formed and carbonised, whereupon the carbon is chemically eliminated. Quite independently of these inventors, the Deutsche Gasglühlicht Aktiengesellschaft (the Auer Co.) applied for a patent which covers a process for the manufacture of pure tungsten filaments. The two patents above mentioned cover the "paste" process, whilst another method called the "coating" process was protected by Drs. Just and Hanaman in 1905.

Among other inventors are: Heany, who proposes to use an alloy of tungsten with titanium; Kuzel, who suggests the manufacture of glowing bodies from colloidal metals; British Thomson-Houston Co., who describe the manufacture of filaments of tungsten with the help of volatile metals or alloys, chiefly amalgams, which could be drawn into wire (it will be interesting to watch the progress of this suggestion); Zerning claims the use of hydrogen and nitrogen compounds of tungsten as the materials from which to construct tungsten filaments. After a careful consideration of the many patents on the subject, I believe I am right in maintaining that the Deutsche Gasglühlicht Aktiengesellschaft and the Just and Hanaman patents alone have during the last two years produced to the world commercial and useful lamps. "Osram" is the name under which the Auer Company introduced the first commercial tungsten metal filament lamp. This lamp is manufactured by the "paste" process, in which the metal in a finely divided form is prepared into a paste with binding or stiffening agents such as the gums or dextrine. This paste is squirted through a fine orifice in a diamond, under a pressure of several tons per square inch. The resulting thread is heated under exclusion of air, and an electric current is afterwards allowed to pass, causing the filaments to sinter. The sintering being carried out in gases which chemically attack the binding agent but not the metal, so that eventually a filament of pure metal remains. Owing to the higher melting-point of tungsten, an osram filament will stand a temperature at least 100°C. higher than the osmium filament. Their specific resistance and resistance coefficients differ and there is considerable difference in their radiation properties. The colour of the osram filament is a steel to a silver grey, whilst the osmium filament has a bluish-grey appearance.

When preparing osram filaments for lamps of 120 volts, 22 c.p. to 27 c.p., burning at an efficiency of about 1·1 watts per candle-power, taking 0·2 to 0·25 amperes, the diameter of the filaments is 0·03 mm. The diameter of the jet from which the filament is squirted is, at the point of issue from the diamond 0·055 mm.; the thread after squirting is 0·050 mm., and after sintering 0·030 mm., this being accompanied by a diminution of 84 per cent. in volume, and, therefore, 55 per cent. in length. It is easy to alter the amount of shrinkage by selecting suitable proportions of the binding medium, or by adding volatile substances which disappear on heating. During this heating process the filament is fastened in clamps and placed in globes or other arrangements containing certain gases. The heating is effected by the electric current to a gradually increasing amount, and while the thread decreases in length and diameter, it at the same time allows the passage of increased currents. This is due to the sintering of the particles and also to the filament being freed from carbon, which even in minute quantities increases its resistance. The same phenomena are observed with osmium, iridium, or molybdenum filaments.

The filament so obtained is elastic but brittle, that is, the osram thread, 0·03 mm. diameter, can be bent into a loop of about 1 cm. diameter without breaking. After this bending it returns to its

* Abstract of a Paper read before the Institution of Electrical Engineers

original form. Each filament is fastened on to its leading-in wires without the application of any paste, by melting the end of the leading in wire to a small globule by means of an electric arc. This globule holds the filament securely, and the resistance from the passage of the current from the leading-in wire to the filament is negligible. The evacuation of the lamp is carried out in the same way as with carbon filament lamps, but as the gases occluded in the tungsten filament escape much more slowly a longer time is required than with the carbon filament lamp.

The other method of constructing tungsten filaments was developed by Drs. Just and Hanaman, their lamp being introduced commercially under the name "Just-Wolfram." They use what is known as the "coating process," in which ordinary carbon filaments of very small diameter, 0·02 mm. to 0·06 mm., are raised to a bright red heat by means of an electric current in an atmosphere of volatile tungsten compounds in the presence of hydrogen. The compounds most used are the chlorides and oxychlorides of tungsten. The heat of the filament causes the hydrogen to reduce the volatile metallic compounds, depositing the metal in homogeneous condition on the carbon filament. To convert them into pure tungsten the filaments are submitted to the action of an electric current in an atmosphere of highly rarefied inert gas, such as, for example, hydrogen at a pressure of about 20 mm., until they show the clearest white incandescence. This process causes the carbon to combine with the tungsten surrounding it, forming a carbide. This change is so complete that in the resulting filament the cross-section is tubular, and no carbon can be distinguished under a microscope at the point of fracture. The filaments so obtained containing carbon (mostly as carbide) present a glittering white metallic appearance. In the next process they are raised to a high temperature through the passage of an electric current while they are surrounded by a mixture of hydrogen and a little steam. This causes the carbon to be oxidised by the same reactions which go on in the water-gas process. The carbon may, however, be eliminated by any other method which gives a resulting filament entirely free from carbon.

Drs. Just and Hanaman have also obtained patents protecting the process of mounting their tungsten filaments to the leading-in wires. This is effected by means of a paste consisting of finely divided tungsten metal mixed with coal tar or gum These paste mounts are dried and finally made red hot by any suitable means before the filament is heated in the bulb. The filaments made by this process have a light grey silvery appearance and a little smoother surface than those made by other methods; in fact, they most nearly approach the appearance of a drawn wire.

Though this process is entirely different from the "paste" process, the final result in each case is a pure, sintered filament of tungsten metal. The sole difference is that the filament made by the Just and Hanaman process is tubular. As regards economy, the tungsten or osram lamps produced by either of the above-described processes have identically the same characteristics. It has been proved that these lamps will burn for from 1,000 to 2,000 hours with a consumption of about 1 watt per candle-power, without any appreciable falling off in the candle-power. Of all the metals which have been experimented with up to now, only pure tungsten has such a life.

The Hefner candle-power is adopted throughout this Paper, as it has so far been the standard mostly used when metallic filament lamps have been discussed, and at the present it is found next to impossible to try to standardise metallic filament lamps per candle-power. It would make the lamp commercially impracticable.

The following figures give a comparison between the energy taken and power radiated from the surfaces of osram and carbon filaments: The filament of a 25 c.p. osram lamp, consuming per mean horizontal candle-power 1·1 watts, has a total surface of about 50 sq. mm., which equals per candle-power 2 sq. mm., or per watt of supplied energy 1·8 sq. mm. A good surfaced carbon filament consumes per mean horizontal candle-power 3·5 watts = per candle-power 5·5 sq. mm., or per watt of supplied energy 1·57 sq. mm. It results, therefore, that 1 sq. mm. surface of osram filament gives 0·5 c.p., and consumes 0·55 watt. 1 sq. mm. surface of carbon filament gives 0·182 c.p., and consumes 0·63 watt. Thus, the osram filament radiates only 87 per cent. of the energy radiated by an equal surface of the carbon filament, but gives 275 per cent. of the light given by the carbon filament. The latter behaves much more like the "black body" of the radiation theory. From approximate calculations the temperature of an osram filament burning at 1·1 watts per candle-power is about 25°C. higher than that of a carbon filament burning at 3·5 watts per candle-power. If a carbon filament were to be overrun to such an extent as to consume only 1·1 watts per candle-power, its temperature would then have to be raised by 360°C. The favourable radiating properties of the osram filament, therefore, mean that its temperature is 100 deg. lower than that of a carbon filament of the same efficiency.

A further favourable property possessed by all tungsten filaments is their high positive temperature coefficient of electrical resistance. If one takes the resistance of carbon, tantalum, osmium and tungsten filaments at ordinary temperatures, the resistances at those temperatures which, in a vacuum, correspond to 1·5 watts per candle will be as follows: Carbon 0·55 of the original, tantalum 5·70 times, osmium 8·50 times, tungsten 11 times. Near the normal conditions the light of a carbon filament lamp rises and falls with the 6·3 power, that of a tungsten filament lamp with the 3·6 power, of the voltage.

The small changes in the light of the osram lamp, as compared with a carbon lamp for the same change of voltage, can only be completely explained by the supposition that with a change of energy the radiated light is altered in a different way with the two lamps. A simple calculation shows that near the normal efficiency the light of a carbon lamp changes with the third power of the energy, whilst such change for an osram lamp progresses with 2·3 power of the energy. Also the increase in light for a 10 per cent. increase in voltage is for an osram lamp 36 per cent. and 84 per cent. for a carbon lamp, whilst the decrease of light for a 6 per cent. voltage reduction is 21 and 34 per cent. respectively.

High-voltage metallic filaments of the osram type have recently been put upon the market, manufactured both by the D.G.A. and the Just-Hanaman processes. A number of these have been tested in commercial use and under special conditions to ascertain their life. From the results obtained, the average life of a 1 watt 1 c.p. lamp seems to be between 800 and 1,000 hours. During this period there is no appreciable drop in candle-power, and the lamps have shown themselves to be equally good as the low-voltage osram or Just lamps. These high-voltage lamps, made for from 200 to 250 volts, require double the number of filaments used in the low-voltage lamps, and consequently up to the present 40 c.p. to 50 c.p. is about the lowest unit that has been obtained in a commercial lamp, and some extraordinary development or discovery will have to be made before that candle-power can be largely reduced.

In so far as the lamp is different from the carbon lamp, it will, therefore, always be necessary to rely on series running whenever low units of light are required on high-voltage circuits; thus, for public lighting the convenience of one lamp will be apparent, and people will stretch a point to use 50 c.p. for such purposes whenever they can, but for the use of private houses and confined spaces it will always be necessary to revert to lamps burning in series. To meet this demand, elaborate arrangements have been made at the Osram Works for testing lamps that will run in series. They are tested to $\frac{1}{100}$ ampere, and sorted out in from five to seven series numbers according to the type of lamp and carefully marked, and the reference numbers (ranging from, say, 28 to 38, which are marked on the caps of all lamps singled out for series-burning) practically mean the consumption of current is 0·28, 0·29, 0·30, 0·31, &c., of an ampere.

On alternating-current circuits auto-transformers can be easily adopted, and tungsten filament lamps burn equally well on either continuous or alternating current, and are quite independent of both frequency and wave form.

Fears have been expressed by some electrical engineers that the introduction of these osram lamps will seriously affect the finances of supply undertakings. Similar fears arose in connection with the gas industry on the introduction of the gas mantle, but the demand for gas has increased. The same process will, I believe, follow the introduction of the metallic filament lamp, and it seems likely that it will mean an increase of 100 per cent. in the unit adopted for electric light. Generally speaking, the metallic filament lamp will not decrease the current consumption of existing consumers to the extent expected, but will, instead, lead to a large increase in the amount of illumination. At the same time, the high efficiency of the lamp, compared with all other forms of lighting, will turn the scale in the favour of the use of electric light rather than other illuminants. Station engineers will find that the increased load from new consumers will more than make up for the decreased consumption of existing ones. This conclusion has already been proved to be correct by Mr. C. P. Sparks, Mr. A. H. Seabrook and others.

As to the disadvantages of the lamp which have been raised, lamps can now be supplied to burn in any position. Also, whilst the price of these lamps is for the moment a trifle higher, before many months I believe they will be supplied at the same price as the others. Much has been said about the brittleness of the filament in connection with packing. This has been overcome as regards bulk supplies, and the question of small parcels is now being dealt with. Also the occasional blackening of individual bulbs occurs at an early stage of their life, and will be generously dealt with by the manufacturers.

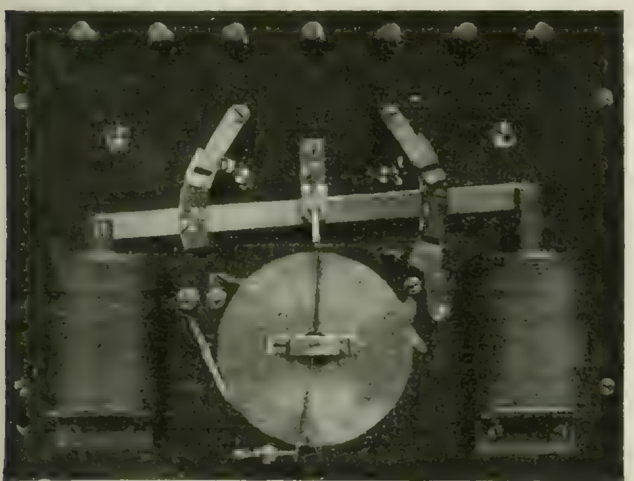
(To be continued.)

Electrical Development in China.—According to the *Elektrotechnische Anzeiger*, the statistics of the last three years reveal an appreciable increase in the imports of electrical apparatus into China. Their value reached £80,000 in 1904, £120,000 in 1905, and over £200,000 in 1906.

AN AUTOMATIC TRANSFORMER SWITCH.

The increasing use of the metallic filament lamp, which shows itself to the best advantage on low tensions, has led to the use of transformers for stepping down the supply voltage. This is very well in its way, but the ordinary man is prejudiced against paying for what he has not had, and since no-load losses come under this heading electrical engineers have been for some time endeavouring to design an automatic switch suitable for cutting off current entirely when no lamps are lighted, but capable of coming into action directly one lamp is switched on, and remaining in action without damage, when the whole available load is on the house mains.

An example of one of these switches, whose design is due to Mr. P. Good, and which has been put on the market by Messrs. Neville, Williams & Co. (of Southwark-street, London, S.E.) is here illustrated. It consists essentially of two solenoids whose cores are connected by a lever and of a small coil and armature, working on the same principle as an alternating current ammeter, which operates the "make-and-break" movement seen near the bottom of the apparatus. As shown in the figure the switch is in the "off" position, connection then being made from the mains through the right-hand solenoid to the lamp circuit; as this is open no current flows. As soon as a lamp is switched on the small coil is energised and the "make-and-break" broken. At the same time, the right-hand solenoid is energised and the core sucked in. This has the effect of



AUTOMATIC TRANSFORMER SWITCH.

breaking the two top switch contacts on the right-hand solenoid and putting in the lower two. It also connects together the two switch contacts over the left hand solenoid and breaks its own circuit. The effect of this is to put the whole transformer across the mains and the 25 volt "tapping" across the lamp circuit, the small "make and break" coil being energised from the latter. This arrangement holds good as long as any lamps are in circuit. When the last lamp is switched off the "make and break" closes, as the coil is de-energised, and puts the left-hand solenoid in circuit. This sucks in its core, breaks the contacts above it, the lower ones above the right-hand coil, but puts the upper in circuit, and at the same time cuts itself out so that the former position is attained. The transformer used is of the "auto" type.

It is claimed that this apparatus is effective over a wide range, coming into and remaining in circuit as long as one lamp is on, but immediately returning to the "off" position as soon as all lamps are cut off. Its first cost is low and its use should, therefore, effect a considerable saving to those consumers fortunate enough to be connected to an alternate-current network.

An Electrical Hygroscope.—An apparatus of this kind is described by J. Pionchon in a recent number of the *Comptes Rendus.* It consists of a sensitive mirror galvanometer in series with a battery or dynamo, supplying current at about 100 volts to the hygroscope proper. The latter is made up of a glass test tube, whose external and internal surfaces are coated with silver from one end to within about a centimetre of the other. The slightest trace of moisture at the operative end of the tube is sufficient to close the circuit and cause the galvanometer to deflect. This instrument is extremely sensitive, a deflection whose amplitude varies with the part presented being obtained by holding the hand a short distance from it.

PARLIAMENTARY INTELLIGENCE.

LONDON ELECTRIC SUPPLY BILLS.

The Select Committee of the House of Lords, presided over by Lord Cromer, resumed on Friday last the hearing of evidence in favour of the first of the Power Bill, to come before Parliament this session, the London and District Electricity Supply Bill, 1908.

Mr. ROBERT HAMMOND, whose examination was continued by Mr. Clode, said the figure of the horse power in use in factories which had been stated by the promoters (370,995 H.P., see the table on p. 185 of *The Electrician* for May 15,) did include the consumers supplied with electric power. In arriving at the estimate he had taken electric power at the 82,000 k.w. which were connected. Probably it was not right to take the whole of it, as there was usually a discrepancy between the H.P. connected, and that actually used. That deduction left about 290,000 H.P. not supplied electrically. The Home Office Return from which the information was taken was dated 1906, but was based on the census of 1904. There would probably be an increase since then. The undertakers with whom the Administrative Co. had entered into provisional agreements or with whom clauses were agreed in the Administrative Co.'s Bill of 1905 were the Barking, Bexley, Stepney, Croydon, Beckenham, and Gravesend Councils, and the County of London, Charing Cross, City of London, Chelsea, Westminster, St. James', and Pall Mall, London Electric Supply, South London Electric Supply, South Metropolitan Electric Light and Power, Kent Electric Power, Empire Electric Light and Power, and Kensington and Knightsbridge Companies.

Mr. BUSHE said the Westminster Co., did not enter into any agreement. A clause was agreed, but it had no reference to supplying them with power.

Mr. HAMMOND said he wished the Committee to draw the inference that some, at any rate, of these companies and authorities would come to arrangements with his company. He was thoroughly satisfied with the transmission system proposed. He had taken the most active part in designing it. They had borne in mind the recommendations of the Committee of 1906, as to the importance of providing for continuity of supply, and they had endeavoured to make it quite impossible, humanly speaking, to have any cessation of supply. They had provided for 15 trunk cables from Barking in the first stage, and 25 in all at the second stage, and they would radiate as soon as possible. They considered that 15,000 volts might now be safely used. The 25 trunk cables with 15,000 volts, would carry about 5,000 amperes, so divided that their capacity was much more than 120,000 k.w. At times they proposed to deliver 180,000, and the cables must be capable of doing this. It would be a calamity for their scheme and the linking up scheme to both be sanctioned. It was certain there would be a growth of the demand for electricity, and there had already been a great growth in the demand for electric power, which was small two or three years ago. This increase was largely in consequence of the lower prices the distributors had charged. The increased demand would have to be provided for by new generating plant. If all this new plant were put under one roof the bulk company would be able to supply to the distributors all the extra electricity they might require. The distributors would be gainers (1) in that they would not have to spend money in capital expenditure on a wasteful basis, or a basis that was not the most efficient, and (2) they would have the benefit of a supply at a cheaper price than they could get it from their own divided up stations. The only thing the distributors objected to was the clause about the 250 k.w. They had been told there were few power consumers with demands over 250 k.w., and he thought they would be better left to a power company. If the two bills were passed there would still remain some possibility of their operating; but the element of mutual destruction would come in the matter of raising capital. If they both went to the public at the same time the capital might not be so secure. Supposing the three bills were passed they would be at this disadvantage. They would be going to the local authorities and competing for their supply. He thought the principle had been laid down in the Electric Lighting Acts that it did not eventually lead to the best results for two companies to lay mains in the same streets. The real antagonism was in the London Electric Bill. The area covered by the Kensington and Westminster Bill was already supplied from two bulk stations, and it was proposed to link those stations up. The promoters of the London and District Bill were very confident, both from the engineering and the financial points of view, of their ability to carry out their engagements. He had advised Hackney Council, when he was their engineer, that it was necessary to extend their plant to provide for the increased load that would certainly come, and they said: "Why not wait until we get a bulk supply. It may suit us better to lay down our own plant, but we would like to have the option." The L.C.C. would also be inclined to say, as they said to Shoreditch last year, and as they say in every case now: "Are you certain you want this money. Cannot you wait until you have the option of bulk supply?" The result would be that many places who would want new plant two years hence would prefer to get supply from the power company.

By LORD WELBY: The period over which the expenditure of the £2,600,000 would be spread would depend on the number of contracts they secured, but they were relying upon getting such encouragement as would justify laying down the plant up to 60,000 k.w. They

would have to begin laying the mains before they had the consumers to fill them up. As soon as they had duplicated plant at Barking they could begin to work. They could begin with 24,000 k.w. They reckoned that in the first year they would have to spend £237,000 in the acquisition of land, foundations, and the river work, and taking in hand the first instalment of the buildings and the beginning of the transmission scheme; in the second year they would spend £657,000, always provided they were connecting the business on from time to time; and early in the third year they would have to spend about £1,200,000. They would not ask for the two millions in the first year. He understood that interest was only allowed to be paid out of capital during the first four years and the £100,000 had been reckoned on that basis. The experience at Newcastle, where two companies had provisional orders, had shown that it wa undesirable for two companies to exercise powers for the same area, and so the companies had drawn a line and agreed to supply on the opposite sides of the line.

By Lord Lamington: In New York proper (exclusive of the Bronx and Brooklyn) there were two main stations. The undertaking was practically amalgamated and the supply station was under the New York Edison Co. He was sure the promoters would accept a condition that unless a substantial sum, to be named by their Lordships, were raised within a certain time the powers should at once lapse, and he felt confident the authorised distributors would come in and co-operate. Sir Alexander Kennedy, in advising the L.C.C. for the purposes of their Bill last year, had estimated the life of plant, &c., at about the same periods as those given in the Tables, 50 years for buildings, mains 30 years, and so on. Mains did not now suffer from obsolescence as they did in the past.

Mr. FitzGerald said the promoters' position was that the bills were not inconsistent, and not strictly competitive, and the bills coming next were not, in their view, substitutes for theirs. He thought he had said the Kensington and Westminster Bill was only a very small matter and he did not think it could be regarded as a solution of the question of supplying the London area. The other measure was practically only an extension of the Kensington and Westminster Bill. It was, of course, quite open to their Lordships to pass all three.

Mr. Hammond was then cross-examined by Sir Ralph Littler (for the Corporation of London), the cost of the main trunk lines such as they proposed to put through the City of London worked out at about £2,000 a mile, including cost of laying, but without the cost of trenching. Trenching was more expensive in the City than elsewhere.

By Mr. Freeman (for L.C.C.): At the end of 42 years' working by the company there would be a considerable quantity of obsolete plant unless it had been renewed at the end of 25 years. There was no provision in the Bill requiring them to renew the plant, but they spoke of net profit, and it would not be net profit unless they had made provision for renewals. He supported Mr. Parshall's view that it was difficult to obtain capital if investors could not be shown what the company would receive in the event of the undertaking being purchased at the end of 42 years. It might be to their interest to go on with plant that was nearing exhaustion, instead of renewing it, if it was capable of earning revenue and he did not consider that would be unfair. If the undertaking were a profitable one the purchaser should give the money the plant cost, provided it had been properly maintained. With regard to a recent report by the Parliamentary Committee of the L.C.C. proposing the insertion in the Company's Bill of provisions that the powers should cease unless £1,000,000 were raised within 12 months, and the works substantially commenced in two years, he thought the time for the capital should be 12 months from the passing of the Bill, and he thought it would be better to put it at half a million. He agreed that the work should be substantially commenced in two years. He did not think they should be any authority, such as the Board of Trade, to decide whether they should lay certain mains or not. They were now before the authority who could give them the powers to lay the mains. They had put in what was practically a Kitson Clause up to 250 k.w.

By Mr. Blennerhassett (for Westminster City Council): In addition to power to supply authorised undertakers who would, probably come to the new company if the latter were supplying more cheaply than themselves, they wanted powers to supply to railways, tramways, and canals. The electrification of railways in London would be hastened by their being able to obtain electric supply cheaply. The same rule applied to tramways and canals. With regard to the supply to small power consumers, they had introduced something that would save going to the Board of Trade, and which was a great improvement on the Kitson Clause. He thought the local authorities would be heard before the Board of Trade gave the company power to acquire any local supply undertaking. If they charged the same rate as the old undertakers, and generated more cheaply they would make a larger profit, but the old company would take care they [illegible] paid for the prospective profit. He thought the Board of Trade would prevent the company from depriving the City Council of their right to acquire an undertaking in their area by buying the station and supplying current from it to another district.

On Monday the cross-examination of Mr. Hammond was resumed, when Witness qualified a statement he had made with regard to the supply in New York. There were two companies supplying in New York proper (Manhattan Island), one supplying c.c. and the other a.c. These covered the separate areas. In the present scheme the trunk cable would be designed to carry 1,000 amps. per square inch.

Mr. Cripps (for the promoters of the London Electric Supply Bill), questioned Mr. Hammond with regard to the Charing Cross Co.'s cost of generation, and said that, according to his calculation, the figure was about £300,000 too high.

Cross-examined by Mr. Cripps, Mr. Hammond said the loss in transformation, &c., under his scheme, would be about 10 per cent. It would be 20 per cent. if they did not make the cables of sufficient size. Cables could be made so large that they would only lose 1 per cent. They would not in some cases work the cables up to even 1,000 amps. per square in. If a consumer could not get his current for power from an authorised distributor, the company could come in and supply him. On the revenue side of Table 7 the figure of 0·688d. per unit from power users for 32,850,000 units (amounting to £94,252) was the estimated revenue. They presumed a consumer would pay £3. 10s. per k.w., and 0·2d. per unit, plus 18 per cent., the difference in charge between 70 k.w. and 250 k.w. He did not think it right to say if a consumer could not get his current at 0·688d. from an authorised distributor the company would come in and supply him at something lower. If the distributor would not make the profit that was offered to him he would be inclined to put the revenue they would receive from that man at a higher figure. In reference to a statement by Mr. Cripps that five of the London Companies would experience a loss of £63,115 by taking their peak-load from the power company, Mr. Hammond said their scheme would not fall because four or five companies could do without them. It did not matter whether the state of things in which the power company's supply would be required came about two or ten or 15 years hence. He thought the plant a company had was an indication of the probable growth of the demand. The companies would not put down plant without any regard to future demands. With respect to metallic filament lamps, the feeling in the profession was that the more efficient filament would make for the good of the industry. When people saw how immensely cheaper electricity was the metallic filament lamp would have a good effect. The estimated prices upon which the estimated revenue under the L.C.C. Bill last year and under the present Bill were taken, were the same. Under the Kitson Clause the authorised distributor came to a bargain to give the supply and keep the power company out, if the supply suited him. There was a difference in the present case, in which the price was fixed in the Bill itself. He thought it was right that they should have to go through the same system of arbitration as under the Kitson Clause, as regarded their duty to supply, and that they should, as regarded their right to supply, be rid of all the machinery and difficulties of the Kitson Clause. If the authorised distributor acted the dog-in-the-manger's part, the consumer should be protected. He thought there would be no objection to a clause being inserted in the Bill making it obligatory to supply those power consumers whom the authorised distributors neglected.

By the Chairman: He raised no objection to arbitration by the Board of Trade except that it was a cumbersome proceeding. The appeal to the Board of Trade was not only with regard to prices. It always appeared in power Bills in the same form. The schedule price which applied to supplies above 250 k.w. did not apply to the smaller consumers, and something might be put into the Bill which would fix the prices to smaller consumers. He would be willing to accept an obligation to supply consumers at the prices at which they proposed the authorised distributors should supply. He had not said that the London Electric Supply scheme (for the promoters of which Mr. Cripps appeared) was an impossible one; but he said the idea of linking up the networks was an absurdity. He agreed with Mr. Cripps that there were not many places so large as London, but there was Niagara, and what they really wanted was Niagara in London.

On the question of the possible demand for power in London, Mr. Cripps said that out of the total of 208,000 h.p., roughly half was within his companies' area, and they were supplying 47,299 h.p., or 46 per cent. They had canvassed the other 54 per cent. of the possible customers, but he was told it meant "endless cigars," and other inducements to draw them away from gas and steam.

By the Hon. S. Holland (for the promoters of the London (Westminster and Kensington) Electricity Companies Bill): Since the time of Mr. Herz's Bill turbo generators had been increased in size, and the class of machines they proposed to use were now in use in Chicago. Probably the largest in use here were at Lot's-road. They were very much larger on ships such as the "Lusitania." He deemed the turbines used by the electric railways here to be a success because the railway services did not stop, but those were a totally different class of turbines to those proposed to be used by his company. He believed that, if the present suppliers had perfect faith that the power company would give them the 1,000 or 2,000 k.w. they would require at the end of two years they would not extend their stations. With regard to the difficulty of erecting a transforming station, supposing the Westminster Co. were willing to take a supply from the new company, he thought Sir Alexander Kennedy and he could find a place for such a station. It need not be in or immediately adjoining the present works.

By Mr. Ernest Pollock (for Middlesex County Council): Lord Camperdown's Committee in 190[illegible] apportioned a part of Middlesex to the Metropolitan Electric Supply Co. and another to the North Metropolitan Co. The bulk authorities in Middlesex would, in his opinion, be very big customers of the new company. The North Metropolitan had not done what they were established to do—give a cheap bulk supply.

In reply to the Chairman: The 15,000 volts could be comfortably transmitted 15 miles.

In reference to Mr. Pollock's statement that there was only a population of 14,862 in the area in Middlesex for which the promoters said there was a field for the supply of 16,240 H.P., Mr. HAMMOND said it did not strike him as curious. People went outside London on purpose to get larger factories

By Mr. WEDDERBURN (for Croydon): Where chimneys were objected to there should, with electric power, be factories springing up on every hand. He was not willing to have it put in the Bill, that they should not have powers in a district except with the consent of the local authority. That would defeat the object of the Bill. He did not agree that if Croydon, for instance, took bulk supply they would still want engineers who would take £792 a year. All that would be required was three men at 30s. a week each, and one switchboard. He hesitated to believe that all the distributors would at once scrap their works. He thought the most practical thing would be for them to come to the new company for the demands occasioned by their growth. The total cost per unit in the last Croydon accounts was 1·129d. including capital charges.

By Mr. WILLIAMS (for Stepney): Even if various distributors who all supplied continuous current on the same voltage linked up it would be unnecessary and wasteful. He would be prepared to advise his company to accept the Stepney clause. Though the new company could supply a consumer in Stepney more cheaply than the Council could do from their own works, they must not do so before the Council had the opportunity of supplying him.

On Tuesday, in further cross-examination, Mr. HAMMOND said cost of distribution varied from 50 to 60 per cent. of cost of generation. It would not necessarily be a loss to Stepney to have to supply a 75 k.w. consumer at 18 per cent. above the price at which they obtained it from the power company. This depended upon the diversity factor. If two consumers took 1,000 k.w. between them, and their demands were for two different times of the day, the Council would only have to take 500 k.w., and the diversity factor would give the Council their profit. The Council would pay £2,250 at £4. 10s. per k.w., and the consumers would pay £4,500 or 100 per cent. [illegible] Stepney were likely to lose a great deal of money by supplying under present conditions, as counsel (Mr. Williams) stated that they now supplied, at a flat rate of 1d. or at ½d. per unit plus a certain charge per kilowatt.

By Mr. MORTEN (for West Ham): If West Ham had to get additional plant during the next two years it would not have to be scrapped after the new company started. Assuming that all the stations had to be closed, and the plant sold, there were stations in other parts of the world, with some of which he was connected, and for which plant might be purchased at a slight discount off what had just been paid for it. With regard to the cables coming through West Ham he thought West Ham should welcome the cables as they would be paid rates for them.

By Mr. A. B. CANE (for Marylebone): Even if Marylebone Council could supply themselves more cheaply than the new company could they would not leave Marylebone out of the Bill. It would not cost them a good deal more to deliver energy at the Councils switchboard than it would cost the Council to do so. The latter's capital charges were £21. 9s. per k.w., and the company's were £12. The load-factor of the company's supply was estimated at 54 per cent. He anticipated that if Marylebone came to them for 2,000 k.w. for the peak, they would in order to take full advantage of the supply at 0·22d. per unit, take as many units as they could. To some extent he would expect a better load-factor in an industrial than in a residential district, but in St. James', where there were practically no factories, the load-factor was 18·3 and estimated to increase to 20. Marylebone Council could not compete with the new company for power supply, on account of higher capital charges. There was always a diversity factor. If the L.C.C. tramways were supplied through 20 substations from a generating station at Barking, there would be a diversity factor of 1·25. If the company had to give such supply to the Council they would treat the 20 substations as separate consumers, and charge £4. 10s. per k.w., and 0·22d. per unit in respect of each of them. He did not know whether a consumer could order current for his motors in 12 different houses, and have the charges for them lumped together so that he would get the advantage of the diversity factor, but he did not think so.

By Mr. CHARTERIS (for Hampstead): Under the Metropolitan Company's powers Hampstead had the option of taking bulk supply In supplying Hampstead, where a periodicity of 90 was used, the company would have to convert their 50 cycles to 90.

By Mr. COURTHOPE MUNRO (for St. Pancras and Shoreditch): Although St. Pancras would get down their costs to 0.924 per unit if they extended their works and relied upon their own plant to deal with increased demands, they would still make a big saving by taking supply from the company. Most of the load factors in St. Pancras were small, but by aggregation they might become of high diversity. In Shoreditch too, the power consumers were all small.

By Dr. MACASSEY (for South Essex Water Co.): The power company's mains as they left Barking would probably occupy a larger space than had ever been occupied by electric mains before. For condensing water for their works they proposed to go to the Thames. They would have about 600,000 gallons of water imprisoned in their pipes on the way back to the Thames. Even for boiler feed water they were not bound to go to the South Essex Co. Thames water would be suitable if purified. They would probably sink their own wells.

By Mr. SNOWDEN (for Hammersmith): He was not aware that Hammersmith was supplying more power than private lighting, and that the power demand was 2,400,000 units per annum. If the power company refused to supply to a consumer over 250 k.w., because he would not enter into a contract for seven years, he could go to Hammersmith, but they would not be obliged to supply him under 8d. per unit.

By Mr. GERALD SANDERS (for Islington): In forecasting the future load factor they had, as Mr. Parshall had said, given Islington the benefit of the doubt. Islington's average price was 2·93d., and even if they took supply at the company's maximum prices they would make a big profit. If Islington supplied some current for power at a 1d. flat rate with a 6 per cent. load factor, the company could not help them. They could not suggest any system at which Islington could make a profit at a flat rate of 1d.

Re-examined by Mr. Talbot, Mr. HAMMOND said the North Metropolitan Co.'s maximum price was 3½d. subject to certain conditions, but their Stoke Newington price was about 1¾d., with some obligation on the company to bear any loss by Stoke Newington, he thought for two or three years. He did not approve, of the suggestion that the local authorities should have the right of veto as to the points at which the company should supply. They must guard themselves against a local authority saying, "We should like 100 k.w. at 12 different points." The bill provided for the control by the authority as to the route. The company would have authority to go to certain consumers, and the local authority would say the route by which they were to reach a particular consumer. That was subject to appeal to the Board of Trade.

Mr. HAMMOND then went fully into his calculations regarding Croydon, which he had taken as a typical case. He said Mr. Wedderburn had stated that Croydon's operating costs were about ¾d. per unit, and therefore if they paid the company £4,500 for 1,000 k.w. they would save by taking current from the company. He showed that the various demands—tramways, private and public lighting, heating, and power—were so varied as to times of demand that, on the 1,000 k.w. assumed to have been paid for, Croydon could get a load factor of 64 per cent. If Marylebone were at a disadvantage in not being able to extend their station the company proposed to relieve them of that disadvantage. The longer term a consumer was required to bind himself to take current under the power bills than under the powers held by the present distributors was necessary because the capital outlay was larger.

In reply to Lord SAUNDERSON: With regard to the question of the power of the company to offer high pressure a.c. to a distributor at a certain low price, and then supply d.c. to somebody within the same district at the same price, and thus compete unfairly, this question was raised with regard to Stepney who now supply c.c. The power company would offer Stepney either transformed a.c. or d.c. Unless they put down special mains Stepney could not distribute the three-phase a.c. The question was whether the company could go to one of the Council's customers and advise them not to take d.c. from the Council, but transformed a.c. from the company.

Mr. TALBOT said the point would be considered, and a suggestion for dealing with it submitted to the Committee.

In reply to Lord Welby Mr. HAMMOND said they did not anticipate getting the demands from the large tramway undertakings. The L.C.C. was the only one within the Administrative County, and they had large generating stations.

PARLIAMENTARY INTELLIGENCE *continued on p. 228.*

Electric Railway for Postal Work.—According to the *Blätter für Post und Telegraphie*, the German Post Office authorities are considering the question of connecting the General Post Office in Berlin with the various stations by means of a special underground railway. It is hoped by this means to avoid the delays inseparable from the ordinary street methods of carriage, and thus to obtain a better postal service. A short length of track from the Post Office to the Potsdamer Bahnhof will first be built and used for experimental work. The tunnels will be built directly under the road surface, and will be 6 ft. wide by 2½ ft. high. The railway will be double-track throughout, and will have a gauge of 1 ft. 4 in. Between the tracks a pit will be provided, allowing an inspection of the track to be made and repairs to be carried out. The "driverless" trains will consist of an electric locomotive drawing four cars each containing a large sack of letters. The running speed will be 25 miles an hour, and will be independent of load, curves and gradients. The headway will be 90 secs. Above each track will be placed two "third-rails," which will be about 1 ft. 6 in. from the track in the tunnels and 6 ft. 6 in. in the postal buildings, the trolleys being 6 ft. 9 in. long. The locomotives and cars are of the two axle type, the former being equipped with two motors. For working this railway low-tension three-phase current will be used.

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"THE ELECTRICIAN" INDUSTRIAL SUPPLEMENT.

With the number of "THE ELECTRICIAN" for Sept. 14, 1906, was issued the first of a series of "Industrial Supplements," to be published from time to time with "THE ELECTRICIAN." The twenty-third issue of the Supplement will be issued (Gratis) with "THE ELECTRICIAN" for May 29.

The "INDUSTRIAL SUPPLEMENT" is a comprehensive record of developments in Electrical Plant, Machinery, Apparatus, Accessories, Sundries and Materials, and of their proved suitability for various Industrial purposes.

We invite descriptions and illustrations of New Applications of Electricity to Industry, and shall cordially welcome any assistance we may receive in connection with the SUPPLEMENT.

The "INDUSTRIAL SUPPLEMENT" is holed for filing or hanging, and filing covers can be supplied for holding 6 or 12 issues.

THE HALIFAX TRAMWAYS ENQUIRY.

The report by Major CARDEW and Mr. GRAHAM HARRIS upon the working and management of the Halifax Corporation Tramways reveals a state of affairs which, although not radically wrong, cannot be described as altogether satisfactory. The tramway routes in Halifax, according to the report, border upon the limits of possible safe working by electric cars fitted with the ordinary flanged wheels running on grooved rails, for not only are the gradients steep, but the hills are long and with many curves, and the exudations from the soil and deposits from the air and from other traffic frequently produce a greasy surface on the rails. Further, the track does not appear to have been maintained in a very efficient state. It was desirable, therefore, that every possible precaution should be taken in the working of these lines.

One of the most important points raised in the report is the question of using double-deck cars. The opinion is expressed that there would be greater safety and ease of control with single-deck cars, and this opinion will probably be endorsed by most engineers. A covered-in top-deck with a full load of passengers cannot conduce to the stability of a car, more particularly if the wheel base is somewhat short. It is noticeable that double-deck cars are very seldom used in other countries. They are to be seen in Paris, but, generally speaking, it is the single deck car that is paramount on the Continent and in America. Sir CLIFTON ROBINSON is reported to have said recently, on his return from abroad, that double deck cars were really disadvantageous on account of the delay they caused in setting down and taking up passengers. No doubt this may frequently be the case, but it appears to us that the question depends to a

large extent upon the density of the traffic. For example, in certain portions of the London County Council tramways system, the use of single-deck cars would necessitate a much greater number of cars, but it would be difficult to reduce the headway to the corresponding extent. On the other hand, in many provincial towns there does not seem to be any reason why single-deck cars should not be largely adopted. There would be less weight, less wear and tear, and the conductor would not be out of sight of the platform, which, from the point of view of safe working, is a desirable feature. To some extent, no doubt, the question is one that is affected very largely by climate. The single-deck open cars which are to be seen in many parts of the Continent are very convenient from the point of view of handling of traffic, but they would not be always acceptable, in our climate, though a convertible type of car might be adopted.

With regard to sanding, great stress is laid in the report upon the necessity of arranging matters so that sand can be distributed both behind and in front of the wheels in case of running back, and also that an emergency supply of sand should be capable of being given when necessary. The brakes also, as might be expected, receive a good deal of attention in this report. The opinion is expressed that every car should be fitted with an efficient emergency brake as well as an adjustable brake for continuous use for controlling speed down steep inclines. Preference appears to be given to some form of magnetic track brake, since this demands the minimum of strength and nerve on the part of the driver, and it is recommended that all the cars which are used on gradients steeper than 1 in 14, or for speeds exceeding 10 miles per hour, should be fitted with either the Spencer track brake or a track brake having at least an equal power and capable of as rapid application. It is remarked, very truly, that no brake acting through the contact between wheels and rails alone can be considered efficient under these conditions. Attention is also called to the desirability of giving a skid brake a trial on these lines.

Perhaps the most unsatisfactory point to which attention is called is the multiplicity of controllers in use at Halifax. At present there are four distinct types—namely (1) No rheostatic brake, a run back being provided for by short-circuiting the motors; (2) rheostatic brake brought into use simply by turning the controller handle to the various brake stops, a run back being provided against by short-circuiting the motors; (3) rheostat brought into use by bringing the controller handle into the off-position, then the reversing handle to backward position, and afterwards the controller handle to the various brake stops, a run back being provided against by bringing the controller handle to the brake stops successively, leaving the reversing handle in the forward position; and (4) rheostatic brake as in the second type, but with no run back. Of these four types the third is particularly bad, because the driver must always consider very carefully what he is doing; as it is necessary to put over the reversing handle in order to obtain a braking effect when running forward, the driver would be very apt to do the same thing in the event of a run back, thus entirely defeating his object. Ideally, all cars on one system should be controlled by precisely the same means. Unfortunately, it is not always easy to obtain such simplicity, more particularly when brakes are being evolved and new types being introduced, but we think that uniformity might be aimed at as far as possible, and that, at least, those types of a dangerous kind should be eliminated.

OBITUARY.

FRANCIS HUGHES WEBB.

We regret to record the death of Mr. Francis Hughes Webb, for 20 years secretary of the Institution of Electrical Engineers, which occurred on Sunday last at his residence, 37, Briardale-gardens, Finchley-road, London, N.W. The funeral took place yesterday at Hampstead Cemetery. Mr. Webb was in his 84th year.

Mr. Webb was born in London on December 8, 1824, and received his early education at University College School and afterwards at the Ecole Normale in Brussels. He made his first acquaintance with engineering work in Germany under Mr. John Player, shortly afterwards returning to England to take up a position in the audit office of the London, Brighton & South Coast Railway. In 1844 Mr. Webb was appointed Secretary and Librarian to the Royal Institute of British Architects, while in 1850 he entered the service of the Electric Telegraph Company as assistant to the engineer-in-chief. Shortly afterwards he became private secretary to Mr. J. L. Ricardo, who, besides being chairman of the above company, was closely connected with many other industrial concerns, and in this position Mr. Webb had the advantage of coming into contact with some of the most prominent engineers of the time.

In 1865, Mr. Ricardo having meanwhile died, Mr. Webb again entered the service of the London, Brighton & South Coast Railway as Assistant Secretary, resigning this position two years later to become associated with Mr. Edwin Clark, under whom he had worked when with the Electric Telegraph Co. Besides his engineering work Mr. Webb was at this time secretary to several public companies.

In 1878 he began his 20 years' connection with the Institution of Electrical Engineers, founded in that year under the title of the Society of Telegraph Engineers and Electricians. He did not at first relinquish his other appointments, but in 1885, owing to the increasing growth of the Society, the Council found it necessary that he should devote his whole attention to the Society's affairs, including editing the *Journal*.

Mr. Webb's efforts on behalf of the Institution are too well known to need recapitulation here. During his occupancy of the secretaryship the membership trebled in numbers, and it is certainly not too much to say that this result was largely due to his exertions. He retired from office on February 12, 1898.

FESSENDEN'S INTERFERENCE PREVENTER FOR WIRELESS TELEGRAPHY.

Several accounts of tests made with the Fessenden system by the U.S. navy representatives have referred to the remarkable immunity secured in working at the same time as other stations close by and with wave-lengths not very different, by the employment of the inventor's so-called "interference preventer." Since, however, no details have been published as to the mode of action of this device, there has existed, besides some curiosity as to the means employed, also no little scepticism.

The patent specification has now been published, and so the principle employed can be described, although there are probably a number of details to which attention has to be paid for successful results to be obtained in practice.

The method is stated to be based upon the fact that resonance curves in general have a curvature of the same sign. Hence, if three circuits having very small damping are carefully tuned, the one circuit to the frequency which it is desired

to receive and the other two circuits to a higher and a lower frequency respectively, the two latter circuits can be made to neutralise the effect of disturbing impulses (*i.e.*, those not of the desired frequency) caught by the properly tuned aerial and which otherwise would be heard in the receiving instrument.

Though in practice a single vertical antenna is employed, connected to three separate tuned circuits, it is preferred to describe the arrangements as applied to the case where three separate antennæ are used to arrive at the same result. Here the three receiving antennæ which we will call A_1, A, A_2 are tuned, A to the frequency at which it is desired to receive, A_1 to a somewhat higher and A_2 to a somewhat lower frequency. Each aerial circuit contains a detector, which is preferably a solid barretter, and the necessary cell and potentiometer arrangement. The receiving or, rather, indicating instrument is a telephone having four coils, two on each limb of the magnet. Calling these coils C_1, C, C, C_2 to correspond with their respective aerial circuits it is arranged that one pair, CC, is in circuit with the correctly tuned antenna A, and one each of the other coils—viz., C_1, C_2, with antennæ A_1, A_2 respectively. These two latter coils are arranged so that their windings oppose the action of those of the coils CC, and they are made somewhat weaker than these coils (fewer turns). It will be seen that on a disturbing impulse striking all three antennæ this will, if not in tune, produce nearly equal effects in the barretters, and hence these effects will neutralise each other as regards their effect on the diaphragm of the telephone. If, however, the oscillations are of the proper frequency, the barretter in the antenna circuit A will be very much more strongly affected than either of the others, and the telephone diaphragm will be actuated.

This effect can be enhanced by making the damping of the circuits A_1 A_2 somewhat greater than that of circuit A. Still further security against disturbances can, if desired, be obtained by having recourse to mechanical means depending upon the use of group frequencies; several arrangements by Prof. Fessenden with this aim in view are already well known.

The adjustment of the relative strength of the coils is, of course, the most important point, and as regards this it is stated that the balancing can be effected by calculation or trial, or by a combination of both.

The arrangement is thus, on the whole, very simple, while the test results have shown that it is effective. It will doubtless be argued in this country that an unnecessary complication has to be added to the existing wireless equipment. But Prof. Fessenden—who can scarcely be considered as a disbeliever in the future of wireless telegraphy—states, with some directness, that mere tuning to the wave-frequency, however careful such tuning may be, does not sufficiently ensure against interruption from disturbing sources, and especially where the number of closely adjacent stations is considerable.

It appears from this that it is the more severe working conditions prevalent in America which have necessitated the development of a self-protective system such as we have scarcely found necessary as yet in this country, where the stations are but little closer now than in the days when it was admitted that interference could not be prevented. In any case, since the British Isles are not very large there will probably come a time, if the use of wireless telegraphy continues to advance at its present rate, when some special device for preventing interference from neighbouring stations cannot well be dispensed with.

CORRESPONDENCE.

IS THE CONSULTING ENGINEER NECESSARY?

TO THE EDITOR OF THE ELECTRICIAN.

SIR: Within the covers of a technical paper, which necessarily addresses itself to makers, designers and vendors of electrical plant rather than to the buyers, one usually has to consider the advantage of the electrical industry as measured (and, indeed, it is to a great extent the case) by the immediate money advantage of the vendors, makers and designers. There is, however, another point of view which, like the second picture in a stereoscope, is necessary to see the matter in its true relief. I allude to the view taken by the buyer and user of that plant. Thus we cannot say, without much statistical data, that the very low prices at which motors are sold is definitely bad, for it is certain that small capital charges for a power house or for the electrical equipment of a factory are of very great good. This is a direct advantage to that section of the electrical industry who are buyers, and incidentally to the vendors of other apparatus, which would not have been called for but for the cheap motors.

The business of buying carefully and well is an important one, and under the modern conditions of high specialisation demands skill, business habits and knowledge. It is incontrovertible that good purchasing is good for the buying half of the electrical community. It is reasonable to believe that it is good for the selling, designing and making half.

As a proposition in political economy it can be maintained that it is better to deal with a purchaser who knows what he wants as well as the limits of what is technically obtainable rather than with one who simply *wants*, in complete ignorance of what he can get, of what is good for him or of what it will cost him. In England it is quite common to hear a person admit frankly that such-and-such a branch of knowledge is entirely outside his province. In certain countries abroad it is far more unusual to hear such a remark, and it is characteristic of this country, in which a man's shortcomings are admitted by himself, that the same man with equal frankness will quote Sir Julian Goldsmid's wise saying, "No advice is worth having that is not paid for." The outcome of this is the paid adviser—the consulting engineer, the consulting chemist, mineralogist, &c. The alternative course, overlooking Sir Julian's dictum, is to try to get advice for nothing—write round to a number of makers, invite schemes and pick the vendors' brains.

Apart from what you, Sir, pointed out so ably in your leading article as to the waste of time and money in which the selling half of the electrical industry is involved by the re-duplication of work so caused, the question may reasonably be asked—Can this self-sufficient buyer really hope to learn his markets in one such plunge, and can anyone buy to advantage without knowing his markets? The answer is quite clear, No! And as for the layman picking the brains of a vendor of electrical goods without paying for the knowledge, the proposition is childish.

Abroad, to get out of this obvious impasse and to make sure of the vendor's interest being identified with the purchaser's in some measure, the latter makes the vendor finance him.

Those who visited Germany with the I.E.E. some few years ago during the days of the electrical depression there heard something of the results of such doings. For then we had the converse proposition.

A man, chiefly or only, versed in electrical matters is suddenly called upon to have an opinion (and to back that opinion with money advances) upon the value of a factory which makes plum-puddings, or glass bottles, or the prospects of a colonisation scheme among the Thibetians. Such a system is faulty.

As a humble member of the fraternity of consulting engineers, I may be prejudiced when I suggest that the question of your headline, "Is the Consulting Engineer Necessary?" is not capable of a monosyllabic answer. No one is necessary, but unseen though they may be by one-half of the electrical world, we have our vile uses to the other half.—I am, &c.,

82, Victoria street, S.W., May 14. MERVYN O'GORMAN.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: As one who has employed a consulting engineer for all my electrical work with the utmost satisfaction for 11 years past, I venture to join in the discussion you have raised.

As far as I know nobody objects to the good consulting engineer, and everybody—including the bad consulting engineer—objects to the *other* bad consulting engineers. The remedy suggested by "Manufacturer" is simple. Let a committee be formed of men of high standing as first signatories to a sort of mutual agreement, and invite consultants to join the list. A minute subscription would pay all postal and organising expenses.

The thing should be done under the ægis of the Institution

of Electrical Engineers for electrical men, and under the other institution for other men; but the whole corporate body of the professional men should form one unit like the Bar.—I am, &c.,

London, May 16. N. G. NEER.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: The question asked in your issue of the 8th inst. is of great interest, and at the same time one which I believe will educe very few judicially-minded answers. It is almost bound to be so by reason of the existence of large numbers of persons who from bad experience in the direct employment of contractors and manufacturers, and others who have fared badly when employing consultants, hold very pronounced views pro and con respectively. In fact, I would say that the question cannot be forcibly and definitely answered at all, and that the only verdict possible is that some consulting engineers are decidedly unnecessary, and that in dealing with some contractors not only is it necessary to have expert advice, but it is prudent to also engage a special staff of detectives, legal assessors, sheriff, hangman, &c.

Any way this gives a fine opportunity for us poor contractors to temporarily drop our wonted subservient attitude to the class now being tried for its life, and I offer the following as what I believe to be a representative contractor's view.

Generally speaking, we should always prefer to have a consulting engineer's specification to quote and work to, and a qualified man to discuss and settle the unexpected problems which are frequently arising, and in the majority of cases I think this works with as much smoothness and general satisfaction as engineering and some few other business matters are ever likely to. On the other hand, however, there are often disturbing facts. Much as we should like to deny it, consulting engineers are not all perfect, and when their specifications are a mass of non-standard fads and "general clauses" of indefinite and potentially oppresive character, the results are increased price to the purchaser, wild tendering by contractors, anxiety to everyone during the progress of the work and a loud chorus of dissatisfaction for finale. I strongly assert that this state of affairs is by no means the rule, but it certainly does occur, and in the past has been so common as to almost justify the opinion that the mission of the consulting engineer has solely been to increase the cost of work without benefit to buyer or seller. In your article you say than an architect is always consulted about even small building operations. Of course, there are good and bad in that profession also, no doubt, but I imagine that in any important work a bill of quantities is furnished to the contractor, and if the consulting engineer would always do what I believe to be the most important part of his duties—*i.e.*, work out sizes and lengths of all cables, steam pipes, &c., and exact quantities of all articles to be supplied without taking quite so much pains to tell us exactly where to purchase the odds and ends of material required—the consultant would very quickly have in us a body of champions always ready to defend his existence. Under such circumstances, the present appalling amount of work we are saddled with in tendering would be reduced to reasonable dimensions and the absurd disparity in prices shown in "Results of Tenders," would disappear. It has often been asserted that the American consulting engineer's specification is better in the respect indicated than the British type of which I complain, and I believe the simple explanation is that the former starts with the broad assumption that the contractor or manufacturer knows his business, and the general aim of the specification is to set out clearly the scope of the duty required from the plant to be installed to the exclusion of doctrinaire opinions on the best selection of material.

As to the buyers, I feel pretty confident that a large proportion at any rate of those who have factories, business premises, &c., requiring electrical equipment, who are consequently to some extent entitled to consider themselves not altogether ignorant of technical matters, have come to look upon the consulting engineer as a luxury of doubtful utility, which truly awful state of mind is chiefly due to the consulting engineer allowing the impression to get about that he always increases the cost and only sometimes improves the job. The tendency to dispense with the services of the consultant has, of course, been very much encouraged by keenly competing sellers deliberately offering to do all necessary advisory work, submitting any number of schemes that may be called for, and so almost ensuring that a smart buyer will be in a position to weigh the pros and cons of every detail for himself, and then skim the cream from everyone's dish, probably in the end offering a dish of his own composition to whichever competitor he has some personal reason for favouring at a price—*i.e.*, about the lowest figure named by the party who made the maximum number of mistakes on the low side. This procedure is slim, of course, but it is the seller only who is responsible for its possibility, and to prevent it he should forsake this method and support the consulting engineer, who on his part should see that it is his duty to lighten the burden to the over-willing beast (the contractor), and this will in turn reduce the cost to the purchaser who will not be slow to signify his appreciation.—I am, &c.,

London, May 20. CONTRACTOR.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: I have read your leading article and the letters signed "Lumen" and "Manufacturer" with considerable interest. In my opinion the answer to your question is in the affirmative, provided he is not one of the "goats" mentioned by your correspondent.

There is no doubt whatever that it is preferable for the manufacturer in tendering for a contract to have a clearly defined specification and schedule of quantities drawn up by a competent engineer than to quote (say) a lump sum for certain work which is outlined in a very sketchy manner. The latter case always leads to trouble; the contractor considers that the purchaser wants more work executed than he is entitled to have according to the contract, and the purchaser in the end considers that the contractor has tried to "rush" him.

Of course a great deal of trouble, in my opinion, has arisen through so many of the consulting engineers of this country having fads and insisting upon having them carried out whether feasible or otherwise. Sometimes the expense falls on the contractor and sometimes on the purchaser, but from the manufacturer's point of view a great deal of unnecessary expense occurs, owing to special drawings and patterns having to be made, which, in all probability, will be useless for another customer and most likely will not be used again by the gentleman who originally specified them.

If the consulting engineer would drop his particular fad the manufacturer would then be able to standardise his particular article and eventually money would be saved to manufacturers, contractors and purchasers.

In the early days some consulting engineers, in deciding upon the voltage at the lamp terminals, seemed to think it necessary to have a different voltage from other installations, thereby causing lamp manufacturers to make and keep in stock lamps of many different voltages.

Again, in cable matters, each engineer has his own particular fancy for cable junction boxes; hence, it has been very nearly impossible for the cable makers to standardise these articles.

During the last few years, however, consulting engineers appear to be more disposed to follow the advice of those who give all their time and energy to the manufacture of particular articles, and I am sure that manufacturers and contractors now feel that it is to their benefit, and to the benefit of the industry generally, that a proper specification should be drawn up by the engineer.

I quite agree with the suggestion that has been made that the Institution of Electrical Engineers should take action in the matter, as I consider that this would put the consulting engineer on a better basis, and would establish an authority to whom the prospective purchaser might apply. I am quite sure that this would be to the benefit of the genuine consulting engineer as well as the manufacturer, contractor and also the purchaser.

Apologising for taking up so much of your space.—I am, &c.,

May 20. WORRIED MANUFACTURER.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: Your leading article on the above subject is not only most interesting, but has opened up an equally interesting correspondence. Both "Lumen" and "Manufacturer" appear to be in agreement with you that good consulting engineers are of service to both purchasers and sellers, the trouble being, apparently, that all who call themselves consulting engineers do not come up to the requisite standard. This is, of course, a direct result of the present unfortunate state of affairs by which anyone can style himself a "consulting engineer." There should be some recognised list of consulting engineers. Obviously, the Institution of Electrical Engineers is the proper body to move in the matter, and for the sake of the industry they should do so.

It is usual in arbitration clauses to refer to the President of the Institution to appoint an arbitrator under certain circumstances. Presumably a list of suitable persons is kept for this purpose, and this list, suitably expanded, might very well form the basis on which to work, as obviously consulting engineers of recognised standing are, owing to their independent position, those most suited to the post of arbitrator. This list should be available for any one desirous of obtaining a copy. Failing this, however, a good deal can be done, as suggested in the correspondence, by manufacturers themselves in supporting those consulting engineers who carry on their profession honourably and with ability, and in helping to weed out those who for any reason are undesirable.

To obtain this result, however, we must have a self-denying ordinance and refrain from poaching on the consulting engineers' preserves unless we are prepared to give up our manufacturing or contracting interests, and devote ourselves entirely to professional work as we expect him to do.—I am, &c.,

London, May 20. A BUSINESS MAN.

PRINCIPLES AND PRACTICE OF RADIO-TELEGRAPHY.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: In connection with any relatively new branch of applied science possessing commercial utility, there is bound to exist a certain amount of difficulty in forming accurate ideas as to its true condition. The causes, to which this familiar accompaniment of practical progress must be assigned, are commonly understood. They mainly arise from (1) public misconception of actual facts, (2) erroneous statements made by persons who are either too sanguine or unduly sceptical, and (3) obscurity in relation to patents and patent rights. The subject of radio telegraphy is no exception to the rule, but rather a notable example of its cogency.

Nevertheless, from time to time, there occur events which, if properly understood, may serve as landmarks, denoting the completion of definite stages of progress. And at this moment we have such evidence in connection with radio-telegraphy. Not only so, the position reached is one from which a considerable distance along the future course of events may be surveyed. These points I will now endeavour to make clear.

The particular and important landmark in this instance, is the rapid transition now occurring in the practice of radio-telegraphy. Last year, when giving evidence before the Parliamentary Committee upon this subject, I expressed the conviction that future progress would be found to lie in the direction of methods for producing continuous and undamped radiations. Further, I emphasised the view that it would be entirely unwise to adopt the suggestion that arc-telegraphy should be modified to suit the requirements of spark telegraphy for purposes of intercommunication. The proper course would be to bring the spark method, so far as possible, into line with the requirements and perfections of the arc. I may, without undue presumption, claim to have forecast the general course of events with some accuracy.

At that time, however, the Poulsen system had but recently acquired public prominence. Persons interested in the spark-methods professed invariable scepticism with regard to the capabilities and general value of the new system from a commercial point of view. Thus, with the exception of Government experts, none of the technical witnesses gave any support to my views upon this particular question. Yet, in spite of their alleged indifference to the claims made for the new system most experimentalists in radio-telegraphy throughout the world, began to devote their energies to the production of continuous electrical oscillations. Every scoffer proceeded to search for means whereby effective electrical oscillations of a non-intermittent character, or wave trains of great persistence and energy could be produced. At the same time, of course, every effort was made to discover means for employing such oscillations, without infringing the Poulsen patents, and others by which the basic claims were constantly being supplemented. This specific group of inventions comprises patent applications which cover a wide field, and which, at the present time, amount to about 250 in number. Other workers, naturally, have also taken out patents by the dozen, which relate to details of minor importance. Some of those patents have been made the basis of impossible statements as to their efficiency in practice. But, notwithstanding all statements to the contrary, there is no shred of evidence, so far, to suggest the idea that any practical arc system has been produced without including essentials which are covered by patents of the Poulsen group.

That consideration, however, has not prevented a general change of attitude towards the arc method on the part of radio-telegraphists at large. We no longer hear experts stating that the spark method is supreme in merit, or even minimising the practical value of the arc system. Those who, only a short time ago, sought to throw doubt upon the capabilities of the arc, now claim to possess efficient arc systems of their own. In effect, we find them all professing, loudly and proudly, that their systems are capable of eventually being made, perhaps, as good as the Poulsen. But it is a significant fact that none of them will attempt to prove his method equal in efficiency to even the most primitive form of Poulsen's apparatus.

Here, again, we find still further evidence as to the precise stage at which radio-telegraphy has arrived. Those who have succeeded in devising an arc system of any efficiency whatever invariably contend that, however deficient the system may be in comparison with modern standards of arc telegraphy, it gives them better results than the spark method they formerly employed. It is a great and unquestionable victory for the arc, when its ardent opponents make so rapid a change in their opinions concerning it. It must also be somewhat humiliating to those former antagonists to admit—as they are unavoidably compelled to do—that the summit of their present ambition is to produce an arc system equal in efficiency to that of Poulsen, which they so recently condemned. Be that as it may, however, the fact remains that, in experimental radio-telegraphy there is hardly anything being done, except with a view to developing the arc principle and utilising the continuous radiations it produces. And, quite naturally, every worker in this branch of investigation hopes to discover means for producing expedients which will evade the patents of the Poulsen group. In this, apparently, their success constantly varies in inverse ratio to the efficiency obtained. The more efficient the result, the less is their success in avoiding palpable infringement of existing claims.

The latest illustration to hand is that contained in Mr. Marconi's lecture at the Royal Institution on March 13th last. Speaking of his trans-Atlantic experiments, he says:—

> Good signals were obtained at Cape Breton from the very commencement of the tests, but some difficulty was encountered in consequence of the effects of atmospheric electricity due to the prevalence of thunderstorms in the eastern part of Canada during the first few days of the tests.
>
> Simultaneously with these tests, others were carried out from Poldhu to Glace Bay with a new system of transmitting apparatus, by means of which continuous or semi-continuous oscillations could be produced. Proportionately to the energy employed, the signals from Poldhu were so much better than those from Clifden that I decided at once to adopt the new method of transmission at Glace Bay and Clifden.

He then gives a description of the apparatus employed in the arc system which replaced the spark method, which at one time was pronounced to be the embodiment of every perfection. This arc apparatus consists of metal discs, which are made to revolve rapidly, and between the peripheries of which the arc is struck from a high-tension continuous current. In

explaining the mode of action, whereby the apparatus generates continuous oscillations, Mr. Marconi says:

> The efficient cooling of the discharge by the rapidly revolving disc seems to be one of the conditions necessary for the production of the phenomena.

There is only one error contained in that statement. It consists in the use of the word "seems." The efficient "cooling of the discharge *is* one of the conditions necessary. Not only so, it is the vital condition upon which success depends, absolutely. There is no "seems" about the matter. If the discs were replaced by suitably formed electrodes there would be no need for rotating them. This question of efficient cooling has been fully investigated in the laboratories of the Amalgamated Radio-Telegraph Co. by Dr. von Traubenberg, and forms the subject of patents dating, under International Convention, from January, 1907. The principal claim runs thus:—

> An arc lamp for producing continuous electrical oscillations in which one or both of the electrodes are formed or provided with cooling or radiating surfaces substantially as and for the purpose specified.

This claim certainly demonstrates the fact that the cooling effect has been previously recognised as being of the utmost importance, and it also shows that the principle of cooling by means of dissipation through the surface of the electrodes had already been protected by patent, before the date of the tests mentioned.

Mr. Marconi's next statement runs thus:—

> By means of this apparatus tests were carried out, but it was found, as was to be expected, that the oscillations were too continuous and of too high a frequency to affect a receiver such as the magnetic detector, unless an interrupter was inserted in one of the circuits of the receiver.

That is perfectly true. The method has been embodied in numerous patents of the Poulsen group, and is completely protected. The principle has been repeatedly described in the Press and at public lectures. Mr. Poulsen himself gave a full description of it in his lecture at Queen's Hall on November 27, 1906. He uses the Danish word "tikker" to describe a device of this kind.

Returning to Mr. Marconi's lecture, we find him saying:—

> The best results over long distances have, however, been obtained by a disc in which the active surface is not smooth, but consists of a number of knobs or pegs, at the end of which the discharge takes place at regular intervals.

The statement, of course, relates to the transmitting apparatus, in which the radiated energy is thus made intermittent. We may, once again, compare the words with those used by Mr. Poulsen the year before last. He said, in his Queen's Hall lecture:

> I may point out, incidentally, that these continuous waves may be adapted to produce signals in the receivers now employed for spark telegraph (*e.g.*, the magnetic detector). All that is necessary is to insert the intermittent or "tikker" contact into the transmitting circuit instead of in the receiver.

This is precisely what Mr. Marconi has done, according to his own account of the matter. I mention his work in this connection, however, merely as a particular instance of what is being done by radio-telegraphists in general. It is the most recent and most readily accessible illustration of my argument. It tends to prove my contention that success in arc-telegraphy essentially depends upon the employment of methods already developed and patented in connection with the Poulsen system. The greater the extent to which those patented methods are employed the more efficient will the results become. If, for instance, instead of using the devices he describes, Mr. Marconi were to adopt the basic principles of the Poulsen system generally, his results would at once become ten times more satisfactory than they are at present. There is no more guesswork in this. What he is now doing others have done long ago. And, one may reasonably believe, all such methods have been thoroughly investigated, and those that are of real value have been protected by patent.—I am, &c.,

St. George's Hall, London, W., May 12. NEVIL MASKELYNE.

THE COMMUTATION PROBLEM AND THE COVERING OF ARMATURE SLOTS.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: In your issue May 1st, p. 101, Dr. Goldschmidt distorts the discussion. In his original Paper he stated clearly that there was *no difference* in the commutation, either with open armature slots or with slots covered by ¼ in. iron bridges. "The limit of commutation was 97 amperes in all cases." These results have been confirmed by "several thousands of machines," as he said in his original Paper in the *Elektrotechnische Zeitschrift*. My explanation referred to these well established facts.

Dr. Goldschmidt's newly introduced assertion, concerning a 20 per cent. difference in commutation limit "in a special case," is in obvious contradiction with his original Paper. That effect was certainly due to accidental circumstances which have nothing to do with the point under consideration. I, therefore, designedly excluded this "special case" from the discussion and from my explanation.

FIG. 1.

As by Dr. Goldschmidt's last letter the discussion diverges from the scientific standpoint, to a controversy about words and uncertain assertions, it is evident that his arguments are exhausted.

The actual result of the discussion is as follows: The fact that iron bridges did not affect the commutation, as was feared on account of the usual commutating field theory, leads to the *supposition* of the "saturation in the neutral zone," illustrated by Dr. Goldschmidt's Fig. 1. To this I opposed my Fig. 2. Dr. Goldschmidt accepted my figure in so far that he sees in the fringe lines the main cause of his supposed saturation. He thinks, however, that the displacement of the brushes brings the commutating bridge in the fringe lines; that is, he supposes that the fringe lines are stationary. My explanation is that the fringe lines are displaced by the armature current, and that the brushes must be shifted to follow the displacement of the neutral zone, as shown in my Fig. 2.

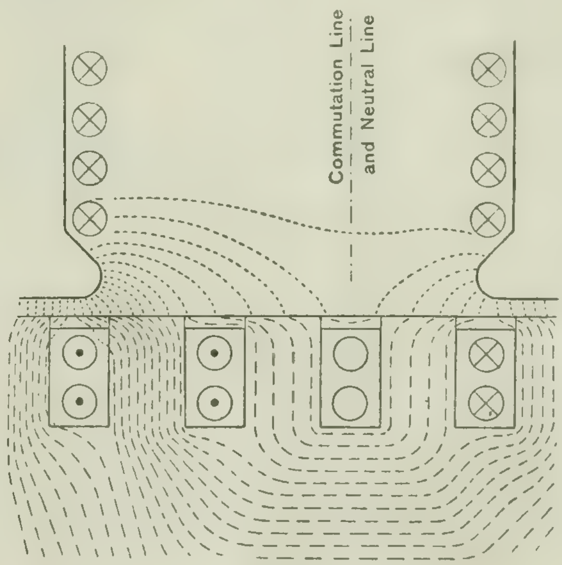


FIG. 2.

In my preceding letter (*see* p. 25) I challenged Dr. Goldschmidt to show by experiments that his opinion, about the fringe lines, is right. I wish now to extend this challenge, under the same conditions, to anyone willing to support Dr. Goldschmidt's views. I offer to pay all the costs of the experiments to the first person who proves that Dr. Goldschmidt's explanation is correct in contradistinction to mine.—I am, &c.,

C. L. R. E. MENGES.

Villa Mar, Scheveningen, Holland, May 6.

[This correspondence is now closed.—ED. *E.*]

[We regret that pressure on our space compels us to hold over some Correspondence.—ED. *E.*]

NATIONAL TELEPHONE STAFF DINNER.

The fourteenth annual dinner of the staff of the National Telephone Co. was held on Thursday evening last at the Trocadero Restaurant, Piccadilly-circus, London, the chair being taken by Mr. ALBERT ANNS, secretary of the company, who was supported by Mr. George Franklin, president of the company, Lord Harris, Sir Frank Crisp, Sir Albert K. Rollit, Sir John Gavey, Sir J. C. Lamb, Sir Robert Hunter, Major W. A. J. O'Meara, Mr. G. H. Robertson, Mr. C. S. Agnew, Mr. E. Forbes Lankester, K.C., Mr. W. M. Mordey, Mr. James Swinburne, Mr. G. F. Preston, Prof. R. Mullineux Walmsley, Mr. J. E. Kingsbury, Mr. D. Sinclair, Mr. T. A. Welton, Mr. H. Fedden, Mr. P. Hammarskjold, Mr. H. H. Gaine, Mr. A. N. Bromley, Mr. E. H. Lloyd, K.C., and of the chief officers of the company, including Mr. Frank Gill, Mr. S. J. Goddard, Mr. C. B. Clay, Mr. C. J. Phillips, Mr. T. Fletcher, Mr. R. A. Dalzell, Mr. J. C. Chambers, and many others, representing a staff of over 18,000 persons.

After the dinner, the CHAIRMAN proposed the loyal toasts, which were received with enthusiasm, after which

The CHAIRMAN said his presence there that evening in the chair would remind them all that since they last met two years ago a great calamity had overtaken them in the loss of their chief, the late Mr. W. E. L. Gaine. He had known Mr. Gaine longer and probably more intimately than any member of the staff, and he wished to take the opportunity of saying how much he admired Mr. Gaine for the qualities with which he was so richly endowed. It was one of Mr. Gaine's chief qualities that he never knew when he was beaten, and that when things looked black for the company he was able to turn apparent defeat into victory, or to so divert the weapons of their adversaries that they passed by harmlessly. Mr. Gaine's example permeated the whole of the National Telephone Co.'s staff. After lamenting the absence of several who were unable to accept their invitation to dinner, Mr. Anns said they had the good fortune to have with them that evening, several distinguished representatives of the Post Office, and he could assure them that the staff of the National Telephone Co. greatly appreciated their presence. 1907 had been a gloomy one for the company in many respects. Early in the year they lost Sir James Ferguson by the earthquake in Jamaica, later an honoured guest at their gatherings—Lord Kelvin—was taken from them. The company was the poorer and the world was the poorer for these losses. He proceeded to briefly review the rise and fall of municipal telephony, and commended the measured rate as a measure of simple justice to the company and to all users of the telephone as placing the charge for the telephone service on an equitable basis. As part of the National Co.'s accomplishments during the past year, Mr. Anns referred to the new exchange at Gerrard-street, which had cost the company £150,000 and was the most perfect telephone exchange in the world. He might say that the progress of the company for the past year was represented by the opening of 176 new exchanges, and this did not include places where the exchange had become obsolete and was abandoned, or a new and up-to-date exchange put in its place.

Regarding the outlook for the future of the staff of the National Co., he said there was anxiety and uneasiness as to what might happen to them in 1911. To those members of the staff who had approached him on the subject, he had pointed out that the directors had always been mindful of the interests of the staff, and were unlikely to permit anything unjust or unfair to happen in 1911. He would like to point out that the Government, in taking over the National Telephone Co., would have a wonderful bargain. Assuming the Government could raise any amount of money they required at 3 per cent., the published accounts of the company would show in what a short period they would reimburse themselves for the amount paid for the undertaking. The National Co. had, at the present time, an annual revenue of nearly £3,000,000, and this the Government would obtain practically for nothing. Therefore, he could not believe that, whatever Government was in power, they would deal other than generously with the men and women who had made the National Telephone Co.'s business such a remarkable success. There was also the question of the pension fund. It was felt by some that this fund would not be equal to its obligations in 1911. That feeling was entirely erroneous. The pension fund was absolutely sound, and although some of the smaller investments showed a depreciation, taken as a whole they would compare favourably with the investments of any bank, insurance or other company in the kingdom. He did believe that when the pension fund was wound up and the assets distributed there would be a handsome surplus, in which every member of the fund would participate. He concluded by proposing the toast of the "National Telephone Co.," coupled with the name of Mr. George Franklin.

Mr. GEORGE FRANKLIN said his first words should be those of warm congratulation to Mr. Anns for the excellent way in which he had discharged his duties in the chair that evening. No man of the staff of the company was more popular, or more deservedly popular, than Mr. Anns. Mr. Anns had struck a sombre note at the commencement of his remarks, and he, Mr. Franklin, felt that he must take up and re-echo this note, and give expression to the feeling of great loss the company and the staff had sustained by the death of Mr. Gaine and other valued members of the staff, such as Mr. Binley and Mr. [illegible], as well as their friends Sir James Ferguson and Lord Kelvin. But they felt that night that, after all, they were in spirit animated by those who had gone before and left them bright examples to follow. Turning to business topics, Mr. Franklin dealt briefly with the measured rate. He said it was perfectly proper for the company, if they found that for 27 years they had been supplying a service upon a wrong principle, not to continue a policy which they believed to be absolutely wrong. They had spent many millions of money in supplying a service on the flat-rate principle, or unlimited user, but for the remaining four years of their life they wished to secure a moderate and modest return upon the capital as yet to be expended. Regarding the future, he felt that it was perfectly clear, following upon the agreement of 1905, and the declaration of Lord Stanley in the House of Commons that the staff were entitled to obtain from the Government, who were to enter into the company's inheritance in 1912, something in the nature of an assurance as to what their position would be under the new arrangements that were to follow. He regarded this part of the property which the Government were then to acquire as the greatest of all the assets which the Postmaster-General was to take over in 1912—the energy and devotion of the staff of the National Telephone Co., and he felt no doubt that the Postmaster-General and the Government of the day would give to the staff of that company such assurance as would satisfy them that in the transfer they would not be either unfairly or unjustly treated. So far as the board of directors was concerned, without having had any conference with his colleagues, he wished to say at once that they would take every opportunity of doing what they could to see that no single member of the staff was placed at any disadvantage by reason of the transfer of that magnificent business to the State (cheers). As to the pension fund, he hoped the assurance given to them had been satisfactory. There were, of course, difficulties in the way to be adjusted, because there were differences between the conditions of service of the company and of the Post Office, but these were difficulties and differences to be got over and adjusted, and the Board would do their utmost to that end. He desired to say that the Board did not discourage any organisation among the staff themselves to that end.

As to the company itself, they were within a few years of the probable termination of their existence and the end of their licence. During the past year they had opened 36,085 stations, bringing the total to 457,564 stations, or 1 in 96 of the entire population, as compared with 1 in 114 when last they met. These figures did not include the stations of the Post Office. Their ratio of development had been greater than that of all the countries of Europe, except Sweden, Norway, Switzerland and Denmark. They had more telephones than any continental country except Germany, and, excluding Germany there were more telephones in the United Kingdom than in any five other European countries put together. Their total number of messages last year was 1,313,511,576, an increase of 136,204,744 over the previous year, and the cost of these messages was 0·45d. Whatever charge might be made against the directors as to their neglect of the shareholders' interest, no such charge could be made against them as regards the interests of the public. It was now 28 years since the Post Office first gave them their licence, and this licence was the only thing the Post Office had given (laughter), and during these 28 years the Post Office had taken £2,500,000 sterling as royalty paid in respect of the licence. It had been said that the shareholders in the National Telephone Co. had done extremely well, but it should be pointed out that the shareholders and debenture holders in the company had only received a return equalling 4⅞ per cent. per annum. Even if they included the reserve, which might or might not be required, the return to the shareholders and debenture holders had never equalled 6⅞ per cent. If he had indicated difficulties with which the company had had to contend it was only with a view of forcibly calling attention to the fact that it was to the staff of the company that the directors felt largely indebted for the great work that had been done. No company had ever had a more loyal or more devoted staff than the National Co., and this was the least that he could say as representing the board of directors, and he said it most emphatically. When the time of transfer came their friends of the Post Office would find that the acquisition of the staff was the greatest advantage they would receive. It had been a great pleasure to him to again partake of their hospitality, and he wished them to feel that at headquarters they had that sympathetic touch which represented one common object they had to serve—to satisfy the public and to satisfy their shareholders (cheers).

Mr. S. J. GODDARD proposed "The Visitors," and, before coming to the toast, thanked the chairman and the board, on behalf of the staff, for the assurances which had been given on their behalf. Amongst their visitors that evening they had several friends from the Post Office, including gentlemen representing the past staff—Sir John Lamb and Sir John Gavey. They had also the representatives of the Institution of Electrical Engineers in Mr. Mordey and Mr. Swinburne, and among their guests were several former important members of the staff of the National Co. These included Mr. Sinclair and Mr. Preston. He wished to couple with the toast the names of Sir Albert Rollit and Major W. A. J. O'Meara.

The toast was drunk with enthusiasm.

Sir A. K. ROLLIT, in a humorous speech, referred to his pleasant recollections of the staff of the National Co. over a long range of years. He was determined to be present that night notwithstanding a bad cold because of the pleasant recollections he had of former occasions. He took pleasure in thanking the staff for the cordial reception they had given to their guests.

Major W. A. J. O'MEARA said that while Sir Albert had replied to the toast as one who had been very long associated with the staff of the National Co., he would take upon himself the duty of responding for those who lived in the rival camp—the Post Office. They would excuse him for referring to the sad event which had deprived them of their chief last year. He knew how much Mr. Gaine was esteemed, and he could assure them that their friends at the Post Office felt the loss almost as keenly as they did. It had been his good fortune to be brought into contact with Mr. Gaine on more than one occasion, and

he was always struck by his ability, and with the great tenacity with which Mr. Gaine fought for the interests of the company. They felt at the Post Office that when they came in contact with the company's staff there is the ability and steadfastness of the men who served the company was immediately manifest. The Post Office representatives and those of the National Co. had met as opponents, but he hoped before long they would meet as colleagues.

Mr. W. A. Valentine proposed "The Chairman," and said Mr. Anns was an old officer of the National Telephone Co., having been connected with that undertaking since 1881. At that time the capital of the company was only £400,000; it was now £14,000,000, and their shareholders numbered between 14,000 and 15,000 persons. The officials, staff and operators now numbered over 18,000. Mr. Anns's courtesy and good feeling to all who came in association with him, and his elevating influence, had done much to make the staff of the National Telephone Co. what it had become. Of the staff pension fund, started by Mr Gaine, Mr. Anns had been secretary from its inception. It was most gratifying to the staff to learn of the support and sympathy they were receiving, and were to continue to receive, from the directors in connection with the transfer in 1912. The staff had undoubtedly felt some anxiety, and they would be greatly relieved by what had fallen from Mr. Anns, Mr. Franklin and others.

The toast was drunk with musical honours.

Mr. Anns having briefly replied, a very enjoyable function was concluded.

AUTO-TRANSFORMERS FOR METALLIC FILAMENT LAMPS.

Progress in the metallic filament lamp world seems to be advancing along two distinct paths. One leads to the high voltage lamp, and the other comprises the adoption of an auto-transformer with the employment of low-voltage lighting units. A few weeks ago we dealt with the success that had been attained in the first of these ways, and in what follows we propose to deal with three of the latest forms of auto-transformer.

The Edison & Swan United Electric Light Co. have lately placed on the market one of these instruments which we illustrate

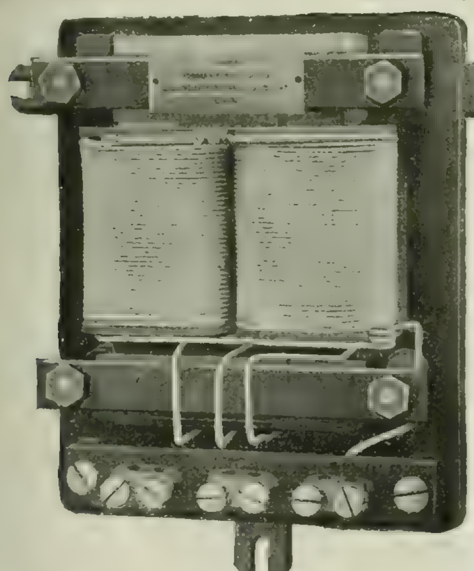


Fig. 1.—The "Ediswan" Auto-transformer.

(with the cover removed) in Fig. 1. As will be seen it is very compact, and is suitable for use as a main transformer in contradistinction to the "fitting" transformer. These transformers are thoroughly workmanlike in construction, and, it is claimed, their efficiency is very high. The cores are of specially selected iron of high resistance, thus reducing eddy-current losses to a minimum and leading to small no-load losses. The winding of high conductivity copper is carefully insulated and accurately calculated for the circuit. All holes are fitted with insulating bushes, and the whole is enclosed in a cast-iron cover, which is, however, easily removable for inspection purposes. The voltage regulation is said to be very close, while for this apparatus a 0·99 power factor at full load is claimed, dropping to 0·98 at half load. These transformers are tested at 1,500 volts before being sent out, thus insuring, it would seem, against all insulation breakdowns.

The Foster Arc Lamp & Engineering Co., of Wimbledon, are among the pioneers in this class of work. Their standard type of transformer, which even the most captious critic can scarcely call obtrusive, its actual size being 7 in. each way, is shown in Fig. 2. By its means the supply voltage can be reduced to what is almost becoming a secondary standard—namely, 25 volts. It is claimed that this transformer is silent and practically everlasting. The activities of this firm do not, however, end here, for they are also making a pendant transformer for use when it is desired to localise the 25 volt circuit. This takes the form of a hollow brass ball containing the necessary windings, and can be finished outside to harmonise with the other decorations. Cord grips are provided at both ends, which relieve the flex from strain, and the ball can be fitted with either four or six arms in accordance with individual requirements. In the case of such large fittings the ball can be made to form a part of the electrolier. The silence of the transformer is a special advantage in this case, as any hum would, of course, be noticeable, while as it is there is nothing to show that anything unusual is taking place.

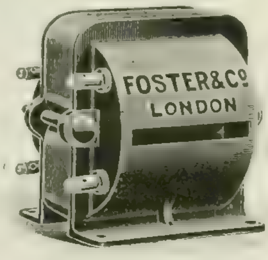


Fig. 2.—The "Foster" Auto transformer.

The London Electric Transformer Co. make three types of auto-transformer. These are the so-called "central" transformer suitable for stepping down the current necessary for a whole house, an adapter transformer for use on single lamps or fittings, and an "H" type transformer, which has been specially designed to obviate the variation in pressure at the lamp terminals when only a few lamps are in circuit. With this type of transformer, it is claimed, the voltage at the lamp terminal is independent of the total load on the transformer. The fittings transformer is exceedingly neat in appearance, as will be seen by reference to the illustration, Fig. 3.

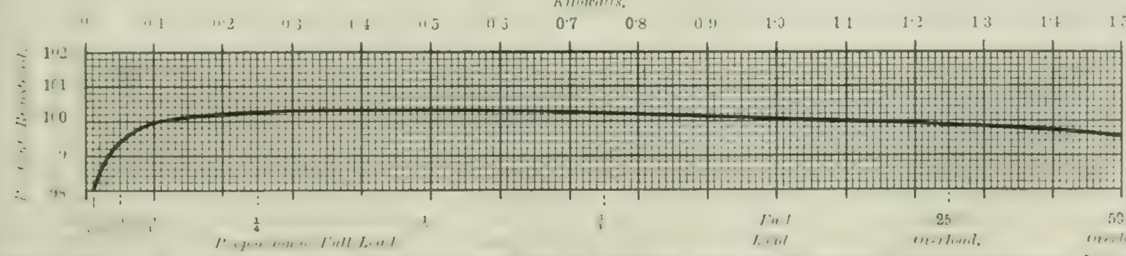
Fig. 3.—The London Electric Transformer Co.'s Lamp Transformer.

Any development along these lines will be watched with interest, for the problem is, whether this system will oust the high-voltage lamp, or the adoption of the auto-transformer make a return to low voltages the most economical proceeding.

ACCURACY OF ELECTRICITY METERS.

In a recent issue we called attention to the necessity for closer accuracy in electricity meters due to the rapidly increasing use of high-voltage metallic filament lamps. We understand that the importance of this point has been fully realised by the Westinghouse Company, and their new type "N" single-phase meter is the outcome.

The accompanying curve, which represents the results of a test of a 5-ampere meter by an independent authority after the meter had been sold, shows the very close registration which is obtained by this meter down to very small loads. The principal feature affecting this point is the extremely low weight of the moving element, which is only about 11½ grammes, in conjunction with the very high torque, amounting to 4 cm.-grammes.



Accuracy Curve or Load Curve of a Westinghouse Type "N" Single phase Watt-hour Meter (5 amps., 200 volts, 50 ~).

It is claimed that at full load this meter has a lighter weight of moving element, and that the ratio of torque to this weight is greater than that obtained in any other single-phase meter on the market. The friction loss being very small and the speed at full load low (only about 40 revs. per min.), the smallest possible amount of wear on the jewel is ensured, and, compensation being thereby reduced to a minimum, there is no tendency for the meter to creep on light loads. We are informed that the type "N" meter will not run on shunt, and a remarkable degree of accuracy has been obtained over the widest range of load. The general design of the meter is such that these important characteristics are likely to be retained throughout its life.

PARLIAMENTARY INTELLIGENCE.

(Continued from page 219.)

On Wednesday Sir HUGH BELL was examined by Mr. FitzGerald and said he was managing director of Bell Bros. (Ltd.) and a director of Dorman Long & Co. and of the North-Eastern Steel Co., and was one of the promoters of the Cleveland & Durham Electric Power Co. in 1901. The capital invested in Bell Bros. was 1½ millions. He had considered carefully the question of power production and had made himself acquainted with electrical matters as far as a non-expert could do so. Before the Cleveland & Durham Co. started Bell Bros. had laid down electrical plant at their works and some of their mines. They were now arranging to take some of their power from the Cleveland & Durham Co. and they were putting down what he believed to be the first electrically-driven rolling mill in England, power for which would be taken from the same company. That would take about 1,000 E.H.P. He desired to see London in the same position as some places in the North as to bulk supply, as it would induce manufacturers to take power on a large scale from a company instead of putting down their own installations. He was satisfied with the calculations made by the engineers. If every authorised distributor could refuse to allow them into their district they could not supply at all. With regard to the purchase clause, in an undertaking of so speculative a character as that of a bulk supply company it was essential that the undertakers should have somewhat extensive powers of recovering the capital. Anything that made the return of the capital less certain meant an increased capital necessary. The question was, What sort of clause was necessary to effect that object without putting the promoters in the position of monopolists? Where you had a fairly certain enterprise, fairly certain of giving a reasonable return for the money, it was not difficult to provide for purchase in certain ways, accompanied by a limitation of dividend; but, where you were doubtful about that, it was desirable to leave the power of paying dividends a much wider one, and to be careful as to the terms upon which purchase should be effected. To supply electric power on reasonably cheap terms they must raise their capital at reasonable rates, and they must have power to get back the money they would expend during the experimental period. What he meant by using the term monopoly was substantially that it was improbable Parliament would authorise another company to come in, and that hitherto two bulk companies had not been authorised for the same area. He believed they would be able to raise the money if the bill passed substantially as presented to their Lordships. He thought he could be responsible for finding as much as a quarter of a million. He also believed Lord Fitzwilliam would be prepared to take a substantial interest and be responsible for the raising of a very considerable sum. Mr. Owen H. Smith would be able to speak for some of the other promoters. They must have a reasonable period to raise the money. The fact that the raising of the capital would, as Mr. Hammond had said, be spread over a considerable period would make it easier to obtain the money. He agreed that the company's powers should cease unless a substantial sum were found within two years.

By Mr. COWARD: Unless they renewed their works at the end of 25 years there would be a considerable quantity of obsolete plant. If it were thought necessary to provide that they should renew it, he thought they would be ready to accept that condition. He thought their purchase clause more satisfactory and equitable than that in the Administrative Bill, which made the undertaking purchasable at the "then value" without addition for goodwill or profit.

By Mr. BALFOUR BROWNE (for the promoters of the London Electric Supply Bill): They took power to pay up to £100,000 in interest during construction. He would not be surprised if the various concerns in which he was interested used 100,000 H.P. Their electric power was, however, very small compared with steam. For their new rolling mill the power required would be a very varying quantity, and by taking current from the Cleveland & Durham Co. they could get any quantity they wanted at any moment and what he was doing on a whole scale in his own works ought to be beneficial under the much more varying conditions of London. If they did not get clause 65 there would be no assurance of getting the capital back, and the money would not be raised. He accepted Mr. Balfour Browne's statements that the present electricity supply companies in London had £13,000,000 already subscribed, that they paid an average return to the shareholders of £3. 18s. 2d. per cent., and he thought they could probably raise £1,000,000. If the present companies could supply electricity as cheaply as his company, there would be no raison d'être for their bill, but they believed they could supply more cheaply. London wanted cheaper electricity, and their scheme was for the companies to come to them for current, and to supply the consumer. If the companies would not do so, they must go to the consumers direct, but they had no wish to compete with the companies. Cheap electric power would produce more consumers. He admitted that the rates of London, as compared with other manufacturing towns, were forcing manufacturers out of London. None of the gentlemen he had consulted regarding the raising of the money would come before the Committee. The bill was a private promotion. As regarded the replacement of plant, this would be made out of revenue, not out of capital; therefore, the purchasing authority would not have to pay increased capital for these renewals of plant.

By Mr. SEYMOUR BUSHE: They looked to the present companies taking their supply, not to the consumers. If they did not succeed in converting the present companies to their scheme, they would only compete in the meantime in the terms of the bill.

By Mr. BLENNERHASSETT: Witness believed every undertaker or municipal body interested in electricity would be put in a better position under the bill.

Re-examined by Mr. CLODE, Sir Hugh said Table 7 showed the provisions for renewing plant out of the gross receipts of the business, and plant would obviously not be renewed out of capital. Therefore, no question would arise as to the purchasing authority having to pay twice for the plant. If necessary, he would be willing to agree to an obligation to form a sufficient depreciation fund or to put aside a certain amount for making renewals properly out of revenue. If they replaced plant in 5 years instead of 25 years, it would be for a good revenue reason, and not for the purpose of charging the purchasing authority 42 years hence with additional capital. For instance, if they had a machine costing £100,000 and giving certain results, and found that by putting in another machine they could get better results, the purchasing authority would have the advantage of the new machine. He considered the provision regarding small power users an important one in the bill. Assuming the authorised undertaker refused to take advantage of the bill, they should be allowed to come in. He considered that a fair provision. In regard to the suggestion that they would jeopardise about £13,000,000 of capital invested by the companies, more than half this was in distributing mains, which reduced any value there might be in that argument by half.

Mr. OWEN HUGH SMITH (one of the promoters of the bill), examined by Mr. F. G. Thomas, said he was one of the proprietors of Hay's Wharf, chairman of the Farringdon Works and H. Pontifex & Sons, and a director of the Provident Clerks Insurance Co. In 1904 he went over the installation at Chicago, and had since taken a keen interest in the problem of electric supply. His interest in the present scheme was the result of conversations he had had with Mr. Parshall. All the promoters of the bill were gentlemen largely interested in electrical matters, and with great financial interests. He had the authority of some of his co-promoters to say that they would be responsible for finding portions of the capital required for the scheme. He believed they would certainly be successful in raising the capital. In his view the provision in the bill by which they had to raise half a million of money before they could obtain the land was a thorough safeguard that the money necessary would be found. Witness hesitated to name a definite sum that he thought could be raised by the promoters, but felt justified in saying that he and his friends would go to a figure substantially equal to that named by the last witness, making £500,000 altogether.

Witness was then cross-examined by Sir Ralph Littler, Mr. Cripps and Mr. Freeman. He had nothing more definite than his confidence in regard to the raising of the capital. Supposing the purchase clause were altered in a perfectly just way, he should not think it would make any difference in the raising of the money.

Lord CROMER: I think it would save a good deal of trouble if the promoters would bring forward some other purchase clause to meet the objections that have been raised.

Mr. FREEMAN: Witnesses have suggested that various amendments might also be made in clauses 64 and 21, in addition to the purchase clause, No. 73.

Mr. OLIVER BURY (general manager of the Great Northern Railway Co.) gave evidence in support of the bill. He said his company had under serious consideration the advisability of electrifying their line for the carrying of their great suburban traffic. If the line were electrified they would be able to manipulate the traffic quicker; it was cleaner than steam, more trains could be run per hour, and they could split the trains more easily than with steam. The power required would be about 325,000 to 326,000 H.P. They must have cheap power, and he thought they would get it cheaper if supplied by the proposed company than if they had a power house exclusively to themselves. The bill would hasten the day when they could electrify their lines, as sooner or later they would probably have to do. He had obtained preliminary estimates, and in his opinion the scheme would relieve them of about 35 per cent. of the capital required for the electrification. He did not take the estimated prices in the bill as final, but they were cheaper than his company could produce the power themselves. In estimating they would save 35 per cent. he had reckoned they would have to pay the company a little less than ½d. per unit for the power they required. He wanted the scheme to come into existence, as he thought they would probably use it.

This concluded Wednesday's proceedings.

On the resumption of the inquiry yesterday (Thursday), Mr. J. F. S. GOODAY (general manager of the Great Eastern Railway Co.) said his company had considered the question of the electrification of their system. Assuming they adopted electric power, this would first be applied to their suburban traffic, which was very large. He estimated they would require about 40,000 H.P., and he knew of no existing power station able to give that supply. His directors were anxious to see whether they could obtain such a supply. One of the considerations would be the saving of capital expenditure. In addition to their large suburban traffic, they had large works at Stratford, employing about 7,000 men. Without pledging himself that they would take the supply offered by the company, he thought it very desirable that it should be available so that the various lines might consider the advisability of taking it. It was inconvenient for a railway to take a supply from a local undertaker, who could not go outside his own district. Along the line they might have to take from two or three different companies. They were seriously considering whether they should not electrify the East London line so as to carry on the interchange of traffic in the same manner as the steam traffic used to be interchanged on that line. They could not at present obtain the requisite power for the electrification of their lines without incurring the expense of erecting their own generating stations. There were a good many manufactories along their line, but there was a large quantity of unoccupied land, and he had no doubt that if cheap electricity were supplied they would find it to their great advantage, as the vacant land would become occupied by power users, who would be a source of revenue to his company. He would much like to see the bill passed. Under clause 68 of the bill it would be possible for the proposed company to supply railways for use outside their area. As regards the taking of power from Lots road and New Cross generating stations for the East London line, he thought these stations were too far away; also that now the Underground Railways were in full operation there was no over production of current.

Mr. V. L. RAVEN (chief assistant mechanical engineer of the North Eastern Raliway),said they were at present using continuously about 4,000 kw., and had 80 miles of single track electrified. They bought their electricity in order to save the capital expenditure involved in putting up a generating station of their own, and had been absolutely satisfied with the result. They had been using electric power since 1904, and had had no discontinuance of supply. They got the supply at a reasonably low price, and as a result of the substitution of electric for steam power the number of passengers carried had largely increased and they had reduced the ratio of working costs to earnings by about 25 per cent. Last year about 4,000,000 more passengers were carried than in 1903. They would probably not have electrified their lines if they had not been able to buy the power.

Mr. E. MACGREGOR DUNCAN, consulting engineer, said he was consulting engineer to Messrs. Maple & Co., who used a large quantity of electric energy. At Tottenham Court-road the annual output was approximately 1,000,000 units, and at their Highgate factory the annual output was 350,000 units. He had been into working costs, and assuming the bill passed it would, in his opinion, be to Messrs. Maple's advantage to take supply from the company, and to scrap their own plant. He estimated there would be a saving of over £400 per annum by their taking current from the company at the maximum price as compared with the amount they would have to pay if supplied by the St. Pancras Council. A reason for their not taking supply from St. Pancras was a proviso he had found in their application form to the effect that the Council were at liberty to discontinue the supply of current at any time upon giving notice to the consumer that the current was required for the Council's ordinary consumers for lighting purposes. He should be prepared to advise his clients to scrap their own plant and to take electricity from the company. He did not, of course, wish to suggest that St. Pancras was more liable to breakdown than any other supply undertaking. He accepted counsel's statement that never during the past 15 years had the clause been given effect to by St. Pancras, and also that in special cases like that of Messrs. Maple the Council would be prepared to waive the clause.

Mr. J. S. CONRADI, superintendent of the London factories of Messrs. Vickers, Sons & Maxim, said at Erith they had large works, covering about 20 acres and employing from 3,000 to 5,000 men. These comprised large machine shops, foundries, woodworking shops, &c. Electric driving was adopted throughout. They did not generate all their own power, but took some from the district council. The capacity of their own generating station at Erith was about 800 kw., and they were taking about 150 kw. from the council. They proposed to increase this to 1,160 kw. They generated about 1½ to 2 million units per annum, with a load factor between 30 to 70 per cent. He thought it would be a considerable saving to them to take their power from the company at the prices set out in the bill. He had invited a number of London manufacturers to discuss the matter, and at a meeting on April 10, after full discussion of the three bills before Parliament, resolutions were passed approving the London and District Bill under certain conditions. A list was put in by witness containing the names of fifty-seven firms who were either present at the meeting or had since expressed their conformity with the resolutions passed. He was definitely authorised by these firms to state that they generally supported the bill.

Other witnesses yesterday (Thursday) who gave general approval of the bill were: Mr. Gill (manager John Jenkins & Johnson & Son, Ltd.), A. L. Rider (chairman and managing director L.T. & S. Railway Co.), Mr. Green (chief goods manager L. & N W.R.), Mr. J. Macgregor (one of the managing directors of Messrs. Johnson & Phillips, Ltd.), Mr. C. M. Simpson (partner in the firm of Jas. Simpson & Co.), Mr. J. Lang (engineer London Central Markets Cold Storage Co.), Major Travers (director Spottiswoode & Co., Ltd.) and Mr. AJ.. Davis (engineer to Messrs. Eley Bros.). A digest of this evidence will be given in our next issue.

North-East London Railway Bill.—Last week the House of Commons Committee on Unopposed Bills considered the bill for extending the time limited by the company's act of 1905 within which a portion of the capital is to be subscribed. The Chairman (Mr. Caldwell) said the Committee would grant the extension, but the promoters must not expect a further renewal.

Sowerby Bridge Provisional Electric Lighting Order.—On Monday the House of Lords Examiner on Unopposed Bills found the Standing Orders complied with in regard to the bill to confirm this order. The bill amends the Order of 1900, and contains provisions as to supply in bulk, amendments as to compulsory works and power to transfer. At any time within one year after the commencement of the order the undertakers may, with the consent of the Board of Trade, transfer or lease any part of the undertaking to the Electrical Distribution of Yorkshire.

Notts & Derbyshire Tramway (No. 2) Bill.—The Standing Orders committee of the House of Commons has dispensed with the standing orders and the bill has been allowed to proceed.

London United Tramways Bill.—A Select Committee of the House of Commons found the preamble of this bill proved on Tuesday. The bill provides (inter alia) for the construction of tramways over Kew Bridge. The committee intimated that unless the company and the County Councils agreed as to the terms to be paid for running cars over the bridge, an arbitration clause would be inserted.

On Wednesday the Committee ordered a clause to be inserted providing for wayleaves of £500 each per year being paid to Surrey and Middlesex County Councils.

LEGAL INTELLIGENCE.

City of London Electric Lighting Co (Ltd.) v. Vanguard Motor 'Bus Co. (Ltd)

In *The Electrician* for March 27 was reported particulars of an action, tried before Mr. Justice Ridley and a special jury, in which plaintiff company claimed damages against the defendants for £75. 10s. 3d., the cost of repairing an electric light standard and lamp damaged through the skidding of one of defendant company's motor omnibuses. In the Court of Appeal on Friday last the plaintiff company applied for judgment or a new trial. In the case before Mr. Justice Ridley the jury found for plaintiffs on the ground of negligence on the part of defendants or their servants, but held that the motor vehicle was not itself a legal nuisance. Upon these findings judgment was entered for plaintiffs for £43. 3s. 4d., the amount of damage attributable to the first accident.

After hearing legal arguments, their Lordships in the Appeal Court directed that there should be a new trial of the whole action, on the grounds that it was not clear what the jury meant by their verdict, and that there had been an unsatisfactory trial. The costs of the appeal and of the first trial were directed to be left to the discretion of the judge at the re-trial.

Ernest Scott & Mountain (Ltd.) v. Kent Collieries (Ltd.).

The hearing of this case was continued before the Official Referee (Mr. Muir Mackenzie, K.C.) on Friday last week.

Mr. J. M. FELLS, a director of defendant company, was recalled and gave evidence as to the different items contained in the defendants' counter-claim for damages.

Mr. W. J. HORNER, another director, also gave evidence.

Evidence on the defendants' counter-claim having concluded on Monday, Mr. BOUSFIELD and Mr. C. A. RUSSELL, in lengthy speeches, summed up the case on behalf of their respective clients, and in the result the learned referee (Mr. MUIR MACKENZIE) reserved judgment.

MUNICIPAL, FOREIGN & GENERAL NOTES.

APPOINTMENTS VACANT AND FILLED.

Applications are invited for the position of head of the electrical engineering department of the Halifax Technical College. Salary £200 per annum. Applications to the secretary (Mr. W. H. Ostler), Education Offices, Halifax, by June 1. See an advertisement.

A professor of mechanical engineering is required for Poona College of Science, India. Salary R.500, rising to R.1,000 per month. Applications to the Secretary, Public Department, India Office, London, by June 15.

Ilford Council have appointed Mr. A. Glazier as third charge engineer.

Mr. S. A. Lovick, of the Stoke Newington electricity department, has been appointed canvasser at Fulham.

Aberdeen.—The Secretary for Scotland has sanctioned the borrowing by the Corporation of £80,000 further for electricity supply extensions, raising the total sum authorised to £330,000.

Antwerp.—By the end of 1908 there will be installed on the docks at Antwerp the large number of electric cranes shown below: One electric sheer of 120 tons at the Kattendyk dock, one electric crane of 50 tons, 80 electric cranes of from 1½ to 2 tons. The 80 electric cranes included in the list are not yet erected. They will be placed at equal distances along the quays of the new intercalary docks, the distance selected being about 50 yds.

Baltimore (U.S.A.).—The Consolidated Gas, Electric Lighting & Power Co., of Baltimore, which owns the monopoly for lighting in the city, has entered into an undertaking with the McCalls Ferry Power Co., who are constructing an immense dam on the Susquehanna River to supply all the required energy for lighting, power and other purposes which the Consolidated Co. may require, not only for Baltimore, but for a radius of 100 miles outside the city. The United Railways Co., which owns the street lines in Baltimore, all of which are worked electrically, has also entered into a contract with the McCalls Co. to supply all electric power required for railways purposes. The Cotton Duck Co., which operates 11 mills in Baltimore, are negotiating for similar contracts with the McCalls Co. The American financial position is, however, retarding progress with these big schemes.

Bath.—The Town Council discussed on Wednesday the amended proposals of Mr. E. Schenk (given in our last issue, p. 188) for the purchase of the Corporation electricity undertaking, but, after a three hours' debate, it was decided to adjourn the question until Monday next.

Bray (Ireland).—The Electric Light committee have approved a scheme of the electrical engineer (Mr. W. J. U. Sowter) for extensions of mains and for adding a 50 B.H.P. suction-gas plant and engine to the generating plant at an estimated cost of £4,792. 10s.

China and Earthenware Manufacture.—The Home Secretary has appointed a departmental committee to inquire into and report on the use of lead in the manufacture of earthenware and china:—

Messrs. E. F. G. Hatch (chairman), W. Burton (director and manager of Pilkington's Tile & Pottery Co.), Noel Buxton, Bernard Moore, Noah Parkes, Dr. George Reid, A. Vernon Harcourt, F.R.S., John Ward, M.P., and Miss Tuckwell.

The terms of the committee's reference are:—

To consider the dangers attendant on the use of lead in the various branches of the manufacture of china and earthenware, and in the processes incidental thereto, including the making of transfers, and to report how far these can be obviated or lessened, (1) by improved appliances and methods in the lead processes, (2) by conducting any of those processes in separate rooms, (3) by limitation of the use of lead, (4) by substitution of harmless lead compounds for raw lead, (5) by substitution of other materials for lead, (6) by controlling the employment of susceptible persons in lead processes, (7) by precautions for detection of lead poisoning in the earlier stages, or otherwise, and how far such precautionary measures are reasonably practicable generally and with regard to the several branches of the said manufacture.

To consider whether the danger or injury to health arising from dust or other causes in the said manufactures can be further obviated or lessened, and by what means, and how far such means are reasonably practicable generally and with regard to the several branches of the said manufacture.

To consider the existing special rules for the manufacture and decoration of earthenware and china, and the making of transfers, and to report what amendments, if any, are desirable for the better protection of the workers from lead poisoning and other diseases.

And to consider and report what modifications, if any, are desirable in the application of the said special rules, so amended, to particular branches of the manufactures named above, in the form of regulations under sec. 79 of the Factory and Workshop Act, 1901.

Correspondence to the secretary, Mr. E. A. R. Werner, Factory Department, Home Office.

Capri (Italy).—A British company, entitled the Society for Public and Private Enterprise in the Island of Capri, commenced their electricity supply service on Oct. 28 last. The service is proving a popular one.

City and Guilds of London Institute.—The chairman of the council (Lord Halsbury) presided at the annual meeting on Wednesday, and among those present were Sir Owen Roberts, Sir Walter Prideaux, Mr. S. S. Gladstone, Sir Edward Busk, Sir John Watney, Mr. Deputy Turner, &c.

The annual report stated that up to the close of the session in July last, the diploma of associate of the City and Guilds of London Institute was awarded by the Council to 87 matriculated third year students, an increase of 20 over the number for the previous year. 24 students of the college presented themselves at the B.Sc. (Eng.) examination of the University of London, of whom 23 obtained their degree, and during the session [illegible] students of the college presented themselves for the Int. Sc. examination, of whom [illegible] passed. The evening department of the college was attended by 302 students, and the institute's examinations were again held last session in India, Cape Colony, Natal, Malta, Australia and New Zealand, the total number of Indian and Colonial candidates examined being 399. The total income of the institute for the past year (including donations for special purposes) amounted to £46,035, and the expenditure to £47,376, including £3,679 extraordinary expenditure on the extension of the Technical College, Finsbury.

Lord HALSBURY, in moving the adoption of the report and accounts, referred to the severe loss the institute had sustained in the deaths of Lord Kelvin, Mr. T. F. Blackwell and Sir William Perkin. Great progress had been made in connection with the new institution at South Kensington. The object of that institution was to bring closer together the work of the science and technical schools already existing in the neighbourhood, and to provide others, so that ultimately they might have there a complete group of schools in science and technology providing advanced instruction and co-ordinated one with the other. That process of co-ordination and development was to be effected by the new institution named the Imperial College of Science and Technology, on the governing body of which was represented practically every interest concerned, scientific, professional and educational. The governing body was presided over by Lord Crewe, and Mr. Gerald Balfour was chairman of the organisation committee. There had been a continued increase in the number of students entering the Central Technical College, and more than half the number of students who had taken their degree in engineering in the University of London had come from the institute's college. The Department of Technology, through which the institute was in touch with technical classes throughout the country and in the Colonies, showed continued expansion. No less than 46,000 students were in attendance at registered classes under that department, an increase of over 1,500 on that of the previous year. The number of those students who came up for examination was nearly 24,000. The institute was in close co-operation with the Board of Education and its certificates were also recognised by the Postmaster-General as qualifying in the subject of telegraphy and telephony for promotion in the Post Office.

City of London Markets.—The annual report of the clerk and superintendent of the London City Central Markets (Mr. H. W. G. Millman) states that the illumination from the electric arc lamps around the market installed during the past year is giving general satisfaction.

Darlington.—The Electricity and Light Railways committee have reduced the charge for electric current for traction from 1¼d. to 1⅛d. per unit.

Dundee.—The Tramways committee has decided to send a deputation (Mr. Speed, the convener, Mr. Johnston, Mr. H. Richardson the electrical engineer, and Mr. P. Fisher, the manager) to Germany to collect information on the trackless trolley system.

Exhibition.—The programme of the International Exhibition to be held at the Hague during July, August and September next, and relating to commerce, industry, science and national and colonial products, may be seen at the Board of Trade, 73, Basinghall-street, London, E.C.

Franco-British Exhibition.—St. Pancras Electricity and Public Lighting committee recommend the Council to contribute a sum not exceeding £25 towards the expenses of providing a combined electrical exhibit at this Exhibition.

Glasgow.—The manager of the tramways (Mr. J. Dalrymple) has reported at some length on authorised and projected new tramways, over 35 miles in length and estimated to cost £557,225. A recommendation has been made by the Tramways committee to proceed with the construction of some of these lines.

Glass Telegraph Poles.—It is stated that a company has been formed at Cassel (Germany) to manufacture glass telegraph poles. The capital is £90,000. The patent rights cost £15,000, with a royalty of 2s. per post. The company state that poles 28 ft. in length can be manufactured at a cost of 15s. (including royalty). An experimental line with 11 wires, on a frequented public highway, has stood the test satisfactorily, and it is further stated that broken or damaged poles can be repaired satisfactorily.

Grimsby.—It was reported to the Electric Light committee on Monday that a profit of over £2,000 had been made on the year's working of the electricity department, and it was generally agreed that the report was very satisfactory.

The borough electrical engineer (Mr. W. A. Vignoles) reported that he had been in further communication with the Admiralty with regard to the wireless station to be established at Humberstone, and he expected to make an agreement between the department and the Admiralty for the supply of current.

Hanley.—The L.G. Board have sanctioned a loan of £20,643 for electricity supply extensions, viz., £8,105 excess expenditure for 28 years, £5,588 additional generating plant, &c., for 17 years, £4,000 mains for 25 years, and £3,000 transformers and sub stations for 15 years. The Board deducted £954, representing payments which would have been made to sinking fund had loans been raised at the time of expenditure, and £372 representing wages paid to workmen permanently employed by the Council.

Hornsey.—The L.G. Board has sanctioned a loan of £10,000 for extensions of the electricity undertaking.

Institute of Metals.—In our issue for March 20 (p. 890) we gave some particulars of the steps taken to form an institute of copper and brass manufactures, &c., similar to the Iron and Steel Institute. At a well attended meeting in Manchester on March 11 it was decided, after an interesting discussion, to hold a further meeting in

London on June 10, by which time it was thought a still larger gathering of the trades interested would assemble, that a general manifestation of interest in the formation of the proposed new "Institute of Metals" would be shown, and that marine engineers and shipbuilders would have an opportunity of supporting the formation of this society.

In a circular issued by Mr. W. H. Johnson, chairman of the meeting, it is stated that, by permission of the Institution of Mechanical Engineers, the proposed conference will be held at 2.30 p.m. on June 10, at Storey's-gate, Westminster. All interested in the manufacture or use of the non-ferrous metals and their alloys are requested to attend. The membership of the proposed society will be open to all practical and scientific men at home and abroad. Already letters have been received from many foreign manufacturers and metallurgists who are desirous of joining the proposed society, and English manufacturers are not behind their foreign rivals.

Japan.—The German Consul at Nagasaki states that the Kinshiu Electric Railway Joint Stock Co., with a capital of about £206,500, has been formed to construct an electric railway, about 16 miles in length, from Moji to Kurosaki, with a branch line 5½ miles in length.

Telegraph wire to the value of £5,348 was imported into Osaka in 1907, compared with £1,199 in 1906, and nil in 1905.

The "London and China Telegraph" says the Kanagawa Prefectural Government have been asked to grant a charter for the supply in Yokohama of electrical energy, which it is proposed to generate at works to be erected at Hakone.

Leather Belting made Moisture-Proof.—The British Consul-General at Chicago refers to an account of the production by a Cincinnati company of moisture-proof leather belting. The belting is said to have stood the most searching tests, and the discovery, according to the extract, is worth especial attention on the part of laundrymen and others who have found it necessary to exclude leather belting from their works by reason of the trouble with water, steam, &c.

Lewes.—The new system of electric fire alarms installed by the Postal Telegraph authorities was inaugurated on Tuesday.

Light Railways.—The Light Railway Commissioners held an inquiry on Friday into the application of the promoters of the Southend and Colchester Light Railway for an extension of time and other powers.

Mr. M. Ridley, engineer to the promoters, said his traffic estimate, based on the 1901 population of the district, showed an income of £84,000, and expenses would be 60 per cent. of that sum. The total sum required would be £536,000, and their powers allowed for £552,000. They estimated a dividend of 6½ per cent. on the share capital.

Southend Council opposed on the ground that they proposed to extend their light railway system to Rochford.

Application is being made for a light railway order authorising the construction and working of a 3 ft. 6 in. gauge light electric railway (single line with passing places) in Minster, Isle of Sheppey.

The Board of Trade have confirmed the Wolverhampton and Cannock Chase Railway (Light Railway) Amendment Order, 1908, and the Clacton and St. Osyth Light Railway (Extension of Time) Order, 1908.

London County Council.—On Tuesday it was agreed to loan £9,500 to Stepney for electric lighting.

Electric Cars.—The adjourned recommendation of the Highways committee to expend £178,450 on electric cars was agreed to. (*See* Tenders Accepted.

Loughborough Junction-Norwood Tramways.—Capital expenditure of £45,330 was authorised for the electrification of these tramways.

Anchoring of Track Rails.—For new work in connection with the anchoring of track rails expenditure of £7,000 was authorised.

Lea Bridge, Leyton and Walthamstow Tramways.—The Highways committee recommended the purchase of a portion of the above undertaking in Lea Bridge-road for £8,040, and electrifying it on the overhead system and lease it to Leyton Council till 1911.—Postponed.

Tramways in Forest Hill.—The Highways committee also recommended an expenditure of £32,630 for the construction of the Forest Hill tramways.—Postponed.

G.B. Surface-Contact System.—The chairman of the Highways committee (Mr. Whittaker Thompson) stated, in reply to questions, that he could not bring up a report until the system had received a trial, but at present they were unable to run a complete service owing to leakage from the gas mains. The gas escaped to such an extent in the Mile End-road that they would be unable to work the system fully until the gas companies had repaired their mains.

London Electricity Supply Scheme.—The London County Council has replied to representations from various borough councils asking them to convene a conference to consider the advisability of the L.C.C. promoting next session a bill for supply of electricity in bulk; but the L.C.C. expresses the opinion that no useful purpose will be served by convening such a conference at present.

Market Lighting.—Mexborough Market is now lighted electrically. The installation was carried out under the supervision of the borough electrical engineer, Mr. J. Senior.

The lighting arrangements are worked from one of the store rooms under the Market Hall, where the wires and fittings, lamps and switches, &c., necessary to the illumination of 80 stalls, are stored. On market day the fittings are brought out and fixed. These consist for the most part of long wooden bars, which are wired and fitted with holders, and are made to fix upon the tops of the stalls. These bars are connected to the lighting circuits by means of pieces of wire about 12 in. long. There are two lamps for each small stall, and four for a larger one. There are 80 stalls arranged in 20 rows, and there are about 170 lamps wired on two circuits.

Manchester.—The question of fixing the contributions to be made by the trading departments of the Corporation to relief of rates was discussed by the Council on Wednesday. The Tramways committee propose to contribute £65,000 and the Electricity committee £10,000. There is, however, a demand for increased contributions, but the chairman of the Electricity committee (Councillor G. Howarth) has submitted the following reasons why his department cannot make a further grant:—

1. The Electricity committee have recently made large reductions in lighting prices, and will feel the full effects of this in the next 12 months. The fall in income is estimated at £20,000, and although there will be a set-off in income from new consumers the set-off cannot, in the ordinary course, balance the loss under two or possibly three years.

2. The coal bill for the current year is likely to be heavier than it was last year, when there was an extra expenditure of £9,000. The bill for the current year may, in view of the larger consumption, be estimated at £14,000 over that for 1905-6.

3. The renewals fund, though greatly improved, is still lower than it ought to be from an ordinary prudent standpoint. This standpoint is that provision must be made for repayment of mortgage debt within the estimated life of the plant, and as the sinking fund term imposed by the L.G. Board does not always coincide with such life, being in some cases longer, it is necessary to supplement the sinking fund by the creation of a renewals fund.

The question of the contributions to be made by the trading departments was discussed by the City Council on Wednesday, when the Finance committee's report on the estimates for the current year was presented. Ultimately it was resolved to refer the report and estimates to the Finance committee, with instructions to revise same so as to bring the total amount required to such a sum as will not involve any increase of the city rates.

Marylebone (London).—The estimates of the Electric Supply committee for the year ending March 31, 1909, put expenditure at £166,652, of which £112,725 represent capital charges, while revenue is calculated at £159,685, leaving a deficit of £6,967 to be met out of a credit balance in hand of £26,325.

The consulting engineer (Mr Arthur Wright) has reported to the committee that "the whole question of electric lighting revenue is in a very critical state, owing to the rapid introduction of the metallic filament lamp. The only chance of obtaining a revenue sufficiently large to meet the charges against revenue account of the Marylebone undertaking is to encourage in every possible way the increase of the lighting business."

Norway.—A company has been formed at Bergen for establishing electricity supply. The works are expected to be completed by October next.

The new aluminium works erected at Bergen are about to commence operations, the output being estimated as from 350 to 500 tons per annum.

At Trondhjem the demand for electric power has necessitated the erection of a new power station, and the waters of the Nedre Lerfos are being utilised. It is calculated that 6,000 H.P. will be obtained from the waterfall. The works are to be completed during 1908.

Norwich.—On Tuesday the Council decided to apply for sanction to a loan of £1,450 to cover revised estimates for providing a water tube boiler, economiser, steam piping, ash elevator, &c.

Omnibuses and Road Maintenance.—The Metropolitan Association of Electric Tramway Managers are suggesting to the Metropolitan Borough Councils that representations be made to Parliament with a view to securing a provision that contribution be paid by motor omnibus proprietors towards road maintenance in each local area in which such conveyances run, and that the tramways undertakings, failing such contribution being made, should not be responsible for making good repairs necessitated by the running of such vehicles. The Association are of opinion that, under existing conditions, the greater part of the repairs necessitated by the running of motor omnibuses falls upon tramways undertakings under the provisions of the Tramways Act, 1870.

Patents and Designs Act; and its Effect on Factory Property in England.—Messrs. Leopold Farmer & Sons, of 46, Gresham-street, London, E.C., write under date May 13 on the subject of the effect of the new Patents and Designs Act on the letting of vacant factory buildings in this country, and especially in the London area. Messrs. Farmer point out the serious effect which the recent action of the London County Council has had upon the older buildings where compliance with the Council's behests in the matter of providing a means of escape in the event of fire has been impossible or difficult. As a means of overcoming the present slump in factory property Messrs. Farmer look to "the establishment of new industries and the re-opening of numbers of unlet works in the United Kingdom, on account of the important alteration in the Patents and Designs Act, 1907. A representative of ours recently toured the principal towns of Germany and interviewed firms who will be directly affected by this act. The result of our inquiries has been satisfactory, and assurances have been given us by some of the

largest firms of their intention to manufacture in this country on the Patent Act becoming law, as this, and the ever-looming possibility of a reform in our fiscal policy, has fixed itself in the mind of the foreigner that England 'means business,' and that he must look to the future and protect his manufacture."

Penarth Cardiff Tramways.—Penarth Council are about to take a poll of the ratepayers on the question of these tramways. Messrs. Herbert Lewis & Fletcher are consulting engineers for the promoters.

Presentation.—On leaving Swansea to become electrical engineer and manager of Neath electricity works, Mr. G. H. Thomson has been presented by the staff and employés of the Swansea electricity works with a fumed oak roll-top desk.

Provisional Orders Revocation.—The Board of Trade have revoked, as from May 12, the Boston electric lighting order, 1906, and the Hampton Wick and District Order, 1904, so far as it relates to Sunbury and Feltham and the parishes of Hanworth, Ashford and Shepperton.

Rome.—The local tramway company recently issued their annual report, and complaint was made that the company's efforts to extend the tramway service has not met with commensurate support from the municipal authorities who are tardy in granting concessions and facilities. The company's contribution to municipal funds under their agreement with the Corporation amounted in 1907 to £27,572, compared with £27,346 distributed amongst the shareholders of the company. The company's lines carried 43,849,583 passengers in 1907, an increase of 7,620,000 over 1906 and of 12,600,000 over 1904. Since the issue of the company's report a statement has been made by the Mayor of Rome, in which it is intimated that the municipality does not contemplate buying out the existing company's interest, but will construct municipal tramways.

Russia.—The electric tramway service in Warsaw was to have been in full operation by the end of 1907. Despite the fact that the track is completed, there has been much delay, and a great deal of work remains to be done before the service is complete. The number of electric tramcars to be brought into service is 200.

Many of the main thoroughfares of Warsaw are now lighted electrically, but there was much delay also in this work, and an extension of time to July next has been granted to the company for its completion. The electric lighting of Warsaw was effected by degrees, the first section comprehending the lighting of 40 streets where the electric tramways were laid.

St. Nazaire (France).—An electric crane with lifting power of 180 tons is to be installed at the Penhouet Dock.

Saltpetre Manufacture in Norway.—The British Consul for Norway (Mr. F. E. Drummond-Hay) reports that the factory at Notodden for the manufacture of calcium nitrate (saltpetre) from air and limestone by the aid of the electric furnace has lately expended 60,000,000 kr. on the works under construction, and will have an equipment of 32 large electric furnaces, each furnace requiring 1,000 H.P. The cellars below the furnace room contain the large air-conveying pipes and the eight electric fans which pass the air to the furnaces. There are nine granite-built absorption towers, each 75 ft. high. The output from these works is expected to reach 20,000 tons per year and the value something like 4,000,000 kr. The Svælgfos power station is the largest of its kind in Europe, being able to develop 40,000 H.P., and second only in size to the Ontario Power Co. at Niagara. The building has a length of 62 yds., breadth 12 yds. There are four turbines of 10,000 H.P., each 23 ft. by 13 ft. 3 in., and each driving its own generator. These generators weigh 110 tons each, and work at 250 revs. per min. The same company is now harnessing the Rjukan waterfall in Thelemarken, which is calculated to give about 220,000 H.P. The grand total of water horse-power that can be brought into use from the Thelemarken sources at reasonable cost is calculated at about 600,000 H.P., being larger than any other water district in Europe can give.

South Stoneham.—Southampton Corporation have been asked to give a supply of electricity in this district, and if the South Stoneham Council consent Southampton Corporation will apply for a provisional electric lighting order.

Southern Italy.—For some time past trains from Naples to Sicily have been carried across the Straits of Messina on a ferry. The acquisition of the railways by the Italian Government has led to certain improvements in working, and it has been decided to build a second dock, so that both up and down trains can be ferried over. A moving bridge is being constructed to convey the trains to the ferry, and this bridge will be operated electrically instead of as now by hand. It is expected that the new works will be completed by the coming autumn.

It is proposed to construct a mountain railway from Castellamare to Amalfi, across the spur of the Apennines. The line will be about 12 miles in length, and will go directly across the mountains to serve the villages of Agerola and San Lazzaro. The new line will connect up the two populous towns, which, although quite near to one another geographically, it now takes several hours by road and rail to connect. The railway route will have five tunnels, and there will be 10 bridges. The line will be operated electrically, electric power being generated by water. It is stated in a report by Mr. Consul Neville-Rolfe that the concessionaires are prepared to place detailed plans before persons prepared to join them in this enterprise.

Subways for Electric Cables and Wires.—The city of Baltimore (U.S.A.) has constructed 95 miles of subways, and into these all electric cables and wires must run, as it has been decided that overhead wires shall not be allowed. In some places the subways contain as many as 48 ducts. The total cost of the subways was £360,000. The rentals, after all expenses were provided for, showed a profit in 1907 of £2,966.

Telephone in Norway.—The increased demand for telephonic apparatus in Norway and for export, we learn, has necessitated the further enlargement of the works of the Elektrisk Bureau (Ltd.), of Christiania, which are to be increased in size by 50 per cent., and will then furnish employment for a further 50 men. The exports of this company's instruments to the United Kingdom, to the Netherlands and to South America have greatly expanded in recent years.

Telephone in Russia.—In reporting upon the trade of Poland and Lithuania, Mr. Consul St. Clair states that subscribers to the telephone in Warsaw are a rapidly increasing number. Within six years the increase has been 414 per cent., the number being now about 11,000. The existing principal exchange is constructed for 13,000 subscribers, and as this number is now nearly reached it is proposed to erect another exchange. The annual subscription for an unlimited service in Warsaw is £7 per annum, and an agitation is on foot to have this reduced to £3. The Warsaw-Lodz trunk line has, so far, not proved a great success, and is little used. It is considered that this lack of success is mainly due to the difficulty experienced in using the service owing to the antiquity of the instruments installed, and the authorities are considering the supply of a new outfit for this service.

Virginia (U.S.A.)—At the end of 1906 there were 427 miles of electric railways being worked in Virginia, the cost of construction being about £6,000,000. The year's earnings reached £619,144, against working expenses £427,445. The total number of employés of these electric lines was 2,791.

Walsall.—An unopposed inquiry was held on Friday into the application of the Council for sanction to borrow £1,000 for condensing plant, extensions of mains, &c.

Worksop.—The Council have decided to purchase an economiser for the electricity works at a cost of £325.

ELECTRICITY SUPPLY AND TRAMWAY ACCOUNTS.

Birmingham.—The gross profit on the past year's working of the tramways was £121,000.

Interest and sinking fund require £47,000, and the Tramways committee propose to write off the cost of the 1901 act (£2,000) leaving a disposable balance of £72,000. It is recommended that £37,000 be added to reserve, and the balance £35,000 be applied in reduction of rates.

Blackpool.—For the year ended March 31 the traffic revenue of the tramways was £52,438. 17s. 3d., and sundry revenue £1,301. 12s.

The traffic expenses were £12,717. 13s. 10d., general expenses £4,182. 14s. 3d., general repairs and maintenance £5,932. 11s. 7d., and power expenses £9,585. 18s., leaving a gross profit of £21,321. 11s. 7d. Interst absorbed £8,549. 18s. 1d. and sinking fund £6,335. 4s. 1d., leaving a net profit of £6,436. 9s. 5d., of which £4,000 has been transferred to the borough fund, £436. 9s. 5d. to reserve and £2,000 to permanent way renewal fund. The total capital expended is £232,631. 12s. 3d., an increase of £1,241. 15s. 11d., on the year. The average traffic revenue per car mile was 13·34d., the average working expenses excluding power 5·81d., and including power 8·25d. per car mile.

Bury (Lancs.).—The total traffic revenue of the tramways department for the year ended March 31 was £57,298. 16s. 5d., and parcels and miscellaneous receips made the total £57,410. 4s. 6d.

Traffic expenses were £13,941. 15s. 2d., general expenses £4,448. 11s. 4d., repairs and maintenance £5,217. 8s. 3d., total £23,607. 14s. 9d. or 3·923d. per car mile for working expenses. Power cost £10,256. 14s. 11d. (1·733d. per car mile). The gross profit was £23,545. 14s. 10d. Interest, sinking fund, &c., came to £11,841. 13s. 2d., leaving a net profit of £11,704. 1s. 8d. The total capital expended is £278,880. 9s. 6d., an increase of £36,414. 1s. 10d. on the year. The number of passengers carried was 11,181,120, and the car miles run 1,486,626, the percentage of working expenses to receipts being £53·98.

Leeds.—The accounts of the electricity department for the year ended March 31 were presented to the Electric Lighting committee on Monday.

The total income was £113,436. 8s. 1d. (against £108,259. 12s. 6d. last year). Working expenses were £35,276. 6s. (against £32,467. 15s. 10d.), and extraordinary renewals £13,372. 9s. 7d. (against £14,272. 2s.), leaving gross profit £64,787. 12s. 6d. (against £61,519. 14s. 7d.). Income tax, interest and redemption fund absorbed £57,855. 19s. 9d. (£58,109. 17s. 6d.), the net profit being £6,931. 13s. 9d. (£3,409. 17s. 1d.). 12,412,861 units were sold (11,368,956), the average price per unit was

2·19d. 2·28d.), the expenses per unit (including extraordinary renewals, interest and redemption fund) were 2·06d. (2·21d.) and the surplus 0·13d. per unit (0·07d.). Capital expended during year was £35,424 11s. 2d. (£15,467. 19s. 3d.), making total expenditure £878,747. 13s. 6d. (£843,323. 2s. 4d.). The number of 35 watt lamps installed was 317,890 (295,933). 5,771,597 units were sold for private lighting (5,627,098), 895,009 for street lighting (870,925) and 5,746,255 for power and heating (4,870,912). The aggregate horse-power of motors installed is 8,379 (6,880), and the revenue per horse-power installed was £3. 13s. 2d. (£4).

The revenue from sales of current for lighting has been severely affected in the final quarter of the year by the rapidly increasing use of metallic filament lamps. The use of electricity for power shows satisfactory increase, and the recent reduction in the charges for power and heating are estimated to affect the current year's income to the extent of £5,000. A 3,000 kw. steam turbo-alternator was installed during the year, bringing the capacity of the plant to 12,740 kw., and another 3,000 kw. turbine set is on order. The maximum load was 8,300 kw. (against 7,470 kw.) and the load factor 17 per cent. (against 18 per cent.).

Nelson.—On the past year's working of the electricity undertaking there was a profit of £590. 0s. 8½d., and, of this, £250 is to be applied in aid of district rate and £341. 0s. 8½d. in reduction of capital expenditure.

Rotherham.—The net revenue from sale of electric current for the year ended March 31 was £13,108. 13s. 9d., meter rental, &c., bringing the total to £13,446. 12s.

Generating expenses were £3,750.18s. and gross profit £7,214.19s.10d. After paying interest, sinking fund, &c., and transferring £725 to tramways department for contribution on loan account and £423. 8s.8d. for renewals and depreciation of machinery, the net profit was £3,301. 15s. 6d., of which £1,959. 17s. 10d. has been allocated to depreciation and renewals fund. Capital expenditure is £50,328. 7s. 4d., an increase of £903. 14s. 10d. during the year.

The traffic receipts of the tramways for the past year were £31,653. 12s. 10d. Power expenses were £7,898. 8s. 11d. (1,263,752 units at 1½d.), traffic expenses £8,124. 9s. 3d., general expenses £2,095. 9s. 5d., repairs, &c., £3,721. 18s. 1d., leaving a gross profit of £10,330. 4s. 10d. to meet interest (£3,818. 15s. 6d.) and sinking fund (£2,364. 13s. 3d.). The net profit was, therefore, £5,618. 11s. 9d. Total capital expended to date £123,518. 7s. 9d., an increase of £4,603.17s.11d. on the year.

Shrewsbury.—The gross receipts of the electricity department for the year ended March 31 were £10,458, and after paying working expenses, interest, sinking fund, &c., there was a profit of £345. 0s. 7d.

Stepney (London).—The capital outlay on electricity supply at March 31 was £287,960 10s. 1d., an increase of £22,888. 4s. during the past year.

The total income was £41,449. 5s. and after paying expenses the balance was £17,102. 8s. 3d. The net profit was £1,927. 18s. 11d. after meeting interest, sinking fund and other charges. £1,000 has been placed to reserve, £200 has been set aside for bad and doubtful debts, and £180. 18s. 11d. has been carried forward. The units sold amounted to 5,712,681, against 4,751,182.

Application is to be made for sanction to a loan of £15,375 for extensions of mains, &c.

Sutton Coldfield.—For the year ended March 25 the total income of the electricity department was £4,951. 19s. 2d., including £4,132. 5s. 4d. from the sale of electric current and £561. 15s. 2d. from public lighting.

Generation expenses were £1,434. 18s. 7d., and the total expenses £2,186. 4s. 1d. After paying interest (£1,207. 6s. 4d.), sinking fund (£1,294. 17s. 10d.), &c., the net profit was £100. 10s. 406,420 units were generated, 243,298 supplied to private consumers and 104,522 to public lamps. The total maximum supply demanded was 241 kw. Capital expended is £41,308. 14s. 8d., an increase of £1,204. 8s. 1d. on the year.

In his sixth annual report the borough electrical engineer (Mr. Trevor Duesbury) states that there are 484 consumers, with the equivalent of 25,116 8 c.p. lamps connected, an increase of 26 consumers and 3,773 8 c.p. lamps. The units sold for power and heating show a greater percentage increase than the units for lighting, and there has been a reduction of 5,342 units for public lighting owing to the installation of osram lamps. Working costs show a small increase to 1·51d. per unit owing to dearer coal.

TRADE NOTES AND NOTICES.

TENDERS INVITED.

Ilford Urban District Council invite tenders for supply and erection of the following plant: Surface-condensing plant and cooling tower, steam and feed pumps, boiler feed pump, &c., extensions and alterations to main switchboard. Copies of specifications, &c. (after the 25th inst.) from the clerk to the Council, Mr. John W. Benton. Further information may be obtained at the offices of the electrical engineer, Mr. Arthur H. Shaw, M.I.E.E., A.M.I.Mech.E., Electricity Works, Ley-street, Ilford. Tenders addressed to Chairman of Council, Town Hall, Ilford, by noon Wednesday, June 10. See also an advertisement.

London County Council invite tenders for the manufacture and supply of two electrically-driven centrifugal pumps, &c., to be erected at the East Greenwich electricity generating station. Tenders, on official forms, to be obtained from the clerk of the Council (Mr. G. L. Gomme), County Hall, Spring Gardens, S.W., by 11 a.m. Tuesday, May 26.

The Electricity committee of *Salford* Corporation invite tenders for supply, delivery and erection at the electricity station, Frederick-road, Pendleton, of cooling towers, tanks, pumps and pipework. Tenders, addressed Chairman of the Electricity committee, to the office of the borough electrical engineer before noon May 25.

The Penrikyber Navigation Colliery Co., *Penhiwceiber*, Glam., want tenders by June 4 for 12 months' supply of stores, including electric lamps and fittings, castings, ironmongery, oils, &c. Forms of tender from the Secretary.

Walsall Electric Lighting committee invite tenders for supply and erection of condensing plant, including surface condenser, air pumps, cooling tower and water purifier. Tenders to town clerk (Mr. John R. Cooper), Council Office, Walsall, by noon 29th inst.

Rawtenstall Corporation invite tenders for supply and erection at the electricity works of two track boosters and l.t. d.c. and h.t. a.c. switchboards. Tenders to the town clerk, Mr. James Whalley, by May 29.

Clyde Navigation Trustees, *Glasgow*, want tenders for 12 months' supply of stores, including electrical stores, indiarubber, castings, ironmongery, tubing, oils, &c. Specifications from the Stores Superintendent.

Worthing Corporation invite tenders for supply and erection of elevated barometric counter-current jet condensing plant, air and circulating pumps and piping. Tenders by noon May 26.

Handsworth Council want tenders by noon May 25 for supply of l.t. distributor cables. Specification, &c., from the generating station.

Dartford Council want tenders for 12 months' supply of lubricating oils, electric meters, house service cable, jointing material and accessories. Tenders by 4 p.m June 9.

St. Pancras (London) Council want tenders by noon June 1 for 12 months' supply of steam coal for their electricity works. Specification from the electricity department offices.

Southend Corporation want tenders by noon May 28 for laying about 1,500 yds. of single tramway track, with loops. Specification, &c., from the Borough Engineer.

The directors of Kingsbury Collieries (Ltd.) *Tamworth*, require an electric haulage plant. Specification from the Secretary.

TENDERS RECEIVED AND ACCEPTED.

For the supply of 175 tramcar bodies the London County Counci received the following tenders:—

Hurst, Nelson & Co. (*accepted*	£72.450
United Electric Car Co.	79,275
Metropolitan Amal. R C. & Wagon Co.	80.500
Cravens Limited	82.687
Gloucester R.C. & Wagon Co.	83,825
Brush Co.	84,525
G. C. Milnes, Voss & Co.	96,250

Hurst, Nelson & Co. are allowed to sublet the following portions of the work: To J. Crowley & Co., Wm. Towler & Co., and Leys Malleable Castings Co., the malleable iron castings; to Hoskins & Sewell, and Player & Mitchell the brass furniture, ratchet brake handles, head lights, window operating gear and lighting fittings.

For the electrical equipment for and assembly of the 175 cars the following tenders were received: —

British Westinghouse Co. (*accepted*)	£55,387	10
Ditto (Alternative tender)	54.950	0
Dick, Kerr & Co.	59,062	10
Siemens Bros. Dynamo Works	63.000	0
British Thomson-Houston Co.	64,750	0

The British Westinghouse Co. are allowed to sub-let to Watlington & Co. or Brecknell, Munro & Rogers (or to such other persons or firms as may be approved by the chief officer under the contract) the supply of the trolleys.

Poplar (London) Council have received the following tenders for a 1,000 kw. turbine generating set to replace a 200 kw. set at the electricity works:

C. A. Parsons & Co., (*a*) alternator by General Electric Co. £6,283, (*b*) alternator by Bruce Peebles & Co. (*accepted* at **£5.907. 10s**. without rotor) £6,365, (*c*) alternator by Siemens Bros. Dynamo Works £6,420, (*d*) alternator by Electric Construction Co. £6,593, (*e*) alternator by Dick, Kerr & Co. £6,648, (*f*) alternator by C. A. Parsons & Co. £6,901.

Willans & Robinson, (*a*) £6,443. 15s., (*b*) £6,498, (*c*) £6,525. 10s., (*d*) £6,731, (*e*) £6,785.

Richardsons, Westgarth & Co., (*a*) £6,390, (*b*) £6,475, (*c*) £6,500, (*d*) £6,725, (*e*) £6,805.

The Electricity committee reported that Messrs. Parsons & Co., whose tender was the lowest, guaranteed the most economical plant, and they would make the spindle, bearings and couplings of the new turbine interchangeable with existing plant, and bring the governor gear of the existing turbines up to the standard of their latest practice without extra charge. The electrical engineer (Mr. J. H. Bowden) advised that the order for the turbine be placed with Messrs. Parsons & Co, having regard to saving in revenue, lower capital cost and the engine being practically a duplicate of existing plant.

Ten firms tendered for the supply of switchgear at the Poplar generating station and two sub-stations. The tender of the British Westinghouse Co. was accepted for the switchgear for the generating station (at £124. 10s.) and the south sub-station (at £213), and that of Johnson & Phillips was accepted for the switchgear for the new sub-station at £593. 15s.

Some time ago Poplar Council agreed with the Western Electric Co. for the supply of cables required for two years at schedule prices, and, in accordance with this agreement, orders have been placed with the company for cable for High-street (Wade's-place) feeder, and cable for e.h.t. feeder at £1,059 and £847. 4s. respectively.

Southwark Electric Light committee has received quotations from the following firms for the supply of cable: —

Western Electric Co. (*provisionally accepted*) (*a*, 1 mile 0·05. £240. (*b*) 1 mile 0 1. £360; British Insulated & Helsby Cables, (*a*) £250; (*b*) £404; Callender's Co (*a*) £365, (*b*) £450; W. T. Glover & Co. (*a*) £245. 10s., (*b*) £358. 10s.; W. T. Henley's Co. (*a*) £253. 10s., (*b*) £381; Johnson & Phillips (*a*) £242, (*b*) £365. 10s; Siemens Bros & Co. (*a*) £248 10s., (*b*) £359. 15s.

Bermondsey (London) Council have accepted the following tenders for annual supplies of coal: —

G. J. Cockerell & Co (Bwllta), 23s. per ton; Myers, Rose & Co. (Exhall, Ansley Hall, Griff, Ibstock, and or Bugsworth and or Kingsbury and Baddeley Beans), 14s., subject to coal being found on testing to be equal to Kingsbury Ryder Beans.

We reported last week that the tender of Switchgears Limited had been provisionally accepted by Hammersmith Electricity committee at £2,014. 10s. for main switchgear. On the matter being further considered by the Council, it was, we learn, decided to accept the tender of Spagnoletti Limited for the switchboard, &c., at £1,500, and the tender of Cowans Limited at £316 for 20 feeder panels.

Hornsey Council received 13 tenders for supplying and laying feeder cable to Muswell Hill, the lowest being £5,651. 9s. 2d., but it has been decided to accept the tender of the Western Electric Co. at £3,322. 18s. 4d. for supply only, and the borough electrical engineer (Mr. N. Staniland) is to carry out the work of laying the cable. Mr. Staniland's estimate for the whole work was £4,986. 10s.

Woolwich Council have accepted the tender of the Western Electric Co. for 750 yds. three-core cable and 170 yds. four-core cable, at £285. There were seven tenders, the amount of the highest being £305.

At the last meeting of Windsor Council tenders for public lighting were considered, and it was decided to renew the present contract with the Windsor Electrical Installation Co. for lighting the main thoroughfares by flame arc lamps at £558 per annum.

Rawtenstall Corporation have placed an order (through Messrs. Yates & Thom) with Ed. Bennis & Co. (Ltd.), of Little Hulton, Bolton, for six stokers and self-cleaning compressed air furnaces for Lancashire boilers.

Aberdeen Electricity committee have accepted the tender of the Brush Co. for additional plant for the Dee Village and Cults electricity stations at £2,485. 15s.

Croydon Corporation have placed an order with British Insulated & Helsby Cables for strengthening and extending the Quin cut-out system on the tramways at £483.

Kingston-on-Thames Council have accepted the tender of Drake & Gorham for a milking booster (£41. 10s.) and a battery booster (£12).

Ipswich Guardians have accepted the tender of the Electrical Power Storage Co. for the maintenance of the batteries at the workhouse at £25 per annum.

Dundee Corporation have accepted the tender of Aiton & Co. for steam and feed pipes and valves at £1,855, and that of W. H. Allen, Son & Co. for circulating pumping machinery, at £1,670.

Hitchin Council have accepted the tender of Christy Bros. for wiring the stage at the new Town Hall and ante-room at £54. 3s.

Portsmouth Guardians have accepted the tender of Ashton & Holt for wiring the infirmary extension blocks at £145.

Bexhill Council have accepted the tender of Mr. F. A. Greene for a new switchboard panel at £71.

Appleby's Limited have received an order for a fixed electric cantilever crane for Sydney (N.S.W.).

Weymouth Council have accepted the tender of the Brush Co. for a turbo-generator, condensing plant, &c.

BUSINESS NOTICES.

S. P. W. D'Alte Sellon and E. M. Sellon, practising as consulting engineers as Stephen Sellon & Partners, Victoria street, Wesminster, S.W., have dissolved partnership. Debts by Mr. S. P. W. D'Alte Sellon, who continues under the present style.

B. G. Jones and G. H. Ingham (trading as Bernard G. Jones & Co.), electrical engineers, Newport, have dissolved partnership.

Mr. M. Mansell, of Elliott & Mansell, electrical engineers and contractors, 12, Soho-street, W., notifies us that he has purchased the interest of his late partner, Mr. J. Elliott, and will be responsible for the debts of the firm.

The title of the London Electrical Fittings Co. (Ltd.) has (we are informed) been changed to Galsworthy Limited so as to avoid confusion with companies bearing a somewhat similar title. The address of the company's showrooms will still be 15 and 16, Newman-street, Oxford-street, W, and there will be no change in the management of the business.

Sale by Tender.—Tenders are invited for the purchase of heating and generating plant at the Nottingham Post Office. Forms of tender from the Controller of Stores, Stores Department, G.P.O., 17-19, Bedford-street, London, W.C. Tenders by 10 a.m. May 25. See also an advertisement.

Plant for Sale.—A modern steam plant, including two 350 H.P. Willans vertical compound engines with air pump and three high-class Lancashire boilers, are advertised for sale.

Premises to Let.—Messrs. Rolleston, Greyfriars, Leicester, and 5, Waterloo-place, London, S.W., advertise to be let two-storey water mill buildings and premises at Lower Mitcham, on the river Wandle, with water wheel, driving tackle and accessories, two cottages, &c

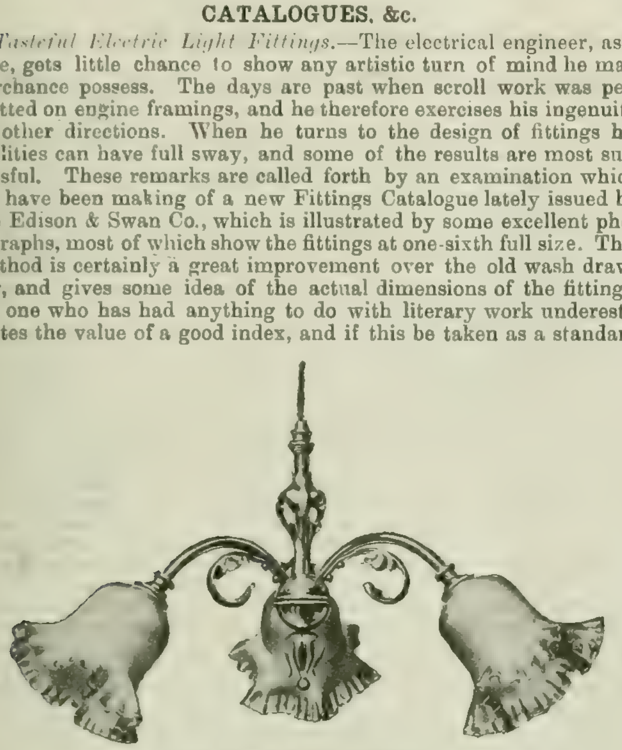
Agency.—A Norwegian firm, about to place electrical patent fire alarm on the English market, would be glad to hear of firms willing to undertake the agency. See an advertisement.

Oil Filters. As evidence of the continuous demand for a good article, we would call attention to a notice given in the advertisement on another page of Messrs. A. C. Wells & Co., Midland road, St. Pancras, London, that up to date over 14,000 of their oil filters have been sold. The number sold at this time last year was 12,000.

"City of London Directory."—We have received a copy of the 1908 edition of this useful directory, which has now been published regularly for 38 years and has become the recognised book of reference on all matters relating to the civic, commercial and social life of the City of London. In the alphabetical street and trade sections is given a complete list of the firms carrying on business in the City, with the names of individual partners in many cases. The section dealing with the local life of London contains a full list of members of the City Corporation, a list of the committees, and a list of the members of London County Council and of its committees. The City Companies' section summarises the history of each Guild, gives a list of the 9,000 liverymen, &c. There is also a carefully-corrected map in colours of the City area. The book is published at the offices of the "City Press," 148 9, Aldersgate street, E.C., price 12s. 6d.

CATALOGUES, &c.

Tasteful Electric Light Fittings.—The electrical engineer, as a rule, gets little chance to show any artistic turn of mind he may perchance possess. The days are past when scroll work was permitted on engine framings, and he therefore exercises his ingenuity in other directions. When he turns to the design of fittings his abilities can have full sway, and some of the results are most successful. These remarks are called forth by an examination which we have been making of a new Fittings Catalogue lately issued by the Edison & Swan Co., which is illustrated by some excellent photographs, most of which show the fittings at one-sixth full size. This method is certainly a great improvement over the old wash drawing, and gives some idea of the actual dimensions of the fittings. No one who has had anything to do with literary work underestimates the value of a good index, and if this be taken as a standard



An Ediswan Art Fitting.

of excellence this catalogue certainly reaches it. There is a comprehensive general and numerical index, by means of which any fitting can be turned up either under its catalogue number or under its description. For the latter purposes all fitting are classed under special sub-headings, which incidentally also make for ease in reference.

We illustrate a fitting which is a good example of the general style of work turned out by the company. The catalogue is not, of course, exhaustive; new designs are constantly being brought out, and a client can, if he pleases, exercise his individual taste in the matter.

Excello Lamps.—The Union Electric Co. is to be congratulated upon the extremely attractive cover in which it has bound up the illustrations showing numerous installations of Excello flame arc lamps. The cover is one of the most effective we have recently seen, and it is both artistic and impressive. The pictures in the booklet illustrate almost every conceivable purpose to which arc lamps can be put. Probably the most striking feature of the series of illustrations is that they show, with few exceptions, British installations. Surrounding each half-tone is a tint block, in which the company's other manufactures, in the shape of motors, switchgear and instruments, are gently impressed upon the reader.

The Choice of a Lift.—The brochure just issued by the Electric Construction Co. with the above title is a most attractive publication, and one upon which the company is to be complimented. It deals mainly with the E.C.C. special lift gear, which has been designed for continuous and alternating-current service. Particular interest attaches to the controlling gear, which is of the solenoid pattern and entirely self-contained. A copy of this publication will, we understand, be forwarded on application to interested inquirers.

Electrical Co.'s Lists.—A budget of leaflets reaches us from the Electrical Co., Charing Cross-road, W.C. One of these deals with continuous-current dynamos and motors, a complete specification for these machines being set out in the list with illustrations. Another leaflet briefly touches upon an automatic self-focussing projector lamp for searchlights, cinematographs, magic lanterns, &c., and a further leaflet deals with the A.E.G. Economica arc lamp. This lamp is suitable for continuous and alternating currents up to 220 volts.

Meters.—Section L, describing the continuous-current meters of Chamberlain & Hookham, is just to hand. It forms part of the company's regular catalogue and is punched for filing. The list deals with house service, switchboard, watt-hour and battery meters. The illustrations are very clearly reproduced, and show in great detail the main features of the construction of the instruments illustrated. Not the least interesting of the types described are the large capacity ampere-hour meters, suitable for current measurements from 150 to 3,000 amperes. We need hardly remind our readers that the selling agents in Great Britain and Ireland are Messrs. Venner & Co., Old Queen-street, Westminster, S.W.

Electric Cranes.—The manufactures of the Maschinenfabrik Oerlikon are multitudinous and various. One of the branches of electrical engineering in which, to judge by a leaflet just received, the company is specially successful is crane work. This leaflet contains several photographs of different types of cranes manufactured and a list of the principal machinery of this kind supplied since 1904. For driving, continuous current is to the fore, though three-phase makes a very good second.

Starting Switches.—Messrs. Donovan & Co., 12, Barwick-street Birmingham, send us their latest circular, No. 41, which describes the Barwick motor starters and regulators. These are made up in various sizes for open, semi-enclosed or totally-enclosed working. They can also be arranged to form iron-clad panels for the complete control of motors.

Electric Railway Working.—The Maschinenfabrik Oerlikon have sent us a list giving details of electric tramways and railways equipped by the company since 1904. These number 37 in all, a considerable percentage being "repeat" orders. The list is well illustrated, two reproductions of mountain scenery being especially good. Continuous-current traction still predominates, single-phase alternating current being next, while three-phase alternating current has only one representative, and that a fresh equipment for an existing line.

Ignition Accumulators.—The motorist who relies upon ignition coil and accumulator ignition has always felt uncertain as to the state of his accumulator owing to the difficulty of judging whether it is fully charged or not. Accumulator Industries (Ltd.), 4, White-street, Moorfields, E.C., and Woking, send us their latest pamphlet, which deals mainly with a special discharge indicator, which can be fitted to all their patterns of cells. The indicator consists of a tube, which can be seen from the front of the cell, and which contains four coloured glass beads, to which the acid has free access. These beads are calibrated to float only at a specific gravity of acid corresponding approximately to the condition of the cell. The makers state in the list that when three beads are up the cell is charged, when only two are up it is about a quarter discharged and with one bead up about a third of the charge remains. Of course, when all the beads are at the bottom of the tube it is essential that the cell should be charged at once. The device is extremely neat, and the various boxes in which the company's cells are carried are slotted, so that the indicator can be seen without removing the cell from its case.

Evaporative Condensers.—Central station engineers and all those in charge of steam plant will be interested in the latest booklet of Messrs. Edward Deane & Beal, which describes in detail their patent evaporative condenser for steam engines. The publication itself has been tastefully got up, and the line drawings illustrating the application of the condenser in practice are particularly distinct. The condenser is constructed on the contra-flow principle, and the makers state that a high vacuum can be produced with a minimum water consumption and a minimum expenditure of power for the circulation of the cooling water.

Water Turbines.—At stand No. 258, machinery hall, Scottish National Exhibition, Edinburgh, Messrs. Carrick & Ritchie, water power engineers, Edinburgh, are exhibiting, a number of their specialities. They have just sent us a copy of a useful list, in which the main features of their water wheels and turbines are described. We gather from this that they make two distinct types, the "Waverley," a pressure turbine of the mixed flow class for low and medium falls, and the "Girard," an impulse turbine of the partial injection class suitable for high falls and moderate speeds. In the booklet several examples are shown of the horizontal type of turbine direct-coupled to dynamo-electric machines. There are also views of jet water wheels of the Pelton type, the utility of which for exceptionally high falls has been abundantly proved.

Net Resistances.—Many great improvements in the design and arrangement of resistances have been introduced during the past decade, but one of the most important is that relating to resistance units made up of asbestos and wire in the form of a net. The manufacture of this type of resistance appears to be specialised in by C. Schniewindt, Neuenrade, Westphalia, Germany, judging by the comprehensive list which we have just received. The catalogue describes in detail the manufacture of net resistances,

and gives illustrations and diagrams showing their application in practice. The units have been standardised for various purposes, and can be obtained in various sizes to build up into complete rheostats. Judging by the products of the firm specialisation has been carried almost to perfection with this class of resistance, and we gather that special machinery has been put down for its production.

BANKRUPTCIES, LIQUIDATIONS, &c.

Alfred W. Bennett (trading as Bennett & Co.), electrical engineer, lately of 32, Park Cross-street, Leeds, has been adjudicated bankrupt. First meeting of creditors on May 25 at 24, Bond street, Leeds, and public examination on June 16 at the County Court House, Albion-place, Leeds.

Ernest Albt. Gresham, electrical engineer, late of Westborough, Scarborough, has been adjudicated bankrupt. The first meeting of creditors will take place on May 28 at 24, Bond-street, Leeds, and the public examination on June 30 at the County Court, Albion-place, Leeds.

A first and final dividend of 2s. 0¼d. is payable at 117, St. Mary's-street, Cardiff, in the bankruptcy of Wm. Aneurin Roderick, electrical engineer, 12, Benham-street, Swansea (late 25, Adare-street, Bridgend).

The Gardner Electric Drill & Hammer Co. (Ltd.) is being wound up voluntarily, Mr. F. F. Fuller, 138, Salisbury House, London, E.C., is liquidator.

The Britannia Electric Lamp Works (1905) (Ltd.), Seven Sisters-road, South Tottenham, is being wound up voluntarily, Mr. J. J. B. Cross, 65, Linzee-road, Hornsey, is liquidator.

Winding Up Petition.—A petition for winding up the Helis Cell & Accumulator Co. (Ltd.) has been presented by the Vieille Montagne Zinc Co., and will be heard in the High Court on May 26.

PATENT RECORD.

APPLICATIONS FOR PATENTS.

NOTE.—*The undermentioned Applications (except those marked †) are not open to public inspection until after acceptance of Complete Specifications. Those marked † are open for inspection 12 months after the date attached to them, if they have not been published previously in the ordinary course. Names within parentheses are those of communicators of inventions. When Complete Specification accompanies application, an asterisk is affixed.*

February 1. 1908.

2,254 COLEBROOKE. Incandescent lamp filaments.
2,261 HOLMAN. Arc lamps.
2,280 THOMPSON. Hand-controlled mechanism of marine engines operated in conjunction with the telegraph.
2,281 DRAKE, BARNES, & DRAKE & GORHAM. Operating electric switches.
2,294 TUNBRIDGE. Accumulators.
2,303 SIEMENS BROS. DYNAMO WORKS & LYDALL. Single phase commutator motors.*
2,308 SIEMENS & HALSKE A.-G. Electrically selecting one of several receivers connected with a common conductor. (Date applied for, 11/2/07.)*†
2,318 MCCULLOUGH & PANTON. Emergency or slipper brakes.

February 3. 1908.

2,357 LAMBERT. Track or emergency brakes for tramcars.
2,375 HOWARD. Alternating current relays. (Date applied for, 2/2/07.)*†
2,404 LE PONTOIS. Magneto generators.*
2,411 STILL. Current generators.

February 4. 1908.

2,452 LLOYD & STIRLING. Electric light or power switch.
2,456 STEWARD & REBBLA. Brakes for tramcars and like vehicles.
2,480 FRIED. KRUPP AKTIENGESELLSCHAFT. Electric elevating gear for ordnance. (Date applied for, 16/5/07.)*†
2,481 SIEMENS BROS. DYNAMO WORKS & WHEAT. Holders for incandescent lamps.*
2,488 WOLHAUPTER. Insulated joints for railway rails.*
2,495 BLOXAM. (Siemens-Schuckertwerke G.m.b.H., Germany.) Electrically propelled motor road vehicles.*
2,498 BURT. Magnetic separators.*

SPECIFICATIONS PUBLISHED.

1906 SPECIFICATION.

24,923 RAWORTH. Control of the circuits in electric traction or haulage.

1907 SPECIFICATIONS.

440 B.T.-H. Co. (A.E.G., U.S.) Regulating alternating current motors of the commutator type.
2,652 JOEL. Batteries.
2,720 PATTERSON. Lighting miners' safety lamps by electricity.
2,750 VON ZWEIGBERGK. Motor starting switches. (Date applied for, 21/5/06.)
2,963 & 2964 WELLINGTON & DANIELL. Arc lamps.
3,000 BOULT. (Elektrizitäts A.-G. vorm. Schuckert & Co.) Electrolytic apparatus.
3,000A BOULT. Elektrizitäts A.-G. vorm. Schuckert & Co.) Electrolytic apparatus. (Date applied for, 6/2/07.
3,029 WYNN. Device for simultaneously bolting doors and switching on electric lights.
3,060 JONES. Arc lamps.
3,693 HEPKE & DIENER. Safety fuse or cut out.
3,881 TORDA. Variable-speed motors or variable-voltage generators.
4,120 BROCKIE. Apparatus for suspending lamps, electroliers, and the like.
4,364 B.T.-H. Co. (G.E. Co., U.S.) Incandescing bodies for electric lamps.
4,706 HOWORTH. (A.-G., Brown, Boveri & Cie.) Single-phase alternating-current motors.
4.742 B.T.-H. Co. (G.E. Co., U.S.) Alternating-current motors.

COMPANIES' MEETINGS AND REPORTS.

Buenos Ayres Grand National Tramways Co. (Ltd.)
Buenos Ayres New Tramways Co. (Ltd.)

On Friday, 15th May, there was held a series of meetings of the shareholders and debenture holders of the above companies, all those of the Grand National Co. being under the presidency of Sir IRVING COURTENAY.

The first meeting was of the 5 per cent. conversion debenture stockholders of the Grand National Co.

The SECRETARY (Mr. Fortescue Thursby) read the notices convening the meetings and the resolutions set out therein in extenso.

The CHAIRMAN said: This meeting is held to consider resolutions (1) to authorise an increase in the present amount of the stock by £200,000 and (2) to comply with certain requirements of the Stock Exchange committee in view of their granting an official quotation for the stock. We are now dealing with the 5 per cent. conversion debenture stock, the original authorised issue of which was £700,000. £100,000 of this represented the then existing 5 per cent. second preference debentures, leaving £600,000 for purposes of capital expenditure. With the conversion debenture stock of the Buenos Ayres New Tramways Co. (£300,000) the total amount available for the conversion to electric traction of the combined systems, then extending to about 70 miles of single line, was £900,000. The proceeds of these stocks, approximately £796,000, together with approximately £108,000 borrowed on open account (£904,000 in all), has sufficed for the conversion of the original 70 miles to electric traction, the construction of a further 16 miles, and the provision of increased rolling stock and materials for the construction of a part of the new concessions granted to the company, of which about 24 miles remains to be constructed. Powers are now being asked for the issue of a further £300,000 conversion debenture stock of the two companies in the proportion of two-thirds for the Grand National and one-third for the Buenos Ayres New, the object being to repay the above loan of about £108,000 and to complete the lines for which concessions are now held. Power is also to be taken to apply a further amount of conversion debenture stock to redeeming the first preference debentures, which will make the conversion debenture stock a first charge. In order to obtain for the conversion debenture stock the advantage of a Stock Exchange quotation, it is necessary that the price of repayment of that stock in the event of voluntary liquidation should be the same as the price provided in the trust deed on repayment after notice by the Company—viz., 105 per cent. The complete accounts from Buenos Ayres have not yet come to hand, but soon after these arrive we shall hold the annual meeting, and these accounts will be dealt with in detail. I can, however, say that the increase of the traffics have fully justified the expenditure upon the electrification. I now move the resolutions which have been circulated amongst the shareholders and have been read by the secretary.

Dr. HARRIS seconded the resolutions, which were carried unanimously.

A meeting followed of the holders of 5 per cent. conversion debenture stock in the Buenos Ayres New Tramways Co. for the purpose of approving resolutions (1) authorising an increase in the present amount of the stock by £100,000, and (2) for complying with the requirements of the Stock Exchange.

At this meeting Mr. JAMES HEAD presided, and Mr. Fortescue Thursby read the notices calling the meeting and the resolutions in extenso.

The CHAIRMAN, in a few brief remarks, dealt with the objects of the issue, and the resolutions were seconded by Mr. C. M. ROSE and carried unanimously.

Sir IRVING COURTENAY then presided at a meeting of the holders of the 6 per cent. debentures in the Buenos Ayres Grand National Co., and said there were now outstanding £226,100 of 6 per cent. debentures. Power was being sought to redeem the first preference debentures, and this would make the conversion debenture stock a first charge on the company's assets, and would raise the 6 per cent. debentures from a third to a second charge.

Mr. LABEY said in the original prospectus of the 6 per cent. debentures provision was made for a sinking fund for their redemption; had this fund been established? and what was the present net amount of income available for the payment of the three issues of debentures?

The CHAIRMAN replied that there was a sinking fund provided, but the details which Mr. Labey had asked for would be gone into at the annual meeting. He could say, however, that there was ample income for all issues.

The resolutions, which were seconded by Mr. ROSE, were carried unanimously.

An extraordinary general meeting of the Buenos Ayres Grand National Co. followed, at which resolutions were approved increasing the amount of 5 per cent. conversion debenture stock to £900,000 by the issue of an additional £200,000, and empowering the directors to further increase the amount of this stock by such amount as may be necessary for the purpose of redeeming the £150,000 5½ per cent. preference debentures at present ranking in priority thereto, or any part thereof, at such times and in such manner and upon such terms and conditions as the directors may determine, the further £200,000 of stock first authorised being issued only for the purposes of the electrification and extension of the company's lines. The directors were authorised to concur with the Buenos Ayres New Tramways Co. and other parties to certain agreements in regard to the working arrangements over the extended lines.

Sir IRVING COURTENAY presided, and said there were now issued and outstanding 90,000 5 per cent. preference shares amounting to £450.000, and 113,436 £5 ordinary shares amounting to £567,180. He proceeded to acquaint the meeting with the purposes for which new capital was required, &c., and moved the several resolutions before the meeting.

Mr. CAIRNS asked the mileage of tramways at present in operation and the mileage already constructed. He thought that, instead of issuing £200,000, if they had taken powers to issue £500,000 it would have obviated their being called together again, as the additional money would doubtless be required. He would also like to know at what price the additional capital was to be issued.

The CHAIRMAN said he could not tell at what price the issue would be made, but they would get the best price they could. There were 86 miles of track converted, of which 81 are being operated.

Mr. CAIRNS asked if the £200,000 now to be issued would complete the whole system of 113½ miles of track.

The CHAIRMAN replied that the estimate was that it would complete the whole system, but he could not state this definitely.

The resolutions were carried unanimously.

At a separate meeting of the holders of 5 per cent. cumulative preference shares of the Buenos Ayres Grand National Tramways Co., at which Sir IRVING COURTENAY presided, the necessary resolutions consequent upon the passing of the resolutions submitted to the previous meetings were approved.

At an extraordinary meeting of the Buenos Ayres New Tramways Co., at which Mr. E. A. LAZARUS presided, the arrangements between the Buenos Ayres New and the Buenos Ayres Grand National Co., as outlined in the above particulars of the previous meetings, were submitted and approved.

Callender's Cable & Construction Co. (Ltd.)

The CHAIRMAN (Mr. Henry Drake), who presided over the twelfth annual general meeting yesterday (Thursday), made feeling reference to the loss the company had sustained by the deaths of Sir David Evans and Mr. W. O. Callender. Having commented briefly upon the figures in the accounts (abstracted in our last issue) he said the dividends in the last few years had averaged 15 per cent., which he thought could not be called unsatisfactory. The valuation of their land and property at Erith by Messrs. Bramwell & Harris was very valuable, and the estimate of shares and investments in other companies had been most carefully made, and there was no doubt that they would realise the value placed against them. He then moved that the report and accounts be received and adopted.

Mr. JOHN VARLEY having seconded the resolution,

Mr. T. O. CALLENDER (managing director) said it had not been expected that during the past year they would do so well as they had done in 1904 and 1905. This was a period when their customers, municipal and otherwise, were filling up mains which they had laid. But perhaps the most important reason for the falling off was the uncertainty in regard to copper. The price rose in the early part of last year to £122 per ton, and it was now below £60, so that there had been plenty of opportunity for loss to be made by those who speculated in copper or copper cables, and those who had refrained from placing their orders had done wisely from their own point of view. The company had been singularly fortunate, and he thought singularly careful. They had followed the market down, and some time since when they cleared their books after the fall they found they were 6 tons short. Seeing that their transactions ran into thousands of tons that was exceedingly satisfactory. The result of the uncertainty as to copper was the abandonment of all work not of the most pressing description, the people who used to lay in a stock of several thousand pounds' worth of copper now ordered 200 yds., and wanted it to-morrow. Even a considerable fall in price did not satisfy the customers, and uncertainty still prevailed. The financial troubles which began in America had extended throughout the world, and made it almost impossible for their customers to obtain the money for extending stations and starting new enterprises. Knowing, however, that the future of electric driving and lighting was assured, the board were not unduly worried about the delay in the placing of orders, and they knew, further, that the orders were not going elsewhere, but were merely hung up. They got their fair share of the business, and with that they must be satisfied. The factory at Leigh had been reorganised and they were pushing the new branch (rubber wires) for all it was worth and doing very well in that business. They had placed £10,000 to suspense account because one of their customers had had to reorganise his business, but they thought they would have a very considerable portion of that come back to the shareholders. The depression in business was not only in this country, but was general throughout most of the areas in which they were working. Their German company was thoroughly organised and in a position to carry out whatever work was necessary, and the manufacturing for such work was, at present at any rate, being done in England. The shareholders would notice that the general expenses in London and elsewhere had increased by nearly £6,000, but that was only a matter of book-keeping, as they had found it necessary to do away with a number of commission houses and have their own representatives. At the moment their output was somewhat as it was last year, and prices were lower owing to lessened cost of metals, but their works were kept occupied to a very considerable extent. They did not expect any material improvement in trade this year, but he felt that it would not be long before an improvement would take place. He had no fear in regard to the future.

The report and accounts were unanimously adopted.

The CHAIRMAN moved that a dividend at the rate of 10 per cent. per annum, tax free (10s. per share), whereof 5s. was paid on Nov. 1 last, be declared, and that a bonus of 5s. per share also be paid, making 15 per cent. in all, and the motion was seconded and carried.

The retiring director, Mr. C. H. McEuen, was re-elected, as were the auditors, and a vote of thanks to the chairman and directors closed the proceedings.

ALDERLEY & WILMSLOW ELECTRIC SUPPLY (LTD.)—The report for 1907 states that the total connections at Dec. 31 were equal to 16,269 8 c.p. lamps. Profit on working was £1,452, and, with the balance forward, the total was £1,655. After paying debenture and loan interest and applying £700 for renewal of accumulators, there was a deficiency of £2. 10s. 3d. 205,969 units were generated and 112,991 were sold to private consumers and 18,726 supplied to public lamps.

AUCKLAND ELECTRIC TRAMWAYS CO. (LTD.)—The Chairman (Mr. C. G. Tegetmeier) stated at the meeting on Wednesday that when the company was formed it was not anticipated that the traffic would develop to such a remarkable extent as it had done. Last year they carried passengers equal in number to 300 times the whole of the population of the district (75,000), and he thought that was quite exceptional in the record of tramway undertakings. Overtures had been made by Auckland Council for the purchase of the tramways. The company went into the business when the Council would not take the risk, and the company's concessions extended till 1932, when the Council might buy the undertaking. Consequently the directors were not anxious to sell at present, but they had declared their willingness to consider proposals for purchase on an equitable basis.

BULUWAYO WATERWORKS CO. (LTD.)—The report for 1907 states that the gross profit from the sale of electricity was £4,648, a decrease of £166 compared with 1906.

CHISWICK ELECTRICITY SUPPLY CORPN. (LTD.)—The number of consumers at the end of 1907 was 1,574, compared with 1,378 in 1906. During 1907 £5,225 was expended on capital account. The total number of lamps, motors, &c., connected to the mains at Chiswick and Aberystwyth was equivalent to 66,580 8 c.p., against 60,351 8 c.p. The profit for the year, with amount forward, was £6,496. 7s. 3d. Interest on debentures and temporary loans required £2,637. 3s. 6d., leaving £3,859. 3s. 9d. The directors recommend a dividend on the ordinary shares of 6 per cent., the same as for 1906.

ISLE OF WIGHT ELECTRIC LIGHT & POWER CO. (LTD.)—At the meeting last week the chairman (Mr. F. E. Gripper) said the company had made steady progress. The lamp connections had increased from 81,921 to 89,300 8 c.p., the revenue from £18,510 to £19,731, and the profit from £9,544 to £10,716. Over £1,000 had been spent out of revenue in keeping the plant in good working order. The directors recommended that no dividend be paid on the ordinary shares, that £500 should be written off value of wiring stocks, and £2,500 should be carried to reserve for renewal of plant.

LISBON ELECTRIC TRAMWAYS (LTD.)—At the meeting last week Sir Chas. Euan-Smith said that during the past year they had practically maintained the figures of the previous year. They had added 25 new cars to their rolling stock. Notwithstanding the grave political unrest through which Portugal was passing, the prosperity of their undertaking had been little affected.

MARCONI'S WIRELESS TELEGRAPH CO. (LTD.)—At an extraordinary meeting on Monday the resolution adopted on April 30, providing for the increase of the capital by the creation of 250,000 7 per cent. cumulative participating preference shares of £1 each was confirmed. Mr. Bovell asked whether the new shares would be offered to the existing shareholders before they were offered to the public. The chairman (Major S. Flood-Page) replied that they would be offered to the shareholders, but not separately. Asked as to whether the shareholders would have an opportunity of participating in any underwriting, the chairman said shareholders would have their proportion. No date had yet been fixed for the issue. In answer to a further question, the chairman said no information could be furnished as to the financial position of the company supplemental to that contained in the annual report.

RANGOON ELECTRIC TRAMWAY & SUPPLY CO. (LTD.)—At the meeting last week, the chairman (Mr. F. Tobin) said that now that the tramway was in complete working order their revenue, as forecasted, had reached £1,000 a week, and there was every prospect of its increasing, while the expenses, which had been very high owing to the small section operated during the year and the exceptionally heavy cost of coal, would, they believed, shortly be brought within measurable distance of the 50 per cent. estimated. After much trouble with the turbines, the public lighting supply had been successfully installed, and attention was being devoted to establishing the private supply and meeting the demand for lighting and power. Already the estimated gross revenue from contracts offered to the company came to £35,000 per annum. It would take two years, however, before the private supply returned a revenue which would reward the patience of the ordinary shareholders.

REUTER'S TELEGRAM CO. (LTD.)—The balance for distribution for the year ended Dec. 31 amounts to £4,884. 2s. 5d. An interim dividend of $2\frac{1}{2}$ per cent. has been paid, and the directors now declare a dividend of 4s. per share, equal to $2\frac{1}{2}$ per cent., making 5 per cent. for the year (tax free).

RUSTON, PROCTOR & CO. (LTD.)—The directors have decided, after providing £30,742 for depreciation of buildings, plant and machinery, to recommend payment of a dividend of 16s. per share, equal to 8 per cent. per annum, tax free, placing £10,000 to equalisation of dividend account, crediting £500 to employees aid account, and carrying forward £6,468.

WEST AFRICAN TELEGRAPH CO. (LTD.)—The revenue for the year ended Dec. 31 was £59,206. 0s. 10d., from which is deducted £15,896. 8s. 6d. for ordinary expenses, and £9,878. 8s. 9d. for expenditure relating to maintenance of cables, leaving £33,431. 3s. 7d., added to £2,155. 1s. 5d. forward, making £35,586. 5s. £1,511. 6s. 6d. has been provided for income tax, £24,000 transferred to general reserve, and an interim dividend of 2 per cent. (tax free) absorbed £4,621. 16s. The directors now recommend payment of a final dividend of 2 per cent. (tax free) (making 4 per cent. for the year), £831. 6s. 6d. being carried forward.

WEST INDIA & PANAMA TELEGRAPH CO. (LTD.)—The directors recommend the payment of the following dividends: 6s. per share on the first preference shares (dividend for six months to Dec. 31) and 26s. per share on the second preference shares (on account of dividends accrued to Dec. 31).

WEST LONDON & PROVINCIAL ELECTRIC SUPPLY CO. (LTD.)—The profits of the company are derived from the business done by the Chiswick Electricity Supply Corpn. (Ltd.) (whose shares the company hold), and during 1907 the corporation made good progress, but, owing mainly to high price of coal increase in profits has not kept pace with increase in revenue. The Chiswick Electricity Supply Corpn. accounts show a profit of £3.859. 3s. 9d., which the directors propose to apply to payment of a dividend of 6 per cent. on the ordinary shares. This will be received by the West London Co., whose accounts show a credit balance of £3,451. 13s. 8d., and the directors propose to apply this sum in paying a dividend on the cumulative preference shares of 6 per cent. for 1907, and in interest at $4\frac{1}{2}$ per cent. on the funding certificates.

NEW COMPANIES, STATUTORY RETURNS, MORTGAGES AND CHARGES.

NEW COMPANIES.

CAMPBELL & ISHERWOOD (LTD.) (97,971.)—Reg. May 15, capital £10,000 in £1 shares, to take over the business of electrical and mechanical engineers carried on by G. F. D. Campbell and J. A. G. Williams at Bootle, Lancs., and elsewhere as Campbell & Isherwood. First directors, G. F. D. Campbell, J. A. G. Williams and L. Murphy. Reg. office, Raleigh-street, Bootle.

E. A PREVETTE (LTD.) (97,963.)—Reg. May 14, capital £3,000 in £1 shares, to acquire patents and rights for inventions relating to an electrical burglar alarm and an electrical clock, to acquire the business of E. A. Prevette, Eastbourne, and to carry on the business of electricians, electrical, telegraph and mechanical engineers, builders of electric tramcars, motor cars, &c., manufacturers of and dealers in dynamos, motors, telephones and arc and other lamps, &c. Reg. office, 55 Grove-road, Eastbourne.

SANTONI ARC LAMP & ENG. CO. (LTD.) (97,956.)—Reg. May 13, capital £5,000 in £1 shares, to carry on the business of electrical and general engineers, contractors, manufacturers of electrical and mechanical appliances for lighting, power and traction, importers and exporters of electrical appliances, dealers in electrical goods and accessories and to acquire the business of the arc lamp department of D. Santoni & Co. Ltd. First director, D. Santoni (managing director for 10 years) and others to be appointed by subscribers.

UNITY MOTOR, ELECTRICAL & GENERAL ENGINEERING CO. (LTD.) (97,911.)—Reg. May 9, capital £1,000 in £1 shares, to carry on the business of motor, electrical and general engineers, machinists, &c., to acquire the business of the Unity Motor, Electrical & General Engineering Works, Bristol, and to adopt an agreement with A. A. Taylor. First directors, T. H. Gore, A. A. Taylor, A. D. Matthews and W. Jenkins. Reg. office, 52 Queen-street, Bristol.

STATUTORY RETURNS.

W. T. GLOVER & CO. (LTD.)—The capital in return to March 30 is £214,850 in 100,000 preference and 114,850 ordinary shares of £1 each, all of which have been taken up. £1 per share has been called up and paid on 67,000 preference and 50,000 ordinary shares. £97,850 is considered as paid on 50,000 preference and 57,850 ordinary. Mortgages and charges, £180,000.

HOWARD ASPHALT TROUGHING CO. (LTD.)—Return to April 8 gives capital as £20,000 in 19,000 ordinary and 1,000 deferred shares of £1 each, of which 1,007 ordinary and 1,000 deferred have been taken up. £7 has been received and £2,000 is considered as paid. Mortgages and charges, nil.

MANN, EGERTON & CO. (LTD.)—Return to March 11 gives capital as £40,000 in 25,000 preference and 15,000 ordinary shares of £1 each, of which 15,619 preference and 6,257 ordinary have been taken up. £1 per share has been called up and paid on 9,450 preference and 257 ordinary. £12,169 is considered as paid on 6,169 preference and 6,000 ordinary. Mortgages and charges, £10,000. (A further 2,000 preference and 250 ordinary shares were allotted on April 23, the ordinary shares being issued at £3 premium.)

MATHER & PLATT (LTD.)—In return to March 12 capital is £1,000,000 in 50,000 preference and 50,000 ordinary shares of £10 each, of which 40,000 preference and 40,000 ordinary have been taken up. £10 per share has been called up and paid on 29,200 preference and 2,500 ordinary. £483,000 is considered as paid on 10,800 preference and 37,500 ordinary. Mortgages and charges, nil.

MELTON MOWBRAY ELECTRIC LIGHT CO. (LTD.)—In return to March 25 capital is £25,000 in £5 shares, of which 4,000 have been taken up. £20,000 has been received. Mortgages and charges, £20,000.

MORTGAGES AND CHARGES.

BUDE ELECTRIC SUPPLY CO. (LTD.)—Issue on May 4 of £1,800 5 per cent. mortgage debentures, part of series created April 14, 1908, to secure £2,500, charged on company's undertaking and property, present and future, including uncalled capital. No trustees. No previous issue of same series.

LONGSTRETHS LIMITED.—£2,300 5 per cent. debentures created and dated April 30, 1908, charged on company's undertaking and property, present and future, including uncalled capital, have been registered. No trustees.

CITY NOTES.

MEMORANDA (May 21).—Bank rate 3 per cent. (since March 19, 1908). Price of silver $24\frac{11}{16}$—$24\frac{3}{4}$d per oz. Consols $86\frac{1}{2}$—$86\frac{5}{8}$ for money, and $86\frac{9}{16}$—$86\frac{11}{16}$ for account. Consols Pay Day, June 1; Stock and Shares Continuation Days, May 27 and June 10; Ticket Days, May 28 and June 11; Pay Days, May 29 and June 12; Mining Share carry-over Day, May 27.

PRICES OF METALS (London).—*Copper*, cash, 57[illegible]—57[illegible]; three months $58\frac{3}{8}$—$58\frac{5}{8}$. *Lead*, English, $13\frac{1}{4}$—$13\frac{1}{2}$; foreign, $13\frac{1}{8}$—$13\frac{1}{4}$. *Spelter*, foreign 20—$20\frac{1}{4}$. *Tin*, English, 134—135; foreign, cash, $132\frac{3}{4}$—$133\frac{1}{4}$, three months, $131\frac{3}{4}$—$132\frac{1}{4}$. *Iron*, Cleveland, cash, 49/6; three months, 49/1.

CASTNER-KELLNER ALKALI CO. (LTD.)—An interim dividend at the rate of 10 per cent. for the six months ended March 31 is payable on 26th inst.

CENTRAL ELECTRIC SUPPLY CO. (LTD.)—The 4 per cent. guaranteed debenture stock transfer books of this company will be closed from 18th to 31st inst. inclusive, preparatory to the payment of interest due June 1.

EDMUNDSON'S ELECTRICITY CORPN. (LTD.)—At the adjourned meeting of the first mortgage debenture holders on Thursday last week the scheme authorising the creation of prior lien debenture stock not exceeding £200,000 was carried with a slight modification.

PEARSON FIRE ALARM (LTD.)—Mr. D. J. Morgan has joined the board of this company.

STOCK EXCHANGE NOTICES.—The Stock Exchange committee have appointed May 28 a special settling day in provisional certificates fully and partly (50 per cent.) paid for £301,630 $4\frac{1}{2}$ per cent. debenture stock of the *Charing Cross, West End & City Electricity Supply Co. (Ltd.)*, and have granted quotations to the same and to £111,700 $4\frac{1}{2}$ per cent. debenture stock of the same company, a further issue of 3,176 £5 fully paid 5 per cent. preference shares of the *Calcutta Tramways Co. (Ltd.)*, $500,000 additional first mortgage 50 year 5 per cent. gold bonds of the *Mexico Tramways Co.*, and a further issue of £173,300 first mortgage $4\frac{1}{2}$ per cent. sterling bonds of the *Toronto Railway Co.* The committee have been asked to appoint special settling days in and grant quotations to provisional certificates fully and partly paid for £500,000 5 per cent. first mortgage debenture stock of the *County of Durham Electrical Power Distribution Co. (Ltd.)*, and a further issue of 10,000 £1 fully paid shares of *Marconi's Wireless Telegraph Co. (Ltd.)*, and also to allow 10,000 additional £10 fully paid ordinary shares of the former company to be quoted.

UNDERGROUND ELECTRIC RAILWAYS CO. OF LONDON (LTD.)—Holders of profit-sharing secured notes are informed that, upwards of 90 per cent. having been deposited, the scheme will be proceeded with. The time for depositing notes has been extended to the 30th inst.

ELECTRIC TRAMWAY AND RAILWAY TRAFFIC RECEIPTS.

Line	Week ended.	Amount.	Inc. or Dec. (a)	Aggregate No. of weeks.	Aggregate Amount.	Aggregate Inc. or Dec. (a)
		£	£		£	£
Airdrie	May 8	212	− 9	18	4,033	+ 61
Anglo-Argentine	,, 13	19,438	+ 1,991	19	352,335	+ 39,263
Ayr Corporation	,, 16	243	− 2	52	14,741	+ 77
Baker St. & Waterloo Ry.	,, 16	3,120	+ 760	20	61,680	+ 14,609
Barnsley	,, 8	168	+ 4	18	3,079	+ 204
Barrow	,, 8	225	− 9	18	4,016	+ 38
Bath Electric Trams, Ltd.	,, 13	729	− 61	19	11,800	− 1,194
Birmingham Corporation	,, 15	6,364	+ 182	7	42,076	+ 1,720
Birmingham & Mid.	,, 1	747	− 11	17	13,725	+ 792
Blackburn Corporation	,, 13	1,169	+ 82	7	8,131	+ 128
Blackpool Corporation	,, 14	549	+ 17	§6	4,899	+ 813
Blackpool and Fleetwood	...	...	...	...	...	...
Bolton Corporation	,, 17	2,354	+ 207	7	16,163	+ 1,202
Bombay	April 23	R34,160	+ R7,863	16	R582,088	+ R107,362
Bournemouth Corporation	May 13	1,126	− 107	6	10,264	− 503
Bradford Corporation	,, 16	4,698	+ 151	7	30,862	+ 2,121
Brighton Corporation	,, 17	775	− 103	7	5,445	− 27
Bristol Trams & Carriage	,, 15	4,799	− 353	19	88,350	− 2,600
Buenos Ayres & Belgrano	,, 13	4,011	+ 59	19	72,208	+ 731
Burnley Corporation	,, 18	1,243	− 14	7	8,982	+ 543
Burton Corporation	,, 17	267	− 16	7	1,775	− 153
Bury Corporation	,, 10	1,221	+ 225	†6	6,919	+ 1,129
Calcutta Tramways Co.	,, 13	R15,826	+ R1,161	...	...	...
Camborne-Redruth	,, 16	117	− 13	20	2,366	+ 168
Cardiff Corporation	,, 16	2,09[illegible]	+ 123	6	11,852	− 57
Cavehill	,, 8	77	+ 1	18	1,363	+ 82
Central London Railway	,, 16	6,630	+ 802	20	120,293	− 2,999
Charing C., Euston & H'stead	,, 16	3,360	...	20	63,895	...
Chatham & Dist. Lt. Rys.	,, 14	794	+ 51	§19	12,648	− 190
City & South London Rly.	,, 17	2,964	− 192	20	65,552	+ 6,555
City of Birmingham	,, 8	2,719	− 192	18	49,311	+ 417
Colchester Corporation	...	...	...	...	...	...
Cork Electric Trams Co.	,, 14	413	− 17	§19	7,820	− 461
Croydon Corporation	,, 15	1,426	− 69	7	8,846	− 650
Devonport & Dist. Trams	,, 8	480	+ 48	18	7,848	− 55
Dover Corporation	,, 16	184	− 18	7	1,244	− 233
Dublin & Lucan Railway	,, 15	120	+ 10	20	1,953	+ 84
Dublin United	,, 15	5,164	− 446	20	84,212	− 345
Dudley-Stourbridge	,, 8	749	− 86	18	13,614	− 1,068
Dundee Corporation	,, 13	1,236	+ 116	52	59,417	+ 2,615
East Ham Council	,, 16	831	− 97	7	5,502	− 437
Exeter Corporation	,, 15	287	− 11	7	1,909	− 169
Gateshead & Dist. Trams	,, 8	967	− 48	18	17,962	+ 273
Glasgow Corporation	,, 16	17,681	− 483	50	868,714	+ 14,041
Glossop	...	...	...	...	...	...
Gravesend—Northfleet	,, 8	193	− 41	18	3,468	− 516
Great Northern & City Rly.	,, 16	1,576	− 164	20	34,641	− 2,203
Gt. Northern, Piccadilly, &c.	,, 16	5,565	+ 1,485	20	108,460	+ 31,741
Greenock & Port Glasgow	,, 8	499	− 156	18	8,787	− 2,107
Hartlepool Tramways	,, 8	191	− 66	18	3,825	− 765
Hastings Elec. Trams Co.	,, 11	882	− 166	20	15,323	− 156
Hong Kong	,, 16	$3,002	+ $57	...	...	...
Huddersfield Corpn.	...	...	...	...	...	...
Hull Corporation	,, 16	2,418	+ 9	7	16,109	− 113
Ilford District Council	...	...	...	...	...	...
Ilkeston District Council	,, 13	153	+ 2	7	959	− 8
Ipswich Corporation	,, 16	374	− 15	7	2,342	− 118
Isle of Thanet Co.	,, 16	410	− 44	33	9,460	− 411
Jarrow	,, 8	94	− 38	18	1,773	− 252
Keighley Corporation	,, 14	165	+ 4	46	7,223	+ 315
Kidderminster & District	,, 8	89	− 20	18	1,604	− 147
Kilmarnock Corporation	,, 15	186	− 14	52	8,066	− 163
Lanarkshire Trams Co.	,, 14	1 318	+ 47	19	24,149	+ 3,047
Lancashire United	,, 13	1,342	+ 122	19	23,350	+ 1,176
Leamington	,, 8	150	+ 7	18	2,518	+ 43
Leeds Corporation	,, 16	6,514	− 91	7	42,295	− 26
Leicester Corporation	,, 15	2,323	− 41	...	.	...
Leith Corporation	,, 9	504	− 23	‡52	26,343	+ 157
Lincoln Corporation	,, 16	115	...	7	829	+ 40
Liverpool Corporation	,, 9	10,714	− 300	19	194,355	− 2,003
Liverpool Overhead Rly.	,, 17	1,423	− 86	20	27,761	− 471
*London County Council	,, 9	33,29[illegible]	+ 1,175	†6	180,341	+ 15,957
London United	,, 16	6,852	− 43	19	109,178	− 2,687
Lowestoft	,, 16	157	− 4	33	5,143	+ 135
Maidstone Corporation	,, 16	184	...	7	1,198	...
Manchester Corporation	,, 16	15,177	+ 221	7	98,147	+ 5,459
Mersey Railway	,, 16	1,956	+ 134	20	38,363	+ 1,624
Merthyr	,, 8	202	− 14	18	3,692	+ 39
Metropolitan Dist. Railway	,, 16	9,005	+ 1,039	20	177,539	+ 19,515
Metropolitan Elec. Trams	,, 8	5,466	+ 890	18	90,181	+ 16,685
Middleton	,, 8	347	+ 2	18	5,872	+ 78
Nelson Corporation	,, 16	139	− 2	¶6	953	− 136
Newcastle-on-Tyne Corp.	,, 16	3,683	− 369	7	25,278	− 2,873
Newport (Mon.)	,, 18	617	− 13	7	4,493	+ 3
Northampton Corporation	,, 15	439	+ 2	¶6	2,776	− 76
Oldham, Ashton & Hyde	,, 8	587	− 16	18	10,512	+ [illegible]
Oldham Corporation	,, 17	1,990	+ 131	7	15,268	− 201
Perth (N.B.) Corporation	,, 13	141	− 5	52	8,030	+ 45
Perth (W.A.) Elec. Trams	,, 15	1,363	− 1	¶20	28,266	− 949
Peterborough	,, 8	111	− 15	18	1,969	− 41
Portsmouth Corporation	,, 16	1,847	+ 66	7	12,082	− 688
Potteries	,, 8	1,782	− 43	18	33,154	+ 499
Preston Corporation	,, 13	750	+ 31	20	13,593	− 171
Rotherham Corporation	,, 14	617	+ 40	§6	3,782	− 7
Rothesay	,, 8	100	+ 5	18	1,423	− 120
Salford Corpn.	,, 18	4,656	+ 96	7	31,687	− 644
Sheerness	,, 6	53	− 2	18	894	− 14
Sheffield Corporation	,, 17	5,6[illegible]0	+ 228	18	41,899	− 1,486
Singapore Trams	,, 16	$10,129	+ $764	...	...	...
Southend Corporation	,, 13	347	+ 1	7	2,114	+ 26
South Metropolitan	,, 8	761	+ 9	18	12,426	− 275
Southport Tramways	,, 8	246	− 11	18	3,968	− 348
South Staffs	,, 8	824	− 59	18	15,634	− 207
Stalybridge, Hyde &c. Jt. Bd.	.	...	...	...	.	...
Sunderland Corporation	,, 17	1,151	− 213	7	7,526	− 1,872
Sunderland and District	,, 13	410	− 2	28	12,673	+ 1,199
Swansea Trams	,, 8	923	+ 100	18	15,719	+ 1,182
Swindon Corporation	,, 13	116	− 29	6	881	− 42
Taunton	,, 8	10	− 2	18	698	− 26
Tynemouth and District	,, 8	153	− 23	18	2,709	− 331
Tyneside Trams Co.	,, 13	381	− 78	20	6,998	− 1,080
Wallasey District Council	,, 16	842	+ 52	†6	5,558	+ 115
Walsall Corpn.	,, 16	539	+ 42	20	10,252	+ 1,133
Warrington Corpn.	...	...	...	...	...	...
West Ham Corporation	,, 14	2,187	− 327	7	15,007	− 1,641
Weston-super-Mare	,, 6	84	+ 21	18	730	− 103
Wolverhampton Co.	,, 8	454	− 19	18	8,001	− 87
Wolverhampton Corpn.	,, 13	785	− 57	49	35,307	...
*Worcester	,, 8	275	− 2	18	4,428	− 53
Wrexham	,, 8	94	+ 1	18	1,736	− 5
Yorkshire W.R. Trams	,, 17	1,296	+ 164	20	22,360	...
Yorkshire Woollen District	,, 8	915	− 55	18	16,031	− 691

(a) These comparisons are with the corresponding period last year. § Plus 2 days. ¶ Plus 3 days. * Partly electrical. † Minus 3 days. ‡ Minus 2 days.

ELECTRICAL COMPANIES' SHARE LIST.

Share	Last Dividend	Name.	Price Wed., May 20.	Rate % Yield £	s.	d.	Dividend Due.	Business Week to May 20. Highest.	Lowest.
		ELECTRICITY SUPPLY.							
10	9/0	Bournemouth & Poole Elec. Sup. Ord.	10½—11	6	7	0	Mar, Sept,	10½	10½
10	4/6	Do. 4½ per Cent. Cum. Pref.	9½—10½	4	7	0	Feb, Aug	..	..
10	6/0	Do. 6 per Cent. Cum. Second Pref.	10½—11	5	9	0	Feb, Aug	..	..
St.	4½%	Do. 4½ per Cent. Deb. Stock (red.)	102—105	4	5	6	Jan, July	104½	..
5	3/6	Bromley (Kent) El. Lt. & Power Shares	4½—5	5	10	0	April, Oct	..	..
St.	4½%	Do. Do. 1st Debs.	94—97	4	12	9	May, Nov	94½	..
5	5/6	Brompton & Kensington Elec. Sup. Ord.	6¾—7¼	6	9	0	March....	7	..
5	3/6	Do. 7 per Cent. Pref.	6¾—7¾	4	10	0	Mar, Sept	7½	..
St.	4%	Central Elec. Sup. Co. 4% Guar. Db. Stock	99—102	3	18	6	June, Dec	..	..
5	2/6	Charing Cross (W. End & City) El. Sup. Co.	3½—3¾	6	13	0	Feb, Aug	8[illegible]	..
5	2/3	Do. 4½ per Cent. Pref.	4⅜—4⅝	4	17	0	Feb, Aug	..	..
St.	4%	Do. 4 per Cent. Deb. Stock (red.)	96—99	4	1	0	Jan, July	..	..
5	2/3	Do. City Undertaking 4½% Cm. Pref.	3¾—4¼	5	8	6	Jan, July	..	..
5	2/6	Chelsea Electric Supply Ord.	3½—3⅝	6	4	0	March ..	3½	..
St.	4½%	* Do. 4½ per Cent. Deb. Stock (red.)	101—104	4	6	9	June, Dec	..	..
10	7/0	City of London Electric Lighting Ord.	9¾—10¼	5	17	0	Feb, Aug	9⅞	..
10	6/0	Do. 6 per Cent. Cum. Pref.	12—13	4	12	0	Jan, July	12⅝	12⅝
St.	5%	Do. 5 per Cent. Deb. Stock (red.)	124—127	3	18	0	June, Dec	..	.
St.	4½%	Do. 4½ per Cent. 2nd Deb. Stock (red.)	102—105	4	6	0	Jan, July	..	..
5	1/10½	County of Durham Elec. P.D. Ord.	2¾—3	8	9	7	April, Oct	.	..
5	5%	Do. 5 per Cent. non Cum. Pref.	3⅞—4⅛	3	9	7	April, Oct	4	..
10	6/0	County of London Elec. Supply Ord.	7¾—8¼	6	1	3	Feb, Aug	..	..
10	6/0	Do. 6 per Cent. Cum. Pref.	10¾—11¼	4	1	3	Mar, Sept	..	..
St.	4½%	Do. 4½% Deb. Stock (all paid) (red.)	107—110	4	2	6	Jan, July	..	..
St.	4½%	Do. Second Deb. Stock Prov. Certs.	96—99	4	11	0	May, Nov	..	..
5	3/6	Folkestone Electricity Supply Co. Ord.	4¾—5¼	5	7	0	April, Oct	..	—
5	2/6	Do. 5 per Cent. Cum. Pref.	5—5½	4	11	0	Mar, Sept	..	..
St.	4½%	Do. 4½ 1st Deb. Stock (red)	94—97	4	13	0	Feb, Aug	..	..
5	4/6	Hove Electric Lighting Ord.	6¼—6¾	6	7	0	April, Oct	.	..
5	5/0	Kensington & Knightsbridge Ord.	7—8	6	5	0	Feb, Aug	..	..
5	6%	Do. 6 per Cent. 1st Pref.	6—6½	4	12	0	Jan, July	..	..
St.	4%	Do. 4 per Cent. Deb. Stock (red.)	96—99	4	1	0	..	..	—
St.	4%	Kensingtn. & Kngtbg. Co. & Notting Hill Co. (Joint Station) 4% Deb. Stock (red.)	97—101	3	19	0	April, Oct	..	..
St.	4½%	Kent Elec. Power Co.	88—92	4	18	3	Jan, July	..	..
3	1/6	London Electric Supply Ord.	1—1½	5	0	0	Mar, Sept	..	..
5	3/0	Do. 6 per Cent. Pref.	4⅜—4⅞	6	3	0	Mar, Sept	4⅝	..
St.	4%	Do. 4 per Cent. 1st Mort. Deb.	90—93	4	8	0	Jan, July	..	..
5	3/6	Metropolitan Electric Sup. Ord.	4⅜—4⅞	6	16	0	April, Oct	4⅝	4⅛
5	2/3	Do. 4½ per Cent. Cum. Pref.	4⅝—4⅞	4	12	0	Jan, July	4⅝	4⅝
St.	4½%	Do. 4½ per Cent. Deb. Stock 1st Mort.	107—111	4	1	0	June, Dec	108½	..
St.	3½%	Do. 3½ per Cent. Mrt. Deb. Stock (red.)	85—90	3	18	0	Jan, July	..	..
100	4½%	Midland Elec. Corp. for P.D. 1st Mort. Db.	96—99	4	11	0	June, Dec	..	..
10	4%	Newcastle & Dist. Elec. Ltg. Ord.	7¾—8¼	5	0	0	Feb, Aug	..	—
100	4½%	Do. 4½ per Cent. Deb.	96—98	4	12	9	Jan, July	—	..
5	8%	Newcastle Elec. Supply Ord.	5⅝—5⅞	6	19	2	Feb, Aug	..	..
5	5%	Do. 5 per Cent. non Cum. Pref.	5⅛—5⅜	4	15	3	Feb, Aug	..	..
100	4%	Do. 4 per Cent. Mort. Deb. red. 1907.	96—98	4	2	6	Jan, July	..	..
1	3%	Northern Counties Elec. Sup.	—	..			Mar, Aug	—	..
100	4½%	Do. 4½ per Cent. Deb.	95—97	4	13	9	Jan, July	..	..
10	8/0	Notting Hill Electric Ord.	11¼—12¼	5	14	0	March ..	..	..
5	4/6	Oxford Electric Ord.	5⅞—6⅞	5	10	0	March ..	..	..
St.	4%	Do. 4 per Cent. Deb. Stock	94—98	4	1	6	Jan, July	..	..
5	5/0	St. James' & Pall Mall Elec. Ord.	7¼—8¼	6	1	3	Feb, Aug	7¾	..
5	3/6	Do. 7 per Cent. Pref.	6¾—7	5	0	0	Feb, Aug	..	..
St.	3½%	Do. 3½ per Cent. Deb. Stock (red.)	85—90	3	17	9	Jan, July	86¾	..
5	..	Smithfield Markets Electric Sup. Ord.	¼—¾	..			Feb	..	..
St.	4%	Do. 4 per Cent. Deb. Stock	70—74	5	8	0	Feb, Aug	..	..
5	4/0	South London Electric Supply Ord.	2⅜—2⅞	6	13	0	April ...	..	..
1	0/6	South Metrop'n Elec. Lt. & Power Ord.	⅜—⅝	4	0	0	..	..	..
1	0/8⅖	Do. 7 per Cent. Cum. Pref.	1 1/16—1 3/16	5	6	0	Feb, Aug	..	..
St.	4½%	Do. 4½ 1st Db. Stk. Red.	99—102	4	8	0	April, Oct	100¾	..
5	2/6	Urban Electric Supply Ord.	1—2	12	10	0	April, Oct	..	..
5	2/6	Do. 5 per Cent. Cum. Pref.	1⅝—2⅛	11	14	0	April, Oct	1⅞	1¾
St.	4½%	Do. 4½ per Cent. 1st Mort. Deb.	87—90	5	0	0	April, Oct	..	..
5	5/0	Westminster Elec. Sup. Ord.	7½—8	6	5	0	Mar, Sept	7⅞	7⅞
5	2/3	Do. 4½ per Cent. Cum. Pref.	4¾—5¼	4	5	6	Jan, July	5[illegible]	—
		ELECTRIC RAILWAYS, TRAMWAYS, &c.							
St.	4%	Baker St. & Waterloo 4% Perp. Db. St.	88—91	4	8	0	Jan, July	90¾	90
1	.	Bath Elec. Trams Pref. Ord.	⅜—⅝	8	0	0	April....	..	—
1	0/6	Do. 5 per Cent. Cum. Pref.	⅝—⅞	5	14	0	Jan, July	⅝	..
St.	4½%	Do. 4½ 1st Mort. Deb. Stock (red.)	85—90	5	0	0	April, Oct	..	..
St.	4½%	B'ham & Midland Trams 4½ 1st Db. Stk.	93—96	4	15	0	Jan, July	94½	93¼
10	9%	Bristol Tramways & Carriage Ord.	10—10½	8	11	9	Feb, Aug	..	..
10	4%	Do. Cum. Pref. (fully paid)	8—8½	4	14	0	..	..	..
St.	4%	Do. 4 per Cent. Debs.	99—100	4	0	0	Feb, Aug	..	..
10	..	British Electric Traction Ord.	1½—1¾	..			June, Dec	1½	1½
10	6/0	Do. 6 per Cent. Cum. Pref.	3¾—4¼	..			Feb, Aug	4[illegible]	3¾
St.	5%	Do. 5 per Cent. Perpetual Debs.	88—93	5	7	0	April, Oct	90½	..
St.	4½%	Do. 4½ per Cent. 2nd Deb. Stock	68—72	6	5	0	May, Nov	68½	..
St.	3%	Central London Ordinary Stock	82—85	3	10	6	Feb, Aug	84	77
St.	4%	Do. 4 per Cent. Pref. Stock	87—89	4	10	0	Feb, Aug	89	87½
St.	2%	Do. Deferred Stock	57—60	3	6	6	Feb	57	..
100	4%	Do. 4 per Cent. Debs.	100—103	3	18	0	Jan, July	100¼	..
St.	4%	Charing X, Euston & Hmpstd Per. Db. Stk.	81—84	4	15	3	Jan, July	..	..
5	2/6	City of Birmingham Trams. 5% Cm. Pref.	4¼—4¾	5	5	0	April, Oct	..	..
100	4%	Do. 4 per Cent. 1st Mort. Debs.	97—100	4	0	0	April, Oct	..	..
St.	1¾%	City & South London Rly. Con. Ord.	40—42	4	3	6	Feb, Aug	42	40½
St.	5%	Do. 5 per Cent. Perp. Pref. (1891)	113—116	4	6	0	Feb, Aug	..	—
St.	5%	Do. (1896)	112—115	4	7	0	Feb, Aug	..	..
St.	5%	Do. (1901)	110—113	4	8	6	Feb, Aug	..	..
St.	5%	Do. (1903)	106—109	4	11	6	Feb, Aug	..	..
St.	4%	Do. 4 per Cent. Perpetual Debs.	99—102	3	18	0	May, Nov	102	..
10	7/0	Dublin United Trams. Ord	12¼—13¼	4	10	6	Feb, Aug	..	..
10	6/0	Do. 6 per Cent. Pref.	12½—13½	4	9	0	Feb, Aug	..	—
10	..	Gt. Northern & City Rly. Pref. Ord. (4%)	¾—1¼	..			Feb, Aug	..	..
10	4/0	G. Northern, Piccadilly & Brompton Ord.	6—7	5	14	0	Feb, Aug	..	..
St.	4%	Do. 4 per Cent. Deb. Stock	86—90	4	9	0	Jan, July	88¼	86
5	4/0	Hastings & Dist. Elec. Trams. 6% Cm. Pf.	4—4½	7	5	0	Mar, Sept	4⅛	..
St.	4½%	Do. 4½ Db. St.	94—97	4	12	6	April, Oct	..	..
10	9%	‡ Imperial Tramways Ord.	10½—11½	7	17	0	Mar, Sept	..	..
10	6%	‡ Do. 6 per Cent. Pref.	[illegible]—10¼	5	17	0	Mar, Sept	..	..
St.	4½%	‡ Do. 4½ per Cent. Debs.	93—94	4	15	9	Jan, July	..	..
5	..	I. of Thanet E. T. & Lt. 5 per Cent. Pref.	⅞—1⅜	..			Mar, Sept	..	..
St.	4%	Do. 4 per Cent. Deb. Stock	58—63	6	7	0	Jan, July	..	—
10	6/0	Lanarkshire Tramways	9¾—10¼	5	12	0	Feb, Aug	..	..
St.	5%	Lancs. Utd. Trams 5% Prior Lien Db. St.	91—94	5	6	0	Jan, July	..	..
10	..	Liverpool Overhead Railway Ord.	1⅜—1½	..			Feb, Aug	..	..
10	5%	Do. 5 per Cent. Pref.	6¼—6¾	7	10	0	Feb, Aug	..	..
St.	4%	Do. 4 per Cent. Deb.	85—87	4	11	0	Jan, July	..	..
10	5/0	London United Trams. 5% Cum. Pref.	6¾—7¼	6	9	0	Jan, July	..	..
St.	4%	Do. 4 per Cent. 1st Mort. Deb. Stock	80—85	4	14	0	Jan, July	81½	—
St.	..	Mersey Con. Ord. Stock	1—3	—			Feb, Aug.	..	..
St.	..	Do. 3 per Cent. Perp. Pref.	3—6	—			..	..	..
1	..	Metropolitan Elec. Tramways Def.	½—[illegible]	..			April.. .	..	..
1	0/6	Do. 5 per Cent. Cum. Pref.	1⅛—1[illegible]	6	3	6	Feb, Aug	¾	..
St.	4½%	Do. 4½ per Cent. Deb. Stock	94—97	4	12	6	Jan, July	95¾	..
St.	½%	Metropolitan Railway Consolidated	44—45	1	2	0	Feb, Aug	45¼	43⅞
St.	2¾%	Do. Surplus Lands Stocks	63—68	4	1	6	Feb, Aug	67½	66¾
St.	3½%	Do. 3½ per Cent. Preference	86—89	3	19	9	Feb, Aug	86	..
St.	3½%	Do. 3½ per Cent. "A" Preference	75—78	4	9	6	Feb, Aug	75	..
St.	3½%	Do. 3½ per Cent. Convertible Pref.	73—76	4	12	0	Feb, Aug	..	..
St.	3½%	Do. 3½ per Cent. Debenture Stock	91—94	3	14	6	Jan, July	93	91½
St.	3½	Do. 3½ per Cent. "A" Ditto.	89—92	3	16	0	Jan, July	..	..

* In calculating the yield allowance has been made for accrued interest but *not* for redemption

ELECTRICAL COMPANIES' SHARE LIST.—*Continued.*

ELECTRIC RAILWAYS & TRAMWAYS (*Continued.*)

Share	Last Dividend	Name	Price Wed., May 20.	Rate % Yielded £ s. d.	Dividend Due	Business Week to May 20. Highest	Lowest
St.	..	Metropolitan District Railway Ord.	13 – 14	..	Feb, Aug	13⅞	12½
St.	..	Do. Extension Pref. (5 per Cent.)	20 – 25	..	Feb, Aug	21	20¾
St.	3½%	Do. Asserted Ext. Pref. (Int. Guar. by Und. Elec. Rlys. Co. of London, Ltd.)	44 – 48	7 6 0	Feb, Aug	..	.
St.	3%	Do. 3 per Cent. Consoltd. Rent-charge	73 – 78	3 17 0	Jan, July	..	..
St.	4%	Do. 4 per Cent. Midland Rent-charge	100 – 104	3 17 0	Jan, July	.	..
St.	1%	Do. Curr. Stock 4 per Cent	42 – 47	3 13 0	Mar, Sept	4⅞	4½
St.	6%	Do. 6 per Cent. Perp. Deb. Stock	110 – 115	5 4 0	Jan, July	..	..
St.	4%	Do. 4 per Cent. Ditto	66 – 71	5 12 0	Jan, July	66	65
5	..	New Gen. Tract. 6 per Cent. Cum. Pref.	½ – 1	..	May	..	–
1	0/9⅜	†Potteries Electric Traction Ord.	¼ – ½	8 0 0	April, Oct	..	..
1	0/6	Do. 5 per Cent. Cum. Pref.	½ – ¾	6 13 0	Feb, Aug	..	..
St.	4½%	† Do. 4½ per Cent. Deb. Stock	91 – 94	4 16 0	May, Nov	..	..
1	0/7½	S. Met. Elec. Trams. & Ltg. 6% Cm. Pref.	¾ – 1	6 0 0	Feb, Aug	..	..
St.	4%	Do. 4 per Cent. Deb. Stock	76 – 80	5 0 0	Jan, July	..	..
100	5%	Sunderland Dist. Elec. Trms. 5% 1st Mt. Db.	73 – 78	6 8 0	Jan, July	–	..
..	5%	Underground Elec. Rys. Co. of London	38 – 42	11 18 0	June, Dec	..	..
5	..	Yorkshire (W.R.) Elec. Trams. Ord.	1 – 1¼	–	March ..	..	..
5	..	Do. 6 per Cent. Cum. Pref.	3⅛ – 3⅝	–	..	..	..
St.	4½	Do. 4½ per Cent. 1st Debs.	84 – 87	5 3 6	Jan, July	.	..

ELECTRIC MANUFACTURING, &c.

Share	Last Dividend	Name	Price Wed., May 20.	Rate % Yielded £ s. d.	Dividend Due	Highest	Lowest
1	..	Aron Electricity Meter Ord.	3/16 – 5/16	..	..	..	..
1	1 2⅖	Do. 6% Cum. Pf.	11/16 – 13/16	7 7 6	April, Oct	..	..
1	2/4½	Babcock & Wilcox Ord	2⅞ – 3⅛	5 3 3	April, Oct	3 1/32	3 1/16
1	0/7½	Do. Pref.	1 7/16 – 1 9/16	3 16 9	..	..	..
5	6/0	British Insulated & Helsby Cables Ord.	6⅛ – 6⅝	7 10 6	July, Feb	6⅜	..
5	3/0	Do. 6 per Cent. Pref.	5⅝ – 6⅛	4 18 0	Jan, July	..	..
St.	4½%	Do. 4½ per Cent. 1st Mort. Deb. (red.)	102 – 105	4 5 6	Jan, July	..	..
St.	4½%	British Thoms'n-Houst'n 4½% 1st Mt. Db.	93 – 98	4 12 0	Mar, Sept	..	..
5	..	British Westinghouse 6 per Cent. Pref.	7/16 – 11/16	..	Feb, Aug	½	..
St.	4%	Do. 4 per Cent. Mort. Deb. Stock	45 – 50	8 0 0	Jan, July	..	..
2	..	Brush Electrical Engineering	½	–	March ..	..	..
2	..	Do. 6 per Cent. Pref. non-Cum.	3/16 – 7/16	..	Mar, Sept	..	..
St.	4½%	Do. 4½ per Cent. Perp. 1st Deb. Stock	70 – 75	6 0 0	Mar, Sept	..	..
St.	4½%	Do. Perpetual 2nd Deb. Stock	55 – 60	7 10 0	Jan, July	..	..
5	5/0	Callender's Cable Con. Ord.	10 – 11	6 16 0	Jan, July	..	..
5	2/6	Do. 5 per Cent. Cum. Pref.	5¼ – 5¾	4 7 0	Jan, July	..	..
St.	4½%	Do. 4½ per Cent. 1st Mort Debs. (red.)	106½ – 108½	4 2 6	Nov, May	107	..
1	1/7½	Castner-Kellner Alkali Co.	1 1/16 – 1 3/16	8 11 0	May, Nov	1 1/16	1 1/32
St.	4½%	Do. 4½ per Cent. 1st Mort. Deb. (red.)	101 – 104	4 6 6	Feb, Aug	103	101⅛
1	0/9⅜	Chadburn's (Ship) Telegraph Ord.	1 1/16 – 1 3/16	8 8 0	March ..	..	..
1	0/7½	Do. 6 per Cent. Cum. Pref.	1 – 1⅛	5 6 6	April, Oct	..	..
1	0/8	Consolidated Electrical Co.	¼ – ½	7 0 0	August ...	–	..
1	1/0	Consolidated Signal Co.	1½ – 1¾	4 5 6	April, Oct	..	..
1	0/7½	Do. 6 per Cent. Cum. Pref.	29/32 – 31/32	6 4 0	April, Oct	..	..
3	3/0	* Crompton & Co. (Nos. 1 to 85,000)	1⅛ – 1⅜	8 6 6	Jan, July	..	..
100	5%	Do. 5 per Cent. 1st Mort. Debs. (red.)	92 – 95	5 5 0	Jan, July	..	..
1	0/7½	Davis & Timmins	⅞ – 1⅛	..	Mar, Sept	..	..
5	2/0	Dick, Kerr & Co. Ord.	1 1/16 – 1 5/16	7 12 3	Sept	1⅛	..
5	0/7½	Do. 6 per Cent. Cum. Pref.	1 – 1¼	4 16 0	Sept ..	1 3/16	..
St.	4½%	Do. 4½ per Cent. Deb. Stock	100 – 103	4 7 3	Jan, July	..	–
5	2/6	Edison & Swan United ("A" Sh.) (£3 pd.)	⅝ – ⅞	..	Feb, Aug	23/32	..
5	4/2	Do. (£5 paid)	1½ – 2½	5 0 0	Feb, Aug	..	–
St.	4%	Do. 4 per Cent. Mort. Deb. Stock (rd.)	78 – 81	4 19 3	June, Dec	..	..
St.	5%	Do. 5 per Cent. 2nd Deb. Stock	85 – 87	5 15 0	Mar, Sept	–	..
5	..	Edmundson's Elec. Corp. Ord.	⅛ – ⅜	..	Jan, July	..	..
5	..	Do. 6 per Cent. Cum. Pref.	½ – 1	..	May, Nov	–	..
St.	4½%	Do. 4½ per cent. 1st Mort. Deb. (red.)	65 – 75	6 0 0	Jan, July	70	63
2	..	Electric Construction Co.	¼ – ½	..	Jan, July	..	..
2	..	Do. 7 per Cent. Cum. Pref.	1¼ – 1¾	..	July	..	..
St.	4%	Do. 4 per Cent. Perp. 1st Mort. Debs.	64 – 68	5 17 0	Jan, July	..	..
10	5/0	General Electric (1900) 5% Cum. Pref.	7¾ – 8¼	6 1 8	June, Dec	..	..
St.	4%	Do. 4 per Cent. 1st Mort. Debs.	87 – 90	4 9 0	Mar, Sept	..	–
5	10/0	Henley's Telegraph Works Ord.	10½ – 11½	6 10 0	Feb, Aug	11	..
5	2/3	Do. 4½ per Cent. Pref.	4⅞ – 5⅜	4 3 6	Feb, Aug	5⅛	..
St.	4½%	Do. 4½ per Cent. 1st Mort. Deb. Stock	106 – 108	4 3 0	Mar, Sept	..	..
10	15/0	India Rubber, Gutta Percha, &c., Wrks.	15½ – 16½	6 2 0	Feb, Aug	15 13/16	..
100	4%	Do. 4 per Cent. Debs. (red.)	98 – 100	4 0 0	April, Oct	–	..
1	2/0	National Elec. Construction Co.	⅜ – ⅝	..	April	..	..
1	0/9⅜	Richardsons, Westgarth & Co., Ltd. Ord.	7/16 – 9/16	7 2 0	Nov	..	..
1	0/7½	Do. 6 per Cent. Cum. Pref.	11/16 – 13/16	6 8 0	May, Nov	..	..
St.	4½%	Do. 4½ per Cent. Perp. Deb. Stock	87 – 91	4 19 0	Jan, July	87½	..
1	..	Simplex Conduits Ord.	1¼	..	..	–	–
5	..	Do. 6 per Cent. Cum. Pref.	5¼	..	..	..	..
12	30/0	Telegraph Construction & Maintenance	29 – 31	6 11 0	Mar, July	..	..
100	4%	Do. 4 per Cent. Deb. Bonds (1909)	100 – 103	3 17 6	Jan, July	101½	..
1	2/0	Vickers, Sons & Maxim, Ltd., Ord.	1 3/32 – 1 7/32	8 2 6	..	1 5/32	1 3/32
1	0/6	Do. 5 per Cent. non-Cum. Preference	15/16 – 1 1/16	4 14 6	..	1 1/32	..
St.	5%	Do. 5 per Cent. non-Cum. Preferred	101 – 105	4 15 6	..	..	..
St.	4%	† Do. 4 per Cent. 1st Mort. Db. Sk. (red.)	100 – 102	3 18 0	June, Dec	101½	101
100	4½%	Do. 4½ per Cent. 2nd Mort. Deb. (red.)	104 – 106	4 5 9	June, Dec	..	.
100		Do. 5 per Cent. 3rd Mort. Debs. Perp.	100 – 102	..	..	101½	101½
1	6/0	J. G. White & Co. 6 per Cent. Cm. Pref.	7½ – 8½	7 1 0	.	..	..
5	1/0	Willans & Robinson Ord.	¾ – 1¼	4 0 0	Apr, Oct	..	..
5	3/0	Do. 6 per Cent. Cum. Pref.	3⅜ – 3⅝	7 15 0	Apr, Oct	3⅜	..
100	4%	Do. 4 per Cent. 1st Mort. Debs.	72 – 77	5 4 0	May, Nov	..	..

TELEGRAPHS.

Share	Last Dividend	Name	Price Wed., May 20.	Rate % Yielded £ s. d.	Dividend Due	Highest	Lowest
10	.	Amazon Telegraph	2 – 3	–	June, Dec	..	–
100	5%	Do. 5 per Cent. Debs. (red.)	84 – 87	5 15 0	June, Dec	.	..
St.	15/0	Anglo American	57 – 60	5 16 0	F,My,Ag,N	60½	56
St.	30/0	Do. Preferred	100 – 102	5 18 0	F,My,Ag,N	101¼	99½
St.	1%	Do. Deferred	16 – 16½	6 1 6	F,My,Ag,N	16 11/16	15
St.	4%	Commercial Cable 4 per Cent. Deb. Stk.	84 – 87	4 12 0	Jn,Ap,Jy,O	84	..
10	6/0	Cuba Submarine Ord.	7½ – 8½	7 5 0	Feb, Aug	..	..
10	10/0	Do. Preference 10 per Cent.	16⅛ – 16⅝	5 19 0	Feb, Aug	..	..
5	2/0	Direct Spanish Ord.	3¼ – 3½	5 13 0	April, Oct	..	..
5	5/0	Do. 10 per Cent. Cum. Pref.	8 – 9	5 11 0	April, Oct		..
100	4½%	Do. 4½ per Cent. Deb.	100 – 102½	4 8 0	Jan, July	..	..
20	4/0	Direct United States Cable	13½ – 14	6 11 6	Ja,Ap,Jy,O	13 25/32	13½
100	4½%	Direct West India Cable 4½% Rg. Db. (rd.)	100 – 102	4 8 0	June, Dec	..	..
St.	15/0	†Eastern Ord nary ... ed & Bonus	129 – 134	5 5 0	Ja,Ap,Jy,O	132½	130
St.	17 6	† Do. 3½ per Cent. Pref. Stock	83 – 86	4 1 6	Ja,Ap,Jy,O	84½	..
St.	4%	Do. 4 per Cent. Mort. Deb. Stk. (red.)	100 – 102	3 18 6	May, Nov	101½	100¾
10	6/6	†Eastern Extension ... ed & Bonus	17¾ – 18¼	5 6 0	Ja,Ap,Jy,O	[illegible]	[illegible]
St.	4%	Do. 4 per Cent. Deb. Stock	100 – 102	3 18 6	Feb, Aug	101½	100
100	4%	Eastern & S. African 4% Mort. Deb. 1909	99½ – 101½	3 18 0	Feb, Aug	..	..
25	4%	Do. 4% Mauritius Sub. Debs. (red.)	99 – 101	3 19 0	May, Nov	..	..
10	2/6	G. N. Tel. (Copenhagen), with Coupon 73	29 – 31	6 1 3	Jan, July	29½	..
100	4½%	Halifax & Bermudas 4½% 1st Mt. Db. (red.)	100 – 102	4 8 0	June, Dec	..	..
25	22/6	Indo-European, F...	53 – 56	5 12 6	May, Nov	.	..
100	$1	Mackay Companies Common	68 – 63	6 7 0	Ja,Ap,Jy,O	..	..
100	$1	Do. Preference	62 – 66	6 0 0	Ja,Ap,Jy,O	..	..
1		Marconi's Wireless Teleg. Co.	⅜ – ½	..	April	..	..
100	4%	Pacific & European Tel. 4% Guar. Dbs. (red.)	98 – 101	3 19 0	June, Dec	..	–
2½	1/3	West Coast of America	1⅜ – 1⅝	8 17 0	May	..	..
100	4%	Do. 4 per Cent. Debs.	99 – 102	3 18 0	Jan, July	..	..
10		West India & Panama	¼ – ½	..	May, Nov	[illegible]	..
10	4/0	Do. 6 per Cent. 1st Pref.	5½ – 6⅛	6 17 0	May, Nov	..	..
10	3/0	Do. 6 per Cent. 2nd Pref. ... of ar.	8 – 9	..	May, Nov	..	..
100	5%	Do. 5 per Cent. Debs.	101 – 104	4 16 0	Jan, July	..	..
10	2/0	Western Telegraph	13¼ – 13¾	6 1 0	Mr,Jn,O,D	13½	13 5/16
St.	4%	Do. 4 per Cent. Deb. Stock (red.)	100 – 102	3 18 6	June, Dec	100¼	100¼
..		Western Union Teleg. ... 4% Bonds	76 – 80		..	..	..

TELEPHONES.

Share	Last Dividend	Name	Price Wed., May 20.	Rate % Yielded £ s. d.	Dividend Due	Highest	Lowest
100	2⅜	Amer. Telephn. & Telegh. Cap. St.	118 – 122	6 14 6	..	120½	120
..	4%	Do. Coll. Trust $1,000 4 per Cent. Bds.	83 – 86	4 13 0	Jan, July	..	..
St.	5%	Anglo-Portug'se Tel. 5% 1st Mt. Db. Stk.	98½ – 101½	4 19 0	Mar, Sept	100½	–
5	3/0	Chili Telephone	7 – 7½	5 6 6	August ..	..	..
1	0/7½	Monte Video Telephone Ord.	29/32 – 1 1/32	6 16 0	Nov	15/16	..
1	0/6	Do. 5 per Cent. Pref.	13/16 – 15/16	5 7 0	May, Nov	..	..
St.	6%	National Co. Pref. Stock	105 – 110	5 9 0	Feb, Aug	109½	109¼
St.	6%	Do. Def. Stock	109½ – 111½	5 7 6	Feb, Aug	111	109¾
10	6/0	Do. 6 per Cent. Cum. 1st Pref.	10½ – 12½	4 16 0	Feb, Aug	11	..
10	6/0	Do. 6 per Cent. Cum. 2nd Pref.	10½ – 12½	4 16 0	Feb, Aug	..	..
5	2/6	Do. 5 per Cent. non-Cum. 3rd Pref.	5⅜ – 6⅜	4 9 0	Feb, Aug	5 7/16	5⅜
St.	3½%	* Do. Deb. Stock 3½ per Cent. (red.)	98½ – 100½	3 9 6	June, Dec	98¾	..
St.	4%	Do. 4 per Cent. Deb. Stock (red.)	101½ – 103½	3 17 0	Jan, July	..	..
1	1/0	†Oriental	1 5/16 – 1 7/16	5 7 6	April, Oct	1 5/16	1 5/32
1	0 7½	† Do. 6 per Cent. Cum. Pref.	1⅛ – 1¼	4 16 0	April, Oct	..	..
St.	4%	Do. 4 per Cent. Red. Deb. Stock	90 – 93	4 6 0	Jan, July	..	..
St.	4½%	Telephone Co. of Egypt 4½% Db. Stk. (red.)	99 – 102	4 8 0	Jan, July	..	..
5	3/0	United River Plate	6¼ – 6¾	5 18 6	July	6½	6⅛
5	2/6	Do. 5 per Cent. Cum. Pref.	4⅞ – 5⅜	4 13 6	June, Dec	5	..
St.	4½%	Do. 4½ Deb. St. Red.	99 – 102	4 8 3	Jan, July	..	..

FINANCIAL, INVESTMENT, &c.

Share	Last Dividend	Name	Price Wed., May 20.	Rate % Yielded £ s. d.	Dividend Due	Highest	Lowest
5	8/0	Elec. & Gen. Investment 6% Cum. Pref.	3¾ – 4¼	7 1 0	Jan, July	–	..
10	2/0	Globe Telegraph & Trust	9¾ – 10¼	5 7 0	Sp De Mr Ju	10	9¾
10	3/0	Do. 6 per Cent. Pref.	13½ – 14	4 5 8	Sp De Mr Ju	14	13⅝
10	6%	Submarine Cables Trust (Cert.)	127 – 130	4 12 0	April, Oct	128	..

COLONIAL AND FOREIGN ELECTRIC RAILWAYS, TRAMWAYS, &c.

Share	Last Dividend	Name	Price Wed., May 20.	Rate % Yielded £ s. d.	Dividend Due	Highest	Lowest
5	3/0	Anglo-Argentine 6% Cum. 1st Pref.	6 3/16 – 6 7/16	4 13 0	April, Oct	6 7/16	6 11/32
5	5/0	Do. 10% Non-cum. 2nd Pref.	7⅞ – 8⅛	6 3 6	Jan, July	8 1/32	7 15/16
St.	6%	Do. Permanent 6% Deb. Stock	140 – 145	4 2 9	June, Dec	..	..
St.	5%	Auckland Elec. Trams. 5% Deb. (red.)	104 – 107	4 13 6	Jan, July	106	105½
5	4/0	Brisbane Electric Trams. Invest. Ord.	3¾ – 4	2 10 0	May	..	–
5	2 6	Do. 5 per Cent. Cum. Pref.	4¾ – 5	5 0 0	May, Nov	..	–
St.	4½%	Do. 4½ per Cent. Db. Prov. Certs.	98 – 102	4 8 0	Jan, July	..	..
St.	8%	British Columbia El. Ry. Df. Ord.	132 – 135	5 18 6	Mar, Sept	133	131½
St.	6%	Do. Pref. Ord. Stock	114 – 118	5 2 0	May, Nov	..	..
St.	5%	Do. 5% Cum. Perp. Pref. Stock	108 – 112	4 9 0	Jan, July	..	..
40	4½%	Do. 4½ per Cent. 1st Mort. Debs.	99 – 102	4 8 0	April, Oct	..	–
100	4½%	Do. Vancouver Power Debs.	101 – 104	4 6 6	Jan, July	..	–
St.	4½%	Do. 4½% Perp. Con. Deb. St.	98 – 101	3 19 0	..	..	..
5	3/0	Buenos Ayres & Belgrano Ord.	4 11/16 – 4⅞	8 1 6	April, Oct	..	..
5	3/0	Do. 6 per Cent. "A" Cum. Pref.	4⅝ – 5⅛	5 17 6	April, Oct	..	..
5	3/0	Do. "B"	4⅝ – 5⅛	5 17 6	April	..	..
St.	5%	Do. 5 per Cent. Debs.	110 – 116	4 6 0	Jan, July	–	..
St.	5%	Do. 5 per Cent. 2nd Debs. (red.)	102 – 105	4 15 3	Jan, July	..	..
St.	5%	Buenos Ayres Elec. Trams (1901) Ltd. Deb. St.	95 – 99	5 1 0	Ja, Jul ..	..	–
5	..	Buenos Ayres Grand National Ord.	2⅛ – 2⅝	..	..	2 3/16	..
5	2/6	Do. 5 per Cent. Cum. Pref.	3¾ – 4¼	5 18 0	Feb, Aug	3 13/16	..
100	5½%	Do. 5½ per Cent. Pref. Debs.	100 – 104	5 6 9	Jan, July	..	..
100	6%	Do. 6 per Cent. 1st Deb. Bonds.	98 – 102	5 17 0	April, Oct	..	..
St.	5%	Buenos Ayres Lacroze Trams 1st Mt. Db.	92 – 95	5 5 0	Mar, Sept	..	..
St.	6%	Buenos Ayres Port & City Tram. 1st Mt. Deb. Stock £75 Paid	64 – 68	6 12 0	Feb, Aug	..	..
5	2/6	Calcutta Tramways (1 to 137,610)	5¾ – 6¼	4 9 0	Mar, Sept	6 1/16	5¾
100	2/6	Do. 5 per Cent. Cum. Pref.	5 – 5¾	4 13 0	Jan, July	..	..
1	4½%	Do. 4½% 1st Deb. Stock (red.)	103 – 106	4 5 0	Jan, July	..	..
St.		Cape Electric Tram Shares	5/16 – 7/16	..	..	..	–
5	1/3	City of Buenos Ayres Trams Co. (1904) Sh.	5⅛ – 5⅝	4 9 0	F,My,A,N	5 11/32	5⅜
St.	4%	Do. 4 per Cent. Deb. Stock	98 – 102	3 18 6	June, Dec	..	..
..	5%	Colombo Tr. & Ltg. 5% 1st Mt. Db.	85 – 91	5 10 0	May, Nov	..	–
100	5%	Electric Traction Co. of Hong Kong 5 per Cent. 1st Mort. Debs.	87 – 92	5 8 6	June, Dec	..	..
1	5%	Havana Elec. Ry. Con. Mt. 5% $1,000 50 year Coup. Bds.	80 – 85	5 17 6	Feb, Aug	..	..
1	..	Kalgoorlie Elec. Trams Sh.	¼ – ½	..	..	..	..
100	5%	Do. 5 per Cent. "A" Deb. Stock	87 – 91	5 8 9	Jan, July	..	–
5	6%	Do. 6 per Cent. "B" Ditto	71 – 75	7 17 0	Jan, July	..	..
5	1/0	†Lisbon Elec. Trams. Ord.	1 – 1¼	4 0 0	July	..	..
100	0/7½	Do. 6 per Cent. Cum. Pref.	1 – 1½	4 16 0	Jan, July	..	–
St.	5%	Do. 5 per Cent. Reg. Mort. Debs.	90 – 95	5 5 0	Jan, July	..	..
St.	5%	Madras Elec. Trams. 5% Deb. Stk.	95 – 98	5 2 0	Jan, July	..	..
..	5%	Manila Elec. Ry. $1,000 Gold Bonds	86 – 90	5 11 3	Feb, Aug	.	
100	$1	Mexico Trams Co. Com. St.	89 – 91	4 8 0	..	90	88½
500	5%	Do. Gen. Con. 1st Mort. 5% Gold Bds.	87¾ – 88¾	5 13 0	..	88½	88
St.	4½%	Montreal St. Ry. Sterling 4½ per Cent. Debs. (1922)	101 – 103	4 7 6	Feb, Aug	..	..
1	1/0	Perth Elec. Trams Ord	9/16 – 11/16	7 5 6	May	11/32	..
St	5%	Do. 1st Mt. Db. Stock	103 – 106	4 14 3	Jan, July	..	–
5	3/0	Rangoon Elec. Trams & Supply Co. 6 Cum. Pf.	5½ – 5¾	5 4 0	..	..	–
St.	4½	Do. 4½% 1st Mort. Deb. Stk.	97 – 99	4 11 0	..	..	..
.	$2½	Sao Paulo Tramway, Light & Power Co. $100 Stock	129 – 134	6 14 0	..	131¾	..
	5%	Do. 5 per Cent. 1st Mt. $500 Db.	98 – 100	5 0 0	June, Dec	99	98½
100	4½%	Toronto Ry. Co. 1st Mt. 4½% Ster. Bonds	98 – 100	4 10 0	Feb, Aug	98	97½

COLONIAL AND FOREIGN ELECTRICITY SUPPLY, &c.

Share	Last Dividend	Name	Price Wed., May 20.	Rate % Yielded £ s. d.	Dividend Due	Highest	Lowest
5	8 0	Adelaide Elec. S'ply Co. 6% Cu. Pr.	4⅝ – 5⅛	6 17 0	Mar, Sept	..	–
10	5/2½	Bombay E. S. & T. 6% Cm. Pf.	10 – 10½	5 14 0	..	10¼	..
St.	4½%	Do. 4½ per Cent. Deb. Stk. (red.)	93 – 95	4 15 0	Jan, July	94½	93
5	3/3	Calcutta Elec. Supply Ord.	6 – 7	6 1 6	April, Oct	..	..
100	7/2	Canadian Gen. Elec. Co. Com. St.	88 – 92	10 17 0	..	90¾	89¾
100	5%	Castner Electrolytic Alkali Co. (of U.S.A.) 1st Mort. Stl. Debs.	94 – 99	5 1 0	Jan, July	.	..
500	5	Elect. Development Co. of Ontario	75 – 81½	6 8 6	..	77½	..
5	..	Elec. Ltg. & Trac. Co. of Aust. 6 per Cent. Cum. Pref.	2¼ – 2¾	..	Feb, Aug	..	..
St.	5%	Do. 5 per Cent. Deb. Stock	84 – 88	5 11 0	Jan, July	..	..
St.	5%	Elec. Supply Co. of Victoria 5 per Cent. 1st Mort. Deb. St.	90 – 93	5 7 6	Jan, July		..
St.	6%	Indian Elec. Sup. & Trac. Co. Deb. St. Rd. Prov. Certs.	95 – 98	6 2 0	Jan, July	..	..
100	0 3	†Kalgoorlie Elec. Power & Ltg. Ord.	[illegible]	..	..	..	..
1	0 7½	† Do. 6 per Cent. Cum. Pref.	[illegible]	8 0 0	April, Oct	..	–
St.	6%	Madras E. S. Corp. 6 per Cent. Constn. Deb. St.	80 – 85	5 18 6	April, Oct	80	..
500	5%	Mexican Elec. Light Co. 5% 1st Mort. Gold Bonds	76½ – 79½	6 5 6	..	78⅜	77¼
St.		Mexican Lt. & Power Co. Cap. St.	55 – 57	..	..	57⅛	5[illegible]
100	5%	Do. 5% 1st Mort. Gold Bonds	84 – 86	5 16 0	..	85¼	84⅜
100	6 2	†Montreal Lt. Ht. & Power Co. Cap. St.	96 – 99	6 1 0	F,My,A,N	98¼	98
1	1/...	River Plate Electricity Co. Ord.	[illegible]	6 8 0	April	[illegible]	⅞
1	1 2½	Do. 6 per Cent. non-Cum. Pref.	[illegible]	6 0 0	May	.	..
St.	5%	Do. 5 per Cent. Deb. Stock	96 – 99	5 1 0	Jan, July	98½	97½
5	3/0	Rosario Elec. Co. 6% Pref. (1–20,000)	[illegible]	5 17 6	April, Oct	..	..
100	$1	Shawinigan Water & Power Co. Cap. St.	65½ – 66½	5 18 0	..	66½	65½
..	5%	Do. 5 per Cent. Bds.	102 – 104½	4 17 0	Jan, July	103	102½
..	7 37d	Victoria Falls Power Co. Pref.	[illegible]	–	Jan, July	.	..

* In calculating the yields allowance has been made for accrued interest but *not* for redemption. † Ex dividend. ‡ The London Stock Exchange Committee have declined to quote these.

// THE ELECTRICIAN:

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CONTENTS OF THE CURRENT NUMBER.

NOTES.

Submarine Cables and Trawlers.

WE referred briefly last week to a matter which has now become the subject of diplomatic representation by the United States to our Government, and which is causing much concern to the Atlantic Telegraph Companies. Not that the matter has interest only for the companies conducting the Atlantic service, but for the moment this is its most important phase. For some time past great damage has been done to the cables which leave the Irish coast near Waterville for the United States, and the damage has now become of so continuous and serious a character that no less than six of the cables lying in these waters have been put out of service. Four of the damaged cables are the property of the Commercial Company, one of the Western Union Company and one of the Direct United States Company. There is some feeling that the British Cable Companies have suffered in the past from lack of sympathy from British Government Departments in this connection, and it is considered, therefore, that the matter having become international in character, American interests being involved, it will now be taken up in a more energetic manner, possibly conforming to a suggestion made, we believe, some time ago to the Government, that a naval vessel should be stationed somewhere off the Irish coast to protect the Atlantic cable zone, it being pointed out that the companies owning the cables have no prescriptive right to interfere with fishing operations in that zone. Of recent years submarine cables have been subject to serious damage from the heavy steam trawls and trawling gear which mark the development of deep sea fishing. This gear is capable of lifting immense weights and of operating down to 800 fathoms. Impact with this gearing, no matter how heavy the type of cable may be, results in serious injury, and we learn that the Anglo-American Telegraph Co. have during the past two years spent no less than £80,000 in repairs and renewals to cables in this particular area. The fishermen themselves will, we believe, welcome regulation, as they are also sufferers in that their nets are frequently damaged while operating in waters where the cables are situated. It is agreed, too, we believe, that the waters off the Irish coast where the trouble is now centred are not essential to fishing operations.

THE repairs of the injured cables are being promptly effected, and we understand that, pending any protection by the Government, the Commercial and Anglo Companies are despatching a vessel with the object of warning fishermen against trawling in the neighbourhood of the cables. The question of the protection of submarine cables has been, we believe, placed before the International Telegraph Conference now sitting at Lisbon, and the opportunity appears favourable for giving the subject that full consideration which its importance commands. Apart altogether from the money value at stake, there is high political necessity for international protection

Leadless Paper Cables.

THERE is no disguising the fact that the expenditure required for cables on an electricity supply network is disproportionately great compared with that required for the generating plant. For much of this capital outlay the lead-covered paper cable is responsible—despite its favourable cost in comparison with rubber—because, not only are special precautions necessary in its manufacture, but its transportation and laying are matters needing more than ordinary care. The fact that many hundreds of miles of lead-covered cables are giving satisfactory service to-day is proof positive of the efficiency of the means taken to render them reliable under existing conditions. Still,

this cannot be accepted as evidence in support of the cost by which such results are obtained. To put it plainly, engineers would welcome the introduction of a form of insulation which would maintain the high standard of the present types and at the same time reduce the initial outlay on the cable and the process and labour of its laying. On another page of this issue we refer to some tests made during the present week with cables which are both novel and interesting from the electricity supply point of view. The material employed for coating the conductors—"Liconite" by name—appears to have moisture-resisting properties combined with a capacity for high dielectric strength which, if substantiated by operating experience, must ensure for its application to cable practice a promising future. The cable possesses the merit of some two years' practical research and experiment, and may, therefore, escape criticism on the score of immature introduction, but the favourable optimism of the engineers who have taken it up has yet to be tempered by encounter with the hard and bitter facts of service. Cable tank tests are useful and necessary, but they produce little or nothing which can be laid by the side of practical working results. Pressure tests will or should assist in the acceptance of trial lengths of the new cable, and we hope they may serve their purpose in this way. At any rate, the maker's claims and tests merit attention, in that they are likely to affect a question of vital importance to the installation and conduct of electricity supply undertakings. It is claimed that by the use of Liconite cables the initial cost of underground transmission will be reduced 25 per cent. below that prevailing at the present time with lead-covered and kindred cables. While we accept this statement with every reserve, we cannot but hope that no time will be lost in hastening its practical confirmation. Unfortunately the very nature of electric cables, and the uses to which they are put, render any change from standard methods very slow and difficult of accomplishment. The field of practical utility becomes necessarily narrowed, for the time being within the limits of brand new installations, and even in such cases practical experience is necessary to induce complete confidence. We wish the Liconite leadless cable every success.

Is the Consulting Engineer Necessary?

In a letter on this subject which we publish this week in our Correspondence columns, Mr. E. H. Freeman points out that the Institution of Electrical Engineers seems to take no interest in the commercial questions connected with the applications of electricity, whereas corresponding bodies in other professions take a keen interest in such matters. For example, the Royal College of Surgeons, the Law Society and the Royal Institute of British Architects all take an active interest in such questions. The reason for this is probably due to the fact that these bodies are more or less homogeneous, whereas the Institution must be described as essentially heterogeneous. The Royal Institute of British Architects, for instance, consists of architects; it does not include equally builders, brickmakers, stonemasons and the manufacturers of building plant. Consequently, it can deal efficiently with all matters of interest to the architect. The Institution of Electrical Engineers, on the other hand, is concerned with so many interests that it leaves them all alone when commercial questions are under consideration. Thus matters of great importance to consulting engineers are left practically untouched because they are not of interest to the manufacturer, or because, perhaps, the views desired by consulting engineers are somewhat in conflict with those of the manufacturer. Similarly, points which are of the greatest importance industrially to the manufacturer and to the contractor are not considered, because, possibly, they do not appeal to the consulting engineer, and are certainly distasteful to the professor. For these reasons, unless the Council of the Institution care to adopt entirely different methods in the future from those in the past, no action can be expected on such a subject as the relations of the consulting engineer to the contractor, and some independent association, as suggested by Mr. Freeman, becomes essential. Not only is this the case for the consulting engineer, but it is equally so for the manufacturer and for the contractor. Each association should be thoroughly representative, and should work in conjunction with the others to see that the respective interests are maintained to the advantage of the electrical industry generally.

Alternating Current Distribution Losses.

It is a well-known fact that whereas an alternating-current supply network operates at its maximum efficiency at times of heavy load, a continuous current network is then working at its minimum efficiency. Similarly, an analysis of the working results of alternating and continuous current supply systems shows that, whereas in the former systems the proportion of units metered to those generated varies from 75 to 80 per cent., depending to some extent on the nature of the load, in the latter this proportion is about 90 per cent. This difference causes the generating costs of alternating current electricity supply stations, when worked out on the usual basis of pence per unit sold, to appear at a disadvantage of at least 10 per cent. in comparison with those stations supplying continuous current. It has been always considered that this increased running cost has been partly, if not entirely, compensated for by the saving in capital expenditure on mains, so that any means whereby the efficiency of distribution in such cases can be considerably increased should certainly produce a balance in favour of alternating current supply. The system designed by Mr. A. F. Berry, of the British Electric Transformer Co., and of which a description appears elsewhere in this issue, provides the central station engineer with a simple yet reliable means for reducing the light load losses of an alternating current network to only a small fraction of their former value, thereby, of course, raising the efficiency of the whole system. The process merely consists in using at times of light load small auxiliary transformers, which are automatically short-circuited when the load increases above the safe limit, the main transformers in series with these auxiliary transformers then coming into operation. It may, of course, be objected that such a system entails a good deal of additional outlay, but this is not the case, for, as we show elsewhere, the rating of the main transformers can be considerably increased, since they are always cool when required for use. This, obviously, is of great importance, and we feel sure

that the resulting advantages will be fully appreciated by engineers in charge of alternating current supply systems; in fact, many of these engineers are already convinced of the great economies obtainable by the Berry "series system," as it is termed by the inventor.

The late Mr. London.—A Reuter's telegram from Mombasa states that the five natives sentenced to death for the murder of Mr. London have appealed to the Privy Council.

Obituary.—We regret to record the death of M. A. de Lapparent, Secrétaire perpétuel de l'Académie des Sciences, which occurred on May 4th. M. Lapparent, who was 69 years old at the time of his death, will be chiefly remembered for his geological work and from the fact that he was secretary of the Committee appointed in 1863 to consider the Channel Tunnel scheme. He was elected to a secretaryship of the Académie only last year on the death of M. Berthelot.

University of Oxford.—It is announced that Mr. C. F. Jenkin, B.A., of Trinity College, Cambridge, has been elected to the newly constituted professorship of engineering science at Oxford. Mr. Jenkin, who was born in 1865, is a son of the late Prof. Fleeming Jenkin, F.R.S., of Edinburgh. Of late years he has been connected with Messrs. Siemens Bros. & Co., as manager of their railway department. Thus Oxford has followed the example of other Universities in appointing a practical engineer to a chair of engineering.

Wireless Telegraph Notes.—It is announced by the *Standard* from Ottawa, that the Canadian Government have been notified that H.M. Government have definitely decided to ratify the Radio-Telegraph Convention. The adhesion of Great Britain and all her dependencies except Newfoundland will, it is stated, be notified to Germany before July 1st. The other countries which have to date notified adhesion are said to be Denmark, Norway, Roumania, Belgium, the Netherlands, Mexico and Sweden.

Correction.—In the article describing the Piccadilly Hotel installation in our issue of May 8th, we referred to the "Diamond H" switches, which have been installed throughout this hotel, as "Hart" switches. As there is another switch marketed under this name we take this opportunity of stating that the switches in the Piccadilly Hotel are "Diamond H" switches made by the Hart Manufacturing Co. The European branch of this company is at 72, Victoria-street, Westminster, S.W., of which the manager is Mr. Wm. Crichton.

The late Mr. F. H. Webb.—We regret that in the obituary notice of Mr. F. H. Webb, which appeared in last week's issue of *The Electrician*, there was a slight inaccuracy. Although Mr. Webb's connection with the Institution of Electrical Engineers dated from 1878, the Institution was founded seven years earlier, in 1871, under the title of the Society of Telegraph Engineers, the first secretary (honorary) being Major Sir Francis Bolton. It was in 1883, five years after Mr. Webb's appointment, that the Society was incorporated under the altered name of "The Society of Telegraph Engineers and Electricians," and the change to the present title was sanctioned in 1889.

Newcastle Section of the Institution of Electrical Engineers. At the annual general meeting of this section to be held this evening in the Electrical Engineering Lecture Room, Armstrong College, Newcastle, the following will be proposed as officers and committee for the ensuing session: *Chairman*—Mr. A. L. E. Drummond. *Vice-Chairman*—Mr. W. D. Hunter. *Past Chairmen*—Prof. W. M. Thornton, Mr. H. L. Riseley, Mr. J. Pigg. *Committee*—Messrs. J. H. Holmes, G. G. Stoney, G. Ralph, C. S. Vesey Brown, A. S. Blackman, C. Turnbull, F. Tremain, J. A. Anderson, E. Fawssett, H. W. Clothier, H. Henderson, T. M. Clague, W. T. Dalton, A. H. Law and G. S. Whitmore. *Hon. Secretary*—Mr. C. Faraday Proctor. *Hon. Treasurer*—Mr. W. A. Clatworthy.

Cable Interruptions and Repairs.

	Date of Interruption.	Date of Repair.
Cayenne—Salinas	May 12, 1908	—
Las Palmas—Arrecife	May 18, 1908	—
Angleterre—Guernsey	May 20, 1908	May 25, 1908

Municipal Tramways Association.—The meeting of the Managers' Section of this Association opened at Wolverhampton yesterday, and will be continued to-day. The members were welcomed by the Mayor of Wolverhampton, and by the chairman and members of the Tramways Committee. The following subjects were then submitted for discussion: "Description of the Wolverhampton Tramways System," introduced by Mr. W. A. Luntley, and "Car Building in Departmental Workshops," introduced by Mr. J. Ferguson. A visit was paid to the Car Depot and the Lorain Surface Contact System was inspected. In the evening the members attended a dinner at the invitation of Ald. C. T. Mander, chairman of the Tramways Committee. To-day the following subjects will be discussed: "Tramway Rating Valuations and Income Tax Assessments," introduced by Mr. F. A. Mitcheson, and "Tabulated Information respecting the Distance at which a Tramway Passenger, paying a Penny Fare, ceases to be remunerative," introduced by Mr. C. W. Mallins.

Fire on the City & South London Railway.—The daily papers on Monday morning announced, with the accompaniment of more or less startling head-lines, a fire at Clapham Common station on the City & South London Railway, which had occurred during the early hours of Sunday morning. This was ascribed, as is usual, to electrical causes, and was said to be due to some fault on one of the locomotives, thrilling accounts being given of the hazardous nature of the firemen's work owing to a short-circuit. It appears that these accounts are somewhat exaggerated, for the fire occurred at a time when the line was "dead," and we are informed by Mr. P. V. McMahon, chief engineer of the City & South London Railway, that, though the actual cause is not yet known, it was certainly not electrical. The fire may have been due to the emergency oil lamp, which is left burning all night, setting fire to some waste or to some such similar cause. At any rate, Mr. McMahon's refutation disposes of another "electrical fire."

Institution of Electrical Engineers.—The annual general meeting was held yesterday morning in the rooms of the Institution at 92, Victoria-street, S.W., the number of members present being larger than usual at such gatherings.

The annual report of the Council was approved, as were also the statement of accounts and balance-sheet for the year ended December 31, 1907. The premiums for Papers and communications have been awarded by the Council as follows: The Institution Premium, value £25, to Messrs. G. Stoney and A. H. Law, for their Paper on "High Speed Electrical Machinery"; the Paris Electrical Exhibition Premium, value £10, to Mr. J. S. Peck for his Paper on "Protective Devices for High-tension Transmission Circuits"; and extra premiums, each of the value of £10, to Mr. J. F. C. Snell, for his Paper on "The Cost of Electrical Power for Industrial Purposes"; to Dr. A. Russell, for his Paper on "Dielectric Strength of Insulating Materials and Grading of Cables"; to Dr. W. W. Haldane Gee, for his Paper on "Electrolytic Corrosion"; and to Mr. T. M. Barlow, for his Paper on "Heat Conductivity of Iron Stampings." Students' premiums have been awarded to Messrs. H. R. Speyer, L. H. A. Carr, A. Hamilton, H. W. Gregory and P. C. Jones. The President (Col. R. E. Crompton, C.B.), in commenting on the report of the Council, said that he was pleased to be able to announce that within the last two days a grant of £100 a year had been made by the Government in connection with the work of the International Electrotechnical Commission. He also announced that, as no nominations had been received other than those made by the Council at the ordinary general meeting of April 30th, the Council nominees were duly elected to their respective offices. The names of the members of the new Council are, therefore, as given in our issue of May 1st. The meeting terminated with the usual votes of thanks to the officers of the Institution.

ARRANGEMENTS FOR THE WEEK.

FRIDAY, May 29th (to-day).

NEWCASTLE SECTION OF THE INSTITUTION OF ELECTRICAL ENGINEERS.

8 p.m. Annual General Meeting in the Electrical Engineering Lecture Room, Armstrong College, Newcastle-on-Tyne. Paper on "Overload," by Mr. C. Turnbull.

MONDAY, June 1st.

SOCIETY OF ENGINEERS.

7.30 p.m. Meeting at the Royal United Service Institution, Whitehall. Paper on "The Engineering Pros and Cons of the Metric System," by Mr. A. H. Allen.

FRIDAY, June 5th.

ROYAL INSTITUTION.

9 p.m. Meeting at Albemarle-street. Discourse on "The Nadir of Temperature and Allied Problems," by Prof. Sir James Dewar, F.R.S.

ELECTRIC TRACTION ON THE BAVARIAN STATE RAILWAYS.

The question, whether or not electric traction should be adopted on main lines, is a many-sided problem admitting of no general solution. The opinion has been expressed in this country that no decrease in running costs is to be expected, but it is said the introduction of the new system will be an advantage on account of increased capacity and receipts ensuing. In any case, the root-principle of the matter is, financial, and in this country, where coal is good and comparatively cheap, the advantages are not so apparent as in other countries where the coal is poor in quality and dear.

A country in which the latter drawback is very evident is Bavaria. But it is happy in possessing a large number of waterfalls, making the possibilities of this system of power generation worth considering.

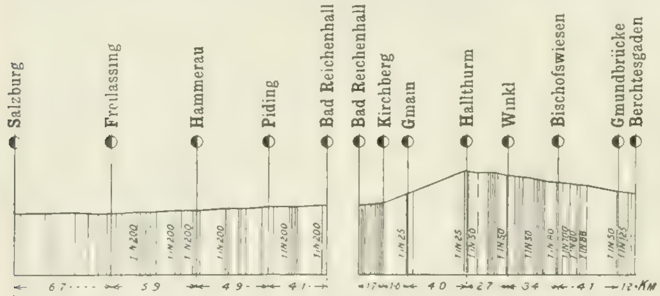

Fig. 1.—Gradient Profile of the Salzburg-Bad Reichenhall-Berchtesgaden Line.

With this object in view, the Bavarian Government authorities a few years ago examined, and subsequently issued a report on, the uses to which the water power of that country could be put. This report stated the water power available to be of special value for railway working and recommended that the question of the adoption of electric traction be considered from this point of view, and certain lines of railways be named on which the conversion could first be most suitably undertaken. The main result of this recommendation has been the issue of a further report entitled "The Introduction of Electric Traction on the Bavarian State Railways," with a copy of which we have been favoured, dealing very fully with the salient questions, and containing much of interest to electrical engineers. As the matter, if not exactly burning in this country, is at any rate smouldering, we propose in what follows to deal with the subject at some length.

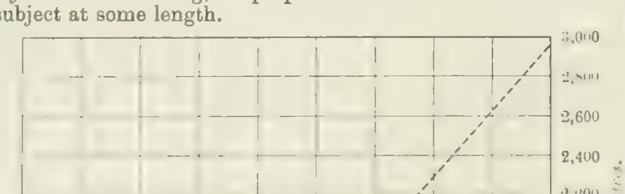

Fig. 2.

The report is divided into three main parts, in the first of which the power required, if the whole of the railways under the jurisdiction of the Bavarian Government, totalling 3,976 miles in 1906, were converted to electric traction, is considered together with the system to be employed and the commercial efficiency of this method of working as a whole. The second part contains the results of estimates of working costs made on the routes it is proposed to convert to electric traction, these being the main line from Salzburg to Freilassing and the branch from Freilassing to Bad Reichenhall. The section from Bad Reichenhall to Berchtesgaden is a light railway. Further, it is proposed to adopt electric traction on a new main line

Table I.—*Traffic Details of the Bavarian State Railway System for an Average Day in July, 1906.*

—	Traffic. in ton-miles. Gross.	Percentage.	Energy in kw.-hrs.	Percentage Of traffic.	Percentage Of total.	Energy per gross ton-mile in watt-hrs.
Main Lines.						
Passenger traffic...	8,532,856	34·5	574,890	44·2	40·0	66·8
Goods traffic	14,742,730	59·6	646,010	49·7	45·0	43·5
Branch Lines.						
Passenger & goods traffic	1,453,746	...	78,525	6·1	5·5	53·4
Total	24,729,332	...	1,299,425	100·0	...	52·2
Shunting............	...	...	135,400	...	9·5	..
Total energy for operation of the State railways	...	...	1,434,825	...	100·0	57·6
Ditto on privately-owned lines	200,080	...	12,270	...	...	61·1
Grand total..	24,929,412	...	1,447,095	...	...	57·6

Table II.—*Estimated Electrical Energy for the Electrical Working of the Bavarian State Railways during 1906.*

——	Traffic in ton-miles. Gross.	Percentage.	Energy in kilowatt-hours.	Percentages of I.	Percentages of II.	Percentages of III.
Main Lines.						
Pass. traffic...	2,692,230,708	31·12	181,291,500	38·14	35·01	33·98
Goods traffic..	5,532,562,621	63·94	242,540,500	51·03	46·84	45·47
Branch Lines.						
Pass. & goods traffic	427,303,116	4·94	23,074,000	4·85	4·46	4·33
Train heating...	...	...	28,378,000	5·98	5·48	5·32
I. *Total for running req'ments*	8,652,096,847	100·00	475,284,000	100·00	...	...
Shunting...	...	...	42,555,000	...	8·21	7·98
II. *Total for traffic req'ments*	..	...	517,839,000	...	100·00	...
Station lighting	...	...	12,575,000	...	...	2·36
Motors......	...	...	2,986,000	...	...	0·56
III. *Grand total*	...	...	533,400,000	.	...	100·00

from Garmisch-Partenkirchen to the frontier at Scharnitz and on a new local line from the same place to the frontier at Greifen. Several existing lines which radiate from Munich will also be converted. The erection of the hydro-electric stations necessary for the supply of power to these lines is also considered and the report concludes with a summary of the decisions arrived at by a survey of the whole question. To the electrical engineer the appendix will be the most interesting section, for in it are considered the pros and cons of the problem from a technical point of view, and it contains what is practically a specification of the work to be carried out.

The first question to be considered in dealing with a matter of this kind is the power required. To find whether the available water power of the country would be sufficient to operate the whole railway system, were it converted, the average daily load with the corresponding energy consumption was determined from a consideration of the ton-miles run during July, 1906, the heaviest month of that year. The results are given in Table I., while the estimated number of kilowatt-hours required for working various sections of the system are shown diagrammatically in Fig. 3, which is self-explanatory.

From a consideration of these results it is estimated that the average daily consumption when all lines are worked by electric traction would be 1,435,000 kw.-hours, while, taking into consideration the various losses, the equivalent horse-power-hours at the turbines would be 3,400,000 and the mean daily load 142,000 H.P. Fig. 2 shows the increase in car-mileage during the period from 1875 to 1906, the dotted line being the mean increase over the same period. By producing this, as shown, it is estimated that the mean load due to the railways in 1920 will be 202,000 H.P. and the maximum load 606,000 H.P. It is not, however, quite equitable to take only one month, especially in the summer, as the criterion for the year, and further calculations show that though the difference is small, there is a variation from month to month, and taking this into account Table II. gives the similar results to those set out in Table I., but applicable to the whole of 1906. According to the report on the water power of Bavaria referred to above, the minimum horse-power available is 300,000. But, taking into consideration probable storage arrangements, and as the figure given above is only a minimum, it is concluded that the water power available will be sufficient to provide the amount necessary for working the railways by electrical means.

As regards the system of traction to be used the claims of direct current, three phase and single phase are exhaustively considered, the various advantages and disadvantages being fully gone into. As a result it is considered that, in the present state of the industry, the single-phase system is quite capable of meeting, and best fulfils, the demands of main line electrical working.

The next section of the report deals generally with the financial side of the question. Its solution is very different from that possible with steam traction, as the various factors are often quite incomparable in the two cases. The points raised are practically repeated when the question of cost of equipment of the particular lines is considered and we shall deal with it below in its proper order. It will suffice at this point to quote the following paragraph which shows that the views on this question in this country and in Germany are not widely different and any development will, it appears, proceed along similar lines in the two countries.

The paragraph is as follows: "The important question, whether adoption of electric traction will be financially advantageous, is answered in the following manner in this report: It is cheaper if the cost of the electrical energy does not exceed a certain amount. Should this amount be exceeded then electric traction is more costly. No financial adv ntages can in that event be expected, but there is a gain on account of the greater efficiency of electric working—*e.g.*, higher working speed, freedom from smoke, &c. But if the cost of electrical energy is below this amount the financial advantages are, *ipso facto*, greater. The first cost of the generating station greatly influences the cost of electrical energy, while this is correspondingly reduced if any current not required for traction purposes can be supplied to other consumers."

The next section of the report deals very fully with the financial side of the problem. Estimates are given, not only for the actual conversion, but for the expected working costs in 1910, when, it is hoped, the new system will be in full working order. These latter are compared with the estimated cost of steam traction in that year, had it been retained, and thus an interesting set of figures is obtained. It is only proposed to deal here with one of these lines, as the results obtained with the others agree very well with figures of the one selected. The section chosen is the main line from Salzburg to Freilassig, and a branch from the latter place to Bad Reichenhall and Berchtesgaden, a distance of 25 miles in all. It is well selected, for the traffic is exceptionally heavy, owing to the attractions of the neighbourhood, though naturally the greater portion of this is confined to the main line section. The general character of the line is shown in the gradient profile given in Fig. 1.

The adoption of electric traction on this section will offer special advantages. The character of the branch line has up to the present made it necessary for all locomotives to be changed at Bad Reichenhall; with electric traction this will not be necessary, and besides gaining time a good deal of smoke nuisance will be avoided. Further, the great acceleration of the electric locomotive will allow the single line sections to be more efficiently worked, while its better hill-climbing capacity will be an advantage, as a reference to Fig. 1 will show that the section is by no means easy. It is proposed to use single-phase current supplied from a generating station at Saalach at a voltage of 10,000, the locomotives being equipped with commutator motors. It is hoped to reduce the time on the journey from Salzburg to Bad Reichenhall from 45 to 50 to 32 to 40 minutes, and on the remaining section to reduce the time taken over one complete journey, go and return, by 35 minutes. The mean load on the turbines during a 20 hour day from 5 a.m. to 1 a.m. is expected to be 660 H.P.

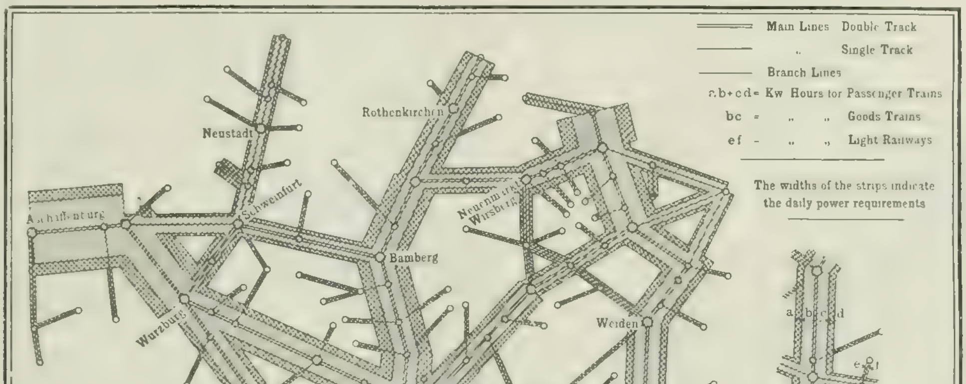

FIG. 3.—DIAGRAM SHOWING REQUIREMENTS OF BAVARIAN RAILWAYS.

Salzburg, Freilassing and Bad Reichenhall are indicated in the right-hand lower corner.

For the equipment of this line the following sums have been voted: £39,000 for the provision of the necessary locomotives; £35,050 for the track equipment, including the cost and erection of trolley and span wires, insulators, masts, &c. For trolley wires hard-drawn copper wire of 0·4 sq. in. in section will be used. £6,000 for feeders, which will be seven in number, varying from 0·1 sq. in. to 0·15 sq. in.; £8,450 for altering the telephone and telegraph wires and for making certain structural altera ions to turn-tables and other similar equipment. A total of £49,500 will, therefore, be needed for this purpose, which, together with the sum mentioned above for locomotives, makes a grand total of £88,500.

During the year 1906-07 (May-April) the number of train-miles run on this section was 79,139 on the main line and 50,900 on the branch—a total of 130,039. The working costs are set out in Table III.

By a consideration of the curve in Fig. 2, together with other similar data, it has been estimated that in 1910 the figures given above for train-miles will have increased to 83,033, 62,630 and 145,663 respectively, and, further, that the electrical energy re-

Table III.—*Cost of Working the Section Salzburg-Bad Reichenhall-Berchtesgaden during 1906-07.*

	Salzburg-Bad Reichenhall.	Bad Reichenhall-Berchtesgaden.	Salzburg-Bad Reichenhall-Berchtesgaden
Wages	£1,478	£921	£2,399
Fuel, water, oil, &c	2,552	2,432	4,985
Repairs and maintenance of locos.	1,013	1,254	2,267
Interest and depreciation of locos.	786	871	1,652
Total	£5,829	£5,478	£11.303
Per train-mile	17·4d.	25·44d.	20·76d.

Table IV.—*A Comparison between the Estimated Cost of Steam and Electric Traction on Salzburg-Bad Reichenhall-Berchtesgaden Line in 1910.*

	Cost of steam working.		Cost of electric working (excluding the cost of energy)	
	Total.	Per train-mile.	Total.	Per train-mile.
Wages	£2,662	4·26d.	£1,431	2·30d.
Fuel, water, oil, &c.	5,866	9·38d.	67	0 10d.
Locos., repairs and m'tenance	2,662	4·26d.	2,250	3·60d.
,, interest & depreciation	1,938	3·10d.	2,496	4·00d.
Repairs, m'tenance, interest and depreciation of overhead & track equipment	...	...	2,738	4·38d.
Total..............................	£13,149	21·00d.	£8,982	14·38d.

Estimated Electrical Energy Consumption on this Section.

	Kilowatt-hours.
Train working	1,448,270
Shunting	29,370
Braking	14,235
Train lighting	3,900
Train heating	81,350
Total	1,577,125
Line losses	118,875
Total at station	1,696,000

quired for that year will be 483,500 kw.-hours on the Salzburg-Bad Reichenhall section, 306,250 kw.-hours on the same section in the other direction and 364,040 and 294,400 kw.-hours on the section from Bad Reichenhall-Berchtesgaden and vice versa, making a total of 1,448,270 required for actual train operation. The amounts required for shunting, braking, heating and light bring this total up to 1,577,124 kw.-hours, which, with the network losses, make, in round numbers, a grand total of 1,700,000 kw.-hours at the generating station.

The question of comparative cost is then gone into, the results obtained being set out in Table IV.

This shows that an amount of £4,167 is available for electric power purposes in order that the actual cost of the two systems shall be the same. Taking the number of kilowatt-hours given above, this allows the cost per kilowatt-hour to be practically 0·5d. without there being any loss. Other lines are considered in the same way, and similar results arrived at though the permissible cost per unit is not so high as in the other cases.

The first cost of building and equipping a suitable generating station at Saalach for supplying this line is estimated at £75,000, though as it is possible that power may also be sold to other consumers the cost may be increased to £100,000. But it is estimated from a consideration of other similar stations that the cost per unit will not exceed 0·15d.—*i.e.*, the necessary kilowatt-hours for railway purposes will cost £1,250, and the estimated saving obtained by the introduction of electric traction is, therefore, £2,917.

The report is summed up in the following "principal conclusions":

1. The introduction of electric traction on main line railways is technically possible both with motor cars and heavy locomotives.

2. Single phase alternating current may, in the present condition of our knowledge, be said to be the system which best fulfils the demands of main line working.

3. Electric traction offers distinct advantages under all circumstances—*e.g.*, the increase in travelling speed and the avoidance of the smoke nuisance.

4. The energy necessary for working the Bavarian State Railways can be supplied by a part of the available water power. Should the adoption of electric traction be only dependent on this, the carrying out of the project would be designed on this basis. It might, however, be opposed on military or technical grounds.

5. The question whether, for military reasons, the adoption of electric traction will be limited cannot yet be answered. But the military authorities have requested that it be first introduced on lines of secondary importance, while the operations of these lines will help towards a more definite solution.

6. The further question, whether the adoption of electric traction offers advantages over steam working, both in technical and financial directions, is answered by the fact that electric traction is financially on equal terms if (*a*) the cost of electrical energy does not exceed a certain limit, and (*b*) there is a certain density of traffic. These conditions are better fulfilled by the lines in southern than by those in northern Bavaria, as in the south coal is dearer, and electrical energy cheaper, on account of the available water power, than in the north.

7. It is thought that the adoption of electric traction on the lines Salzburg-Bad Reichenhall-Berchtesgaden and from Garmisch-Partenkirchen to Scharnitz will be very advantageous financially.

8. If it is true that the coal supplies of the earth are not inexhaustible and that its price will continue to increase, the value of water power and the number of industrially-used waterfalls will augment. And the financial advantages which already exist by working some sections of railway electrically will also increase and be further extended to other lines.

9. The following procedure should be followed on all sections, except the first experimental lines: (*a*) The selection of such lines or groups of lines which, owing to their proximity to cheap water power and to their traffic requirements, are specially suitable for electric traction. The water power necessary for this purpose will be stated by the Ministry of Railways, as soon as the necessary regulations for use are promulgated by the Ministry of the Interior. (*b*) On the remaining lines electrical traction will, according to circumstances, not be adopted for some considerable time; as certain waterfalls may be more advantageously put to other uses, though their possible eventual employment for railway work will not be lost sight of. In this connection the Ministry of Railways will always have under consideration the best interests of the Bavarian industries.

RECENT PROGRESS IN TUNGSTEN METALLIC FILAMENT LAMPS.†

BY H. HIRST.

(*Concluded from page 216.*)

Summary.—A historical *résumé* is given of the development of metallic filament lamps up to the present time. Particulars of typical tests of osram, wolfram, tantalum and carbon lamps are recorded in the shape of curves, and finally the author shows the effectual saving to be obtained by employing auto-transformers and low-voltage lamps, although he believes that the supply companies will not be disadvantageously affected.

The author then calls attention to the data in table I. and to the curves (Figs. 1, 2, 3 and 4), showing some characteristic tests of osram, tungsten and tantalum lamps made by various independent testing authorities.

Table I. *Life Test Results.*

No. of test.	Type.	Cost per lamp.	Tested by	Duration of test.	Average useful life.	Mean efficiency.	Cost per 1,000 c.p.-hours. Renewals.	Energy at 4d. per unit.	Total.
	Low voltage.	d.		Hrs.	Hrs.	W. per C.P.	d.	d.	d.
I	Osram ...	48	Faraday House	2,000	1,520	1·12	0·98	4·48	5·46
II.	Osram ...	48	Westminster Testing Laboratory.	1,500	1,360	1·29	1·31	5·16	6·47
IIA.	*Osram ...	48		3,350	2,850	1 42	0·67	5·68	6·35
III.	Osram ...	48	T. R. Charlottenburg ..	1.000	1,000	1·11	1·54	4·44	5·98
IV.	Osram ...	48	Robertson E. L. (Ltd.)	1,800	1,720	1·36	1·06	5·4	6 50
V.	Wolfram.	48	Robertson E. L. (Ltd.)..	1,000	1,000	1·27	1·65	5·08	6·74
VI.	Tantalum	55	Westminster T. L. .. .	1,000	700	1 84	2·19	7·36	9·55
VII	Carbon ...	12	... ..	1,000	1,000	3·25	0 67	13·00	13·67
	High voltage.								
VIII.	Wolfram ..	90	Robertson E. L. (Ltd.)	880	720	1·12	2·12	4·48	6 60
IX.	Carbon ...	12	..	1,000	1,000	3·95	0·66	15·80	16·46

NOTE.—All the above results have been expressed in "Hefner" units.

* This is a continuation of Test II. to 3,350 hours to show that it pays to burn osram lamps to the limit of life.

† Abstract of a Paper read before the Institution of Electrical Engineers.

The samples of osram lamps were selected at efficiencies corresponding to the limits of sorting—that is, 1·0 to 1·25 watts per candle-power—so that they represent the lowest and highest efficiency at present on the market.

The first test in Table I. and I in Fig. 1 is a good example of an

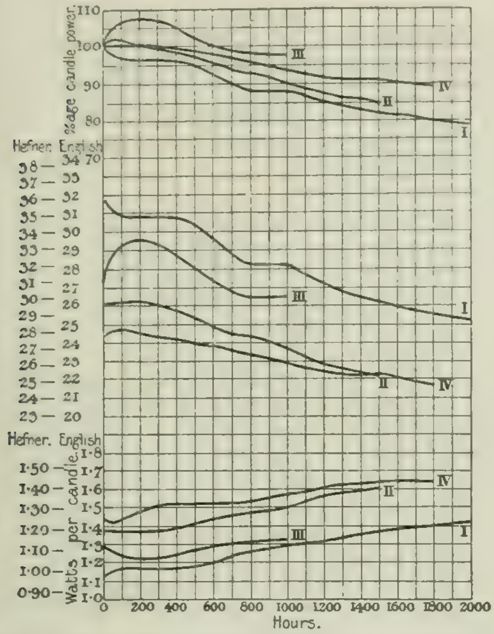

FIG. 1.—"OSRAM" AVERAGE LIFE TEST CURVES, &c.

osram lamp. It was made by Faraday House on an ordinary commercial lighting alternating-current circuit, with a variation of voltage of about 3 per cent. each way. Twelve lamps were tested, and nine gave a life of 2,000 hours, with a 20 per cent. drop in candle-power. The first failure took place at 900 hours, the other two failures following between 1,200 and 1,400 hours. The

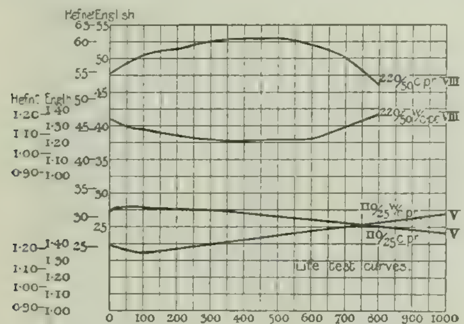

FIG. 2.—"JUST-WOLFRAM" LAMP.

Test No. V. in Fig. 2 of tungsten lamps made by the Just-Hanaman process shows that the lamps are quite as good as the osram. The test was only carried to 1,000 hours, but it is quite possible that the lamp could have lasted up to 2,000 hours or more, with a proportionate reduction in the cost of renewals. After the

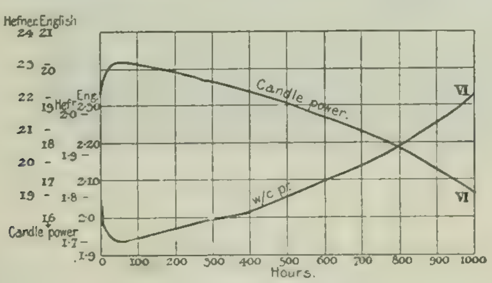

FIG. 3.—TANTALUM LAMP.

1,000 hours the drop in candle-power was exceedingly small, amounting to only 3 per cent. The tantalum tests, No. VI. on Fig. 3, give a much less favourable result than the above figures. The test is a typical performance on a direct-current circuit. The carbon filament lamp results, test No. VII. on Fig. 4, represent the average English-made lamp. A comparison of the figures in the last column of the table shows that the total saving from the use of osram lamps over carbon lamps when equal voltages are compared is 60 per cent.

Test No. VIII. in Table I, shows the high-voltage trials of tungsten lamps, which were made on an ordinary alternating-current lighting circuit, 50 cycles, with a voltage variation of 5 per cent., most of the variation being up. The figures show that, even paying 7s. 6d. for these 65-watt lamps, there is a saving of over 60 per cent. over the average high-voltage carbon lamp when all the factors of the cost are considered.

As an instance of the life of osram lamps for public lighting, the author gives figures showing the life of the lamps installed in the streets of Canterbury. The average life of 16 osram lamps, of which eight are still burning, works out at present at 1,834 hours in the case of lamps in the open, and at 1,792 hours for 29 lamps (15 still burning) enclosed in lanterns.

Reference is then made to the use of 25 volt osram lamps. For use with these lamps special static alternating-current transformers have

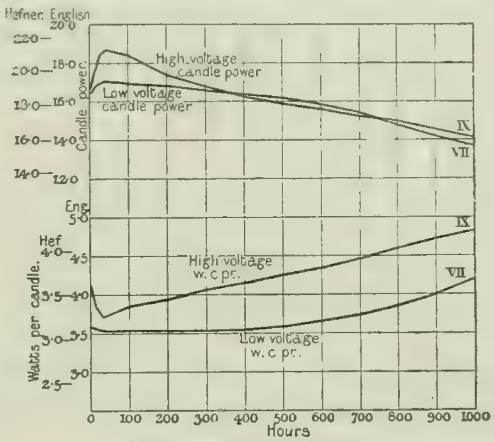

FIG. 4. CARBON LAMPS.

been constructed, from which the following figures have been obtained on test: The iron loss on the transformer designed for 300 watts output is as low as 5 watts, and the copper losses are small and only occur when the lamps are used.

Table II.—*Details of Iron Losses of Small Transformers.*

Output of transformer in watts.	No load.	Iron losses.	Units taken per year.	Cost per year at 4d. per unit.
	Watts.	Percentage.		£ s. d.
300	5	1·67	44	0 14 8
750	10	1·33	88	1 9 4
1,500	17	1·13	149	2 9 8

Table III. shows the financial results from the use of these 25 volt 16 c.p. osram lamps in a private house requiring 25 lamps. I have assumed that the smallest size of transformer in the preceding table will suffice, and 19 lamps alight at one time as about the extreme maximum load in such a house.

Table III.

No. of hours per ann. at max. load.	Max. load in watts.		Units used per ann. with osram lamps.			Units used for carbon lamps.	Cost of current at 4d. per unit.		Cost of renewals.		Total saving with osram lamps.
	Osram lamps.	Carbon lamps.	Osram lamps.	Transformer.	Total.		Osram lamps.	Carbon lamps.	Osram lamps.	Carbon lamps.	
400	304	1,140	122	44	166	456	£2 15 3	£7 12 0	£2	£0 9 6	£3 6 3
600	304	1,140	182	44	226	684	3 15 3	11 8 0	3	0 13 3	5 6 0
800	304	1,140	243	44	287	812	4 15 6	15 4 0	4	0 19 0	7 7 6

As some engineers may object to my statement above as to the copper losses of the transformer being small, I give below a formula which will enable them to calculate what the comparative cost of osram and carbon lamps would be if these copper losses are also taken into account. Using the following symbols, a = open circuit loss in watts, b = number of lamps, c = candle-power, d = cost per unit, e = average hours of running per year, f = copper loss on average load. The cost of lighting with osram lamps per year works out at $8{\cdot}76ad + \frac{bced}{1,000} + \frac{fed}{1,000}$. The yearly cost of lighting with carbon filament lamps as against this works out to be $3{\cdot}5\frac{bced}{1,000}$, under the assumption of an efficiency of 1 watt per Hefner candle

for the osram lamp and 3·5 watts for the carbon filament lamp. The saving in running cost, therefore, is per year

$$= d\left(\frac{2\cdot5bce - fe}{1{,}000} - 8\cdot76a\right).$$

An unexpected objection has arisen to the use of these small transformers from certain central station engineers—they find that the iron losses are so small that they will not keep the meter running. If this is the case, these iron losses, which should be borne by the consumer, fall on the station—which is obviously incorrect. I would suggest, therefore, that those supply engineers who wish to make use of osram lamps to extend their private-house load should themselves supply these small transformers and charge the consumers a slight increase per unit to cover the iron losses, and also the capital expenditure involved.

There is another large field for these low voltage lamps in connection with isolated plants for the supply of country houses, workshops, &c. Where small units of light are quite sufficient, the cost of the generating plant can be reduced very largely, and neither the factory inspector from the Home Office nor the fire insurance company claims that supply at 25 volts is dangerous. The same reduction in the cost of generating plant in mains can be realised when designing electric lighting equipment for the numerous small towns and villages within the United Kingdom yet to be supplied with electrical energy. In such undertakings the capital burden to be borne by the relatively few consumers obtainable is the chief deterrent.

We regret that owing to pressure on our space we have been compelled to hold over an account of the discussion until our next issue.

THE FRANCO-BRITISH EXHIBITION.—III.*

In a previous article we referred to the great opportunity offered by this exhibition to electrical engineers for making an effective display of decorative illumination, and we are pleased to see that they have not missed this chance of outshining their gas competitors. In fact, the *Journal of Gas Lighting* is so convinced of this that it remarks "Electricity has nothing of which to complain. It has here a big advertisement, and without cost to the industry." Throughout, from the main entrance in Uxbridge-road through the long passage and galleries leading to the Exhibition grounds, the visitor is conscious of the universality of electric lighting, and on his arrival in the Exhibition proper "the buildings that first meet the eye"—to again quote our contemporary—"are outlined with incandescent lights; the minarets, the domes, the kiosks, the lakes, the waterfall (with the handsome Congress Hall in the Court of Honour as a background), the interior of the buildings (save the Indian Palace), the Stadium are all lighted by electricity." No wonder that visitors depart from the Exhibition with the impression that gas lighting is non-existant; in fact, it needs an excursion into the furthermost recesses of the Exhibition to come across examples of illumination by gas mantles.

The firm who have been responsible for the most extensive and effective scheme of decorative illumination of buildings are Messrs. W. J. Furse & Co., of Nottingham. The section which is supposed to represent the finest example of decorative work is that of the Indian Court, or Court of Honour as it is more generally called. For the decorative illumination of this Court 16,000 incandescent lamps have been fixed—viz., 4,000 on the Congress Hall, 4,000 round the lake, on the bridge crossing the lake and on the water pavilion jutting out into the lake, 1,500 on the building at the south end and 3,550 on each of the terraces running along the east and west sides of the court. In the case of the lamps round the lake and on the pavilions, &c., the artistic effect is increased by the reflections on the water, the result being one of unparalleled beauty, of which only an imperfect impression can be gathered from the illustration herewith which represents the work in an unfinished state, as is evident from the large number of unilluminated sections; nevertheless, the illustration serves to give some idea of the way in which the lighting has been carried out.

View showing Part of the Court of Honour when Illuminated at Night.

The lamps fixed are 5 c.p. Ediswan lamps of the ordinary clear glass type, and these are controlled from six switchboards, about half the lamps being fed from the 220 volt single-phase supply and the other half from the three phase supply. The conductors for supplying the lamps round the lake are run in wrought-iron gas piping coated both inside and outside with insulating compound, and are run to 20 switches fixed in the Congress

* The previous articles on this subject appeared in our issues of May 15th and 22nd.

Hall, whilst each of the small kiosks is controlled by a separate switch. In all cases the lighting has been arranged so that the failure of any circuit does not impair the general effect, as can be very well seen from the accompanying illustration. The switches throughout are of the totally enclosed D.P. "push and pull" pattern, mounted on slate bases.

Messrs. W. J. Furse & Co. have also carried out the illumination of the "Palace of Music," the building noticed in the background of Fig. 4 (in our issue of May 15th), the special feature of which is the square lofty tower in the shape of an organ. The total number of lamps fixed on this building is about 5,000, and they are distinctive in being coloured, plain lamps usually being fixed. In the case of these lofty buildings it might be thought that considerable difficulties would be encountered due to the failure or burning out of lamps, which, of course, could not in many cases be replaced without the erection, at great expense, of scaffolding. This point has been foreseen, however, and, besides testing all lamps before fixing, it was known that due to the length of the circuits which supply the lamps in such elevated positions there would be very large drops in pressure, so that such lamps as are fixed for decorative purposes on the outsides of the buildings are in all cases "under-run," and little difficulty should be experienced from lamps burning out.

We have on a previous occasion mentioned that some of the wiring contractors have been working at the Exhibition for quite six months; this, however, is far from being so in the case of Messrs. G. Hopkins & Sons, of 152 and 154, St. John-street, E.C., who commenced their section of the wiring only about three weeks before the opening of the Exhibition. When account is taken of this fact, the work carried out by this firm seems almost incredible, but it must be remembered that for some days previous to the opening the employés were working continuously day and night to complete the wiring.

No less than 15,540 electric lamps have been fixed for decorative purposes outside the Royal Pavilion, and. as the colours are blue and white, the effect is very striking. Seventy lights are also installed in the interior of this building, the work being completed in the remarkably short time of two nights and one day, so as to be ready for the official opening by the Prince of Wales; but, unfortunately, His Royal Highness was prevented by the unfavourable weather from visiting this Pavilion.

The British Applied Arts Palace possesses the two highest towers in the grounds. Messrs. Hopkins have installed 3,600 lamps on the outside of this building, the "Fairyland" strip, to which reference has been made in a previous issue, being employed in this as in all other buildings for outside lighting. The colours of the lamps fixed are yellow and white, and it is interesting to learn that special steeplejack wiremen were employed for the wiring of the towers mentioned. Other work carried out by this firm consists of 700 decorative lights on the British Education Building, and the wiring of about 24 stands in the Machinery Hall, together with the supply and fixing of the motors on the stand of Messrs. Watson, Laidlaw & Co.

The switches which have been fixed by Messrs. Hopkins & Sons are in all cases of the 25 ampere size of the "Cantie" type, and they have been supplied by the Sun Electrical Co., whilst the cables used are of Messrs. Henley's manufacture. We understand that Messrs. Hopkins & Sons, who have a large engineering business, are now paying considerable attention to the development of their electrical branch, which is being managed by Mr. L. Hermes (who was in business at High-street, Acton, until the Council themselves undertook to carry out wiring) and the whole of the work carried out by this firm at the Exhibition has been under his supervision.

Tungsten Lamps v. Gas.—The *Electrical World* contains some interesting figures on this subject referring to the lighting of a chemist's shop. It was formerly lighted by 24 8 c.p. lamps consuming 711 watts. These were replaced by three "gas arcs" consuming gas at 5s. 8d. per 1,000 cubic ft., and the total cost for 1,000 hours, including maintenance, was £13. 10s. 9d. The tungsten lamps now installed are of the 40 watt type, and cost, including renewal of the lamps, £10. 12s. per 1,000 hours.

THE BERRY "SERIES SYSTEM" IN CONNECTION WITH ALTERNATING-CURRENT NETWORKS.

One of the most serious disadvantages under which alternating-current supply systems have laboured has always been the poor efficiency of distribution at light loads. This is, of course, due to the current required to supply the magnetising losses of all the transformers connected to the mains, and the effect is seen in the proportion of units metered to those generated, or, rather, sent out. In many alternating-current supply systems this proportion is in the neighbourhood of 80 per cent., so that the tabulated costs per unit sold appear in an unfavourable light in comparison with those of stations giving a continuous-current supply, although, on the other hand, considerable economy is obtained as regards the capital outlay on mains.

Many attempts have been made to produce an arrangement whereby the full benefit of an alternating-current system can be realised without the attendant disadvantage mentioned above. One of the difficulties met with in designing such apparatus has always been the trouble due to breaking or making high-tension circuits. A method whereby this may be obviated is that known as the "series system," which has been devised by Mr. A. F. Berry, of the British Electric Transformer Co., the principle being the use in each sub-station of a small auxiliary transformer, arranged with its primary and secondary windings in series with the corresponding windings of the main transformer or bank of transformers, and connected with an automatic switch of special design, so that the small auxiliary transformer is short-circuited whenever the load rises above a predetermined limit corresponding to full load on the small transformer. Similarly the switch is arranged to remove the short-circuit and so place the auxiliary transformer in circuit again as soon as the load falls once more below the fixed limit.

It will be seen that whenever the transformers are connected in series nearly full pressure will exist across the ends of the windings of the small transformer owing to its impedance, whilst the large transformer will be practically idle, so that the light-load losses will

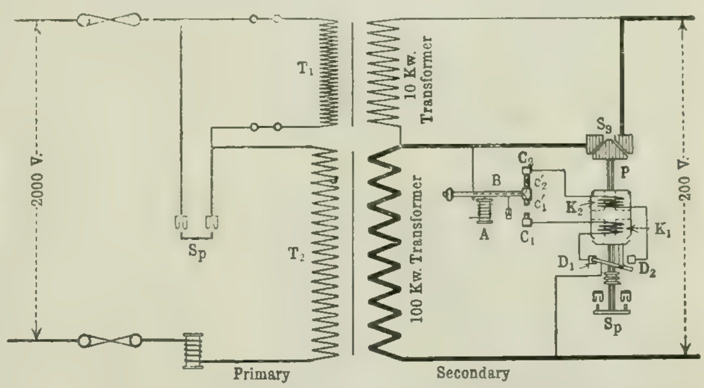

FIG. 1.—DIAGRAM OF CONNECTIONS OF SWITCH USED FOR BERRY SERIES SYSTEM.

be practically only those of the small transformer. Thus, if a 10 kw. transformer is placed in series with a 100 kw. transformer across 2,000 volt mains it will be found that the small transformer absorbs about 1,900 volts, giving, say, 190 volts at its secondary terminals, whilst the large one absorbs the remaining 100 volts and gives 10 volts on its low-tension side. That is to say, the total losses with no load on the secondary side will be practically only one tenth of those which would result from placing the 100 kw. transformer direct across the 2,000 volt mains. The diagram Fig. 1 shows in a simplified form the arrangement of transformers and automatic switch for such a 2,000-200 volt single phase system. A 10 kw. transformer, T_1, is shown in series with one for 100 kw., T_2, the switches S_p and S_s serving to short-circuit the former whenever the load rises above 10 kw. With the switches open, as in Fig. 1, the windings K_1 and K_2 of the switch will carry no current. On the load increasing above 10 kw. the relay A, which is shown on both the primary and secondary sides of Fig. 1, slowly pulls over the arm B and closes contacts C_1, C_1', so that current flows through the winding K_1 of the switch. This winding serves to lift up the plunger P, thus closing switches S_p and S_s', at the same time, by means of a rocking lever, breaking the circuit of K_1 at contact D_1 and closing contact D_2, so that, as soon as the current in the relay A decreases again, contacts C_2C_2' are closed, current passes through coil K_2 and switches S_p and S_s are opened.

The relay is fitted with carbon contacts and an adjustable balance weight, so that the load at which it operates can be altered if desired. A dash-pot is also provided, so that the motion of the relay arm takes place very gradually, and all tendency to "hunting" at

the critical load is removed. To the left of the relay in Fig. 3 will be noticed two porcelain covers; these are fitted over the terminals of the relay coil. In order to transfer the load on to the large transformer in the case of a breakdown of the small transformer, a very simple, yet interesting, device has been adopted. This consists of a small weight suspended by a silk cord, which hangs against the fuse strips of the small transformer. If these fuses melt, or become overheated, the silk cord is burned through, allowing the weight to fall on the relay arm, causing the latter to close on the bottom contacts, and so putting the large transformer alone in the circuit.

An inspection of Fig. 2, giving the details of the switch, will show that its construction is such that a large movement of the plunger only results in a small movement, and consequently large force, at the main contacts. Also it will be noticed that the arrangement of the levers is such that the contacts are maintained closed, without any current passing through the operating coils until released by the descent of the plunger. The switch is very substantially constructed, and as it does not have to break the circuit there is no trouble due to arcing at the contacts. In the standard pattern

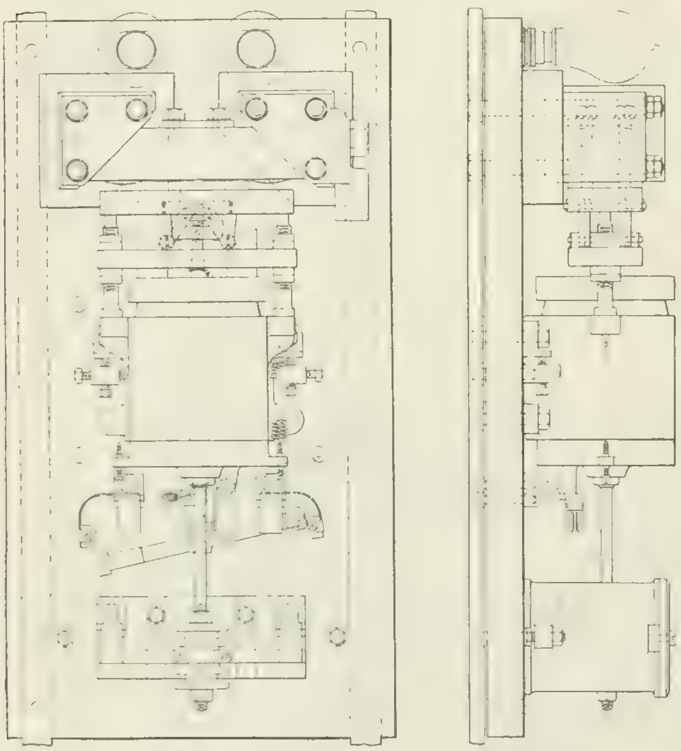

Fig. 2.—Diagram showing Construction of Switch.

it is mounted on one panel, whilst the relay and transformer fuses are situated on an independent panel, which can be placed in any required position. The complete apparatus is usually enclosed in a locked case with a glass front, as seen in Fig. 3. The arrangement for three phase working is practically identical with that for single-phase circuits, as can be seen from Fig. 4, in which the three-phase control gear is illustrated, the primary switch S_p in Fig. 1 being of the three-pole pattern.

We have already mentioned the benefit resulting from the reduction of the light-load transformer losses, and this, of course, is what is most likely to appeal to engineers whose plant may be loaded with a large amount of wattless current. There are, however, other advantages resulting from the adoption of the "series system." Considerably improved voltage regulation can be obtained, since, as the loads on the various sub-stations increase, the larger transformers with higher voltages at their terminals come into operation. In this way the pressure is maintained at its correct value at different parts of the network which may be unequally loaded.

A more important point, however, is in connection with the design of the large transformers. These, owing to the smaller importance of the iron losses, can be designed to have small copper losses, which are thus at times of heavy load less serious than is usually the case, with consequently improved voltage regulation, also aided by the fact that the main transformer will be practically cool when coming into operation. That is to say, a transformer intended to be operated on the series system would be designed with larger iron losses than usual, although its efficiency at full load would be the same on account of the smaller copper losses. Also as these latter increase as the square of the current it is obvious that the efficiency of such a transformer would differ at other loads from one of the usual design where the copper and iron losses are made about equal at three-quarter full load.

This question of heating is of very great importance. In Fig. 5 we give particulars of an actual test on a 450 kw. Berry transformer. It will be seen that, even with full load maintained continuously,

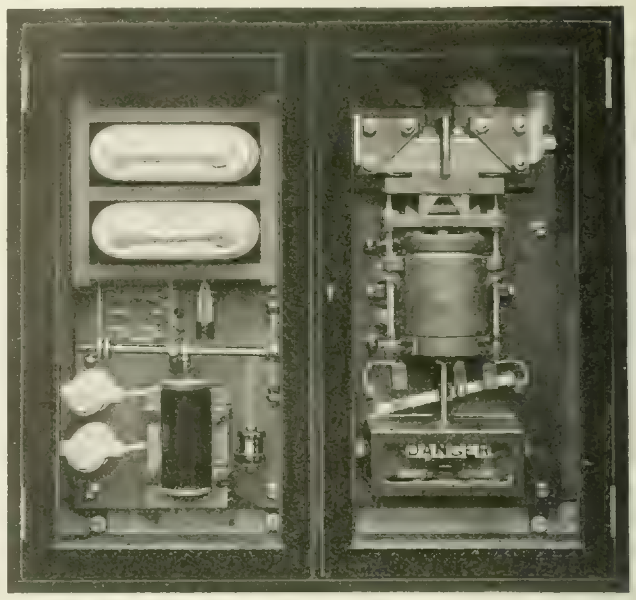

Fig. 3.—Control Apparatus as usually fixed, Enclosed in a Case.

the transformer requires about 48 hours to attain a steady temperature. If, however, as is nearly always the case, the load on the transformer is light for a considerable period every day, the heating curve will be as represented by I. in Fig. 6, where full load is supposed to be on the transformer for six hours daily. It will be seen that the magnetising losses in the case represented by curve I. are sufficient to keep the temperature of the transformer at about 27°C.

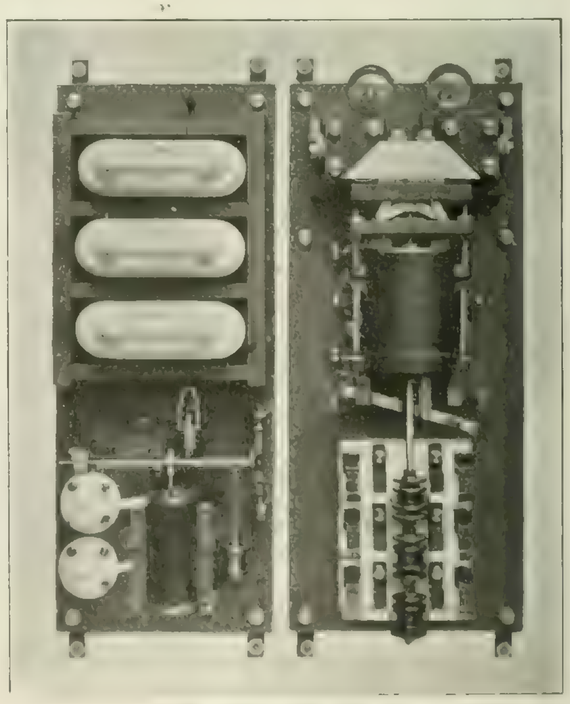

Fig. 4.—Three-phase Control Gear.

above its surroundings, and it will be noticed that with full load in operation for only six hours daily it would take several days for the transformer to reach its maximum temperature. With the Berry series system in operation, however, the main transformer will be practically out of operation for the greater part of every 24 hours, so that it will never rise to any temperature approaching what it

would if permanently connected across the mains, and in consequence it can be designed to have very much larger losses or, in other words, may be rated at a much higher capacity. If the transformer of which particulars are shown in curve I. (Fig. 6) were to be connected up on the Berry series system the resulting curve showing the rise in temperature would be somewhat of the character of curve II., and since this curve would never rise so high as curve I., it is evident that, as mentioned above, a smaller size of transformer, probably to the extent of 25 per cent., could be installed to give the same output without its temperature rising above that of a larger transformer permanently connected across the mains.

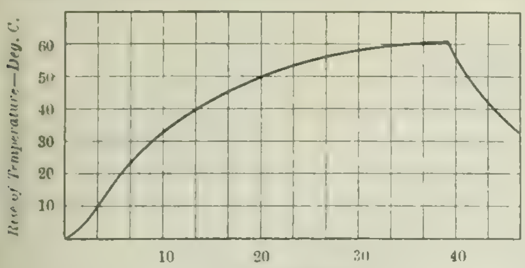

FIG. 5.—TEST ON 150 KW. BERRY TRANSFORMER.

Also it will be noticed that the transformer cools down every day, so that it is always in its most efficient condition at the time of coming into operation.

In conclusion, we may summarise some of the advantages claimed by Mr. A. F. Berry for his system, as follows:—

1. The light load iron losses of transformers connected may be reduced by 70 to 90 per cent.

2. The transformer copper losses at full load may be reduced nearly 40 per cent.

3. The pressure regulation at consumers' terminals is improved, with consequently increased number of units sold.

4. Increased life and less rate of depreciation, since the main transformers are relieved of pressure for the greater portion of every 24 hours.

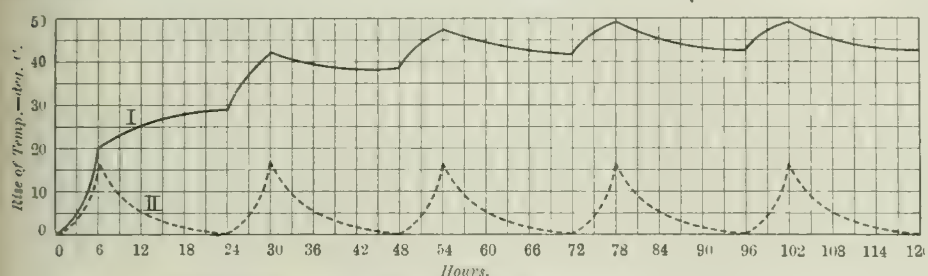

FIG. 6.—CURVES SHOWING COMPARATIVE RISE OF TEMPERATURE OF A 100 KW. TRANSFORMER WHEN USED FOR 6 HOURS A DAY AT FULL LOAD AND CONNECTED, FIRSTLY, PERMANENTLY ACROSS THE MAINS AND, SECONDLY, ON THE BERRY SERIES SYSTEM.

5. Possibility, owing to reduction of light-load output, of using a motor-generator in connection with a battery, and so improving the load factor on the supply-station plant.

6. Smaller capital outlay on transformers.

Other possible economies might be mentioned, but the above are sufficient to show that the British Electric Transformer Co. have undoubtedly provided for central-station engineers in charge of alternating-current systems a means whereby the distribution of electricity can be carried on with the greatest possible efficiency. Judging from the repeat orders in hand from many supply stations, the claims are substantiated in actual working to an extent that makes its installation desirable if not absolutely necessary.

ELECTRICAL PORCELAINS.*

BY H. W. BRADY.

From the electrical engineer's point of view, the manufacture of porcelain insulators is no doubt merely a backwater subject rather than in the main tide of electrical effort or interest. For this reason it receives scant attention in text books, just as information on the rearing of the caoutchouc tree is omitted from a wireman's pocket book. Although electrical porcelain has been in use for the last half century, and is quite a common object, it is by no means easy to define. We can only say that true porcelain has this or that quality, and must be without this or the other quality. The best understanding of electrical porcelain can be obtained by approaching the subject historically and by the technical names that have characterised some of the principal varieties of pottery. From the Greek word *Keramos*, meaning potter's clay, we have *Ceramic*, but the derivation of the word "porcelain" is not so obvious. *Faience* is another word used to denote artistic pottery. The technical names are very indefinite. Porcelain, strictly speaking, is not pottery at all, for this term really refers to earthenware. Leaving definitions, and passing on to the qualities which pottery must possess to be among the true porcelains we find that there are three features. First of all there is the fineness of finish, secondly there is extreme hardness, and thirdly there is the most distinctive quality of all—translucence. The latter property is not valuable in electrical porcelain, but its presence indicates ingredients that give porcelains some of the properties of a good insulator.

The potter's art is extremely ancient. The Chinese were not the first to make pottery that would now be admitted as true porcelain, but it seems to be clear that their discovery of making a white, hard, translucent pottery from mixtures of natural clay and powdered rocks, brought to perfection in the 17th century, was the beginning of our modern porcelain. The name which the Chinese potter gave to his clay is still in current use. He used the purest and whitest aluminous clay, and called it "Kao-lin." Emulation of the Chinese resulted in the Vincennes factory, which was transferred in 1753 to Sévres, and the early part of the 18th century saw English competition. The last 50 years has seen a great expansion in the province of porcelain to many trades, but the greatest new use is in connection with electricity. The quantity of electrical porcelain that is produced and used in this country and abroad is now astonishing

INSULATOR PORCELAIN.

To try to classify porcelain in a summary way is almost like tempting Providence, but if we accept a classification, which is very reasonable from the engineer's point of view, we may divide all porcelain into these two classes: (1) Hard, true porcelain; (2) brittle porcelain. The latter may be divided again into French or glass porcelain and bone porcelain, which abroad is often referred to as English porcelain. Large portions of bone ash enter its composition. It is vitreous and translucent. Although on the Continent it is called English porcelain its trade name in England is simply "china."

The hard or true porcelain is the only kind at all suitable for line insulators, and as a matter of fact all first-class insulators, whether emanating from this country or the Continent, are made of true porcelain. Certainly there is a marked difference in the ingredients of English and German insulators which necessitates, too, a different method of manufacture, to be discussed later.

Materials used for Insulator Body (English).—These are clays or substances related to clays. All clays, including that suitable for porcelain, have been formed by the action of the weather on felspathic rock, such as granite and porphyry. Feldspar, or felspar, is generally understood to be orthoclase, $Al_2K_2Si_6O_{16}$, though the word felspar stands for a class of mineral rather than any particular chemical compound. The gradual decomposition brought about by the action of water containing carbonic acid converts the potassium silicate, K_2SiO_3, into potassium carbonate, K_2CO_3, which washes away to lower levels, leaving deposits of alumina silicate, or the clay which, in its pure form, the Chinese discovered to have valuable properties in potters' work, and called "Kao-lin." This mineral, silicate of alumina, is the basis of all clays, and the sevral varieties of clays are due to other different substances being included in their composition.

Unfortunately for the manufacturer of porcelain, the majority of clay beds are contaminated with various impurities, though certain of these are welcomed by other manufacturers. Chalk, for instance, in a clay helps the brickmaker. Clays vary so much both physically and chemically that it is difficult to group or classify them in a way that is simple yet accurate and comprehensive, so the following classification is only presented as being at any rate simple and clear.

1. *Strong Clay.*—This is fairly free from stones and is rich in iron compounds. Bricks can be made of it.

2. *Mild or Loamy Clay.*—This often contains a great deal of gravel, which, of course, has to be got rid of by washing out before the clay can be put to any industrial purpose. It contains a large proportion of sand, and this renders articles made from it less liable to severe contraction and warping on being fired than is the case with the strong clay. The texture is loose, however, and an addition of chalk is necessary to act as a flux and make the articles bind.

3. *Marl.*—This is a clay containing a considerable amount of chalk, which is useful for brickmaking.

We have three more classes of clays to consider.

4. *Plastic Clay*, or Potter's Clay, occupies an intermediate position between the coloured-burning common clays and the white burning china clay. The cause of its extreme plasticity is not at all certain. This plastic clay in the hands of the potter is called

* Abstract of a Paper read before the Birmingham and District Electric Club.

"ball clay." There is "black" ball clay and "blue" ball clay, though neither are really black or blue, but both are a dirty greenish yellow, the "black" being, oddly enough, the lighter colour of the two. The colour, such as it is, is accounted for mostly by organic matter, and as firing gets rid of this, the colour after firing is much lighter, but still not so white as the kao-lins; though, except for the larger amount of organic matter and some extra silica, the composition is pretty much the same.

5. *Fireclay.*—Since pure clay is highly refractory the best fireclay is simply the purest available clay.

6. *China Clay or Kao-lin* is the finest kind of clay known. It is the most distinctive ingredient in the composition of porcelain. It consists almost exclusively of alumina, silica and water. It is less plastic than the commoner clays, and when burnt it becomes very white and porous. In its finest form it is used for porcelain; in its less pure form it is used for ware intended to withstand very high temperature. The so-called porcelain tube which protects the thermo-couple of an electric pyrometer is a good example of this. It is not true porcelain; break it, and it exhibits no translucency.

Kao-lin being pure clay its composition is $Al_2Si_2O_7 2H_2O$; but even in its best natural state it is contaminated with mica and undecomposed felspar. These impurities are removed by washing the clay, which is done at the mine. Most of the processes are carried out in quite a primitive way. The clay is washed in a stream—often a natural one—and is then allowed to settle in tanks and the water drained off or evaporated in a hothouse known as a "dry." Or sometimes hydro-extractors are used. It is allowed to stand for a considerable time in the open so that the weather may affect still further decomposition. The best "weathering" agent is frost: frost and thaw

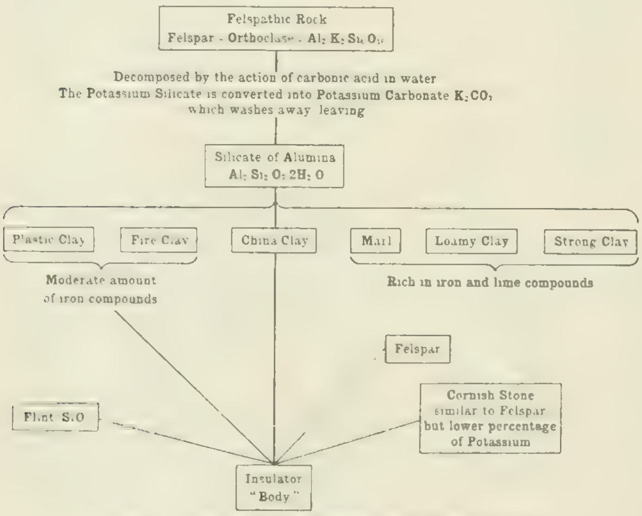

FIG. 1.—DIAGRAM OF DERIVATIONS OF CLAYS.

disintegrating the clay particles better than crushing, and, as many people hold, without so much damage to the nature of the substance. To this end as large a face of the quarry as possible is exposed. In its raw state china clay is white or creamy. Sometimes it has brown or blue markings running through it, caused by organic matter. When burned these colours disappear and there comes from the kiln a perfectly white mass which is quite unvitrified and has very little cohesion. The quality of china clay depends principally on its freedom from iron, which spoils the colour, and alkalies which affect its infusibility.

It is easily crumbled to a fine powder; it readily takes up a large quantity of water, which makes it plastic and tenacious so that it can be worked and moulded. It is not soluble in water, and no matter how finely powdered it settles to the bottom. Remove the excess of water and the clay becomes plastic and tenacious again. When moulded into a shape and allowed to dry it toughens and becomes feebly coherent. If it is now fired it shrinks considerably—about 1 in 12—and though it does not fuse it becomes very hard.

The diagram (Fig. 1) shows graphically the derivation of clays classified as above. The china and plastic clays are obtained in Cornwall, Devon and Dorset. The purifying processes are generally performed at the mines and the clay is shipped in a condition to be used by the potter. The chief shipping places are Poole and Teignmouth. Cargoes intended for use in the Staffordshire potteries are discharged at Runcorn, and thence by canal.

As for the other substances that enter into the composition of an insulator, potters generally, and what few firms have made a speciality of insulators, regard their recipes as their own secrets; however, I am enabled to give for the first time the following list of ingredients of what is probably the best insulator "body" yet made, the proportions being roughly approximate (naturally those persons who produce articles of the highest grade are those who may least be expected to give their secrets away entirely): 3 parts of china clay, 12 parts of ball clay, 2 parts of flint, 2 parts of Cornish stone and 4 parts of felspar.

It will be seen that the ball clay is in preponderating proportion, that, in fact, it is the body of the mixture, which may seem to be at variance with the statement that china clay is the distinctive ingredient. Yet this is really the correct view, for insulators, or, to put it generally, true porcelain, can be made without any ball clay at all, but not without china clay. The ball clay gives plasticity and ductility to the mixture, making it easy to work, and rendering the finished articles less liable to mechanical damage than articles made without it. Further, articles made without ball clay require a different method of working, a method which we know in this country as the German method, though possibly it is not peculiar to Germany. At any rate, the omission of ball clay results in a brittle article, though one which is electrically quite the equal of an insulator made according to the English recipe.

The object of the flint is to counteract the shrinking and liability to crack, and, in addition, it makes the finished article extremely tough. Owing to the fusibility of felspar an article made without flint would suffer so much melting in the oven that there would be very great distortion or collapse.

Felspar and Cornish stone are fluxes. Cornish stone or pegmatite is chemically similar to felspar, but contains only 3 to 6 per cent. of potash. It is less fusible than felspar, but more fusible than china clay, and in other ways it occupies a position intermediate between those two substances. It cannot be distinguished from felspar by any simple chemical test, but of course analysis discovers the lower proportion of potash. So far as the potter is concerned, however, an experienced man can tell it by its lower melting point and the difference in texture. The "stone" supplements the felspar as a flux. It is not such a strong flux as felspar, but it is more easily obtained, and, in fact, except for such porcelain as insulators are made of, it is often considered sufficient flux by itself, or with only a very little felspar added. Felspar is obtained from Norway, but there is plenty of Cornish stone in the south of England, and with prices ranging from 15s. to 18s. per ton f.o.b. Cornwall, it is something like half the price of felspar. No substance has been tried which makes the body run together into a dense, glassy mass so well as felspar, and for insulator work, where a high vitrification with absolute freedom from porosity is essential, felspar is a sine quâ non. The china clay being an ingredient which sets with considerable porosity plays the important part of keeping the body open during firing and thus allowing the gases formed to escape.

It cannot fail to strike one unacquainted with pottery as singular that, where the ingredients are so similar, so many ingredients—five—should be required. For instance, both the plastic clay and the flint give toughness, and both felspar and Cornish stone are fluxes. Though it may seem unscientific yet the potter knows well enough that though he may vary his proportions somewhat to suit his conditions, articles made without one or other of these components would fail in some respect. An insulator without flint would not be sufficiently tough; one without felspar would not be vitreous enough and would have to depend on the outer glaze for its insulation. Then, again, insulators are made in Germany with little or no plastic clay, with the result that they are very easily broken, the inclusion of flint in this recipe being a case of bones with no body, as a Chinese porcelain merchant said at the expense of a Dutchman who tried in this way to improve on Chinese methods. Possibly the stone might be omitted and compensated for by more china clay and felspar, but both substances are more expensive than the stone. Then, again, felspar is rich in silica, and flint practically is silica; yet the former is introduced as a flux while the function of the latter is to prevent vitrification taking place too soon. No doubt a great deal might be said on this and other such curiosities, but for the present purpose it is perhaps sufficient to point out that the behaviour of silica in the oven depends upon whether it is free or combined, and—what is very important to know—whether it is finely or coarsely divided. Coarsely divided free silica makes the body refractory, finely divided or combined as in felspar it acts as a flux. This is exemplified in a class of ware already referred to as "glass porcelain." This early European ware was composed of a small proportion of white burning clay and a large proportion of artificial silicate such as ground glass. The glass melts in the oven and dissolves, as it were, the clay, and though it is not usual now to regard the result as true porcelain, yet the great quality of porcelain is exhibited—namely, translucency.

(To be continued.)

BOOKS RECEIVED.

(Copies of the undermentioned works can be had from *The Electrician* office, post free, on receipt of published price. Add 10 per cent. for abroad or for foreign books)

"Practical Induction Coil Construction." By John Pike. (London: Percival Marshall & Co.) 1s. net.

"Steam-Electric Power Plants." By Frank Koester. (London: Archibald Constable & Co.) 21s. net.

CRANE CONTROLLERS.

In the serial article on "Electric Cranes," which is appearing from time to time in our columns, the author, Mr. H. H. Broughton, has already described the types of controller which are most generally used. Messrs. Siemens Bros. Dynamo Works have just issued a price list of crane controllers, containing a lot of information not usually found in such publications. Sufficient electrical and mechanical data are given to enable a controller to be selected suitable for almost any requirement. The list also contains diagrams of connections for continuous-current controllers, when used with series, shunt and compound motors, and for three-phase controllers for reversible motors, with the various methods of control. Some of these were described by Mr. H. H. Broughton, in our issue of February 21st last.

Fig. 1.—Crane at Tower Bridge Wharf.

The controllers, of which descriptions are given, are all of the drum type and have been specially designed for use with cranes, hoists, winches, turntables, gun turrets, &c., where the motions are frequently reversed and the loads intermittent and varying. Fig. 1 illustrates one of Messrs. Waygood's cranes at Tower Bridge Wharf, London, which has been equipped with Siemens motors and controllers. This crane is capable of raising a load of 1 ton 200 ft. per minute and is of the reversible pattern—that is to say, the load when being lowered drives the motor which then acts as a generator. This method allows light or heavy loads to be lowered gently or quickly and without any sudden strain upon the gearing, the current produced in this operation being absorbed in a resistance which can be readily varied to obtain different speeds. In this way the cost of a mechanical brake and its maintenance are saved—by no means small items. A simple holding brake is, however, necessary to hold the load steady in any position. Also the field of the motor has to be excited from the supply mains, since, if the field were self-exciting, the load would fall rapidly at the commencement of lowering.

Fig. 2.—Controller with Automatic Return to "Off" Position.

Fig. 3.—Horizontal Controller with Vertical Lever and Catch.

In connection with controllers for travelling, &c., they can be arranged so that the motor, when switched off and running by its own momentum, acts as a generator short-circuited across a variable resistance, thus dispensing with a mechanical stopping brake. A special feature of this control is the fact that the braking positions are effective for both directions of movement; a contact device automatically reverses the connections before the controller handle has reached the positions corresponding to the direction of travel. This arrangement has the great advantage that the braking action is not interrupted in the middle position of the controller, which causes heavy sparking at both the controller and commutator, and that it is effective even if the operator should overrun the middle position. It is, therefore, specially suitable for remote control. This patented arrangement has the further important advantage that the change-over switch is alive only during the short time of braking and not in the power positions, and it can, therefore, be made very small.

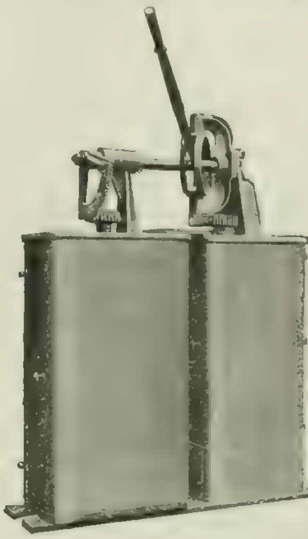

Fig. 4.—Double Controller operated by a Single Handle.

Figs. 2, 3 and 4 show a controller with automatic return to "off" position, a horizontal controller with vertical lever and catch, and a double controller operated by a single handle.

PARLIAMENTARY INTELLIGENCE.

LONDON ELECTRIC SUPPLY BILLS.

In our report of the proceedings of the House of Lords Committee on the London and District Electricity Supply Bill in *The Electrician* for May 22 we referred to the evidence of Mr. J. S. Conradi, superintendent of the London factories of Messrs. Vickers, Sons & Maxim, in which evidence reference was made to resolutions which had been passed at a meeting of London manufacturers in connection with the London and District Electricity Supply Bill, 1908. Mr. Conradi put in a list of 57 firms which had approved the resolutions passed at the meeting referred to, which were as under :—

1. That in the opinion of this meeting of London manufacturers, the prices at present charged by authorised distributors for the supply of electrical energy for power purposes are high, and that manufacturers are, owing to these prices, precluded from availing themselves to the full of the advantages attending the use of electricity for power purposes. This meeting further considers that the establishment of an undertaking which would afford a cheap supply of electricity for power purposes throughout London and the adjoining areas would be of great benefit to the industry of London, and that the time has arrived when Parliamentary sanction to such a scheme should no longer be delayed. This meeting is further of opinion that it would be to the advantage of manufacturers to use electricity for power, instead of using separate installations of either steam or gas plant, at the prices contemplated under the London and District Electricity Supply Bill, except in special cases, and that if these prices were in vogue a very considerable increase in the use of electricity for power purposes would take place.

2. That a committee be formed to confer with the promotors of the London and District Electricity Supply Bill, and, subject to their obtaining such concessions as they may deem necessary in the interests of manufacturers and other power users, to arrange to support the measure by evidence or otherwise as may be deemed fit.

Mr. Conradi said that, up to the present, none of the concessions referred to in the second resolution had been obtained from the promoters of the bill. The concessions related to the interpretations to be put upon clauses 53 and 59 of the bill.

Cross-examined by Mr. Munroe: The list of firms was made up of those present at the meeting and of some who were not present but who had expressed their approval of the resolutions since.

Mr. Gill, manager of John Jenkins and Johnson & Son (Ltd.), cement manufacturers, said his company were large users of power. They had electrical machines installed of about 240 kw. capacity. They also took 500,000 units from Poplar Council and 1,300 units from Stepney per annum, at 0·8d., 0·9d. and 1d. respectively. He thought that under the present bill he would be able to get current cheaper, and he therefore supported it. He knew Stepney Council supplied energy cheaper than any other authorised authority in London.

Mr. A. L. Rider, chairman and managing director L.T. & S. Rly. Co., said his company had about 5 miles of line operated by electric traction, which started working in 1905. They had been endeavouring to get a supply of power for some years previously. The difficulty was that the authorised companies or local authorities could not supply out of a certain area. Ultimately they came to an arrangement with the Underground Electric Railways Co. for a supply of power, but there was some loss owing to the distance of transmission. They were consuming something like 7,566,000 units per annum. They were so satisfied with the results of electric traction that they were desirous of extending. The advantages to his company of a supply of electric power at a cheap rate were such as could not be estimated. He considered the terms of the bill would give them this supply at much lower rates than could be procured elsewhere at present. If the present companies could supply outside their area and at as cheap a rate as provided in the bill his company would be just as willing to take current from them.

Mr. Green, chief goods manager, L. & N.W. Rly., said his company had obtained powers for an electric line from Euston to Watford, the erection of a generating station being provided for, the object being to develop the suburban traffic, which they had not hitherto specially catered for. He had carefully considered the present bill in company with the company's electrical expert, and thought it would be an advantage to take current from its promoters for power to work the line. This would obviate large capital expenditure on a generating station of their own before they got the traffic. The company would not care where they got their supply from, so long as they got it from a reliable source at the rates set out in the bill.

Mr. J. Macgregor, one of the managing directors of Johnson & Phillips, Old Charlton, Kent, said that at present they were employing electrical power to about 300 kw. capacity, the annual consumption being over 500,000 units, from the South Metropolitan Co., at 1½d. per unit for lighting and 1¼d. for power. If they could obtain electric power at more reasonable rates they would be able to extend their works. The supply must, however, be not only cheap but reliable. If cheap supply could be had in any quantity that might be required it would lead to a very large extension in the use of electric current for power. The prices set out in the bill would mean a very large saving to his company.

Mr. C. M. Simpson (J. H. Simpson & Co., engineers) said they had plant of 150 h.p. capacity for generating electricity and also took from the Westminster Company about 144,000 units per annum at 1½d. per unit. The proposed charges in the bill would be advantageous to them. Their maximum demand would be under 250 kw., and they would therefore get their supply from the authority in the district who would obtain it in bulk from the company.

Mr. John Laing, engineer to the London Central Markets Cold Storage Co., said they were at present getting current from the Central Markets Co., but supply at the prices in the bill would result in a considerable saving to them. He did not care where he got his current from so long as he got it at a cheap rate and from a reliable source.

Major Travers (Spottiswoode & Co., printers) said his firm employed between 950 and 1,000 men and used about 55,000 units of electric energy per annum, purchased from the Charing Cross & City Co. at 1d. to 1½d. per unit. They also used a large steam plant. They would be glad to change from steam to electric driving if they could obtain power at a low price. There was a great saving in space by the use of the electric drive, and as printing machines were only in use about one-third of the time much of the steam power was wasted. He welcomed the bill.

Mr. A. J. Davis (engineer to Esly Bros., ammunition manufacturers) said his firm used electric energy for driving small machines. At present about 500,000 units per annum were used. He thought the bill would be an advantage to them.

On Friday, Mr. A. G. Lupton, M.P., in examination by Mr. FitzGerald, said he was chairman of the Yorkshire Electric Power Co. and a director of Electrical Distribution of Yorkshire, Ltd. The Power Company's area was 1,800 square miles in extent. Mr. Parshall was called in by the company after they got their bill. The shares were largely taken up by manufacturers in the area. The demand for power had steadily increased, and the company was making sufficient revenue to pay all expenses and interest on borrowed capital. They had made agreements to supply between 700,000 and 800,000 h.p. The Ossett, Honley, Horsforth, Hipperholme and Sowerby Bridge Councils had transferred their orders to the company and for Gomersal and Liversedge the Distribution Company had taken out an original order with the consent of the local authority. The company supplied Pudsey Corporation and Mirfield and Ravensthorpe District Council, and an agreement had been made with Brighouse Corporation who would close down their station and take the whole of their supply from the company. They had agreed to supply in the areas of 26 local authorities. The local authorities opposed the company severely when they applied for their powers, but had since found the company beneficial to them. The establishment of a generating station had a tendency to bring new industries into a district. On land adjoining the Yorkshire Company's station there had just been erected a factory for making calcium carbide. That had hitherto been done in Norway or Niagara, or wherever there might be cheap water power, but the Yorkshire Company were able to supply current at such a price that they could establish the works in their district. He believed it was the first time calcium carbide had been made in this country on a manufacturing scale. The Power Company had not yet established a depreciation fund. Their dividends were limited to 8 per cent., but if they reduced their prices they could increase their dividend. There was no purchase clause in their Act, because the dividends were limited.

By Mr. Freeman (for L.C.C.): Under their Act they had to substantially commence their works in two years, and their station was to supply in four years. That clause had not prevented their success. The clause relating to the ratio of charges for current and dividends was the ordinary sliding scale clause in Electric Power Acts.

By Mr. Blennerhassett (for Westminster Corporation): They had no power for direct supply, except to railways and tramways, in the districts of authorised distributors, without their consent.

By Mr. Seymour Bushe (for promoters of the Westminster and Kensington Bill): They had no clause corresponding to the 250 kw. clause in the present bill. Below 250 kw., if they did not obtain consent from the distributor, the question had to be referred to the Board of Trade.

Mr. W. B. Woodhouse, engineer and manager of the Yorkshire Company, was asked to give particulars of their prices, and said they charged £6 per kilowatt and ¼d. per unit. They did all the conversion and they guaranteed the maximum price should not exceed 1¼d. The maximum distance at which their station supplied was to the Distribution Company in Horsforth, 18 miles away. 18 miles was not the limit.

Mr. Lupton (cross-examined by Mr. W. E. Tyldesley Jones, for promoters of Joint Committee Bill): The company had no competitor outside the boroughs. There was no analogy between his company's area and the area of London. They were in the coalfields and paid between 7s. and 8s. for coal. The Kitson clause did not apply to the Distribution Company, and through that company they could supply free from the restrictions of the Kitson clause.

By Mr. Rigg (for Corporation of London): In the cities—Leeds, Bradford and, he thought, Sheffield—the company described a circle of about a mile round an area, with the town hall as the centre, which was restricted as to laying mains. They had power to take their mains through these centre areas, but did not wish to do so, as there were no large works there, and the supply would be done by the Distribution Company. Certain conditions in their bill had a hampering effect, and if released from those conditions the undertaking would undoubtedly have made greater progress. The company was not authorised to supply for lighting. Installing of plant for consumers was part of the business ordinarily carried on by power companies, and this was advantageous for consumers.

Asked by the Chairman to explain the hampering conditions in the Yorkshire Company's Act, Mr. Lupton said consumers in towns where the Corporation's supply was compulsory would prefer to take current from the company but could not do so. In places where there were no provisional orders the company could supply for power purposes and for lighting on premises where power was used.

Sir Hugh Bell was here re-called, but before his examination commenced, Mr. FitzGerald stated that it was proposed to alter the wording of the purchase clause (clause 65, lines 31, et seq.) so that it will read "upon the terms of the purchasing body paying to the company a sum equal to the amount expended by the company upon the undertaking and *properly* chargeable to capital account" and so on, the word "properly" having been transposed from its original position preceding the word "expended." Sub-sections 4 and 5, relating to the auditing of the company's accounts annually and the deposit of a copy of the accounts with the Board of Trade and giving authority to the Board of Trade to appoint such auditor, were to be struck out by the desire of the Board of Trade, who proposed that the auditor should be appointed by them under the provisions of the Electric Lighting Acts. This was only a drafting alteration. New sub-sections were proposed, one providing that sums to be determined by the auditor should be placed aside for maintenance of buildings, plant and apparatus, another giving the company the right to appeal to the Board of Trade in regard to the amount so determined, and a third providing that sums expended for renewals shall not be considered properly chargeable to capital account.

Sir Hugh Bell said the effect of the proposed alteration would be to carry out what he had agreed to in cross-examination—that the plant should be kept in efficient working order, that a renewal fund should be formed, and that the auditor should determine whether the amounts placed to same were sufficient. He had considered the question of what he could say further on the subject of finance, and he might inform the Committee that Sir Edward Tennant had agreed to place himself in the same position in regard to the scheme as he (Sir Hugh) had taken up. He might put it that he (Sir Hugh) would increase the amount he had stated from £250,000 to £350,000.

By Mr. Freeman: He still intended that the purchase clause should require the purchasing authority to make up the company's dividends to 6 per cent.

On the suggestion of the Chairman, it was decided that counsel should confer on the renewal fund and purchase clause questions, and see how nearly they could make their views approach each other. Mr. FitzGerald said the complete reprinted purchase clause would be submitted to the Committee on Monday.

When the Committee met on Monday, Mr. FitzGerald, replying to Mr. Seymour Bushe, said it was not proposed to alter the schedule of prices in clause 52 of the bill.

Mr. FitzGerald announced that the promoters and their counsel had had a conference with London County Council, but, although the parties had got nearer than they were, they had not arrived at an agreement, and negotiations would be resumed.

Mr. Freeman said they had arrived at a clearer understanding of each other's views than they could have done at a public inquiry, but as they thought it desirable to know the views of the borough councils before coming to a final decision, it was not proposed to make any further proposal at present.

Mr. W. B. Woodhouse (engineer and manager of the Yorkshire Electric Power Co.), examined by Mr. Clode, said with regard to Mr. Lupton's statement that the local authorities had an absolute veto regarding supply by the Company, that was the case except where the local authority had sold its order. In that case the distributing company had only a veto if the business had been brought under the Power Act instead of the Electric Lighting Acts. The average prices received by his company was below ¾d. per unit. They supplied large consumers at £4 per kilowatt, and at 25 per cent. load-factor the charges worked out at 0·69d. per unit. Their charges were very much lower than the prices in the present bill. Their works costs had gone down to 0·188d. per unit, and he estimated that when their present station was fully loaded the cost would be 0·13d. He was at Newcastle for some time. There were formerly eight generating stations there but five had been converted into sub-stations and were taking bulk supply. The Yorkshire Company made a regular start in December, 1904, not 1903. The increase in demand last year was over 100 per cent., and this year would be considerably in excess of that. Not one of the large textile mills in Leeds took electrical power for all their machinery, and it was practically the same in all the towns in Yorkshire. The company had obtained seven textile mills, who took all their power from the public mains, and a number of other mills were using it for part of their machines. The h.p. in use in the district where their mains extended at present was 36,000, of which they were supplying 8,000, and they had contracts for another 2,000. In Leeds, Bradford, Batley, Dewsbury, Morley and all the districts in the neighbourhood of the company's mains where there was a supply by the local authorities, power users had asked the local authorities to consent to the company giving supply, or, alternatively, to supply as cheaply themselves, and in practically every case the local authority had refused. Thornhill Council recently proposed to apply for a provisional order, but agreed to put a clause in the order renouncing their power of veto. In the whole of their area of supply the h.p. required had been estimated at 2,000,000. The principal towns reserved power to take bulk supply, but objected to the company supplying in their areas. They had not a Kitson clause, unfortunately. If they had not been hampered by the provision as to not supplying without the local authorities' consent they would have been able to erect their four generating stations and to have given a supply from each, in which case he thought they would have done an immensely larger business. Some manufacturers had moved their factories out of the boroughs to get the outside supply, and the boroughs had so lost in the rates. They would prefer to have the Kitson clause to the weak clause they had. He thought they should have an appeal to the Board of Trade. They had an appeal in the case of companies' refusal, but the companies had never refused.

Sir Ralph Littler objected to the postponement of the settlement of the purchase clause. The conferences on the subject should have been held earlier. People had been forming their conclusions on the clause as it stood and the promoters should endeavour to establish their case as it stood, and if afterwards there were some new feature, it was in their lordship's discretion to say whether they should introduce it.

The Chairman said the procedure which had been adopted with regard to the purchase clause, at his own suggestion, was, no doubt, slightly irregular, and as it had been challenged perhaps they had better stick to the regular course of proceeding.

Mr. L. Maltby, chartered accountant, member of the firm of Deloitte, Plender, Griffiths & Co., was therefore called by Mr. FitzGerald, and gave evidence on the general question of borrowing powers, depreciation allowances, reserves, arbitration, &c. On the question of plant renewals, Mr. Maltby said supposing the company's plant had been worn out and they had started again with fresh plant, and at the end of the 42 years there was only half the life of the plant left, half the cost of the plant would represent the value from the auditors' point of view, but it might not satisfy a valuer under the 1888 Act. Suppose the company spent a large sum on copper, its value in the books would be the cost, less a certain percentage of depreciation, but if a valuer came in and there had been a heavy depreciation of copper he might value it at the depreciated amount, and the company would suffer a heavy loss. If a proper definition of the "then value" were arrived at he thought there would be no harm in having those terms in the bill, if it had the effect of removing uncertainty. If, after 10 years' working, the company, in order to take up some newly-invented machinery, scrapped their original machinery, the whole of the value of the difference in its life between 10 and 25 years would have to be written off. Each section of the plant would have to be dealt with on its merits. The difference would have to be placed to suspense account, and written off in a reasonable period.

In answer to the Chairman: The unexpired portion of the life of the plant would be in the books as an asset, but the asset would not exist, and the balance would have to be written off by depreciation fund, or it would be reasonable to allow it to be written off over a short period of years. If they were to be purchased at the "then value" they would get a larger sum if they put in new machinery near the end of their term, but in any case they would lose the value of the old plant. If the company had not been able to pay dividends until nearly the end of their period they should, he considered, be given the opportunity of running another 10 years. If only 4 per cent. had been paid in dividends for the 42 years the amount the purchaser would have to pay to make up the dividends to 6 per cent. would be 3¾ millions.

In reply to a remark by the Chairman that the Witness's suggestion that if the company had not been doing well they should be allowed a longer period threw quite a new light upon the bill, Mr. FitzGerald called attention to the fact that clause 65 provided that the purchasing authority had the option of purchase at 42 years or any subsequent period of 10 years. There was no obligation to make up the dividends at the 52 years. Clause 64 was a comparatively new proposal, instead of a sliding scale.

By Sir Ralph Littler: As the purchase clause originally stood it might be possible to make the purchaser pay for plant that had been scrapped. He was told the clause that had been provided had great weight with capitalists. The system of selling at the amount of the properly expended capital was certainly not meant to increase the purchase price, but to create a feeling of safety for the investor. The idea was that the value might be too great at the end of 42 years, and some plan had to be devised to cut it down. The method of returning the capital was arrived at so that the investor, if he had not had a large return, would at any rate get his capital back. No one could tell how a valuation of the works would come out. It was commonly thought to mean scrap iron value.

Mr. FitzGerald here announced that an agreement had been come to with the Commissioners of Works in accordance with Standing Order No. 106 of the House of Commons, and clauses and amendments had been agreed with the Board of Trade. Clauses in the filled-up bill had also been agreed with the Thames Conservancy, the Duchy of Cornwall, the Metropolitan Water Board, Camberwell Council, the Inns of Court, the Duke of Bedford, the London United Tramways, the sewers authorities of Havering-atte-Bower, Essex, and West Kent, and all the railway companies in the metropolis, with the exception of one.

This concluded the case for the promoters.

THE OPPOSITION CASE.

Mr. Wedderburn (for Croydon), in opening the case for the opposition, said Mr. Parshall had stated that Croydon was not essential to the scheme. In 1905 and 1906 the power companies agreed to clauses for Croydon in regard to wayleaves, breaking up of roads, and also providing that the powers of the Acts then proposed or of the principal Acts should not be exercised in Croydon except (a) for obtaining access to places beyond; (b) for supply to railway companies, docks, navigations or Government departments; and (c) for supplying energy to the Corporation by agreement only. He thought he same clauses should be given to Croydon in the present case. He contended that no advantage to any person in Croydon had been shown. If the company competed with Croydon Corporation they would do so on unequal terms. The company took powers to supply fittings, &c., and the Corporation had no such powers. The bill also provided that the company could apply for provisional orders and it might be used as an argument hereafter that this Committee had contemplated the company applying for provisional orders for lighting. If the company could compete with the Corporation for lighting the position would be an absolutely impossible one for the Corporation.

Mr. A. C. Cramb, borough electrical engineer of Croydon, said there was not much room for factories in Croydon. There would be no advantage for the Corporation either to combine with the bulk company or to scrap their works. The £2,000 a year which the Corporation had applied to relief of rates for the last two years would be lost. The figures in Mr. Hammond's tables, particularly in regard to coal consumption, were inconsistent and unreliable. More than half the income at Croydon was for lighting. The income from power supply was growing—so far as there was any power. As to whether a large power consumer would think of taking a supply at the Corporation's prices for power, which varied from 2½d. to 1½d., they had not had to consider the case of the large consumer. Their coal cost from 15s. to 23s. a ton, and would, if their output were doubled, only increase by 50 per cent., as they would use larger units of machinery, which would be much more economical. The charge for water went to the Corporation water department, so that it did not really matter whether it was high or not.

Mr. E. R. Debenham, chairman of the Marylebone Electricity committee, said when they took over the undertaking of the Metropolitan Electric Supply Co. in their area they were given to understand that no competition would be allowed. They had reduced their charge for current for lighting from 5·15d. to 4·42d., and they had a good profit in hand. Their charge for power was 2d. per unit for the first 125 hours per quarter and 1d. after. Large consumers were given 25 per cent. discount above £50 per quarter. Their prices were about 2d. per unit all round. If there were not the amount of the award (£1,250,000) to consider, they were advised by their engineer that they could supply more cheaply than the power company. Their load factor was 15 per cent. He thought Marylebone should be dealt with as it was dealt with in the Administrative Bill. They had no power consumer with a maximum demand of 250 kw. They feared if the company came in they would have to reduce their prices, because of the threatened competition. They supplied nearly 900 kw. for power and the demand had grown 140 per cent. in the last two years. Their works could deal with double their present output. They could, at small cost, increase their capcaity to 16,000 kw.

Parliamentary Intelligence continued on p. 262.

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With the number of "THE ELECTRICIAN" for Sept. 14, 1906, was issued the first of a series of "Industrial Supplements," to be published from time to time with "THE ELECTRICIAN." The twenty-third issue of the Supplement is issued (Gratis) with the current number of "THE ELECTRICIAN."

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METAL LAMP PROBLEMS.

Interest in what Mr. MORDEY calls the "wire lamp," but what we prefer to call the "metal lamp" in contradistinction to the carbon lamp, if abbreviations are to be introduced, continues unabated, and last week Mr. HUGO HIRST read a Paper on "Recent Progress in Tungsten Metallic Filament Lamps" before a crowded audience at the Institution of Electrical Engineers. As was natural, the Paper was devoted largely to processes of manufacture (in so far as these are disclosed to the public by patent specifications), and with the properties of metal lamps, though some information of a general kind was also given. In the discussion which followed the reading of the Paper, Dr. LOUIS BELL emphasised some of the differences which exist between this country and America. In America the shading of lamps appears to be more general than with us and lighting by diffusion rather than directly is becoming more practicable. Owing to the high efficiency of metal lamps, indirect illumination by means of reflected light becomes much more practicable, and we hope that this method will accordingly be borne in mind. Another point emphasised by Dr. BELL was that, in America, lamps are much more under the control of the station engineer than they are in this country. In America lamps are often sent out at a certain rental, and central stations even make a point of supplying (that is, charging for) light instead of electrical energy. These methods solve certain difficulties with which we are troubled, but we think it will be difficult at this stage of development to introduce such methods into this country. The Englishman prefers to look after his own affairs, even if he does not do so to the best advan-

tage, and it would be regarded as a hardship if a consumer were not permitted to try any lamp that might take his fancy.

Among the interesting points emphasised in the Paper and in the discussion was that of street lighting. Excellent results have been obtained at Canterbury as regards the life of osram metal lamps, the figure, as given in the Paper, exceeding 1,800 hours, and many of the lamps are still running after something like 2,450 hours. Any question, therefore, of fragility, which is important, and from which trouble might have been expected, may be set at rest. It must also be remembered that there is no necessity to have low candle-power lamps for street lighting. Probably anything less than 50 c.p. will in future be looked upon as hopelessly out of date, and naturally as the candle-power is increased the lamp becomes more robust. Apart from the use of metal lamps for street lighting, singly or in pairs, there is the question whether groups of metal lamps could not replace arc lamps to advantage in certain situations. The efficiency expressed as watts per candle would, of course, not be so good, but, on the other hand, when the cost of carboning is taken into account it is quite possible that the metal lamp will be found the cheaper of the two in many cases.

In conclusion, there is one point to which we should like to refer with a protest. Many metal lamps are finding their way on to the market with candle-power marked in Hefner units. Although such lamps for the time being may be manufactured abroad, there appears to us to be no sufficient reason for this practice to continue. It must give rise to much confusion, and to the obvious retort of our gas friends that the electrical profession is trying to claim a higher efficiency for the metal lamp than that to which it is entitled. The metal lamp is quite good enough to stand on its merits, even if the candle-power is expressed in terms of the English candle, and we think that every effort should be made to put a stop to the introduction of the Hefner unit in this way. When, if ever, it is decided once for all by a competent authority that the Hefner unit is preferable to the English unit, and that it is to be the legal unit for this country, then by all means mark lamps in this way, but not before.

OBITUARY.

CHARLES HENRY REYNOLDS.

We record with regret the death, at Lisbon (while attending the International Telegraph Conference as a delegate of the Pacific Cable Board), of Mr. C. H. Reynolds, C.I.E., general manager of the Board.

Mr. Reynolds was the son of the late Major W. Reynolds, Bombay Army, and was born at Ootacamund, Southern India, on January 15, 1844. Intended originally for the army, Mr. Reynolds, after three years' service in banking, in 1866 joined the newly organised service of the Indian Telegraph Department, after having passed the preliminary examination for the telegraph service at University College, London, and afterwards under Mr. (now Sir) William Preece. At the final examination of candidates in 1867, Mr. Reynolds gained first place, and as a reward was granted a further special course of training at Glasgow University in the laboratory of the late Lord Kelvin. In 1870 he was appointed personal assistant to the late Major-Gen. D. G. Robinson, R.E., then director-general of telegraphs. In 1871 he gained the thanks of the Government of India for services in connection with the Behar famine, a period when the telegraph played an important part In connection with the working arrangements between the telegraph and postal departments in India, which were carried out in 1882-3 by Sir Albert Leppoc Cappel and Sir F. Hogg, directors-general of the two departments, Mr. Reynolds services were engaged. In 1885, Mr. Reynolds represented India, in conjunction with the late Sir John Bateman Champain, K.C.M.G., at the International Telegraph Conference of Berlin. After graduating in almost all the higher appointments of the department, Mr. Reynolds succeeded Sir W. Brooke, K.C.I.E., as director-general of telegraphs in India, on April 1, 1895. Mr. Reynolds retired from India in 1899 under the 55 years' rule, having been made a Companion of the Order of the Indian Empire in June, 1897. In September, 1901, he was appointed general manager to the Pacific Cable Board, a position he has held with conspicuous ability.

We understand that Mr. Reynolds' last illness commenced shortly before his arrival at Lisbon, and that his condition at that date was serious. Commencing with liver trouble, other complications speedily ensued, and Mr. Reynolds' condition became very grave. He became unconscious some days before his death, and remained so to the end. Mrs. Reynolds and two of his daughters were at Lisbon, and there are two other daughters to mourn his loss.

A Requiem Mass was solemnised at Lisbon on Monday, at which all the delegates at the International Telegraph Conference were present, the King of Portugal being represented by his Private Secretary. Mr. Reynolds' remains are on their way to England, where they will be interred.

REVIEWS.

(Copies, of the undermentioned works can be had from *The Electrician* Office, post free on receipt of published price. Add 5 per cent. for abroad or for foreign books.)

Introduction à l'Etude de l'Electricité statique et du Magnétisme. By E. Bichat and R. Blondlot. 2nd edition. (Paris: Gauthier-Villars.) Pp. viii.—182. Fr. 3.

The first edition of this small book was published in 1885, and now, after 12 years, it has been "entirely refounded." In spite, however, of the great length of time which has been at the disposal of the authors for the purpose of this re-construction they are scarcely to be congratulated upon the result of their efforts. There is practically nothing in it that might not well have had a place in the first edition, and modern theories of electricity are absolutely ignored. It is essentially of a highly academic character, and the matter that it contains is sound enough, but even that does not compensate for the antiquity of its contents.

Wie stellt man Projekte, Kostenanschälge und Betriebskostenberechnungen für Elektrische Licht u. Kraftanlagen auf? By Fritz Hoppe. 4th edition. (Leipzig: Johann Ambrosius Barth.) M.2·50.

The problems connected with the drawing up of appropriate plans, estimates and working costs for electric lighting and power installations are admirably and critically explained in the pocket-book under review, which has now reached its fourth edition. It is divided into three main sections, each of which starts with an introduction explanatory of the object and scope of the section, and the subject matter is then clearly and concisely set forth in the ensuing chapters. The regulations of the Verband deutscher Elektrotechniker form the basis of the book, and each section is preceded by the regulations referring to the particular subject under discussion.

Part I. explains the preparatory work necessary in the preparation of a scheme, and in eight chapters gives the details required upon which the plans and estimates have to be based. In Chapter I. will be found a vast amount of information and data relating to the horse-powers of various classes of industrial and domestic machinery, candle-powers of light sources, illumination allowable in different situations, and so on. Chapter II. briefly considers the question of buildings. Chapters III.–V. contain information and data respecting the mechanical and electrical equipments of an installation with a critical survey of the characteristics, relative advantages and proper selection of the systems and machines. Chapter VI. deals with cables,

feeder and distributing systems. The methods of installing motors, arc and incandescent lamps are next considered in Chapter VII., with remarks on driving, crane equipments, &c. The final chapter of the section includes worked-out estimates with explanatory notes.

Part II. shows how to determine the working costs and anticipated revenue of electric lighting and power plants. Seven chapters are devoted to this question which is fully treated, and numerous tables are given including statistics and tariff systems of several central stations in Germany.

Part III. is divided into eight chapters and contains contract prices of complete station equipments, tables of prices of individual machines, instruments, lighting material, &c., supplied by different German firms.

The information covers a very large field, is reliable, well treated and well arranged ; and the book has a very complete index.

CORRESPONDENCE.

IS THE CONSULTING ENGINEER NECESSARY?

TO THE EDITOR OF THE ELECTRICIAN.

SIR : This question, which has resulted in a most interesting correspondence during the past few weeks, is to my mind only part of a much wider subject. In considering the necessity for the existence of the consulting engineer the positions of the manufacturer and the contractor must be taken into account, for each section should be acting in conjunction with the others if the maximum of efficiency in the application of electricity is to be achieved, and this, I take it, is the object of every section.

It is the fact that there has been little or no mutual consideration between the sections that has made your question even possible. It is obvious that the manufacturer must be limited by the possibilities of his own goods if he wishes to advise a buyer as to the best apparatus for certain requirements. The contractor, too, is equally limited, though in a different manner, for he will have but an indirect inducement to recommend, at the risk of losing business in competition with less scrupulous rivals, expensive apparatus rather than something cheaper but less effective. It follows that the independent expert adviser, or consulting engineer, is a necessity if the buyer is to have a proper opportunity of obtaining the best results consistent with the price he desires to pay. If the electrical industry were in a more satisfactory condition each section would confine itself strictly to its own business, but unfortunately we are very far from this ideal. A glance, for example, at the list of so-called consulting engineers in the trade directories will show how defective is the present condition of things. The list includes many well known contractors pure and simple, manufacturers, agents for special apparatus and machinery, and so on and so forth, and the number of those who are justly entitled to the term "consulting engineer" is but a small proportion of the whole. This is ridiculous, and should be remedied promptly. One of your correspondents has suggested that a list of bona-fide consulting engineers should be compiled. This is certainly necessary, and the profession should form an association, just as every other profession has, with power, if it could be obtained, to take proceedings against incompetent unregistered individuals who pose as consultants. The matter could not rest, however, with the formation of such a society. It is equally necessary that contractors and manufacturers should be allied and registered. The consulting engineer should then refuse to place business with any firm not so registered, and the manufacturer or contractor should only do business through registered consulting engineers. This is the correct position for the various sections relatively to one another if the electrical industry is to be placed on a sound footing. We do not find a doctor sending his patients for medicine to an unregistered chemist, nor a solicitor recommending his client to anyone but a barrister for expert legal advice. Why should not similar methods hold for us? There may be necessary exceptions at times—the chemist might make up medicines for a quack doctor, if they were harmless—but the rules should exist, and the exceptions really be exceptional. Now the exception is more often the rule, and almost every manufacturer or contractor takes every opportunity of robbing the consulting engineer of business. I can imagine the outcry there would be amongst the contractors if a few of our leading consulting engineers took on a staff of wiremen and fitters and started in to instal plant themselves!

It is easy enough to thus picture the ideal conditions, but the real trouble is how to get them reduced to practical working, and here we can only regret that the Institution of Electrical Engineers seems to take no interest in the commercial questions connected with the applications of electricity. That it should do so is obvious. The Royal College of Surgeons, the Law Society, the R.I.B.A., all take an active interest in such questions, as well as in the purely technical matters connected with their professions. Why such points should be considered as of no importance to our own Institution it is difficult to conceive. But so it is, and it is, I am afraid, useless to wait for the Council to take action. The only thing to be done is for each section to take separate action. We already have a Manufacturers' Association and a Contractors' Association, but both are unrepresentative and therefore ineffective. These Associations must be strengthened, and the consulting engineers, the inspectors for the insurance companies and the central station engineers have the power of doing this and at the same time of strengthening their own position. Let these three bodies, of which the consulting engineers are at present, I believe, the only section without organisation, agree to recognise membership of the other bodies by sending their inquiries only to firms belonging to these associations and giving other special facilities to such firms. The manufacturers and contractors in return must agree to eliminate from their ranks all firms blacklisted by the other bodies. The result would be a list of reliable firms, manufacturers and contractors, which would speedily embrace all those of importance, on the one hand, and a body of real consulting engineers and expert advisers on the other, who would have always available the names of plenty of firms who could be trusted.

Probably this would lead to a temporary rise in the cost of installation work, but I think it would soon be found that cheaper methods of work could be used with safety when the work was properly carried out. Wiring on insulators in factories and with flexibles in private houses *properly carried out*, for example, could frequently be substituted for the expensive wiring methods now in use, and in the end the buyer would find the cost coming out lower, whilst the contractor would be able to obtain a reasonable return for his work.

I must apologise for the length of this letter. The subject is a vast one, and I have only been able to barely sketch out my ideas, but the question is of such vital importance to the whole industry and to the future of electricity, that I trust you will be able to find room for it, and that the discussion you have raised will lead to something more than words.—I am, &c.,

20, New Bridge-street, E.C., May 25. E. H. FREEMAN.

PRINCIPLES AND PRACTICE OF RADIO-TELEGRAPHY.

TO THE EDITOR OF THE ELECTRICIAN.

SIR : We should not have thought it necessary to take any notice of Mr. Maskelyne's remarks on the above subject in your last issue were it not for the fact that he makes statements concerning Mr. Marconi's inventions which, being entirely misleading, must be corrected.

1. Mr. Maskelyne quotes some paragraphs from a recent lecture of Mr. Marconi referring to a form of discharger invented by the latter, and proceeds to describe it as an "arc apparatus," and to give an account of its operation evolved out of his own imagination. The discovery on which this invention of Mr. Marconi is based is that a permanent electric arc cannot be maintained between metallic surfaces moving in air in a certain manner with a sufficient relative velocity, whereas condenser discharges can pass. That this is the case can easily be verified by means of the revolving mirror.

2. Mr. Poulsen in his 1908 British Specification claims the use of an electric arc in a hydrogenic atmosphere and also in a magnetic field. Mr. Marconi neither uses hydrogen nor a

magnetic field, and, moreover, he takes most effective means to prevent the formation of the inefficient arc.

3. Mr. Maskelyne next refers to the interrupter, suggesting that the interruption of the transmitting circuit as done by Mr. Marconi is analogous with Mr. Poulsen's "tikker." Mr. Marconi interrupts the transmitting circuit to produce intermittent radiation and economise power at the transmitting station, while Mr. Poulsen uses his "tikker" in the receiving circuit to accumulate, at the receiving station, the feeble continuous radiation from the transmitting station. There is, therefore, no analogy between the two devices.—I am, &c.,

For Marconi's Wireless Telegraph Co. (Ltd.)
London, W.C., May 27. ANDREW GRAY.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: In your last issue Mr. Nevil Maskelyne draws attention in a very interesting letter to the gradual passage of the spark variety of wireless telegraphy towards the arc method, developed so splendidly by Poulsen and his collaborators. Your correspondent in his letter paints an eloquent picture of a period only a year or two ago, when all the wireless telegraph experts were, he says, decrying the arc and resisting its introduction into wireless telegraphy. This picture he contrasts with another of the present day, wherein these same experts are calling blessings on the arc, and even tendering bantling arc methods of their own to the admiring world. In Mr. Maskelyne's view, it would seem, all these little strangers—if burly—are palpable infringements of the Poulsen group of patents.

I venture to write as a detached observer of all matters radio-telegraphic to point out that this vivid antithesis is much overdrawn. In the first place, there really did not exist at the period of the commercial début of the Poulsen method any such fierce universal opposition as your correspondent portrays. Of course, people whose interests were likely to be affected adversely by the commercial success of the arc formed choruses in praise of the spark—just to encourage themselves, and old-standing wireless telegraph firms did *not* scrap existing installations or refuse new orders. But leaving out this limited class of biased experts, there was, as a fact, a very warm welcome extended to the arc method on its introduction in 1906. I need only refer to past editorial utterances and to other articles in *The Electrician* to illustrate the fairness with which the new method, as yet untried commercially, was received, and the good wishes that were extended towards it.

Nor is the second part of Mr. Maskelyne's picture, wherein he sketches the modern spark telegraphist hastening to substitute the arc for the spark, any better proportioned than the first part. Quite aside from the fact that a great deal of spark telegraphy is still going on, it is not correct to say that the spark people are changing their opinions concerning the advantages of sustained oscillations in wireless telegraphy. For many years methods of generating sufficiently sustained oscillations have been most eagerly sought, solely because this is the natural culmination of the syntonic ideal. The whole movement towards syntonic radio-telegraphy has been spread over some 9 or 10 years, and the rise of the Poulsen method of telegraphy is a part—a very important part, of course—of that movement, but not the cause of it. What the spark people objected to, even sneered at, in the Poulsen method on its introduction was an alleged impracticability. Thanks to the labours of their gifted technical staff, the Amalgamated Radio Telegraph Co. have, I think, now made this reproach so inapplicable that great commercial success should now be assured. Meanwhile, quite legitimately, other experimenters have been trying to develop improved syntonic methods, and many of them have, like Poulsen, resorted to the Duddell arc phenomenon in one or other of its increasingly numerous shapes. But this is not the proper place to discuss whether every arc user is infringing the original Duddell patent.

Mr. Maskelyne draws very special attention to Marconi's very ingenious method of forming the oscillating arc between metal surfaces in swift motion. It would indeed be very interesting to know if this process had its beginning in the mere endeavour to evade the Poulsen patent, as suggested by your correspondent. Starting from the same premisses as Mr. Maskelyne I am inclined to think, in contradistinction to him, that Marconi probably began by seeking to improve the Sahulka or some similar mode of making a regular series of sparks of sufficiently high frequency to produce a musical tone. By such a train of sparks, however produced, monotonic signalling is obtained and thus discrimination between signals and atmospherics becomes possible. An interesting letter on this subject from Mr. Mortimer A. London was printed in *The Electrician* of the 8th inst. Doubtless while trying this rapid spark, Marconi discovered the virtues of the arc formed between moving electrodes. Though there are good scientific reasons for expecting the Marconi arc apparatus as a whole to be a very powerful oscillation generator, and for expecting it, in contrast with the hydrogen arc, to work the easier the greater the rate of radiation from the aerial, yet it is more to the point at this moment to state baldly that if Marconi keeps to his patent specification the arc is formed in air and not in hydrogen. It is not a Poulsen arc. Further, I may mention, that no patent concerning cooling of electrodes can be infringed by this Marconi apparatus, for the simple reason that the mere "principle" of "cooling" is not patentable. Finally—if I may now be allowed to lay down what is merely a personal opinion—since the Marconi method combines the merits of the musical spark with some of the syntonic virtues of the continuous arc, and since it banishes the Tesla or Poulsen "ticker" principle at the receiver end (which interprets atmospherics and signals equally well), this method may, I believe, ultimately prove to be one of Marconi's greatest triumphs.—I am, &c.,

South Western Polytechnic, Chelsea. W. H. ECCLES.

MARCONI'S SYSTEM OF WIRELESS TELEGRAPHY.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: An extraordinary general meeting of Marconi's Wireless Telegraph Co., held on Monday, May 18th, considered, and unanimously consented to an increase of capital by the creation of 250,000 7 per cent. cumulative participating preference shares of £1 each.

On Wednesday, May 20th, an article under the heading "Wireless Telegraphy. Marconi System's Improvements," appeared in the *Morning Post*, giving particulars of an interview between Mr. Marconi and a *Morning Post* representative.

In Mr. Marconi's narration of his company's achievements in improved apparatus and working speed the unbiased man finds much to admire, especially in view of the energy and determination evident throughout all Mr. Marconi's undertakings. Indeed, all fair-minded persons—whatever their own particular interests—can but wish success to any keen scientific undertaking allied to honest commercial enterprise.

When, however, Mr. Marconi—as reported in the *Morning Post*—proceeds to compare his attained trans-Atlantic wireless working speed with a seriously understated speed rate alleged to obtain over long-distance trans-Atlantic cables, any one acquainted with the highly effective performances of the cables must perforce offer a respectful but none the less emphatic protest.

Such action is necessary, not only in the interest of scientific accuracy, but also on behalf of cable shareholders, who could not have read the *Morning Post* article without considerable misgivings as to the safety of their investments. Influenced by these considerations, I wrote, on May 21st, to the editor of the *Morning Post*. A copy of my letter—which the editor of the *Morning Post* has this morning definitely declined with thanks—I here submit, Sir, to your good pleasure and judgment.—I am, &c.,

E. RAYMOND BARKER.

12, Edge Hill, Wimbledon, Wednesday, May 27.

Below we reproduce from the *Morning Post* the article referred to by Mr. Raymond Barker, and the letter on this subject which he addressed to our contemporary:—

WIRELESS TELEGRAPHY.

MARCONI SYSTEM'S IMPROVEMENTS.

Accustomed as we are of late years to the wonderful advances made in the practical applications of science, few people could have believed that within five years long-distance super-marine wireless telegraphy would, from isolated and even sensational experiments, have passed into ordinary commercial use. Yet such is the case, and little by little

the many and varied difficulties in the way of the everyday applications of wireless telegraphy are being overcome.

Two great desiderata in telegraphy are rapidity of transmission and secrecy, and to those two points Mr. Marconi has been applying his inventive genius. Seen yesterday by a representative of the *Morning Post*, Mr. Marconi said that at the present moment, by the employment of a new form of discharger and improved methods of working, introduced last year, the speed of message sending had been greatly increased. The speed now attained was as great as could be achieved by single transmission hand sending on land lines, and greater than any which even expert operators had reached on long distance—say trans-Atlantic—cables. The limits of speed on such cables were well known, and regulated by various natural laws. Of course, on short-distance cables the speed was greater. Already, Mr. Marconi stated, wireless messages could be transmitted across the Atlantic at a speed of 24 words a minute, and with favourable circumstances and a highly-skilled operator—for, of course, the personal equation comes in—30 words a minute had been achieved between shorter distance stations, though this was not usual. Mechanical sending, employing punched-paper strips as in the Wheatstone automatic system used in land wire telegraphy, might, he added, eventually increase the speed considerably. In any case, the increase of speed was a comparatively small thing when what has already been achieved was considered.

Mr. Marconi's recent work has, however, led him to some results which may and probably will mean highly increased efficiency. His efforts are in the direction of a duplex arrangement for the receipt and transmission of messages. The advantage of such a duplex system is clear. At present, when a station is receiving a message, it has to wait until that message is concluded before it can itself transmit to another station. If, as appears probable, Mr. Marconi's latest invention does all that is hoped from it, a station will be able to receive and transmit at the same time, so that on the ordinary basis of the transmission of 20 or so words a minute, double that number may be "waved" across space in the same period, half each way, each station sending and receiving at the same time. How this wonderful increase of efficiency is attained is as yet Mr. Marconi's secret, and the mechanical means adopted for "cutting off" the transmitted waves from the incoming waves he naturally enough declines, for the present, to make public. He has tested the duplex system over short distances, up to 4 or 5 miles, and it has proved successful, and he added yesterday, "I see no reason why it should not prove efficient over long distances as well, though I have not yet tested that. Over short distances it certainly looks very promising. I believe that what is efficient at 4 miles will be so at 400 miles or more, and if so, it will double the efficiency of the system."

Passing to the secrecy of messages, Mr. Marconi said that no system of telegraphy, whether with or without wires, was absolutely secure from "tapping," but he pointed out that when two wireless stations were communicating, each sending and receiving messages at the same time, a third station would get those messages super-imposed, and therefore be unable to decipher them. In that manner, the duplex system would give further security in the way of secrecy. Should Mr. Marconi's hopes be fully realised, a further and an important step forward will have been taken in assuring to wireless telegraphy a considerable share in the conduct of the inter-communications of the various parts of the world.

On this article Mr. Raymond-Barker sent the following comments:—

TO THE EDITOR OF THE "MORNING POST."

SIR: Regarding some of the statements made under the heading "Wireless Telegraphy. Marconi System's Improvements" in your issue of the 20th inst., I pray you to allow me to make some comments.

My professional as well as personal interest both in submarine cable work and in radio-telegraphy will vouch for the impartiality of my word. Without for a moment impugning the good faith of Mr. Marconi I am of opinion that his words, as reported by your representative, will tend to mislead the non-technical public.

Actual up-to-date trans-Atlantic wireless working speed is subsequently stated by Mr. Marconi to be 24 words a minute, or under favourable circumstances, with a highly-skilled operator, 30 words a minute. It is mentioned as being "as great as could be achieved by single transmission hand sending on land lines, and greater than any which even expert operators had reached on long distance—say trans-Atlantic—cables."

In *The Electrician* of October 12th, 1894, will be found an article by Mr. Arthur E. Dearlove, A.M.I.C.E., M.I.E.E., giving full technical particulars of the Anglo-American Telegraph Co.'s 1894 Atlantic cable, including an electrotype print of actual signals received over the cable at [illegible] five-letter words a minute. On inspecting these signals the expert can see at a glance that the above speed might have been increased, and, curiously enough, *The Electrician* of November 30th, 1894, in an article by Mr. Patrick B. Delany, records a highest speed with regular traffic during the month of September, 1894, 249 letters—say 50 words—a minute. The theoretical speed of this cable is, in my opinion, between 50 and 60 words a minute, which, with duplex working, would give a total 100 words a minute for that one cable.

Here I have dealt with only one out of the many trans-Atlantic cables, most of which are duplexed and are capable of attaining in each direction a speed far higher than that mentioned in your report. The objection may be raised that Mr. Marconi was speaking of hand speed. If so, it follows that the 30 words a minute by Morse code, transmitted by his highly-skilled operator, would equal the cable recorder code of equal time-element speed, and in the hands of an equally expert cable operator, be 25 per cent. faster—say 38 words per minute.

But, Sir, why do Mr. Marconi's statements, as reported by your representative, ignore the for-a-long-time-past everyday use of mechanical or automatic sending on the trans-Atlantic cables? This rapid method is mentioned, in your report, in connection only with land wire telegraphy, so the non-technical reader might very reasonably infer that in submarine work punched-paper strip transmission is unknown, whereas it is now practically in universal use. Only quite recently the speed possible over long submarine cables has been still further greatly increased by the inventions of Mr. S. G. Brown. Any of your readers who may find themselves on our coasts anywhere in the neighbourhood of the great cable stations of Porthcurnow, Valentia, or Waterville, would do well to see for themselves what the cables are doing. They would be repaid by one of the most interesting sights in the world.

Again I repeat that I am interested in both cable and radio systems. There is room for both, and all both parties ought to ask for is a fair field and no favour. In your representative's report of his interview with Mr. Marconi the fair field for the cables is not much in evidence.—I remain, Sir, your obedient servant,

(Signed) EDWARD RAYMOND-BARKER, M.I.E.E.

CAPACITY OF CABLES.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: Referring to Mr. Howe's article on "Capacity of Cables," which appeared in recent issues of *The Electrician*, the error of the "Charge Method" is not due to leakage, as Mr. Howe states, but to absorption, and this is shown very simply by the ordinary "discharge method," commonly used in the United States. Instead of obtaining the ballistic throw by charging the dielectric through the galvanometer, the previously charged dielectric is discharged through the galvanometer. Now, if the error of which Mr. Howe speaks were due to leakage, the throw obtained on discharge would be too small, as, obviously, some of the charge would have leaked and the remainder have passed through the galvanometer. As a matter of fact, the errors of the two methods are both of the same sign and approximately equal.

The absorbed charge of a dielectric is superposed on the free charge and cannot be separated therefrom. The total charge of a condenser, therefore, consists of these two components, and depends greatly upon the time during which the absorbed charge is allowed to flow. The free charge flows into the condenser, as we know, in a few thousandths of a second according to the logarithmic law, but the absorbed charge, also flowing according to some exponential law, is superposed on the free charge and continues to flow indefinitely. The total absorbed charge of an ordinary dielectric is enormously greater than the free charge.

If the flow of the free charge be cut off at the end of a few seconds as represented by the period of an ordinary galvanometer, the total quantity will be greater than the free charge by an amount depending upon the period of the galvanometer and the nature of the material. This error in the case of the best mica condensers may amount to a few tenths of 1 per cent. (see *Bulletin* of Bureau of Standards, Vol. III., No. 3, F. W. Grover), in the case of paper telephone cables it may amount to 10 or 20 per cent., and in power cables from 50 to several hundred per cent., as Mr. Howe states.

If alternating current of commercial frequency be applied to a condenser the time of charge is reduced to a few hundredths of a second, and the amount of charge absorbed is a very small part of the total charge. It is sufficient, however, to cause appreciable variation on the charging current with changes in frequency. The effective capacity therefore of commercial dielectrics is a function of the applied E.M.F. For telephone cables the capacity at 800 cycles has been found to be approximately two-tenths of one per cent. less than at 200 cycles, and for some power cables the difference in capacity at 25 and at 60 cycles has been found to be several per cent.

When a cable has been charged for 60 seconds the flow of absorbed charge appears to have reached a steady value, and it has always been customary to call this leakage current. That this is not the condition of affairs may be shown by charging the cable for a long time, several days or a week. A galvanometer is included in the circuit and provided with a short circuit which may be removed at intervals to observe the charging current. If care be taken to keep the charging E.M.F., and especially the temperature of the cable constant, it will be usually found that the so-called leakage current will eventually reduce to an amount scarcely measurable. The charging

curve of a dielectric has a logarithmic appearance and is very deceiving, since it appears flat at the end of a minute or so. When, however, a dielectric is free from all flaws or cracks and will pass a high-tension test, it will usually be found that the true leakage current taken at the end of an indefinite time is, for all practical purposes, nil.

I think that there is very little physical significance in "insulation resistance" as ordinarily measured. It merely gives a crude indication of the absorption, and is not true insulation at all. When direct current is applied to a cable in use the dielectric becomes fully charged in a few days, and then the leakage through the dielectric is nothing compared to that obtained in the factory test. When alternating current is applied to a dielectric it is much more desirable to know the power factor of the dielectric, since absorption and leakage both produce the effect of shifting the phase of the charging current.

A cable which passes the factory high-tension tests must be free from flaws and streaks of conducting material, and I think that in all such cables the true leakage is negligible. In this connection I do not wish to be understood as stating that the actual insulation resistance of all or of any dielectric is infinite, since many substances, such as slate, for example, contain streaks of conducting material. Such a conclusion would be absurd, but it is a fact that the insulation of commercial cables is much greater than usually supposed, and quantitative measurements of this are of no commercial value as long as the cable will withstand the tension tests.

It is because the effects of absorption and leakage are so widely different, and in the Paper referred to so much stress is laid upon the "leakage" so-called, that I offer the above criticism.—I am, &c.,

7, Follen-street, Boston, U.S.A., April 28. H. S. PARDEE.

We have submitted Mr. Pardee's letter to Mr. Howe, from whom we have received the following reply:—

TO THE EDITOR OF THE ELECTRICIAN.

SIR: Replying to Mr. Pardee's criticism on my article of the above title, I quite recognise the effect of absorption on the correctness of the results obtained when testing capacity by the charge or discharge method.

On p. 864 I write: "When testing capacity by the discharge method, six tests on the same cable may give six different results, according to the time of charging, and therefore to the amount of polarisation set up in the dielectric." However, I cannot agree with Mr. Pardee's view that the leakage through the dielectric has no effect on the results obtained, nor with his "proof," so called. As a matter of fact, the throw obtained upon charging a low-insulation cable is very much greater than the discharge throw. As this assertion is opposed to that of Mr. Pardee, the point must be decided by means of tests. I have, therefore, taken a 440 yd. length of cable, having the abnormal insulation resistance of 8 megohms per mile, after one minute's electrification, and have had the following tests carried out:—

The figures given below are the galvanometer throws obtained:

A. Charge	...	1,050	divisions.
B. Discharge.	Time of charge = short as possible...	576	,,
	,, 5 seconds	709	,,
	,, 10 ,,	743	,,
	,, 30 ,,	780	,,

This great difference between the throws obtained on charge and discharge is due to the leakage and absorption current which produces, or tends to produce, a deflection in the opposite direction to the discharge throw. If this deflection be added numerically to the discharge throw the result should equal the charge throw. That this is the case can be seen from the following tests:—

The galvanometer was opened directly after charging, and the deflection, or back kick, obtained shows the leakage and absorption current flowing at the time of discharge.

Time of charge before discharge.	Deflection at time of discharge.	Discharge throw.	Total throw.
Short as possible	− ?	+ 580	580 + ?
5 seconds	− 563	+ 480	1,043
10 ,,	− 570	+ 570	1,140
30 ,,	− 390	+ 620	1,010

The above tests clearly show that the charge and discharge throws are not equal, and also shows the reason of their inequality. Moreover, it can be seen from the discharge throw after 5 seconds—namely, 480 divisions—that a result can be obtained much below the true capacity. This error in the capacity obtained by the discharge method has been observed on numerous occasions, and has no doubt been observed by various cable engineers.—I am, &c.,

Old Charlton, Kent, May 25. F. J. O. HOWE.

P.S.—I find that in Table IX. of my article on p. 904 (Vol. LX.) the last "connection" should read "cores 1 + 3 against 2 + 4. Lead free."

REGISTRATION OF WIRING CONTRACTORS.

TO THE EDITOR OF THE ELECTRICIAN.

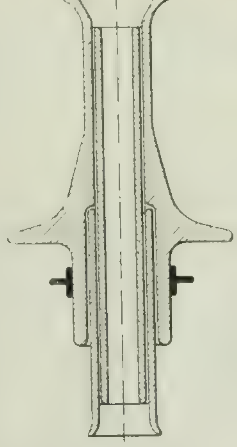
SIR: With reference to a note published in *The Electrician*, May 22nd, p. 202, on the above subject, I would point out that this plan was adopted about 12 months ago in the City of Wellington, N.Z., at the suggestion of Mr. C. E. Richardson, M.I.E.E., city tramways and electrical engineer. It was made the subject of a Council bye-law, and, in order to make wiremen more competent, pass subjects were prescribed at the Technical College, passes being required in cases where the city electrical engineer had any doubt as to the competency of a contractor or his men (subjects such as splicing, jointing, reading and drawing architect's plans of wiring, &c.). No wireman is now allowed to touch or connect to Council's mains unless licensed, and such licence is issued, subject to renewal each year, on payment of a fee of £1. 1s. This plan, I understand, has led to a very satisfactory issue, and, as far as I know, no legal complications.—I am, &c.,

May 26. E. H. WYNDHAM WESTWOOD.

ON PORCELAIN INSULATORS FOR TRANSFORMERS, SWITCHES, &c.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: With reference to the article by Dr. C. C. Garrard, "On Porcelain Insulators for Transformers, Switches, &c.," which appeared on p. 160 of your issue of May 15th, we beg to state that for nearly a year past we have been carrying out experiments on the same subject in our laboratory, and are glad to find that Dr. Garrard's results agree very closely with ours. We think that corrugated insulators are quite unsuitable for indoor work and prefer, as does Dr. Garrard, to employ plain insulators and bushes on account of their being less liable to collect dirt. We have extended our researches up to voltages of 100,000, and, as a result, we have designed and adopted a smooth insulator for use on the high-tension terminals of our latest types of potential and current transformers, which work on voltages between 2,000 and 80,000. The sketch, reproduced herewith, shows the type of insulator we have adopted on our measuring transformers for voltages between 60,000 and 80,000. Its design embodies our experimental results.—We are, &c.,



Milan. C.G.S. SOCIETÀ ANONIMA PER INSTRUMENTI ELETTRICI, GIÀ C. OLIVETTI & C.

BRAKES RECOMMENDATION IN HALIFAX REPORT.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: I was interested in reading your leading article in last week's issue, dealing with Major Cardew's and Mr. Graham Harris's report on the working of the Halifax Corporation Tramways. In dealing with the brake recommendations, you stated that attention is also called as to the desirability of giving a skid brake a trial on these lines. This reference is somewhat of a general nature. From the wording of their report, I think it is fairly obvious that my groove skid brake is the one referred to, and which was described in your issue for May 1st last.

It is particularly interesting to me to see that these experts have recommended that every car should be fitted with an efficient emergency brake, and, in addition, an adjustable brake for continuous use for controlling speeds down steep inclines

I see that in the House of Commons on May 7th a question was put as to whether the Board of Trade proposed to introduce any legislation which would render an independent emergency brake, under the control of the driver and conductor, compulsory on all tramways. This inquiry is on the same lines as the recommendation in the Halifax report, and is in exact agreement with the requirements I have been emphasising for the last two years.—I am, &c., P. J. PRINGLE

Burton-on-Trent, May 25.

[No specific mention was made of Mr. Pringle's brake in the Halifax report, but we do not doubt that this particular brake was what Major Cardew and Mr. Harris had in mind.—ED. *E.*]

LICONITE LEADLESS CABLES.

Ever since the advent of the paper-insulated oil-impregnated cable, engineers have sought for a cable in which lead as a protective covering was entirely absent. Meantime lead-covered cables have practically become standardised, and manufacturers have installed expensive machinery for their production. The leadless cable has been a long time in coming, and even to day, when "leadless" systems are in use, the paper insulated cable without a protective metallic sheath cannot be said to have "arrived." At the invitation of Messrs. Johnson & Phillips, acting on a request from Messrs. A. Heindrichs & Co., of Amsterdam, an inspection by a party of technical journalists was made of a cable insulated with a prepared material known as liconite. The actual composition of this preparation was not disclosed, though it is said to be bituminous in character. It is applied to the cable either as liconite paper or liconite elastic. For high voltages a "reinforced" insulation is employed which consists of alternate layers of tape and liconite elastic, the former being bound on tightly so as to hold the layers firmly together. What was termed "hessian" tape is then bound round the whole mass.

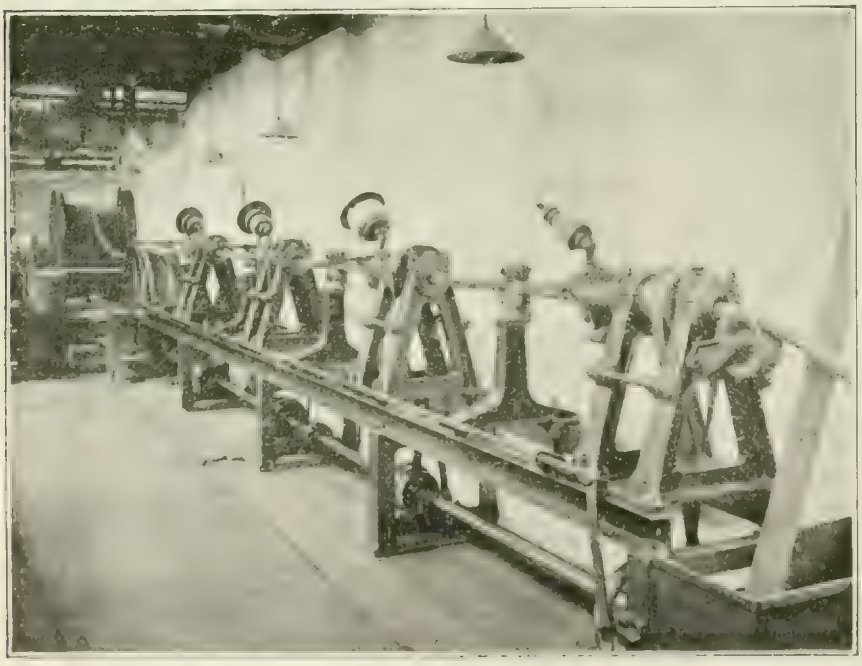


FIG. 1.—A WRAPPING MACHINE FOR LICONITE CABLES.

Messrs. Johnson & Phillips have made the special machinery for the manufacture of these cables, and a number of tests were carried out on Tuesday, the occasion of our visit, in their new cable shops which had been placed at the disposal of Heindrichs & Co., who were responsible for the tests. The samples selected were as follows:—A 220 yds. length of three phase cable for working pressure of 20,000 volts and capable of transmitting 500 kw. The core consists of stranded aluminium covered with a thin coating of lead for the purpose of providing a smooth surface and to reduce electric stress. It is intended for underground or surface work, and it is claimed by the owners that this cable laid underground would involve less expenditure of capital for high-tension transmission than an overhead line, while at the same time it is more permanent and durable and would cost less for maintenance.

FIG. 2.—A TEST IN PROGRESS.

Another cable consisted of 220 yds. of 0·25 sq. in. of stranded copper insulated with paper treated with liconite. This cable had no lead covering, the insulation being merely mechanically protected by hessian tape. The third length of cable of 0·25 sq. in. copper area was of the reinforced type already referred to.

These cables were submitted to various pressure tests, three oil insulated transformers being used for the purpose. The details of the tests carried out are tabulated below:—

Test 1.—A leadless paper cable, after immersion in water for 12 days, was flashed with 30,000 volts for five minutes without being pierced. The length of cable was 200 yds., and it was a 0·25 sq. in. copper cable, insulated with 56 layers of liconite impregnated paper to a thickness of ⅜ in. and covered with two layers of liconite tape and one layer of hessian tape. Insulation resistance was said to be 10 3 megohms per mile.

Test 2.—A 2 yds. length was cut off the above cable, bent round a drum 18 in. in diameter three times in each direction, and flashed until it broke down. After bending, the insulation drew over the conductor about 1½ in. On the application of 43,000 volts the test piece showed signs of smoking, and on the pressure being further raised it started firing; finally, after the voltage had been increased to 63,000, in a few seconds the high-voltage terminals flashed to the water in the tank.

Test 3.—A 2 yds. length of the same cable, after being immersed with its ends bare and under water for seven days, and which before being immersed was bent round a drum 18 in. in diameter three times each way, was then flashed. A pressure of 70,000 volts was applied without damage being done, but on its reduction to 52,000 the length broke down.

Test 5.—Three phase liconite elastic cable, each core 19/·085 aluminium-covered, with thin layer of lead to a diameter of 0·550, the whole equivalent to 0·070 sq. in. of copper, flashed up to 50,000 volts between each pair of cores without damage. The pressure was applied for seven minutes. The length of cable was 200 yds., thickness of insulation ⅛ in., lay of cable 40 in., and the outside diameter of the three cables laid up 3¾ in. The test pressure was maintained for seven minutes, and the cable showed no sign of breaking down.

Test 6.—Liconite impregnated paper, sheets of varying thicknesses, similar in character to the paper tape, flashed until they broke down. One-fold withstood 1,490 volts, two-fold 2,400 volts, and three-fold 2,300 volts.

Test 7. Liconite elastic sheets of varying thickness were flashed until they broke down. The results were as follows: ⅓ in. thick 63,000 volts, 106 mils 42,000 volts, 152 mils 45,000 volts, and 62 mils 31,000 volts.

It was stated at the luncheon, given after the demonstrations, that liconite has been developed by Mr. E. S. Ali Cohen, of Singapore, and that, while it has the advantages of rubber and guttapercha, it is superior to these as an insulator and at a fraction of their cost. It is said to be non-hygroscopic, proof against dilute acids, alkalis, oils, moisture or electrolysis. It is both tough and elastic, and will not crack or flow like ordinary bitumen, while it is also claimed that it is light and easily handled.

The cable is being exhibited at the Franco-British Exhibition, Stand No. 260, Machinery Hall, where apparatus has been erected for the testing of the cables at high pressure. We illustrate a wrapping machine in use for liconite cable at Johnson & Phillips' works and also a view of the test tank taken at the time of the demonstrations.

SWITCH GEAR CONTROL APPARATUS AND RELAYS FOR ALTERNATING CURRENT CIRCUITS.*

BY C. C. GARRARD.

Introduction.—The installation of control relays on high-tension alternating-current circuits has become and is likely to remain standard practice. Their correct design and lay out is, therefore, of the highest importance, while on their proper action the success of the system greatly depends. Many systems are, notwithstanding, designed on erroneous lines, due to the facts both that this type of apparatus has not been thought worthy of much attention, and for economical reasons.

Polyphase Maximum Time Element and Reverse Relays.—The polyphase maximum time element relays which have been installed in many supply stations consist of a polyphase relay with a single moving element, which is operated by the currents in two or three of the phases. Such a relay with three windings energised could be put on a two-phase four-wire network and adjusted to operate after 30 seconds on a 150 per cent. load. This means that after 150 per cent. full load has flowed in *each phase* for 30 seconds the relay operates. In this case each phase contributes one-third of the operating torque, but should an overload occur in only one phase, it will have to be greater than this amount for any action to take place. It is therefore possible with maximum polyphase relays for large and dangerous loads to flow in one phase without operating the relay. For this reason single-phase relays, connected separately to two or three of the phases on a four-wire system, should be used.

The above applies with equal force to polyphase reverse relays, for, under some conditions, with a reversal in one phase only the tendency towards operation is neutralised by the unreversed phases. The only perfect solution, therefore, is to instal a separate single-phase relay in each phase.

Solenoid Relays.—A considerable number of maximum time-limit relays operating on the solenoid principle are in use at the present time. They consist of a solenoid having a movable iron plunger, which is sucked up when the current in the solenoid exceeds a certain value. The iron plunger is attached to a dash-pot or air-bellows which retards the travel of the plunger, the amount of the retardation being varied by means of a small valve which controls the clearance in the dashpot, or the rate at which air can pass in or out of the bellows. The plunger, therefore, takes a certain time to travel to its top position; when it is reached contact is made in the trip coil circuit and the controlled circuit is opened. Experiments were made on a typical relay of this description, the current being maintained constant, while the voltage-drop across the coil was measured for different positions of the plunger. It was found that as the plunger was raised the drop increased and, knowing this value and the constants of the coil, the reluctance of the circuit was calculated. This quantity decreases as the plunger is raised, while the force on the latter is inversely as the square of the reluctance. It may, therefore, happen that the plunger "floats," thus shortening the time element. The relay, then, will operate sooner than under ordinary conditions, should another overload come on. These results show that the dashpot solenoid type of maximum relay is not reliable in dealing with intermittent overloads or short-circuits.

Fuse-shunted Trip Coils.—A method sometimes adopted to give an ordinary circuit-breaker a time element is to shunt the trip coil with a fuse through which the secondary current of the current transformer is shunted. The time taken for the fuse to blow gives the time element. This arrangement is suitable only for alternating currents, and its chief merit is its cheapness. But the characteristics of every device of this kind should be (1) to prevent the circuit-breaker opening for every abnormal rush of current and (2) to allow of a discriminating action so that of two circuit-breakers in series one can be opened before the other. Tests made on this type of circuit-breaker show that this discriminating action cannot be relied upon and for any particular arrangement there is no guarantee on heavy loads that one circuit-breaker will act before the other. This uncertainty is not overcome by using thicker fuse wire. The fuse is only traversed by the *secondary* current of a current transformer, and although the primary current in the generating station may be larger than that in the sub-station, the secondary currents are usually equal, the ratios of the current transformers being varied according to the values of the primary current. This type of control is, therefore, not suitable for important circuits, though it may find a place on motor control panels where ordinary fuses are not desired.

For three-phase three-wire systems two separate single-pole relays are theoretically necessary to afford complete protection. When what may be designated the "resultant" scheme of connections has been used a single one-phase relay only has been installed, but in conjunction with two current transformers, so connected that the current in the relay is the vectorial resultant of the current in each of the phases in which the current transformers are situated. A number of supply stations in this country have protective apparatus installed in this manner. On working out the currents in the relay vectorially, however, it will be found that the protection afforded by this method is doubtful. Assuming the normal full-load secondary current of the transformers to be 10 amperes, and the relay to be set to operate at 200 per cent. full-load current—*i.e.*, when 34·6 amperes flow through it. If now the overload occur on both the phases connected to the relay, and the phase displacement in each phase is the same, then the circuit is opened when 20 amperes secondary current flows in each phase. It is quite likely, however, that the overload will only occur in one of the phases, and in this case the phase displacement will most probably not be the same in

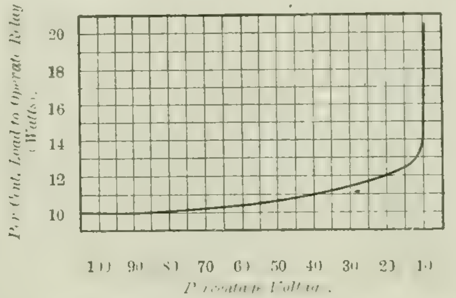


FIG. 1.—A. C. REVERSE RELAY VARIATION OF CALIBRATION WITH VOLTAGE.

each phase. If the angle of lag in each phase is equal, and only one of them is overloaded, it will require 282 per cent. full-load current in the single overloaded phase to cause operation. Should, however, the current in the overloaded phase lag 60 deg. more than the other phase, which is quite possible, then the current in the overload phase would have to increase to 386 per cent. full load current before the circuit is broken. That is to say, with this scheme of connections and the circuit breaker set to come out with the ordinary test at 100 per cent. overload, one of the phases, and of course the unprotected phase, could be overloaded to the extent of 200 or 300 per cent. without the circuit being opened.

In the three phase four wire system three current transformers are necessary, but only two relays are used. This is due to the fact that there could not be an abnormal current in any one of the three phases without the relays also being affected. The argument given above applies with equal force in this case, and the only safe arrangement is to have the same number of relays as current transformers.

Generator Relays.—When relays are installed between 'bus bars and sources of electrical energy—*e.g.*, for controlling generator switches and switches at the far end of feeders—complete protection is afforded by a reverse arrangement, and the fitting of maximum current circuit-breaking apparatus must be regarded as bad practice.

Reverse current relays on generators should only come into operation when a serious fall has developed on the generator or prime mover, such as a breakdown in the winding or a total failure of steam power. Many cases of accidents to the prime mover would be aggravated by an automatic disconnection from the 'bus bars, and a generator relay which operates instantaneously is not desirable. Further such relays are excited from the 'bus bars, and should, therefore, be so arranged that they are as little as possible affected by a reduction in the 'bus-bar voltage.

It will be understood that any form of relay, one of whose constituent parts is a shunt coil, will be affected by variation in the voltage applied to the same. The shunt coil of the generator reverse relay is excited (through the intermediary of potential transformers) directly from the 'bus bars. On the occasion of an accident to one

* Abstract of a Paper read before the Institution of Electrical Engineers.

of the generators the 'bus-bar volts will tend to go down. The trouble is intensified by the fact that, as has been shown, an instantaneous relay cannot be used, therefore there is more time for the voltage to fall. It must be remembered, however, that a failing generator in parallel with one or more good ones is not likely to pull the volts down to any very alarming extent. Probably a 50 per cent. reduction is the maximum to be expected. It is clear, however, that the calibration of the relay should be as little affected by variation in the 'bus-bar voltage as possible. Curve Fig. 1 shows the effect of reduction of the shunt voltage on the calibration of a reverse-power relay, consisting of a specially designed wattmeter movement. It will be seen that the calibration is practically unaffected down to 10 per cent. of the normal voltage. The limit down to which it works is 7 or 8 per cent., below that it becomes inoperative. The relay is also absolutely inoperative on forward power under all conditions. Tests made up to 10 times full-load current in the forward direction proved this. The most suitable value to which a generator reverse relay can be set is such that it will operate, after the requisite time element, with an energy reversal of 10 per cent. of the full rating of the machine.

Reverse Relays at End of Feeders.—The function of reverse relays at the ends of feeders is to prevent a fault on the feeder being fed back from the sub-station or distribution network. Their working conditions render them more likely to be affected by the voltage drop than are those on generators, and for this reason it is desirable that they should act as quickly as possible after the reversal. But in this case also the use of an instantaneously acting relay might cause the circuit to be needlessly opened, for instance, by the hunting of the sub-station machinery. This relay should, therefore, be set so that the minimum power required to operate it is above that likely to flow back owing to hunting. The higher setting of this relay than that at the generator end is quite admissible, for the current flowing through it will be of high-power factor, and, if not interrupted, of considerable magnitude.

Protection of Interconnector Cables.—Interconnector cables are used for connecting two sub stations together. This arrangement avoids the running of duplicate feeders to each sub-station and, owing to the reduction in cable lengths used, leads to a saving in capital expenditure. The ordinary system of protecting feeders is not applicable, for in this case the current will alter in direction in accordance with the relative loading of the sub stations, and special arrangements must be made. A maximum circuit-breaking device is desirable, but the time element should be very long so that this apparatus will not come into action under ordinary conditions, but only when the interconnector itself becomes badly overloaded or earthed. The function of the interconnector may be considered as being the passing of energy from one sub-station to the other in either direction. When, however, it takes energy from one sub-station and does not deliver it to the other—*i.e.*, when energy flows into the cable at both ends at the same time—it is not performing this duty. It follows that circuit-breaking apparatus must be installed at either end and that these must be interconnected, which is usually done by means of pilot wires.

In Merz and Price's system a current transformer is included in the interconnector at each end, and their secondaries are connected through trip-coils to a pilot wire, the return being made through earth. As long as current flows in the same direction through both primaries, the induced E.M.F.s balance and no current flows through the pilot wire. Should, however, the currents become unequal, or a relative reversal take place, the trip-coils are energised and the switches opened.

As the criterion of failure of an interconnector is the simultaneous flow of current into either end, such a circuit might be protected by the installation of reverse power relays at both ends, the relays being connected to a common tripping circuit arranged so that only when energy is flowing into the cable at both ends is the trip-coil circuit closed at both relays and the main switches opened. Normally the trip-coil circuit is broken at one relay and made at the other, or *vice versa*, according to the direction of the current. The relays close circuit with a slight time element, so that on the direction of the current reversing, one relay contact is opened before the other is closed. A pair of contacts, which are closed automatically when the main circuit at the corresponding end opens, are also provided.

If the switch at the left end of the interconnector opened slightly before the one at the right-hand end, the trip coil circuit would be closed by the relay at the right-hand end. Thus the circuit-breaker at the right-hand end would also operate. The object of this arrangement is to ensure that both ends of the interconnector will be disconnected even if the two switches do not act quite as quickly as each other. Each trip-coil is also arranged so that it is cut out of circuit when its main switch has opened circuit, after, however, the contacts mentioned above have been closed. The trip-coils, therefore, experience no danger of burning out. The state of affairs might, however, arise that the left-hand switch was open and the right hand switch was closed, there being a short circuit or earth on the interconnector. By the act of closing the right hand switch the trip-coil of this switch will be put into circuit ready for operation, and the circuit through the same will be complete through the right-hand relay, which operates due to the flow of current into the fault and through the contacts. The right-hand circuit-breaker will be opened at the same time cutting out its own trip-coil. It is impossible, therefore, to connect up the interconnector at either end while there is a fault on it.

The arrangement as set forth above of course necessitates that there should be some voltage in order to operate the relays. If the voltage absolutely disappears, the reverse relay will not work, and it may be thought that in the case of a very bad short-circuit this will happen. Considerable experience has shown, however, that, even under the worst conditions, the voltage does not entirely disappear, and that, if the calibration of the apparatus is unaffected by fall of potential down to 10 per cent. of the normal working voltage, all working conditions will be met (*see* Fig. 1). As the pilot wire only carries the tripping current it will be seen that only one pilot is necessary, whether the relays are single, two or three pole. On a three-phase system the relays will be two or three pole, according as the system is three wire or four wire. Messrs. Merz & Price suggest that the pilot wire, or wires, can be made up in the same multicore cable as the main conductors, there being generally sufficient space for this in the filling, which is used to make up the cable to a cylindrical cross-section. This, however, is open to the serious objection that if a serious fault or burn-out occurs the pilot wire will be most probably broken. It would be much better to keep the pilot wire quite distinct from the main cable, preferably laying it in a different duct. A system, therefore, which, under all conditions, only requires one pilot wire is an advantage.

(To be continued.)

PARLIAMENTARY INTELLIGENCE.

(Continued from page 255.)

Mr. Arthur Wright, consulting electrical engineer to Marylebone Council, was called, and said, in examination by Mr. Cane, that the generating costs at Marylebone were low, considering the load factor, which was lower than in most London districts, and their standing and running charges were very low. He did not think they would gain by taking the company's bulk supply. The estimates in the company's tables of Marylebone's generating costs were incorrect. He made the cost of the combined supply very much higher than Mr. Hammond, and the result a loss at the particular load contemplated by the tables. They had room in their engine room for plant up to 18.000 kw. If they extended their boiler house to supply 12,000 kw. the extra cost would be £1. 14s. per kw. He estimated that they could not give more than 35 or 40 per cent. load factor for the load Mr. Hammond had estimated, 54 per cent. load factor assumed a very big night load. He did not know why Mr. Hammond gave Marylebone, a residential district, 54, which was higher than St. Pancras, and higher than Stepney, the latter an entirely manufacturing district. Their present costs were £4·36 per kw. per annum and 0·395d. per unit. They had 350 power consumers, and the average of 25 of the largest was 11·4 kw.; their average load factor was 12·8. The price now charged for that load factor was 1·445d., without allowing what they called commercial discounts. All big consumers had a further discount of 25 per cent. when their demand reached a certain point. Allowing the adjustment for sizes lower than 250 kw., the company's cost for direct-current for a similar supply with the same load factor would be 1·473d. The Council's price to two large consumers last year was 1d. and 0·981d., including discounts. The company would charge 0·996, and 0·915 respectively. To a 70 kw. consumer with 25 per cent load factor the Council's present prices with discount would be 0·946d and the company's would be 0·842d. If the whole of the award in the arbitration between themselves and the Metropolitan Co. were put on the lighting customers, the charge to the power consumer would be 0·815. He thought their district would get the idea that the Council's prices were higher than they need be, if the company came into their district. If the company could quote anything less than £4. 10s. he presumed they would begin to interfere with the Council's prices seriously. Every unit sold for power reduced the standing charges, because it enabled them to be spread over a bigger output. A consumer in Marylebone taking current for power could use 20 per cent. of it for lighting. The diversity factor of 1·5, he thought a very high one, and the diversity factor was a thing which he thought few of them had any information about. He thought in dealing with propositions like the present it was usual to assume a much lower diversity factor. In dealing with large blocks of power he had assumed a diversity factor of one, as the consumers might all come on at once. It was practically possible to have a diversity factor of one. In the case of many large lighting consumers in Christmas week it would be one. The diversity factor was most difficult to measure. It was usually the last thing people wanted to know. His Council supplied the small power users more cheaply than the company could. They would not fear in fact this competition. It looked as though the company's cost of distributing their power to the local distributors would wipe out the advantage to be gained in generation unless the £1 10s. were a mistake and too high. Under the combined supply the cost of coal per unit would be just as much. He saw nothing

to prevent the company raising their prices in future. He did not think there would be any saving in the coal by saving one shift.

On Tuesday Mr. CANE in addressing the Committee on behalf of Marylebone Council, said it had been stated that Marylebone had made a bad bargain, and had to put up with it. They desired to entirely repudiate that position. They had not come to ask for mercy but only for fair dealing. The Metropolitan Co. had developed an exceedingly fine business, and the Borough Council made an agreement to buy the undertaking on arbitration terms. The result was an award of £1,250,000. It was 20 years' purchase of the profits of the company, and the estimates of probable increase of demand had been more than justified. They had lowered the price from 5·14d. to 4·5d. per unit. They were compelled to buy because it was said to be unfair for them to compete, and the same applied to the present case. This company, with all the benefit of experience and the advantage of having to do nothing but go into the best market to buy their plant, should not be allowed to compete with those who had earned their experience and bought other people's. He failed to see why a company should be allowed to come in and compete with them merely because it called itself a power undertaking. The kind of supply they contemplated was germane to a lighting undertaking, and was most useful because it was required at a time when lighting was not required. Marylebone was not the kind of area where power competition ought to be allowed. He claimed he had disproved the company's argument that they could save the Council money, so far as the small power users were concerned. Mr. Wright had told them that actual experience of distribution had convinced him that the bulk supply would not be cheaper. The company's capital cost would be lower than the Council's because it would be bigger, and their coal cost was also cheaper, but they had to get their energy to London and transform down to 15,000 volts, and lose some of it on the way, and the cost of the expensive transmission mains had to be added. They had to generate 10 kw. at Barking to produce 9 kw. in London, and that necessarily meant a further increase in capital cost. Marylebone Council had to carry coal, and the company had to carry electrical energy, and the latter was the more expensive item. Mr. Wright estimated that at an imagined load of 12,000 kw., the standing charges would be £3. 1s. in Marylebone against £4 10s., and that wiped out the advantages the bulk company had. The object of the Bill was to secure the authorised distributors' custom. This was written large all over the Bill. What had been called the "virgin field" in London had been greatly over-estimated at 600,000 H.P., but had now dropped to something like half. He asked that Marylebone should be isolated as it was in 1905, when the Administrative Co. brought in their Bill. They would prefer the Kitson Clause to the clause which took its place in this Bill, as the former gave them a certain measure of protection.

Mr. CLODE (for the promoters) said they were prepared to accept the Kitson clause if the Committee inserted it.

Mr. A. H. SEABROOK, borough electrical engineer of West Ham, said his corporation served one of the most important manufacturing districts in London. Supply commenced in 1898. A new generating station had been erected at Tucker-street, Canning Town, capable of housing three times the present plant, which was capable of supplying 100,000 kw. and they had also ample land for further building. Their capital expenditure was £410,000. The units sold during the year ended March last were a little over $11\frac{1}{4}$ millions, of which over four millions were for power. Only a quarter of the corporation's business was for lighting, three-quarters being power, heating and traction. The corporation's power business was larger than that of any of the power companies, except the Newcastle company. One consumer alone took a supply greater than the whole of last year's output of the Yorkshire Power Co. West Ham charged 3d. for lighting and 1d. for power, subject to discounts according to load factor and quantity. The average price the year before last was 0·95d. for power, and for the year ended March last approximately 0·8d. In the next two weeks the corporation would be supplying at the rate of $8\frac{1}{2}$ to 9 million units per annum, or over 12 million including traction. Since 1901 they had hired out motors and equipped factories. The total connections for power were about 6,000 kw., of which about one-third was to consumers over 250 kw. It would be absolutely impossible to keep down the generating costs to the 0·502d., at which it was estimated by Mr. Hammond. The sum of £31,459 generating cost in connection with combined supply would not work out correctly. It would be 0·905d. He estimated that the load-factor at which they would generate in conjunction with the company would be 14 per cent. They had three peaks in the day. They could make no reduction in their staff if they adopted the combined supply. There was practically no difference except the cost of coal. The Corporation were not disposed to rely upon an outside supply which they could not control. They could not afford to take stand-by supply at £3. 10s. per kw. They could buy the plant they might want at slightly over that, and the capital charges would not exceed 10s. per kw. He placed no reliance on the diversity factor. It would make no difference for all practical purposes, if they did not sink so much capital in generation and confined it more to distribution. Their price for coal was 0·32d. approximately for the whole of last year, not 0·39d. It was now 0·25d. A high price per ton did not affect a big concern with a high load-factor by 10 per cent. The question whether a combination of the company's supply and West Ham's own supply could be made which would pay the Corporation depended upon whether the supply could be usefully employed. There would be practically no saving to the Corporation in taking bulk supply. They had their land, their wharf, buildings, generating plant and apparatus; and the capital charges on a small additional expenditure would not exceed 10s. per kw. He would not say a combination which would pay could not be made. It would be possible for the company to cut prices to do away with the Corporation's competition, and then raise their prices afterwards. He did not like the clause which had been substituted for the Kitson clause. The Charing Cross Co. had a station in the borough and they could take a supply from them if they required it.

Mr. H. E. BLAIN, manager of West Ham tramways, examined by Mr. Morten, said the tramways last year carried over 35 million passengers. He did not think there would be any objection to submitting a clause for the protection of the tramways.

Mr. MORTEN then addressed the Committee, and said West Ham claimed to be judged on their merits. The only case that had been made against them was founded on aggregates and averages. The promoters included them in a big area and drew deductions which might be applicable to the whole area but were not applicable to West Ham taken alone. They took areas in which 3d. was charged for power and West Ham, in which current was supplied at 1d., and said the cost for that area was 2d. They had been told by Mr. Parshall that some consumers were coming from West Ham to say they wanted current from the company, but none had come forward. West Ham had done its work well, and all the power users in the borough could be supplied at a moderate figure. They would not complain if the company's proposed powers to supply railways were only for traction or for lighting the vehicles, but, under the Bill, the company could compete for lighting buildings, &c., as 20 per cent. of the railways demand would be no limit in their case. That was a provision in the next Bill. West Ham was opposing that on certain grounds, but not on the question of haulage or traction. In the North Metropolitan Co.'s Bill the supply to railways was limited in that way. The present company could go to the Wholesale Co-operative Society, whose demand was 1,000 kw., and offer them current at any price. Lord Camperdown's Committee declined to sanction supply by a bulk company to large consumers without the distributor's consent on the ground that they might gain a footing by supplying at a loss and, after having compelled the existing undertakers to close their works, put their prices up. It was idle to say that the 1 per cent. the company would allow them to charge for every 10 kw. by which the consumers' demand fell short of 250 kw. would enable the distributors to carry on supply on that basis. The capital charges on distribution amounted to about $\frac{1}{4}$d. per unit, and the company allowed them about $\frac{1}{10}$d. for the whole of their profit. They said the distributors would get the diversity factor, which was a very nice thing in theory but was not likely to work well in West Ham where it was the only thing to provide the profit. If other distributors took the same stand as West Ham the scheme was doomed to fail whatever attitude their Lordships adopted. Rather than take a supply from these people West Ham would sell even at a loss. There was no sign yet that the 20,000 kw. which they could instal in their own station being exceeded.

Mr. CHARTERIS (addressing the Committee for Hampstead) gave information regarding capital expenditure, the date of commencement of supply and the period for repayment of loans, and went on to say the price of current for power had been steadily reduced from 2d. in 1905 to the present average of 1d., which was the Yorkshire Company's average price. They had also reduced the rates by $\frac{1}{2}$d. out of the profits of the last three years. The Administrative Company agreed not to go into Hampstead at all, and a competing bill, that of the Metropolitan Company, sought to include Hampstead, but only by way of giving the Council the option of taking bulk supply. It would be easy for Hampstead to agree to take current in bulk from the Metropolitan Company, and if they did so this company, if they got the powers they asked for, could come in and compete. He thought the promoters should be required to show grave reasons for their Lordships to reverse the decision which was come to by a Committee of their Lordships' House in 1905. Hampstead's power supply, though small, was a valuable adjunct, which they were anxious to keep, and they believed it would be jeopardised if this scheme passed. There was no possibility of a genuine power supply in Hampstead, but the prospect of developing the demand for domestic heating was very great, and there was nothing in the bill to prevent the company competing for that purpose.

Mr. FLEETWOOD PRITCHARD, an alderman of Hampstead Council, and Chairman of the Electric Lighting committee, gave evidence in support of Mr. Charteris' arguments. They were, he said, producing 1,500,000 units more than in 1903. The works costs had been reduced 30 per cent. during the last two years. It would be absurd for them to scrap £200,000 worth of plant. By the time the company would be ready to supply them he thought their works costs would be far below the figure the company gave. Changing their periodicity from 90 to 50 would involve very great expense in changing transformers, meters, small motors, fans, and arc lamps, and would mean a charge of £7,000 a year for the period in which their loans had to be repaid.

Mr. WILLIAMS addressed the Committee for Stepney, and said the main object of the bill was practically to get a monopoly for supply at a cheap rate throughout the whole of the county of London, and the municipal authorities, except as distributors, would have to go to the wall. In the Electric Lighting Acts it was laid down that Parliament intended that the municipal authorities should ultimately become the authorities for supplying electrical energy in their own districts. The promoters deprecated competition against their company but asked the present distributors to submit to it. There was no question that the Kitson clause would be less injurious than the clause which had been substituted in the present bill.

Mr. W. C. P. TAPPER, borough electrical engineer of Stepney, examined by Mr. Williams, gave particulars of outputs and lamp connections. They charged, he said, 1d. per unit for power flat rate or $\frac{1}{2}$d. per unit plus 5s. per month per E.H.P., equivalent to £3 per H.P., or £4 per kw. During the last financial year the average charge for private lighting was 2·21d., 0·95d. for power, and 12·7d. for public lighting. The total average was

1·62d. The undertaking was a financial success. They had a substantial reserve fund after paying interest and sinking fund charges. If they took their whole supply from the company he calculated they would be bound to supply at a loss in every case, except where the demand was under 10 kw. If they took their whole supply distribution cost would bring the cost per kw. to £10. In this figure he had compared the maximum charge of the London & District Company with the charges for which the Administrative Company had actually made contracts. His Council agreed to take supply from the Administrative Company. The reasons which lead them to make the bargain then had now disappeared.

The Committee then adjourned.

On Wednesday Mr. W. C. P. Tapper was further cross-examined by Mr. Clode, and said the figure he had taken in his calculations of the cost of taking bulk supply was £4. 10s. per kw. and 0·33d. per unit. That was the maximum price in the bill. If he took the company's estimated price per unit (0.22d.) that would reduce the cost for 7½ million units from £810.312 to £6,875. Assuming that, as Mr. Clode stated, Stepney would be supplying at a loss if generation cost £3. 12s. per kw., distribution making it £9. 2s. and the diversity factor reducing it to £5. 9s., if they would be supplying at a loss because they could not generate at less than £3. 12s., obviously a greater increase in prices would be necessary to make a profit if the standing charge were £4. 10s. which the company proposed to fix.

Re-examined by Mr. Williams: He had considered the effect of the provision allowing power consumers to use 20 per cent. of their current for lighting. The lighting load for factories was small compared with the amount required for power and the 20 per cent. would give them all the light they require. It would be a serious competition, and the company would also be a serious competitior for power consumers over 10kw., because the prices at which they would have to supply above 10kw. at the Stepney load factor would average 1·027d., which equalled the company's prices. He did not know any authorised distributor in the area with a load factor as high as 30, the figure taken in the company's tables. The average was about 25.

Mr. Clode said with regard to the supply at 1·027d., Stepney would buy at 25 load factor and would sell at the same, therefore the diversity factor must give them a profit.

Mr. Courthope-Munroe (for St. Pancras and Shoreditch) said the Chairman had said on Monday that the whole question appeared to him to be whether the distributors would lose under the competition clause and not whether they would lose by combining with the bulk supply or scrapping. There were two points touching the boroughs. The first was bulk supply and the second the question of competition. Both the engineers he would call would tell the Committee that they hoped to be able to get a bulk supply in time which would give much better rates than they were now getting and cheaper than this bill proposed. St. Pancras started supply in 1891. They had invested over half a million of money in the undertaking; they had paid about £18,000 odd in relief of rates, and their prices were low. Their power prices were 1d. per unit, or the original terms in Mr. Merz's bill (£4 per kw. and ½d. per unit), at the consumer's option. They had 80 per cent. of the people who were using energy, which was half the possible horse-power in St. Pancras—that was, half of 6,670 h.p Last year they generated four million units for lighting and 1½ million for power and heating. They supplied direct current, and their average load factor was 20 per cent. Their station was on a canal bank. Shoreditch started supply in 1897. They had one-third of a million invested, and supplied two-thirds of the power in the borough, and the power was all in small units. No one consumer took 250 kw., and the average was 5 kw. The load factor was 15. They also supplied direct current and had a canal station. Last year they generated 4,750,000 units for light and 2,000,000 for power. They supplied power at £4 and ⅜d. up to 75,000 units and £4 and ½d. beyond that quantity. The promoters had no right to draw a circle round a district and deal with everybody inside the line. They had made out no case for attacking St. Pancras or Shoreditch. The promoters should be obliged to show before they came into St. Pancras or Shoreditch that there was some hardship upon a reasonable body of consumers and that they would confer a benefit on some substantial portion of the constituents. If the day demand were taken away from the present suppliers the cost of lighting, which was now 4d., would probably become 5d. or 6d.

In reply to the Chairman, Mr. Munroe said he would reserve until the clauses stage his argument in regard to the desirability of inserting the Kitson clause. That clause would allow competition if the Board of Trade sanctioned it. He was afraid the Board of Trade might simply say "Here is a consumer who wants power at so much and here is some one who will give it to him," and he was not sure that the question whether it was politic to allow it would come before them.

Mr. S. W. Baynes, borough electrical engineer of St. Pancras, confirmed Mr. Munroe's statements. There were 443 power users on the mains of his department. The average revenue from power supply per customer for six months was £6. The average load factor for each consumer was 6. Only four consumers had a load factor of 20 or over. There were only three with demand over 100 h.p. St. Pancras' capital cost was about £40 per kw., or with overhead about £7 10s. He disputed the accuracy of many of the figures in the promoters' tables. He could not agree with the figure for scrap value. If the company got the local authorities' demand the scrap value would be nothing. He could not allow a credit for sale of land as they might buy improved machinery in a few years and use the land again. The alteration he proposed in the table would show a loss to the Council of £3,400 odd. Their works costs had dropped ½d. in four years, and if they improved as much in the next four years the bulk supply at the prices mentioned would be of no good When they had completed the conveyor, which was being erected, their coal would be cheaper than the company's. He was dissatisfied with the bill altogether and did not think he would take a bulk supply from any company under any circumstances.

Mr. C. Newton Russell (chief electrical engineer to Shoreditch Council), examined by Mr. Courthope-Munroe, supported generally the statements made by counsel. Witness said that were the proposed company's supply available immediately it would pay Shoreditch to take supply at the estimated prices offered under the bill, but inasmuch as the company would not be able to supply for another three or four years, Shoreditch would by that time be in as good a position and would be able to sell to consumers at the same price as the promoters of the bill could. It would not then, therefore, be of any advantage to Shoreditch to take a supply from the company, more especially as it would have to be delivered from Barking, a distance of 7 miles. In regard to the 20 per cent. for lighting clause, this would give small consumers more than was usually required for lighting, especially if they take into account the metallic filament lamp. At present users of more than 75,000 units were allowed to use 20 per cent., taken at 1½d. per unit, for lighting. The present works costs were 0·772d., or with capital charges 1·19d. He though a great objection to taking current from the company would be the loss in distribution. If they were offered a supply at a rather cheaper rate than they could generate themselves, assuming the offer to be made by a substantial company, they would seriously consider the matter, but as regarded the competition he maintained his opposition.

Mr. Snowden (for Hammersmith) said Hammersmith Council were empowered by Parliament to give an electric service to a certain area, and had done so in the past to the complete satisfaction of consumers. Its works had been planned with the object of supplying all possible demands. They were now asked to introduce into this area what must be a very disturbing influence, not only on the ground of the large powers for breaking up the streets, but the company would be able to dictate, to some extent, to the Council their prices, and with regard to larger consumers would be a formidable competitor. They had their hands tied, to a certain extent, as their sinking fund and interest on capital must be paid, but there was nothing in the bill which compelled the company to pay any dividend once they had started work, and nothing which compelled them to have any sinking fund. The company would be able to suspend both for a few years while they conducted a competition which might be ruinous to Hammersmith, and put the company in an impregnable position. There was no justification in the case of a borough like Hammersmith for the introduction of this disturbing influence. At the present time they were supplying about equal units for power and lighting. They had six power consumers of from 100 kw. to 1,500 kw., and had entered into contracts with two others, one for 1,000kw., the other for 2,500 kw. The latter, for the Franco-British Exhibition, was a striking instance of the value of a duplicate supply. They also supplied Olympia. In regard to these large places, he believed London County Council demanded that there should be a subsidiary source of supply. The whole tendency of the bill was to get the source of supply eventually concentrated, and he submitted that one of the disadvantages would be that so valuable an arrangement for duplicate supply would thereby become impossible. Hammersmith were supplying at the present time roughly 2,400,000 units to 176 power consumers, out of which nearly 1,900,000 was supplied at 14 consumers, and it was in regard to these large consumers that competition would be most unfortunate.

Mr. G. Gilbert Bell (chief engineer to Hammersmith Council), examined by Mr. Snowden, said the works covered about one-third of the 4 acres of land available, and were 500 yds. from the river. There was, therefore, ample room for extension. Their coal was water-borne, and if anything they got it cheaper than the promoters of the bill. The coal weight per unit supplied was 3·39 lb. Their water supply was taken direct from the river to the works. He regarded the company's estimate of £10,000 in Table 7 for repairs and renewals as extremely small, considering the size of the station and the work it would be required to do, and that it could not be substantiated. He could not see how they could possibly gain by taking bulk supply from the company. He had calculated that at the maximum prices, taking it solid, they would lose £6,000, and at the estimated prices they would lose £3,000; on the peak they would lose £3,000 at the maximum prices, or £2,500 at the lower prices. In regard to the danger of competition under the bill, the bulk of their current was going out at practically 1d. per unit., including lighting, giving a return of about 8 per cent. on their capital liabilities, out of which 3·6 per cent. had to come for renewals. The system of charging so much per kw. and so much per unit had been tried at Hammersmith, but had given so much trouble and had caused so much friction that it had been abandoned and they had adopted a flat rate. They were rapidly paying off their capital charges. In 18 years they would have paid off the whole of the costs of the machinery, which had 25 years' life. After that they would be in a very good position, if their plant were not wrecked in the meantime by competition. They had contributed nearly £7,000 in aid of the rates.

Mr. Freeman then addressed the committee for London County Council, and briefly traced the history of the previous bills brought before Parliament to deal with the question of the electricity power supply for London. In the course of his speech Mr. Freeman said that the Administrative Company's scheme, brought forward in 1905, was a

totally new suggestion and came with considerable surprise upon all connected with the question of electricity supply in London. The Administrative Company proposed to supply electric power to the whole of London, almost every inch of which was already occupied either by companies or local authorities, and the scheme therefore came as a very startling proposition. Arising out of the consideration of the Administrative Company's, and the succeeding bills, it had, he thought, been clearly established that from a large central station a cheaper supply of electricity could be given under certain circumstances, and that if some large scheme could be devised with a reasonable chance of financial success, this would solve the question. The subject was one which the London County Council considered of the utmost importance at the present time, and one to which they had devoted very serious attention. The Council felt that there was very great responsibility upon them in the matter, partly in consequence of their past connection with the question of electricity supply in London and partly because they were extremely anxious that if any bill were introduced before Parliament which had a reasonable chance of solving the question once for all, they would not stand in its way, except in their proper position as safeguarding public interests, and the interests of those municipalities and companies who had spent very large sums of money in the supply of electricity within the area. When this new scheme came forward this year London County Council felt a very serious responsibility indeed. They felt it was impossible for them to take up an attitude of absolute hostility to the scheme, which was founded upon two propositions of a large area, and a central generating undertaking. The proper thing was to consider the bill carefully on its merits and to see whether it was such a bill as offered reasonable chances of being the final solution of the question, and whether there was reasonable prospects of money being raised, and the work carried out within a reasonable time. The Council thought the time had come when there should be no further delay, and, therefore, if a bill came before the Committee with reasonable chances of financial success, and which, at the same time, dealt justly with the companies and local authorities, they considered it was not a bill they could absolutely oppose. Mr. Freeman continued his remarks up to the conclusion of the proceedings on Wednesday, and also for a portion of the sitting yesterday (Thursday), when

Mr. FITZGERALD (for the promoters of the bill) handed in an amendment to clause 65 (known as the "purchase" clause), and also consequential alterations to clauses 62 and 64 involved by the reprinting of clause 65.

Mr. Freeman was followed by Mr. Felix Cassel, K.C. (Chairman of the Parliamentary Committee of the London County Council), and Mr. H. E. Haward (comptroller and financial adviser to London County Council).

A digest of this later evidence, &c., will appear in our next issue.

DUBLIN AND CENTRAL IRELAND ELECTRIC POWER BILL.

In the House of Common on Thursday last week, Mr. JOHN O'CONNOR moved the recommittal of this Bill to the Committee by which it was considered. He stated that steps had been taken to meet the objections which appeared to have influenced the Committee in its decision. The finance of the scheme had been set right and the opposition of Dublin Corporation would be obviated.

Mr. LUKE WHITE stated that if the motion was carried, the Bill would become nearly, if not entirely, non-contentious. Having consulted his colleagues who formed the Committee, he asked the House to accept the motion.

The motion was agreed to, as was an instruction empowering the Committee to reconsider their decision on the preamble of the Bill, except in so far as it related to the city of Dublin, the urban districts of Pembroke, Rathmines and Rathgar, and King's County.

On Tuesday a select committee of the House of Commons (presided over by Mr. Luke White) had before it this bill, which, after being rejected in committee on April 1 was recommitted by the House of Commons. The proceedings were reported in *The Electrician* for April 3.

Mr. FREEMAN, K.C., said the promoters had struck out Dublin, Rathmines, Rathgar and Pembroke from the bill and proposed to reduce the capital from £450,000 to £150,000, with the usual borrowing powers. When they were before the Committee on the first occasion he was afraid the promoters' financial support was not put forward properly.

Sir RALPH LITTLER, K.C., for the Dublin Alliance Gas Co., protested against the procedure, which he said was contrary to all precedent.

The CHAIRMAN held that the Committee were bound to reconsider the bill.

Sir RALPH LITTLER said that under those circumstances he was not in a position to give the Committee any assistance, and must withdraw.

Mr. ARNOLD LUPTON gave evidence that the scheme for the use of peat in generating electricity would be profitable. He would support the scheme financially and could secure a considerable amount of capital for it.

Further evidence in regard to the altered financial clauses of the bill, &c., was taken and the Committee found the preamble of the bill proved, subject to the insertion of clauses for the protection of the water and electric mains and pipes of Dublin Corporation. The clauses having been gone through and adjusted, the bill was ordered to be reported to the House for third reading.

LEGAL INTELLIGENCE.

Postmaster-General v. National Telephone Co.

The Court of Appeal (the Master of the Rolls and Lords Justice Moulton and Buckley) delivered judgment on Wednesday in this appeal of defendants from a decision of Mr. Justice Swinfen-Eady. The action related to the question as to the payment by the company to the P. M. G. of the 10 per cent. royalty on a certain portion of the service provided by the company, for which the company claimed exemption. The facts were reported in *The Electrician* for March 15 and 22, 1907, and March 13 and April 10, 1908.

The MASTER OF THE ROLLS in giving judgment, said that the principal question to be decided was as to the extent of the exceptions of the Postmaster-General. The first exception was as follows: "Telegrams in respect of the transmission of which no charge was made, transmitted by a telegraph, maintained or used solely for private use, and relating to the business or private affairs of the owner." The second exception was: "Telegrams transmitted by a telegraph, maintained for the private use of a corporation, company, or person, and in respect of which, or the collection, receipt and transmission, or delivery of which no money or valuable consideration shall be or be promised to be made or given." Those exceptions resembled each other so closely that it was not easy to put a case of a message, which could fall within the first exception, and which would not fall within the second. The only distinction he could suggest was that the first might relate to the case in which a person who was owner of the telegraph also maintained it, and the second might include the case where the telegraph was maintained by a person, who was not the owner. It was contended by appellants that telephonic lines between two places for affording communication between A at one end and B at the other end, which were erected and maintained by the appellants, but were worked and used independently of and without the intervention of any servants of the appellants, were within one or both of these exceptions. Mr. Justice Swinfen-Eady had rejected that contention, basing his judgment mainly on the words, "solely for private use," which he held to mean solely for the private use of the owner of the telegraph, including in the term "owner," his family and his employees. But the words "solely for private use," were not found in the second exception, and his Lordship doubted if "solely" could fairly be read as applying also to the words: "Relating to the business or private affairs of the owner thereof." The second exception seemed to him to meet the present case. The telegraph was maintained by the appellants for the private use of their customer, and no money was paid for the transmission of telegrams by means of the telegraph. The "private" use of the customer extended to the case where he wanted to communicate with the person at the other end of the wire, whether that person was his partner or employee, or his banker or broker. He thought that what had been described as an A to B private wire was within the exception, just as much as an A to A wire. Assuming that according to the true construction of the Act of 1869 A to B private lines were not within the Postmaster-General's monopoly. A question of great difficulty arose upon the terms of the licence granted to the appellants by deed, date Nov. 29, 1884, clause 2 of which seemed to describe minutely and with perfect accuracy, an A to B line; but expressly to exclude an A to A line. The words in clause 7 directing the company to pay a royalty of 10 per cent. seemed to refer to clause 2, and the company having accepted the licence in those terms, could not refuse to pay the royalties on the ground that, in truth no licence was required as to A to B lines. It was admitted that from 1884 to 1897 royalties were paid on A to B lines, but that since 1897 payment had been refused by the company, though claimed by the plaintiff. He thought the parties to the deed bargained that A to B line, whether or not within the monopoly, should be treated as being within it, and the conduct of the parties for 13 years supported that view. The result was that defendants, in his view, were accountable to plaintiff for royalties, under clause 7 of the licence in respect of all the classes of lines mentioned in the first schedule. As to the second question the licence had no application, and it followed that in his opinion, differing from Mr. Justice Swinfen-Eady, the answer should be that the defendants were not acting in contravention of the exclusive privilege of the Postmaster-General, but as the other members of the court took a different view as to the first question, the appeal would be allowed on both points.

Lord Justice MOULTON said that taking both the exceptions into consideration he was of opinion that the legislature intended that private telegraphs should be outside the monopoly of the post-office to the extent that such a telegraph might be used for sending telegrams relating to the business or private affairs of the owner, and that he was at liberty to deal with such telegrams when received just in the same way as he could with a message sent by himself, without the intervention of the telegraph, namely, he could pay for its collection, receipt or delivery. The exception then granted, reasonably protected the use of private telegraphs belonging to or maintained for a person for his private use. If, therefore, a firm chose to establish private telegraphs to their bankers, or their customers, for the convenience of their business and made no charge for the transmission, collection, receipt or delivery of any of the messages sent thereby they appeared to him to be well within the exception. In his view, therefore, the A to B line was outside the monopoly of the Postmaster-General. He was of opinion that the agreement of Nov. applied only to telegraphs and telegrams which required the licence of the Postmaster-General, and that it was the common intention that telegrams which were statutorily outside his monopoly were not to be affected by it. He was also of opinion that telegraphs used only for the transmission of telegrams within the statutory exemptions, A to B

lines for instance, were outside the licence. He thought the appeal should be allowed.

Lord Justice BUCKLEY delivered judgment to the same effect and by a majority of the court, therefore, the questions in the special case were answered as follows: (1) That the defendants were not accountable to the plaintiffs for royalties in respect of the lines, specified in schedule 1 of the special case, and (2) that the lines in schedule 2 were not in contravention of the Postmaster-General's licence.

The appeal was therefore allowed with costs.

MUNICIPAL, FOREIGN & GENERAL NOTES.

APPOINTMENTS VACANT AND FILLED.

The Board of Trade are prepared to receive applications for the post of meter tester and general assistant in the Electrical Standards Laboratory of the Board. Applicants must state their practical experience in instrument-shop and test-room work and college training in mathematics, physics, elementary chemistry and electrical testing. Commencing salary £120, rising by annual increments of £7. 10s. to £200 per annum. Applications to the Electrical Adviser to the Board of Trade, 8, Richmond-terrace, Whitehall, S.W. See an advertisement.

A superintendent is wanted for electrical manufacturing shop. Applicants must have had first-class experience in the manufacture of alternating and direct-current machinery of all sizes and shapes and must be thoroughly capable of managing men. Applications to Messrs. Vickers, Sons & Maxim, Sheffield. See an advertisement.

A professor of mechanical engineering is required for Poona College of Science, India. Salary R.500, rising to R.1,000 per month. Applications to the Secretary, Public Department, India Office, London, by June 15.

Mr. F. W. Purse, deputy electrical engineer at Warrington, has been appointed electrical engineer of the Watford electricity works. Mr. H. A. Howie and Mr. B. H. Hornby, deputy electrical engineers Wolverhampton and Bolton respectively, were also interviewed by the Council.

Mr. A. A. Watkins, of Sheerness, has been appointed managing engineer to the Musselburgh & District Electric Light & Traction Co.

Mr. Walter R. Rothenberg has been appointed general manager of the English branch of the Schorch Electrical Co.

Mr. F. W. Wilson has been appointed by the Government as electrical inspector in Bombay at a salary of R.600 per month.

For the position of manager of the tramways at South Shields 64 applications were received, and these have been reduced to the following three: Messrs. L. E. Harvey, assistant manager and resident engineer, Sunderland Corporation tramways; R. Chadwick, chief assistant, Birkenhead Corporation tramways; and F. Taylor, assistant tramways engineer, Bolton. The salary is £250 per annum.

Anglo-French Post and Telegraph Rates.—A bill has been introduced in the Chamber of Deputies by MM. J. Siegfried and G. Gerald reducing the postal and telegraph rates between France and Great Britain. The bill provides that the rate on letters shall be reduced from 25 to 15 centimes, and the telegraph rate from 20 to 10 centimes per word. This corresponds with a similar bill introduced in the British Parliament by Mr. H. Heaton, under the auspices of a Committee presided over by Sir E. Sassoon. The French measure is said to be supported by nearly 100 deputies.

Bath.—The discussion on Mr. E. Schenk's amended proposals for the purchase of the municipal electricity works was continued on Monday.

The Electric Light committee recommended the acceptance of Mr. Schenk's offer, and the adoption of the committee's report was moved by Mr. Hatt at the meeting of the Council last week. To this an amendment was moved "That this Council declines to entertain the alternative proposal of Mr. Schenk, but is willing to extend the time for the purchase of the undertaking to March 31, 1909, subject to the conditions and price already agreed by resolution of the Council of Feb. 26, 1907, and subject to a further deposit by Mr. Schenk of £2,500."

After some discussion this was withdrawn in favour of the following amendment by Mr. John: "That the Council declines to sell the undertaking to Mr. Schenk on the terms now proposed, but is prepared to lease the undertaking to a responsible company for such a term of years as may be agreed upon."

Ultimately, the latter amendment was rejected by 28 votes to 8, and the main resolution, authorising an agreement being entered into with Mr. Schenk for the sale of the undertaken on the terms set out in our issue for May 15 (p. 188), and that application be made to the Board of Trade for their consent to the transfer, was carried by 27 votes to 9.

The purchase price has been fixed at £162,839.

Battersea (London).—The borough electrical engineer (Mr. F. A. Bond) has prepared schemes for wiring consumers' premises on (1) a cash purchase system (based on net cost, plus percentage for supervision, &c.), (2) a hire-purchase system (based on payment by instalments within five years), or (3) a perpetual rental hire system.

Mr. Bond also advises the fitting up of a showroom in the borough, the supply and maintenance of arc lamps, motors, &c., on the hire-purchase system, and the distribution of suitable literature among probable customers in the borough.

The Electricity committee are not in favour of the whole scheme, but recommend the Council to start with the supply of arc lamps for cash or on the hire-purchase system. The committee have further decided that the wiring for arc lamps shall be done through contractors, and that this course be continued until the scheme seems likely to be a success, or the applications for installations are sufficiently numerous to justify the Council in doing the whole of the work themselves.

Bolton.—Last week the Council were invited by Mr. H. M. Harwood to condemn the proposal to vote £7,500 out of the past year's profits of the electricity department in aid of the rates. He thought that the sum should not exceed £6,000, as in 1906. The net profit of the department was £2,900 less than last year, and it seemed curious, he said, that they should increase their dividend by £1,500. The proposal was, however, adopted.

Bournemouth.—The inquest on the victims of the recent tramway disaster has been adjourned until June 11 owing to the continued illness of driver Wilton.

Cowper-Coles Process for Manufacture of Copper Wire.—We are informed that, in regard to Mr. Sherard Cowper-Coles' process for producing copper wire in one operation from crude copper such as Bessemerised copper bars, a plant is now in course of completion on the Continent for working this process on a large scale.

Electricity on Indian Railways.—It has been decided to use an electric tractor for working a locomotive turntable at the Khargpur station of the Bengal-Nagpur Railway.

Glass Handling by Electric Method.—The British Consul at Philadelphia (U.S.A.) reports that there has been an electric method recently introduced there for the easier handling of large sheets of plate glass, shop windows, &c.—viz., by the use of heavy magnets placed against the glass on one side, whilst on the other are flat plates of iron or steel. The magnet holds the plate tight to the glass, thus enabling a heavy plate of glass to be handled with ease by the use of as many magnets as may be required, each magnet being connected by wire with the current producer, which current can at once be cut off when necessary to release the glass plate from the steel or iron plate at the back. Vast mechanical improvements have been introduced of late years into the glass-making industry of the United States, by which the output has been enormously increased and the quality greatly improved.

Japan.—The British Commercial attaché in Japan (Mr. E. F. Crowe) reports that the Japanese Customs returns for 1907 show the following values for imports of electrical machinery and apparatus which have not previously been classified: Dynamos and electric motors £180,900, all other electrical machinery £78,600, telephones £10,700. The total for machinery of all kinds was £2,827,600. This total (of which the United Kingdom supplied more than 52 per cent—the same proportion as in 1906) was £941,800 over that of 1906, and an average of £1,490,800 over the five preceding years.

Light Railways.—The Light Railway Commissioners have granted in part the application for an extension of time to construct and vary the direction of the Southend to Colchester light railway. No extension of time has been granted for the Burnham-River Blackwater section.

Llandudno.—The Council have increased the salary of the electrical engineer (Mr. H. Morton) to £275 per annum. The salary of the chief assistant (Mr. L. H. Tylecote) has also been increased.

London County Council.—On Tuesday the Council considered the taking over of the Lea Bridge, Leyton and Walthamstow tramways, and it was agreed to carry out the Highways committee's recommendations on the subject.

Dulwich Forest Hill Tramway.—The adjourned report of the Highways committee dealing with the construction of the authorised tramways on this route was considered, and the committee recommended that the estimated expenditure of £32,630, for construction of track on the conduit system be approved.—Agreed.

Additional Supply of Rails.—In the same report the committee stated that they had considered the question of obtaining the rails, fastenings, &c., required for the electrification of the tramways which it was proposed should be put in hand during 1908-9. They recommended that the estimated capital expenditure of £70,000 submitted by the finance committee be adopted.—Carried.

Manchester Electrical Exhibition (Oct., 1908).—At the last meeting of the committee (held on May 12) applications and inquiries for space from some 130 would-be exhibitors were dealt with and a very large number of allotments were made. Since that date applications and allotments are being dealt with as received, and there are ample indications, we learn, that the exhibition will be thoroughly supported by all branches of the industry. A number of interesting exhibits have already been arranged for between the principal motor manufacturers and makers of textile machinery, machine tools and the like. The exhibition is receiving the support

not only of Manchester and Salford Corporations, but of some 30 adjoining towns, and of the Lancashire Electric Power Co. As Manchester is the centre of one of the greatest manufacturing districts in the world, far-reaching effects of a beneficial character will result.

A further meeting of the committee was held at the Town Hall, Manchester, on Tuesday last, when further applications for space were dealt with and other business transacted.

Manchester.—The Tramways Committee have decided that applicants for appointments on the general traffic staff must undergo a medical examination.

Municipal Telephony.—At a meeeting of the Glasgow Council yesterday the auditor reported that the deficiency in connection with the late municipal telephone department is £16,000.

Newport (Mon.).—The Tramways committee have decided to adopt a scheme of tramway parcels delivery.

Personal.—We regret to learn that, owing to continued ill-health, Mr. H. R. Chapman has been obliged to resign his position as chairman of Messrs. Clarke, Chapman & Co., of Gateshead. He is succeeded in that office by his co-director, Mr. H. Walker.

Rome.—The Municipal Council have approved a scheme for the erection of municipal electricity works.

Sheffield.—An inquiry will be held on June 2 into the application of the Corporation to borrow £20,000 for extensions of the electric light undertaking.

Smoke Prevention.—Smoke preventing and fuel economising apparatus lately supplied by the British Fuel Economiser & Smoke Preventer Co. on approval to Battersea Baths committee has (we are informed) recently undergone severe tests at the hands of the borough officials on one of the boilers at Latchmere-road baths, with the result that the economy guaranteed is said to have been considerably exceeded, and at the same time it has been found that any class of fuel can now be consumed without causing smoke nuisance. The apparatus has been accepted, and the Council have approved an order for the supply of similar apparatus for the whole of the remaining boilers.

Stalybridge, Hyde, &c., Joint Tramways and Electricity Board.—An inquiry was held last week into the application of the Board for sanction to borrow £25,223 for extensions of the electricity department.

Mr. Simister, solicitor to the Board, said that the application was made under happier circumstances than the one made in February last year. At that time there was a deficit on the working of the electricity portion of the undertaking of about £5,500. The work of construction was drawing to a close, certain capital was compelled to lie idle, and there being no power to pay interest out of capital during that period the loss fell somewhat heavily on the rates. The whole of the last loan (£28,600) had been expended, and the plant purchased had enabled the board to satisfy the demands, which were becoming extremely urgent, for the supply of electric power, with the result that £5,500 of the deficiency on the electricity undertaking was wiped off, leaving only a small deficit of about £500. The board estimated that they would require extra machinery as follows: One 2,000 kw. turbine generator set and condenser, three Lancashire boilers and the necessary pipe work, &c. The estimated cost of the plant was £20,223, and the board also estimated that they would require transformers costing £5,000, making in all £25,000.

Mr. Robert Blackmore, electrical engineer to the board, gave technical evidence.

There was no opposition.

The Electrobus.—The London Electrobus Co. were honoured with an order from the Admiralty to take 264 French sailors in London in connection with the visit of the French President, for a day's outing in London. By special permission of the King the 'buses were the first public licensed vehicles admitted in the Royal parks, and allowed to travel through the Royal gates.

Wallasey.—The Council are recommended to extend the tramways.

Wigan.—The Electric Light committee have decided that the Wigan and Pemberton electricity stations shall be re-modelled in accordance with the recommendation of the electrical engineer (Mr. J. Slevin), and application has been made to the L.G. Board for sanction to borrow £36,345 for the purpose.

Will.—Mr. Carl Heinrich von Siemens, of Gostilitzy, Russia, and of Berlin, electrical engineer, chairman of Siemens Bros. & Co., &c., who died March 21, 1906, aged 76 years, left personal estate in the United Kingdom of the net value of £33,588.

Wireless Telegraphy Receivers.—At his lecture on Receivers, in the course he is now giving at the Northampton Institute, Clerkenwell, E.C., Dr. J. E. Erskine-Murray has been able to show, by the courtesy of the makers concerned, a collection of detectors and complete receivers which is remarkable in that almost every known class was represented.

Workhouse Lighting.—Rawtenstall Corporation have offered to supply electricity for lighting Haslingden workhouse at 3d. per unit.

Foleshill Guardians have entered into an agreement with the Newdigate Colliery Co. for a supply of electricity.

Electro Harmonic Society.—At the annual general meeting on Wednesday the statement of accounts was presented. During the past season 112 new members have been elected and placed on the register. In the same period the society lost six members by death, 40 resigned and 8 were struck from the register for non-compliance with Rule 11. There are now 640 names on the membership roll. The receipts (including balance forward) amounted to £410. 7s. 4d. and the expenditure to £326. 11s. 11d. Cash in hand and at bank was £83. 15s. 5d., and subscriptions due were estimated to realise £20. Liabilities outstanding were £7. 2s., and the balance, being surplus assets, were £96. 13s. 5d.

ELECTRICITY SUPPLY AND TRAMWAY ACCOUNTS.

Burton on-Trent.—The total revenue of the electricity department for the year ended March 31 was £12,261. 11s. 7d., against £11,115. 10s. 3d., and the surplus was £1,104. 10s. 9d., against £793. 11s. 11d.

1,398,014 units were sold (against 1,164,355), including 335,550 (310,382) for private lighting, 1,255 (1,517) for public lighting, 401,690 (250,974) for power, 10,694 (9,627) for heating, &c., and 648,825 (591,855) for traction. There are 497 (426) lighting and 60 (52) power consumers, and the total number of 8 c.p. lamps connected to date is 31,775 (30,116). The total h.p. in motors connected is 737·25 (475·1), and the total h.p. for heating and other purposes is 27·45 (24·95). The total equivalent in 8 c.p. lamps for lamps, motors, &c., is 50,130 (42,116). The maximum load is 515 kw. for lighting and power and 375 kw. for traction. The load factor for lighting and motor units is 16·60 (12·7) and for traction 19·75 (18), the combined load factor being 17·93 (15). The works costs were 0·812d. per unit (0·821d.), and the total costs (including interest and sinking fund) 1·915d. (2·127d.). Of the surplus, £636. 2s. 10d. was applied in wiping off certain items of capital expenditure, and the balance (£468. 6s. 11d.) has been placed to renewals fund. The increased surplus this year is particularly satisfactory in view of several adverse conditions that have had to be met. The average price of fuel, compared with last year, has increased 33·7 per cent., reducing the surplus by approximately £580. The high-efficiency metallic filament lamp has reduced the revenue in many directions, and the cold summer caused £250 less revenue to be obtained from Messrs. Bass & Co.'s motor demand. The depressed state of trade has in addition affected the lighting and motor demand, and the expansion of new business. The gross profit increased from £5,828 last year to £6,117 this year, and amounts to 7·5 per cent. on capital expenditure, and the sinking fund contribution amounts to 3·36 per cent. on the capital. Out of a total of 737·25 h.p. in motors connected, 481·75 h.p. is on the restricted hour principle. This is the supply of power which is entirely cut off during the hours of peak load in the winter months, so there are no generating station or mains capital charges to allocate to this load. This power is sold at 1d. per unit down to ¾d., and the mean price at which the 412,384 motor units have been sold is 0·99d. per unit.

Erith.—For the year ended March 31 the total income of the tramways department was £8,539 (an average of 6·37d. per car-mile); working expenses were £8,393 (6·26d. per car-mile), leaving a gross profit of £145. Interest and loan charges came to £4,594 (3·43d. per car-mile), and the net deficit was £4,449 (3·32d. per car-mile).

Hampstead (London).—For the year ended March 25, the income of the electricity department was £65,738, compared with £64,587 for 1906.

The receipts from the sale of current were £60,582 (against £57,475) and public lighting £2,970 (against £3,150).

A recommendation of the Lighting committee to substitute flame arc lamps for 28 lamps in Finchley-road and to erect 10 additional lamps has been referred back. The annual cost of the 38 lamps would not, under the proposal, be increased, but the Finance committee thought the cost of the charge should be borne out of revenue.

Sunderland.—For the past year the traffic receipts on the tramways amounted to £68,797, against £72,054 in 1906. After paying expenses, interest and sinking fund the profit was £10,101, of which £3,348 has been applied in relief of rates.

TRADE NOTES AND NOTICES.

TENDERS INVITED.

Ilford Urban District Council invite tenders for supply and erection of surface-condensing plant and cooling tower, steam and feed pumps, boiler feed pump, &c., extensions and alterations to main switchboard. Copies of specifications, &c., from the clerk to the Council, Mr. John W. Benton. Further information may be obtained at the offices of the electrical engineer, Mr. Arthur H. Shaw, M.I.E.E., A.M.I.Mech.E., Electricity Works, Ley-street, Ilford. Tenders addressed to Chairman of Council, Town Hall, Ilford, by noon Wednesday, June 10.

Norwich Electricity committee want tenders by 10 a.m. June 9 for supply and erection of water-tube boiler, mechanical stoker, economiser, &c., and for wiring supplies. Specification, &c., from the City Electrical Engineer.

Tenders are invited for the electric lighting of the *Carlisle* girls' new secondary school. Tenders to the Secretary, Education Department, The Courts, Carlisle, by June 5.

Manchester Tramways committee invite tenders (by June 2) for supply and delivery of a quantity of block tin.

The Penrikyber Navigation Colliery Co., *Penhiwceiber*, Glam., want tenders by June 4 for 12 months' supply of stores, including electric lamps and fittings, castings, ironmongery, oils, &c. Forms of tender from the Secretary.

Adelaide (South Australia) Municipal Tramways Trust want tenders by noon July 14 for rotary converters, transformers, boosters, switchboards and equipment for converter stations. Specifications from the Engineer, 8, King William-street, Adelaide.

Orsova (Hungary) Municipality want tenders by June 1 for the equipment and working of electricity works. About 1,600 incandescents will be required for private lighting, 350 incandescents and 10 arcs for street lighting and 26 incandescents for the works. The concession is for 50 years. Further information from the Gemeindevorstand, Orsova.

Tenders will be received at the Raadhuset, *Copenhagen*, until June 10 for supply of from 4,000 to 5,000 electricity meters. Conditions can be seen at the Board of Trade, 73, Basinghall street, London, E.C.

TENDERS RECEIVED AND ACCEPTED.

L.C.C. have extended the contract for slot and conductor rails with the Frodingham Iron & Steel Co. to include the slot and conductor rails required for the construction of the Dulwich Library and Forest Hill tramways.

On Tuesday London County Council received the following tenders for supply of track rails and fastenings:—

	About 2,000 tons.	5,000 tons.
Bolckow, Vaughan & Co. (*accepted*)	£13,307	£34,640
Walter Scott (Ltd.)	13,761	35,832
P. & W. MacLellan (made by Angleur Co.)	13,116	34,058
*Bolling & Lowe (made by Phœnix Co., Ruhrort	13,191	33,803
E. Le Bas & Co. (made by Société Anon. d'Ongreée)	12,623	32,523
Société Anonyme des Aciéries d'Angleur	12,430	32,098

* Not to specification.

The chief engineer's estimates were £14,227. 10s. and £35,567. 10s. respectively.

The Highways committee reported that the last four tenders were for rails of foreign manufacture. The lowest tender for rails of British manufacture was that of Bolckow, Vaughan & Co., which was £2,541. 13s. 4d. higher than the lowest tender actually submitted for the same quantity (5,000 tons). They would, however, point out that in the past, in cases in which materials required for tramway construction and re-construction works had been obtained from abroad, considerable delay had arisen owing to difficulty in arranging for deliveries to be made in accordance with requirements, and in the case of its being necessary to reject any work the delay caused was serious. In these circumstances, and having regard to the Council's resolve to give preference, wherever possible in the purchase of manufactured goods, to articles made within the United Kingdom, the committee recommended that the tender of Messrs. Bolckow, Vaughan & Co. for 5,000 tons should be accepted.—Agreed.

For the manufacture, supply and delivery of 175 sets of maximum traction swing bolster trucks for L.C.C. tramways the following tenders have been received:—

	£	s.
Heenan & Froude (*accepted*)	£27,037	10
Hurst, Nelson & Co.	29,793	15
Thornewill & Warham	29,575	0
Met. Amal. Ry. Carriage & Wagon Co.	29,050	0
Magnolia Anti-Friction Metal Co.	28,043	15
United Electric Car Co.	27,650	0
Mountain & Gibson (British steel)	27,650	0
,, ,, (foreign steel)	26,775	0
Brush Co.	26,670	0

Three tenders were also received "not to specification."

The lowest tender was that submitted by the Brush Co., but that company took exception to the terms of the arbitration clause in the contract. The committee did not feel able to recommend the Council to accept a particular interpretation of the clause, which was in the usual form. Moreover, the firm had not completely filled in, as required, the schedule of rates of pay to be observed in the execution of the work. One of the tenders of Mountain & Gibson provided for the use of steel of foreign manufacture. The third lowest tender, according to specification (by Heenan & Froude), provided for steel of British manufacture. Having carefully considered the matter, the committee were of opinion that the tender of Heenan & Froude for £27,037. 10s. should be accepted.—Agreed.

For supply of steel tyres for tramcar wheels the following tenders have been received by London County Council. The prices are *per tyre*.

	3,500 driving wheels.	2,000 trailing wheels.	Total.		
Henry Bessemer & Co. (*accepted*)	23s. 0d.	18s. 0d.	£5,825	0	0
Cammell, Laird & Co.	24s. 0d.	21s. 6d.	6,350	0	0
Brown Bayley's Steel Works.	26s. 0d.	21s. 9d.	6,725	0	0
Steel Co. of Scotland	28s. 0d.	25s. 0d.	7,400	0	0
Steel, Peech & Tozer	29s. 1d.	26s 7d.	7,747	18	4
Taylor Bros. & Co.	—		8,060	8	4
Hadfield's Steel Foundry Co.	34s. 9d.	31s. 9d.	9,255	5	0
Standard Steel Works Co.	—	—	10,100	0	0
Vickers, Sons & Maxim	42s. 0d.	30s. 0d.	10,350	0	0
Wm. Beardmore & Co.	—	—	10,775	0	0
John Brown & Co.	*25s. 0d.	21s. 3d.			
John Baker & Co.	†24s. 6d.	—	—		

* For 2,000 only. † For 1,500 only.

For the provision of sand-drying apparatus for use in tramways department London County Council have accepted the tender of Mountain & Gibson at £650. There were six tenders, varying from £620 to £1,450.

London County Council have accepted the lowest tender submitted for supply of bearings required for the tramways department, and an order has been placed with the Anti-Attrition Metal Co. for (*a*) 200 halves bronze motor axle bearings, 11½d. a lb.; (*b*) 300 bronze journal bearings d.w., 8s. 3d. each; (*c*) 300 bronze journal bearings p.w., 8s. each. An allowance of 8d. a lb. on worn bearings.

Marylebone (London) Council have accepted the following tenders for annual stores for the electricity department:

British Insulated and Helsby Cables, binding wire; Edison & Swan Co., batten, cord grip and screw holders, tumbler switches, &c.; Baxter & Counter, wall sockets and plugs; A. P. Lundberg & Sons, switch plugs; W. T. Henley's Telegraph Works Co., v.i.r. insulated wires and cables, flexibles, fire-resisting tape, &c.; St. Helens Rubber & Cable Co., rubber tubing; General Electric Co., para rubber strip tubular lamps;

Pyke & Palmer, asbestos braiding tape, manhole gaskets; grease cups and plumber's black; F. Bird & Co., hack saw blades and tinman's solder; Naylor Bros., paint; Pooley & Austin, white silesian tape, incandescent lamps, &c.; W. McGeoch & Co., distribution boards, [illegible] fuse; Union Electric Co., flame arc lamp carbons; Sloan Electrical Co., Excello arc lamp globes, arc lamp carbons; Le Carbone, carbon brushes with flexibles; Glenboig Union Fireclay Co., bricks, &c.

Partick Corporation have accepted the following tenders for annual stores.—

P. & W. MacLellan & Co., engine room stores; Cookson & Co., bleached rags; Fleming & Co., tools and ironmongery; W. H. Keys, bitumen, pitch and compound; Callender's Co., cable jointing requirements; British Insulated & Helsby Cables, service cutouts; Chamberlain & Hookham, meters (up to 50 amperes), and Electrical Co., meters up to 100 amperes; Siemens Bros. Dynamo Works, incandescent lamps; Sloan Electrical Co., arc lamp carbons; Englebert & Co., lubricating oils for first six months, and Henry Wells Oil Co. for six winter months; Walker & Cameron, coal; Robinson, Dunn & Co., wood troughing; W. C. Yuille & Co., steel tubing and Nernst materials.

East Ham Council received nine tenders (varying in amount from £14,951 to £17,839) for the reconstruction and electrification of the Romford road tramways, and that of W. Griffiths & Co. has been accepted at £15,108, or alternatively £15,761, with an allowance of 1s. 6d. per yard in case of old setts taken up and retained by them and £2 per ton for old rails, but subject to the company supplying English-made rails (the original tender being for Lorain American steel rails), the track work being commenced within three weeks from acceptance of tender, and being ready for Board of Trade inspection within 10 weeks. The borough engineer's estimate was £16,094.

Camberwell (London) Council have placed an order with S. Burnby & Son for supply of English made plain and frosted electric lamps: Plain lamps, 100 and 200 volts 8 c p., 7s. per dozen; 16 c.p., 7s.; 32 c.p., 8s.; frosted lamps, 100 and 200 volts, 8 c.p., 7s. 6d.; 16 c.p., 7s. 6d.; 32 c.p., 8s. 6d.

For wiring the new hospital buildings at Uxbridge the Joint Hospital Board received nine tenders, and the lowest, that of Wells, Rayner & Co. at £89. 13s. was accepted. The highest tender was for £193. 5s.

Doncaster and Mexborough Hospital Board have accepted the tender of Taskers Limited for repairs to and partial renewal of the storage battery at £75.

Southend Corporation have accepted the tender of E. & B. H. Davey for the construction of a condenser water tank at the electricity works at £370.

Foleshill Council have accepted the tender of the Electrical Trades Supply Co. for an electric light installation at the infectious hospital at £268.

The South Greta Colliery Co. have ordered from T. K. Steanes (Sydney) a Willans engine direct coupled to a Siemens 70 kw. c.c. dynamo, 12 H.P. motor, cables, switchboard, &c.

Portsmouth Electric Light committee have accepted the tender of W. T. Glover & Co. for high-tension cables at £1,030.

Haslingden Council have accepted the tender of Dick, Kerr & Co. for overhead tramway equipment.

Southend Council have accepted the tender of P. & W. MacLellan for steel rails at £6. 4s. 9d. per ton, and fishplates at £7. 19s. per ton.

Worksop Council have accepted the tender of H. P. Forrest for one gross of Ediswan Electric lamps at 12s. 9d. per dozen.

The contract for the supply of prepayment electricity meters to Gillingham Council has been secured by the Rochdale Electric Co.

Erith Council have accepted the tender of Beadle Bros. for rough small coal at 12s. per ton.

Leek Council have accepted the tender of Crompton & Co. for switchboard extension.

R. Waygood & Co. have secured (through Turner, Hoare & Co.) the contract for an electric lift for the municipal building, Bombay.

The Postmaster-General's Department, Sydney, N.S.W., have accepted the tenders of the Union Cable Co., for brass-sheathed rubber telephone cable; British Insulated & Helsby Cables, paper-insulated and lead-covered cables; R. B. Hungerford, common battery wall telephone sets, paper-insulated and lead-covered cables and switchboards; Jas. Paton & Co., common battery table telephone sets.

BUSINESS NOTICES.

Owing to increasing business, the Ingersoll-Rand Co. have removed to more convenient offices at 165, Queen Victoria-street, E.C. Goods should, however, still be sent to 114, Queen Victoria-street, E.C.

The new offices of our American contemporary "Telephony" are 342-347, Monadnock Block, Chicago, Ill.

J. Moores and J. R. Makinson, trading as Moores, Makinson & Co., electrical engineers, &c., Manchester, have dissolved partnership

Sale by Tender.—Tenders are required for the purchase of machinery, consisting of a horizontal compound balanced steam engine and a bipolar shunt-wound d.c. dynamo (240 amperes at 350 volts), by Easton, Anderson & Goolden. Forms of tender and schedules of the plant from the Superintendent of Building Works, Royal Arsenal, Woolwich. The plant can be inspected on application to the Chief Ordnance Officer, Royal Army Clothing Department, Pimlico, London, S.W. Tenders to the War Office, Whitehall, S.W., by noon, June 17. See also an advertisement.

Plant for Sale.—A 60 kw. Mordey-Victoria alternator, 2,000-2,250 volts, 100 periods, 375 revs. per min., complete with exciter, is advertised for sale. Applications to Engineer, Verulam House, Bournemouth.

Patent Licence.—The owners of patents relating to an improved metal or alloy are desirous of arranging for the granting of licences to work upon royalty or to dispose of their rights. Particulars from Messrs. Allison Bros., 52, Chancery-lane, E.C. See an advertisement.

Electric Fittings at Olympia.—In connection with the Royal Naval and Military Tournament, now being held at Olympia, we learn that the whole of the electric light fittings which were used in the Royal box were supplied by the Edison & Swan Co., 36-37, Queen-street, London, E.C.

CATALOGUES, &c.

Vickers' Electrical Machinery.—The latest production of Messrs. Vickers, Sons & Maxim, of Sheffield, deals fully with the products of the company's extensive electrical department. In the space of a note it is not possible to do justice to the main features of these products, and we shall, therefore, refer to them more fully on a future occasion. We may, however, take this opportunity of remarking that the illustrations have been carefully prepared and classified. They are a credit to the engraver and the printer, and bring out in a most effective manner the main features in the design and construction of the dynamos and motors manufactured by the company.

Electric Lamps.—The Electrical Co. are issuing from their lamp department a small brochure which deals with a special flexible miniature lamp strip, which the company is putting forward for illumination purposes. There should be a large demand for this strip.

"Little Hustler" Drills.—We have referred from time to time to the "Little Hustler" drills which the Armorduct Mfg. Co. place on the market. The latest catalogue dealing with these useful tools has been clearly compiled and arranged in an appropriate and tasteful cover. The illustrations showing the parts of the machines are also well brought out.

Silk and Cotton Covered Wires.—List No. 27 issued by the India-rubber, Gutta-percha & Telegraph Works Co. contains tabulated prices and particulars of the company's guttapercha, indiarubber, silk and cotton covered wires; also jointing tools and materials.

A Question of Gearing.—The electric motor is by nature somewhat fast. For this reason it is necessary to find some means of reducing its speed on nearly every occasion. To effect this gearing is necessary whose design opens up a number of possibilities, and brings into juxtaposition the double reduction as opposed to worm method. The Power Plant Co., of West Drayton, are among the supporters of the former method and have sent us a catalogue which contains a good deal of information on the subject. They make out a strong case for their "client," and show by means of curves that its all-round efficiency is greater. It is claimed that, therefore, it is cheaper in both first cost and upkeep, figures being given in substantiation. All interested in the subject of the electric drive should get this catalogue.

BANKRUPTCIES, LIQUIDATIONS, &c.

A receiving order has been made against Ernest Goacher, electrical engineer, &c., Gateford-road, Worksop.

A meeting of creditors of A. W. Bennett, electrical engineer (trading as Bennett & Co.), was held at Leeds on Monday. Liabilities £1,124. 13s. 4d., assets nil. Debtor (who was formerly a telegraph engineer) commenced business in 1897 as an electrical engineer.

Adjustable Resistance Device.—A patent recently issued to H. S. Martin deals with this subject. The resistance material consists of a powder containing both finely divided conducting and insulating material, such as graphite and mica. With them is mixed sand. An alteration in resistance is produced by bringing the particles of graphite into more or less intimate contact by exerting or releasing pressure. In the latter case the scales of mica act as springs, which are distorted when pressed against the sand. The resistance consists of a hollow cylinder lined with insulating material, and provided at the ends with a metal disc. The pressure is applied by means of the thumbscrew at the top, and the current is passed through the resistance, the leads passing in through the base.

PATENT RECORD.

APPLICATIONS FOR PATENTS.

NOTE.—*The under-mentioned Applications (except those marked †) are not open to public inspection until after acceptance of Complete Specifications. Those marked † are open for inspection 12 months after the date attached to them, if they have not been published previously in the ordinary course. Names within parentheses are those of communicators of inventions. When Complete Specification accompanies application, an asterisk is affixed.*

February 5, 1908.

2,547 ATKINSON & WHITE. Connecting terminals or couplings to electric cables.
2,569 RAWLINGS & SMITH. Adjustably supporting incandescent lamps, and shades or reflectors therefor. (Application for patent of addition to No. 8,151 07.)*
2,581 NORTH & ORCHARD. Relay devices for electric circuits.
2,610 BAKER. Switches and the like.

February 6, 1908.

2,621 DAVIES. Induction coils for igniting miners' safety lamps.
2,673 BAKER. Safety devices for use with electrical apparatus.
2,676 LOEBL & BRITISH EVER-READY ELECTRICAL CO. Holders for incandescent lamps.*
2,685 FESSENDEN. Receivers for wireless telegraphy. (Date applied for, 8 2/07.)* .
2,707 HOWARD. Incandescent lamps.

February 7, 1908.

2,727 VAN RADEN & CO. & METZ. Accumulators.
2,728 VAN RADEN & CO., ROBINSON & METZ. Electrodes for secondary batteries and manufacture of same. (Application for patent of addition to No. 21/719 06.)
2,733 BLOCKLEY & FLETCHER. Primary galvanic cells.
2,769 HOOKHAM & HOLDEN. Prepayment electricity meters.
2,795 SOANS & GRAVES. Party-line telephone systems.*
2,797 LAKE. (Jahoda and Elektrisches Glühlampenfabrik "Watt" Scharf, Loti & Latzko, Austria.) Incandescent lamp.
2,823 HEADLEY. Switches.
2,824 FALKENTHAL. Producing ringing currents in telephone systems. (Date applied for, 22 2/07.)*†

February 8, 1908.

2,838 AMPHLETT & AMPHLETT. Double-revolving dynamo-electric machines with internal and external field magnets which, keyed together in shafts, rotate in an opposite direction to that of their armatures.
2,871 HUTTON. Appliances for use with telephone transmitters.*

SPECIFICATIONS PUBLISHED.

1907 SPECIFICATIONS.

5,037 B.T.-H. CO. (G.E. Co., U.S.) Regulating electric lighting systems.
5,350 WARWICK MACHINERY CO. (G.E. Co., U.S.) Turbines.
5,537 BAMES. Magneto-electric ignition devices.
6,455 LEA. Tumbler switch.
6,751 RAVENSHAW, MIDDLETON & TOWNSEND. Magnetic clutches or brakes.
6,925 ATKINSON. Switches.
7,449 THORPE. Electricity meters.
8,642 B.T.-H. CO. (G.E. Co., U.S.) Mounting lamp filaments.
8,874 HAHN. Alternating current vapour apparatus.
9,345 ELLIOTT. Electric pendant lamps.
9,963 B.T.-H. CO. (G.E. Co. U.S.) Electric signals for railways.
11,071 ALLGEMEINE ELEKTRICITATS GES. Electric winding gear. (Date applied for, 12 5 06.)
11,873 SIEMENS BROS. DYNAMO WORKS & POYNDER. Altering the working speed of polyphase motors.
14,100 B.T.-H. CO. (G.E. Co., U.S.) Lightning arresters and like protective devices.
14,725 SIEMENS BROS. DYNAMO WORKS. (Siemens Schuckertwerke Ges.) Electrical potential regulators or speed-controlling devices.
15,009 FELTEN & GUILLEAUME LAHMEYERWERKE A. G. Alternating current electromagnets. (Date applied for, 2 4 07.)
15,442 CONRAD. Voltage regulation of dynamo electric generators. (Date applied for, 9 7 06.)
16,574 LUNDBERG, LUNDBERG & LUNDBERG. Switches.
16,745 LE MANQUAIS. Junction boxes for electrical apparatus.
16,854 TARDIEU. Telephone apparatus. (Date applied for, 12 1 07.)
17,308 WAPPLER & FAYER. Interrupters for circuits.
17,410 SIEMENS SCHUCKERTWERKE GES. Switches. (Date applied for, 24 9 06.)
17,455 DEUTSCHE TELEPHONWERKE GES. Electric signalling apparatus. (Date applied for, 24 8 06.)
17,617 CARTER. Coin controlled pay station for telephones.
18,452 STONE. Apparatus for determining the direction of space telegraph signals. (Date applied for, 17 8 06.)
18,868 KWAPIL & BIHN. Electromagnetic make and break ignition devices for explosion engines.
19,293 BLEICHERT & BLEICHERT. Trolley cars for wire rope or suspension railways.
19,626 SIEMENS BROS. & CO. (Siemens & Halske A.-G.) Electrical locking apparatus for railway signalling.
19,696 COWPER-COLES. Annealing and galvanising or tinning metal articles.
19,794 GES. FUR DRAHTLOSE TELEGRAPHIE. Detectors for wireless telegraphy. (Date applied for, 8 9 06.)
19,856 SIEMENS BROS. DYNAMO WORKS. (Siemens Schuckertwerke A. G.) Connecting alternating current generators to their prime movers.
20,676 CONRAD. Electric switching and other devices. (Date applied for, 20 9 06.)
20,947 SIEMENS BROS. DYNAMO WORKS. (Siemens Schuckertwerke Ges.). Method of inserting former wound coils of flat copper into slotted iron cores of electrical machines.
21,035 YATES & LUM. Electric motor control and apparatus therefor. (Date applied for, 22 9 06.)
21,119 VON PEEZ. Electric indicators.
22,638 SMITH. Winding and connection of phonophore and like induction coils.
22,746 SIEMENS & HALSKE A. G. Manufacture of filaments for electric lamps and apparatus therefor. (Date applied for, 16 10 06.)
23,641 HANWELL. Electric light pendants.
24,706 JOHNSON & PHILLIPS & TUBBS. Arc lamps.
24,862 ARCIONI. Integrating train for double tariff electric energy meters.
27,541 PAULI. Incandescent lamps.
27,933 UNTERBERG & HELMLE. Testing apparatus for magnetic-electric spark ignition apparatus. (Date applied for, 17 10 07.)

COMPANIES' MEETINGS AND REPORTS.

West African Telegraph Co. (Ltd.)

The twenty third ordinary general meeting was held yesterday, the MARQUESS OF TWEEDDALE, K.T., presiding.

The SECRETARY (Mr. John Cambrook) read the notice calling the meeting and the auditors' report.

The CHAIRMAN said: Gentlemen, the gross revenue for the year under review amounted to £59,206 against £66,158 for the year 1906, or a decrease of £6,952. This Company's proportion of the receipts from the South African joint purse continues to decline, and is this year £3,588 less than for the preceding year. There is also a considerable falling off, amounting to £2,509, in the receipts from Portuguese traffic, and a further diminution, as compared with 1906, in the sum received on account of the diversion of traffic over our lines owing to interruptions to cables of other telegraph companies. The gross revenue is also adversely affected this year in consequence of the rate of exchange not being so favourable as it was in 1906, the reduction under this head amounting to £1,200. As a part set-off against these reductions, the interest on reserve fund investments shows an increase of £853. The expenses of the year are about £1,000 more than those of 1906, due to special repairs to certain station buildings, while the expenses attending maintenance of cables are about £650 more than they were in 1906. I referred at last meeting to the fact that it had been decided to renew a portion of the St. Thome-Loanda section of our cables. This work has been carried out during the year, and about 106½ knots of new cable have been used in the operation. The total cost of this renewal has not yet been ascertained, but the general reserve fund has been debited with £8,625. 14s. 7d. After making a contribution of £24,000 to the general reserve fund and allowing for the interim dividend of 2 per cent. paid in December last, the Directors are able to recommend the payment of a final dividend of 2 per cent., making 4 per cent. for the year, leaving £831. 6s. 6d. to be carried forward to the next account. I now move the adoption of the report and accounts.

Sir HENRY C. MANCE, C.I.E., M.Inst.C.E., seconded the resolution, which was carried unanimously.

The retiring Director (the Hon. A. G. Brodrick) and auditors were re-elected, and a vote of thanks to the Chairman and Directors terminated the proceedings.

CALCUTTA ELECTRIC SUPPLY CORPN. (LTD.)—Col. Filgate at the meeting on Friday last said capital expenditure during the past year amounted to £59,994, bringing up the total to £604,347. They had added 13 miles to their underground and two miles to their overhead system. Their gross revenue was £103,360, compared with £89,242. During the year nearly 12 miles of feeders in iron casing, on improved lines, has been laid at a net cost of £19,016. They had still about 20 miles to relay. The net profit was £57,275, and the board recommended a final dividend at the rate of 9½ per cent., making 8 per cent. for the year.

DOULTON & CO. (LTD.)—The report for 1907 states that, after paying the preference dividend and writing £500 off goodwill, there is a credit balance of £8,327, which it is proposed to carry forward.

FELTEN & GUILLEAUME-LAHMEYERWERKE AKTIEN-GESELLSCHAFT. The gross profit for 1907 was M. 15,444,748 (about £772,237), against M. 15,022,820 (about £751,141), and the net profit was M. 6,585,622. A dividend of 10 per cent. is recommended, against 11 per cent. in 1906, the reduction being due to the adoption of a more conservative financial policy and to the rather uncertain trade outlook. The report states that the past year has been one of exceptional activity in all departments, and the works are still well supplied with orders. The export trade is being unfavourably influenced by new tariff arrangements, including preferential tariffs granted by British colonies to the mother country. Special stress is laid on the effects likely to be exercised on the German electrical industry by the English Patents and Designs Act, of 1907, and the German Government are urged to come to some mutual agreement with England on the question. Last year the dynamo department delivered 9,330 machines, with a total capacity of 358,000 H.P., against 8,070 machines (265,000 H.P.) in the previous year.

GENERAL ELECTRIC CO. (U.S.A.)—The profits for the year ended Jan. 31 (including $9,778.93 from securities sold, and $1,010,961.63 from royalties, dividends, &c., and after deducting patent, general and miscellaneous expenses and allowances for depreciation and losses, and writing off $3,745,989.06 from factory plants were $6,586,653.37 of which $5,183,614.00 was paid in dividends during the year, leaving $1,403,039.37 to be carried to surplus account which amounted at Jan. 31 to $16,513,836.14. Late in the year there was a sudden and severe shrinkage in the value of all merchandise and materials used, notably copper. All materials, whether raw, manufactured, or in process of manufacture, on hand at Jan. 31 were inventoried at the prices then prevailing. During the year the undertaking of the Stanley G. I. Electric Mfg. Co., were taken over and the factories owned by that company at Pittsfield (Mass.) are now a part of the factory plants of the General Electric company. In view of the then great expansion in business, the directors deemed it wise, early in 1907, to provide for future development at some point nearer the central west, in preference to a further enlargement of the plants at Schenectady and Lynn, and about 700 acres of land adjacent to the City of Erie, Pa., were purchased at a cost (including engineering and other expenses) of $232,301.53. In view of the existing depression the erection of buildings thereon is deferred for the present. The securities in the stocks and bonds account of the company have been re-valued and the book value thereof has been fixed at $18,000,089.85.

The sales department reported that the total sales billed came to $70,977,168, and the total orders received to $59,301,040, against $60,071,883 and $60,483,659 respectively in 1907. Orders received during the first six months of the year increased 22 per cent. over the corresponding period of 1906. Owing, however, to the disturbed financial conditions prevailing during the latter part of the year orders received for the second six months decreased 23 per cent. The total number of separate orders and contracts received during the year was 237,006. Among important orders received were:—G. W. Power Co., three water wheel generators, 10,000 kw. each, with transformers and other electrical apparatus for transmitting current at 100,000 volts, a distance of about 165 miles; Central Colorado Power Co., four 5,000 kw. generators and other electrical apparatus for water power development at Glenwood Springs on the Grand River; Detroit River Tunnel Co., apparatus for equipment of the Detroit tunnel under the St. Clair River, the contract including several 1,000 kw. motor-generator sets with accessories and six 100 ton locomotives each equipped with four 250 H.P. motors; Great Northern Railway, for electrification of the Cascade tunnel, water wheel generators and 100-ton locomotives, each equipped with four 250 H.P. a.c. motors giving a continuous output of 1,000 H.P. per locomotive; Southern Pacific Railroad Co., for electrification of its suburban lines in Oakland and Alameda (Cal.), 44 four-motor 125 H.P. equipments with Sprague-General Electric control; Hudson Tunnels Co., turbine-generators, rotary converters, motors and controlling apparatus for complete electrical equipment of its system of tunnels under the Hudson River connecting New Jersey and Manhattan; West Jersey & Sea Shore R. R. Co., orders for additional equipment to provide for increased traffic; New York Central and Hudson R. R. R. Co. is now operating in its New York City terminal 35 electric locomotives of G.E. manufacture each equipped with four 550 H.P. d.c. motors. Twelve additional locomotives have recently been ordered, making 47 in all.

The use of electrical apparatus for industrial purposes is extending rapidly and large purchases of the company's apparatus have been made during the year for completely equipping mills with turbine and engine driven generators for lighting and power, and with motors of standard and special design for driving machinery of every description. Orders for meters, transformers, arc lamps, wiring devices, electric heating devices, repair parts of electrical apparatus, &c., show an increase over last year. The company's list of supplies comprises upwards of 50,000 items, separately catalogued and priced.

To meet the requirements of interurban railways where a potential higher than 600 volts is desirable and the conditions are unfavourable to the adoption of the single-phase a.c. system the company has developed a high voltage d.c. railway system to operate at 1,200 volts. Two roads have been operating under this system for several months with entire success. Equipment for several additional roads of this character is in process of installation. The Curtis steam turbine continues to give excellent service, and the confidence of users is evidenced by numerous additional orders for existing installations. The total number of Curtis turbines shipped to date is 960, having a total capacity of 1,086,000 H.P. Orders were received during the year for turbines aggregating 380,000 H.P. The company has in process of manufacture for the Commonwealth Edison Co., of Chicago, and the New York Edison Co., a number of turbine-generators of 14,000 kw. capacity each, which will be the largest steam driven electrical units ever produced. The consumption of carbon filament lamps has steadily increased during the year. In addition the company has received large orders for different types of high efficiency metal filament lamps, first consideration being given to such sizes and types as will aid central lighting stations in providing for the requirements of their customers and the extension of their business. The business of the foreign department has been well maintained.

In the manufacturing branch of the General Electric Co.'s business the number of employees decreased in 1907–8 to 20,000, compared with 28,000 in 1906–7, and 22,500 in 1905–6. The reduction was chiefly in the last quarter of the financial year (Nov.–Jan.).

The engineering department reports that more attention has also been given to the design of special apparatus intended to meet novel conditions and to the extension of our business along profitable lines. The apparatus designed for long distance transmission has proved most reliable, economical and satisfactory in operation. There has been a continued increase in the capacity of electric generators and transformers. The company's h.t. switching apparatus has been still further improved. The details of the steam turbine-generators have been improved, great economy and proved reliability being now assured, and the turbine-generator is now standard for all new important electrical installations where steam is utilized. The company is now building turbine units of a capacity of 14,000 kw.; the largest electrical generating units ever produced. The Commonwealth Edison Co. (Chicago), has now in operation in one station nine large turbines capable of generating a total of 103,500 kw. The engineers have devoted considerable attention to the design of a line of turbine-generators for use with exhaust steam. Such steam turbines are so much more efficient than steam engines when operated by low pressure steam that they can be most usefully employed to supplement steam engines in existing installations. Their use will result in large increases in output without any increase in coal consumption.

The single-phase alternating-current railway equipments have been greatly improved during the past year. The new d.c. railway motor has proved so satisfactory in practical operation that it is rapidly being adopted as the standard type. The range of economical operation of d.c. railway apparatus has been extended by designing it for use at 1,200 volts, and such equipments have been sold to the Southern Pacific R. R. Co. The Great Northern R. R. Co., have purchased four 1,000 ton three-phase electric locomotives for handling all trains traversing the 2½ miles of Cascade tunnel in Washington. This installation will be the first instance of the substitution of electricity for steam on a mountain division of one of the Continental railways. The traffic conditions are peculiarly difficult on account of the grades and tunnels. These electric locomotives, because of their increased speed and better control will practically double the traffic capacity of the present steam locomotives. Electricity for their operation will be supplied from water power hitherto unused. A gas-electric car which fully meets the requirements of steam railroad companies for service on branch lines has been perfected. The equipment consists of a gasoline engine driving an electric generator which furnishes current to standard railway motors. The engine and generator are located in the forward end of an especially designed car conveniently divided into passenger and baggage compartments, making a complete self-contained unit. The company has made many improvements in the design of machinery for electric reduction of metals and in apparatus for various industrial applications. Several large motors of special design of about 10,000 H.P. capacity each have been shipped for driving rolling mills and orders for additional equipments have been received. Important improvements in the design of wiring devices, rheostats, circuit breakers, switches, instruments, &c., have been made during the year. The new tungsten incandescent lamp, which gives more than double the illumination of the carbon filament for the same expenditure of power, has been further developed and has now become a standard commercial article. Several novel types of arc lamps of greatly improved economy have also been perfected and sold in large quantities.

PERTH (W. AUSTRALIA) ELECTRIC TRAMWAYS CO. (LTD.)—At the meeting on Friday the chairman said the results were not quite so good as in 1906, which was a boom year owing to the Perth exhibition. It was said that Western Australia was under a cloud of depression, but the only cloud that he could see was the fact that so much capital was not going into the country as was the case a few years ago. The Australians, unlike the Canadians, have done their utmost to keep immigrants out of the country and to drive capital away, a very mistaken policy, which he believed they were now beginning to recognise.

REUTER'S TELEGRAM CO. (LTD.)—At the meeting on Wednesday, the chairman (Admiral Sir John C. D. Hay) gave a resumé of the past year's work, and expressed regret at having to make the admission that news gathering and distribution was unremunerative. Did the company not possess other sources of revenue they could not possibly afford what they at present spent on news telegrams. A dividend of 4s. per share was declared, making 5 per cent. for the year, tax free.

SAO PAULO TRAMWAY LIGHT & POWER CO. (LTD.)—The gross earnings for 1907 were $2,111,523, compared with $2,018,703 for 1906; net earnings $1,395,873, compared with $1,368,162; operating and maintenance charges $715,649; bond interest, Government and municipal taxes, &c., $359,422; and three quarterly dividends of 2 per cent. each and one of 2½ per cent., aggregating $691,476. Of the balance there was placed to contingent account $100,000, and to profit and loss $244,974. $100,000 was also placed to contingent account to meet renewals, &c. The demand for light and power is increasing very rapidly. In addition to the light and power to be supplied Sao Bernardo progress is being made in the illumination of the city streets, arc lamps having been placed upon several of the business thorough-

fares. There are now in use 45,570 arc and incandescent lamps compared with 38,119 in 1905. The motors connected increased by 108, the horse-power contracted an increase of 1,102½ H.P., and the prospects are that there will be continued increased demands upon the plant. Contracts have been placed for the necessary transformers, &c., required for the utilisation of the current from the seventh unit of plant. The company purchased the rights and property of the Santa Anna Railway, a narrow gauge mule line extending from the terminus of one of the company's trunk lines at Ponte Grande to Santa Anna, and as soon as this is electrically operated much larger returns will be obtained. The company has acquired an exclusive 30 year concession for the distribution of light and power in the municipality of Sao Bernardo.

URBAN ELECTRIC SUPPLY CO. (LTD.)—The gross profit for 1907 amounted to £36,433. 10s., and, after deducting London expenses, the balance was £34,639. 19s. 9d. Adding £633. 10s. 2d. interest and deducting debenture interest, &c. (£12,761. 6s. 7d.), there remained a profit balance of £22,512. 3s. 4d., which is short by £9,987. 16s. 8d. of the amount required to meet the 5 per cent. guaranteed dividends on the issued capital. This deficit was provided by Edmundsons' Electricity Corpn. under their contract. Provision has been made of £1,612. 8s. for depreciation of stock of wiring goods and fittings, and of £462 7s. 6d. for depreciation of plant and machinery under the terms of the agreement with the contractors. At Dec. 31 last the equivalent of 37,784 8 c.p. lamps was connected to the mains at Hawick (against 33,524 8 c.p. in 1906), 30,624 (29,443) at Stamford, 46,322 (40,538) at Weybridge and Walton, 23,773 (21,162) at Godalming, 75,762 (63,908) at Twickenham and district, 21,115 (19,702) at Dartmouth, 53,286 (39,322) at Camborne and Redruth, 14,140 (12,753) at Newton Abbot, 33,233 (30,907) at Grantham, 24,578 (22,495) at Glossop, 16,044 (13,781) at Berwick, 10,833 (10,058) at Caterham, and 15,105 (12,042) at Newbury, making a total of 402,597 8 c.p. against 349,640 8 c.p.

WEST INDIA & PANAMA TELEGRAPH CO. (LTD.)—The directors' report for the six months ended Dec. 31, states that the amount to credit of revenue (including £1,000 transferred from income tax account) is £37,262. 7s. 11d., against £34,203. 9s. 7d. for the corresponding half-year of 1906. Expenses have been £23,028. 3s. 5d., against £21,611. 19s. 7d. The result is a balance of £14,234. 4s. 6d., added to £1,747. 5s. 3d. interest on investments and £1,014. 2s. 9d. brought forward, making £16,995. 12s. 6d. The directors propose that this amount be dealt with as follows: Dividend of 6s. per share on first preference shares for six months to December 31 last (£10,363. 18s.) and £1. 6s. per share on account of dividends accrued on second preference shares to Dec. 31 last (£6,069 14s.), leaving £557. 0s. 6d. to be carried forward. The directors refer with pleasure to being able to pay £1. 6s. per share to the second preference holders on account of accrued dividends. The traffic receipts for the six months show an increase of £2,074, compared with the corresponding period of 1906. During the half year the company's repairing ship "Henry Holmes" was thoroughly overhauled at a cost of £892. 3s. 2d., charged to reserve for depreciation. In December a contract was entered into with the Telegraph Construction & Maintenance Co. for the manufacture of 252 knots of cable for stock, which have since been delivered in the West Indies. The cables continue to be maintained in good working order.

NEW COMPANIES, STATUTORY RETURNS, MORTGAGES AND CHARGES.

NEW COMPANIES.

BRADNINCH & DISTRICT ELECTRIC SUPPLY CO. (LTD.) (98,024.)—Reg. May 20, capital £2,000 in £1 shares, to carry on at Bradninch and elsewhere in Devonshire the business of an electric light company in all its branches. Reg. office, Kensham, Bradninch, Devon.

GRASSE & CANNES ELECTRIC TRAMWAYS SYND. (LTD.) (98,071.) Reg. May 23, capital £2,100 in 2,000 ordinary A shares of £1 each and 2,000 deferred B shares of 1s. each, to construct, lease or acquire tramways and light railways in France or elsewhere, to equip, maintain and work same by electricity or other power, &c.

OXFORD TRAMWAYS SYND. (LTD.) (98,054.)—Reg. May 21, capital £55,000 in £1 shares, to adopt an agreement with the City of Oxford Electric Tramways Ltd., to acquire, hold or deal with any stocks, shares or securities in the said company or any other company formed for constructing, maintaining or working all or any of the tramways authorised by the Oxford and District Tramways Act, 1907, and to carry on the business of railway and tramway owners, electric light and power suppliers, electrical engineers, metal workers, contractors for the supply of electrical plant, manufacturers of and dealers in apparatus used in connection with the generation, distribution, accumulation and employment of electricity, &c. First directors, B. Bernheim and W. B. Cowan (appointed by the National Electric Construction Co.) and Sir Robert Buckell and Col. R. F. Webb (appointed by the City of Oxford & District Tramways Co.). Reg. office, Queen Anne's chambers, Westminster.

REX ELECTRIC & GENERAL SUPPLIES (LTD.) (98,090.)—Reg. May 23, capital £3,000 in £1 shares, to carry on the business of electrical and general engineers, contractors, manufacturers of electrical and mechanical appliances for lighting, power and traction, importers and exporters of scientific and other electrical appliances, dealers in electrical goods and accessories, &c., to acquire the goodwill of the wholesale electrical supply department of D. Santoni & Co. (1905) (Ltd.) and to adopt an agreement with D. Santoni.

STATUTORY RETURNS.

BRITISH RAILWAY TRAFFIC & ELECTRIC CO. (LTD.)—In return to May 12 capital is £100,000 in £1 shares, of which 70,000 have been taken up. £1 per share has been called up on 100 and 10s. per share on 69,900 and £35,050 has been received. Mortgages and charges, nil.

COUNTY OF DURHAM ELECTRICAL POWER DISTRIBUTION CO (LTD.)—Return to March 24 gives capital as £500,000 in 50,000 preference and 50,000 ordinary shares of £5 each, all of which have been taken up and paid for in full. Mortgages and charges, £219,643.

DIRECT SPANISH TELEGRAPH CO. (LTD.)—According to return to April 2, capital is £95,000 in 13,000 ordinary and 6,000 preference shares of £5 each, of which 12,931 ordinary and 6,000 preference have been taken up. £94,655 has been received. Mortgages and charges, £30,000 1st and £8,000 2nd mortgage debentures.

ELECTRIC LIGHTING & TRACTION CO. OF AUSTRALIA (LTD.)—The capital in return to April 20 is £300,000 in 30,000 ordinary and 30,000 preference shares of £5 each, of which 4,834 ordinary and 30,000 preference have been taken up. £5 per share has been called up on 2,003 ordinary and 30,000 preference and £160,015 has been received. £14,155 is considered as paid on 2,831 ordinary. Mortgages and charges, £150,000 debentures and £125,000 bank loan.

GUILDFORD ELECTRICITY SUPPLY (LTD.)—Return to April 8 gives capital as £55,000 in 25,000 preference shares of £1 each and 6,000 ordinary shares of £5 each, of which 11,276 preference and 2,782 ordinary have been taken up. £25,188 has been received, including £2 paid on two forfeited shares. Mortgages and charges, £25,000. (A further 2,000 preference shares were allotted for cash between April 30 and May 18.)

METROPOLITAN ELECTRIC SUPPLY CO. (LTD.)—In return to March 24 capital is £1,500,000 in 200,000 ordinary and 100,000 preference shares of £5 each, of which 200,000 ordinary and 76,121 preference have been taken up. £5 per share has been called up on 195,936 ordinary and 76,121 preference and £1,360,285 has been received. £20,320 is considered as paid on 4,064 ordinary. Mortgages and charges, £468,000.

CITY NOTES.

MEMORANDA (May 28).—Bank rate 2½ per cent. (May 28, 1908). Price of silver 24⅜d per oz. Consols 87¼—87⅜ for money and 87¼—87⅜ for account. Consols Pay Day, June 1; Stock and Shares Continuation Days, June 10 and 24; Ticket Day, June 11; Pay Days, May 29 and June 12; Mining Share carry-over Day, June 9.

PRICES OF METALS (London).—*Copper*, cash, 57¼—57½; three months 57¾—58. *Lead*, English, 13—13¼; foreign, 12⅞—13. *Spelter*, foreign 19. *Tin*, English, 127½—128½; foreign, cash, 127—127½, three months, 126—126½. *Iron*, Cleveland, cash, 49/9—49/10½; three months, 49/6—49/9.

BRITISH COLUMBIA ELECTRIC RAILWAY CO. (LTD.)—An interim dividend on the preferred ordinary stock will be paid on 30th inst. at the rate of 5 per cent. for the half-year ended March 31, with an additional dividend at the rate of 1 per cent. for the nine months ended same date.

GLOBE TELEGRAPH & TRUST CO. (LTD.)—The directors have declared a final dividend of 3s. per share on the preference and 5s. 9d. on the ordinary shares, making a total for the year of 6 per cent. on the preference and 5¾ per cent. on the ordinary shares, carrying forward £27,000.

MACKAY COMPANIES.—A regular quarterly dividend of 1 per cent. on the preferred shares and a regular quarterly dividend of 1 per cent. on the common shares in the Mackay companies will be paid on July 1 to shareholders of record as they appear at the close of business on June 13. The transfer books will not be closed.

RIO DE JANEIRO TRAMWAY, LIGHT & POWER CO. (LTD.)—It is announced that the great dam which has been in process of construction for the past two years at Rio was completed on 19th inst. The dam, one of the largest in the world, will store over 6,500 million cubic ft. of water, sufficient to operate the entire plant of 50,000 H.P. for several months without utilising any of the normal flow of the river Lages.

WESTERN TELEGRAPH CO. (LTD.)—The directors have declared the third quarterly interim dividend of 3s. per share (tax free) for the year ending June 30, being at the rate of 6 per cent. per annum. The transfer books will be closed from June 17 to 23 inclusive, and the dividend will be payable on June 24.

STOCK EXCHANGE NOTICES.—The Stock Exchange committee have appointed June 4 a special settling day in scrip, fully paid, for $1,500,000 $100 7 per cent. cumulative convertible preference shares of the *Mexican Light & Power Co. (Ltd.)*, and have ordered a further issue of 20,000 £5 fully-paid ordinary and 20,000 £5 fully-paid cumulative preference shares of the *British Aluminium Co. (Ltd.)* to be quoted. The committee have been asked to appoint a special settling day in and grant a quotation for a further issue of £100,000 preferred ordinary stock of the *British Columbia Electric Railway Co. (Ltd.)*, and also to grant quotations to $6,000,000 additional general consolidated first mortgage 50 year 5 per cent. gold bonds of the *Mexico Tramways Co.*, and £160,000 4½ per cent. sterling debentures in lieu of scrip now quoted of the *Montreal Street Railway Co.*

ELECTRIC TRAMWAY AND RAILWAY TRAFFIC RECEIPTS.

Line	Week ended.	Amount.	Inc. or Dec. (a)	Aggregate No. of weeks.	Aggregate Amount.	Aggregate Inc. or Dec. (a)
		£	£		£	£
Aberdeen Corporation	May 20	1,390	+ 85	51	68,743	– 1,231
Airdrie	,, 15	225	– 9	19	4,258	+ 53
Anglo-Argentine	,, 20	18,483	+ 964	20	370,818	+ 40,227
Ayr Corporation	,, 23	294	+ 8	1	294	+ 8
Baker St. & Waterloo Ry.	,, 23	2,775	+ 195	21	64,455	+ 14,801
Barnsley	,, 15	179	+ 8	19	3,288	+ 212
Barrow	,, 15	226	– 5	19	4,272	+ 33
Bath Electric Trams, Ltd.	,, 20	745	– 94	20	12,545	– 1,288
Birkenhead Corporation	,, 24	1,040	– 57	...	...	...
Birmingham Corporation	,, 23	2,415	– 511	8	48,522	+ 1,189
Birmingham & Mid.	,, 8	776	– 34	18	14,501	+ 758
Blackburn Corporation	,, 20	1,123	– 225	8	9,255	+ 97
Blackpool Corporation	,, 21	547	– 1,210	§7	5,447	– 126
Blackpool and Fleetwood	,, 23	375	– 1,128	...	...	...
Bolton Corporation	,, 24	2,344	– 649	8	18,508	+ 552
Bombay	April 30	R35,990	+ R8,068	17	R618,078	+ R115,930
Bournemouth Corporation	May 20	1,472	– 612	7	11,736	– 1,115
Bradford Corporation	,, 23	4,839	– 629	8	35,701	+ 1,495
Brighton Corporation	,, 21	837	– 380	8	6,282	– 407
Bristol Trams & Carriage	,, 22	4,839	– 1,133	20	93,189	– 4,233
Buenos Ayres & Belgrano	,, 20	3,696	– 204	20	75,904	+ 292
Burnley Corporation	,, 23	1,263	– 106	8	10,245	+ 437
Burton Corporation	,, 24	256	– 72	8	2,031	– 225
Bury Corporation	,, 17	1,290	+ 201	‡7	8,119	+ 1,329
Calcutta Tramways Co.	,, 23	R14,320	– R1,0[illegible]	...	...	...
Camborne-Redruth	...	...	...	...	...	...
Cardiff Corporation	,, 23	2,059	+ 60	7	13,991	+ 3
Cavehill	,, 15	90	+ 3	19	1,452	+ 91
Central London Railway	,, 23	6,518	+ 1,045	21	126,811	– 1,954
Charing C., Euston & H'stead	,, 23	3,200	...	21	67,185	...
Cantham & Dist. Lt. Rys.	,, 21	860	+ 7	§20	13,508	– 183
City & South London Rly.	,, 24	2,804	– 253	21	68,355	+ 6,302
City of Birmingham	,, 15	2,806	– 125	19	52,117	+ 292
Colchester Corporation	...	...	...	...	...	...
Cork Electric Trams Co.	,, 21	473	– 19	§20	8,294	– 491
Croydon Corporation	,, 22	1,575	– 80	8	10,421	– 750
Devonport & Dist. Trams	,, 15	449	+ 3	19	8,297	– 52
Dover Corporation	...	...	...	...	...	...
Dublin & Lucan Railway	,, 22	132	– 38	21	2,169	+ 46
Dublin United	,, 22	5,474	– 1,291	21	99,687	– 1,599
Dudley-Stourbridge	,, 15	776	– 51	19	14,391	– 1,121
Dundee Corporation	,, 20	1,202	+ 102	1	1,202	+ 102
East Ham Council	,, 23	880	– 203	8	6,381	– 616
Exeter Corporation	,, 22	302	– 102	8	2,211	– 271
Gateshead & Dist. Trams	,, 15	983	– 43	19	18,946	+ 231
Glasgow Corporation	,, 23	18,218	+ 26	51	886,932	+ 14,066
Glossop	...	...	...	...	...	...
Gravesend—Northfleet	,, 15	204	– 41	19	3,672	– 557
Great Northern & City Rly.	,, 23	1,551	– 112	21	36,192	– 2,315
Gt. Northern, Piccadilly, &c	,, 23	5,260	+ 960	21	113,720	+ 32,701
Greenock & Port Glasgow	,, 15	520	– 178	19	9,307	– 2,585
Hartlepool Tramways	,, 15	210	– 73	19	4,305	– 838
Hastings Elec. Trams Co.	,, 21	948	– 388	21	16,271	– 544
Hong Kong	,, 23	$7,695	+ $176	...	...	...
Huddersfield Corpn.	,, 23	1,591	– 288	8	12,696	– 294
Hull Corporation	,, 23	2,370	– 205	8	18,480	– 319
Ilford District Council	...	...	...	...	...	...
Ilkeston District Council	,, 20	157	– 26	7	1,116	– 35
Ipswich Corporation	,, 23	389	– 86	8	2,731	– 201
Isle of Thanet Co.	,, 23	444	– 320	34	9,904	– 731
Jarrow	,, 15	106	– 28	19	1,879	– 280
Keighley Corporation	,, 21	157	– 20	47	7,381	+ 295
Kidderminster & District	,, 15	93	– 7	19	1,697	– 155
Kilmarnock Corporation	,, 23	161	– 6	1	161	– 6
Lanarkshire Trams Co.	,, 21	1,402	+ 162	20	25,551	+ 3,209
Lancashire United	,, 20	1,367	– 59	20	24,722	+ 1,160
Leamington	,, 15	142	– 1	19	2,660	+ 41
Leeds Corporation	,, 23	6,609	– 633	8	48,904	+ 822
Leicester Corporation	,, 23	2,317	– 288	...	...	...
Leith Corporation	,, 15	518	+ 23	§52	26,708	+ 328
Lincoln Corporation	,, 23	112	– 17	8	942	+ 23
Liverpool Corporation	,, 16	10,788	– 103	20	205,143	– 2,113
Liverpool Overhead Rly.	,, 21	1,475	– 279	21	29,236	– 750
*London County Council	,, 16	34,285	+ 2,521	†7	214,626	+ 18,478
London United	,, 23	7,691	– 1,444	20	116,869	– 4,131
Lowestoft	,, 23	173	46	34	5,316	+ 39
Maidstone Corporation	,, 23	196	...	8	1,394	...
Manchester Corporation	,, 23	15,549	– 2,320	8	113,696	+ 4,837
Mersey Railway	,, 23	1,855	– 125	21	40,280	+ 1,499
Merthyr	,, 15	195	– 11	19	3,887	+ 28
Metropolitan Dist. Railway	,, 23	8,885	+ 756	21	186,424	+ 20,271
Metropolitan Elec. Trams	,, 15	5 823	+ 830	19	96,004	+ 17,515
Middleton	,, 15	370	+ 2	19	6,241	+ 80
Nelson Corporation	,, 23	140	– 12	¶7	1,034	– 149
Newcastle-on-Tyne Corp.	,, 23	3,643	– 563	8	28,922	– 3,435
Newport (Mon.)	,, 23	635	– 272	8	5,129	– 208
Oldham, Ashton & Hyde	,, 15	602	– 8	19	11,144	– 3
Oldham Corporation	,, 24	2,001	+ 32	8	17,269	– 169
Perth (N.B.) Corporation	...	...	...	...	...	...
Perth (W.A.) Elec. Trams	,, 22	1,407	+ 175	¶21	29,673	– 852
Peterborough	,, 15	125	– 11	19	2,094	– 52
Portsmouth Corporation	,, 23	1,906	– 425	8	13,988	– 1,11[illegible]
Potteries	,, 15	1,795	– 65	19	34,951	+ 434
Preston Corporation	,, 20	726	– 296	21	14,319	– 467
Rotherham Corporation	,, 21	619	– 166	§7	4,402	– 173
Rothesay	,, 15	101	– 15	19	1,625	– 135
Salford Corpn.	,, 25	4,169	– 1,642	8	36,305	– 2,186
Sheerness	,, 13	51	– 2	19	948	– 16
Sheffield Corporation	,, 24	5,694	– 267	†9	47,593	– 1,753
Singapore Trams	,, 23	$8,902	– $838	...	...	...
Southend Corporation	,, 20	373	– 100	8	2,487	– 74
South Metropolitan	,, 15	791	– 12	19	13,217	– 287
Southport Tramways	,, 15	261	– 5	19	4,220	– 358
South Staffs	,, 15	847	– 33	19	16,481	– 210
Stalybridge, Hyde, &c., Jt. Bd.	,, 16	735	– 32	†7	5,126	– 55
Sunderland Corporation	,, 24	1,111	– 462	8	10,936	– 2,299
Sunderland and District	,, 20	455	– 164	20	13,132	+ 1,036
Swansea Trams	,, 15	880	+ 10	19	16,599	+ 1,222
Taunton	,, 15	39	...	19	737	– 25
Tynemouth and District	,, 15	181	– 30	19	2,890	– 362
Tyneside Trams Co.	,, 20	389	– 116	21	7,387	– 1,196
Wallasey District Council	,, 23	883	– 107	†7	6,414	+ 7
Walsall Corpn.	,, 23	541	– 133	21	10,793	+ 1,000
Warrington Corpn.	,, 21	375	– 12	7	2,758	+ 57
West Ham Corporation	,, 21	2,262	– 335	8	17,269	– 1,976
Weston-super-Mare	,, 13	85	+ 5	19	815	– 98
Wolverhampton Co.	,, 15	431	– 32	19	8,433	– 119
Wolverhampton Corpn.	,, 20	804	– 558	50	36,111	...
*Worcester	,, 15	266	+ 2	19	4,696	– 50
Wrexham	,, 15	162	+ 5	19	1,938	+ 1
Yorkshire W.R. Trams	,, 24	1,180	– 397	21	23,539	...
Yorkshire Woollen District.	,, 15	937	– 65	19	16,968	– 756

(a) These comparisons are with the corresponding period last year. § Plus 2 days. ¶ Plus 3 days. * Partly electrical. † Minus 3 days. ‡ Minus 2 days.

ELECTRICAL COMPANIES' SHARE LIST.

Shre.	Last Dividend	Name.	Price Wed., May 27.	Rate % Yielded. £ s. d.	Dividend Due.	Business Week to May 27. Highest.	Lowest.
		ELECTRICITY SUPPLY.					
10	9 0	Bournemouth & Poole Elec. Sup. Ord.	10½–11	6 7 0	Mar, Sept,	..	..
10	4 6	Do. 4½ per Cent. Cum. Pref.	9½–10½	4 7 0	Feb, Aug	..	..
10	6 0	Do. 6 per Cent. Cum. Second Pref.	10½–11	5 9 0	Feb, Aug	..	..
St.	4½%	Do. 4½ per Cent. Deb. Stock (red.)	102–105	4 5 6	Jan, July	104½	104
5	3 6	Bromley (Kent) El. Lt. & Power Shares	4½–5	5 19 0	April, Oct	..	..
St.	4½%	Do. Do. 1st Debs.	94–97	4 12 9	May, Nov	..	..
5	5 6	Brompton & Kensington Elec. Sup. Ord.	6¾–7¼	6 0 0	March	6¾	..
5	3 6	Do. 7 per Cent. Pref.	6¾–7¾	4 10 0	Mar, Sept	..	..
St.	4%	Central Elec. Sup. Co. 4% Guar. Db. Stock	99–102	3 18 6	June, Dec	..	..
5	2 6	Charing Cross (W. End & City) El. Sup. Co.	3½–3¾	6 13 0	Feb, Aug	3½	..
5	2 3	Do. 4½ per Cent. Pref.	4½–4¾	4 17 0	Feb, Aug	4⅝	4½
St.	4%	Do. 4 per Cent. Deb. Stock (red.)	96–99	4 1 0	Jan, July	97½	97
5	2 3	Do. City Undertaking 4½% Cm. Pref.	3¾–4¼	5 8 6	Jan, July	..	..
5	2/6	Chelsea Electric Supply Ord.	3–3½	6 8 9	March	..	..
St.	4½%	* Do. 4½ per Cent. Deb. Stock (red.)	101–104	4 6 9	June, Dec	..	..
10	7 0	City of London Electric Lighting Ord.	9–10	6 0 0	Feb, Aug	9½	9¼
10	6/0	Do. 6 per Cent. Cum. Pref.	12–13	4 12 0	Jan, July	12½	..
St.	5%	Do. 5 per Cent. Deb. Stock (red.)	124–127	3 18 0	June, Dec	..	
St.	4½%	Do. 4½ per Cent. 2nd Deb. Stock (red.)	102–105	4 6 0	Jan, July	..	..
5	1/10½	County of Durham Elec. P. D. Ord.	2¾–3	3 9 7	April, Oct	..	..
5	5%	Do. 5 per Cent. non Cum. Pref.	3⅞–4½	3 9 7	April, Oct	..	..
10	6 0	County of London Elec. Supply Ord.	7½–8½	6 3 6	Feb, Aug	..	..
10	6 0	Do. 6 per Cent. Cum. Pref.	10⅞–12⅞	5 2 0	Mar, Sept	10[illegible]	..
St.	4½%	Do. 4½% Deb. Stock (all paid) (red.)	107–110	4 2 6	Jan, July	..	..
St.	4½%	Do. Second Deb. Stock Prov. Certs.	96–99	4 11 0	May, Nov	98	..
5	3 6	Folkestone Electricity Supply Co. Ord.	4¾–5½	5 7 0	April, Oct	..	..
5	2 6	Do. 5 per Cent. Cum. Pref.	5–5½	4 11 0	Mar, Sept	..	..
St.	4½%	Do. 4½ 1st Deb. Stock (red)	94–97	4 13 0	Feb, Aug	..	..
5	4 6	Hove Electric Lighting Ord.	6⅛–6⅝	6 9 0	April, Oct	..	..
5	5/0	Kensington & Knightsbridge Ord.	7–8	6 5 0	Feb, Aug	..	..
5	6%	Do. 6 per Cent. 1st Pref.	6–6½	4 12 0	Jan, July	..	..
St.	4%	Do. 4 per Cent. Deb. Stock (red.)	96–99	4 1 0	..	..	—
St.	4%	Kensingtn. & Kngtbg. Co. & Notting Hill Co. (Joint Station) 4% Deb. Stock (red.)	97–101	3 19 0	April, Oct	..	..
St.	4½%	Kent Elec. Power Co.	88–92	4 18 3	Jan, July	..	..
3	1/6	London Electric Supply Ord.	¾–1¼	6 0 0	Mar, Sept	1¼	..
5	3/0	Do. 6 per Cent. Pref.	4¼–4¾	6 6 0	Mar, Sept	..	..
St.	4%	Do. 4 per Cent. 1st Mort. Deb.	90–93	4 8 0	Jan, July	..	..
5	3/6	Metropolitan Electric Sup. Ord.	4⅜–4⅞	6 16 0	April, Oct	4½	..
5	2/3	Do. 4½ per Cent. Cum. Pref.	4⅜–4⅞	4 12 0	Jan, July	4⅝	..
St.	4½%	Do. 4½ per Cent. Deb. Stock 1st Mort.	107–111	4 1 0	June, Dec	..	..
St.	3½%	Do. 3½ per Cent. Mrt. Deb. Stock (red.)	85–90	3 18 0	Jan, July	..	..
100	4½%	Midland Elec. Corp. for P. D. 1st Mort. Db.	96–99	4 11 0	June, Dec	97½	97½
10	4%	Newcastle & Dist. Elec. Ltg. Ord.	7¾–8¼	5 0 0	Feb, Aug	..	—
100	4½%	Do. 4½ per Cent. Deb.	94–98	4 12 9	Jan, July	..	..
5	8%	Newcastle Elec. Supply Ord.	5⅝–5⅞	6 19 2	Feb, Aug	5¾	..
5	5%	Do. 5 per Cent. non Cum. Pref.	5⅜–5⅝	4 15 3	Feb, Aug	..	..
100	4%	Do. 4 per Cent. Mort. Deb. red. 1907.	96–98	4 2 6	Jan, July	..	..
1	3%	Northern Counties Elec. Sup.	—	..	Mar, Aug	..	..
100	4½%	Do. 4½ per Cent. Deb.	95–97	4 13 9	Jan, July	..	..
10	8/0	Notting Hill Electric Ord.	11½–12½	5 14 0	March	..	..
5	4/6	Oxford Electric Ord.	5¾–6¼	5 12 0	March	7⅛	..
St.	4%	Do. 4 per Cent. Deb. Stock	94–98	4 1 6	Jan, July	..	..
5	5/0	St. James' & Pall Mall Elec. Ord.	7½–8½	6 1 3	Feb, Aug	7⅝	..
5	3/6	Do. 7 per Cent. Pref.	6½–7½	4 16 6	Feb, Aug	..	..
St.	3½%	Do. 3½ per Cent. Deb. Stock (red.)	85–90	3 17 9	Jan, July	..	..
5	..	Smithfield Markets Electric Sup. Ord.	½–¾	..	Feb	..	..
St.	4%	Do. 4 per Cent. Deb. Stock	70–74	5 8 0	Feb, Aug	..	..
5	4/0	South London Electric Supply Ord.	2¼–2¾	7 6 0	April	2⅜	2⅜
1	0/6	South Metrop'n Elec. Lt. & Power Ord.	⅜–⅝	4 0 0	..	..	..
1	0/8⅜	Do. 7 per Cent. Cum. Pref.	1⅛–1⅜	5 6 0	Feb, Aug	..	..
St.	4½%	Do. 4½ 1st Db. Stk. Red.	99–102	4 8 0	April, Oct	..	..
5	2/6	Urban Electric Supply Ord.	1–2	12 10 0	April, Oct	..	..
5	2/6	Do. 5 per Cent. Cum. Pref.	1⅞–2⅛	11 14 0	April, Oct	..	..
St.	4½%	Do. 4½ per Cent. 1st Mort. Deb.	87–90	5 0 0	April, Oct	..	..
5	5/0	Westminster Elec. Sup. Ord.	7½–8	6 5 0	Mar, Sept	7¾	7½
5	2/3	Do. 4½ per Cent. Cum. Pref.	4¾–5¼	4 5 6	Jan, July	..	—
		ELECTRIC RAILWAYS, TRAMWAYS, &c.					
St.	4%	Baker St. & Waterloo 4% Perp. Db. St.	88–91	4 8 0	Jan, July	90½	—
1	..	Bath Elec. Trams Pref. Ord.	⅜–⅝	8 0 0	April	..	—
1	0/6	Do. 5 per Cent. Cum. Pref.	⅝–⅞	5 14 0	Jan, July	..	..
St.	4½%	Do. 4½ 1st Mort. Deb. Stock (red.)	85–90	5 0 0	April, Oct		..
St.	4½%	B'ham & Midland Trams 4½ 1st Db. Stk.	93–96	4 15 0	Jan, July	94½	94
10	9%	Bristol Tramways & Carriage Ord.	10–10½	8 11 9	Feb, Aug	..	..
10	4%	Do. Cum. Pref. (fully paid)	8–8½	4 14 0	..	..	..
St.	4%	Do. 4 per Cent. Debs.	99–100	4 0 0	Feb, Aug	..	..
10	..	British Electric Traction Ord.	1½–1¾	..	June, Dec	1¼	1¼
10	6/0	Do. 6 per Cent. Cum. Pref.	3½–4½	..	Feb, Aug	3¾	3½
St.	5%	Do. 5 per Cent. Perpetual Debs.	89–91	5 6 0	April, Oct	92	89½
St.	4½%	Do. 4½ per Cent. 2nd Deb. Stock	69–73	6 3 0	May, Nov	..	..
St.	3%	Central London Ordinary Stock	79–82	3 13 0	Feb, Aug	81½	79
St.	4%	Do. 4 per Cent. Pref. Stock	90–92	4 7 0	Feb, Aug	91½	90
St.	2%	Do. Deferred Stock	62–65	3 1 6	Feb	65	64½
100	4%	Do. 4 per Cent. Debs.	100–103	3 18 0	Jan, July	102	100½
St	4%	Charing X, Euston & Hmpstd Per. Db. Stk.	81–84	4 15 3	Jan, July	84½	..
5	2/6	City of Birmingham Trams. 5% Cm. Pref.	4¼–4¾	5 5 0	April, Oct	..	..
100	4%	Do. 4 per Cent. 1st Mort Debs.	97–100	4 0 0	April, Oct	..	..
St.	1¾%	City & South London Rly. Con. Ord.	39–41	4 5 6	Feb, Aug	40½	39½
St.	5%	Do. 5 per Cent. Perp. Pref. (1891)	113–116	4 6 0	Feb, Aug	..	..
St.	5%	Do. (1896)	112–115	4 7 0	Feb, Aug	..	..
St.	5%	Do. (1901)	110–113	4 8 6	Feb, Aug	..	..
St.	5	Do. (1903)	106–109	4 11 6	Feb, Aug	106	..
St.	4%	Do. 4 per Cent. Perpetual Debs.	100–103	3 17 6	May, Nov	..	..
10	7/0	Dublin United Trams. Ord	12¼–13¼	4 10 6	Feb, Aug	..	..
10	6/0	Do. 6 per Cent. Pref.	12½–13½	4 9 0	Feb, Aug	..	..
10	..	Gt. Northern & City Rly. Pref. Ord. (4%)	¾–1¼	..	Feb, Aug	1	..
10	4/0	G. Northern, Piccadilly & Brompton Ord.	6–7	5 11 0	Feb, Aug		..
St.	4%	Do. 4 per Cent. Deb. Stock	86–90	4 9 0	Jan, July	88½	87½
5	4/0	Hastings & Dist. Elec. Trams. 6% Cm. Pf.	3¾–4¼	7 1 0	Mar, Sept	..	..
St.	4½%	Do. 4½ Db. St.	94–97	4 12 6	April, Oct	..	..
10	9%	‡ Imperial Tramways Ord.	10½–11½	7 17 0	Mar, Sept	..	..
10	6%	‡ Do. 6 per Cent. Pref.	9½–10½	5 17 0	Mar, Sept	..	..
St.	4½%	‡ Do. 4½ per Cent. Debs.	93–94	4 15 9	Jan, July	..	..
5	..	I. of Thanet E. T. & Lt. 5 per Cent. Pref.	⅞–1⅛	..	Mar, Sept	..	..
St.	4%	Do. 4 per Cent. Deb. Stock	58–63	6 7 0	Jan, July	..	..
10	6/0	Lanarkshire Tramways	9¾–10	5 19 0	Feb, Aug	..	..
St.	5%	Lancs. Utd. Trams 5% Prior Lien Db. St.	91–94	5 6 0	Jan, July	92	..
10	..	Liverpool Overhead Railway Ord.	1⅛–1½	..	Feb, Aug	..	..
10	5%	Do. 5 per Cent. Pref.	6½–6¾	7 10 0	Feb, Aug	..	..
St.	4%	Do. 4 per Cent. Deb.	85–87	4 11 0	Jan, July	..	..
10	5/0	London United Trams. 5% Cum. Pref.	7–8	6 5 0	Jan, July	7¼	7¼
St.	4%	Do. 4 per Cent. 1st Mort. Deb. Stock	80–85	4 14 0	Jan, July	80½	..
St.	..	Mersey Con. Ord. Stock	1–3	—	Feb, Aug.	..	..
St.	..	Do. 3 per Cent. Perp. Pref.	3–6	—	..	..	..
1	..	Metropolitan Elec. Tramways Def.	¼–½	—	April	..	..
1	0/6	Do. 5 per Cent. Cum. Pref.	⅞–1⅛	6 3 6	Feb, Aug		..
St.	4½%	Do. 4½ per Cent. Deb. Stock	94–97	4 12 6	Jan, July	95	95
St.	½%	Metropolitan Railway Consolidated	43½–44½	1 2 6	Feb, Aug	45	43½
St.	2½%	Do. Surplus Lands Stocks	65–68	4 1 6	Feb, Aug	67½	67
St.	3½	Do. 3½ per Cent. Preference	86–89	3 19 9	Feb, Aug	87	85½
St.	3½	Do. 3½ per Cent. "A" Preference	75–78	4 9 6	Feb, Aug	77½	..
St.	3½%	Do. 3½ per Cent. Convertible Pref.	73–76	4 13 0	Feb, Aug		..
St.	3½	Do. 3½ per Cent. Debenture Stock	91–94	3 14 6	Jan, July	93	91½
St.	3½	Do. 3½ per Cent. "A" Ditto	89–92	3 16 0	Jan, July	..	..

* In calculating the yield allowance has been made for accrued interest but *not* for redemption.
† Ex Dividend

ELECTRICAL COMPANIES' SHARE LIST.—*Continued.*

ELECTRIC RAILWAYS & TRAMWAYS—*Continued.*

Share.	Last Dividend	Name.	Price Wed., May 27.	Rate % Yielded. £ s. d.	Dividend Due.	Business Week to May 27. Highest.	Lowest.
St.	..	Metropolitan District Railway Ord.	13 —14	..	Feb, Aug	13½	13
St	..	Do. Extension Pref. (5 per Cent.)	20 —25	..	Feb, Aug	..	..
St.	3½%	Do. Assented Ext. Pref. (Int. Guar. by Und. Elec. Rlys. Co. of London, Ltd.)	44 —48	7 6 0	Feb, Aug	..	..
St	3%	Do. 3 per Cent. Consoltd. Rent-charge	70 —75	4 0 0	Jan, July	72	..
St	4%	Do. 4 per Cent. Midland Rent-charge	100 —104	3 17 0	Jan, July	102½	..
St	1¾	Do. Guar. Stock 4 per Cent	42 —47	3 13 0	Mar, Sept	..	..
St.	6%	Do. 6 per Cent. Perp. Deb. Stock	114 —119	5 1 0	Jan, July	119	117
St.	4	Do. 4 per Cent. Ditto	70 —75	5 6 8	Jan, July	75	70
5	..	New Gen. Tract. 6 per Cent. Cum. Pref.	½—1	..	May	..	—
1	0/9⅝	†Potteries Electric Traction Ord.	¼—½	8 0 0	April, Oct	..	—
1	0/6	Do. 5 per Cent. Cum. Pref.	½—¾	6 13 0	Feb, Aug	..	..
St.	4½%	† Do. 4½ per Cent. Deb. Stock	91 —94	4 16 0	May, Nov	..	..
1	0/7½	S. Met. Elec. Trams. & Ltg. 6% Cm. Pref.	¾—1	6 0 0	Feb, Aug	..	..
St.	4%	Do. 4 per Cent. Deb. Stock	76 —80	5 0 0	Jan, July	..	..
100	5%	Sunderland Dist. Elec. Trms. 5% 1st Mt. Db.	73 —78	6 8 0	Jan, July	..	..
..	5%	Underground Elec. Rys. Co. of London	39 —43	11 12 0	June, Dec	*41⅛	40
5	..	Yorkshire (W.R.) Elec. Trams. Ord.	1 —1½	—	March ..	..	..
5	..	Do. 6 per Cent. Cum. Pref.	3½—3⅝	—	..	..	..
St.	4½	Do. 4½ per Cent. 1st Debs.	84 —87	5 3 6	Jan, July	.	..

ELECTRIC MANUFACTURING, &c.

Share.	Last Dividend	Name.	Price Wed., May 27.	Rate % Yielded. £ s. d.	Dividend Due.	Highest.	Lowest.
1	..	Aron Electricity Meter Ord.	3/16—5/16	..	..	..	..
1	1/9⅝	Do. 6% Cum. Pf.	1 1/16—1 3/16	7 7 6	April, Oct	..	..
1	2/4½	Babcock & Wilcox Ord.	3⅝—3⅞	5 3 3	April, Oct	3 11/16	3 11/16
1	0/7½	Do. Pref.	1 7/16—1 9/16	3 16 9	..	.	..
5	6/0	British Insulated & Helsby Cables Ord.	6⅛—6⅝	7 10 6	July, Feb	6¼	..
5	3/0	Do. 6 per Cent. Pref.	5⅝—6⅛	4 18 0	Jan, July	..	..
St.	4½%	Do. 4½ per Cent. 1st Mort. Deb. (red.)	102 —105	4 5 6	Jan, July	.	..
St.	4½%	British Thoms'n-Houst'n 4½% 1st Mt. Db.	93 —98	4 12 0	Mar, Sept	..	..
5	..	British Westinghouse 6 per Cent. Pref.	7/16—11/16	..	Feb, Aug	..	..
St.	4%	Do. 4 per Cent. Mort. Deb. Stock	46 —50	8 0 0	Jan, July	..	..
2	..	Brush Electrical Engineering	½	—	March ..	..	..
2	..	Do. 6 per Cent. Pref. non-Cum.	3/16—7/16	..	Mar, Sept	..	..
St.	4½%	Do. 4½ per Cent. Perp. 1st Deb. Stock	70 —75	6 0 0	Mar, Sept	..	—
St.	4½%	Do. Perpetual 2nd Deb. Stock	55 —60	7 10 0	Jan, July	..	..
5	5/0	Callender's Cable Con. Ord.	10 —11	6 16 0	Jan, July	..	..
5	2/6	Do. 5 per Cent. Cum. Pref.	5¼—5¾	4 7 0	Jan, July	5⅝	5⅝
St.	4½%	Do. 4½ per Cent. 1st Mort Debs. (red.)	107 —109	4 2 0	Nov, May	..	..
1	1/7½	Castner-Kellner Alkali Co.	1 5/16—1 7/16	8 11 0	May, Nov	1⅜	..
St.	4½%	Do. 4½ per Cent. 1st Mort. Deb. (red.)	101 —104	4 6 6	Feb. Aug	..	..
1	0/9⅝	Chadburn's (Ship) Telegraph Ord.	1 1/16—1 3/16	8 8 0	March ..	..	..
1	0/7½	Do. 6 per Cent. Cum. Pref.	1 —1⅛	5 6 6	April, Oct	..	..
1	0/8⅝	Consolidated Electrical Co.	¼—½	7 0 0	August ...	13/32	..
1	1/0	Consolidated Signal Co.	1½—1¾	4 5 6	April, Oct	..	..
1	0/7½	Do. 6 per Cent. Cum. Pref.	29/32—31/32	6 4 0	April, Oct	..	..
3	3/0	* Crompton & Co. (Nos. 1 to 86,000)	1⅛—1¼	8 6 6	Jan, July	..	..
100	5%	Do. 5 per Cent. 1st Mort. Debs. (red.)	92 —96	5 5 0	Jan, July	..	..
1	0/7½	Davis & Timmins	⅞—1⅛	..	Mar, Sept	..	..
5	2/0	Dick, Kerr & Co. Ord.	1 1/16—1 5/16	7 12 3	Sept	..	..
5	0/7½	Do. 6 per Cent. Cum. Pref.	1 —1¼	4 16 0	Sept	..	..
St.	4½%	Do. 4½ per Cent. Deb. Stock	100 —103	4 7 3	Jan, July	..	—
5	2/6	Edison & Swan United ("A" Sh.) (£3 pd.)	½—¾	..	Feb, Aug	⅝	..
5	4/2	Do. (£5 paid)	1½—2½	5 0 0	Feb, Aug	..	—
St.	4%	Do. 4 per Cent. Mort. Deb. Stock (rd.)	78 —81	4 19 3	June, Dec	..	..
St.	5%	Do. 5 per Cent. 2nd Deb. Stock	85 —87	5 15 0	Mar, Sept	—	..
5	..	Edmundson's Elec. Corp. Ord.	⅛—⅜	..	Jan, July	..	..
5	..	Do. 6 per Cent. Cum. Pref.	½—1	..	May, Nov	..	..
St.	4½%	Do. 4½ per cent. 1st Mort. Deb. (red.)	65 —75	6 0 0	Jan, July	67	..
2	..	Electric Construction Co.	¼—½	..	Jan, July	..	..
2	..	Do. 7 per Cent. Cum. Pref.	1¼—1¾	..	July	..	..
St.	4%	Do. 4 per Cent. Perp. 1st Mort. Debs.	64 —68	5 17 0	Jan, July	..	..
10	5/0	General Electric (1900) 5% Cum. Pref.	7¾—8¼	6 1 8	June, Dec	..	..
St.	4%	Do. 4 per Cent. 1st Mort. Debs.	87 —90	4 9 0	Mar, Sept	..	—
5	10/0	Henley's Telegraph Works Ord.	10½—11½	6 10 0	Feb, Aug	11	..
5	2/3	Do. 4½ per Cent. Pref.	4⅞—5⅜	4 3 6	Feb, Aug	5⅛	..
St.	4½%	Do. 4½ per Cent. 1st Mort. Deb. Stock	106½—108½	4 2 6	Mar, Sept	..	..
10	15/0	India Rubber, Gutta Percha, &c., Wrks.	15½—16½	6 2 0	Feb, Aug	15¾	..
100	4%	Do. 4 per Cent. Debs. (red.)	98 —100	4 0 0	April, Oct	..	..
1	2/0	National Elec. Construction Co.	⅝—⅞	..	April	..	..
1	0/8⅝	Richardsons, Westgarth & Co., Ltd. Ord.	7/16—9/16	7 2 0	Nov	..	..
1	0/7½	Do. 6 per Cent. Cum. Pref.	13/16—15/16	6 8 0	May, Nov	..	..
St.	4½%	Do. 4½ per Cent. Perp. Deb. Stock	87 —91	4 19 0	Jan, July	..	..
1	..	Simplex Conduits Ord.	1½	..	..	—	—
5	..	Do. 6 per Cent. Cum. Pref.	5½	..	..	..	..
12	30/0	Telegraph Construction & Maintenance	29 —31	6 11 0	Mar, July	28½	29
100	4%	Do. 4 per Cent. Deb. Bonds (1909)	101 —103	3 17 6	Jan, July	..	..
1	2/0	Vickers, Sons & Maxim, Ltd., Ord.	1 7/32—1 9/32	8 2 6	..	1 9/32	1 9/32
1	0/6	Do. 5 per Cent. non-Cum. Preference	15/16—1 1/16	4 14 6	..	1 1/32	..
St	5%	Do. 5 per Cent. non-Cum. Preferred	102 —106	4 14 3	..	..	..
St.	4%	† Do. 4 per Cent. 1st Mort. Db. Sk. (red)	100 —102	3 18 0	June, Dec	..	..
100	4½%	Do. 4½ per Cent. 2nd Mort. Deb. (red.)	104 —106	4 5 9	June, Dec	..	..
100	.	Do. 5 per Cent. 3rd Mort. Debs. Perp.	100 —102	..	..	101⅜	101⅜
1	6/0	J. G. White & Co. 6 per Cent. Cm. Pref.	7½—8½	7 1 0	..	..	..
5	1/9	Willans & Robinson Ord.	¾—1¼	4 0 0	Apr, Oct	..	..
5	7/0	Do. 6 per Cent. Cum. Pref.	3⅞—4⅞	7 15 0	Apr, Oct	3½	..
100	4%	Do. 4 per Cent. 1st Mort. Debs.	72 —76	5 5 6	May, Nov	..	..

TELEGRAPHS.

Share.	Last Dividend	Name.	Price Wed., May 27.	Rate % Yielded. £ s. d.	Dividend Due.	Highest.	Lowest.
10	..	Amazon Telegraph	2 —3	—	June, Dec	..	—
100	5%	Do. 5 per Cent. Debs. (red.)	81 —87	5 15 0	June, Dec	..	..
St	15/0	Anglo American	58 —61	5 14 6	F,My,Ag,N	58⅝	57
St	30/0	Do. Preferred	102½—104½	5 14 0	F,My,Ag,N	103⅞	101½
St.	1%	Do. Deferred	16 —16½	6 1 6	F,My,Ag,N	16½	15 15/16
St.	4%	Commercial Cable 4 per Cent. Deb. Stk.	84 —87	4 12 0	Jn,Ap,Jy,O	85½	85
10	6/0	Cuba Submarine Ord.	7½—8½	7 5 0	Feb, Aug	8	..
10	10/0	Do. Preference 10 per Cent.	15½—16½	5 19 0	Feb, Aug	..	..
5	2/0	Direct Spanish Ord.	3¼—3¾	5 13 0	April, Oct	..	..
5	5/0	Do. 10 per Cent. Cum. Pref.	8 —9	5 11 0	April, Oct	..	..
50	4½%	Do. 4½ per Cent. Deb.	100 —103	4 7 6	Jan, July	..	..
20	4/0	Direct United States Cable	13½—14	6 11 6	Ja,Ap,Jy,O	13¾	13¾
100	4½%	Direct West India Cable 4½% Rg. Db. (rd.	100 —102	4 8 0	June, Dec	..	..
St.	65/0	†Eastern Ordinary ... ed & bonus	130 —135	5 5 0	Ja,Ap,Jy,O	132½	131¼
St	17/6	† Do. 3½ per Cent. Pref. Stock	84 —87	4 1 6	Ja,Ap,Jy,O	85¾	84
St	4%	Do. 4 per Cent. Mort. Deb. Stk. (red.)	100 —102	3 18 6	May, Nov	101¼	100½
10	6/6	†Eastern Extension ... ed & bonus	12¾—13¼	5 6 0	Ja,Ap,Jy,O	13½	12¾
St	4%	Do. 4 per Cent. Deb. Stock	100 —102	3 15 6	Feb, Aug	101⅛	100¾
100	4%	Eastern & S. African 4% Mort. Deb. 1909	100 —102	3 18 6	Feb, Aug	..	..
25	4%	Do. 4% Mauritius Sub. Debs. red.	99 —101½	3 19 0	May, Nov	..	..
10	[illegible]	G. N. of Copenhagen with Coupon 73	28 —30	6 13 4	Jan, July	30½	28¾
100	[illegible]	Halifax & Bermudas 4½% 1st Mt. Db. red.	100 —102	4 8 0	June, Dec	..	..
..	[illegible]	Do. European, F...	53 —56	5 12 6	May, Nov	64⅛	63½
100	$1	Mackay Companies Common	58 —63	6 7 0	Ja,Ap,Jy,O	..	..
100	$1	Do. Preferred	62 —66	6 0 0	Ja,Ap,Jy,O	..	..
1	..	Marconi's Wireless Telg. Co.	⅜—¾	..	April	..	..
100	4%	Pacific & European Tel. 4% Guar. Dbs. red.	98 —101½	3 18 6	June, Dec	.	—
2½	1/3	†West Coast of America	1⅛—1¼	3 17 0	May	..	..
100	4%	Do. 4 per Cent. Debs.	99 —102	3 18 0	Jan, July	..	..
10		West India & Panama	[illegible]	..	May, Nov	[illegible]	[illegible]
10	6/0	Do. 6 per Cent. 1st Pref.	8½—9	6 13 0	May, Nov	8½	..
10	0/0	Do. 6 per Cent. 2nd Pref. ...	9 —10	..	May, Nov	9½	..
100	..	Do. 5 per Cent. Debs.	101 —104	4 16 0	Jan, July	.	..
10	[illegible]	Western Telegraph	13¼—13¾	6 1 0	Mr,Je,S,D	13½	13½
[illegible]		Do. 4 per Cent. Deb. Stock (red.)	100 —102	3 18 6	June, Dec		
..	4%	†West... [illegible]	[illegible]	5 .. 0	..	.	..

TELEPHONES.

Share.	Last Dividend	Name.	Price Wed., May 27.	Rate % Yielded. £ s. d.	Dividend Due.	Highest.	Lowest.
100	2$	Amer. Telephn. & Telegh. Cap. St.	118 —122	6 14 6	..	..	..
..	4%	Do. Coll. Trust $1,000 4 per Cent. Bds	84 —87	4 12 0	Jan, July	85¾	..
St.	5%	Anglo-Portug'se Tel. 5% 1st Mt. Db. Stk.	101½—101½	4 19 0	Mar, Sept	.	—
5	3/0	Chili Telephone	7 —7½	5 6 6	August ..	7¼	..
1	0/7½	Monte Video Telephone Ord.	27/32—1 1/32	6 16 0	Nov	..	..
1	0/6	Do. 5 per Cent. Pref.	13/16—15/16	5 7 0	May, Nov	..	..
St.	6%	National Co. Pref. Stock	108 —110	5 9 0	Feb, Aug	109½	108
St.	6%	Do. Def. Stock	109½—111½	5 7 6	Feb, Aug	111¼	110
10	6/0	Do. 6 per Cent. Cum. 1st Pref.	11½—12½	4 16 0	Feb, Aug	..	..
10	6/0	Do. 6 per Cent. Cum. 2nd Pref.	11½—12½	4 16 0	Feb, Aug	..	..
5	2/6	Do. 5 per Cent. non-Cum. 3rd Pref.	5⅛—5⅝	4 9 0	Feb, Aug	5⅛	5⅛
St.	3½%	* Do. Deb. Stock 3½ per Cent. (red.)	99 —101	3 9 0	June, Dec	98½	..
St	4%	Do. 4 per Cent. Deb. Stock (red.)	101½—102½	3 17 0	Jan, July	102¼	102
1	1/0	†Oriental	1 3/16—1 5/16	5 7 6	April, Oct	1 3/16	..
1	0/7½	† Do. 6 per Cent. Cum. Pref.	1⅛—1¼	4 16 0	April, Oct	..	..
St.	4%	Do. 4 per Cent. Red. Deb. Stock	90 —93	4 6 0	Jan, July	..	..
St.	4½%	Telephone Co. of Egypt 4½% Db. Stk. (red.)	99 —102	4 8 0	Jan, July	101½	—
5	3/9	United River Plate	6¼—6¾	5 18 6	July	6½	..
5	2/6	Do. 5 per Cent. Cum. Pref.	4⅞—5⅜	4 13 6	June, Dec	..	..
St.	4½%	Do. 4½ Deb. St. Red.	100 —102	4 8 0	Jan, July	101½	101

FINANCIAL, INVESTMENT, &c.

Share.	Last Dividend	Name.	Price Wed., May 27.	Rate % Yielded. £ s. d.	Dividend Due.	Highest.	Lowest.
5	3/0	Elec. & Gen. Investment 6% Cum. Pref.	3¾—4¼	7 1 0	Jan, July	..	..
10	2/0	Globe Telegraph & Trust	10—10½	5 5 0	SpDeMrJu	10½	10
10	3/0	Do. 6 per Cent. Pref.	13⅝—14⅛	4 5 0	SpDeMrJu	13 15/16	13⅝
10	6%	Submarine Cables Trust (Cert.)	127 —130	4 12 0	April, Oct	127¼	127

COLONIAL AND FOREIGN ELECTRIC RAILWAYS, TRAMWAYS, &c.

Share.	Last Dividend	Name.	Price Wed., May 27.	Rate % Yielded. £ s. d.	Dividend Due.	Highest.	Lowest.
5	3/0	Anglo-Argentine 6% Cum. 1st Pref.	6¼—6½	4 12 0	April, Oct	6 5/16	6 5/16
5	5/0	Do. 10% Non-cum. 2nd Pref.	7¾—8⅛	6 3 6	Jan, July	8 1/32	7⅞
St.	6%	Do. Permanent 6% Deb. Stock	140 —145	4 2 9	June, Dec	140	..
St.	5%	Auckland Elec. Trams. 5% Deb. (red.)	104 —107	4 13 6	Jan, July	105½	..
5	4/0	Brisbane Electric Trams. Invest. Ord.	3¾—4	2 10 0	May	3⅞	3⅞
5	2/6	Do. 5 per Cent. Cum. Pref.	4¾—5	5 0 0	May, Nov	4 11/16	4⅝
St.	4½%	Do. 4½ per Cent. Db. Prov. Certs.	98 —102	4 8 0	Jan, July	..	..
St.	8%	British Columbia El. Ry. Df. Ord.	132 —135	5 18 6	Mar, Sept	..	..
St.	6%	Do. Pref. Ord. Stock	115 —119	5 1 0	May, Nov	117⅛	117
St.	5%	Do. 5% Cum. Perp. Pref. Stock	108 —112	4 9 0	Jan, July	..	..
40	4½%	Do. 4½ per Cent. 1st Mort. Debs.	99 —102	4 8 0	April, Oct	..	—
100	4½%	Do. Vancouver Power Debs.	101 —104	4 6 6	Jan, July	..	—
St.	4½%	Do. 4½% Perp. Con. Deb. St.	98 —101	3 19 0	..	..	..
5	3/0	Buenos Ayres & Belgrano Ord.	4 11/16—4⅞	8 1 6	April, Oct	*9⅜	9⅜
5	3/0	Do. 6 per Cent. "A" Cum. Pref.	4⅝—5⅛	5 17 6	April, Oct	..	..
5	3/0	Do. "B"	4⅝—5⅛	5 17 6	April	..	..
St.	5%	Do. 5 per Cent. Debs.	110 —116	4 6 0	Jan, July	—	..
St.	5%	Do. 5 per Cent. 2nd Debs. (red.)	102 —105	4 15 3	Jan, July	..	..
St.	5%	Buenos Ayres Elec. Trams (1901) Ltd. Deb. St.	95 —99	5 1 0	Ja, Jul ..	..	—
5	..	Buenos Ayres Grand National Ord.	2½—2⅝	..	..	..	..
5	2/6	Do. 5 per Cent. Cum. Pref.	3¾—4¼	5 18 0	Feb, Aug	..	..
100	5½%	Do. 5½ per Cent. Pref. Debs.	100 —104	5 5 9	Jan, July	..	..
100	6%	Do. 6 per Cent. 1st Deb. Bonds.	98 —102	5 17 0	April, Oct	..	..
St.	5%	Buenos Ayres Lacroze Trams 1st Mt. Db	92 —95	5 5 0	Mar, Sept	..	..
St.	6%	Buenos Ayres Port & City Tram. 1st Mt. Deb. Stock £75 Paid	64 —68	6 12 0	Feb, Aug	..	..
5	2/6	Calcutta Tramways (1 to 137,010)	5¾—6¼	4 9 0	Mar, Sept	5⅞	..
100	2/6	Do. 5 per Cent. Cum. Pref.	5 —5½	4 13 0	Jan, July	5 5/16	5 5/16
1	4½%	Do. 4½% 1st Deb. Stock (red.)	103 —106	4 5 0	Jan, July	..	..
St.	.	Cape Electric Tram Shares	5/16—7/16	..	..	..	—
5	1/3	†City of Buenos Ayres Trams Co. (1904) Sh.	5 7/16—5 11/16	4 8 0	F,My,A,N	5½	5½
St.	4%	Do. 4 per Cent. Deb. Stock	98 —102	3 18 6	June, Dec	..	..
	5%	Colombo Tr. & Ltg. 5% 1st Mt. Db.	88 —91	5 11 0	May, Nov	..	—
100	5%	Electric Traction Co. of Hong Kong 5 per Cent. 1st Mort. Debs.	87 —92	5 8 6	June, Dec	.	..
1	5%	Havana Elec. Ry. Con. Mt. 5% $1,000 50 year Coup. Bds.	80 —85	5 17 6	Feb, Aug	82½	81
1	..	Kalgoorlie Elec. Trams Sh.	—	..	..	..	..
100	5%	Do. 5 per Cent. "A" Deb. Stock	87 —91	5 8 9	Jan, July	..	—
5	6%	Do. 6 per Cent. "B" Ditto	71 —75	7 17 0	Jan, July	..	..
5	1/0	†Lisbon Elec. Trams. Ord.	1 —1¼	4 0 0	July	..	..
100	0/7½	Do. 6 per Cent. Cum. Pref.	1 —1¼	4 16 0	Jan, July	..	—
St.	5%	Do. 5 per Cent. Reg. Mort. Debs.	90 —95	5 5 0	Jan, July	..	..
St.	5%	Madras Elec. Trams. 5% Deb. Stk.	95 —98	5 2 0	Jan, July	..	..
	5%	Manila Elec. Ry. $1,000 Gold Bonds	86 —90	5 11 3	Feb, Aug	..	..
100	$1	Mexico Trams Co. Com. St.	93 —95	4 4 0	..	96	94
500	5%	Do. Gen. Con. 1st Mort. 5% Gold Bds.	88½—89½	5 11 6	..	89	88¾
St.	4½%	Montreal St. Ry. Sterling 4½ per Cent. Debs. (1922)	101 —103	4 7 6	Feb, Aug	..	..
1	1/0	Perth Elec. Trams Ord.	9/16—11/16	7 5 6	May	—	..
St.	5%	Do. 1st Mt. Db. Stock	103 —108	4 14 3	Jan, July	..	—
5	3/0	Rangoon Elec. Trams & Supply Co. 6 Cum. Pf.	5½—5¾	5 4 0	..	..	—
St.	4½	Do. 4½% 1st Mort. Deb. Stk.	97 —99	4 11 0	..	..	..
..	$2½	Sao Paulo Tramway, Light & Power Co. $100 Stock	129 —134	6 14 0	..	132½	131¼
.	5%	Do. 5 per Cent. 1st Mt. $500 Db.	97½—99½	5 0 6	June, Dec	98½	98
100	4½%	Toronto Ry. Co. 1st Mt. 4½% Ster. Bonds	98 —100	4 11 0	Feb, Aug	95	..

COLONIAL AND FOREIGN ELECTRICITY SUPPLY, &c.

Share.	Last Dividend	Name.	Price Wed., May 27.	Rate % Yielded. £ s. d.	Dividend Due.	Highest.	Lowest.
5	3/0	Adelaide Elec. S'ply Co. 6% Cu. Pr.	4⅝—5⅛	5 17 0	Mar, Sept	..	—
10	5/2½	Bombay E. S. & T. 6% Cm. Pf.	10 —10½	5 14 0	..	..	..
St.	4½	Do. 4½ per Cent. Deb. Stk. (red.)	93 —95	4 15 0	Jan, July	95	94
5	3/3	Calcutta Elec. Supply Ord.	6 —7	6 1 6	April, Oct	6 5/16	..
100	7/2	Canadian Gen. Elec. Co. Com. St.	88 —92	10 17 0	..	..	..
100	5%	Castner Electrolytic Alkali Co. (of U.S.A.) 1st Mort. Stl. Debs.	94 —99	5 1 0	Jan, July	.	
500	5	Elect. Development Co. of Ontario	81 —84½	5 19 0	..	83	83
5	..	Elec. Ltg. & Trac. Co. of Aust. 6 per Cent. Cum. Pref.	2½—2¾	..	Feb, Aug	..	..
St.	5%	Do. 5 per Cent. Deb Stock	84 —88	5 14 0	Jan, July	..	..
St.	5%	Elec. Supply Co. of Victoria 5 per Cent. 1st Mort. Deb. St.	90 —93	5 7 6	Jan, July		..
St.	6%	Indian Elec. Sup. & Trac. Co. Deb. St. Rd. Prov. Certs.	95 —98	6 2 0	Jan, July	..	..
10	0/3	†Kalgoorlie Elec. Power & Ltg. Ord.	⅛—¼	..	..	..	..
1	0/7½	† Do. 6 per Cent. Cum. Pref.	¼—¾	8 0 0	April, Oct	..	—
St.	5%	Madras E. S. Corp. 5 per Cent. Constn Deb. St.	88 —90	5 11 0	April, Oct	..	..
500	5%	Mexican Elec. Light Co. 5% 1st Mort. Gold Bonds	79 —81	6 1 6	..	80	79½
St	..	Mexican Lt. & Power Co. Cap. St.	54 —59	..	..	56½	56½
100	5%	Do. 5% 1st Mort. Gold Bonds	84 —86	5 16 0	..	85½	85
100	4/2	†Montreal Lt. Ht. & Power Co. Cap. St.	95 —99	6 1 0	F,My,A,N	95½	95
1	1/[illegible]	River Plate Electricity Co. Ord.	[illegible]	6 8 0	April	..	.
1	1/2½	Do. 6 per Cent. non-Cum. Pref.	[illegible]	6 0 0	May	..	..
St.	5%	Do. 5 per Cent. Deb. Stock	96 —99	5 1 0	Jan, July	98	..
5	[illegible]/0	Rosario Elec. Co. 6% Pref. (1 20,000)	4⅞—5⅛	5 17 6	April, Oct		..
100	[illegible]	[illegible] Water & Power Co. Cap. St.	66—68½	5 18 0	..	68¼	68¼
		Do. 5 per Cent. Bds.	102 —104	4 17 0	Jan, July	102½	102¼
.	[illegible]	Victoria Falls Power Co. Pref.	.	—	Jan, July	..	..

* In calculating the yields allowance has been made for accrued interest but *not* for redemption. † Ex dividend. ‡ The London Stock Exchange Committee have declined to quote these.

CONTENTS.

THE
ELECTRICIAN
INDUSTRIAL SUPPLEMENT.

Electrician No. 1567.
Indust. Suppt. No. 23.
Gratis to Subscribers.

MAY 29, 1908.

The Purchase of Power.

THE generally accepted opinion among manufacturers to-day is that power should be obtained for the driving of productive machinery much in the same way as raw material. This opinion appears to be based on a purely literal interpretation of the term "manufacturer": presumably the man in this position argues that he is entitled to make everything he can. Without committing ourselves to the hard-and-fast statement that these are actually the motives for the present treatment of the power problem by the manufacturer, we feel that some such directive influence is behind the policy too commonly adopted of *making* power instead of *buying* it. We hear much talk on the subject of works organisation and the marshalling of forces both for the efficient production and the effective selling of articles of commerce. In the ordering of these forces the prime object is the conversion of raw material into finished product with a minimum of capital outlay, and subsequent expenditure on labour, staff and the conduct of sales. So highly developed has specialisation become, however, that a manufacturer who at one time made everything from the raw material, now finds it pays him to purchase certain parts, unfinished or finished, which can be turned out by, say, a specialist outside his works. The words "raw material," in so far as these parts are concerned, consequently have a different meaning for him. If it were now suggested to him that instead of buying the partly finished or even the finished item he should obtain the raw material and do the rest himself he would ridicule the idea. What applied once to his regime does not now hold good. Every day it is more and more becoming an axiom of specialisation that only certain parts of a complete piece of machinery or apparatus can be made by any one manufacturer. Other parts are supplied to him either finished or partly so. By concentration on one thing the specialist learns the real economies of production, and the advantages of these can be placed at the disposal of the maker of the complete article. This fact strengthens the case for purchased power, and should help to clench the matter from the manufacturer's point of view. Now he has no reasonable excuse for shirking the problem. At one time he could not buy cheaply from the outside specialist some of the parts of his manufactures; at one time he could make power more cheaply than he could buy. Now the reverse is the case in both instances—that is, speaking in a general sense. In purchasing electric power, by comparison with the making of steam power, he confers upon himself further advantages coincident upon the use of electric motors. Output increases, quality of product improves, there is an economy in handling material, there are cost reductions everywhere. So the electric *v.* steam problem in its real solution leaves the manufacturer no choice of two minds. The question of manufactured *v.* purchased electric power is rather more complex, but even it does not admit of much argument. Power is a necessity to production, but it occupies no tangible position in respect of the finished product. The manufacturer makes and uses it, but he does not sell it. He is in business to make. The question of purchased electric power *v.* the same energy manufactured on the works may be placed in much the same category as the above. Where factories are within reach of power mains they come under the head of the works which relies upon an outside specialist to supply certain finished parts. They can buy what otherwise they would have to make. It should be more and more borne in upon the manufacturer that he is not in business to make power. He has a certain well-defined object in view in the product of his works, and that is enough to require all his attention. Electric power supply authorities have established many precedents and have many good arguments to go upon. Let them take this also and use it as occasion demands.

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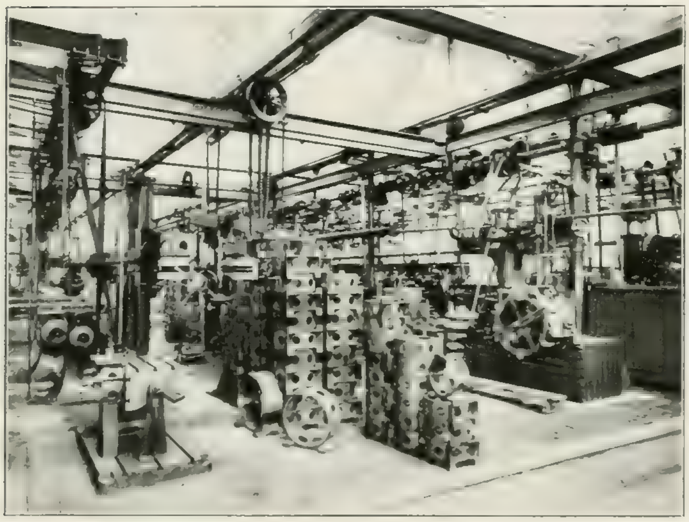
The Small Motor Department at the Oerlikon Co.'s Works.

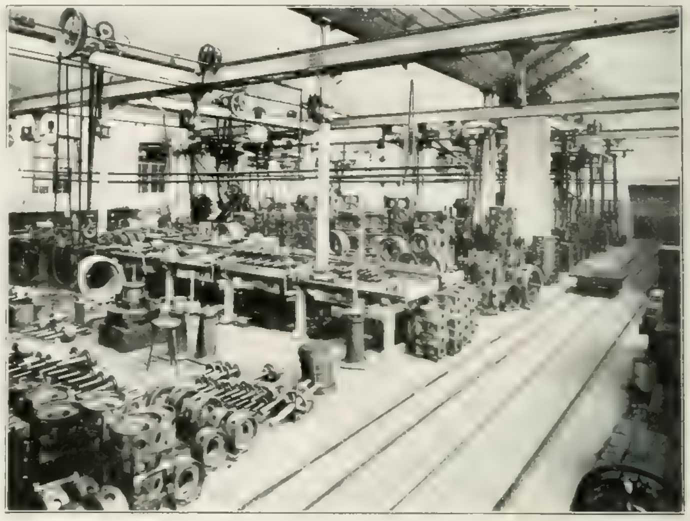
IN these hard times it is indeed a comfort to hear of somebody doing well, though the pleasure may be rather tinctured with jealousy when we consider the unhappiness of our own lot. For some considerable time the well-known Maschinenfabrik Oerlikon of Zurich have been unable to cope with the growing demand for their small motors, and as a direct consequence the rather circumscribed space at their disposal for this class of work has fast been becoming quite inadequate to their needs. Besides, the construction of motors of this type has undergone an important change owing to the adoption of several new types, and it has, therefore, become increasingly necessary to provide a new organisation, in order that these machines may be made " in bulk."

An appropriate occasion for doing this presented itself during 1906, when it was decided to do away with the tool works. The reason for this was curious, for the department was not unsuccessful. On the contrary, besides being one of the earliest branches of engineering work undertaken by this firm, it had increased very rapidly and was one of the largest of its kind extant. But the turbine department also required extensions, and the Oerlikon Company, therefore, decided to cease manufacturing both machine tools and porcelain work. The shops in which this work was carried on were situated at the east end of the works and were adapted for the construction of small motors and crane work. The space till then occupied by crane work was added to the steam turbine department.



Sta or Frame Turning, Planing and Drilling Shop.

The manufacture of small motors, which till that time had been carried on in the same shop as those of large size, has been reorganised and now forms a quite separate branch. A drawing office, in which the work pertaining to this section is carried out, is situated quite close to both test bed and machine shops. The latter comprise a bay in which such necessary work as turning, boring and finishing shafts, journals and motor frames is done, a forge, and stamping machinery, together with sections devoted to winding, assembling and painting. Accessible stores are also provided for both machine tools and other accessories.

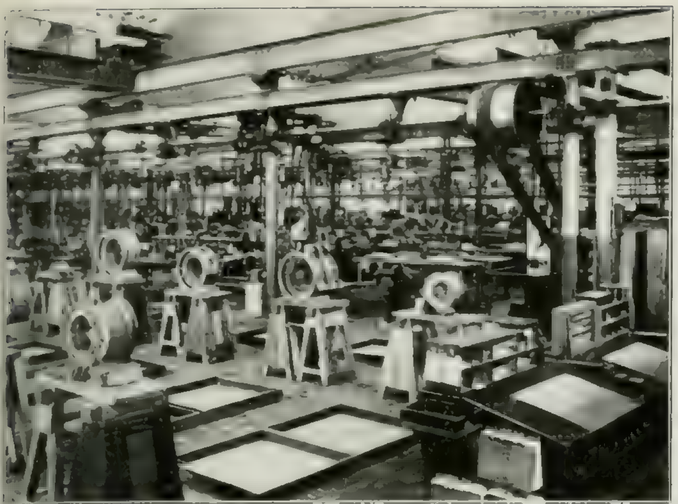


Core Stamping and Assembly Shop.

Method being the order of the day, it is not surprising to learn that the machines have been arranged in an order corresponding to that in which the work is carried out, so that transport within the works is reduced to a minimum.

To the right of the western entrance, through which the raw material is brought from the foundry, are placed lathes, polishers and boring machines for working the larger motor parts. This shop is divided into three bays, in which end pieces, shafts and frames are respectively completely finished. It is also equipped with a large number of modern machine tools, allowing all turning to be carried out without any alteration in the position of the work being necessary.

In another bay are made the smaller parts, such as slip-rings, commutators, brush holders, and lifting gear for brushes, as well as the thousand and-one other things which go to make up a motor's internal economy. The remark made above as to the machine tool equipment applies with equal force in this section where the most modern arrangements are employed and a minimum of handling is required. Close to this is the section in which the auxiliary parts are made up, while in the north shop are the stamping machines



A Corner of the Winding Shop.

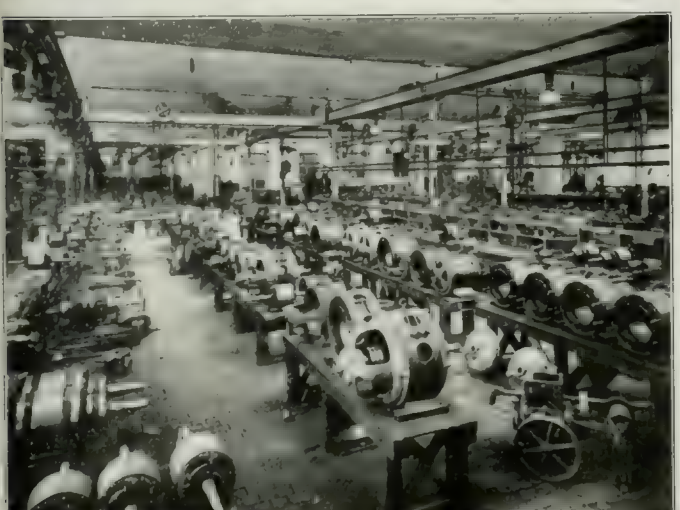
which are engaged only on small motor work. Rotor and stator stampings are also made in the vicinity.

There are, therefore, two principal divisions, one for finishing the ends, shafts and frames, and the other for stamping and assembling the laminations, which, though quite distinct, work in to a common centre. The stators and rotors then pass to the winding benches or the motors may be assembled and placed in store without winding.

As far as possible the existing shafting has been employed for driving the machine tools, though in some cases they are worked by separate motors. The test bed is in direct communication with both drawing office and shops, and is equipped with all necessary instruments and apparatus.

The arrangements for storing and issuing tools are very complete, and make for a complete check on the way the work is being done and give an idea of its cost. As in all modern shops the comfort of the workpeople has not been forgotten, lavatories and cloakrooms being provided for their convenience.

It is always interesting to learn how our Continental friends manage their affairs, and we are, therefore, more than usually indebted to Mr. G. Wüthrich, Engineer and English representative of the Maschinenfabrik Oerlikon, of Oswaldestre House, Norfolk-street, London, W.C., for placing the above information and photographs at our disposal and thus enabling us to give some idea of the progress this well-known firm is making.



Motor Assembly Shop.
(Note portable Electric Drill in foreground.)

Tinned Tube Wiring.

THE issue of a complete catalogue by the Sun Electrical Co., setting out the advantages of the "Kalkos" system of wiring will serve to concentrate the attention of wiring contractors on the advantages claimed for this decidedly novel method. We have on two previous occasions (October, 1907, and March, 1908) referred to the details of the system in some detail, so that our readers will be familiar with them. We may, however, at the risk of repetition remind interested engineers of the chief claims made for "Kalkos" wiring work. The all important subject of sweating is worthy of notice. Messrs. Handcock & Dykes, consulting engineers, are referred to in the catalogue above mentioned as having been amongst the first to use embedded iron pipes for wiring work; their experience was that troubles, which could be traced to nothing but sweating in the tubes, were very frequent. The idea at once suggested itself of using, as a substitute for iron, a metal which would follow more closely the rapid changes in temperature which characterise the climate of these islands. Brass was selected, and by the use of tinned tubes and suitable fittings the "Kalkos" system has been evolved. Wiring contractors cannot fail to be impressed with the advantage of simplicity in fittings which the system confers. The fundamental idea is a brass box with base ring and cover. Everything else is an extension from this starting point of interchangeable fittings which meet the requirements of switch, ceiling rose, wall plug, &c. The combination of these simple elements to form a complete system is a matter of mere multiplication of the

original unit. A contractor is accordingly spared the trouble of keeping in his head the names and numbers of a great number of different parts. Boxes, base rings, flush rings, outlet connectors, &c., answer equally well for switch, ceiling rose bracket and wall plug. Practically any known combination of switches can be made up. The adjoining diagram shows the use of three similar "Kalkos" boxes at a switching point controlling two pendants and a wall plug. When the whole is soldered up all possibility of moisture entering either the boxes or the tubes is obviated. It is not difficult to see that a greater number of these boxes can be assembled with identical fittings.

We may remark that "Kalkos" wiring is applicable to surface, semi flush, and flush work by the use of standard boxes, and fittings in each case. Similarly distribution boxes and ironclad switches and cut-outs are adapted to "Kalkos" tubing, which is brought into the boxes in a simple and neat manner.

Through the courtesy of the Sun Electrical Co. we were recently given an opportunity of inspecting a "Kalkos" installation in process of erection. The work is being carried out by Rawlings Bros., Ltd., in a large town house in the West End of London. Naturally only the best possible work finds acceptance in cases of this kind, particularly as the alterations to the house were in the hands of an architect. We were particularly struck with the small number of joint boxes required with the system, and the ease with which it can be installed for both surface and flush work. Without actually describing the work in full we cannot show in detail the amount of tubing saved in making runs, but we can certainly say that, on account of the ease with which boxes can be entered from the back, whether it be on walls or ceilings, a considerable economy in tubing and wire results. This method of working into a length of tubing from a box, which may also carry a switch, wall plug, ceiling rose or bracket, is a feature of "Kalkos" wiring which should appeal to contractors. There seemed to be an entire absence of elbows. All bends are made on a machine, and the angles are all long, so that drawing in is a comparatively easy matter. By a careful planning of the runs, it is possible to draw in quite long lengths of bunched wires without the use of any kind of lubricant; a little French chalk does all that is required. An interesting detail of the system is the nut and countersunk screw for fixing "Kalkos" boxes to the wall. The nut is tapered, and has splayed feet at one end, and a deeply recessed tapped hole at the other. The back of the box is tightly clamped against this recessed end of the nut by the countersunk screw, the effect being to draw the metal of the box into the recess, thereby making a watertight joint. The self-fixing of the tubing and boxes is another useful feature. When a

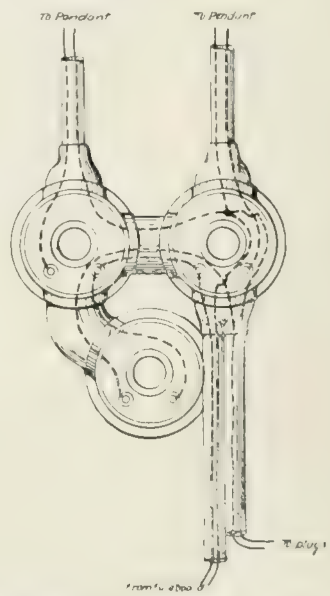


Diagram showing method of Bunching Switch Box on "Kalkos" System.

box is in position, it is practically a solid support for the tubing which may enter it. On this account the saddles and nails required are comparatively few. We were shown over the installation by Mr. C. Bartlett, who is in charge of the work, and to whom our thanks are due. In conclusion, we may mention that the whole of the wiring is in "Kalkos," the same boxes and other fittings being used in the smallest size of tube.

Although the idea of concentric wiring has always been an attractive one little has been done with it, principally because there was a feeling that special concentric fittings were needed, which were difficult to obtain quickly and easily and when obtained were invariably not satisfactory. Rule No. 27 in the new Wiring Rules of the Institution recognises this, and the "Kalkos" system, requiring no special concentric attachments, provides a good method of concentric wiring whether for concealed or open work. One wire only is required, the return being by means of the brass tube, thus effecting a saving not only of half the wire in an installation, but enabling tubes of only $\frac{3}{8}$ in. internal diameter to be used. Installations in this system have, as stated, been installed in asylums, factories, country houses and places having independent generating plant. It is especially useful in works using three phase plant, the motors working at 100 volts and the lighting being connected between either wire and the earthed point of the star at a pressure of 230 volts.

Sewage Pumping.

THE pumping of sewage by electric centrifugal pumps is growing in favour both in this country and abroad. Instances are on record in which the ordinary steam pump and pneumatic ejectors have failed entirely to meet the conditions required, and after disastrous experimenting, electric motors have been installed. In a recent issue of the *Electrical World* a description was given of a pumping plant at Dayton, Ohio, in which electric centrifugals took the place of steam. Dayton lies in a valley surrounded by hills whose slopes drain very rapidly, and at this point, several streams unite to form the Great Miami River. This stream in summer is small, but in late winter and early spring, after a sudden rain or melting snow, it rises in a few hours to the proportions of a great river. To protect the city from inundation, levees are maintained, but a rise in the river cuts off the sewers and it is necessary to close the gates at the outfalls to prevent the river backing up into the streets and houses. At such times it is necessary to raise the sewage and discharge above the flood level. After careful investigation it was decided to install automatic electric pumps. Central station service was accepted as the most satisfactory, since power can be obtained on a moment's notice at any time, night or day. There is also an entire elimination of steam boiler and engine troubles, and the maintenance and operating charges are a minimum.

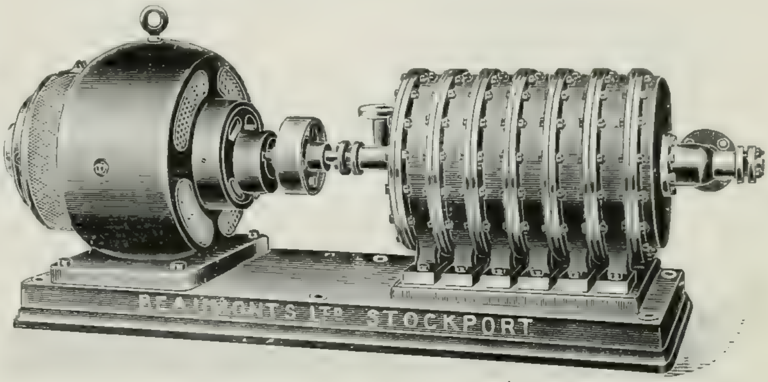
Three stations have so far been constructed in various sections of the city. The first is equipped with two vertical 2,500 gal. submerged centrifugals, geared to 20 H.P., horizontal, three-phase, 60-cycle motors. The motors are started and stopped by oil-switch compensators, operated by hydraulic pistons controlled by float switches. The lift is variable, averaging about 20 ft. The discharge is through a check valve at a point below extreme high water. The operation of these pumps is entirely automatic, it being only necessary to inspect them occasionally and keep the oil receptacles filled. Upon notice of a rise in the river, the gates are closed and the current turned on, after which the pumps cut in and cut out automatically with the rise or fall of the sewage in the pits. The second station has three units, and the third two, each consisting of a double-suction vertical submerged 4,500 gal. centrifugal, direct connected to a 40 H.P., vertical type, three-phase, 60 cycle, 2,080 volt motor.

The starting apparatus at these last two stations consists of floats which operate the valves on a hydraulic piston, using water under pressure from the city mains. On starting, this piston raises the lever on the auto-starter to the starting position, at the same time rotating an arm carrying a heavy counterweight which, by the time the motors have picked up speed, falls, and by means of a pawl, drops the lever to the running position. On stopping, the reverse motion given the counterweights moves the lift to the cut-out position. The operation of this apparatus is extremely satisfactory, and the motors cut in and cut out automatically with great regularity and smoothness. During a heavy rain, when the river was quite high, one pump was sufficient to take care of the flow in the sewers at the Lehman Street station when running three minutes out of each ten, being idle the remaining seven minutes.

This is but a single instance of the application of electrical energy to sewage pumping. It may, however, be taken as typical of the solution of a somewhat difficult problem and one which has doubtless presented itself to the surveyors of many towns.

Beaumont Turbine Pumps.

ONE of the most notable features in the engineering progress of the last few years, as we pointed out in our last issue, is the adoption of the turbine pump, which consists of a number of centrifugal pumps mounted upon and driven by one spindle; and connected together in series. They are now being largely used in place of plunger and bucket pumps, for raising large volumes of water to considerable height, and they prove very efficient and possess the great advantage of taking up very little space.



High Lift Turbine Pump coupled to D.C. Motor.

For mine pumping, the electrically-driven turbine pump is very compact and simple in construction, and of great capacity, particularly for heavy duty. It is rapidly coming into favour on account of the total absence of working

valves and reciprocating parts which reduces the liability of breakdown to a minimum, and makes the set very reliable.

The foregoing illustration shows a turbine pump, made by Beaumonts Limited, Stockport, direct coupled to a continuous-current motor. The capacities and heads of various sizes of this type of pumping unit, vary from 20 to 180 gallons of water per minute to heights of from 90 to 600 ft. These pumps are supplied coupled to single or polyphase alternating-current motors, and Beaumonts Limited are prepared to supply sets designed for any capacity or head, and for driving by a.c. motors of any frequency and voltage.

The turbine pump is suitable for any purpose in which water is required at high pressure; and there is no limit to its adaptability. It is suitable for filling sprinkler tanks and water towers, and for forcing water to high altitudes. For the convenience of firms wishing to supply or fix their own motors, these pumps can be built to any centre and are provided with extended baseplates ready to receive motors, or Beaumonts Limited can arrange for fixing turbine pumps to customers motors, and fitting everything necessary to complete the sets.

For group-driving or driving by ordinary mechanical power, this pump is fitted with fast and loose pulleys, which are mounted upon the spindle between two substantial self-oiling bearings, fitted with ring lubrication. Messrs. Beaumonts Limited have also special facilities for producing electrically driven single-stage centrifugals in moderate sizes, suitable for condenser circulation, filling feed water tanks, supplying water softening plant and cooling towers, &c. They invite inquiries for any description of centrifugal water-raising plant which may be required.

The "Bandy" Electric Punkah. . . . . . .

THE number of hand operated devices which have given place to electric motor driving is now so large that what was once a minority for electric power has become so for mechanisms worked manually. At one time it was an easy matter to discover examples of small machines which were not electrically driven, mainly on account of some peculiarity which rendered the adaptation of the

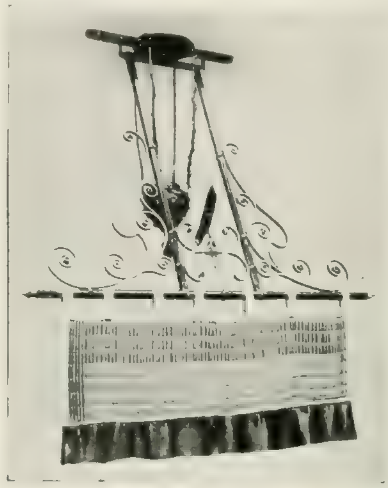


Fig. 1. "Bandy" Punkah, Shore Type.

motor a difficult process. Until recently one of these mechanisms was the punkah, so largely used in tropical countries for the gentle moving of the air to create a cooling breeze. The native "punkahwallah" imparted a peculiar flick to the swinging curtain which considerably increased its efficacy, and was in fact one of the saving graces of the human element in punkah operation. To reproduce this desirable flick was the problem confronting the would-be converter of the punkah from hand to electric pulling. Like the solution of many another difficulty, the electric punkah is simplicity itself, so simple in fact that one almost marvels at its remaining so long in the background. The "Bandy" patent electric punkah of Messrs. Bergtheil & Young is a complete answer to the call for an efficient tropical cooling device, as the following description and illustrations will show. The small motor required to operate the punkah

Fig. 2.—"Bandy" Punkah for Ship and Railway Carriage Use.

has been applied to its work without the need for gearing or belts of any description. As will be seen by Fig. 1, the motor is rigidly supported in a vertical position from the ceiling and the shaft projecting from the underside is fitted with a conical pulley of small diameter. Engaging with the pulley is a spring-controlled pivoted quadrant attached to the horizontal tube of a rectangular swinging frame, hung, like the motor, from the ceiling. The revolving coned pulley tends to roll away the quadrant pressing on it, thereby causing the frame to swing to one side (Fig. 3); the impetus given to the frame carries the quadrant clear of the pulley, and gravity causes the return swing. This journey, however, the quadrant presses against the underside of the coned pulley, and while in contact receives an impulse in the direction in which it is now travelling. While the motor is running this to-and-fro motion is kept up (Fig. 4). From an examination of the fans which we were permitted to make at the manufacturers' works, the action of the punkah is quite smooth and practically noiseless. The most that can be heard is a soft whirr from the motor which would pass unnoticed in a room. It is certainly less objectionable than the roar of an open fan.

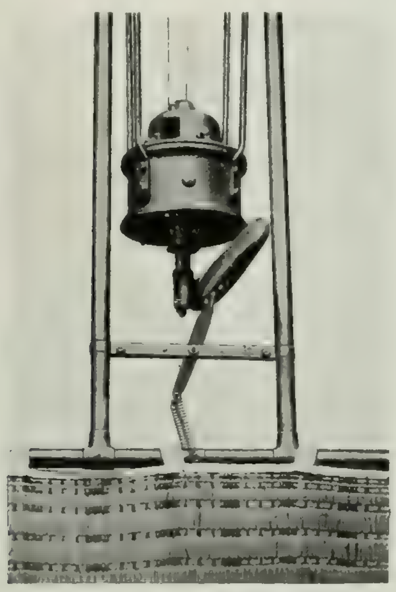


Fig. 3.—Shore type Punkah, Quadrant leaving Pinion.

The "Bandy" punkah is made in two patterns, for shore and ship use. The former is arranged with vertical motor, as shown in Fig. 1, and the latter is fitted with horizontal motor and quadrant as illustrated in Fig. 2. The action of both types is essentially the same. The motor may be an a.c. or d.c. machine, and in the latter case the energy for running does not exceed 30 watts, the starting energy being 50 watts. A special single-phase motor of the commutator pattern is made by Messrs. Bergthiel & Young for driving these punkahs. Its characteristics are dealt with on another page of this issue, but we may remark here that the punkah motor is very small and neat, and runs practically without hum. A motor we saw running was coupled to a 210 volt 50 cycle single-phase circuit. As with the d.c. motors, the a.c. machine is fitted with a flywheel, this being carried on the shaft outside the motor body. In the d.c. motor the flywheel is housed within the motor frame.

The punkahs are supplied in standard sizes differing only in the length of the swinging frame, the longest of these

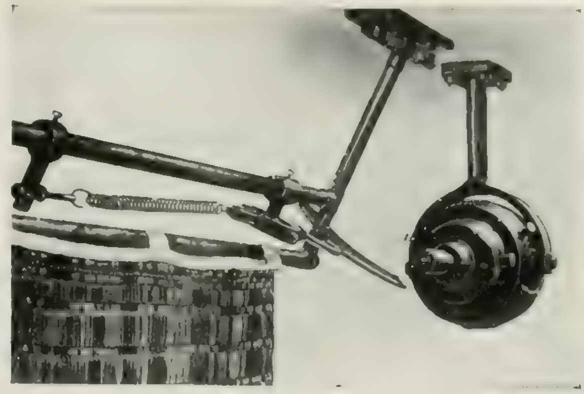


Fig. 4.—Ship type Punkah Fan, Quadrant about to engage with Pinion on under side.

being 20ft. For longer frames, which require to be specially made, two driving motors are used. All motors, both a.c. and d.c. are fitted with speed regulators which give five speeds and an "off" position. The swinging curtain, which is looped to the horizontal bar of the frame, is of India matting with a red satin fringe, both of which harmonize well with the most elaborate surroundings. The standard length of the frame, or drop from the ceiling line to the edge of the fringe is 8ft., though the punkah can be made for both narrow as well as lofty ceilings.

We need hardly state that so novel a device as the "Bandy" punkah has been well received in tropical countries. It has solved so completely the problem of punkah pulling by electric power that its future in India and other places is practically assured.

Mining Ventilation.

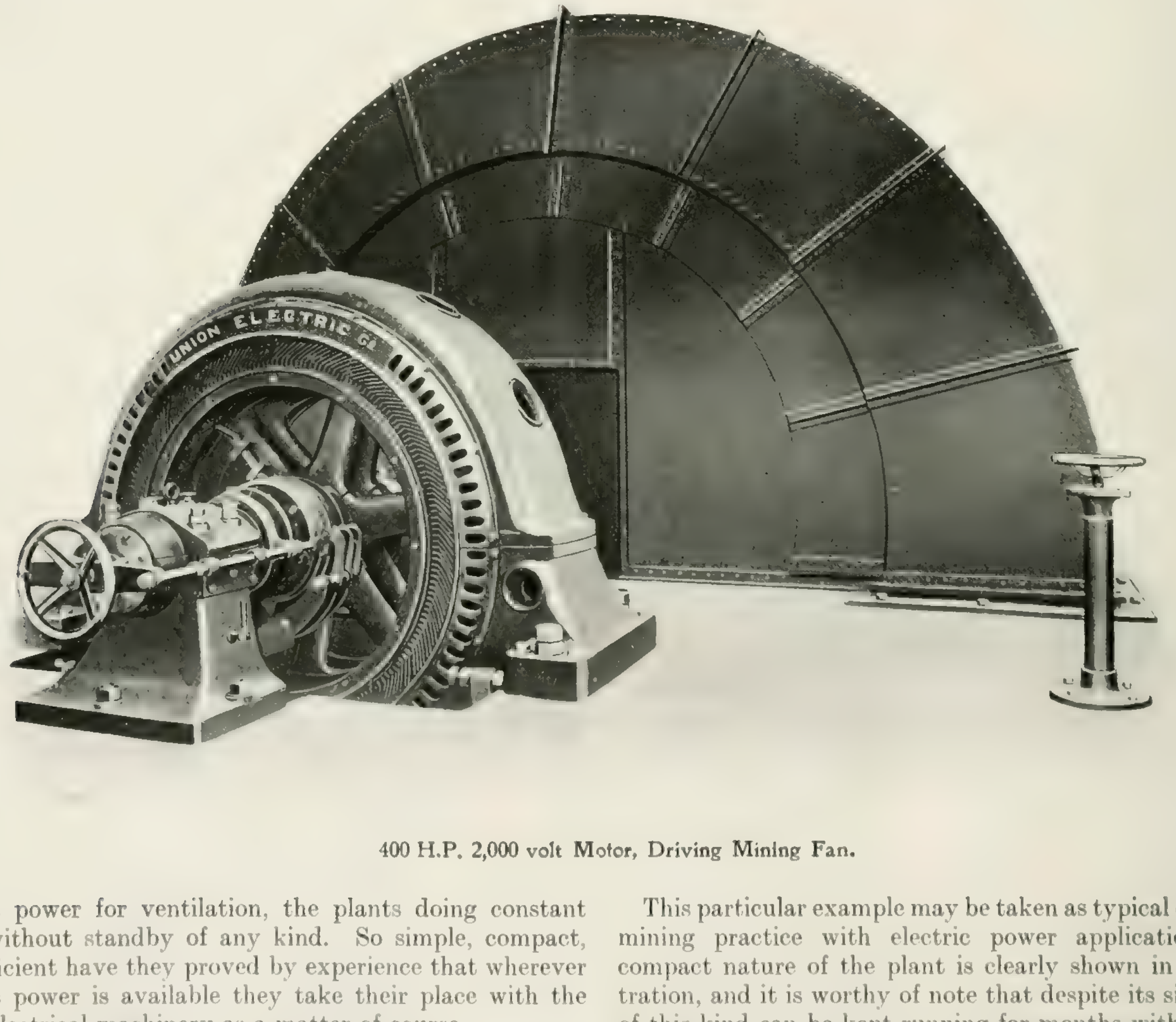
SIDE by side with the application of electric motors to coal cutters, haulage gears, winding plants, &c., in and about collieries and mines, has grown the idea of electric ventilation. The ventilation of a mine is so vital a matter that it can only be entrusted to reliable and well-tried machinery. For years the steam engine filled the important duty of driving the main fan. Despite the comparative complexity of its parts it was kept in service for months on end, and it stood up well to the arduous duties imposed upon it. With the entrance of the electric motor into the field, however, the mine manager has at disposal a ventilating unit which may be run even for years without stopping and which, from the point of view of mechanical construction, is the acme of simplicity. A very large percentage of the world's mines now depends entirely on electric power for ventilation, the plants doing constant duty without standby of any kind. So simple, compact, and efficient have they proved by experience that wherever electric power is available they take their place with the other electrical machinery as a matter of course.

When electric power was first introduced into mines and collieries, the fans were always belted to the motors particularly where belt driving from a steam engine had been previously in vogue. As time went on, however, the motor was found worthy a place nearer the fan, by reason of the increase in the mechanical efficiency obtained by direct coupling. Most modern installations now adopt this method of driving as occupying, in addition to the advantages enumerated above, less floor space.

The adjoining illustration shows a large mining fan, direct connected to a motor of the Union Electric Co.'s make. This motor is coupled to a 2,000 volt three phase circuit, being operated from the transmission line without reducing transformers. The motor output is 450 H.P., at 230 revs. per min., and the diameter of the fan is 13 ft. When running at normal speed the fan has an exhausting capacity of 6,000 cubic metres per minute.

The motor is fitted with slip rings and also an arrangement for short-circuiting the rotor and lifting the brushes when the motor is running at normal speed. The stator frame is made in halves so that the rotor can be easily examined or removed. Large ventilating holes are also provided in the carcase. Between the motor and the fan is a flanged coupling.

The starting gear is conveniently placed below the floor level, and is actuated from a handwheel surmounting a pedestal fixed near the motor itself.



400 H.P. 2,000 volt Motor, Driving Mining Fan.

This particular example may be taken as typical of modern mining practice with electric power applications. The compact nature of the plant is clearly shown in the illustration, and it is worthy of note that despite its size, a unit of this kind can be kept running for months with no other attention than seeing to the lubrication of the bearings. Direct coupled fans of this class are also widely used for induced draught work, in which capacity they give great satisfaction.

Since the installation of large power stations in mining districts machinery is now more frequently operated by motors supplied with energy from the transmission line direct. On the Continent and in America there are more high voltage motors in service than in this country, but British engineers are now alive to the importance of connecting motors direct to the line without the use of transformers.

Electric Pumping on Shipboard.

THE application of electrical energy for lighting on shipboard was rapidly followed by its extension to the driving of subsidiary machinery in various parts of the vessel. All modern steamships now boast lighting and power plants which would do justice, in the case of the larger vessels, to any small town. The more recent mammoth liners are noteworthy not only for the modern character of their electrical installations but also for the application of motors to many purposes hitherto untouched in shipwork.

One of the largest, if not the largest, pumping installations ever put on board a sea-going ship has been made by Messrs. Laurence, Scott & Co., Ltd., of Gothic Works, Norwich, for a Russian cruiser built in England. It consists of seven electrically-driven pumps, each delivering 500 tons, and six electrically-driven pumps, each delivering 300 tons.

The centrifugal pumps, which were made by Messrs. Gwynnes, Ltd., of Hammersmith, are driven through vertical shafts, averaging 25 ft. long (Fig. 1), by compound-wound vertical motors. The motors and also the shafting were designed and made by Messrs. Laurence, Scott & Co., the shafting constituting, we believe, a new departure in the arrangement of electrical pumping plants.

In order that the centrifugal pumps should be always available for completely clearing the compartment of water, they were arranged in the lowest possible part of the ship. The motors, in order that they might be kept in good serviceable condition, and be relied upon for working when most required—*i.e.*, when the compartment was flooded—were placed over the protective deck, between 20 ft. and 30 ft. higher up, but in warship construction, owing to the racking strains of gun fire, &c., the decks are not rigid. They are liable to movements of various kinds, and great difficulty has hitherto been experienced in getting the bearings and vertical shafting under these severe conditions to run satisfactorily. There is also the difficulty of continuous lubrication of vertical shaft bearings of the ordinary type. The problem was attacked by Messrs. Laurence, Scott & Co. and, in conjunction with the Hoffmann Manufacturing Co., of Chelmsford, they designed self-aligning self-adjusting bearings, as shown in the sketch (Fig. 2.) herewith. These have been found to answer perfectly. The ball bearings, it will be seen, are arranged to continuously contain the special grease lubricant that is required not so much for lubricating purposes as to prevent rusting of the balls, and the complete design allows for movements of the deck in any direction without undue strains being put on the ball races.

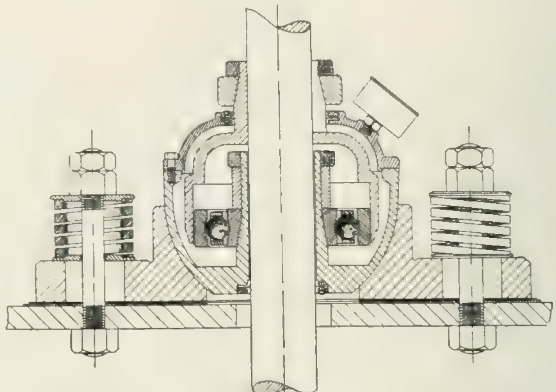


Fig. 2.—Special Ball Bearing for Vertical Shaft.

The plants were tested very thoroughly in the manner shown in Fig. 1. the arrangement being fitted up in Messrs. Laurence, Scott & Co.'s yard at Norwich. Each pump had to deliver the specified amount to an actual head of 26 ft., and the quantity was measured in the usual manner by means of the depth of water falling over a weir as shown after the pump had had sufficient run to get a fairly steady volume of flow.

The power taken by this kind of vertical shafting with these ball bearings is extremely small. A test was made by Messrs. Laurence, Scott & Co. at their works with a $2\frac{3}{4}$ in. shaft, 21 ft. long (Fig. 3), fitted with three bearings, two of them journal bearings only and one a journal and thrust bearing to take the weight. The shaft was driven by an electric motor through a short length of vertical shaft

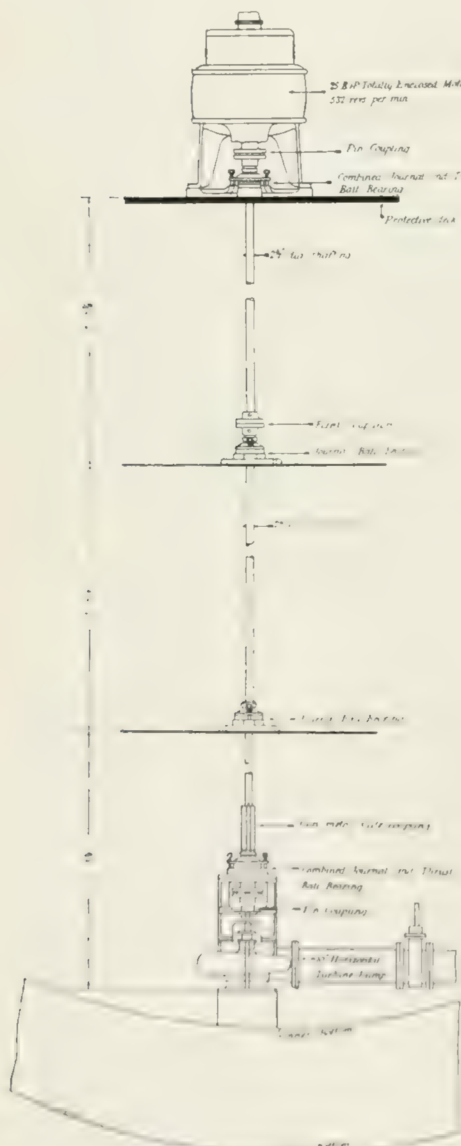


Fig. 1. Arrangement of Motor and Pump showing their respective Positions on Ship.

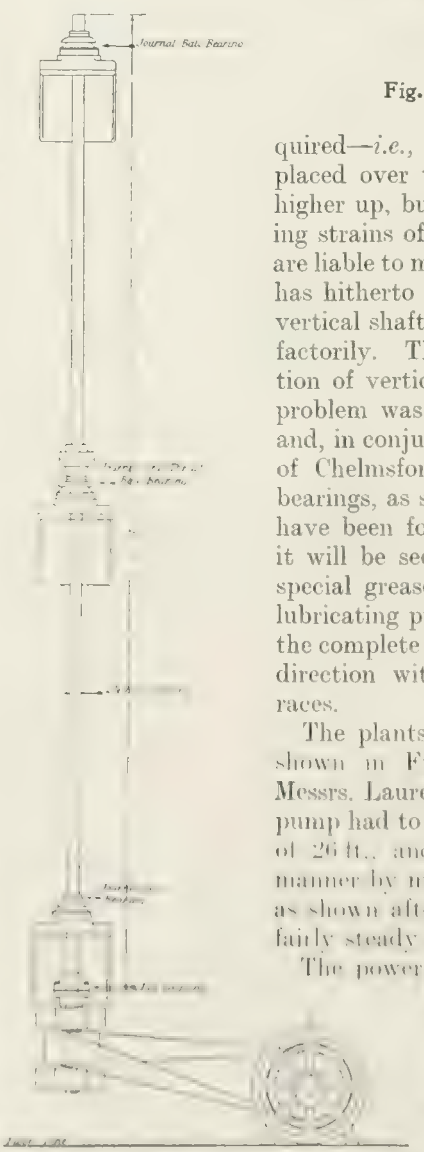


Fig. 3. Method of Testing Vertical Shaft.

by means of a pin drive, as is shown in the illustration. The pin was removed, and the current taken to drive the short piece of vertical shaft without the main length was noted. The pin was then put in and the vertical shaft was driven and the current again taken, and the amperes below were those actually used in driving the vertical shaft :—

Revolutions.	Amperes taken at 100 volts.
900	0·9
1,070	2·0
1,200	3·0
1,380	6·5

The running of this shaft at 900 revs. was perfect, but above that evidently some slight vibration was set up, hence the greatly increased power. At 1,380 revs. the slight " twig " of the shaft between the bearings was visible, though not alarming, and for higher speeds, of course, the bearings could be placed closer together.

Fig. 5.—Group of Vertical Pump Motors in Test Shops.

The motors were also fitted with ball bearings, and are of Messrs. Laurence, Scott & Co.'s well-known type, specially insulated for marine work, and which have been most successfully applied for working on board ship. Over 2,000 of these motors have been supplied to the British Admiralty in the last six or seven years, aggregating nearly 11,000 B.H.P. besides large numbers to shipbuilders and steamship companies. Failure of the insulation, even under severe ship conditions, is, we understand, practically unknown. This result is obtained partly through the extreme care taken with the insulation and the severe tests put on the insulation at every stage, a 2,000 volt alternating-current test being applied not only to the finished machine but to the armature and parts in progress. It is also partly due to the special method of impregnating the coils, particularly the armature coils. In the wire armature coils every wire is separately varnished, the taping being done after this varnish is dry, so that the cotton covering of each wire has a distinct coat of varnish, which is found to insulate perfectly even when the cotton covering is charred. After being taped, the coils are again dipped twice: first, in an impregnating varnish, which dries by the evaporation of the spirit solvent, and, secondly, in an oxydising varnish consisting of good copal varnish. This latter makes a skin which is impervious to oil, and the armature coil treated in this way will stand for from 12 to 24 hours immersed in water with the conductor connected to the negative of a 100 volt circuit and the water connected to the positive. This is a very searching test, as by the phenomena of electrical osmosis which presents itself in continuous-current working water endeavours to force its way through the minutest opening in the negative cable. A test with the conductor connected to the positive is, of course, no test at all, as even poorly-insulated coils will stand this indefinitely.

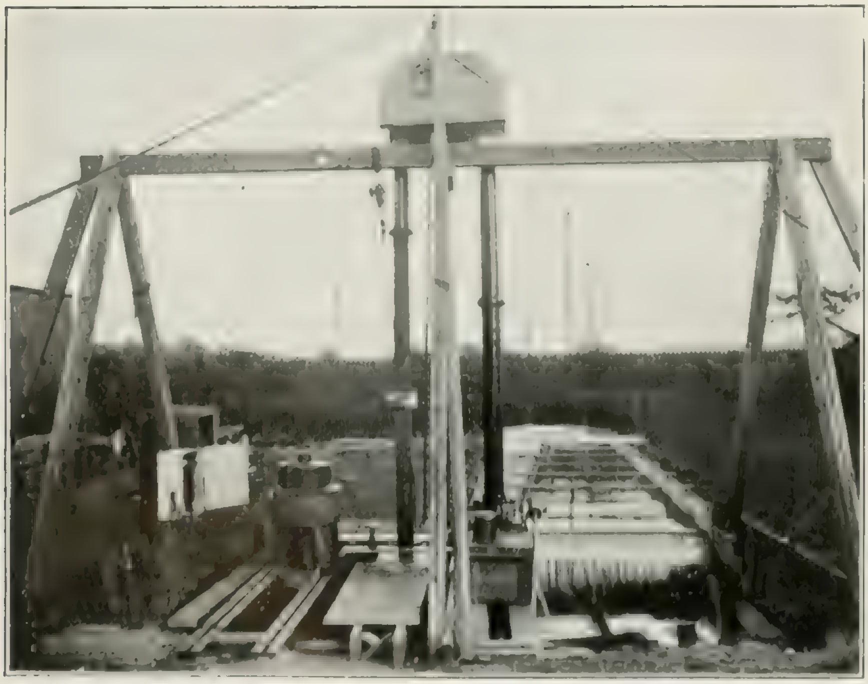


Fig. 4.—Pumping Testing Plant at Laurence, Scott's Works.

A large number of tests with different varnishes has been made by Messrs. Laurence, Scott & Co. by this method, and it was by this means that their present system of insulation was worked out some three or four years ago.

In pumping installations the question of insulation is, of course, of very special importance, and in a number of important plants, as well as the shipwork mentioned above, Messrs. Laurence, Scott & Co.'s method of insulation has been found to be most reliable.

Messrs. Laurence, Scott & Co. also have in hand several installations for sewage pumping with similarly arranged vertical motors, and comparatively long shafting. A group of motors in the company's Norwich shops is illustrated in Fig. 5. As these have to run for long periods without any attention, and have to be absolutely reliable, the method of arranging the ball bearings, as described, is a special advantage, and one worthy of the attention of engineers interested in pumping plants.

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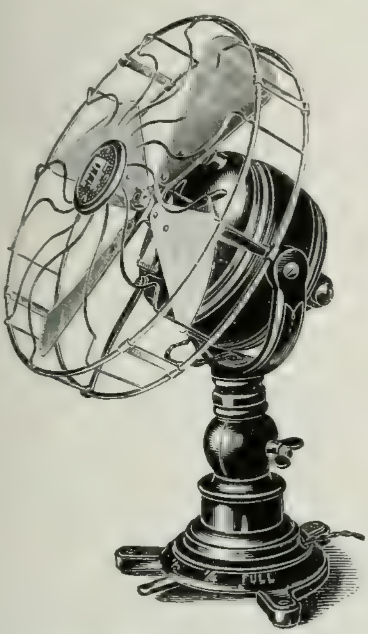

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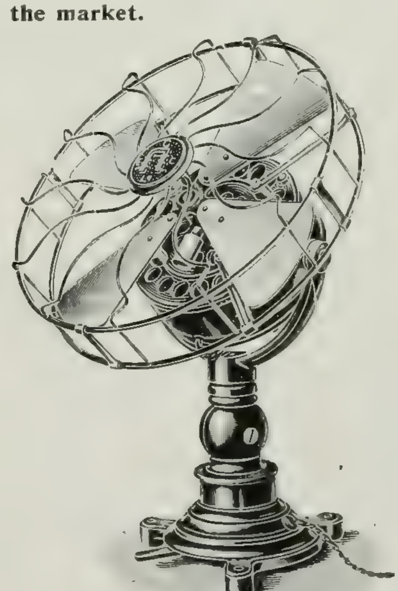

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Editorial.

Electric Power and Ventilation. With the rise in temperature coincident upon the approach of summer, problems of ventilation seem to assume an imposing, almost aggravated, aspect. The hot days bring out the electric fan, that small but expressive apparatus which is available to all—even the humblest—users of electric light; but they do more than this. They serve to emphasise the importance of the duty now imposed upon thousands of horse-power of electric motors driving ventilating fans in large buildings. We naturally want to see more of these fans installed. They are standardised by manufacturers and specified by architects, and in a general way they are recognised as the best thing for the purpose. Still, the science of ventilation suffers, if anything, from a lack of practical application. Electric power distribution is gradually changing this. A glance through the catalogues and at the advertisements of fan makers will demonstrate this truth. Power supply companies encourage the ventilating fan load as being steady and valuable. The user has really no excuse for avoiding electrically-driven fans, because everything he wants is cut and dried. Fan makers are keen enough to obtain fullest details of the requirements to be met by their apparatus, and when inquiries come or business is going they know as much about the problem as the prospective buyer. Since we last dealt with the subject of ventilation in these columns there has been little or nothing new added to the list of ventilating appliances now on the market. There are, however, plentiful enough signs that the existing standards have been improved in various ways, and steam driven patterns have been adapted for electrical operation. Again, we we must not forget that during the year many important installations have been put down, and probably the most interesting are those which are now in regular service on board the world's largest liners. No better evidence than these shipboard installations could be found anywhere for the advantages of electric driving. Power users with a biassed affection for steam might do worse than consider the conditions on shipboard which favour steam driving and yet in the face of these, dynamos and motors are regularly installed on new boats and introduced also on older vessels.

Pumping on Shipboard. Electrical energy on board ship has passed from the comparatively insignificant stage of lighting to the more important—we had almost said dignified—position of power and light supply. The application of motors to ships machinery proceeded somewhat slowly for a time, but the developments on land appear to have given a fillip to the marine side of the industry, which is now evident on every hand. Certain work on shipboard, such as the driving of capstans, warping engines, hoists, conveyors, &c., is now practically standardised as far as electric driving is concerned, but it is naturally to be expected that special problems will present themselves. An interesting example of one of these is referred to in another page of the present issue. It relates to the driving of centrifugal pumps in the ship's hold, from motors placed on the deck. The use of long lengths of vertical shafting was necessary and the manner in which these were fitted with ball bearings is certainly novel and interesting. It should also be noted that the driving of the pumps in this special manner was tackled by the motor makers and successfully carried through by them in the manner described. The installation probably creates a precedent in marine work, and should be the forerunner of other pumping plants of a similar character. It appears to us to solve a distinct difficulty on board ship in a highly satisfactory manner, and one which should appeal to so practical a man as the marine engineer.

Coal Storage. We hear much in these days of the troubles of the manufacturer who finds works costs high, depreciation charges alarming and the selling price of his goods above that of his competitors. How often does such a one reflect upon the conduct of his works, their organisation and management, and remark that everything possible has been done to reduce expenses. Some recent reflections on the subject of coal by Mr. E. G. Bailey before the National Association of Cotton Manufacturers, at Boston (U.S.A.), are worthy of comment in that they serve to throw into bold relief the importance of purchased power. Mr. Bailey points out, as other engineers have done before him, that where factories are some distance from coal supply, storage bunkers must be provided, and with them troubles from deterioration and spontaneous combustion have to be taken into account. Where large quantities of coal are stored the percentage loss may be a serious item. Investigation of the problem has unfortunately left little or no reliable data behind, while the trouble itself continues much as before. Again, to secure the best results, the coal used must be carefully selected, and a close watch kept on the manner of its combustion by the use of CO_2 recorders.

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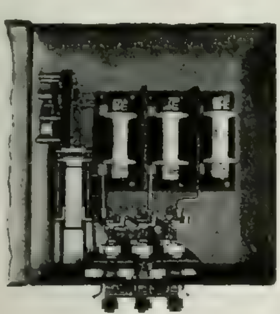

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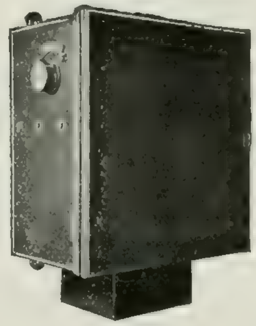

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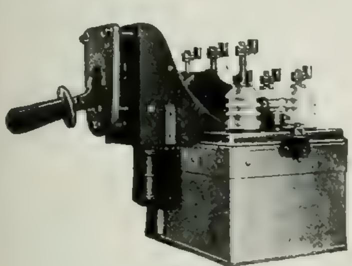

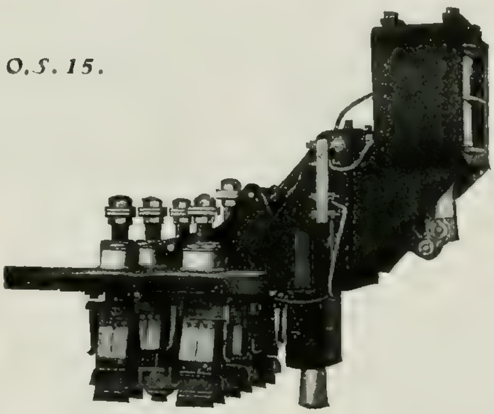

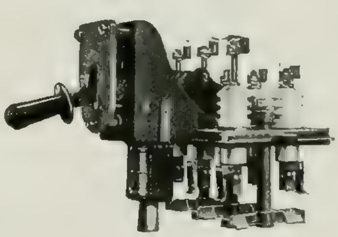

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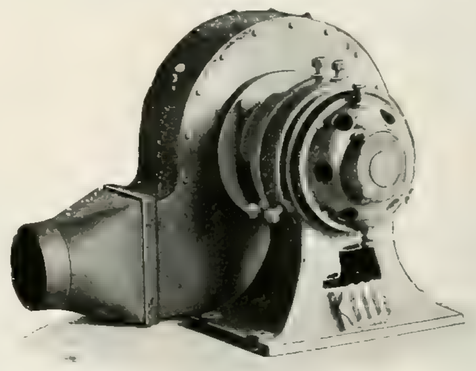
But what manufacturer takes the trouble? Who cares if the coal deteriorates and is used wastefully in stoking? Judging by the manner in which most industrial steam plants are run—there are of course exceptions—the question of economy does not figure to any great extent. The inevitable is accepted, because it is felt to be the inevitable. What we have difficulty in understanding is that manufacturers should regard power as raw material, and yet refuse to treat its production in the same way in which they deal with the manufactured articles emanating from their works. It is just as reasonable to expect scientific treatment of the power plant as of the fashioning by special machinery of iron, steel, brass, &c., into some useful and efficient article. Why then do the coal pile, the boiler house and the steam engine contribute to the already swollen list of inefficiencies in the art of production? While the cry of competitive troubles and works costs is being raised, we earnestly commend these items to the notice of manufacturers.

A.E.G. Fans.

PARTICULARS of the range of electric fans carried by the Electrical Co. are to be found in a booklet just issued. The designs embrace a number of useful and artistic desk fans supplied for a.c. and d.c. circuits. The smallest of these (d.c.) weighs only 6 lb., is fitted with 6 in. blades and has a power consumption of 9 watts. The small pattern a.c. fan weighs practically double, has $9\frac{1}{2}$ in. blades and consumes 40 watts for an air displacement of 525 cubic ft. per min. The d.c. fans have two-speed regulators fitted in the pedestal base, but the a.c. fans run at one speed only. The ceiling fans are supplied in both long and short types; we illustrate one of the latter herewith. Four blades, 12 in. diameter, are fitted to these fans, and the power consumption (d.c.) is 55 watts at a speed of 1,500 revs. per min. A two-bladed fan driven by an a.c. motor at 180 revs. per min. with 4 ft. 7 in. blades consumes 160 watts and weighs 132 lb. A line of porthole fans is also put forward by the company. One of these is fitted with a special blind for closing the opening through which the fan discharges. Another pattern has an Iris shutter for the same purpose. We illustrate also a centrifugal blower suitable for a.c. and d.c. motor driving. The former are supplied in two sizes and the latter in three. These blowers are mainly intended for smiths' fires. The largest d.c. unit will operate five fires for an energy consumption of 280 watts and an air displacement of 315 cubic ft. per min. The largest a.c. blower operates two fires and consumes 130 watts.

A.E.G. Ceiling Fan.



A.E.G. Centrifugal Blower.

Sun Fans.

A WIDE range of electric fans is carried by the Sun Electrical Co., whose designs include a number of interesting, and somewhat novel types. The ordinary desk bracket and wall patterns are included in this season's list, and some of these are also fitted on trunnions for directing the breeze. A useful design, illustrated herewith, is a punkah fan, comprising the usual motor body in oriental or repoussé bowl and four bladed propeller. The

Index to Advertisers.

punkah effect is obtained by a number of oscillating deflecting plates. These are moved backwards and forwards by a small trip motion driven from the motor shaft. The effect is to distribute the air from the blades between wide limits, by the constant movement of the deflecting plates. This

Sun Ceiling Punkah Fan.

type is made in two patterns and the motors are supplied for direct or alternate currents. The Sun Electrical Co. also supplies porthole ventilating fans in sizes varying from 1,250 cubic feet per min. capacity, to 30,000 cubic feet per min. In addition it carries a line of ceiling fans for d.c. and a.c. circuits. The a.c. fans are fitted with three-speed switch which enables the motor to be run at 225 r.p.m., or 140 r.p.m. there being an intermediate speed. The fans are of the induction type so that brushes and commutator are despensed with. These fans are provided with a cluster fitting for three or more lights. The same fans are arranged on a vertical column for floor use in restaurants, hotels, &c., but this type has only one speed. Centrifugal fans for moving both large and small volumes of air are also stocked by the company. These are of the overhung pattern, and the sizes vary from 6 in. wheel upwards.

"Freezor" Fans.

A MORE appropriate trade name than that selected by the General Electric Co. for its fan designs could not well be imagined. "Freezor" at once suggests cooling breezes, and these are dispensed by suitable patterns of electric fans. The fans made by the General Electric Co., under the above name, have been before the trade for some years now, but we are informed that numerous improvements have been made in the 1908 patterns. The d.c. motors are specially made for fan duty, and embody such important features as cartridge carbon brushes, hard copper commutator, field poles cast in one piece with the yoke, &c. Three-speed regulators can be supplied with the fans, the resistance wire being wound on fireproof bobbins.

In the latest pattern "Freezor," the motor is hung on trunnions, so that one fan can be placed in three positions, doing service as a desk, bracket and trunnion fan. The motor body is securely locked in the three positions into which it is possible to place the fan. The "Freezor" fan is also made for alternating current, the motors being of the induction short-circuited rotor class. The rotor spindle is hung in ball bearings, and lubrication is practically automatic, there being sufficient oil for a whole season.

In addition to the usual ceiling and pedestal fans, the "Freezor" is made in porthole patterns, suitable for the ventilation of restaurants, basement offices, &c. Either a.c. or d.c. motors can be supplied with these fans. These porthole fans are made as small as 10in. in diameter, and the motors run at 1,450 revs. per min. on 50 cycles.

Hydro-Electric Notes.

ENGINEERS the world over are alive to the value of "La Houille Blanche" the "White Coal" of countries blessed with abundant water power. The world's technical press is constantly recording developments in this direction. The centres of greatest activity are the North-Eastern States of America, the Rockies from north to south, Central America and the mountainous districts of all Continental countries. The distribution of "La Houille Blanche" has revived many industries in France, Italy and Switzerland. A company is in operation on the Mditerranean, La Société Energie Electrique, which operates a 200 mile transmission, and has both steam and hydro-electric plants running in parallel at opposite ends of power lines. The same company has recently completed a large substation for the supply of power to Marseilles and district, the capacity of the station being 36,000 kw., with 1,000 kw. transforming units. Energy is supplied at 50,000 volts three-phase 25 cycles from a number of hydro-electric stations, one of which is 60 miles distant. South America is a country to which the eyes of hydro-electric engineers naturally turn, and it is interesting to note that Rio de Janeiro will before many months be supplied from a 50 mile line transmitting power from a 30,000 kw. plant. The water for this plant is taken from a large reservoir, which is supplied by a mountain stream; the impounding of the latter has been materially assisted by a mountainous formation favourable to the project. The turbines operate under a head of 1,000 ft. and drive the main generators through vertical shafts. Hydro-electric developments in Brazil are likely to affect in time the traffic to that country in Welsh coal, large quantities of this being now used for steam raising purposes. According to the "Electrical World," which recently described the electrical situation in Rio de Janeiro, less than 100 buildings out of 60,000 in the city have electric light or power installed.

Stellite and Ordnance Fans.

IN the design and construction of large and small electric ventilating fans, considerable advantages obtain with a firm which undertakes the manufacture of the entire apparatus—motor and fan complete. The Electric & Ordnance Accessories Co. have specialised in fan and motor construction for some years past, and therefore can draw upon a fruitful experience in dealing with ventilation problems. Both their Stellite and Ordnance fans are made at their Birmingham works.

The Stellite A.P. fan is the embodiment of many severe tests applied by the British Admiralty. It is of simple construction, and its most prominent feature is the mounting of the motor on trunnions locked by thumb nuts. These screws admit of easy adjustment so that the motor and fan blades can be turned in any direction desired. The fan may, therefore, be used on table, floor, wall, or ceiling at will.

The details of construction are worth noting. The field frame of the motor is cast in one piece to furnish an unbroken magnetic circuit. The commutator segments are of hard drawn copper carefully assembled and insulated, and both field and armature windings are of double silk-covered wire, which is twice impregnated with a special compound before and after taping; the armature slots also are lined with insulating material. Carbon brushes and wick feed lubricators for the phosphor bronze bearings are other noteworthy features of the motor. Starter and regulator are fitted neatly inside the supporting base. Fig. 1 illustrates a Stellite porthole fan, with fluted blades, arranged for belt driving. It is also made for direct coupling to electric motor.

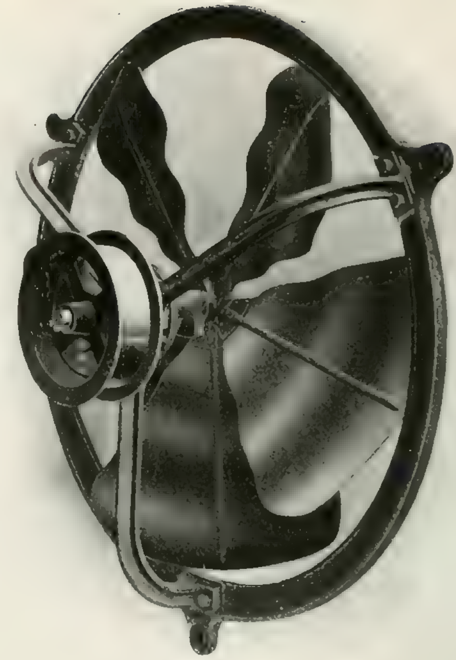


Fig. 1.—Stellite Porthole Fan.

The principal features in the construction of the "Ordnance" centrifugal fans are those which prevent the back slip of the air through the space between the blades when the fan is operating against pressure, and also any churning of the air inside the casing. One of the outstanding features is the patent corrugated blade which by its "spoon" like shape tends to prevent the back-slip of the air referred to when operating against pressure, and which by its special curvature radially impels the air with the greatest velocity in the direction of rotation of the fan runner, minimising thus the effects of eddy currents set up by air rebounding from the fan casing.

The impeller is constructed with a number of these corrugated blades closely pitched and firmly riveted to mild steel revolving plate discs, the inside one of which is mounted on a cast-iron hub keyed to the shaft, and forming the driving side of the fan; the outer ring forms the air inlet to the fan, and is firmly stayed to the cast-iron hub by mild steel rods screwed into special bosses cast on the hub and secured by double nuts, giving thereby a very rigid construction. The impeller or runner revolves inside the fan casing which is constructed of mild steel plates stayed with angle and "T" iron stiffeners.

The casing is supplied with a suction intake eye which is of equal diameter to the impeller, and made detachable so

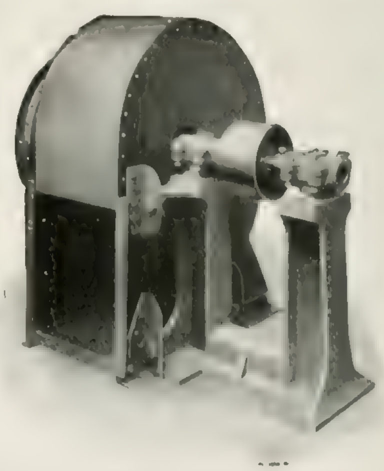


Fig. 2.—Ordnance Fan for Belt Drive.

that the impeller may be readily removed through this same opening. In the larger sizes of fans the casings are also split horizontally on the centre line of the fan thus forming a top and bottom half, which again are jointed together by means of angle jointing irons.

These fans are made in many different types to suit the various requirements of customers. The standard type, as illustrated in Fig. 2 is arranged for belt drive, but a larger number is supplied for direct coupling to continuous and alternating current motors, for direct coupling to steam engines, and as a matter of fact, to any other suitable power agent. A motor driven fan is shown in Fig. 3.

On the larger sizes of fans a bearing is provided on the suction inlet side, and this bearing is generally mounted on an "A" shaped cast-iron stand, or on a cast-iron wall box whichever may be most convenient. When fans are required to deal with hot gases, as in the case of induced draught fans, the outer bearings are always supplied with water-cooled jackets. All bearings are of the self-oiling type, and are lined with patent anti-friction metal.

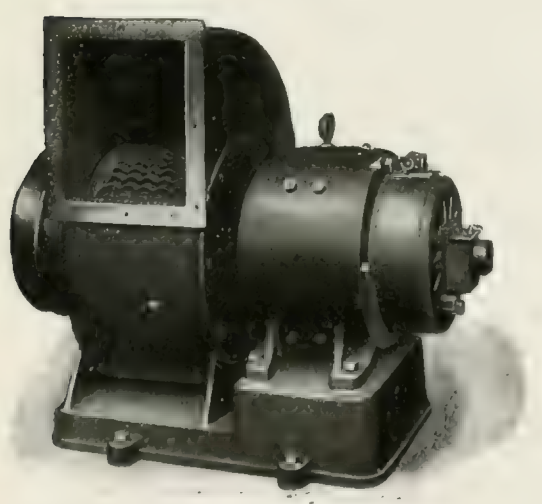


Fig. 2.—Ordnance Motor Driven Fan.

All shafts are made from Siemens-Martin best mild steel and finished bright all over. The fans are of the very best workmanship throughout, and the makers state that the average mechanical efficiency obtained is about 60 per cent. These fans are applied for a number of different purposes, such as induced and forced draught for factories, electric light stations, and steam power generating plants of all descriptions, mine ventilation, dust removing, ventilation (plenum and exhausting) cooling, the drying of paper and timber, &c.

Electrically-Driven Rotary Pump.

IN our last issue we published some general information on Siemens rotary pumps, and are now able to give additional particulars of the apparatus. We may preface our remarks by mentioning that these pumps are specially suitable for small quantities of water and medium heads, in which case they possess the advantage of higher efficiency as compared with centrifugal pumps.

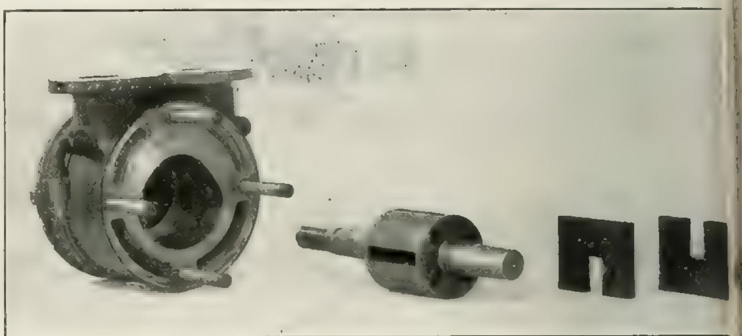


Fig. 3.—Parts of Siemens Rotary Pump.

Fig. 1 shows a section through the pump; the rotating part consists of the phosphor bronze shaft w, the enlarged central part of which is provided with two slots at right angles, in which slide the vanes s_1 and s_2. These consist of a special kind of vulcanite. The fixed portion of the pump consists essentially of the central part p, containing the working chamber and the flanges for inlet and outlet, and two covers d_1 and d_2. These three parts are rigidly clamped together by four bolts. The part p has the same

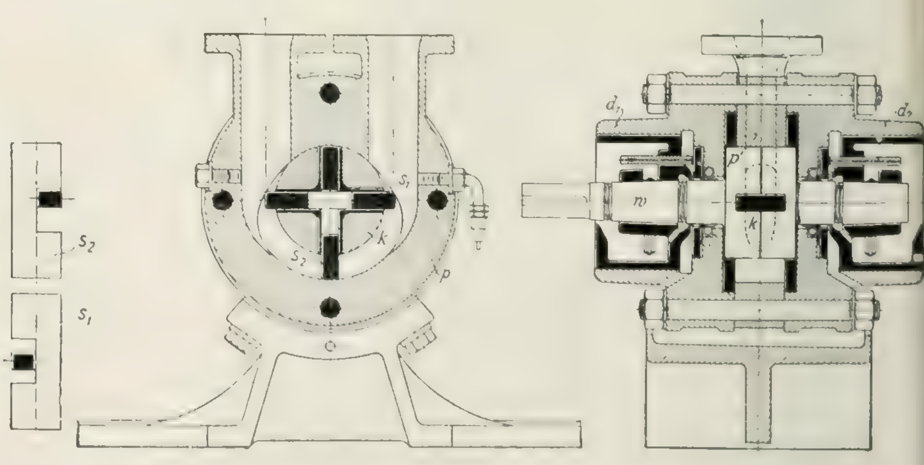


Fig. 1. Section through Siemens Rotary Pump.

width as the vanes, and the chamber is so shaped as just to touch the enlarged central portion of the shaft at the top. The inner sides of the covers d_1 and d_2 are fitted with brass discs, which serve as lateral guides for the rotating vanes. When the shaft is rotated, the vanes are guided by the inner surface of the working chamber, the action being assisted by centrifugal force, which presses the vanes against the lower surface of the chamber. The movement of the vanes is further assisted by the pressure of the liquid. A small quantity of air, which is permitted to enter through a suit-

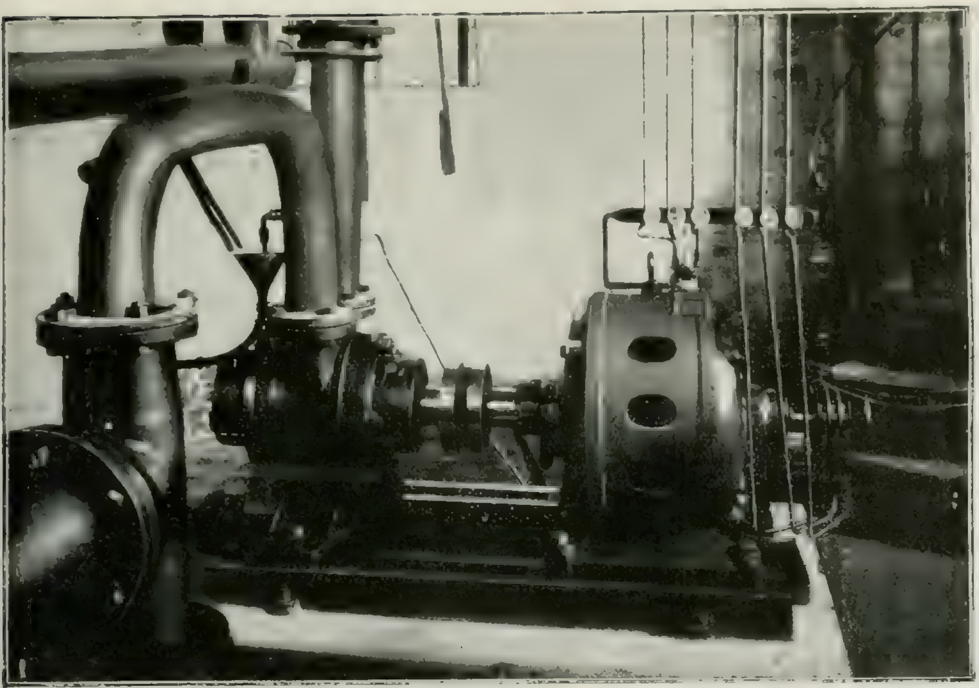


Fig. 3.—Siemens Rotary Pump Direct Coupled to Induction Motor.

able valve into the suction chamber, provides an air cushion and ensures a practically constant velocity of the outgoing water.

The motor and its principal parts are also shown in Fig. 2. The efficiency remains practically constant over a wide range of speed. The pump may be driven by a continuous current or three-phase motor, which is coupled to the pump by means of a flexible coupling as shown in Fig. 3.

It will be observed from the illustrations that a pumping set occupies very little space. It can be started and stopped either by hand or automatically, as in the case of water tanks in which the motor is cut in by a suitable float and contact device when the water level sinks below a predetermined point, and is shut down again when the water level has been raised to the desired height.

The bearings are automatically lubricated by the water passing through the pump, and require no attention whatever. The only parts requiring renewal at intervals are the vanes, and these are inexpensive, and can be replaced very quickly. These rotary pumps can also be driven in certain cases by petrol engines, small steam engines, water motors, &c. These pumps are made for various capacities, and are suitable for a head of water up to about 200 ft. They have the advantage of a good suction at all times.

Electrical Ventilation.

IN an age of applied science we may naturally expect to find ventilation treated in a scientific manner. Whether it be the provision of pure air for a single room or a whole building the electrically-propelled fan is unrivalled as a ventilating agent, and the most exacting requirements in this field can now be met by standardised apparatus which has reached its present stage only after many years exhaustive tests. Makers of electric motors have contributed largely to this result, and have materially advanced the practice of mechanical ventilation for buildings and other purposes. We are appoaching the age in which the provision of pure air in large and small buildings will be a necessity—probably a legal necessity The electric motor will, as a matter of course, figure prominently in the bringing about of this desirable state of affairs. We attribute the popularity of the electric propelled fan almost entirely to the reliability of the electric motor, and in this respect we cannot but identify motor makers with the progress made. Fig. 1 illustrates a standard propeller fan, made by Electromotors Limited, driven by a two pole d.c. motor. The air is drawn over the motor, and therefore it tends to run cool at all times. These fans are made by the firm mentioned in several standard sizes and in two classes, suitable for high and low speeds.

The choice of a fan of this class is a matter upon which we may fittingly comment. The makers dwell upon the importance of exercising care in the selection of a fan to meet the conditions imposed. Where the outlets are not restricted a slow speed fan will answer admirably. A fan of this type has the advantage of being silent, while the energy consumed for the amount of air displaced is comparatively low. For instance a 25 in. fan, similar to that illustrated, running at 550 revs. per min., will discharge

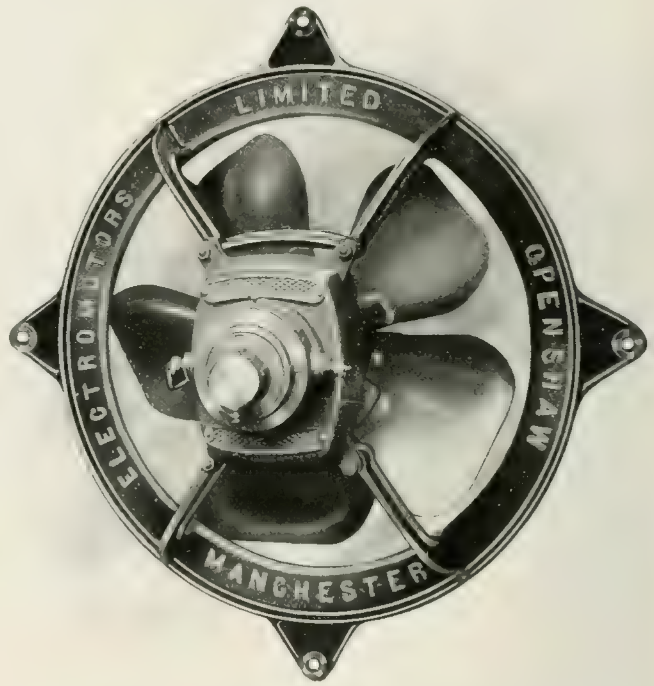


Fig. 1.—Electric Propeller Fan driven by Two-pole Motor.

practically 5,000 cubic feet of air per min., and the motor will absorb 240 watts. The same fan, if run at 700 revs. per min., will absorb nearly double the energy—namely, 400 watts—but its capacity in air moved will not go beyond 6,300 cubic ft. per min. This example shows the importance of selecting a slow speed fan wherever it can be satisfactorily introduced.

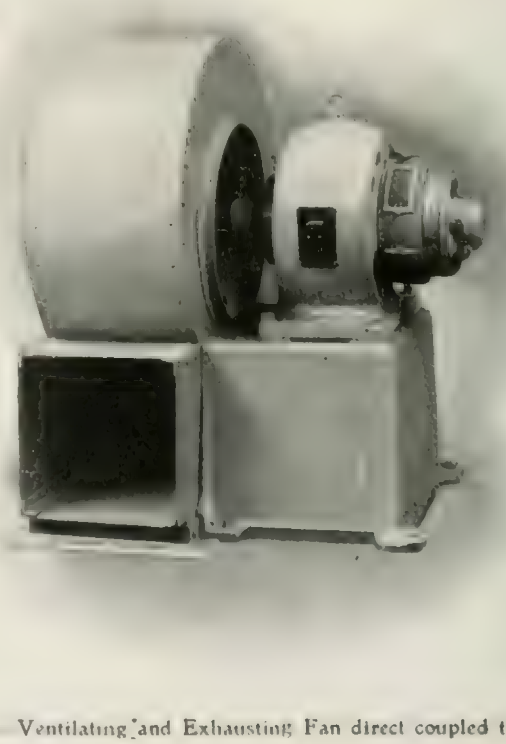


Fig. 2. Ventilating and Exhausting Fan direct coupled to Motor.

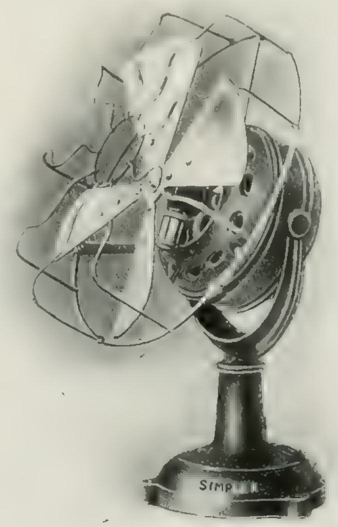
In addition to the propeller fans referred to above, Electromotors Limited also supply cased fans for forced draught, heating and cooling plants, small blowers for smithies, suction gas plants, &c. Motor and fan are mounted directly on the same shaft and the unit is compact and of neat appearance.

We understand that Messrs. Electromotors Limited have a large number of their ventilating specialities installed in hotels, restaurants, private houses, public halls, assembly rooms, workshops, foundries, &c.

Simplex Electric Fans.

FOR the present fan season Messrs. Simplex Conduits Ltd., are putting forward a range of small electric fans which merit notice. The designs are provided with motors suitable for operation on a.c. and d.c. circuits, and in the case of the latter for working from accumulators. We understand that the patterns put forward are standardised throughout, and that all parts are interchangeable.

The d.c. fan has round field frame of cast-iron of high magnetic permeability with field coils wound with silk-covered wire, heavily varnished. These coils are submitted to a pressure test of 1,000 volts before leaving the works. The armature is drum wound, of the ironclad type, having windings well insulated and thoroughly varnished to exclude moisture. The commutator segments, which are of hard drawn copper, are insulated with mica. Concealed within the base of the fan is the speed regulating switch, with german silver resistance wire wound on and embedded in asbestos. The alternate current fans are of the induction type, the rotor being built up of soft iron laminations assembled on a brass spider. This is ground accurately to size to run as closely as possible to the stator. The other details of construction are similar to those of the d.c. fans. The bearings are of ample proportions, and the oil cups are, we understand, large enough to keep the bearings running cool a whole season without refilling.

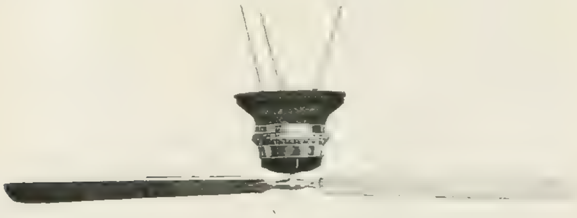


Simplex A.C. Desk Fan.

Glancing through the latest Simplex catalogue of fans we find almost every known type represented. The universal desk, trunnion, and bracket fan, for a.c. and d.c. circuits, is a useful pattern in that by a few simple adjustments the fan can be turned in any direction, and also may be hung on the wall, attached to the ceiling, or planted upright on table or desk. A pattern of cabin fan for alternating currents is somewhat striking, in that it can be applied to low rooms. Four sizes of this pattern are listed, two of each having 12 and 16 in. diameter blades; the energy consumption is 45 and 90 watts respectively.

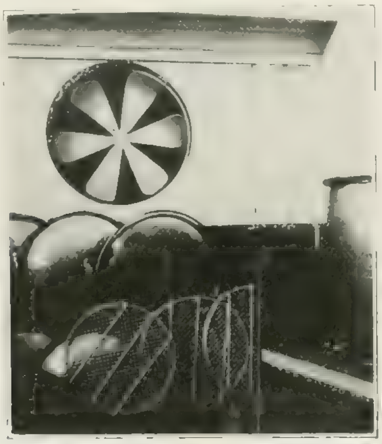
Siemens Electric Fans.

AMONG the product of Siemens Brothers Dynamo Works Limited are electric fans of all the usual sizes and types, such as table fans, ceiling fans and port-hole fans. In order to meet all possible requirements and conditions, the firm gives customers the choice among the following types of fan motors :—Continuous-current motors



Siemens Ceiling Fan - Short Type.

for any voltage up to 500 volts, and single-phase commutator motors, single-phase induction motors and three-phase induction motors for any frequency and for any supply pressure up to 500 volts. The motors are of the protected type or of the totally-enclosed type, as may be desired. The brushes are of carbon, and are readily accessible for



Siemens Porthole Fan in Hotel Kitchen.

inspection and renewal. As will be gathered from the adjoining illustrations, which show several different types, the fans are neat and of strong design.

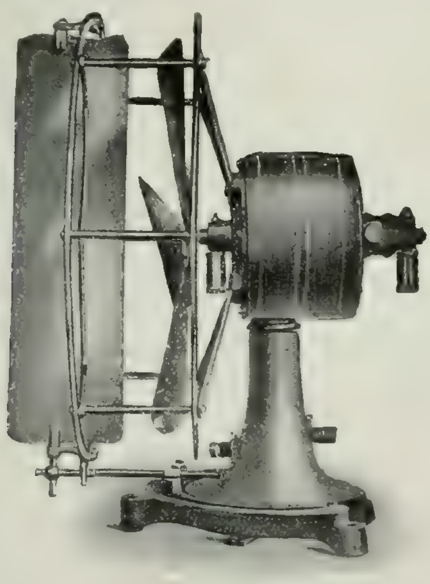
All the table fans are supplied complete with brass wire guards and the guards and blades are nickel plated if required. In all but the smallest sizes the fan may be rotated in a bearing in its base to give the current of air any desired direction. The starting and speed-regulating gear is mounted inside the base of fans of the table patterns, but it is fixed independently of the fans in other patterns. The ceiling fans are made of the "short" or "long"

Siemens Porthole Fan in the Bathroom of a Hospital.

type, as desired, in the latter case the fan is attached to the end of a suspension, the length of which is made to order. Porthole fans may be fixed either vertically or horizontally, and may be fitted, if desired, with Iris or Venetian shutter. The Iris shutter is a convenient adaptation of the well-known diaphragm so commonly used in photography. It is not automatic, as the shutter plates are moved by cords depending from the motor support, but it effectively excludes air when the fan is not working. These fans have been before the public some years now and have proved highly satisfactory in service.

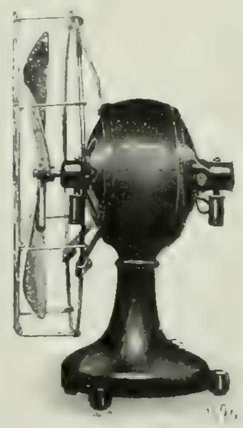
Ediswan Fans.

THE approach of summer has brought out the fan lists of makers and suppliers of these specialities. We use the term "approach" advisedly, because at the moment of writing it is uncertain if the present warm weather will continue. Among the catalogues recently issued that of Messrs. the Edison & Swan Co., relating to electric fans, may be read with interest. As in previous years the company is putting forward a varied selection of designs upon which its customers can draw during the warmer months of the year. The A and B type fans are supplied

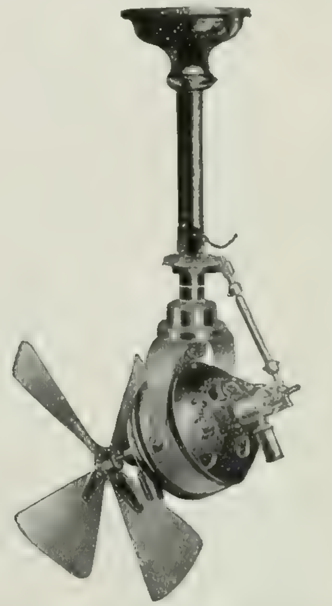


Ediswan Fan on Oscillating Base.

for continuous and alternate currents, the first mentioned being a high quality well-finished design. The d.c. motors have a three-speed regulator, and the a.c. machines run at a fixed speed. The standard patterns are finished in black enamel. The fans are made in the ordinary desk form, and are also fitted in trunnions being in addition serviceable as bracket fans. We illustrate various typical fans herewith. Among the special fans we may mention a short pattern for ship and train use. It is essentially intended for hot climates and sea air, consequently the insulation of the windings is specially treated. A patented bracket is one of the features of the design, this being arranged to allow of the speedy removal of the fan when not required. This bracket is fitted with a swivel which can be locked after the fan is adjusted to the position required. This pattern is made in three sizes, having $9\frac{1}{2}$ in., 12 in., and 16 in. blades. A polished and lacquered brass guard is fitted to the fan. Alternate-current fans figure among the ceiling patterns, two types being put forward, one of these is a slow running

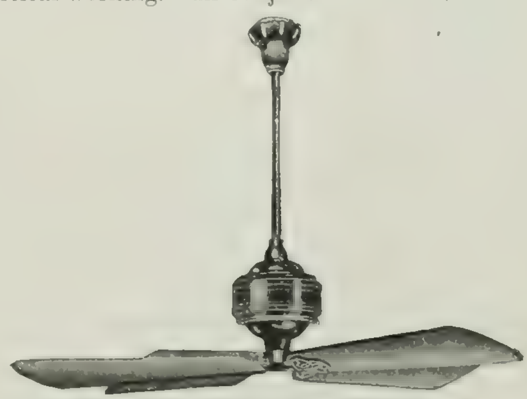


Ediswan Desk Fan.



Ediswan Suspended Fan with Arrangement for Revolving the Fan.

machine (170 revs. per min.), which can be switched directly on to the line without a starting resistance. The company's porthole fans are made in sizes varying from 9 in. to 16 in. diameter of blade, and they are arranged for both horizontal and vertical working. In conjunction with these automatic



Ediswan D.C. Ceiling Fan.

shutters can be provided which open under pressure of the breeze from the pan, and close automatically by gravity; preventing effectively all back draughts. A larger pattern of porthole fan is supplied from a series which ranges in size from 12 in. to 60 in. diameter.

Ceiling Fans.

THE electric ceiling fan is deservedly popular in hotels and restaurants because it can be conveniently hung, is silent in working and requires practically no attention. Ceiling fans are more widely used in foreign countries, and especially in the colonies, than the desk fan, probably on account of the need for constantly moving large volumes of air. Messrs. Ercole, Marelli & Co., of Milan, have specialised in fan construction for many years past, and they have regularly applied themselves to the task of perfecting, wherever possible, small motors for fan operation. We understand that special machines have been designed for the winding of armature and field coils with a view to securing uniformity in the turns and even layers. All armature coils are separately impregnated and varnished before being dropped into the slots The makers claim that these precautions ensure the windings against risk of damage due to damp or extremely hot climates. The same care which is exercised in the winding of d.c. motors is also taken with a.c. machines. These latter are generally of the induction type, and are applied to the driving of all known types of fans for bracket, desk, wall and ceiling use.

Special interest attaches to the alternating-current ceiling fan, known as the "Maestrale" which Messrs. Marelli have just put on the market. This fan is fitted with four wooden blades, which have a sweep of 60 in., and is

Marelli Two-Blade Ceiling Fan driven by Single-phase Motor.

driven by a single-phase induction motor with short-circuited rotor. The makers state that this fan is absolutely noiseless, and that certain features give it a high starting torque. The motor can also start with 40 to 50 per cent. of the normal voltage. An induction regulator is used to control the speed, which can be varied from 160 to 210 revs. per min. It is stated that the energy consumption of this fan is extremely low in proportion to the air moved. As will be seen by Fig. 1, the construction of the fan is elegant yet substantial, and the particular pattern illustrated is interesting in that the stator is inside the motor, the latter revolving outside it. The rotating member is supported by a special bearing, which is kept lubricated by a grease cup at the base of the fan. This transposition of rotor and stator is said to considerably lighten the construction of the fan, while it also assists in the cooling of the rotor, which tends to heat up sooner than the stator.

This firm also manufactures a.c. single phase ceiling fans fitted with four blades of 24 in. and 32 in. sweep, and also with two blades of 36 in. and 44 in. sweep, as illustrated. The firm has branches in Paris, Berlin and the principal towns of Italy and has recently opened a branch office at 26, Garlick hill, Queen Victoria street, London, E.C., mainly to further its export trade, which is a very extensive one.

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THE ELECTRICIAN:

THE OLDEST WEEKLY ILLUSTRATED JOURNAL OF

ELECTRICAL ENGINEERING, INDUSTRY, SCIENCE AND FINANCE.

ESTABLISHED, First Series (Weekly), 1861; Second Series (Weekly), 1878.

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CONTENTS OF THE CURRENT NUMBER.

NOTES.

Is the Consulting Engineer Necessary?

We are glad to notice that three correspondents this week have the courage to sign their names to their opinions on the necessity for the consulting engineer, and that, whereas the correspondence on this important subject began by being wholly anonymous, in the present issue all the communications are signed. Mr. W. R. Rawlings directs attention to a difference between the architect and the consulting engineer, to the disadvantage of the latter. To the architect application is made in the first instance when a man desires a house, but as the lighting is a matter of comparatively minor importance, the architect in such matters applies directly to the electrical contractor. This, no doubt, is often the case, and not infrequently the result has been unfortunate, if not disastrous. Some architects, on the other hand, recognise that electrical matters are not of a simple kind, and have but a remote connection with architecture and plumbing, and they prefer to follow the safer plan of referring such work to a consulting engineer. It is, of course, impossible to ensure that this shall always be done, but we think that the desirability of doing so might be impressed upon architects if suitable means were taken to do so, and an understanding of this kind would be much more feasible if there were a recognised list of consulting engineers.

Mr. Gerald Hooghwinkel deals with the growth of the consulting engineer as a class. This class is one which, for obvious reasons, can be entered very easily, chiefly because but little capital is required. This in itself is a potent reason for limiting the class to those who are duly qualified, and to those in whom the contractor can have some confidence. If that were done the large manufacturer would have little necessity to employ so large an estimating staff, for which some one must pay, though not necessarily the man for whom the work is done. In reference to this system Mr. Hooghwinkel states that the English system, that is, with the consultant, is at least 10 per cent. the cheaper of the two.

Messrs. Pooley & Austin raise some interesting points as to the origin of some of the evils to which allusion has been made on previous occasions. It is pointed out that much of the present difficulty is due to the very nature of the electrical industry; it is somewhat hybrid in its character, it does not stand by itself, and it has never been organised or put on a proper basis. Thus the good of the industry as a whole has been made subservient to individual interests; there has been a scramble for work of any kind irrespective of price, with the result that the industry has suffered and the individual has lost more than he has gained by his short-sighted policy. This state of affairs would have been much improved by the general employment of the consulting engineer. Although the consultant cannot regulate the prices tendered, a specification is the surest preventative of tendering in the dark, and of tendering on a basis which it is hoped will be more favourable than that of some other competing contractor. With regard to the consulting engineer himself, Messrs. Pooley & Austin feel that he has in many cases in

the past placed himself on a pedestal from which to look down upon the manufacturer. In some cases, no doubt, this has been the case, though we think it is now generally recognised that the consultant cannot have the same intimate knowledge as the manufacturer when it comes to a question of details of apparatus. The function of the consultant is essentially to deal with a scheme as a whole, making use of standard apparatus, except in those cases where there is no doubt that special designs are desirable.

Electrification of Railways.

ALTHOUGH there has been a tendency to wait and see what other companies would do, it may, perhaps, be said, if we may judge by the evidence given before the Select Committee considering the Power Bills, that the railways are now looking seriously into the question of electrification. It has generally been thought that the companies would prefer to generate power for themselves, but this does not seem to be altogether the case. The Great Northern, the Great Eastern, and the London & North-Western all gave figures of probable power requirements. The managing director of the London, Tilbury & Southend Railway expressed the opinion that his company were very satisfied with the results so far obtained, and they wished to extend. Suburban lines in London should certainly offer a good field, and until this field has been worked we cannot expect anything to be done in the nature of main line electrification. Unlike certain other countries, coal is cheap in Great Britain, and we have but little in the way of water power. Where water power is abundant it may prove an important factor in the case, as, for example, on the Bavarian State Railways. In our last issue there appeared an abstract of a report dealing with these railways, the subject being considered with that completeness so characteristic of German investigations. Owing to the fact that coal is expensive, and that there is ample water power, the electrification of the whole railway system, amounting in 1906 to 3,976 miles, has been under consideration, but it has been decided in the first instance to electrify quite a small portion in order to gain experience. It is recognised from the outset that electric traction can only be a cheaper system than steam under certain conditions, but that there are other very marked advantages which must not be forgotten. In the particular section selected for experiment it is estimated that the cost of electric working, excluding the cost of energy, will amount to 14·38d. per train-mile, as compared with 21d. for steam working. The two systems will however be on an equality if the cost of electrical energy rises to 0·5d. per unit. Those engineers who are pledged to the single phase system will note with satisfaction that this particular system is to be adopted, and is regarded as that which best fulfils the demands of main line working.

The Marconi Company.

WE have discussed elsewhere the main features of the new issue of capital by Marconi's Wireless Telegraph Co. Ltd. It will be gathered that we have little faith in the company's ability to earn a profit from its transatlantic service. We do not consider that dividend-earning prospects are improved, but are rather retarded, by the proposed extension of the transatlantic service by means of a Poldhu-Cape Cod transmission equipment. It is rather, we think, in the development of its original business, including the manufacture of apparatus for general wireless telegraphic working throughout the world, that the company will overcome its financial troubles, which are, it seems to us, considerable, and are handicapping the good work which the company could perform if its hands were free of this particular business. The shareholders have already waited long and patiently for some return upon their investments, and if the policy of sinking money in transatlantic transmission is persisted in, they will have to wait much longer.

THERE is one point in the prospectus to which, perhaps, reference might here be made. Mr. MARCONI is stated to have "agreed to act as chief engineer to the company for not less than three years." Mr. MARCONI is also acting as managing director, and the duties thus imposed upon him must be of a somewhat arduous and exacting nature. No mention is made in the prospectus, nor was the subject referred to at the recent meeting of the company, as to whether the heavy premium of insurance on Mr. MARCONI'S life continues to be paid by the company. There can be no difference of opinion as to the importance to the company of this particular matter.

University of Leeds.—It is announced that Prof. W. H. Bragg, F.R.S., professor of mathematics and physics in the University of Adelaide since 1886, has been appointed to succeed Prof. Stroud in the Cavendish chair of physics in the University of Leeds.

University of Cambridge.—On the occasion of the installation of the new chancellor (the Right Hon. Lord Rayleigh, O.M., P.R.S.), on June 17th, it is proposed to confer, among others, honorary degrees upon Hon. C. A. Parsons, F.R.S., Sir Andrew Noble, K.C.B., F.R.S., Sir Wm. Crookes, F.R.S., Prof. H. Lamb, F.R.S., and Prof. G. D. Liveing, F.R.S.

The Late Mr. C. H. Reynolds.—At the sitting of the International Telegraph Conference on Wednesday last week, the president (Senhor Pereira) proposed a vote of condolence with the family of the late Mr. Reynolds. This was unanimously accorded, and subsequently communicated to Mrs. Reynolds.

We learn that the funeral takes place to-day (Friday) at Mortlake Roman Catholic Cemetery at 11:30 a.m.

Capacity of Cables.—We regret that some small errors crept into the correspondence on this subject in our last issue. In the particulars of tests given by Mr. F. J. O. Howe, the deflection at the time of discharge of 10 seconds should have been – 470 instead of – 570, whilst the total throw should have been 1,040 instead of 1,140.

Sir William Preece.—Sir William Preece, who has been anything but well for more than two years past, has recently undergone a serious operation. We are pleased to say that the operation appears to have been entirely successful, and Sir William is making excellent progress towards recovery. Despite the serious nature of the trouble, Sir William is in excellent spirits, and is looking forward to being in harness again before many weeks have passed.

Liconite Leadless Cable.—With reference to our description of this cable, which appeared on p. 262 of our last issue, we are informed by Messrs. A. Hendrichs, of Amsterdam, the makers, that Messrs. Wm. Geipel & Co., Vulcan Works, St. Thomas-street, London, S.E., are their agents in this country. The latter firm are exhibiting liconite and liconite cable on Messrs. Hendrichs' behalf at stand No. 260 in the Machinery Hall of the Franco-British Exhibition.

Cable Interruptions.	Date of Interruption.
Cayenne–Salinas	May 12, 1908
Las Palmas–Arrecife	May 18, 1908
Trinidad–Demerara	June 1, 1908
Dardanelles–Constantinople	June 1, 1908

Royal Society.—At a meeting held on Thursday 28th ult. Mrs. Ayrton gave a demonstration of "Wave Motion in Water," in connection with a Paper read by her on the subject on January 30, 1908, before this Society.

Among the Papers read before this Society at the meeting yesterday afternoon was one on "The Electrical Qualities of Porcelain, with Special Reference to Dielectric Losses," by Mr. H. F. Haworth.

Royal Institution.—At a general monthly meeting of this Institution, held on Monday last under the presidency of the Duke of Northumberland, K.G., the chairman announced that he had nominated the following as vice-presidents for the ensuing year: The Right Hon. the Earl of Halsbury, Dr. D. W. C. Hood, Dr. Ludwig Mond, the Right Hon. the Earl of Rosse, Mr. Alexander Siemens, the Right Hon. Sir James Stirling, Sir James Crichton-Browne (treasurer), and Sir William Crookes (honorary secretary).

International Telegraph Conference.—On Thursday the delegates to the Conference and the representatives of the cable and telegraph companies assembled at Lisbon were entertained in the grounds of the Eastern & Associated Telegraph Companies' station at Carcavellos, the guests, who included the president of the Council (Señor Alfredo Pereira) and the British, American and Russian Ministers to Portugal, being received by Sir John and Lady Denison-Pender. A dinner was given in the evening, and was followed by a reception at the British Legation.

Wireless Telegraph Notes.—In the House of Commons a few days ago the Secretary of State for India was asked whether communication by wireless telegraphy had been established between India and any of the other British possessions; and, further, whether any wireless telegraph stations exist in the Indian Empire. Mr. Buchanan replied that, so far as he was aware, no wireless telegraph communication had been established between India and any other British possession. There was wireless communication between Diamond Island and Port Blair and between Sangor Island and the pilot steamer at the sandheads.

Royal Meteorological Society.—At a meeting of this Society held on Wednesday 27th ult., under the presidency of Dr. H. R. Mill, Mr. S. C. Russell read a Paper on "Observations on the Colour of Lightning, made at Epsom, 1903 to 1907." He had for the past five years kept a record of the colours or series of colours noted during each thunderstorm or display of sheet lightning and had tabulated them. He had thus obtained results of observations of fork lightning made during 57 thunderstorms and 78 observations of sheet lightning. It appears that in fork lightning red is the most frequently occurring colour, followed closely by blue, the least frequent colours being orange and green. White is of the greatest frequency in sheet lightning, red and yellow being next. It seems that the presence of hail, when occurring in association with a thunderstorm, is intimately connected with blue lightning.

Lightning and Wireless Telegraph Stations.—While discussion ranges round the question of the damage caused to submerged telegraph cables by steam trawlers, recent happenings show that danger of no little seriousness attends the operations of wireless telegraphy. During the thunderstorm on Tuesday, Mr. H. Prout, the wireless operator who was on duty at the L.B. & S.C. wireless station at Newhaven, Sussex, underwent a somewhat troublesome experience, which, although not so uncanny as the half-penny papers would have us believe, was quite sufficiently exciting for Mr. Prout personally, as he received a very severe shock and had to be relieved of his duties for a time. Considerable damage, too, was done to the station and apparatus by the lightning. The experience at Newhaven would show that the most complete arrangements must be made to protect these stations from the effects of lightning. Obviously, some stations will be more exposed to this class of danger than others.

The Institution of Civil Engineers.—The Council of this Institution propose to award annually a prize to be called the Indian Premium to the author, being a corporate member of the Institution in practice in India, of the best Paper received during the year on a subject connected with Indian engineering. This special award, which when made will be irrespective of any other recognition of the merits of such Paper which the Council may accord to it in the ordinary course, is derived from the proceeds of certain trust funds conveyed to the Institution on the closing of the Royal Indian Engineering College, and will be of the value of about £33 annually. The Council further propose that the income of a legacy of £1,000 bequeathed by the late Mr. L. F. Vernon-Harcourt to the Institution be applied, in general accordance with the testator's wishes, to provide for a biennial lecture on some subject relating to rivers, canals, or maritime engineering to be delivered before meetings of students of the Institution in London and before such of the provincial associations of students as the Council may determine from time to time. The Council recently have accepted on behalf of the Institution a legacy of £1,000, bequeathed by the late Mr. F. W. Webb, to be applied to establish a "Webb Prize," to be awarded by the Council once in every three years, or oftener, as the Council may think fit, for the best Paper submitted to the Institution on "Railway Machinery," or upon some branch of railway machinery which may be prescribed by the Council.

The Tramways and Light Railways Association.—The *Official Circular* of this Association for May announces that the Tramway Congress of the Association will be held at the Franco-British Exhibition on July 9th and 10th. The mornings only will be devoted to business; this will leave the out-of-town members, a large number of whom are expected to attend, free to visit the many attractions of the Exhibition during the afternoons. Members will be received by the Chairman of the Association and the members of the Reception committee in the Congress Hall at 10:30 a.m. on Thursday, July 9th. At 11 a.m. Sir Clifton Robinson, one of the vice-presidents, will deliver a lecture on "The Tramways of the World." At 12 noon Mr. A. H. Gibbings, member of the Association, will read a Paper on "Tramway Rail Joints." At 11 a.m. on Friday, July 10th, Mr. A. L. C. Fell, vice-chairman of the Association, will take the chair; Prof. C A. Carus-Wilson will deliver a lecture on "Rail Corrugation," with illustrations of his experiments. A meeting will be held at the Association's offices on July 24th, when there will be a discussion on this lecture., At 7:30 p.m. on Friday, July 10th, the Banqueting Hall will be reserved for dinner, for the use of members and their friends (including ladies). Applications for tickets should be sent as early as possible to the Secretary, 35, Parliament-street, S.W. The *Circular* contains other matters relating to the Association: the final decision of the Court of Appeal, given on March 13th last, in a case relating to repairs of permanent way which has been going on since 1904; also the report to the Halifax Corporation of Major Cardew and Mr. Graham Harris

ARRANGEMENTS FOR THE WEEK.

FRIDAY, June 5th (to-day).

ROYAL INSTITUTION.

9 p.m. Meeting at Albemarle-street. Discourse on "The Nadir of Temperature and Allied Problems," by Prof. Sir James Dewar, F.R.S.

TUESDAY, June 9th.

FARADAY SOCIETY

8 p.m. Meeting at the Institution of Electrical Engineers, 92, Victoria-street. Paper on "The Utilisation of Atmospheric Nitrogen in the Production of Calcium Cyanamide and its Use in Agriculture and Chemistry," by Dr. A. R. Frank.

WEDNESDAY, June 10th.

INSTITUTE OF METALS.

2:30 p.m. Inaugural Meeting at the Institution of Mechanical Engineers, Storey's-gate, under the presidency of Sir Wm. White, K.C B., F.R.S.

FRIDAY, June 12th.

PHYSICAL SOCIETY.

8 p.m. Meeting in the Physics Laboratory of the Royal College of Science, Imperial Institute-road, South Kensington. Agenda: "Experiments on a Directive System of Wireless Telegraphy," by Messrs. Bellini and Tosi; "On the Lateral Vibration and Deflection of Clamped Directed Bars," by Dr. Morrow; "On the Resistance of a Conductor of Uniform Thickness whose Breadth suddenly Changes and on the Shapes of the Stream Lines," by Prof. Lees: "On the Self-Inductance of Two Parallel Wires," by Dr. Nicholson; "On Homogeneous Secondary Radiation," by Dr. Barkla and Mr. Sadler; and "Notes on the Motion of a Corpuscle and on Cloud Formation," by Prof. Morton.

ELECTRIC TRACTION ON RAILWAYS.*

VI.—GENERAL COMPARISON OF CONTINUOUS AND ALTERNATING-CURRENT TRACTION.

BY PHILIP DAWSON.

(*Continued from page 208.*)

Summary.—The author, having discussed the characteristics of continuous-current and three-phase traction motors in our issues of January 31st and February 28th respectively, now passes on to the consideration of the single-phase motor. After summarising the development of this motor from the historical point of view the author gives particulars of the Westinghouse, Oerlikon, Siemens-Schuckert, General Electric and Eichberg motors.

So far we have discussed the standard series motors practically constructed, and already in actual use, but we must now consider the other type generally known under the name of "compensated repulsion" motor, as constructed by the Allgemeine Elektricitäts Gesellschaft, of Berlin, and patented and designed by Dr. Friedrich Eichberg. But before doing so it may be interesting to briefly summarise the particular characteristics common to practically all series single-phase motors.

The voltage at the terminals of a motor is, as far as present experience shows, limited to a maximum of 300 volts, which, however, is very rarely reached, the practiced maximum being nearer 250 volts, and the average power factor being probably in the neighbourhood of 87 per cent., and consequently it is at this pressure, and with a fairly low power factor for the few seconds which must elapse while speed is being gathered, that the currents which have to be handled by the contactors, reversers and other main controlling gear have to be ascertained. It will also be seen that although in some cases each set of motors for service reasons are generally restricted to two, although the original series motor only required one transformer, a secondary exciting series transformer is in many cases utilised, as is done for instance both by the Oerlikon Company and Messrs. Siemens Schuckert, and furthermore that except in those exceptional cases where the number of commutator segments is very large and the voltage between sections can therefore be considerably reduced, resistance leads between the armature coils and the commutator segments are a necessity, with the result that care must be taken not to allow heavy currents to circulate through the armature, except when it is revolving, for if the currents had to be carried for any appreciable time by one resistance lead there would be danger of it being burnt out. The two principal features of the series system therefore are: (1) A transformer is essential and the pressure of current to motors cannot exceed 250 to 300 volts. (2) In practice it has generally been found necessary to put resistances in the armature circuit between the armature coil and the commutator segments. (3) The currents dealt with by the contactors are at the low pressure of 250 to 300 volts.

We will now consider the compensated repulsion type of motor so successfully developed by Dr. Friedrich Eichberg.

The motor consists of a stator (*see* Fig. 41) like that of the ordinary induction motor with a series single-phase winding in slots, and a commutator armature or rotor (Fig. 42) arranged in the same way as that of the D.C. motor. Two brush holders are fixed over the armature having their axis at 90 degrees. Fig. 43 is a diagram of the connections. The first holder, whose axis is parallel with that of the stator winding, is short circuited and carries the proper working current, which is induced by the main magnetising field in the direction of the axis of the stator winding. The second brush holder is connected to the secondary of an auto-transformer in the main circuit, and carries only the magnetisation currents which produce a cross field at right angles to the first mentioned field. This, with the stator current, provides the effective torque.

Sparkless commutation is secured by the arrangement of the two separate fields. The E.M.F. which will be produced through the induction of the field in the short-circuited winding will entirely disappear as the speed increases by reason of the E.M.F. produced through rotation in the second field. Also in the short-circuited winding there will be induced an E.M.F. which is independent of the speed, and which cannot be in any way reduced.

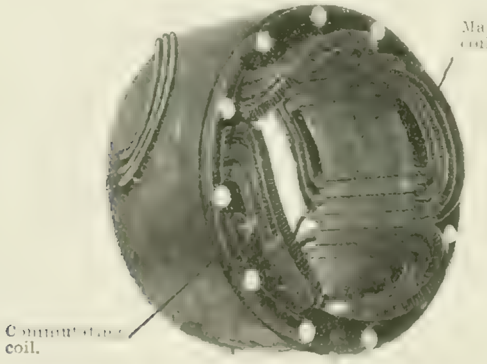


FIG. 41. STATOR OF WINTER EICHBERG 115 H.P. SINGLE-PHASE MOTOR.

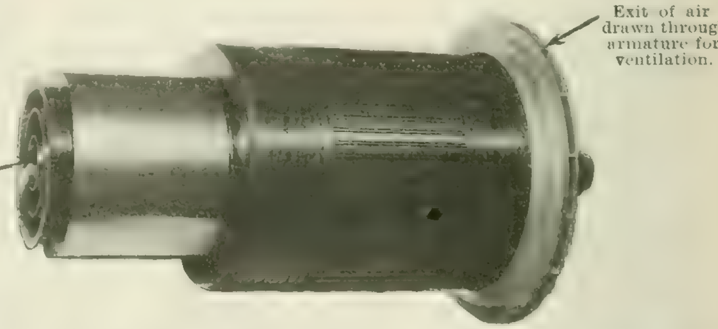


FIG. 42. ROTOR OR ARMATURE OF WINTER EICHBERG SINGLE-PHASE 115 H.P. RAILWAY MOTOR MANUFACTURED BY THE ALLGEMEINE ELEKTRICITÄTS GESELLSCHAFT, BERLIN.

An E.M.F. will further be produced in the exciting circuit of the rotor by reason of its rotation. This E.M.F. will not only be able to reduce the injurious E.M.F. of self induction of this circuit, but also the E.M.F. arising from the primary and secondary leakage flux, that is to say as the speed increases the power factor approaches the value unity, which value can be kept constant within broad limits by reason of the special form of regulation.

Thus one can make the air gap practically as big as in the D.C. machine without affecting the electrical value, and have open stator slots instead of closed ones. The ratio of transformation of the exciter transformer can be regulated by changing the contact point on the winding. When the auto-transformer is kept at a particular ratio of transformation, the motor works exactly like a D.C. series motor that is to say, the current strength and moment have their greatest value at standstill, and both fall off with increasing speed.

This happens in the following way: a given line current corresponds to a current in the exciter circuit, proportional to the ratio of transformation, to which the field will also be proportional. By rotation in this field an E.M.F. is produced in the short circuited brush circuit, which is pro-

portional to the instantaneous speed, and which opposes the E.M.F. induced by the principal field ϕ.

The difference of these two electromotive forces causes a current to flow in the short-circuited circuit, to which the current in the stator corresponds. This produces, as already shown, the effective turning moment; the exciter field F working with it to this end. When this moment is greater than the required working moment it then follows that both the speed of the motor and the counter E.M.F. increase; the short-circuit current, the total current, and so the exciter current and field then decrease.

The field and current, which together produce the moment, both decrease with increasing speed, and so a speed will ultimately be established at which the obtained and required moments will be equal. Through the turning of the rotor in the field, an E.M.F. is produced which opposes the self induction of the exciter circuit; that is the impedance of the exciter circuit, and thence the E.M.F. produced by the exciter circuit, decrease with increasing speed.

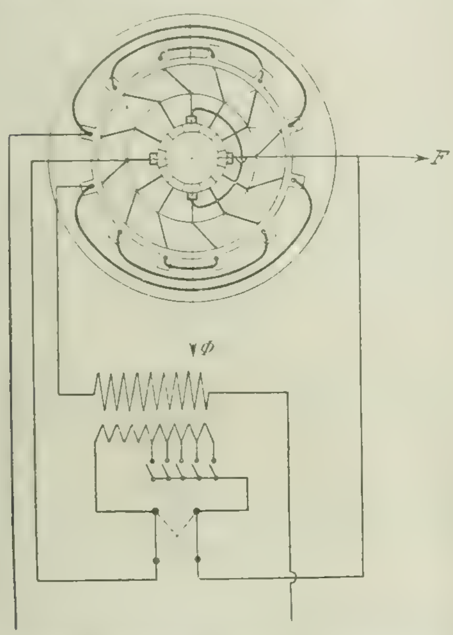


Fig. 43.—Diagram Showing Principal Connections of Winter Eichberg Single-phase Motor.

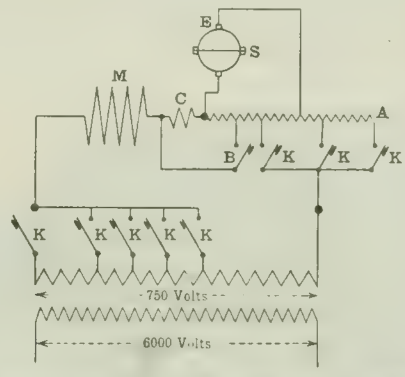
Also the apparent impedance of the auto-transformer decreases and with increasing speeds a greater part of the total voltage goes to the stator; thereby the E.M.F. induced in the short-circuited circuit increases, and the speed must still further increase in order to produce a counter force to balance the propelling force.

Now diminish the ratio of transformation of the auto transformer; this will have the effect of displacing the characteristic curve of the motor in such a way that the same moment which before corresponded to a speed N, now corresponds to a greater speed N_2; the same speed corresponds to a greater moment than formerly, the standstill moment is also greater.

The reason that with a greater number of secondary turns of the auto-transformer the characteristics of the motor are higher is as follows:—The exciter current is, as explained, proportional to the ratio of transformation of the primary to the secondary, thus it decreases for the same line current with an increasing number of secondary turns. The exciter field, of course, decreases with the current, and the motor must have an increased speed to produce the necessary counter E.M.F. The same line current corresponds now to a smaller moment and a greater speed than formerly. In a similar way the starting of the motor will be effected by changing the ratio of transformation of the regulating transformer.

At standstill the current-circuit of the exciter brushes remains interruped. The primary winding of the auto-transformer works as a choking coil, and the whole motor has now but little current flowing through it. It is thus superfluous to open the high-tension primary winding of the motor to stop, it is sufficient to open the exciter circuit (low tension), for the motor will only run when the exciter circuit is closed. When the motor stands still close first the stator circuit and then the exciter circuit, which will start the motor, the speed will increase and the current decrease.

After the speed has been obtained which corresponds to the required torque, the next point of the regulatory transformer will be connected. Instantly the current and torque will increase, since for the second point the same speed corresponds to a greater moment than the first. Then the current strength again begins to decrease and the speed to increase, and when the steady speed for the second point has been obtained, move to the third, and so on, till the required torque at the required speed is obtained. So that at each particular point the motor always runs in the neighbourhood of the speed most suitable for this point, that is to say, cos ϕ is pretty well constant at unity during the starting period. Resistance losses do not come in at the start. When the motor first starts the currents are not quite the same as in the D.C. machine.



M Main stator magnetising coils. C Commutating coils. A Exciting auto-transformers. E Exciting brushes. S Short-circuited brushes. B Switch closed in order to secure sparkless running with heavy loads. K Contactors operated by electromagnets operated by the master controller.

Fig. 44.—Diagram of Connections of Eichberg Low-tension Single-phase Compensated Repulsion Motor as proposed for London, Brighton & South Coast Railway.

The motor is necessarily changing the direction of the current in the exciter circuit by means of the usual two pole low-tension switch. In this motor, starting, regulating, and reversing are all accomplished on the low tension side. It will be noted that in this type of motor it will be quite possible to so construct it that the only current requiring to be transformed is that used for excitation purposes, and supplied to the excitation brushes on the commutator. Thus as far as possibility of being worked directly off the high tension working conductors, this type of single phase motor is on a par with the three phase motor, only that owing to the fact of only one overhead conductor being necessary there is no theoretical reason why this motor should not have its stator windings constructed for anything up to say 10,000 volts.

There are, however, practical reasons both from the point of view of cost of manufacture and upkeep, as well as the increase in size of machines (space for which is limited), which make it undesirable in practice to have any motor winding wound for extra high tension; in fact the only extra high tension winding which present experience indi-

cates can be tolerated on a car are those which are cased with a metallic case, and covered with oil. And this remark would seem to apply to all alternating current systems no matter whether polyphase or single phase.

Fig. 44 represents the diagram of a motor similar to the connections of those that will be used on the motors for the London, Brighton & South Coast Railway electrification, and this diagram must be considered simultaneously with Fig. 41, which illustrates the stator of these motors, and shows the magnetising and commutating coils in position. It will be noted that the magnetism and commutating windings can be varied by closing and opening the switch B, such movement in practice, of course, being effected by a special contactor operated by the master controller; experience would seem to show that the simplest way would be to have the switch constantly closed.

The latest method of connections is shown in Fig. 44. In this arrangement the exciter transformer is placed in series with the magnetising and commutating coils, and the commutation can, by means of what may be called over compensation, be improved for high currents.

The speed regulation is effected in this arrangement by changing simultaneously the ratio both of the exciting and main transformer as shown in the diagram, and furthermore, by this means it is quite impossible that greater pressure should be applied to the terminals of the regulating transformer than that corresponding to the motor armature. In

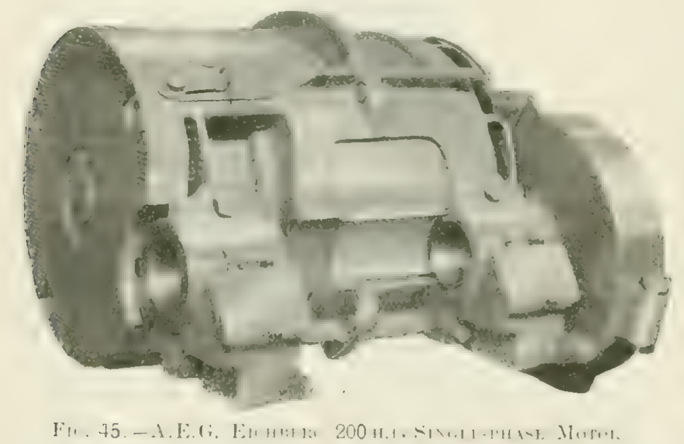


FIG. 45.—A.E.G. EICHBERG 200 H.P. SINGLE-PHASE MOTOR.

other words the difference between this system of connection and that previously used consists in an electrical connection as well as a magnetic connection between the rotor and stator circuits. The difference is clearly shown by looking at Fig. 43 already referred to, and Fig. 44, from which it will be seen that in this latter arrangement there is no direct connection between the rotor, stator and regulating transformer circuits.

This diagram also clearly shows why it is that the contactors only deal with currents at 750 volts instead of at half or one-third of this pressure, i.e., 250 volts as must necessarily be the case with the plain series single-phase motor, and therefore have much smaller currents to control than in the case of the series machine; also a stator winding of the distributed portion is used as is the case with the majority of the other single-phase motors already discussed. Fig. 42 is a view of the rotor of this machine. The armature punchings have special holes punched, the shaft at its commutator end is hollow and air is sucked through it, which escapes through holes specially devised in the shaft at the armature end of the commutator, so that from these it passes through the rotor punchings, escaping at the other end through holes arranged at the periphery of a special disc, shown in the illustration, which, acting like a centifugal fan, assists in drawing air in through the shaft at th commutator end of the rotor. The general appearance of such a motor is clearly shown in Fig. 45, which represents a 200 H.P. motor. The actual characteristic curves deduced from actual tests carried out specially for the writer are given in Fig. 46 for the single-phase motors now in practical operation on the Hamburg Blankenese Altona line, an important suburban railway owned by the Prussian Government, and the services already obtained on this line have brought about the decision of the Prussian Minister for Railways to electrify the whole of the Berlin

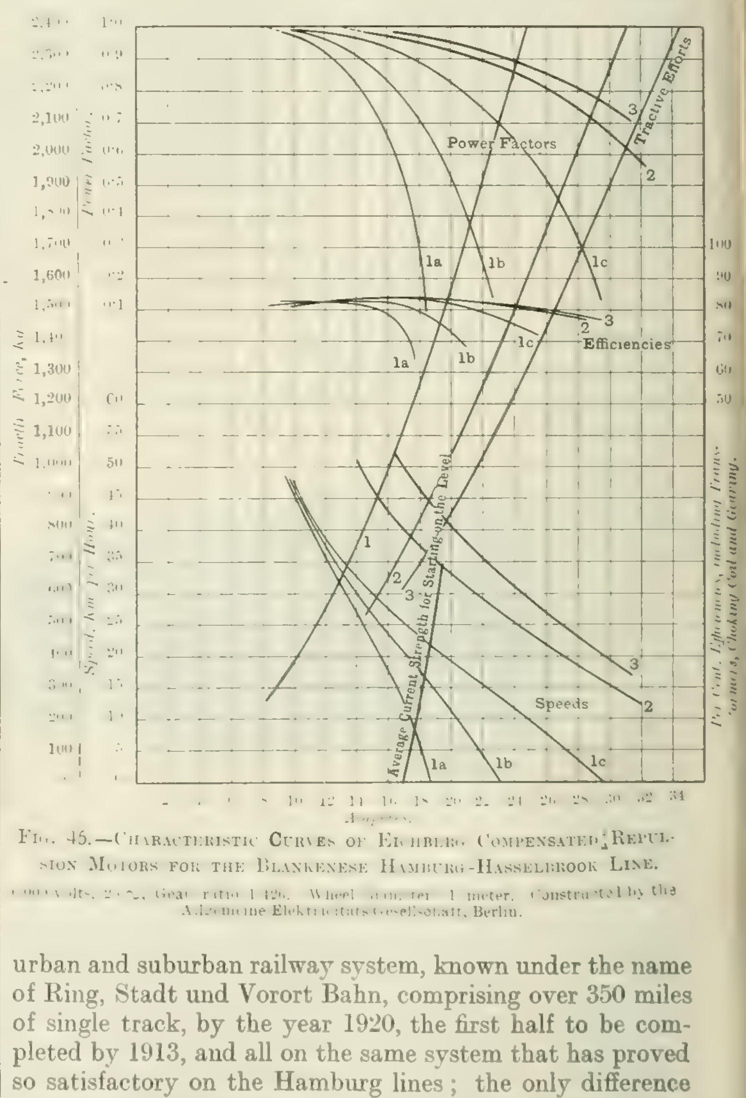


FIG. 46.—CHARACTERISTIC CURVES OF EICHBERG COMPENSATED REPULSION MOTORS FOR THE BLANKENESE HAMBURG-HASSELBROOK LINE.

6,000 volts, 25 ~, Gear ratio 1:4.26. Wheel diameter 1 meter. Constructed by the Allgemeine Elektricitäts-Gesellschaft, Berlin.

urban and suburban railway system, known under the name of Ring, Stadt und Vorort Bahn, comprising over 350 miles of single track, by the year 1920, the first half to be completed by 1913, and all on the same system that has proved so satisfactory on the Hamburg lines; the only difference being that the voltage used for the overhead working conductor will have a pressure of 10,000 volts instead of 6,000 volts, as is the case in Hamburg.

(To be continued.)

THE ELECTROLYTIC COPPER-REFINING INDUSTRY IN 1907.

BY JOHN B. C. KERSHAW.

I. PRODUCTION AND PRICE.

If capitalisation be accepted as a measure of importance, the electrolytic copper-refining industry is by far the most important of the electrochemical and electrometallurgical industries, for although the power used in this industry is comparatively small, the capital sunk in it is large, and probably exceeds £15,000,000 sterling. The tendency in recent years towards the substitution of mechanical appliances for hand labour in the larger and best managed refineries, has also increased the first cost of the plant and equipment, although the working costs have been reduced by this change.

The value of the copper locked up in the vats of the refineries, represents alone a very big item in the capital account. The writer has calculated that for an output of 400,000 tons of electrolytic copper per annum, 50,000 tons of copper, valued at £2,500,000, must be present continually in the vats of the refineries. Recent improvements in the process have therefore been directed towards obtaining a quicker turn-over of the copper in the vats, by means of more rapid and more efficient circulation of the electrolyte, and by the use of higher-current densities. The actual output of electrolytic copper in 1907 is estimated to have been about the same as in 1906, or 400,000 tons, equal to 56 per cent. of the world's production.

The total output of raw copper in 1907, according to Messrs. H. R. Merton & Co.'s annual statistical circular, was 716,435 tons, an increase of only 2,335 tons (or 0·3 per cent) upon the total of 1906. The average price of bar copper in 1907 was £87. 1s. 8d. as compared with £86. 5s. 2d. in the previous year. A fall of £44 per ton in value occurred between January and December, copper starting the year at £106. 10s. and ending it, at £62 per ton. The highest point was touched at the end of February and the first week in March, 1907, when bar copper sold for the record price of £110. 6s. per ton. The figures for the production and price of copper during the period 1889-1906 were discussed in detail by the present writer in an article published in the issue of *The Electrician* for April 19, 1907, nd there is consequently no necessity to submit them to further examination in this article.

The consumption of copper in the United Kingdom during 1907 has been greatly restricted by the high price prevailing during the greater portion of the year, and it is doubtful if the consumption of the metal has approached within 20 per cent. of the total for 1906, which has been estimated at 107,600 tons.

The depression in the electrical engineering industry in this country has also affected the consumption adversely, but at present there is no means for ascertaining the extent of this falling off in the demand for copper.

II.—Works Details.

The total number of works refining copper by the electrolytic process is now between 36 and 40—new works being in course of erection in Russia and in Australia.

The latest returns for the distribution of these works are as follows: –

America (United States & Canada)...	11	
United Kingdom	6	
Germany	9	
France	4	
Russia	2	(2 erecting)
Austria-Hungary	2	
Japan	2	
Australia		(1 erecting)
Totals........................	36	(3 in course of erection.)

The American refineries are by far the largest and most important, no less than 86 per cent. of the total output of electrolytically refined copper being produced in these 11 refineries. The six refineries of the United Kingdom are believed to produce between 35,000 and 40,000 tons per annum, but in the absence of any official information or returns, this figure must be accepted as an estimate only. The remaining 19 refineries thus contribute only 6 per cent. to 8 per cent. of the world's total output of electrolytic copper, though this proportion is increasing.

The largest refinery in the world is that known as the Raritan Copper Works, situated at Perth Amboy, N.Y. This refinery is owned by the United Metals Selling Co., of New York, and is stated by Ulke to have a capacity of 200 short tons (2,000 lbs.=1 ton) of refined copper per day, equivalent to a production of 64,000 tons (of 2,240 lbs.) per annum. The vat house contains 1,600 depositing vats, each vat when fully charged contains 22 anodes and 23 cathodes arranged on the multiple system. Each anode weighs 400 lbs. and the weight of copper in a newly-charged vat, apart from that present in the electrolyte, is thus about 8,800 lbs. or 4 tons. The electrolyte is maintained at a temperature of 120°F. by the aid of steam coils in the circulating wells, and by this means the E.M.F. is kept low. About 43 days are required to transfer the greater part of the copper from the anodes to the cathodes in the vat, and assuming that 1,500 vats are maintained continually in operation, this is equivalent to a lock up of 6,000 tons of copper in the Raritan works.

Since 43 days are required to complete the turn-over of the metal, the annual output of electrolytic copper cannot exceed $6{,}000 \times \frac{365}{43} = 51{,}000$ tons, and the figure given by Ulke is thus seen to be somewhat too high.

It is quite possible, however, that the higher output is at times attained by the use of a higher-current density than the 15 amperes per square foot of cathode area, which represents that normally used.

The silver and gold recovered from the slimes of the copper vats at the Raritan refinery amount to between 8,000 and 10,000 oz. of silver, and from 175 to 200 oz. of gold per day.

III.—New Developments and Processes.

Australia.—The Electrolytic Refining & Smelting Co., of Australia has been floated in Sydney, New South Wales, for the purpose of erecting and operating an electrolytic-copper refinery at some central position in Australia. The Mount Morgan Copper Co. have decided to take an interest in the new organisation, and have given up the idea of erecting a refinery at Mount Morgan in connection with their own smelting works. The capital of the new Company is £150,000, and building operations are to be commenced as soon as the locality and site of the works are settled. The Mount Morgan Co. has hitherto sent its raw copper to America for completion of the refining process.

Russia.—An electrolytic copper *extraction* process, patented by Laschinsky, is being operated at the "Medianke" copper mine at Boleslav. Details of this process are given in *The Electrician* of September 6, 1907, and by Professor Piltschikoff in a paper read before the Faraday Society on April 28. From the few details supplied, this process appears to be very similar to the Carmichael extraction process, patented in U.S.A. and operated for some months at Dorchester in Canada, in 1903. The Carmichael process used a dilute solution of sulphuric acid as a leaching liquid, with lead anodes and cathodes in the depositing vats. An output of one ton of copper per day was attained. The cause of the non-success of this process at Dorchester is not known—but probably the low percentage of copper in the original ore, and accumulation of iron in the electrolyte were the causes of failure.

Laschinsky, according to *The Electrician* note, makes use of a 5 per cent. solution of sulphuric acid as leaching liquid, and obtains a liquor containing 5 per cent. of copper and 1 per cent. of free acid. This liquor is filtered, and is then electrolysed, using lead plates enclosed in cloth as anodes, and thin copper sheets as cathodes. A current of 1,000 amperes at 2·5 volts is used for depositing the copper, with continual agitation of the electrolyte.

It may be doubted whether this process will be more successful than the Carmichael and other processes that have preceded it, in spite of the richer character of the ore which is being worked. Copper "extraction" processes, using a liquid solvent, have always failed owing to the accumulation of other metals in the electrolyte, and the Laschinsky modification of the Carmichael process does not appear to contain any precautions against the recurrence of this difficulty.

The consumption of electrolytic copper in Russia ranges from 7,000 to 9,000 tons per annum, while the output of raw copper in 1907 is stated by Mesrs. H. R. Merton to have been 15,000 tons. A group of financiers interested in the copper mining and smelting industry, have formed a new company, for the purpose of erecting a central electrolytic refinery at Moscow. The raw copper will be obtained from the mines in the Ural and Caucasus Mountains. The copper refinery of Messrs. Siemens Bros. at Kalakant is not now in operation,

while that of Nikolajev at Moscow only produces 500 tons of copper per year.

The United Kingdom. – A process, patented by H. G. Dolphin, for improving the circulation and aeration of the electrolyte in copper depositing vats has recently been installed in several refineries in this country. This process differs from that patented by Messrs. Siemens & Halske and Borchers Bros., and used by them at the Goslar Refinery in Germany. Messrs. Siemens & Halske use compressed air for agitating and aerating the electrolyte, while Dolphin makes use of the force of gravity, and causes the electrolyte as it enters the vat to draw in with it the requisite amount of air. The advantages of this method of feeding the vats are stated to be as follows :—

1. The electrolyte is always of one density throughout the vat, and an absolutely steady motion is given to the liquor entering the vat from the feed tube.

2. The silver slimes are not disturbed, and the cathodes do not contain more than ½ oz. of silver per ton of copper.

3. The iron in solution is oxidised, and is precipitated with the other impurities on the floor of the vat.

4. The cathodes are practically free from nodules, owing to the air bubbles which form on their surface being constantly removed by the friction of the electrolyte.

5. The possibilities of short-circuits are minimised.

STREET LIGHTING IN THE CITY OF LONDON.

For the past two years the question of whether or not the streets of the City should be electrically lighted has been a prominent topic. About nine months ago (see *The Electrician*, Vol. LIX., p. 622) we mentioned that experiments were to be made in Cannon street and Holborn-viaduct on this subject and expressed the hope that the results would be such as to induce the Corporation to light all the streets of the City electrically. We give below in extenso a report of the electrical engineer of the City of London, Mr. A. A. Voysey, to the Streets Committee of the Corporation dealing with this subject. If the statements there made are to form the basis of any change a further adoption of electric lighting should not be long delayed. The report is as follows :—

It is now my duty to report on the subject of the public lighting of the City, having regard to recent experiments which have been made with a view to improve and cheapen it. In the first place, I propose briefly to refer to what is called the science of photometry, of which I have made some use for the purpose of this investigation.

Many people, even to-day, in dealing with questions of artificial light, are content with a statement of the candle-power of the source of light a statement frequently as false as it is vague—taking no account of the directions in which light is given, of the globe, lantern, reflector, position and surroundings of the lamp, all factors of the utmost importance in determining the useful lighting effect. However important the study of the source of light may be, the study of the actual illumination in the street under working conditions is far more essential. In 1892, the work of Mr. A. P. Trotter, now the electrical adviser to the Board of Trade, showed the lines on which such an examination might proceed, and at the same time provided an excellent illumination photometer for the purpose. I worked a great deal with this instrument in the City in 1896, taking measurements of the illumination on a horizontal surface 6 in. from the ground, and formed the opinion that the illumination measured on a horizontal surface may be taken as a sufficient indication of the effective lighting of a street. I am now again led to the same conclusion. But as the tendency is to measure illumination at a height of 4 ft. from the ground, my recent tests have been made at this level. The photometer used is an improvement on the one used in 1896, and was sent to the National Physical Laboratory for verification. The unit of illumination is that produced by 1 c.p. at a distance of 1 ft., and is called 1 candle ft.

Attached hereto will be found some curves showing the illumination given in Holborn Cannon street and Queen-street by the experimental lamps. The length of the street in feet is plotted along a horizontal scale, and the vertical scale is marked in candle-feet and fractions thereof, so that the curves show the variation in illumination along the street. Curves "A" show the illumination along the curb line given by flame arc lamps in Holborn-viaduct and Cannon street and by gas in Queen street. Curves "B" are similar, but are taken along the centre of the road. Curves "C" show the difference in illumination along the curb in Cannon street, between the central suspension of lamps at a height of 28 ft. and lamps on posts at a height of 20½ ft. Curves "D" are similar, but along the centre of the road. There is also shown the effect of turning out one of the centrally-hung arc lamps. Curves "E" show the effect of suspending the lamps in Cannon-street at

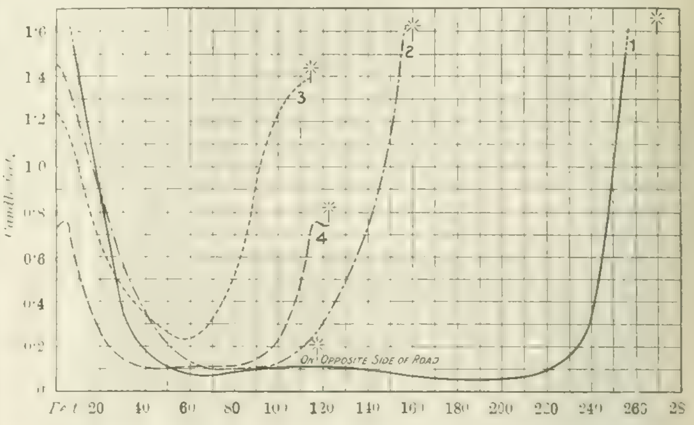


FIG. A.—CURVES SHOWING ILLUMINATION ALONG THE CURB LINE IN HOLBORN VIADUCT, CANNON-STREET AND QUEEN-STREET.

Curve No.	Street.	Lamps.	Current. Amps.	Height and support	Illumination. Max.	Avg.	Min.	Width of street.	Relative cost.
1	Holborn-viaduct	Flame arc	10·6	20·5′ Post	2·0	0·41	0·05	77·5′	118
2	Cannon-st.	Ditto	11·0	28·0′ Central	1·6	0·56	0·1	50·0′	100
3	Ditto	Ditto	11·0	Ditto	1·4	0·12	0·23	50·0′	139
4	Queen-st.	High pres. gas (two mantle	...	13·0′ Post	0·76	0·29	0·1	50·0′	196

26 ft. instead of 28 ft. Curves "F" show the effect of lighting Tower Royal with the centrally-suspended flame arc lamp in Cannon-street, with a flame arc on a post and with two incandescent gas lamps. The arc light curves marked "A" and "B" are each

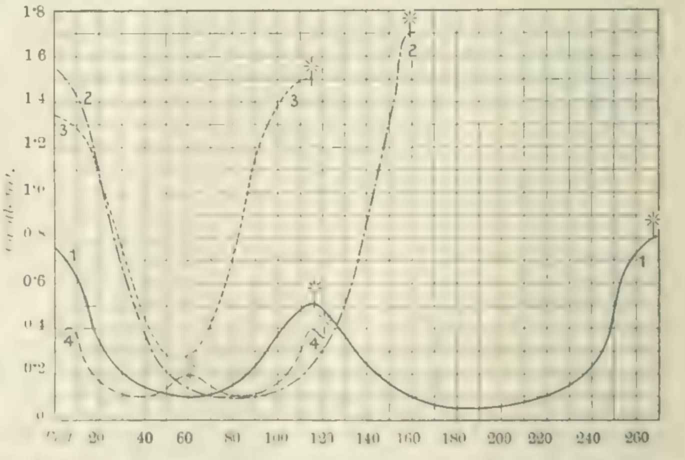


FIG. B.—CURVES SHOWING ILLUMINATION ALONG THE CENTRE OF THE ROAD IN HOLBORN-VIADUCT, CANNON-STREET AND QUEEN-STREET.

Curve No.	Street.	Lamps.	Current. Amps.	Height and support	Illumination. Max.	Avg.	Min.	Width of street.	Relative cost.
1	Holborn viaduct	Flame arc	10·6	20·5 Post	0·8	0·28	0·06	77·5	118
2	Cannon st.	Ditto	11·0	23·0 Central	1·7	0·66	0·10	50·0′	100
3	Ditto	Ditto	11·0	Ditto	1·5	0·38	0·28	50·0′	139
4	Queen st.	High pres gas (two mantle	...	15·0 Post	0·4	0·21	0·10	50·0	196

taken as the mean of several curves, and the atmospheric conditions when the tests were made were clear and favourable. The curves "C," "D," "E" and "F" were taken with a view to make specific comparisons, and they each represent a single set of observations.

The atmospheric conditions prevailing when curves "E" were taken were distinctly inclined to be foggy.

It is now necessary to consider what conclusions can be drawn from the curves. I have already stated that I think the illumination given on a horizontal surface can be taken as a sufficient indication of the value of the lighting in a street. Next, I have formed the opinion, from observation and testing, that the minimum illumination is the most important factor in good lighting,

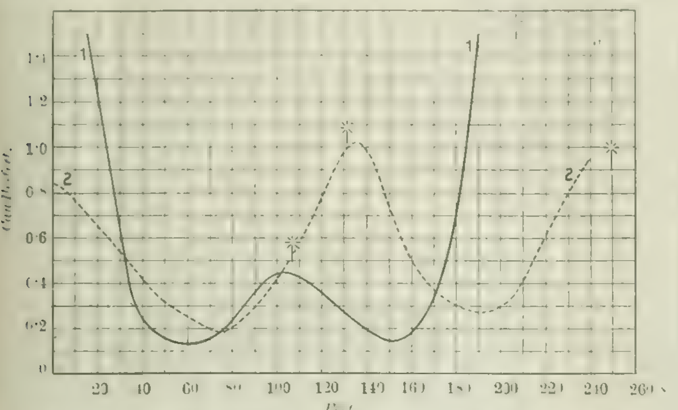


FIG. C.—CURVES SHOWING ILLUMINATION ALONG THE CURB IN CANNON STREET.

Curve No.	Street.	Lamps.	Current Amps.	Height and support.	Illumination. Max.	Avg.	Min.	Width of street.	Relative cost.
1	Cannon-st	Flame arc	11·0	20·5′ Post	2·0	0·68	0·14	50′	155
2	Ditto	Ditto	11·0	28·0′ Central	1·02	0·56	0·19	50′	127

and I have come to the conclusion that about one-tenth of 1 candle ft. is the minimum below which it is not desirable to go in the main streets of the City. If that figure is adopted and maintained, then I think that the main streets of the City will be very well lighted. If the curves for Holborn-viaduct are studied, it will be seen that, although Holborn-viaduct is a very wide thoroughfare, the lighting is not very far from complying with the minimum value which I think necessary.

In order to meet any possible objection to unpleasant colour, the Holborn-viaduct lamps are trimmed with carbons giving a pleasantly-

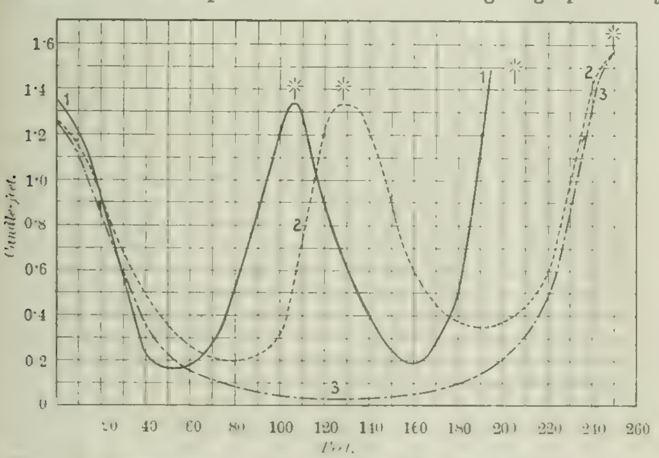


FIG. D.—CURVES SHOWING ILLUMINATION ALONG THE CENTRE OF THE ROAD IN CANNON-STREET.

Curve No.	Street.	Lamps.	Current Amps.	Height and support.	Illumination. Max.	Avg	Min.	Width of street.	Relative cost.
1	Cannon-st.	Flame arc	11·0	20·5′ Post	2·00	0·70	0·17	50′	155
2	Ditto	Ditto	11·0	28·0′ Central	1·56	0·72	0·20	50	127
3	Ditto	Ditto	11·0	28·0′ Central	1·56	0·40	0·04	50′	64

toned light, but the illumination is thereby reduced. If 7 mm. and 6·35 mm. (cores $\frac{3}{32}$ in. and $\frac{1}{16}$ in. respectively) carbons are used in Holborn-viaduct, giving a yellower light, the minimum illumination would be increased so as not to fall far short of the necessary value, and it could be regarded as approximately fulfilling what I think are the reasonable requirements for the sufficient lighting of a City main street. I do not think that Holborn-viaduct can properly be compared with Cannon-street, because in addition to other reasons, the width of the viaduct is about 50 per cent. greater than the width of Cannon-street. Therefore, I determined to make another test in Cannon-street, first with the centrally hung lamps as used at present and then with identical lamps on posts on the footway, keeping the conditions of current and carbons the same for both. The arrangements for this

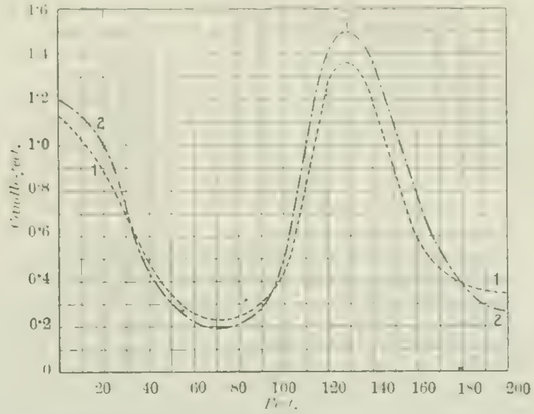


FIG. E.—CURVES SHOWING ILLUMINATION ALONG THE CENTRE OF THE ROAD IN CANNON-STREET.

Curve No.	Street.	Lamps.	Current. Amps.	Height and support.	Illumination. Max.	Avg.	Min.	Width of street.	Relative cost.
1	Cannon-st.	Flame arc	11·0	28′ Central	1·37	0·66	0·23	50′	—
2	Ditto	Ditto	11·0	26′ Central	1·50	0·72	0·23	50′	—

test were kindly made for me by the City of London Electric Lighting Co., and the results shown in curves "C" and "D" indicate the advantage obtained by central hanging in a street such as Cannon-street, which is fairly typical.

The illumination curves of the centrally-hung lamps in Cannon-street show that the lighting also fulfils the suggested condition that the minimum should not be less than one-tenth of 1 candle-ft., and I think the curves are very good ones and indicate what is obvious from an examination of the street—namely, that the lighting is very good—and if we study the curves the advantages of the central suspension and the extra height of the lamps are evident. From the central suspension there is, however, an additional gain for side streets and at the junctions of streets owing to the fact that the light of one lamp can be used over a greater area. For instance, 45 per cent. of the cost of lighting in Cannon-street is saved on gas in the side streets. This economy could to some extent be obtained by placing posts at the corners of streets, but I do not think it

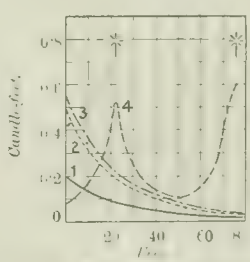


FIG. F.—CURVES SHOWING SIDE STREET ILLUMINATION (TOWER ROYAL).

Curve No.	Street.	Lamps.	Current.	Height and support.	Illumination. Max	Avg.	Min.	Relative cost.
1	Tower Royal	Flame arc	11·0	20·5′ On Post	0·20	0·08	0·025	Nil
2	Ditto	Ditto	11·0	28·0′ Central	0·48	0·16	0·04	Nil
3	Ditto	Ditto	11·0	26·0′ Central	0·56	0·19	0·04	Nil
4	Ditto	Low pres. gas (single mantle)		11·6′ Bracket	0·60	0·25	0·08	£6 14 4 per annum

could be obtained to the same extent as is possible with the higher centrally-hung lamp. An experiment was made in Cannon-street at the suggestion of the late chairman, Mr. Stopher, some of the lamps being hung at 26 ft. instead of 28 ft. The result is given in curves "E," which, I think, show that the higher position is slightly better than the lower one. Curves "F" show the illumination in

Tower Royal, a turning off Cannon-street, lighted by the centrally-hung arc lamp, and by the arc lamp on a standard in Cannon-street, and by the two incandescent gas lamps on brackets in Tower Royal. The curves show the advantage of the central suspension.

Attention should be drawn to curve "D," No. 3, which shows the effect of extinguishing alternate lamps in Cannon-street. The curve does not fulfil the requirements of a well lighted main street, but it shows a better result than Queen Victoria-street, and the lighting is very fair. If it were not for the fact that the cleansing of the streets is an operation which may be greatly assisted by good lighting, I should be inclined to recommend the turning out of half the lights in main streets at midnight, and I think the matter is worth consideration. This is, perhaps, an opportune place to discuss the question of lighting hours. In my opinion the fixing of lighting hours between sunset and sunrise is a mistake, and I think the lighting might be curtailed on a average by about one hour per day, half in the morning and half in the evening, if a reasonable reduction were made in the annual charges. It is now desirable to consider the question of comparative cost, and this is bound up with the question of spacing.

The average distance between the centrally-hung lamps in Cannon street is approximately the same as that of the standards in Holborn, though Holborn is 50 per cent. wider than Cannon-street. The average spacing of the centrally hung lamps in Cannon-street is a little closer than the spacing of the old standards in that street, there being 11 of the suspended to 10 of the lamps on standards. The extra lamp results really from the consideration of the side streets rather than from any need in Cannon-street itself. With regard to spacing, a regular distance should be followed as closely as possible, but due consideration must be paid to side streets and cross streets in order to obtain the most economical results. As will be seen from the curves, the distance between the lamps in Cannon street varies from 112 ft. to 165 f'. I think the latter distance may be regarded as the extreme, beyond which it is not desirable to go; whereas the former is closer than is necessary, and can only be justified by a consideration of the side streets.

For the purpose of comparing the effect of gas with elec'ric lighting I made a test in Queen Victoria-street, but I found a large portion of this street with a very low illumination, and neither from observation nor test did it appear to me at all comparable with Cannon-street. I therefore sought out a piece of good gas lighting, and I found this in a portion of Queen-street. It was interesting to find that the piece of street I picked fulfille l the condition which I had fixed as essential for a well-lighted street—namely, that the illumination on a horizontal surface 4 ft. from the ground should in no place be less than one-tenth of 1 candle ft. The average illumination of the picked piece of gas lighting in Queen-street—which is, fortunately, just the same width as Cannon-street—is only about half that in Cannon-street, though it is about double the cost. This confirms what I reported three years ago as the result of some photometric tests—namely, that light for light, high-pressure incandescent gas light costs four times as much as the flame arc light. It may here be observed that Departments of the Corporation, other than the Public Health Departmen', are now saving at the rate of about £3,000 a year, partly by changing from gas to electricity, and partly by bringing electric lighting up to date, and I have good reason for saying that this sum could be considerably added to.

On the whole, I think it may be fairly assumed that about 500 11 ampere flame arc lamps will light the main streets well, whether centrally-hung or on standards. The cost of these at £17. 10s. each would be £8,750. The present cost of lighting the whole City is about £22,000 a year, about half the cost being for electric light and the other half for gas. In addition to this a sum of about £17,000 appears to have been spent in the last nine years on providing and maintaining apparatus for gas lighting. The side streets can be very much better lighted by centrally-hung arc lamps than they are at present for a sum which I estimate approximately at £5,000 to £6,000 per annum. It is very important in my opinion that the main street lighting should not be arranged independently of the side streets. Economical effective lighting of both is bound up one with the other. A few lamps arranged in the side streets off Cannon-street would quickly show what can be done. I have very little doubt that the average illumination throughout the whole of the City streets can be at least doubled, and a saving of about £6,000 a year effected.

On the subject of lamp supports, I think it may be remarked, with regard to the central suspension, that the plan followed in Cannon-street of making them as invisible as possible is a good one. Attachments would have to be securely made and the supporting wires carefully examined, and, no doubt, the existence of a large number of such supports in the City would necessitate some extra cost to the Corporation in the supervision of overhead wires. But if reasonable care is used in the matter, there should be no danger whatever attaching to the central suspension of lamps.

In the main streets the plan of trimming the lamps in position during the early hours of the morning is a sound one. No doubt some small occupation of the roadway space during busy hours would take place when a lamp went wrong at such a time, but it must be remembered that a standard on the footway remains for several thousands of hours each year as an obstruction to traffic, and must necessarily be a much greater cause of inconvenience than the very occasional visit for a few moments necessitated by a fault in a centrally-hung lamp.

In narrow streets it would be advisable to arrange for bringing the lamps down to the footways for trimming, because otherwise a serious obstruction to traffic would occur. In some very wide streets, like Holborn and Farringdon-street, it might be advisable to use standards placed in the centre of the road, and, in any case, a certain number of standards may be required.

While I recognise the importance of economy and the consequent need to use existing material as much as possible, I think I ought to point out the unsatisfactory condition of London in the matter of lamp standards and especially electric-lamp standards. The design is usually left to an ironfounder's draughtsman. Mr. Norman Shaw has very kindly given his gratuitous aid in matters affecting the appearance of London, and I think his help might very well be asked. If new posts are found to be necessary, I think some endeavour should be made to redeem the reputation of London in this matter.

I will re state my main conclusions: (1) That the illumination on a horizontal surface 4 ft. from the ground is a sufficient indication of the useful light in a street. (2) That the minimum value of such illumination is the most important factor in good lighting. (3) That such minimum should not be less than one-tenth of 1 candle-ft. (4) That this illumination can be approximately obtained by 11 ampere flame arc lamps with yellow flame carbons, spaced approximately as at present, either on standards at 20½ ft., as in Holborn viaduct, or centrally hung, as in Cannon-street, at 28 ft. from the ground. (5) That a more even distribution of light and a more economical result can be secured by the centrally-suspended lamp at 28 ft. than by the lamp at 20½ ft. on a standard. (6) That economy and efficiency require the treatment of main streets and side streets together. (7) That a demonstration should be made in the side streets of centrally-hung arc lamps as soon as possible. (8) That about £6,000 a year may be saved and a doubling of the average illumination throughout the City streets effected by flame arc lighting assisted by a few metallic filament lamps where arc lamps have not a sufficient area for economical lighting. (9) That, where central suspension is used, it should be without lowering gear in broad streets and with lowering gear in narrow streets. (10) That any new standards which may be required should be designed according to the advice of some reliable guide, such as Mr. Norman Shaw. (11) That the lighting hours can be reconsidered with a view to economy without prejudice to lighting efficiency. (12) That the question of reducing the lighting in the main streets at midnight should be considered.

In order to obtain as soon as possible the great advantages in economy and better lighting that I have shown to be possible, I think a small demonstration should be invited from both companies in the side streets, and some of the streets adjoining Cannon-street would be very suitable for the purpose. I also think it would be a great advantage if a provisional decision were come to as to whether the lighting is to be divided between the two companies, and, if so, in what proportions. If that is done, and the side street demonstration of lighting found satisfactory, then the way will be clear for the preparation of complete plans and specifications for lighting the whole of the City, and instructions might be given accordingly.

I ought to acknowledge the assistance kindly given me by the police, by the engineer in the lighting and extinguishing of gas lamps for testing purposes, and in supplying me with details of gas costs; also the assistance given by those in my office, which entailed night work. Both the electric supply companies afforded me every facility to measure the current given to the lamps during tes', and at their own expense made the temporary arrangements which were required in Cannon-street for testing purposes.

ELECTRICAL PORCELAINS.*

BY H. W. BRADY.

(*Continued from page 252.*)

PROCESS OF MANUFACTURE (ENGLISH).

All the materials come to the potter in a form fit, or almost so, for making into "slip." "Slip" is the potter's name for the mixture of clay and water which is the starting point of his operations. The ball and china clays, which do not disintegrate so readily as the other substances, are put through a "blunger" (a sort of mill which stirs them up with water). The slip is afterwards put through sieves of brass wire, 37 gauge and 50 meshe, and at the base of a column of sieves there is a trough containing a range of magnets, generally permanent magnets, to arrest any small par-

* Abstract of a Paper read before the Birmingham and District Electric Club.

ticles of iron that may be in the slip. The slip is condensed by pumping into a press (Fig. 2). This comprises 24 to 36 chambers, each fitted with a canvas bag and opening into the next in a zig-zag fashion. The pumps are fitted with porcelain rams, which work satisfactorily. The slip is then put through a pug mill to render it more homogenous, from which it comes in a continuous bar, and is ready for use, though some manufacturers store it to make it still more homogenous by decomposition. In any case it is rendered more homogenous by "throwing"—that is, by throwing several lumps heavily one upon the other. The throwing table of to-day is the potter's wheel of old

The modern potter's wheel (Fig. 3) is power-driven, the variation of speed being got by friction cones underneath the table. For insulator work, the speed is 60 to 150 revs. per min.

From the thrower the articles go to the first drying room at a temperature of 80°F. It is advisable to dry as quickly as possible, because the particles have less time to move over one another and

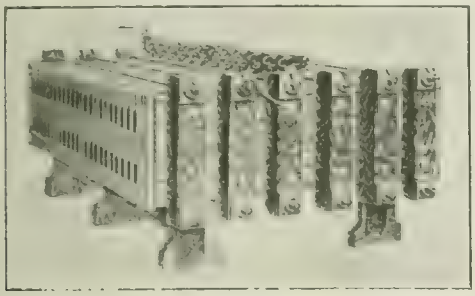


Fig. 2.—Filter Press.

the shrinkage is not so marked. As a rule, what is thrown to-day is turned to-morrow. The articles are carefully examined for flaws, and are then passed on to the lathes, which are similar to those for wood turning. The articles are chucked in a cup chuck or on a flat plate, the clay being wetted with slip and scored on its chucking surface (Fig. 4). The machine is known as a dicing lathe.

The articles after turning go to a second drying room, which, like the first, is heated by steam pipes. Care and skill are required or distortion may result. Articles having small projecting parts should have those parts covered to prevent them drying more quickly than the larger body, which would distort and weaken them. The whole question of drying is an important matter, and one in which a good many patents have been brought out to effect proper heating and ventilation. The articles stay in the second drying room for a period varying with their size, the only rule being that they must be per-

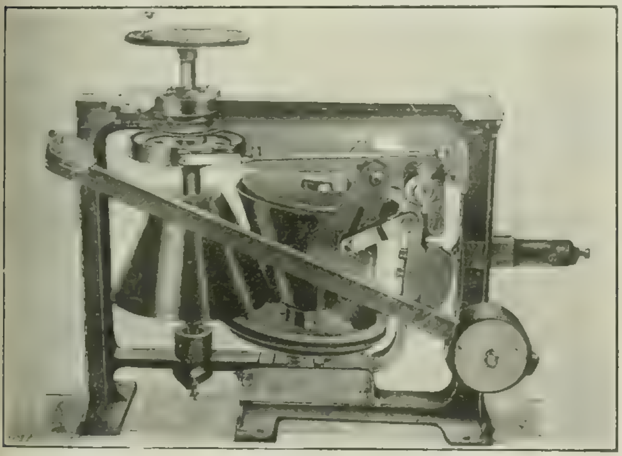


Fig. 3.—Power Driven Potter's Wheel

fectly dry before going to the kiln to be fired. On leaving the drying room the insulators are examined for flaws, and, whatever may be the case with ordinary china, either ornamental or domestic, no insulator is allowed to pass that shows the very faintest sign of a crack or fissure, whether on its outer surface or its inner surface. The smallest visible crack, even if it only affects one screw thread, is sufficient to condemn the article. An insulator in which a tiny crack is detected might, if the crack were in a position where it could be got at, have the surfaces evenly pressed together by the finger or with a little tool, but it would be labour in vain, for even if the crack had only a very slight depth it would open again in the firing to an even greater extent than before.

The insulator is now ready to receive any small holes or grooves that the design requires. The holes are drilled and the grooves cut, and then all that remains to do is to fettle off any rough edges before the goods are fired. The kilns for firing porcelain take a great many forms. The diagrams (Figs. 5 and 6) show the general arrangement of an old Chinese kiln and and a simple form of English kiln. Kilns may be classified as direct heating or indirect heating, according to whether the flame impinges on the contents of the kiln or not. They may be further classified as continuous or intermittent. Both types shown are intermittent—*i.e.*, when the goods have been fired the kiln is allowed to cool down and is then opened up. So-called continuous kilns are really a series of ovens, generally placed in a circle, as in the Hoffmann kiln, and the flues so arranged that the heat can be arranged to some ovens and withheld from others, so that ware may be entered or withdrawn from one part of the kiln while the rest of it is at firing heat. Coal is generally used, and a long flaming coal is to be preferred.

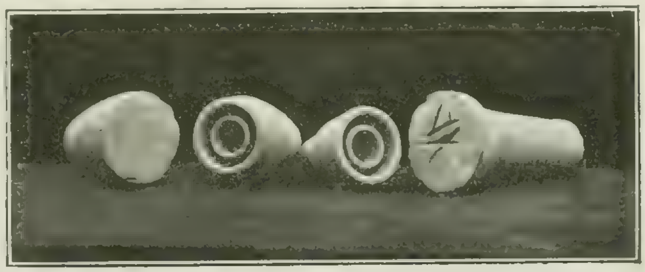


Fig. 4.—Three Stages of Turning, showing Insulator scored for Suction.

The goods to be fired are placed in fireclay pots known as saggers, which are then stacked in the kiln. The doorway being walled up, firing is commenced. The first stage, generally known as "smoking" the ware, has for its object the drawing off of the remaining moisture. Articles which come from the drying room, though dry to all ordinary intents and purposes, actually contain over 10 per cent. of water. Whether this water is combined or not is a matter of conjecture, but it is noteworthy that after it has been driven off by raising the goods to a temperature just approaching a dull red heat no further addition of water would make the clay plastic again. Yet no fusion of the clay has taken place. That this water must be evaporated carefully is evident when we consider that 1 oz. of water makes something like 2 cubic ft. of steam. The length of time for "smoking" depends on the size of the oven and the size of

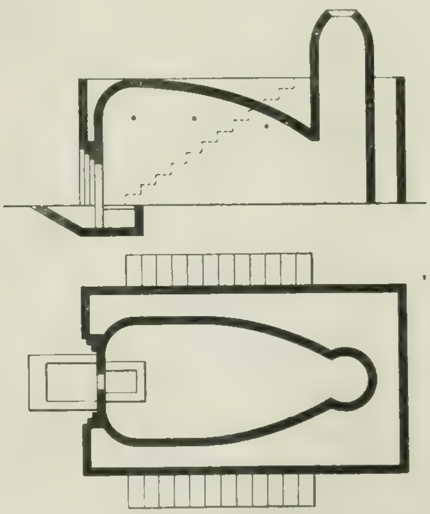


Fig. 5.—Chinese Kiln.

the goods, and no hard and fast rule can be laid down, but an experienced man knows how soon he may let his fires burn clear without risk of setting up internal strains in the goods due to the outside being dried and the inside not. So much importance is attached to the careful smoking of goods that it is sometimes made a special operation with a special stove. The temperature at which vitrification begins varies greatly with the composition of the clay. It may be anything from 700° to 1,200° C., according to the amount of flux present. An insulator kiln is fired up to about 1,450° C. at which point complete vitrification of the "biscuit" is certain. The whole operation takes some 50 hours. The goods are allowed to cool slowly in the kiln, this occupying about as long

as the firing. The biscuit insulators are then carefully checked over again before glazing.

So far we have dealt with vitreous insulators for outdoor work, whether telegraph or telephone, or for the heavier currents and higher voltages of power transmission. Before leaving this part of the subject, we might note the difference between our methods and those in vogue on the Continent. It is, of course, not an easy thing to find out how many plums our neighbour puts into her pudding, but all indications seem to show that there is little or no ball clay in a German made insulator. We have already noted that this omission results in a brittle article; it also, however, necessitates a different method of manufacture. The clay is too "short" and "crumbly" to be thrown and turned in two separate operations. Instead it is formed by methods closely similar to those in use here for forming ordinary china articles. It is "jolleyed." The lump of clay is put into a plaster mould having the shape of the finished article. The mould is rapidly revolved and a "jigger" is forced down with a hand lever into the lump of clay, pressing it outwards to fill the mould. The outside of the clay lump thus takes the shape of the mould, and the inside takes the shape of the jigger. The axis of revolution is vertical. The arrangement is well adapted to clay of that "short" nature, as the object is supported all the time it is in the mould. When moulded, the plaster mould is taken off the machine and allowed to stand until the insulator has dried somewhat, and then the mould, which is in halves, is opened. This waiting for the article to dry necessitates a large number of moulds. Each mould can be used several times a day. The absence of ball clay accounts for the whiteness of German insulators and also for their brittleness. Fig. 7 shows a vertical machine arranged to cut the screw thread in a small single-shed insulator. The remainder of the processes are not much different from our own.

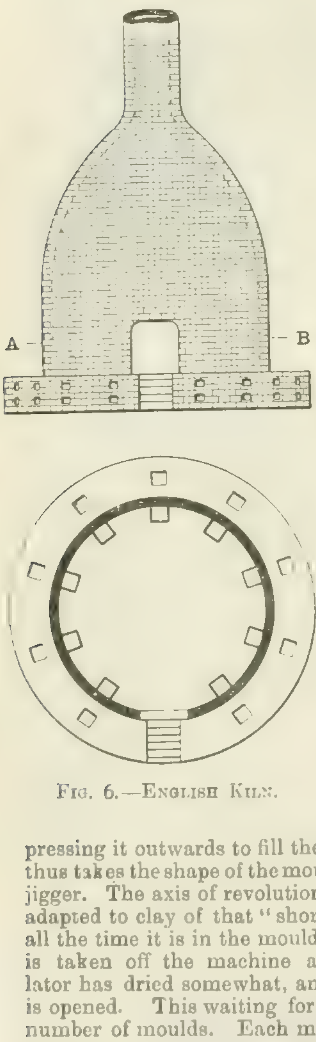


Fig. 6.—English Kiln.

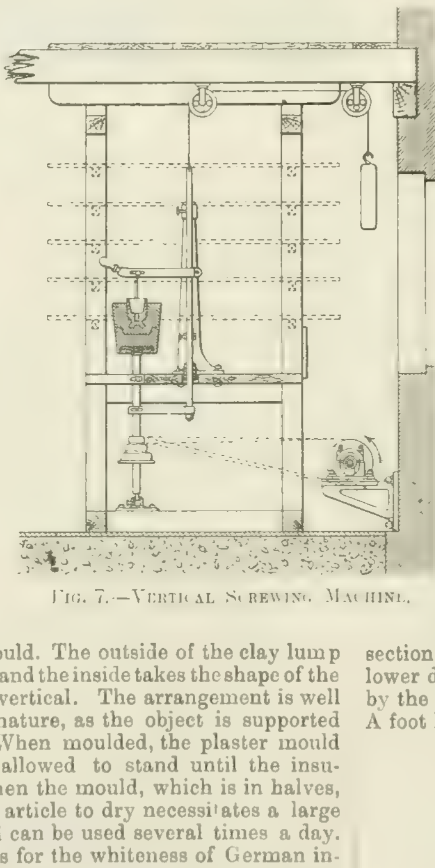


Fig. 7.—Vertical Screwing Machine.

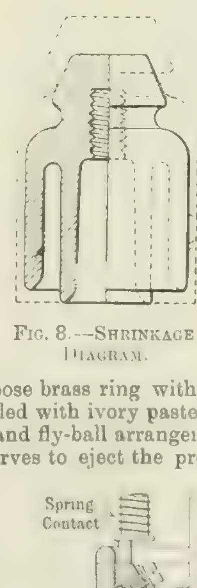


Fig. 8.—Shrinkage Diagram.

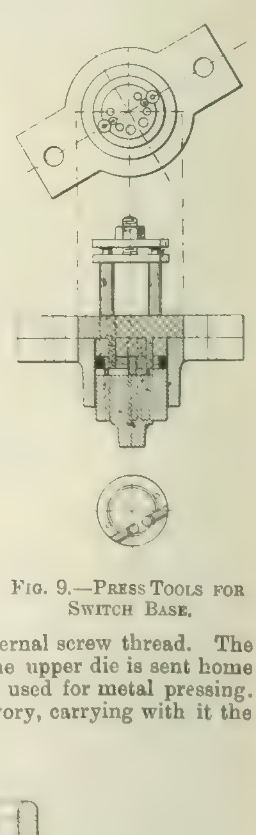


Fig. 9.—Press Tools for Switch Base.

Brown Insulators.—These have nothing to commend them except that their appearance is occasionally preferred. Nothing else has ever been claimed for them. The colour is obtained by adding some red burning marl to the porcelain body. They require to be much more carefully dried than white insulators, and on this account they cost the potter more, though generally he asks no higher price for them. Abroad, brown insulators and white are made of the same body, the colour simply being obtained by the glaze. Since coloured glazes show rather unequal on a white vitreous surface, they are often very unsightly.

Shrinkage.—As the clay is vitrified in the kiln it shrinks, the shrinkage amounting from [illegible] to something like 1 in. per foot. This may not matter very much for domestic ware, but for pieces that have to engage with metal parts the matter has to be very carefully dealt with. As a rule, the drawing office takes care of this and issues prints to each department suitably dimensioned. Fig. 8 shows the size of a finished insulator compared with the same one fresh from the lathe.

Materials other than Porcelain.—Such electrical accessories as ceiling roses, switch bases and a hundred and one other things, which are more or less protected from mechanical damage and the weather, are made of an earthenware material called by the trade "ivory." It is non-vitreous and more or less porous, so that it depends on the glaze to keep the mass dry. A very little exposure of unglazed surface is enough to let the whole body become damp. There a good deal of variation, however, in the quality of ivory, some being much more porous than others, but the very best ivory cannot be compared with porcelain as an insulator. A rough test may be made by touching a broken piece with the tongue. The tongue will adhere to the ivory as to an unvarnished clay pipe, but this is not so with porcelain. The ingredients of the ivory body differ from porcelain, in that ivory contains no felspar, and consequently it is not fired so hard in the kiln. Pressed articles are generally of ivory; thrown and turned articles generally of porcelain. The distinction is not a necessary one, but one that has grown up. We may expect to see complicated pressed articles done in porcelain in the future. The ivory body is dried somewhat and reduced to a damp flaky powder suitable for pressing up to the required shape in dies. Continental practice is to mix fat with the ivory, as their material will hardly stand—as it would seem—removal from the press without something of this sort to bind it; the use of ball clay in English ivory body obviating the necessity for fat. Fig. 9 shows the press tools for an ordinary wall switch base. The completely black portion of the figure is the section of a loose brass ring with an internal screw thread. The lower die is filled with ivory paste and the upper die is sent home by the screw and fly-ball arrangement as used for metal pressing. A foot lever serves to eject the pressed ivory, carrying with it the

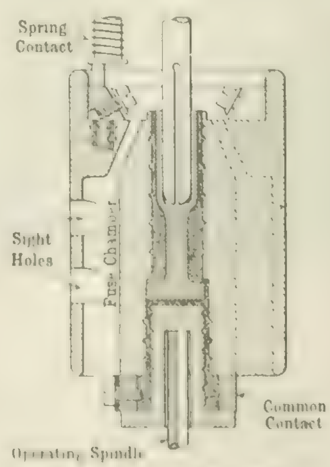


Fig. 10.—Denny Fuse Drum.

brass screwed ring, which latter is then screwed off by the operator and again dropped into the die. The operator—usually a girl—has the opportunity of showing some wisdom, and incidentally of increasing her output and her wages, in deciding just how much of the paste she must put into the die. For instance, if the body

changes from a heavy to a lighter density she must put her finger into the paste in the die and fill up the hole thus made with more paste. Success comes when she knows just how far to insert her finger. A very considerable stress is put upon the slender parts of these dies and they must not be made of brittle metal. Bessemer steel is the most suitable. A good instance of what can be done in pressed work is the revolving fuse-carrier for the Denny patent magazine fuse (Fig. 10). The drum carries five 30 ampere fuses, each in a separate chamber. Each chamber has two inspection holes, and it will be seen from the illustration that even considered as an ordinary metal casting job, it would require careful coring and moulding. It has to be made exact to dimensions so that it may run perfectly true on the spindle and engage correctly with the other parts. It is made in true porcelain treated the same way as ivory body. The enormous shrinkage of p rcelain makes the production of articles of this intricate nature, all exact to size, not so easy as it looks.

The composition of ivory body results in the yellow colour associated with such electrical accessories as are usually made from it. When they are required to be black, a red burning clay is added to the body and a blue glaze applied, the result being an apparently black surface. This is only possible when the body is non vitreous, as on a vitreous article the glaze does not spread at all evenly, but tends to collect in hollows and leave any projecting ridges bare and, therefore, showing red or brown.

Porous Articles. Such electrical accessories as the inner pots of Leclanche cells, &c., which are designedly porous, are produced from a body having a large proportion of china clay and very little flint. Such a recipe as 12 parts ball clay, 12 parts china clay, 6 parts flint and 6 parts stone would make a porous pot. There is, of course, no felspar, and the firing is very low.

Glazing.—Although an insulator must not depend on the glaze, the question of glaze is important because the unglazed surface attracts moisture even when it does not absorb it. The best glaze is simply the smoothest and most durable, and that most free from alkalies. The presence of alkalies produce the same defect that is laid to the charge of glass insulators—a hygroscopic surface. Surfaces intended for cementing to metal parts should never be glazed. A glaze may be described simply as a slip abnormally rich in flux so that it vitrifies at a lower temperature than the article it is applied to. This does not hold good, however, for Continental practice, in which usually the biscuit firing is carried out at the comparatively low temperature of 900°C., which only partially vitrifies the insulator, the second or "glost" firing completing the vitrification, both of the body and the glaze. It is questionable which method is best. In England the glost kiln is frequently of just the same construction as the biscuit kiln, but on the Continent a very usual arrangement is to make the biscuit oven and the glost oven separate chambers in one large kiln. China clay, borax, felspar, whiting and mon-oxide of lead are usual ingredients of glaze, and there is nothing particularly distinctive about glazes for electrical work with the exception of what has been said above. The question, which attracted a good deal of attention at one time, of leadless versus lead oxide glazes is one in which hardly two opinions exist among potters. The lead glaze is not radically different from leadless glaze, but the addition of some mon-oxide makes the glaze take more evenly and adhere more firmly. As against this there is the danger, such as it is, to the opera ives if they are careless in the matter of cleanliness. A few years ago the question was arbitrated upon by Lord James of Hereford, and his decision was that not more than 5 per cent. of mon-oxide was to be used unless and until the operatives were insured by the employers. The great difficulty is to compel the operatives to use the safeguards that are provided.

(To be continued.)

RECENT PROGRESS IN TUNGSTEN METALLIC FILAMENT LAMPS.

We give below an abstract of the discussion which took place at the meeting of the Institution of Electrical Engineers, on May 21st, in connection with Mr. H. Hirst's Paper on the above subject. An abstract of this Paper appeared in our last two issues.

Mr. Haydn Harrison remarked that the author compared the tungsten lamp with the gas mantle, but he had not called attention to the fact that the gas mantle differed in a most important feature. In the first 100 hours of burning its candle power dropped 20 per cent., and in 500 hours 40 to 50 per cent., whereas the tungsten lamp had the peculiarity that in 1,000 hours it dropped less than 10 per cent. The author mentioned that tungsten at a temperature below that of oxidisation was ductile. Was it not possible, therefore, to draw it down? It was likely in practice that the consumer with an economical large unit of light could afford to diffuse it by the use of frosted globes, so that the eye did not suffer from the glare of the filament. Throughout the Paper the author compared the osram lamps with other incandescent lamps, but did not deal with its effect on other forms of lamps. At one watt per candle the metallic filament lamp was more economical than the enclosed arc lamp, which took more than one, and nearly two watts per candle, and when the cost of carbons and labour was included he had found that for a 500 or 600 c.p. unit it was more economical to use a group of osram lamps than the enclosed arc, if the average life of the metallic filament lamp was as high as shown in the Paper.

Mr. B. M. Drake thought that central station engineers should endeavour to persuade consumers to use their lamps in a more rational manner than the ordinary way with clear globes. With a high candle-power lamp they should use a frosted globe, and so get a better distribution of light. As regards the name Mr. Mordey had suggested at a previous meeting—the wire lamp—he thought this applied more to the tantalum lamp than to the tungsten. He suggested the metal lamp. The great difficulty with the metal filament was that it was so brittle. With the tantalum lamp no special precautions were necessary, and they were, therefore, most in favour. With regard to the use of metal lamps for outside lighting, it was the opinion of some that the life of such lamps was shorter where they were exposed to the sun's rays. As regards competitors, they had to combat with two recent forms of lighting—acetylene and petrol gas. Acetylene cost 2·2d. per 1,000 c.p. hour, and the electric lamp, at 1 watt per c.p., 2d. for the same unit of light. The cost of petrol gas depended on the price of petrol in the district.

Dr. Louis Bell referred to the development of the metallic filament lamp in America as they found it to-day. They had had many metallic filaments in use. First came the tantalum lamp, which was received with open arms and a great deal of enthusiasm, but was very promptly passed over for the tungsten lamp, chiefly owing to the fact that most of the circuits in America were alternating-current circuits, and to the fact that the tantalum lamp was comparatively ineffective on account of its short life, due perhaps to faulty filaments. He found that the tantalum filament worked badly both at high and very low frequencies. Experiments which he had carried out with these lamps led him to the conclusion that the faults which developed in the filaments were due to the continual heating and cooling rather than to anything else. The heating and cooling, of course, took place more rapidly as the frequency rose. On the other hand the temperature change became at the higher frequencies somewhat less, and the cooling-off was less complete. As a result he had found that at 60 cycles and above the life was very limited, while at the very low frequencies of from 5 to 10 cycles they could hardly put the lamps in fast enough to keep them alight. Manufacturers in America were very slow to put out low candle-power lamps, the standard lamps being in 100, 60, and 40 watt sizes; save for its fragility the success of the lamp was fairly good. He had noticed that the candle-power of tungsten lamps sometimes increased during the first hours of burning and sometimes it rapidly fell, as noticed in the authors curves. As to the most economical efficiency at which to run the lamps, he thought that in most cases in England the lamps were being overrun. He suggested that it might pay to work the lamps at $1\frac{1}{2}$ watts per candle. They then gave an admirable light, and the life was materially increased. Metallic filament lamps should always, he thought, be used in such a way that the light was shaded from the eyes. In America, every tungsten lamp was fitted with a half frosted globe, and where they were used on a level with the eyes, the lamps were fitted with a shade that came nearly down to the tip. The candle-power emitted by metallic filaments was about 1,000 to 2,000 candle-power per sq. in., and if the light were not shaded the eyesight of the users would suffer. A point of advantage in America was that they were able to control the output of such lamps. They were sent out to the consumers not free but at a small rental charge, less than the cost of the lamp to the central station, but enough to make the consumers share the benefits of the reduced current consumption. One central station engineer in America had told him recently that he proposed to put out the tungsten lamps free, and added that every time he had reduced his price to the consumer he had increased his net profit. Taken in that spirit he thought that the metallic filament lamp was going to be a boon to the industry.

Mr. H. W. Handcock hoped that some means would be found of settling a standard by which they could measure their lamps in the future. The use of both the Hefner and the British unit led to some confusion. Then again there were the two methods of taking the measurement of light—the horizontal, and the mean spherical. The horizontal method he was quite sure was unfair to the metallic lamp if no regard was taken of the mean spherical candle-power. He thought they might with advantage lay some stress on the benefits that accrued to the central station as regards facility of regulation. He thought also that they could not lay too much stress on the fact that the candle power of the metallic filament lamp was so well sustained as compared with that of the carbon lamp. It was not so much advantage to know the efficiency at the beginning of its life as the efficiency throughout the whole life. The metallic lamp was a great advance in that direction. It was wonderful what remarkable progress had been made with it when one considered the years it took to bring the carbon lamp to its present state of perfection. Metallic filaments at high voltages were unsuitable for the ordinary portable lamp. The question as to the effect on the central stations of the metallic filament lamp had been thrashed out at some length recently. Mr. Hirst had stated in the discussion on the previous Paper that he had made an offer to the London station engineers to supply metallic filament lamps to them, so that they could control the output of such lamps; and in refusing that offer he thought the station engineers had missed a golden opportunity.

Mr. A. A. Campbell Swinton called attention to the statement by the author that it had been "shown that bodies exist which at the same

temperature radiate as light a larger percentage of the supplied energy than the so-called black bodies." He wished to express the opinion that it had not been proved that the Welsbach burner owed its high efficiency to this as the author stated. He had heated up filaments made of the Welsbach mixture and of pure thorium, and they both gave the same amount of light. He had made the same experiment at the Royal Society, heating up the filaments by means of cathode rays in a vacuum, and the same results were obtained. In the incandescent gas mantle an addition of 2 per cent. of cerium oxide enormously increased the amount of light whereas experiments had shown that an increase in cerium in the filament made no difference, which seemed to show that the benefit of the mixture when heated was brought about by a chemical action.

Mr. C. C. Paterson referred to the statement by the author that it was next to impossible to standardise metallic filament lamps per candle-power. He, the speaker, could not quite see why they should not standardise the lamps in that way. He was sorry to see Mr Hirst expressing so many of his results in the Hefner unit. He asked the author to state the total output of carbon lamps in Great Britain, and how many would it be possible to replace with metallic filament lamps, say, during the next five years. With regard to Mr. Harrison's remarks as to gas mantle tests, he had found that the candle-power remained fairly constant during the first 100 hours or so.

Mr. T. H. Lowden remarked that the Paper apparently dealt with only the osram lamp. The author had stated that up to the present 40 to 50 c.p. was about the lowest unit that had been obtained in a commercial lamp, and that some extraordinary development or discovery would have to be made before that candle-power could be largely reduced. He, the speaker, absolutely denied that statement. At the present moment there were 30 c.p. 200 volt lamps being sold, and in a short time 25 c.p. lamps for that voltage would be for sale. With regard to the blackening of lamps, this was caused by the bulbs not being properly exhausted.

Mr. C. H. Wordingham said he would like to record his conviction that the metallic filament lamp was a blessing, and only a blessing, to the industry. The people from whom additional business and revenue could be obtained were those now using gas, and the only possibility of getting them was by some epoch-making event such as the metallic filament lamp. There was an ample field before them as they had not at present even a fair proportion of the possible consumers, and he was sure the metallic filament lamp would enable them to enter that field. He thought that manufacturers should devote their attention to the invention of a simple and useful anti-vibrator holder for metallic filament lamps.

Mr. L. Gaster asked if Mr. Hirst was going to treat them liberally in cases of lamps blackening. Did he intend to change such lamps over the counter? The public ought to be informed that the metallic filament lamp was a fragile one, and that the outsides of the lamp globes ought not to be cleaned with a dry cloth, which set up an electrostatic effect which broke the filaments. Only a damp cloth should be used. There were, of course, many other metallic filament lamps on the market besides the osram, but if there was likely to be any trouble with regard to patents they ought to know where they were. As to small transformers, he was perfectly satisfied that their use was only a temporary expedient.

Mr. J. Raworth said he remembered the time when they paid 25s. per dozen for carbon lamps, and when the boxes were opened half of the lamps were found to be broken. That liability to breakage was got over in the case of carbon filament lamps, and it would be got over in the case of metallic filament lamps. In his drawing room he had some carbon lamps that had been in use for 10 years, which showed how long a carbon filament lamp would last if it was given a chance. Its day was, however, now over. For years they had been burning more coal under their boilers than they ought to have done.

The President (Col. R. E. B. Crompton) said, as to the effect of the metallic filament lamp on the industry, that in many places where gas did not now practically compete, and where they had obtained all the lamps that they could hope to get, the reduction in the current consumption might mean a serious loss of dividend. Also the money that would be spent during the next few years in the replacing of lamps would be largely taken out of the consumers' bills. The immediate future would be a very anxious time for some.

Mr. H. Hirst, in reply, said he had tried to keep the manufacturer in the foreground, and the trader in the background, but some of the questions put to him he would have to answer in the capacity of a trader. They were not very well organised in this country for introducing a new delicate scientific article. In America and in Germany the manufacturers were also the station engineers. They were also traders in direct contact with the consumer, and could bring out a new article after carefully thinking it out from the beginning to the end. They had to reckon here in England with a different state of affairs, and with difficulties which were not found in other countries. That was why he suggested that the central station people should take the metallic filament lamp in hand. [illegible] that they could not fall out with the contractors, whose business it was. The contractors had got into the [illegible] upon the manufacturer [illegible]. He [illegible] frosted globes or with shades [illegible] Dr. Bell [illegible] New York. They had various ideas [illegible] of the great brilliancy, but they [illegible] feeling was necessary, and few contractors troubled to let the consumer know. The same remarks applied to [illegible]. He [illegible] had been liberal, so far as he knew, in [illegible] leading contractor would bear him out in that. But there were small contractors who thought that it was better to arrange not to hand the lamps on to the customer. With regard to Mr. Harrison's remarks, if tungsten could be drawn, which had not been done up to date, he would certainly have put it in the Paper. He failed to see how they were going to get a smaller unit of light with their present knowledge, but if there were other methods he thought it would be some considerable time before those methods would be introduced. All the metallic filament lamp makers on the Continent had no idea how a lamp could be commercially made with a lower unit of light. There was a quite exaggerated idea as to the breakage of metallic filament lamps. His company had introduced a 5 per cent. breakage allowance on such lamps, or had offered to exchange such broken lamps without, of course, making the 5 per cent. allowance. In every instance the user had preferred to take the 5 per cent. allowance. Breakage was more due to careless handling than to actual transit. He had used the Hefner candle-power for the simple reason that the lamps came from countries in which the Hefner candle-power was generally used, and he did not wish to introduce figures which might lead to confusion with those used in Charlottenburg in the official tests. If the lamps could be sold by British candle-power he would like to do so. He thought they would have a very good case when the Standardisation Committee went into the matter. He would try and stick out for watts, however. So far as radiation was concerned, he did not suggest that he made the statement on the strength of his own experience. The statement had been made by the inventors of the incandescent gas mantle, who had been working on that theory, and he thought it wise to give the statement to the meeting.

200,000 VOLT INSULATORS.

In our issue of November 22, 1907, we described briefly the new form of insulator which is being extensively adopted in America for high-tension power transmission lines. One of the pioneer firms concerned in the manufacture of these insulators is the Locke Insulator Mfg. Co., of Victor, New York, who have one of the largest and most modern equipped high-tension insulator works in the world.

Fig. 1.—Locke Insulators in Use.

The underhung insulator, as first developed, consisted essentially of several conventional type line insulators, and these, when tested, gave such excellent results that they were quickly recognised as the proper method of insulating extra-high-potential lines. Since lines erected in this manner are usually of considerable importance, the matter of mechanical weakness was first under consideration, and as the conventional type line insulators have no great amount of strength in tension some new development was seen to be necessary. This was first provided for by using a single shell of porcelain, on the outside of which was cemented a metal cap and on the inside an eye bolt. Mechanically, the device was very nearly ideal, since mechanical strength in excess of 20 tons could be readily obtained, but electrically the device was not a success when built in this manner, since the condenser effect causes a rise of potential around the end units, and if the insulators are made of reasonable size they will be found not to have dielectric strength comparable with the flash-over potential. Thus, in the case of a lightning shock or surge upon the line approaching a point of support, which consists, say, of several underhung insulators, these latter behave exactly like condensers in series, and if the approaching wave be steep and moving with great rapidity, the first unit has to stand a very high potential. For this reason it was found necessary to introduce two pieces of porcelain which could be

made thin and, therefore, of good quality and would stand a pressure of about 100,000 volts, also adding materially to the leakage distance of the whole device.

It is the custom of the Locke Insulator Mfg. Co. to test the shells of this underhung insulator to flashing over potential for about five minutes before assembling, and after assembling to test the unit to 100,000 volts for a period of five minutes. A mechanical test of 5,000 lb. is then applied to ensure that the porcelain and cement have been properly put together and are of good quality.

The mechanical features of this insulator are not without interest. Each of the shells is recessed on the inner side, and the inner connection is made by means of a "U" bolt which springs out in the recess, and then the annular space is filled with neat Portland cement which is allowed to obtain its permanent set under water. Analysing the mechanical stresses which fall upon this joint, it will be noticed that, from the upper end of the "U" bolt, stresses may be transmitted at 45 deg. through the porcelain and cement to the expansion cap, which supports the whole device, through throwing the porcelain into compression and permitting of the development of any desired mechanical strength.

The insulator will normally be used in a vertical position, allowing about 25,000 volts per unit. Thus, 4 units would be allowed for a 100,000 volt star-connected line. For corners it will, of course, be necessary to use the insulators in a horizontal position to by-pass the line, as shown in Fig. 1. There need be no concern about using

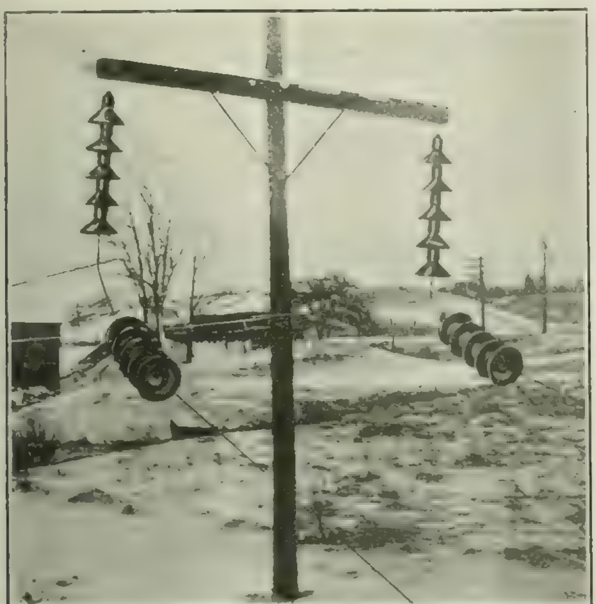


Fig. 2.—Transmission Line at Victor, N.Y.

this insulator horizontally, for, in making tests upon it, it was assumed that all the surfaces of the porcelain would in time become wet. It is important to note that this insulator is said to be much safer when operating in a horizontal position than vertically, for if the arc does leap over the surface it is immediately blown out by i's own heat and away from the insulator, whereas in the conventional type of insulator, if an arc plays over it, sufficient heat is usually libera'ed underneath the shells to destroy them.

Fig. 2 shows these insulators in use on the experimental line which has been in operation at Victor, N.Y., for several months at a pressure of 200,000 volts.

We learn that Messrs. Geipel & Lange, of Vulcan Works, St. Thomas-street, S.E., are the sole representatives for the United Kingdom, Europe, and the Colonies, of the Locke Insulator Manufacturing Co.

Truing up Commutators on Rotary Converters.—C. L. Greer in a recent issue of the *Street Railway Journal* gives a method of performing the above where no prime mover is available, or the armature cannot be placed in a lathe. The direct-current brushes on the machine to be trued up are lifted from the commutator. This, of course, opens the field circuit, and the cutting tool is then set up and properly adjusted. The rotary is then switched on to the alternating-current 'bus bars which are not alive. The alternator—with a weak field—is then connected to the 'bus bars and its engine moved slowly round. The rotary will start and run as an induction motor, its speed being adjusted by varying that of the engine, which is throttled down to a very low speed.

SWITCH GEAR CONTROL APPARATUS AND RELAYS FOR ALTERNATING CURRENT CIRCUITS.*

BY C. C. GARRARD.

(Continued from page [illegible].)

Time Limit Maximum Circuit breakers.—At the present time it is general practice to instal time-element maximum circuit-breaking devices in various positions on all large systems. Some of these have a constant time element, independent of the degree of overload; these are, however, rarely required, and inverse time-element circuit breakers will only be considered. The present method of stating time elements—*i.e.*, by time—is open to question. To completely understand the question, the current, time on test load and time on dead short-circuit should be given, for this latter time fixes the order in which several inverse time-element circuit-breakers in series will operate on heavy short circuits. Hitherto it has been considered that fuses possess an inverse time element. This has been shown by R. P. Jackson to be not altogether true, and apart from the difficulty of arranging two fuses in series with the certainty of one operating before the other, high-tension fuses cannot now compete with automatic circuit breakers either in cost or efficiency.

Inverse Time Limit Circuit breakers on Feeders.—After a time-element circuit-breaker has been decided upon the next question is to determine the time element. Curves (Fig. 2) are given showing

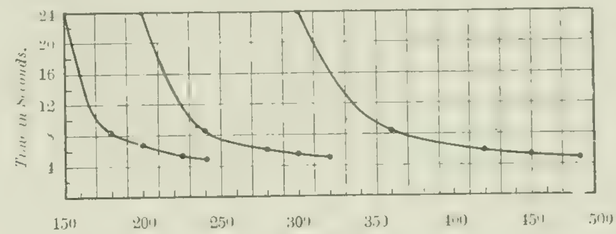


Fig. 2.—Standard 10 Amp. Relay 25~.

Set to operate at 60 per cent., 80 per cent. and 120 per cent. of full load, that is 150 amp., 200 amp. and 300 amp. in conjunction with a 25/1 ratio current transformer.

the operation of the outgoing feeder relays in a large 6,600 volts 25 cycle three-phase station in Scotland, of the machines relays in the sub-station fed from this station and of the relays on the outgoing feeders installed in a similar station.

If it were only a question of arranging the various switches to open in a pre-determined order, the feeder time-lag would be made as long as possible. As naturally the longer it is the more chance have the distant circuit-breakers of operating before those on the feeders. The drawback to this arrangement is that with comparatively long time elements, whenever a high-tension short comes on the system, a great deal of the synchronous sub-station machinery falls out of step. This was experienced in practice at the station mentioned above, and to get over it the time element was shortened several times until the curve shown in Fig. 3 was obtained. It will

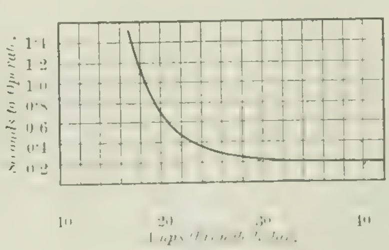


Fig. 3.

thus be seen that the advantage of the long time element circuit-breakers has to be dispensed with, and the question at once arises whether it is worth while to retain the short time element remaining. There is, however, in reality a greater difference between the curve in Fig. 3 and instantaneous action than between the curves in Figs. 2 and 3. In order to get an idea as to the time a so-called instantaneous relay takes to work, an ordinary alternate-current trip-coil was investigated. An examination showed that the time taken for the plunger to rise from the bottom to the top position did not exceed 1/10th second. It follows that the time element of the instantaneous release is less than one-fifteenth the time element shown in Fig. 3, and to go from this curve to the instantaneous release is a larger step than the sum total of the previous steps taken in arriving at Fig. 3. There is no doubt that instantaneous releases have been tried and found unsatisfactory by reason of their too often and unnecessary operation. If now it should be found that the

* Abstract of a Paper read before the Institution of Electrical Engineers.

transitory currents that have given trouble with the instantaneous release are of shorter duration than the times of the curve in Fig. 3, then the retention of the time element, even if shortened to the extent shown in Fig. 3, is desirable.

The general conclusion to be drawn from these notes is that the necessary and desirable time elements of the circuit-breakers on each system must be determined experimentally. When installing maximum relays, therefore, they should be such that their time elements may be varied within wide limits independently of the currents at which they operate. It is not desirable to have the time element too easily adjustable by means of a screw or some such arrangement outside the relay, as this allows time settings to be altered by unauthorised persons. The time elements of all the circuit-breakers on the system must be considered as a whole, and after the correct values have been found the settings need never be altered.

DISCUSSION

Mr. H. W. CLOTHIER thought that if the Home Office or some corresponding authority were directly interested in the protection of apparatus there would be a general scrapping of much of the protective apparatus in use at the present time. It had become a matter of course in the event of a fault occuring on any section of the system to look round and find how many other parts were cut out needlessly by the so-called automatic protective gear. In his experience one of the worst offenders in this respect had been the reverse current relay. As a matter of fact on the supply systems of the Newcastle and Durham Power Companies, where reverse current relays were installed, there had been so much trouble with them tripping at the wrong time that they had been thrown out of the generator circuits and the feeder network. With regard to time element relays he thought that these were almost as undesirable, the trouble with them being that they allowed a fault current to remain on the system long enough to cause surging, throwing synchronous machines out of step and disorganising the whole system. To add time limit to reverse current (or reverse power relays as the author called them) only added the disadvantage of the time limit to the already unsatisfactory apparatus. The essential features, he thought, of a feeder protection system on large high-tension networks were: (1) The gear must operate absolutely instantaneously, so that the fault was disconnected before it

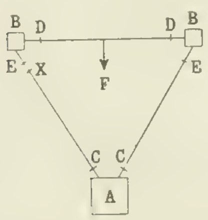


FIG. 4.

A, Power Station; BB, Sub-stations; CC, Time limit overload relays; DD, Reverse-current relays interlocked; EE, Reverse-current relays.

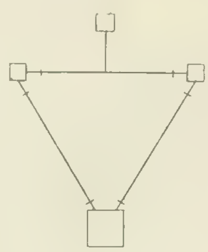


FIG. 5.

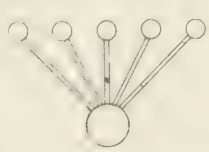


FIG. 6.—CONNECTIONS OF H.T. NETWORK WITH OVERLOAD TIME LIMIT AND REVERSE CURRENT RELAYS.

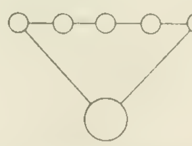


FIG. 7. — CORRESPONDING STATIONS ARRANGED WITH RING MAIN, SAVING 25 PER CENT. IN INITIAL COST.

rose to dangerous dimensions; (2) the gear must be as simple as possible; (3) it must be applicable to any network; and (4) it must not cut out a healthy section through a fault developed on another section. The Merz Price system was explained clearly enough in the Paper; there were one or two details which were not quite accurate in the Paper, but the main principle was described all right, and it was the only system that he knew of that complied with the conditions he had enumerated. Dr. Garrard's proposal as to interconnected reverse power relays was certainly ingenious, but it did not cover all the points. It had one serious objection, which very much limited its usefulness. In the case shown in Fig. 4, [illegible] main switch at A was open and a fault occurred at F the protective gear was inoperative, because the system depended upon a reverse current through both ends. Also another sub-station could not be added as shown in Fig. 5. Whereas the Merz Price system was suitable for any network including tees, loops, ring mains, &c., and with it they could instantaneously isolate a faulty section without interference with the supply, as was proved by demonstration. A further example of the economic advantages was seen from Figs. 6 and 7, Fig. 7, which was only possible with the Merz Price system, being not only more reliable but showing a saving of at least 25 per cent. in mains, which fully compensated for the cost of the necessary pilot wires. The Merz Price system also dispensed with potential transformers on the switch panels, a constant source of danger.

(To be continued.)

ELECTRIC SUPPLY PROSPECTS AND CHARGES AS AFFECTED BY METALLIC-FILAMENT LAMPS AND ELECTRIC HEATING.

We give below a brief abstract of the discussion which took place at a meeting of the Glasgow Local Section of the Institution of Electrical Engineers in connection with Messrs. Handcock and Dykes' Paper on this subject. This Paper had previously been read and very fully discussed in London, an abstract of the Paper appearing in our issue of April 10th and of the discussion in our issues of April 17th and May 1st.

Mr. W. W. LACKIE (Glasgow) thought the prospect depicted by the authors was not so gloomy as they had made out. His advice was to encourage power consumers. The tendency was, he found, in Glasgow, to get by the use of metallic-filament lamps increased light for the same cost, rather than a reduced consumption. The price in Glasgow for lighting was 3½d. Comparing the costs of production of gas and electricity, he pointed out that, whereas gas was sold at 2s. 3d. per 1,000 cubic ft., 1s. 9d. of this went in the price of coal, so that there was hardly any margin to work on by way of reduction in capital charges, whereas with electricity exactly the opposite might be said to hold good, and any reduction in capital charges was immediately felt in the price per unit. The hot plate referred to in the Paper was most decidedly a long-hour consumer, as it would be used morning and evening more or less all the year round, whereas the lighting of the room would not. With regard to rental, why not use sec. 21 of the Electric Lighting Act, which related to consumers guaranteeing 20 per cent. of the capital outlay for three years? He did not agree with the contract-demand system advocated, but would agree with a charge per kilowatt installed. The indicator suggested would be of no use for arc lighting.

Mr. ROBERTSON (Greenock) said the load on his system was a power one to the extent of fully 75 per cent., so that metallic filaments were no bogey to him. If there was an entirely lighting load, then he would have no hesitation in raising the price per unit right away. He found, for the few months of the present year, that metallic-filament lamps on an installation in a public institution in his area, as compared with the previous four months with gas at 2s. 8d., would result in a very great saving to the advantage of the new lamps. The number of lamps was 400. He found the average life of the new lamp was, on the average, 692 hours. He had decided objections to the maximum-demand system. One weakness was that it took no account of the time of the peak load. He was not in favour of the Norwich system of rating, as it would vary according to the district the consumer was in. The contract-demand system was, he thought, an improvement on the maximum-demand system. He was afraid, however, that it would limit consumption. His ideal system was a flat rate with sliding scale.

Mr. SILLERY (Partick) was of opinion that the advent of metallic filament lamps was of the greatest importance to electrical engineers, as it would certainly tend to popularise electricity, and their use would convince consumers that electricity was not the luxury it was made out to be. He favoured a flat rate system of charging and deprecated the use of endless complicated devices.

Prof. BAILY thought the maximum demand system's great objection was that it ignored the time of peak load. One scientific way he would suggest would be to make the meter go faster at peak load times. Lighting load was, he thought, the bugbear of station engineers; therefore, he was of opinion that the use of metallic filament lamps would reduce that, much to the station engineers' delight, especially where there was a combined power and lighting load. There would, of course, be some premature spare plant for a time, but that would be more mournful for manufacturers of plant than for station engineers.

Mr. DYKES, in reply, thought sec. 21 referred to by Mr. Lackie applied to mains only. The limit indicator was not meant for arc lamps. The idea of so much per kilowatt installed would tend to make consumers cut down unnecessarily the kilowatts installed. He was not sure that Prof. Baily's idea would be practicable.

INSTITUTION OF ELECTRICAL ENGINEERS.

In our last issue we referred briefly to the annual general meeting which was held on May 28th at 92, Victoria street, London, S.W. At this meeting the Council presented to the members their report for the session 1907-8.

Reference is made in the report to the death of Lord Kelvin, president and honorary member of the Institution, and it is mentioned that the last occasion upon which he took part officially at a general gathering of the members was at the Annual Conversazione in June, 1906, when he assisted with Lady Kelvin in receiving the members and guests of the Institution. As a memorial of Lord Kelvin's work and connection with the Institution, a Kelvin lectureship has been founded, the first lecture being given by Dr. S. P. Thompson.

Growth of the Institution.—Since the date of the last annual general meeting 7 members, [illegible] associate members, 17 associates and 303 students have been elected, whilst to the [illegible] of members have been transferred

45 associate members and 5 associates, and to the class of associate members 43 associates and 96 students have been transferred, also 1 student has been transferred to the class of associates. The total roll, subject to later revision, is now 6,048, composed of 6 honorary members, 1,093 members, 2,154 associate members, 1,145 associates, 1,543 students and 107 foreign members.

Meetings and Papers. During the past session 19 general meetings, 21 council meetings and 95 committee meetings have been held. There have been 42 meetings of local sections, namely, 7 at Birmingham, 6 at Dublin, 6 at Glasgow, 7 at Leeds, 9 at Manchester and 7 at Newcastle. A complete list of Papers and lectures, with the places where read or delivered, is given in the report.

Scholarships and Premiums.—The Council have awarded two Salomons Scholarships, value £50 each, to Mr. H. Carnegie, of the Finsbury Technical College; and to Mr. A. Hutt, of the Central Technical College; whilst a David Hughes Scholarship, value £50, has been awarded to Mr. C. Higgins, of the Central Technical College.

The list of premiums awarded was given in our last issue.

Students' Section.—At the opening meeting of their session an address to the students was delivered by Mr. Robert Hammond on the subject of "Electrical Legislation." Nine meetings altogether have been held in the Library of the Institution, at which seven Papers have been read and discussed. The Students' committee also organised a visit to Switzerland in the summer of 1907, where they visited the following works, laboratories, and other places of interest: Messrs. Brown-Boveri & Co., Messrs. Escher Wyss & Co., Maschinenfabrik Oerlikon, Messrs. Sulzer Bros., Schweizerischer Lokomotiv und Maschinenfabrik, Winterthur, Zurich Polytechnic and the Jungfrau Electric Railway Co. A series of visits to works and laboratories in and about London was made during the session, and the annual dinner of the Students' Section, held on March 24th, was very well attended.

The Manchester branch of the Students' Section has also completed a successful session, having held seven meetings and read seven Papers. Visits to various works in the district were also organised. Two meetings have also been held by the Glasgow branch of the Students' Section, at which two Papers have been read under the chairmanship of Prof. Magnus Maclean.

The Imperial College of Science and Technology.—The Council have appointed Mr. Robert Kaye Gray, past president, as the first representative of the Institution upon the governing body of the College.

Home Office Regulations for the Use of Electricity in Factories.—By the courtesy of the Home Office the Institution was invited last year to consider and offer observations upon the new Draft Regulations prepared by the Secretary of State in pursuance of the Factory and Workshop Act (1901). The question was referred to the Traction, Light and Power and the Parliamentary and Industrial committees in joint meeting, with Mr. Alex. Siemens as chairman. Suggestions for the amendment of the rules were in due course submitted to the Home Office. Subsequently Mr. J. Swinburne, F.R.S., was appointed Commissioner by the Home Office, to conduct a public inquiry, at which Mr. Alex. Siemens again gave his services by attending on behalf of the Institution.

Wiring Rules.—About 3,600 copies of the new edition have been distributed. It is satisfactory to note that the rules have been adopted by 36 fire offices and that 30 local authorities and supply companies have agreed to accept them as standard practice and to recommend their use. The committee hopes to resume its meetings in the autumn to consider such proposed amendments as have already been received, and also to revise the rules as far as may be rendered necessary by the putting into operation of the new Home Office Regulations.

British Electrotechnical Committee.—In accordance with the rules of the Institution the committee is re-appointed annually. It has full direction of the work of the sub-committees, of which at present two have been appointed, the sub-committee on Nomenclature, with Mr. A. P. Trotter, the Electrical Adviser to the Board of Trade, as the chairman, and the sub-committee on Symbols, appointed January 16, 1908, with the Right. Hon. Lord Rayleigh as the chairman and Prof. S. P. Thompson the vice-chairman.

At the second meeting of the committee, Col. Crompton, the honorary secretary of the International Commission, reported that committees had been formed in Austria, Belgium, Denmark, France, Germany, Hungary, Mexico, Spain, Sweden and the United States, and that the matter was being considered in Australia, the Argentine Republic, Canada, Japan, South Africa and Switzerland. With regard to Italy, he understood from Mr. G. Semenza, who had been a delegate at the preliminary conference, that there was every likelihood of a committee being formed there at no very distant date.

Owing to the death of Lord Kelvin the office of president of the Commission became vacant, and steps to fill the vacancy will be taken at the next meeting of the Commission.

According to the rule which provides that each committee shall elect one delegate to the Council of the Commission, Dr. R. T. Glazebrook, F.R.S., has been appointed British delegate, and, together with the president, Sir John Gavey, C.B., will attend the meeting of that Council, which in all probability will be held in London next October.

A sub-committee will shortly be appointed to deal with the classification of electrical machinery and apparatus—that is to say, to undertake all practical questions. One of the first points to which they are likely to turn their attention is the question of "Standards of Light," and, with the co-operation of the other electrotechnical committees, it is hoped that a satisfactory decision may in due course be arrived at.

City and Guilds of London Institute—Examinations in Wiremen's Work.—It has been agreed, subject to approval of the syllabus of instruction, to give assistance this year by appointing qualified persons to represent the Institution and attend the practical examinations. A list of members is given who have offered their services on behalf of the Institution and to furnish a short report on the manner in which the candidates performed the practical part of their work.

Science Abstracts. In the work of publishing *Science Abstracts* the committee has continued to receive the assistance and financial support of the Physical Society of London. The American Institute of Electrical Engineers and the American Physical Society have also again given valuable assistance in distributing the periodical among their members and in bringing it prominently to their notice. This year the Associazione Elettrotecnica Italiana has also joined in supporting the publication by promoting the circulation of it among their members, to whom there has been granted a special subscription rate, in return for which the Italian Society has kindly offered a similar concession to the members of the Institution in respect of its own *Transactions*.

In 1907, 2,132 and 1,474 abstracts were published in the two sections, "Physics" and "Electrical Engineering" respectively (1,296 pages in all). The usefulness of the publication is shown by the fact that the amount realised by sales to the public and members of other institutions, apart from members of this Institution and of the Physical Society, was £487.

Other Work of the Institution. The Council was recently informed by the Army Council that the War Office proposed to establish Electrical Engineering Corps for attachment to the Territorial Army at certain centres in the United Kingdom, and the Institution was invited to cooperate with the County Associations in finding officers with electrical engineering qualifications to command these units. The Council is at present in communication with the County Associations on the matter.

A request was received in the course of last year from the Executive Committee of the Franco-British Exhibition to assist in organising an electrical section in connection with the Engineering and Shipping Group of the Exhibition. The electricity supply companies of London have agreed, subject to satisfactory support for the scheme being forthcoming, to give financial assistance, and they have undertaken the responsibility of organising a collective electrical exhibit in the Machinery Hall.

Reference is then made in the report to the presentation of the bust of Benjamin Franklin by the American Institute of Electrical Engineers and to the gold medal presented by the Société Internationale des Electriciens.

Museum.—Space has now been provided at the Institution for the temporary accommodation of the articles collected for the Museum. Some valuable apparatus and objects of historical interest have been accumulated, due chiefly to the generosity of members and firms interested, and a committee is now in charge of the work of classifying and arranging the articles. It is hoped that members will assist in creating a museum worthy of the Institution by presenting apparatus of historical interest or by advising the Council of the existence of such.

Benevolent Fund.—The committee of Management reports that the Benevolent Fund of the Institution shows a satisfactory increase for the past year. On December 31, 1907, the capital account of the fund stood at £2,755. 9s. 11d., as compared with £2,532. 16s. 4d. at the end of 1906. Four grants in aid were made during the year under the rules of the committee. The Wilde Benevolent Trust Fund stands at £1,744. 16s., and one grant in aid has also been made from the income of this fund in 1907.

Annual Accounts.—The report of Mr. R. Hammond, the hon. treasurer, shows that the balance carried to the general fund at the end of 1907, being excess of income over expenditure, was £3,678. 9s. 2d., as compared with £3,548. 15s. for 1906, the increase for 1907 being £129. 14s. 2d. The balance-sheet sets out the total investments other than the investments of the Trust Funds. The total assets amount to £46,358. 16s. 8d., against which are to be set liabilities amounting to £1,046. 2s. 5d., leaving as the net assets of the Institution £45,312. 14s. 3d.

Building Fund.—This fund has increased during 1907 by the amount of £643. 9s. 1d., the increase being due to revenue from property, subscriptions and sundry other items.

General Fund.—This fund has increased to the extent of £3,678. 9s. 2d., and now stands at £13,900. 6s. 4d.

Library.—Of the 1,623 books recommended to be added to the Institution's collection of electrotechnical literature, 1,162 have now been acquired, whilst 142 new books have been purchased since June 1, 1907, and 186 books and pamphlets have been presented to the Institution during the same period. The number of members who make use of the library has considerably increased, the total number of readers during the past 12 months being 640. Permission to use the library has been given to members of the Association of Engineers-in-Charge.

An appendix to the report contains a list of transactions, proceedings, &c., received by the Institution.

Osram Lamps for Street Lighting.—In our abstract of the Paper recently read by Mr. Hirst before the Institution of Electrical Engineers, mention was made of the excellent results obtained with osram lamps in the streets of Canterbury. We have been informed by the city electrical engineer, Mr. C. A. Blascheck, that these osram lamps are of the 32 c.p. 115 volt type, and are run two in series on 220 volt circuits. It will be noticed that they are being slightly "under-run."

PARLIAMENTARY INTELLIGENCE.

LONDON ELECTRIC SUPPLY BILLS.

In our last issue appeared the commencement of Mr. Freeman's speech on behalf of London County Council before the House of Lords Committee on the London & District Electricity Supply Bill.

Mr. FREEMAN, continuing his address on May 27 said the present bill was open to great objections, and he should ask that it be modified in several important ways. They did not, of course, criticise the area of supply or the site of the generating station, which were identical with those proposed under the Council's own bill. The engineering details were also the same. Also, as regarded the question of finance, if the Committee were satisfied that the financial support of this bill was such as would reasonably be assured of their getting the money on proper terms and being able to carry out the work within a reasonable time, the Council did not propose to stand in the way. They had listened to the financial evidence, and it was obvious that it was far short of the strength of the financial support provided for the Administrative bill. What the Council desired was such provision as would be a real protection, on the one hand, to the people who would take electrical energy from the company, and on the other hand for those who up to the present time have been suppliers of electricity under statutory powers. There should be a stronger clause than the present clause 75, making a provision that within 12 months the company shall have obtained a subscription of a substantial amount of money. The County Council suggested £1,000,000 but would not stand out for any particular figure so long as a reasonable amount was inserted. The Council also thought the company should come under terms to make a serious beginning of work within two years from the date of the passing of the Act, instead of five years as now stated. They would also like certain modifications made in clauses 61 to 64. The latter dealt with the surplus profits, and in the opinion of the Council was objectionable in its present form. The company had provided for an 8 per cent. dividend, and for power to pay back dividends if in the early years they could not get 8 per cent., they had given themselves insurance and reserve funds, and, if there were any surplus funds, they wished to divide these in such a way that the consumer got very much less benefit than he would under the provision of a sliding scale.

On May 28, dealing with the purchase clause, Mr. FREEMAN proceeded to argue in favour of this clause being kept to the actual words of the Electric Lighting Acts, namely, "then value," or some equivalent words. Unless some very good reason could be shown for altering the terms of the purchase clause under the Electric Lighting Act of 1888, which had a defined meaning, it was very unwise to do so, because they would be introducing an element of uncertainty into what was previously a perfectly well recognised matter. There was no difficulty in ascertaining what might be reasonably expected to be the "then value." They were told that although under the Electric Lighting Acts certain purchase terms were given, these were not as a rule given in power company's acts. To some extent this was true, but the Committee would recollect that the words dealt with in provincial power company's acts were entirely different to those dealt with in the London district, because they generally represented enormous tracts of country and all the Corporations were excluded from the operations. In London there was an entirely different state of things, the area being crowded in all directions and being served by distributing authorities. The Administrative company's bill in the first instance contained no purchase clause, and so left the House of Lords Committee, but on the second reading in the House of Lords this was pointed out and they consented to bring up a purchase clause. This was a clause very much on the lines suggested in the present bill, the only difference being that they asked for 50 years, instead of 42 years. The County Council strongly objected to that clause, very much on the grounds that they objected to the clause to-day, and the clause was altered mainly on "then value" terms, and was finally reduced from 50 to 42 years. Mr. Freeman referred to the decision of the House of Lords in regard to the taking over of the London and Edinburgh tramways, when the finding of the arbitrator was approved by the House of Lords, and the "then value" was defined as the fair market value of the tramway as a concern ready to earn money. It looked as if the words in the Electric Lighting Acts were an amplification of those findings under the Tramways Act of 1870, and there was really no uncertainty as to what "then value" meant. The alternative suggested by the promoters was that the auditor should certify from time to time the amount of capital expended. So far as the ordinary depreciation of plant was concerned, there would be no difficulty; but a great difficulty would arise because at certain periods, before it could be said that plant was worn out, it would perhaps be superseded by something much better. Whether the machinery had been wisely substituted, whether the existing machinery was so obsolete that it was good policy to scrap it altogether, or whether it would have been better to run it for another three or four years, was a matter in which there might be considerable difference of opinion amongst experts; therefore, it was difficult to see how an auditor could determine this difficult question. The auditor would [illegible] one expert who might or might not be the best [illegible] for the purpose, and would go by his opinion. The company had taken precaution that if they were dissatisfied with the auditor's [illegible] they could appeal to the Board of Trade, but there was no [illegible] by which local authority could appeal. He submitted [illegible] from existing arrangement. The next [illegible] proposal that at the end of 42 years the dividend should be made up to an average of 8 per cent. This was without precedent, and he characterised the clause as the outcome of his learned friend's (Mr. Fitzgerald's) ingenuity. Mr. Maltby had, in the course of cross-examination, made a curious statement in regard to this clause, suggesting that it had been inserted in order to obtain a further life of 10 years, when the provision would not apply. Another matter in regard to the purchase clause was that most of the present undertakings were purchaseable in the year 1931, and London County Council desired that there should be an option to purchase the company's undertaking in the same year, instead of at the end of the 42 years, upon payment of the then value of the plant in 1931 and of such goodwill as was represented by the intervening period. Another point was that, as the clause was drawn in the bill, the "undertaking was liable to purchase by any County Council or joint committee of County Councils or other authority who may be authorised by Parliament to purchase." London County Council were of opinion that there should be something definite in the act. Parliament had said that London County Council were the proper persons to deal with the matter, and he suggested that the clause should be altered to read "London County Council or such other body as Parliament may authorise." The Council also thought that whoever purchased the company's undertaking should be entitled to make the purchase in stock, not in cash. In the case of the London water companies, this was the course adopted, and it had been so successful that he suggested it should be put into this bill.

In reply to the Chairman, Mr. FREEMAN said they wanted it to be optional on the part of the purchasing authority to pay either in stock or in cash, so as not to flood the market with the raising of the large sum of money required. It was not to be optional on the company.

Continuing, Mr. FREEMAN said another point in regard to the present bill was that the Kitson Clause was practically thrown over and a new clause introduced. The local authorities were dissatisfied with the new clause, and London County Council did not approve. The clause erred in two or three important respects. He did not see why, in this case, for the first time, provision should be made enabling the company to supply the large consumers without reference to the wishes of the authorised distributors. According to the new clause, the test was to be the unreasonable refusal of the local authority to supply at a certain ratio above the price they would pay the power company. This did not take into account any consideration of the varying positions of the distributing authorities. One of the main elements to consider was what had been the capital outlay of the distributing company, having regard to its position, its authority, and the time it was started. These were matters which could not be decided by any fixed rule, but only by reference to an absolutely impartial tribunal such as the Board of Trade. It was all very well to say that there had never been such references to the Board of Trade, but the fact of there being such a tribunal made both sides to the bargain reasonable, whereas if left to themselves they might go on wrangling for ever. In the public interest, there was one modification which might be advisable. The local authority were to be in a position to take the supply from the power company at a reasonable price, and he thought there should also be some provision that they should distribute it at a reasonable price. This part of the Kitson Clause would operate directly in favour of the consumers. The view of London County Council was that there was no advantage whatever to be gained by substituting the new clause proposed by the promoters for the Kitson Clause, and that the Kitson Clause should be kept as the foundation of legislation.

Replying to the Chairman, Mr. FREEMAN said the general position of the County Council was what they recognised the advisability of having a large bulk supply. Therefore, under certain conditions, they would not oppose the present proposal. The County Council were not going to do the work themselves, and had endeavoured not to make any suggestion that, in their opinion, would wreck this bill. He did not think that any of the suggestions made would in any way make it difficult to raise the money.

Mr. FELIX CASSEL (chairman of the Parliamentary Committee of London County Council) supported the views expressed by Mr. Freeman. Examined by Mr. Coward, he said Parliament rejected the bill brought forward by the County Council, which the Council thought was the solution of the bulk supply question. Their attitude regarding the present bill was that they did not desire to offer any opposition on the grounds of engineering details, or the area of supply, but that so extensive a franchise ought not to be granted unless there were clauses adequately protecting the interests of the public and also securing fair dealing with the existing undertakers. The present bill complied with these requirements in certain respects, but not altogether. The view of the Council was that the promoters should be in a position to carry out the powers quickly if they obtained them, and the work should be substantially commenced within two years; also that there should be some provision that a substantial sum be raised within a period of one year. They were willing to accept the figure of £600,000. In regard to the purchase clause, the Council thought it unsatisfactory that the company should not be subject to purchase without another Act of Parliament. If the clause passed as it stood no one could terminate the franchise until they obtained another Act of Parliament, and the Council suggested that the purchasing authority should be someone definitely named, and that the Council should be named unless Parliament definitely authorised someone else. If they had the power to purchase, the money act would be only a formal matter. He urged no objection to the term of 42 years, but thought it desirable that there should be option to purchase in 1931, although the Council fully recognised they would have to pay compensation for goodwill from 1931 to the expiration of the 42 years. Why the Council thought the option desirable was because the purchasing rights over the distributing systems of most of the companies would occur in 1931, and it might be desirable at that period to be in a position

to get both the bulk supply system and the distributing system under one control. The Board of Trade laid particular stress upon that when the County Council Bill was before Parliament last year. As regarded the clause dealing with the dividends, the Council preferred the ordinary sliding scale usually adopted in power acts, which seemed to be the most effective way of making it in the interest of companies to reduce their prices to consumers, and to put both the working of the company and the raising of the capital on as economic a basis as possible. London County Council recognised the urgency of the question, and desired that a bill giving a cheap supply of electricity should be passed this session, provided public interests were properly safeguarded, and also the right of existing undertakers.

Mr. H. E. HAWARD, Comptroller of London County Council, examined by Mr. Freeman, K.C., said he had considered all the power supply bills which had been before Parliament. There were several clauses in the present bill to which he took exception. The clause relating to the accounts being passed by an auditor of the Board of Trade did not compel the company to carry out such auditor's recommendations. He might advise that certain sums should be set aside as depreciation, for sinking fund, or for other purposes, but there was no clause actually compelling the carrying out of such recommendations. Witness did not suggest that a Board of Trade auditor was an unsuitable person to carry out the audits, but he would not have sufficient technical knowledge of the working of electricity supply concerns to efficiently carry out the audit without expert advice. He thought what was known as the electric lighting purchase clause should be embodied in the bill and that the London County Council should be cited as the purchasing authority. A 42 years' term was a quite reasonable one. The company should also be compelled to make provision for sinking fund on the rigid principle adopted in the case of the London County Council tramways. If the accounts were properly kept they would at the end of their term get back the whole of their capital, as obsolete capital would be periodically written off. The bill ought also to contain a clause as to charges on what was known as the sliding scale, so that no increase in price beyond the standard fixed could be made unless the dividend payment was decreased, and that a reduction below the standard must be made before the dividend could be increased.

Mr. FITZGERALD : Do you know of any single company that has ever been able to raise capital under the accumulated conditions which you have laid down ?—There are some, I think, but I cannot call one to mind at the moment. He agreed that if the auditor refused to certify unless certain of his directions with regard to allotment of revenue or other matters were carried out such directions would have to be executed, but the clause did not give the County Council or any other outside authority access to the books. He admitted that one of the objections to the purchase clause on behalf of investors was that capital properly spent on plant might be depreciated very considerably by new inventions cropping up just before the expiry of the purchase term. With regard to London County Council being cited as the purchasing authority, he was aware the area sought to be covered by the bill extended considerably beyond the London boundary in more than one direction and that the other County Councils concerned might want to be in that position.

By Lord LAMINGTON : It was true that the other power companies had no purchase clause imposed on them. That was because their range of operations was so wide.

On Friday the CHAIRMAN said the Committee did not wish to hear any further arguments or evidence with regard to the extent of the competition which would result from the passing of the bill, unless anything perfectly new could be brought forward.

Mr. ERSKINE POLLOCK (for Middlesex County Council) said he objected to the purchase clause, which contemplated purchase by the L.C.C., and apart from that he had a strong objection to any portion of Middlesex being included. Middlesex County Council considered that the County of Middlesex was a proper unit for an independent supply of electricity and that the Council or a company approved by them (the Council having the right to purchase at 30 years) would be the right authority to undertake the supply. Purchase of the company's undertaking by the L.C.C. would involve either the L.C.C. working in the areas of other County Councils or, if a joint body of County Councils purchased, it would lead to great difficulty in apportioning charges, &c. The L.C.C., if they took possession in the whole of the proposed area, would have powers to break up roads in a portion of Middlesex Council's area, which would be 52,669 acres with a rateable value of £4,432,511 and a population of 768,417. Ratepayers in the L.C.C. area would say if the undertaking under the L.C.C. were a failure, that the Middlesex ratepayers should bear a share of the loss and if it were a success the Middlesex ratepayers would be dissatisfied. With regard to the question of distribution, he (Mr. Pollock) believed that all electricians agreed that at a certain point economy was annihilated by distance. Middlesex would, if struck out of this bill, not be without bulk supply, as the North Metropolitan had an up-to-date station at Brimsdown and another at Willesden, the former of which supplied the Middlesex County Council tramways, the largest bulk customer in Middlesex, and the Metropolitan Company also had a station at Willesden, which provided an excellent source of supply. Possibly Kent, Essex and other County Councils were not there as opponents, because London was not growing so much in their directions as in Middlesex or their districts adjoining London were too fully supplied to necessitate active opposition. The time was near when Middlesex should be dealt with as a whole, and therefore it should not be touched by this bill

In reply to Lord Welby, Mr. Pollock said, supposing it were decided that purchase should be on " then value," if the purchase were to be by both London and Middlesex Councils, there would be great difficulty in apportioning how much of the cost should be borne by the respective Councils and what would be the portion acquired by each. He objected to the proposal by Mr. Freeman that L.C.C. should be specifically included in the bill as the purchasing authority so that they could purchase without further reference to Parliament. He thought Mr. Freeman would agree that Middlesex should be struck out rather than have any complication as to purchase.

Mr. R. S. CLEASE, in the absence of Mr. Freeman, said he would ask the Committee not to accept Mr. Pollock's suggestion.

Mr. J. BIGWOOD, chairman of the Parliamentary Committee of Middlesex County Council, said the Council had 20 miles of tramways, and many more miles were under construction. The Metropolitan Electric Tramways, the company which worked the tramways, took current from the North Metropolitan Electric Power Co. It was perfectly satisfactory, and beneficial to the county. The Council had already received from the company their interest and sinking fund and some small profit. The Council's share of the profit was 45 per cent. He agreed with Mr. Pollock that the bill should include either all or none of Middlesex. They preferred to be struck out altogether. The furthest distance in Middlesex from Barking was about 23 miles. The whole of the County of Middlesex was included in the areas of the two companies now supplying. The proposal to include Southgate, Edmonton and Enfield was some improvement upon the 1906 bill. His Council was prepared to promote a bill themselves rather than have a bill for a portion of the county promoted by others.

On Monday, Mr. HARPER (for Middlesex County Council) said he found the distance from Barking to the furthest point in Middlesex was $27\frac{1}{2}$ miles.

Mr. BLENNERHASSETT (for Westminster Council) said the Council had no electrical undertaking, but was supplied by seven companies. They wished to retain intact the right given them by Parliament to acquire the electrical undertakings in the district, which they looked upon as a very important asset. The Electric Lighting Acts gave them exceedingly favourable terms and they could acquire the undertakings without any charge for goodwill or allowance for profits. The promoters could make their bill harmless to Westminster Council. The Council not only had the right to acquire stations in their area but also one in Marylebone which supplied the Westminster Company. They had a valuable site for a future station on the banks of a canal, which would enable them to obtain cheap coal. His Council strongly objected to clause 52 which enabled the company to come in and compete with the authorised distributors for power supply without appeal to the Board of Trade. He would rather have the Kitson Clause, although he objected to that also. He thought the exceptional circumstances of Westminster made it reasonable to ask that the company should not be allowed to come in and supply energy for power, except for railways, canals, &c., without the consent of the local authority. With regarh to clause 73, which gave the company power to acquire transfers of undertakings of authorised distributors, subject to the approval of the Board of Trad, the owners might go behind the backs of the City Council and sell to the company and the latter could then supply at the prices of the old undertakers. Part of clause 73 said, in words, that the right of purchase by local authorities should still apply, but this would be perfectly useless, as the company would, after acquiring such local undertakings, be in complete possession of the field, and he asked the Committee to say the company should not buy the business of any undertaker without the consent of the City Council. In 1931 the present companies would be tempted to come to the bulk company and ask to be bought up by them, which would in fact interfere with the Council's right to buy them. The Council had no desire to wreck or destroy the present bill.

In reply to the Chairman Mr. BLENNERHASSETT said the Council did not want powers to supply before 1931, but they wanted their right to purchase at that date preserved intact.

Mr. PHILIP PILDITCH, chairman of the Law and Parliamentary Committee of the Westminster Council, said he could not say at present whether Westminster Council would in 1931 take over the undertakings of the three self-contained undertakings in their area and leave out those which would need compensation for severance. It might be desirable to have the option of bulk supply from the Power Company if it were not tied up with other objectionable features. The undertakings of the Pall Mall, Westminster, Kensington and Central companies would be sufficient to supply all the needs of Westminster.

Mr. JOHN HUNT, town clerk of Westminster, said he believed the capital required to buy up the self-contained undertakings in Westminster would, as Mr. Clode estimated, be £2,000,000. The promoting company should not have the power to purchase them. If the capital of the company would not enable them to buy up the companies in the district why should they have this clause in their bill. It would only be necessary for the new company to buy one of the existing companies' undertakings to cripple the Council's prospects. An inducement to the existing companies to sell to the new company in 1931 would be the compensation for severance.

Mr. GERALD SANDERS (for Islington) said the circumstances of Islington showed the hardship which might be inflicted by the bill. The Council regarded the matter not merely as one of competition, but as competition for the best part of the supply, leaving the most burdensome part to the Council, which had spent £449,000 on their generating station and mains, and commenced supply as far back as 1896. They had done everything in their power to induce consumers to give up their own plants and take current from the Council, and the result was that in 1907 1,100,000 units were supplied against 76,000 in 1903.

PARLIAMENTARY INTELLIGENCE *continued on p. 304.*

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"THE ELECTRICIAN" INDUSTRIAL SUPPLEMENT.

With the number of "THE ELECTRICIAN" for Sept. 14, 1906, was issued the first of a series of "Industrial Supplements," to be published from time to time with "THE ELECTRICIAN." The twenty-third issue of the Supplement was issued (Gratis) with "THE ELECTRICIAN" for May 29.

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STREET LIGHTING IN THE CITY OF LONDON.

A YEAR or two ago it was felt that electric lighting in this City was not receiving that attention which it deserved, and that the way in which antiquated arc lighting had been replaced by the most recent forms of gas lighting was by no means justified. As the result of much expostulation the Streets Committee decided to allow the electric lighting companies concerned to demonstrate experimentally what could be done by means of the most recent forms of flame arc lamp, such experimental lighting to be run for six months in certain of the streets. The effect of this experiment is now apparent in a report to the Streets Committee by Mr. A. A. VOYSEY, City Electrical Engineer, which confirms all that the adherents of electric lighting have ever claimed. Starting out with the contention that illumination measured on a horizontal surface can be taken as a sufficient indication of the value of the lighting in a street (the actual surface being taken at a height of 4 ft. above the street level), and that the minimum value of the illumination is the most important criterion of good lighting, one tenth of a candle foot being taken as the minimum below which it is not desirable to go in main streets, Mr. Voysey draws some very interesting comparisons between electric lighting and gas lighting.

It is, of course, acknowledged that the ultimate basis on which methods of illumination must be compared is purely financial unless there happen to be very distinct advantages, apart from any question of light which are worth paying for. Electrical engineers will, therefore, read

with a good deal of satisfaction from Mr. VOYSEY's report, which we reproduce elsewhere, that the average illumination of a good sample of gas lighting in Queen-street, which has the same width as Cannon-street, is only about half that by arc lighting in Cannon-street, though the cost is about double. Mr. VOYSEY is of the opinion that, light for light, high-pressure incandescent gas costs four times as much as the electric flame arc. Apparently, departments of the Corporation other than the Public Health Department are now saving at the rate of about £3,000 a year, partly by changing from gas to electricity, and partly by having electric lighting of an up-to-date style. Mr. VOYSEY is of opinion that the main streets could be well lighted by means of 500 11-ampere flame arc lamps at an annual cost of £8,750, and he has very little doubt that the average illumination throughout the whole of the City streets could be at least doubled by this means, and, in addition, a saving of about £6,000 per annum effected.

There are other points, apart from financial considerations, that are of great interest in this report. The central form of suspension, which originally came in for some criticism, more particularly by our gas friends, is shown to be more effective than side or central standards, as might have been expected. It is naturally an ideal method of placing a lamp, if the surroundings are convenient, and, as pointed out by Mr. VOYSEY, this method affords a distinct saving in the illumination of side streets, because such lamps can be placed at crossings in such a way that the illumination is much more effective for any side street than is possible by means of a standard at one corner. There is another advantage also, to which we have previously referred—namely, that lamps can be suspended by this method at a greater height than that for which lamp standards are conveniently made, and the higher the lamp the more uniform is the effect. Although the minimum value of the illumination may be a suitable guide as to the good or bad illumination of streets under most conditions, we think there is, nevertheless, no doubt that the more uniform the illumination the better. Consequently the source of illumination should be placed as high as possible in the case of flame arc lamps. We say as high as possible, because the height is not likely to be made so great as to give an inefficient result. It can be seen, very simply, that if the illumination between two sources of light is to have the same value midway between them as directly below the sources of light, then, neglecting obliquity of the rays to the horizontal surface at the mid point, as a rough approximation the height of either source of light should be half the distance between them. We do not anticipate that this idea can be carried out to the limit in practice, but undoubtedly the higher the source of light under these conditions the better, and this is borne out by some curves which Mr. VOYSEY gives in his report showing the difference in illumination between a lamp suspended at 28 ft. and one suspended at 26 ft.

Our readers will find several minor points of interest to which we cannot here refer, and we do not doubt that, on reading Mr. VOYSEY's report, they will experience considerable encouragement as to the future of street lighting by means of flame arc lamps in competition with incandescent gas.

REVIEWS.

(Copies of the undermentioned works can be had from *The Electrician* Office, post free on receipt of published price. Add 5 per cent. for abroad or for foreign books.)

Electrical Traction. By ERNEST WILSON and FRANCIS LYDALL. Vol. I. (Direct Current), Vol. II. (Alternating Current). London: Edward Arnold.) Pp. v.-426 and v.-319. 15s. net each.

Owing to the rapid progress of electric traction since the appearance of the first edition of the work in 1897, this book has been almost entirely re-written and considerably enlarged, and the subject matter has been arranged in two volumes, of which Vol. I. deals with direct-current electric railways and tramways, and Vol. II. with the application to traction of alternating currents. This method has undoubtedly many advantages, and, on the whole, has been successfully followed by the authors.

Vol. I. (Direct Current), contains 22 chapters, and an appendix which gives the Board of Trade Regulations, &c., relating to tramway and railway matters. The first 14 chapters, with the exception of Chapter I., which is of a short, general and introductory character, outlining the plan and scope of the book, deal with electric tramways, while the remaining eight chapters contain the matter relating to direct-current railways explained on practically parallel lines.

Chapter II., "The Direct-Current Tramway Motor," is restricted to the considerations of the special features and requirements of a motor for tramway work. These characteristics are, for the sake of illustration, exemplified by means of calculations with special reference to a 35 B.H.P. motor of a certain firm, particular attention being given to the various performance curves—efficiency, speed, time-temperature and so on. While recognising the importance and usefulness of such data, we think that calculations with reference to other equally good tramway motors would have enhanced the value of this chapter.

Chapter III. is on "The Tramway Controller." After explaining the series parallel system of control, the construction of controllers is detailed with examples and illustrations of several well-known types. Under the heading "Other Details of Tramcar Equipment" the method of calculating starting resistances is discussed by the aid of numerical examples in the following chapter, in which are given different types of resistances, trolley wheels, poles, standards, the bow collector and various lightning arresters. Chapters V. and VI. deal with the mechanical features of the subject. The former gives general information of the rolling stock required for electric tramways, car bodies, underframe, trucks and brakes, which are satisfactorily treated, and the latter deals with the track both from the mechanical and electrical points of view.

Chapter VII. is on overhead equipment and poles. It is somewhat superficial, the question of the overhead construction on curves, &c., not being so satisfactorily dealt with as one would expect in a book of this character. The diagrams relating to these points are, in our opinion, incomplete, as they do not show the track rails. The diagrams could have been made much clearer and much more intelligible with the track rails included. This is specially the case in Fig. 100 (p. 143), relating to the overhead construction for a bow collector.

Conduit and surface contact systems are discussed in Chapter VIII., and various examples of typical constructions are given. The feeder systems of a tramway undertaking are gone into in the following chapter—positive, negative, and auxiliary cables—the chief feature being the example of the feeder system of the Belfast City Tramways with chart showing the routes, cables, and feeder pillars. Chapters X. and XI. give details of generating stations, car sheds and repair shops, while Chapter XII., the last dealing with the first section of this volume is on accumulator traction and regenerative control.

The second section relates to direct-current railways and contains a large amount of extremely useful information culled from various sources. Details of direct-current railway motors, critically examined, will be found in Chapter XIII., the various systems of control used on railways in Chapter XIV., which has been very ably worked out, and details of motor-car equip-

ments on direct-current railways in Chapter XV., while Chapters XVI.-XX. are on rolling stock, the direct-current railway track, energy consumption on direct-current railways, feeder systems and substations.

Chapter XXI. gives some highly interesting figures of first costs of electric tramways and Chapter XXII. information as to receipts, working expenses and tramway accounts in general.

Vol. II. contains 11 chapters and, as already mentioned, is on alternating-current traction—three-phase and single-phase. Chapter I., "The Polyphase Railway Motor," is divided into two parts, of which the first gives general theory, and the second the practical design and examples of actual motors. This chapter is very readable and merits careful study; it contains some excellent examples of three-phase motors used on typical continental railways—Berlin-Zossen, Burgdorf Thun, Valtellina railways, to enumerate just a few.

Chapter II. discusses the control and equipment of electric rolling stock on the three-phase system, and Chapter III. the overhead construction for three-phase railways. In Chapter IV. will be found the calculations of the energy consumed on three-phase railways; the subject is given in a very able manner.

Chapter V. is divided into four main sections, of which Part I. is on the general theory of single-phase commutator motors, and the design of single-phase series motors without commutation poles, Part II. gives the design and method of calculation for single-phase motors with commutation poles, Part III. treats of the design and the method of calculation for the compensated repulsion motor, and Part IV. compares the three types of single-phase commutator motors, and includes structural details and examples of the best known English, Continental and American types, with a number of excellent performance curves and diagrams. This chapter is one of the best in the work, and, in addition to the valuable information it contains, is admirably written and illustrated. The peculiar features of the commutator motor are well brought out and explained.

Chapter VI. goes into the methods of the control and equipment of the electric rolling stock on the single-phase system, and describes typical methods of control used on the latest single-phase railways and tramways, reference also being made to the system of the London, Brighton & South Coast Railway.

In the following chapter the overhead construction for single-phase railway systems is next discussed with numerous illustrations. Chapter VIII. is devoted to the explanation of the calculation of feeder systems for alternating-current railways, and much useful matter has been collected and embodied in it. The remaining three chapters explain the calculation of the energy consumption and give interesting statistics of costs relating to a number of direct and alternating-current railways, data of working costs, maintenance and accounts. Each volume has a very complete index. The two together form a valuable survey of modern electric traction practice, and contain a large amount of reliable and useful information.

Die Elektrizität als Wärmequelle. By Dr. Friedrich Schoenbeck. Vol. LXI. of "Bibliothek der Gesamten Technik." Hanover: Dr. Max Jaenecke. Pp. 100. M.1·60.

This little volume is an elementary treatise on the application of electricity for the production of heat. Although, owing to its restricted size, it only gives an abridged survey of the subject, this is done in a satisfactory manner. The book opens with a short introduction on energy, and then follow, in Chapters I. and II., the fundamental ideas of resistance, conductivity, temperature-coefficient, current, E.M.F., Ohm's law, Joule's law, the units of energy and power, and the mechanical equivalent of heat. Easy numerical examples are also given. In Chapter III. the method of calculating electric heating of bodies is explained with examples, and there are some useful figures relating to nickelin wire and strip. There is a slight inaccuracy in this chapter. The calorie is given as equal to 1·19 watt-hours, whereas this should mean the kilogramme-calorie, and the numerical value should be 1·157, as on p. 31 in the preceding chapter the watt-second is stated to correspond to 0·24 gramme-calorie.

The methods of electric heating by wire resistances, glow-lamps, arcs, granulated material and eddy currents are next discussed in Chapter IV. Cooking and heating apparatus for various purposes are described and illustrated in the following chapter, which also contains information on the heating of rooms, electric furnaces, laboratory and measuring instruments, welding and soldering apparatus and electric heating in clinical work. The final chapter gives conclusions of a general character.

PHYSICAL SOCIETY.

At the meeting held at the Royal College of Science on May 8th Dr. C. Chree, F.R.S., president, in the chair, a Paper on

"A Modified Theory of Gravitation"

was read by Dr. C. V. Burton. If we are to regard gravitational attraction as exerted through the medium of the æther, it appears to the author difficult to avoid the conclusion that the very great (or possibly infinite) velocity with which such attractions are propagated is due to the very great (or complete) incompressibility of the æther. This conception is embodied in the pulsatory theories of Hicks and of subsequent writers; the chief outstanding difficulty has lain in providing for that agreement of phase which must be assumed to subsist amongst the centres of pulsatory disturbance associated with the mutually attracting masses. This difficulty is avoided if we suppose that primary waves of compressional-rarefactional type are being propagated through the æther with a velocity enormously transcending that of light. These primary waves may be travelling in directions indifferently distributed, or predominantly or exclusively in one direction; but an essential point is that all effective wave-lengths should be very great, measured even by astronomical standards. Thus the pressure changes will be sensibly in the same phase over considerable regions, and if the ætherial compressibility is locally increased (or diminished) by the presence of electrically neutral matter, every particle of such matter will act as a centre of pulsatory motion.

For the electron, so far as concerns this modification of ætherial compressibility, a specification is assumed which involves no restraint on the free mobility of the electron through the æther. Incidentally the dynamics of the problem assumes a relatively simple form, and a value which could be quite insignificant attaches to a "gravitational (or non-electromagnetic) term" appearing in the expression for the total inertia of an electron. It has to be shown that, in its primary aspect, the assumed wave motion would give rise to no observable effects. This, in fact, follows from the assumptions made, and it is only through the feeble secondary effect of gravitation that any evidence of the wave motion could be obtained. In attempting to work out the theory on a numerical basis, values have to be found for a considerable number of physical quantities, several of these requiring to be independently conjectured, before the remaining quantities can be determined. But the range of the values which could be reasonably assumed is a good deal more restricted than might be supposed. The author gives a plausible set of values for these physical constants.

Mr. C. S. Whitehead asked if the amount of energy stored in the ether was greater or less than it was in the past.

Prof. C. H. Lees asked if the ether considered was the old one or a new one. He referred to an interesting point in the author's representation of gravitation—namely, that matter was produced by the absence of something from the ether. In the theory advocated by Osborne Reynolds matter was produced by a deficiency in the normal piling, and recent theories seek to explain matter and gravitation by the absence of something which is present in free ether.

Dr. C. V. Burton, in reply to Mr. Whitehead, said he was not aware whether the amount of energy in the ether varied with time or not.

A Paper on

"An Examination of the Formulæ for the Grading of Cables"

was read by Mr. C. S. Whitehead. In the *Journal* of the Institution of Electrical Engineers both Mr. O'Gorman and Dr. Russell have shown that it would be advantageous if cables for electric lighting were constructed so that the component of the electric intensity along a radius (in cylindrical co-ordinates) was kept constant for all points in the dielectric in the same plane perpendicular to the axis. They both find that to attain this object λr ought to be kept constant if the current is alternating, and σ/r constant if the current is steady, where λ is the specific inductive capacity, σ the specific resistance and r the distance from the axis. In this Paper the question is regarded from a much more general point of view. Maxwell's two curl relations are taken in cylindrical co-ordinates, and it is supposed, as is quite legitimate, that the electrical and magnetic quantities are symmetrical round the axis, and that they vary as [illegible]. We can then solve the equation, and from the continuity of the tangential components of the electric and magnetic forces obtain an equation to find m. If P is the component of the electric

intensity along a radius, β the component of the magnetic force perpendicular to a radius in a plane perpendicular to the axis, we find

$$P = -\frac{im\beta}{\frac{4\pi}{\sigma} + \frac{\lambda ip}{c^2}},$$

where c is the ratio of the electrostatic to the electromagnetic unit of electrical quantity. Also if I be the total current in the wire parallel to the axis, and we neglect the displacement-current in the wire in comparison with I, we have $\beta = 2\,I/r$. Putting $m = -a + ib$, it is found that $\sqrt{a^2+b^2} = \sqrt{\lambda}\,.\,h$, where h involves no quantities which have reference to the dielectric. Taking the real parts and putting P_0 and I_0 for the factors of P and I which are independent of the trigonometrical factor, we obtain

$$P_0 = 2I_0 \frac{c^2}{\lambda r}\sqrt{\frac{a^2+b^2}{p^2+\left(\frac{4\pi c^2}{\lambda\sigma}\right)^2}}.$$

If we suppose I_0, a, b to be constants of the cable which do not vary as we vary λ or σ, we get the rules given by Mr. O'Gorman and Dr. Russell. Thus let σ be very great, then to keep P_0 constant we must make λr constant, but if $p=0$, that is for steady currents, we must make σ/r constant. We have seen, however, that $\sqrt{a^2+b^2}$ varies as $\sqrt{\lambda}$, so that in the case of σ very great this process suggests the rule make $r\sqrt{\lambda}$ constant. When $p=0$ it is shown that $a=0$ and that b varies inversely as $\sqrt{\sigma}$, so that this case suggests the rule make $\sqrt{\sigma}/r$ constant. The equation for P_0 is, however, strictly true.

Dr. A. Russell complimented the author on his interesting Paper and on the skill with which he had handled the mathematical equations. The question of the grading of cables was one of great importance to the electrical engineer, and it was necessary to attack it both from the mathematical and the experimental side. The author took the case of an infinitely long concentric main and assumed that the amplitude of the current remained constant. In the practical problem the main is of finite length and the amplitude of the applied voltage is constant. The mathematical difficulties in the way of getting a complete solution were great, and so he hoped the author would continue his investigations further. Dr. Russell exhibited a portion of a Jona graded cable which had successfully withstood a testing-pressure 150 kilovolts applied between the core and the lead sheath. If the dielectric had been air a disruptive discharge would have ensued at 23 kilovolts.

A Paper entitled

"Illustrations of Geometrical Optics"

was read by Mr. R. M. Archer. The principles of geometrical optics are frequently illustrated by experiments in which the images of narrow obstacles are obscured by similar obstacles arranged in the line of vision. This method is tedious and is open to the objection that the path of a shadow is traced rather than that of a beam. The author's method is free from these objections. Light from a narrow rectilinear source is allowed to pass through a slit and fall upon a flat white surface at almost grazing incidence. It is easy to obtain upon the surface a long narrow streak of light with sharp edges; and if a mirror be placed with its plane approximately normal to the surface, another streak corresponding to the reflected ray can be seen. Similarly the path of the beam after its emergence from a glass block or prism may be traced. Interesting effects can be obtained by using many slits and casting the beam from a distant optical lantern upon them. This mode of illumination is useful in demonstrating the formation of caustics. Quantitative results can be obtained comparable in accuracy with those given by an ordinary optical bench. The author exhibited a series of slides illustrating various cases of reflection and refraction, and showed also several experiments with the apparatus described in the Paper.

Prof. C. H. Lees expressed his interest in the neatness of the experiments, and said the author's method of dividing up a beam was a very useful one.

Mr. A. Campbell congratulated the author and remarked that the methods described could be applied to other optical experiments. In using a vibration galvanometer or an oscillograph, an easy way to obtain a curve of the wave-form was to put obliquely in the path of the beam a sheet of white paper and vibrate it.

Dr. W. H. Eccles also congratulated the author upon his Paper.

Franco-British Exhibition.—In connection with the description of the wiring carried out by Messrs. W. J. Furse & Co., which appeared in our last issue, we omitted to mention that our illustration showing the illumination of the Court of Honour at night had been reproduced from a photograph taken by Mr. F. N. Birkett, of Shepherd's Bush.

CORRESPONDENCE.

IS THE CONSULTING ENGINEER NECESSARY?

TO THE EDITOR OF THE ELECTRICIAN.

Sir: This is one of the most important questions of the day, but I fear it is one which cannot be answered with any degree of certainty.

Writing from a contractor's point of view whose business it is to deal direct with consumers, my remarks must be confined within those limits. With all large engineering works, there can be no question that the consultant is a necessity, but with small plants and wiring and fittings jobs there are several points which require carefully considering before an answer can be given.

The first point is, "What is a consulting engineer?" I know many who are a credit to the higher branches of electrical engineering, and who look after the interest of both employer and contractor, and to such I would open my arms on all jobs; but I regret to say there are those posing as consultants who know less than the contractor, and who seem to think their duty in life is to get all the information possible from the contractor and to make him lose money over his contract.

It is not long since a stall attendant at an exhibition of ironmongery started as a "consulting electrical engineer," and this man had no more idea of Ohm's Law than a ploughman, and so long as such are allowed to pose before the public, how can confidence be gained? Again, there are those whose training stops short at the college, and who complete their knowledge at the cost of the contractor and client by drawing up impossible specifications and obtaining a score or more of detailed prices from as many contractors so as to complete his knowledge of prices, &c. There is also the faddist, who has done more to check the industry than the jerry wireman, and unless the consulting electrical engineer comes within the category first referred to, I feel that he is unnecessary.

In your article you suggest that contractors should refuse to tender without a consultant, but this I fear would not work in practice, one reason being that the contractor can and the consultant cannot advertise, which opens up an important point. A consumer is generally "worked up" by the advertisements of the contractor, and when the latter gets a "look in," and has spent a day or so going over the premises giving advice, he does not care to say "put this into the hands of a consultant," who is almost obliged to obtain competitive tenders, with the result that his labour might end in one of love. Again, the consultant cannot be classed with the architect, for the latter is first applied to when a man wants a house, but as the lighting of that house is only a minor matter, the architect, with few exceptions, applies directly to the contractors for sanitary work, heating, lighting, lifts, &c., he having every confidence in the contractor.

When a client desires competition, I always advise employing a consultant, as I am of opinion that there is no possible means of obtaining a competitive tender or receiving fair value without the assistance of our professional friend. Subject to the bona fide consulting engineer obtaining a status such as a doctor or solicitor, I have no hesitation in saying that the public would have increased confidence, and so would benefit by always engaging their services, the contractors would also save time, and, better still, the consultant would eliminate from the ranks of the contractors those who bring discredit to the industry. From this point of view and others, I say without hesitation that the consulting engineer is necessary.—I am, &c.,

82, Gloucester-road, S.W., May 28. W. R. Rawlings.

TO THE EDITOR OF THE ELECTRICIAN.

Sir: Your perfectly clear and fair introduction to the ventilation of the question as to whether the consulting engineer is necessary or not, has come just in time. From the answers which have been forthcoming up to the present, it is clear that hardly anyone objects to the *good* consulting engineer, and that a few really consider his services a necessity,

for which they are willing to pay. Much has been made of the fact that *some* consulting engineers used to insist on the working out of fads, thereby increasing the prices and hampering the manufacturer in his desire to standardise (the one and only means of successful competition with the foreign makers). True such instances have occurred, but they now belong to the past. And this was not altogether a danger; as the engineers who insisted on these fads—as the manufacturer termed them—were, as a rule the pioneers, and men who knew some thing of their profession. Standardisation did not exist in those days as it does now, and the fads were not infrequently real, practical hints. However, this is practically done with now, but instead of this, we have another danger. The number of consulting engineers has increased something like tenfold since those days, and many have joined the profession who, excellent men though they may be, have not the necessary early scientific training and long and varied experience which go to make the real consultant. Especially is this the case in the large provincial centres where every electrical engineer not employed as a sales engineer by a manufacturing concern, opens a small office and proudly puts up his brass plate. These gentlemen, mostly former representatives of manufacturing firms, can hardly have the qualifications mentioned above, and it is by this new generation of semi-practical, but not scientific, consultants that those lengthy but useless documents called "specifications" are issued, which so often cause legitimate ire to rise in the breast of the contractor. As a rule, the younger and the less experienced the consultant the longer the specification.

A really experienced consultant should issue a short document specifying certain results to be obtained from the plant, to be verified by specific tests. Furthermore, certain outside limits should be given to insure that these results shall not be obtained only temporarily. Wherever possible standard material should be admitted, and in adapting existing and (to him) well-known standards to his clients' requirements lies the sphere of usefulness of the consultant. Quantities should be given wherever possible, and drawings should also be supplied. This and the smoothing out of innumerable small points between client and manufacturer is worth the fee paid.

Does the client imagine that he is not paying for his engineering advice by leaving the matter in the hands of the large manufacturers? Who pays the army of estimating and advising engineers, palatial offices, expensive trips, &c., in the German Electrical Trust concerns? Having had experience with both systems, I may say from my own knowledge that our English system is at least 10 per cent. cheaper for the purchaser. It is only when the German system is being followed by a few of our large contracting firms—*e.g.*, where the manufacturer or his friends are also the financiers—that the desire to suppress the consultant (for reasons not difficult to understand) is evident. In these cases, especially where the consultant is often the creator or inventor of the scheme, he finds, as a rule, that the manufacturer-financier is his bitterest opponent. This evil is difficult to overcome, except by the separation of the manufacturing and financial interests.

It may therefore be taken as conceded that both in the purchaser's and the manufacturer's interests (but principally in that of the former) the consultant is necessary, and his appointment should be insisted on. How is this desideratum to be obtained?

The reason for the hard times on which many of the consultants seem to have fallen may be found in the following facts:

(*a*) Nearly all Corporations have their own engineers, who, being mostly young and ambitious, resent any outside advice and generally succeed in impressing these ideas on their Councils.

(*b*) This example is being followed even by mining companies, factories and other large consumers, although the engineers in these cases are hardly of the required status.

(*c*) The dearth of new electrical enterprises.

(*d*) In the case of large new schemes the combination of the interests of the manufacturer and the financier.

(*e*) The overcrowding of the profession.

In the case of (*a*) there seems little chance of alteration, although the small towns might, perhaps, be brought to view the matter differently. But all the other cases are capable of being considerably modified, especially (*b*) and (*e*).

In the first case, manufacturers should only quote on proper specifications issued by a consultant of recognised standing; but, although I see the reasonable claim for protection for the manufacturer from bad consultants, I would not go so far as suggested in your article. This would open the way for too many abuses. However, this question is one and the same as the one mentioned in (*e*). The number of consultants must be reduced by some process of elimination, not only in the future, but at present. Obviously, the Institution is the only body likely to undertake this work, but I do not think it is a matter for the Council. At present such professional etiquette which exists, by the Council's creation, is only a hindrance to the many, and a sort of protection for the few who happen to be on councils, committees, or in other prominent positions. If this etiquette is to benefit all consultants, then their number should be limited, and no one should have the right to practice as a consulting engineer without being a full member. In addition to this, the sanction by a special committee appointed by the Board of Trade, or some other authority, should be required.—I am, &c.,

Dacre House, Victoria-street, Westminster, S.W., May 27. GERALD HOOGHWINKEL.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: We have been much interested in the leading article and subsequent correspondence in your columns on the question of the consulting engineer in the electrical industry.

We say unhesitatingly, that, in our opinion, the employment of a consulting engineer is not only necessary, but from the contractor's point of view, highly desirable. The contractor (and in the term contractor we include the manufacturer and supplier) as a rule knows exactly where he stands with reference to any work which he is carrying out on which a consulting engineer is engaged.

The unfortunate part about the electrical industry is that it is of a somewhat hybrid nature. It has practically no standing of its own; in many cases very few qualifications are necessary, with the result that it has become overcrowded with individuals who have no claims to be electrical or engineers of any other kind. The industry has never been organised and has not been put upon a proper basis. Its present condition is largely the result of uncultured and untrained growth; we believe that during the next three or four years, it will have to pass through a very critical time, during which much will be done to purge it of that undesirable class which forms so very large a proportion of the total number now engaged in it. There is probably not a score of firms in the country at the present time who will not take any order quite irrespective of the price at which it is offered to them. This is largely due to the fact that there has always been a mad scramble for work of any sort, and at any price, while with the exception, perhaps, of the cable branch of the industry, no serious organised attempt has been made to stop this cut-throat competition. The employment of a consulting engineer in connection with any work should tend to do away with this unfortunate state of affairs. If a reputable, honest and able consulting engineer is engaged to draw up a specification and prepare plans a contractor knows exactly what he is tendering for, as do all his competitors. If the consulting engineer is a man of integrity every tender is judged exactly upon its merits, and the contractor knows that if the consulting engineer has a reputation, as every consulting engineer should have, for seeing that the contractor carries out the work exactly in accordance with the specification on which he has tendered, he must put in such a price as will cover the sound work called for under that specification. Although the purchaser may have to pay slightly more for the work, he at any rate gets full value for the money that he does pay.

Of course, there are black sheep in every branch of the profession, and we are afraid that the proportion in the case of the consulting engineer is somewhat high. This is largely due to the fact that anybody can call himself a consulting engineer, but probably of all those individuals who put up a brass plate with their name and the term "consulting engineer" upon it,

not 10 per cent. are worthy of the name. To us it appears that they are divided into three classes—the consulting engineer who is a genuine engineer and knows his work; the consulting engineer who has some smattering of the requisite knowledge and experience, but who, nevertheless, is not fit to be entrusted with any responsible work whatever; and the third class, which consists of the man who has no ability, and who has probably lost his situation through being of no use to himself or his employers, and who drifts into the profession of a consulting engineer because all he has to do is to stick up a name and hire a small office from which he can address his correspondence. We believe it would be better for the whole industry if the two latter classes were entirely wiped out.

We are glad to be able to think that the time has passed when it was possible for a so-called consulting engineer to be engaged for electrical work of the greatest magnitude while at the same time morally acting as the agent for firms supplying the kind of machinery, &c., that would possibly be used in the execution of the contract. There have been clear cases of this in the past, and it seems extraordinary to us that such an immoral state of affairs was ever allowed to exist. It has probably been due to the fact that the Institution of Electrical Engineers, without a charter of incorporation, is not in a legal position to bring defaulters to book.

With regard to your remarks in your leading article on the question of the combination of financing with contracting, this, we believe, has been one of the greatest drawbacks to the prosperity of the manufacturing branch of the industry in this country, owing to the fact that a firm, anxious to secure the contract, was forced to make an investment which it would probably otherwise have considered to be absolutely unsound. The right type of consulting engineer, the man who would lay himself down as being a consulting engineer, and not a financier, should be able to put an end to this, one of the many drawbacks to our prosperity.

Any manufacturing firm or contractor who has the best quality of goods to dispose of, or who makes a point of carrying out the best work, cannot, we feel, do otherwise than back up the consulting engineer, not only from the broad point of view that the whole industry would benefit from the profession of the consulting electrical engineer being put on a high and sound basis, but also from his own personal point of view, because under the supervision of the high-class consulting engineer cheap and often fraudulent contractors and manufacturers are bound to go out of existence.

We feel, therefore, that it behoves the manufacturer, the supplier, the contractor and the electrical industry generally to support the high-class consulting engineer throughout the business. If the industry were only properly organised it should be possible for the contractor to refuse to carry out work except to the specification of a consulting engineer without the certain knowledge that some other contractor would come along and take the work without any such stipulation.

In the past the consulting engineer has been too prone to look down upon the contractor and manufacturer, but we think that he now realises that the manufacturer is after all the expert in his own particular line, and though the consulting engineer may have the highest possible knowledge in connection with any scheme as a whole, he cannot know as much about the actual details of the different parts of the work as the man who is engaged the whole of his time in designing and manufacturing that actual part. Since the consulting engineer has come off his pedestal a much better feeling exists between the two classes, and when it is so clearly evident that the existence of cordial relations between them would be so very much to the advantage of each, there should be no difficulty in arranging for some system of mutual support.

We think that the consulting engineers have made the first step in this direction by endeavouring to arrange their specifications so as to fall in with the manufacturers' standard practice, instead of, as in former times, stipulating all sorts of ridiculous and vexatious conditions, the net result of which was the self-glorification of the consulting engineer, an increased price in the cost of manufacture, without the slightest increase in efficiency, and the disorganisation of the manufacturers' works methods.

From our own point of view, we always feel that when we quote to a consulting engineer on behalf of his clients, there is a very much better chance of our tenders being carefully considered and dealt with on their merits than if we are dealing with some irresponsible individual who either takes the lowest price or else offers the work to some special friend at the price of the lowest tender sent in.

There is a leading article in one of your contemporaries on the uneconomical methods of pushing trade, in which, indirectly, a very strong case is made out for the employment of the consulting engineer. It is shown that in many cases the manufacturer, by his representative, in his anxiety to secure the work, say, of electrifying a factory, recommends plant for intermittent overload working of a very much lower normal rating than is desirable, in the hope that by that means he may be able to cut below the figure of his competitors. If a consulting engineer were engaged, he would definitely state what the actual power of the electrical equipment should be, and, not being interested financially in securing the order, would see that electrical plant of ample power for the work required of it was installed.

In conclusion, we may say that we consider it would be better for the whole industry if it were definitely settled that all electrical contract work should be carried out to the specification of a duly qualified consulting engineer.—We are, &c.,

25, Victoria-street, S.W., May 28. POOLEY & AUSTIN.

PRINCIPLES AND PRACTICE OF RADIO-TELEGRAPHY.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: Though many interesting facts and suggestions have been brought forward by your correspondents, it appears to me that no one has, so far, explained clearly the essential point of difference between Mr. Marconi's generator and the Cram, Duddell and Poulsen circuits. It is this: In the latter arrangement the main oscillating circuit is in parallel with the gaseous section (the arc), while in Marconi's generator it is actually connected at one end, through condensers, to both terminals of the supply, and at the other to the middle point of the gaseous section.

Thus, if one of the gaps has no current across it, the main oscillating circuit forms a connection between the supply terminals in series with the second gap.

Mr. Maskelyne's suggestion appears to be that the gaps between the electrodes form two similar arcs in series, as used by Poulsen. This cannot, however, be their function, because, if so, no oscillations whatever could be created in the main condenser circuit, since its terminals are connected to points which, under these circumstances, would be at the same potential, each point being half-way along one of the parallel branch circuits connecting the terminals of the supply.

The action must, therefore, be of a quite different character and must take place somewhat as follows: (1) The direct current from the positive terminal of the supply, which we shall suppose to be on the right hand, strikes across the gap from right to centre and rushes into the condenser of the main jig circuit. As a secondary consequence of the new distribution of charge, the negative potential on the left-hand electrode is made less, and the tendency for an arc to strike from centre to left is reduced. As the charge in the condenser increases the current across the gap decreases, finally dying out at the moment when the charge in the condenser has reached a maximum.

The motion of the centre electrode at once restores the dielectric strength of the gap by sweeping away the ionised gas.

The centre electrode is now charged positively, the right positively and the left negatively, so the discharge next strikes across from the centre to the left. The main condenser thus discharges itself and gains a reverse charge, the centre electrode becoming negative. Hereupon the cycle recommences, its frequency being mainly dependent on the natural frequency of the main jig circuit.

The direct current component of the charge, therefore, travels by two distinct steps from the one supply terminal to the other—firstly, from the positive across the right-hand gap into the condenser, and, secondly, out of the condenser by the

left-hand gap to the negative. The purely oscillating component, which will reach a steady maximum after a few cycles, travels to and from the main condenser through the circuits formed by the auxiliary condensers.

It is clear, therefore, that the gaps have never, simultaneously, arcs in series in them, under efficient working conditions. This is the more easily understood when it is remembered that the centre electrode is alternately positive and negative while the sides are fixed in sign.

In conclusion, I may point out that a somewhat simpler, though probably less efficient form of this generator is possible. It would be constructed as follows: One end of a long insulated conductor, say an ærial, would be connected to the rotating centre electrode. The positive and negative terminals of the dynamo would be connected to the side electrodes. No further apparatus whatever is absolutely necessary, though it would be advantageous to connect each side electrode through a condenser to earth.—I am, &c., J. Erskine-Murray.

Norfolk-street, London, W.C., May 30.

MARCONI'S SYSTEM OF WIRELESS TELEGRAPHY.

TO THE EDITOR OF THE ELECTRICIAN.

Sir: I am inclined to think that Mr. E. Raymond-Barker somewhat over-estimates the effect which any of Mr. Marconi's statements to the Press would have on the cable shareholder. Any such effect as might occur has been largely discounted by unchallenged statements of an opposite kind, such as have possibly escaped Mr. Raymond-Barker's notice. I have myself being called upon by more than one newspaper representative desiring to obtain independent opinion in regard to Mr. Marconi's allegations; and I have secured copies of the *Morning Post* of October 9th, *Daily Telegraph* of October 19th and *Daily Graphic* of August 16th, so that you may see that important sections of the London daily Press have, after all, been more or less impartially disposed in the matter.

I admit that certain incorrect inferences might be drawn from Mr. Marconi's statement such as would be unfair to cable telegraphy, and I certainly regret that I had no opportunity of seeing a proof of my press interviews on the subject, for I should then have been able to render clear the difference between manual and machine transmission, simplex and duplex working, &c., showing that the duplex-automatic system was for long distances only applicable to wire telegraphy at present. This revision would have been especially to the point in the instance of the *Morning Post*, whose representative I saw in the course of a short interval preceding a lecture I was delivering at the Engineering Exhibition at Olympia.

But, as I have already suggested, I very much doubt whether over statements on one side or lack of technical details on the other, in connection with lay newspaper interviews, would, in themselves, have any tangible influence with a cable shareholder—especially when the over statments and inaccuracies emanate from an interested and optimistic inventor anxious for financial support.—I am, &c., Charles Bright.

Parliament Chambers, Westminster, June 2.

[We regret that, owing to lack of space, we cannot give extracts from the newspaper articles referred to by Mr. Bright. We are glad that the Press does occasionally look into the submarine cable side of the question, though sometimes the attitude taken, as put forward by Mr. Raymond-Barker, indicates ignorance if not bias. We fear that we cannot agree with Mr. Bright that one-sided articles produce no effect on cable shareholders; they certainly have produced a very marked effect, and if they had not done so there would not be much object in showing the other side of the picture.—Ed. *E.*]

HIGH TENSION SWITCHBOARDS WITH REMOVABLE SWITCH CARRIAGES.

TO THE EDITOR OF THE ELECTRICIAN.

Sir: We were much interested in your description of the high tension switchboard on the "draw-out" carriage system supplied to the Franzisca Pit, Gelsenkirchen, Westphalia. We beg, however, to point out to you that this system is in no wise new. It was originally designed and developed by the A.E.G., of Berlin, of whom we are the British representatives, some 10 years ago. In its earliest form it consisted of a "draw-out" carriage carrying fuses and an ammeter for the feeders at the Oberspree works of the Berlin Electricity Works. A modified form of this carriage was installed on the feeders in the Stuart-street generating station of the Manchester Corporation Electricity Works.

The idea was gradually developed from that of a "draw-out" fuse carrier to a complete "draw-out" switchboard, and the first board of this kind erected in this country was the high-tension switchboard at the power station of the Powell-Duffryn Steam Coal Co., near Aberdare, which was installed by us in 1905. A full description of this board is given in Mr. Charles P. Sparks' Paper on the installation in question, read before the Institution of Electrical Engineers on March 22, 1906. We enclose reprint of this Paper, which contains a description, drawings and illustrations of the board in question.

The operation of this board was so satisfactory that the Powell Duffryn Co. decided on the same type of board for their generating station in the Bargoed Valley, an illustration of the first portion of which station we also have pleasure in enclosing herewith. Since then this station has been extended by the addition of a generating set of double the size shown, and the switchboard has been extended correspondingly by the addition of further "draw-out" switch-panels.

The Penrikyber Navigation Colliery Co. have also installed a switchboard of a similar design.—We are, &c.,

The Electrical Company,

May 26. J. Stottner, General Manager.

[In publishing the account of the switchboard at the Franzisca Pit in our issue of the 15th ult. we did not wish to give the impression that the idea involved was essentially new; in fact we described a somewhat similar board made by the Electrical Co. some time ago. The subject appeared, however, to be of interest.—Ed. *E.*]

LICONITE LEADLESS CABLES.

TO THE EDITOR OF THE ELECTRICIAN.

Sir: With reference to the article which appears in your issue of to-day on the above subject, we observe a clerical error in the figures you give for the transmitting capability of the three-phase cable which you saw tested at 50,000 volts for a working pressure of 25,000 volts between each core.

The cable is capable of carrying about 70 amperes, and of transmitting about 2,500 kw., not 500 kw., as you put it.

With regard to your notes as to the result of the test on the 2 yds. length of leadless paper cable which had been immersed with its ends bare and in water for seven days, we suggest to you that the actual breakdown was 70,000 volts, at which pressure the insulation began to give way and to be disrupted. This in its turn caused a drop in the voltage and a final failure at 52,000 volts. Had the voltage not been raised above, say, 60,000, the sample would not probably have been broken down at all.

We venture to say that so severe a test has never yet been successfully attempted on any paper or bitumen cable.—We are, &c., Wm. Geipel & Co.

PORCELAIN INSULATORS FOR TRANSFORMERS, &c.

TO THE EDITOR OF THE ELECTRICIAN.

Sir: In your issue of the 29th ult. you give prominence to a letter from a Continental firm as the makers of a particular form of insulator, referred to by Dr. Garrard in his recent article on porcelain insulators for transformers, switches, &c.

We happen to have used this type of insulator, as well as supplying it to other firms who specialise in extra-high-tension plant. They are made for us in the Potteries at home, and it is quite unnecessary to go abroad for them.—We are, &c.,

June 1. Johnson & Phillips (Ltd.)

Electrical Development in Lapland.—It is stated that the building of a large new station in Lapland is shortly to be taken in hand. Either the Norr or Soderland falls will be used, and it is proposed to erect the power station close to the Bronnland railway station and within about 10 miles of the sea. The power available is estimated at 88,000 H.P.

THE FARADAY SOCIETY.

The thirty-fifth ordinary meeting of the Faraday Society was held on Tuesday, May 12th, at the Institution of Electrical Engineers, 92, Victoria-street, S.W. Mr. L. Gaster occupied the chair. Dr. F. Mollwo Perkin and Mr. L. O'Dowd read a Paper on

"Determination of Boiling-points of very Small Quantities of Liquids."

The determination of boiling-points of small quantities of liquids by distillation is not satisfactory, owing to the considerable loss which may take place, and also because of the difficulty of accurately arriving at the boiling-point before the liquid has distilled away. In the method described a small test tube, made of thin glass, is passed through a hole in the cork in such a way that the end of it comes against the bulb of the thermometer. Through another hole a stirrer is passed. The heating vessel contains about 100 cubic cm. of sulphuric acid or glycerine. About ¼ cubic cm. of the liquid, the boiling-point of which is to be determined, is placed in the small test tube, this amount will rise nearly a centimetre up the tube. A small capillary tube, about 1 cm. long and sealed at one end, is dropped into this in such a manner that the open end rests upon the bottom of the test tube. The external liquid is then heated fairly rapidly until a constant stream of bubbles is seen to rise from the end of the capillary tube. The source of heat is then removed, when the speed at which the bubbles are given off slackens, and, finally, when the last bubble makes its appearance and shows a tendency to suck back the thermometer is immediately read. This is the boiling point of the liquid, because it is the point at which the vapour pressure of the liquid is equal to the pressure of the atmosphere. This method is really a modification of an older method, which, however, gives results which cannot be depended upon. The authors have determined the boiling points of a large number of liquids and found the results to be perfectly accurate, both with low boiling-point substances such as ether and with high boiling-point substances such as safrol.

Dr. F. Mollwo Perkin read a Paper entitled

"The Industrial Uses of Ozone, particularly in Connection with Water Purification."

A brief account was first given of the various methods for obtaining ozone, and of the different processes employed for water purification and sterilisation. The method used by Siemens & Halske was then described in detail. The apparatus consists of two concentric electrodes, the inside one being of aluminium and the outside one of glass. The aluminium one in order to keep it cool is hollow and has water circulating through it. The external one is also kept cool by water contact, and as the water is in an iron container which is earthed, this acts as a negative pole, and of course water is a conductor on the high tensions which are employed. Dried air is passed up the annular space between the two electrodes, and, by means of the silent electric discharge which is there taking place, is ozonised From the ozoniser the air passes up towers which are filled with pebbles, and over which the water trickles; by this means the water is divided up into a number of small streams, and consequently a very large surface is exposed to the action of the ozone. After the water has been thus treated it is allowed to flow into the reservoir in a series of cascades. By this means it comes in contact with the air, and any excess of ozone which may be in it is removed. It is found that the water purified in this way becomes almost absolutely sterile, and any bacteria which may happen to remain are not of a pathogenic nature, consequently the water is absolutely safe for potable purposes. Messrs. Siemens & Halske have a large installation for dealing with water at Wiesbaden and another for purifying the water supply at Paderborn. They have also erected experimental plant in several other places. The process can be very cheaply carried out, as it does not cost more than ½d. for every cubic meter of water which is treated. A portable plant has also been devised and is of particular use in case of war; in fact, some of them were employed in the late Russo-Japanese war. They should also be of value for other purposes—if the water supply of any town were to become contaminated with typhoid, for example. The Paper finally discusses other uses for ozone, such as the oxidation of eugenol in the preparation of artificial vanilla and the bleaching and sterilising of flour, a process used in a very large number of mills in this country. Flour so sterilised is capable of export for long distances, and may be kept for a very long time without deteriorating.

Dr. T. M. Lowry thought that a simpler method of sterilising on a large scale was to soften the water and bring down the bacteria in the precipitated chalk.

Dr. H. Borns pointed out that water from rapidly flowing rivers needed little further purification.

Dr. G. Senter referred to the difficulties of removing the last traces of ozone from the sterilised water.

Dr. V. H. Veley remarked that germs that could not easily be destroyed were, as a rule, harmless.

The Chairman described an ozonising plant he had lately visited in Philadelphia, where the water purified was practically diluted sewage. This plant was capable of treating water for a population of 30,000, but occupied only 30 ft. by 50 ft. of ground, as against acres required for sand filters. He also gave some particulars of the Lahmeyer process.

Dr. V. H. Veley, F.R.S., exhibited an

"Apparatus for the Determination of the Dielectric Constants of Non conducting Liquids."

In the usual bridge method balance is obtained by varying a resistance. In the author's apparatus a capacity is varied in such a way that variations are proportioned to the distance traversed by the movable condenser plate. These are read off directly and a simple calculation gives the specific inductive capacity under measurement.

PARLIAMENTARY INTELLIGENCE.

(*Continued from page 295.*)

Mr. Gerald Sanders (for Islington) continuing, said: The plant at Islington could be extended so that the total capital cost would only be £22 per kw., or £10 less than the promoters said their plant would cost them. They were supplying at 1d. flat rate for power and their coal cost an average of 11s. 7d., which was also less than the promoters said they were going to pay. There were 317 power consumers in Islington, all small, and the Council were supplying 206 of these. The total power demand was 3,448 H.P., of which the Council were supplying about 1,840. He arrived at the figure of £32 per kw. (as the company's capital cost) by dividing the total of £1,930,000 in Mr. Hammond's Table 22 by 60,000 kw., which gave £32 per kw. Islington's cost so far was more like £80 per kw., with distribution, but he had calculated that with extensions they could make the total £22 per kw. by reason of their pioneer expenditure. He disputed the accuracy of many of the figures in the tables. Table 2 seemed to be based on the assumption that Islington would be generating at 1·6d., as they were two years ago. Their costs under the combined scheme would be greater than the promoters estimated. No case had been made out in favour of Islington benefiting by the promoters' proposals. Islington objected to this bill, whether it contained the Kitson clause or the present clause 52, but they preferred the former. Under clause 73 they would inevitably be brought to a position when they would be obliged to sell at a disastrous loss, because they could not make their undertaking pay by reason of the power load having been taken away.

Mr. Albert Gay, borough electrical engineer of Islington, said the Council's provisional order was granted in 1903. Their capital expenditure was £87 per kw., including buildings, mains and everything. The present capacity of their works was 51,000 kw., and extensions this year would bring it up to 66,000 kw. They could put in 40,000 kw. more in their present station, which would make the total capital expenditure £900,000 and the cost of the whole undertaking £22. 10s. per kw. He gathered from Table 22 that the company's cost would, even if the load were assumed to be 75,000 kw., be about £25 per kw. There was not much demand for power, but it was growing. There were no consumers over 250 kw. Generation, which cost 2·65d. in 1902-3, came down to 1·51d. in 1905. He estimated cost of production in 1909 as 1d. per unit, and not 1·6d. as shown in the promoters' tables. Their total costs, including capital charges, were 2·86d. in 1906-7 and 2·52d. in 1907-8.

Mr. Reader Harris, K.C. (for Ealing and Barnes), asked that these two districts should be excluded. They were both residential districts. It would not be necessary for the company to have wayleaves through the districts, as they were on the boundary. The Metropolitan Company had powers to supply Ealing, and they had power to take supply from that company. It would be impossible for some time to come for Ealing to become an industrial area. Four-fifths of the land was restricted by covenants in the leases against the erection of buildings for manufacturing purposes. The bill offered Ealing no possible benefit, but much possible injury and Ealing offered no benefit to the company. Ealing was excluded from the Administrative bill and from the next bill to come before the Committee. Barnes had room for very large extension at their electricity works.

Sir Ralph Littler (for the City of London) said the City were always unwilling to oppose any public undertaking likely to be of public benefit, and they never did so unless such undertakings injured their privileges. The City had not ventured upon municipal trading in any shape or form. They expressed no opinion against it, but they did not think it desirable in their own case. The City would come into possession of so much of the undertaking of the City of London Co.'s undertaking as affected the City of London in 1914. It was highly improbable that the promoters would be able to do anything for the City as they would not get to work until 1913. There were a tremendous number of pipes and mains under the streets of the City and it could only involve the company in a few thousand pounds more expenditure to take their mains round the City. He preferred a decision by the Committee that the company should not go through the City to submitting the matter to the Board of Trade when questions arose as to the route. He asked that the company should be absolutely excluded from the City. All the railway companies whom he had asked said there could be no railway company who would wish to take a supply in the City.

Mr. M. R. Pryor, chairman of the Sun Life Insurance Co., and a director of the St. James' & Pall Mall Electric Light Co., said he had looked into the financial aspects of the present promotion. It appeared

to him that the £237,000 to be spent in the first year would hardly provide for the preliminary expenses. According to the bill the promoters could not pay interest until £3,000,000 had been issued. He believed the time was not favourable for raising £3,000,000, as the market had been perturbed by the unfavourable results of previous London enterprises, especially the Underground Railways of London. Even important companies and the L.C.C. had had to pay what would have been considered a high price a year ago. From 60 to 90 per cent. of the issues of the present year had been underwritten. He did not anticipate that the issue of this company would be successful unless it were made by a great financial firm, and he looked in vain for such a firm behind this scheme. There was a low bank rate and some return of confidence, but he thought London enterprises were not in favour at present. He thought it somewhat rash to embark on an undertaking which would require two millions by its third year, with a promised subscription of only £500,000. The existing companies would be unfairly affected by the bill in various ways.

Mr. Talbot (for the promoters) pointed out that the condition in the bill relative to payment of interest not being permitted until two-thirds of the capital had been issued referred to two-thirds of the share capital *in respect of which such interest may be paid*, and not to two-thirds of the whole share capital.

Cross-examined, Mr. Pryor said he thought the company would have to wait some time before they got the money. He did not think great success of the power company would be so injurious to the existing companies as less success would be, as they might adopt a dog in the manger policy.

By the Chairman: During the period the power company had to get their capital the other companies would be inclined to hold their hands so far as spending money on generation was concerned, although they might spend large sums on distribution. The clause authorising purchase in 42 years was not in the public interest. The provision for making the dividends up to 6 per cent. was not calculated to encourage thrifty management. With regard to repayment of capital, the existing companies had only their value to fall back on, and that had discouraged investment, and the public had to pay much more for their electric light than they would have done if the companies had reasonable security for their capital.

On Tuesday Sir Alexander Kennedy was called on behalf of the Westminster and Kensington Companies, and examined by Mr. Kennedy, Sir Alexander said he did not think the bill was necessary for the districts served by the Westminster, Kensington, St. James' & Notting Hill Companies, which had had considerable success in supplying for power and heating and at low rates. The industrial power users in those districts numbered 194, of which the present companies supplied 145. There were many customers for heating scattered all over the district. The four companies had expended £650,000 in distributing mains and low-tension feeders. The average demand in the district was about 5 kw. If the bill was intended to supply all consumers for non-lighting purposes in the West End he thought the district should be excluded. In the Administrative Bill provisions were inserted for their protection. In Westminster two companies, each capable of supplying all the lighting demand, were already working in competition. An undertaker could not supply at 1 per cent. above the price paid to the bulk company. In the case of the Westminster Company distribution (merely upkeep and maintenance of mains and meters and depreciation of mains and meters) took over 20 per cent. of the company's entire revenue. The company had a very large number of consumers whose average demand did not exceed 1 kw. Clause 52 gave more encouragement for an outsider to come in and cut out the existing companies than the Kitson clause would. If the District Company bought the undertaking of one of the distributors (under clause 73) they would become a direct distributor and competitor. Mr. Hammond had underestimated the Westminster Company's cost of generating a peak load in 1913, when they would have increased difficulty in working at a low load factor, and he had over estimated the company's costs if their works were extended. According to his (Sir Alexander's) calculations the profit estimated by Mr. Hammond to accrue to the Westminster Company under the combined supply would disappear and become a loss. On the general question his view was that large installations made for economy but a large number of small stations gave increased security.

Cross-examined by Mr. Talbot: He would not draw a considerable distinction between the West End and other districts. In existing circumstances (which had rapidly changed during the last few years) there was no case for a bulk supply for London. He agreed that a supply for the surrounding districts and not for London would be uncommercial. The Westminster Co. were charging 1d. for power. The maximum price in the Joint Committee Bill was £6 15s. per kw. and 0·33d. per unit. In the whole of his companies' district there was only one consumer over 250 kw. They would welcome any number of them, and could supply them without the slightest difficulty.

By the Chairman: He would like the Kitson clause without the 20 per cent. for lighting and with the provision which was put in the Administrative Bill preventing the bulk company from acquiring distributing undertakings.

By Mr. [illegible]: The 1 per cent. which the distributor was allowed to charge per 10 kw. below 50 would not enable them to supply on that basis. They had according to the bill to sell at that price at the load factor at which they bought. The Westminster Company would, he estimated, spend £54,000 on extension of plant in the next five years. The interest on that at 6¼ per cent. would be £3,375. It could not be assumed that the new company would deal with that increase, as they would not be there. Even if he knew that the District Company's supply was coming he could not restrict his expenditure as he was under statutory obligation to supply. The Westminster Company had a margin of plant slightly over 4,000 kw. and the Central had about 30 per cent. margin, but he had no doubt they would be compelled to spend the amount he had mentioned.

Re-examined by Mr. Kennedy: With metallic filament lamps the 20 per cent. of the power supply allowed by Lord Camperdown's Committee to be used for lighting would correspond to 50 or 60 per cent. with carbon filament lamps. The Westminster Company's price for power had been reduced from 4½d. to 1d. and he had no reason to believe it would remain even as high as 1d.

Mr. L. H. Hordern, manager of the Westminster and joint manager of the Central Companies, examined by Mr. Kennedy, said 94 per cent. of the Westminster Company's power consumers had demands of less than 10 kw. His company's new connections last year were 1,722 kw. for power and 1,296 kw. for lighting. About 18 per cent. of their consumers used power. They could not get consumers to take supply at the prices proposed by the bill. A consumer could not know what he had to pay until the last day of the year, as the greater part of the charge depended upon his maximum demand. Prices for power in London compared favourably with those in Edinburgh, Glasgow, Hull, Berlin, Charlottenburg and other places. His company sold about 12 units per £1 of capital expenditure.

Cross-examined by Mr. FitzGerald: Their income from power supply last year was £12,940 out of a total income of £252,000, or about 5 per cent. He objected to the new company because it might take some of their power customers, which would necessitate raising the price to the remainder, and he also objected to its taking powers for public lighting.

The Hon. Sydney Holland (for the companies interested in the Westminster and Kensington Bill) said the promoters of the bill now before the Committee should be held to have failed to prove the preamble of their bill if they had not shown that the generation and supply of electrical energy in London was unduly expensive and that its use had thereby been limited and that they would remedy this condition of affairs. They now knew accurately the possible demand in London, and the present companies were ready to give the necessary supply. There was no evidence of any unsatisfied demand for power or of the price being prohibitive. Railway companies' representatives had said they would like the option of bulk supply, but they had not said the present prices had prevented them from taking supply. Some of the promoters' witnesses had said they preferred to have more than one source of supply, and most of the 38 persons who replied to the circular asking for their support (of which 378 copies were sent out) only agreed to take supply if various concessions were given, such as reduction of prices and liberty to use a greater proportion of their supply for lighting. In the Administrative Bill evidence was given that the £5,000,000 capital could be placed without difficulty, but there was a great difference in this case. None of the promoters or witnesses had shown that they would be able to raise the money required nor that they had experience of the promotion of an undertaking such as this. Mr. Parshall had said St. Pancras should be left out if it could not be shown that the company would confer any benefit on St. Pancras, and he argued that his companies' district should be left out because it would not benefit by the bill. Did the new company intend to supply small power consumers or not? They were not bound to supply them, and if the small consumer did get supply from them there was no assurance that he would get it at a reasonable price. Let them put in the bill an obligatory clause for supply to small consumers and the whole scheme would come down, because there was no money to do it. They had a longer purchase clause, they could supply outside the area of the present companies, they were associated with other companies, they had no obligation to supply, and their maximum penalty for failure to supply was £5 a day while the present companies' was £50. If electricity supply was at present insufficient or too dear let the limitations and restrictions upon the present companies be removed.

Mr. James Falconer, examined by Mr. Balfour Browne, for the companies interested in the Joint Committee Bill, said he was chairman of the Mersey Railway Co. and was formerly chairman of the company that promoted the Administrative County of London Bill. He and his colleagues who were interested in the Administrative Bill decided last year not to proceed with a bill this session, and they were not interested in any of the bills promoted. At the time of the promotion of the Administrative Bill in 1905 the price charged in London for power was about 2d., and the promoters came to the conclusion that they could supply at an average of ¾d. per unit. The suppliers at that time were not in a position to compete. Their plants were not, in the promoters' view, up-to-date, and they had not developed the power business. When the promoters of the Administrative Bill considered six or eight months ago the question of promoting another bill they found the present suppliers were prepared to supply the principal power consumers at about 1d., so that there would be a much more serious competition for the bulk company. The London companies had also made agreements with the best consumers for periods up to seven years, and the power company had to assume that the best of the business could not be got for a considerable time. The existing undertakers' costs had been reduced and were now so low that it had been concluded that the Administrative Company could not safely offer to supply on lower terms. The financial position was bound up with the same question. They were satisfied that they could not put forward proposals which would enable them to get the strong financial backing necessary for a bulk supply. There was effective competition now by the existing companies, and he did not think there was room for a power company on an independent basis.

Mr. John [illegible], general manager of the Metropolitan Electric Supply Co., examined by Mr. Cripps, criticised figures in the promoters' tables and submitted statistics of the capital, output, dividends, &c., of

the present metropolitan undertakings. As showing how much more stringent were the conditions under which the present companies worked than those proposed in the bill for the District Company, he mentioned that the former were bound to connect up any public lamp within 75 yards of their mains at a price fixed by arbitration: they were bound also to supply any consumer who asked for supply, provided he paid a minimum of 13s. 4d. per quarter, and there were other obligations placed upon them by the L.C.C. with regard to testing and certification of meters, and they were subject to penalties up to £50 a day for failure to supply. The compulsory purchase clause had a serious effect on the financial position of the companies, and they had had to lay aside large sums not only to enable the original investors to get their capital back but to induce other investors to supply capital required from time to time. Up to the end of last year the London companies had laid by in the shape of reserves, depreciation funds, &c., and undivided profits £2,842,462, or one-fifth of the total capital expended. Their average charges for power had gone down in three years from 1·86d. to 1·37d. Power plant of all kinds actually installed in London was 209,000 H.P., and 46 per cent. of that was already being supplied electrically. It was generally considered that a smaller amount of electric power than of any other kind of power would be required to supply the residue, because there was no waste in the electric drive. There was a tendency to increase the uses of electrical energy in private houses for purposes other than lighting and this would increase the quantity of the power companies' supply which could, under the 20 per cent. rule, be used for lighting, and metallic filament lamps would also enable more lighting to be taken from their supply. Although the industrial character of London was less than that of the six next largest towns in England the quantity of electricity supplied per head of the population was greater in London than in any of the other six towns except Manchester, where it was slightly more. The provision in bills permitting bulk companies to purchase distributors' undertakings, and thus become direct competitors, was usual, and perhaps proper enough, in the country, where there were no competitive supplies but was not applicable to London.

On Wednesday, Mr. CONACHER said the consequence of the statutory disability of the existing companies to purchase the undertakings of or associate with other companies had been that the supplies were of a more or less parochial character and the disability of the companies to supply outside their areas had had somewhat the same effect. In 1905 his company and the North Metropolitan and County of London Companies came to Parliament for powers to supply energy to railways, notwithstanding that the current was to be used outside their areas. He considered it was desirable to have two trunk mains in preference to relying upon one. Where powers of bulk supply had been given to distributing companies they had been successfully carried out. This had been done by five companies in London, and one in Newcastle. He was of opinion that the bulk supply and distributing powers should be substantially in the same hands. From the outset the London Companies made considerable provision for the future. They had six millions of authorised capital not yet called up, their buildings were capable of taking additional plant, and they had land to accommodate five times the present plant. The time was coming when the companies would reap the reward of capital expenditure which had not yet become remunerative. The Yorkshire Power Co. had now, after six years, only been able to pay interest on about one-eighth of their capital, and had made no provision for depreciation. His own company (the Metropolitan) paid its first dividend in 1891, its second year. The South Wales Co. was backed by a strong financial group, but it had been broken up and parts of its undertaking had been sold. The effect of the very agitation of the power supply question in the last four sessions had shown that the passing of a scheme like the present would further prejudicially affect the condition of the money market, and that the existing companies would not be able to get capital they might require at rates which would enable them to continue to the same extent as hitherto the process of cheapening the prices of current. The quoted prices of ordinary and preference shares of electricity supply companies had shown a great falling off owing largely to the uncertainty as to whether a large power company was coming in.

Cross-examined by Mr. FITZGERALD: He was of opinion that his company could give any power supply that might be required more cheaply than the London District Co., having regard to their capital already expended. In the first few years most of the districts supplied by the Metropolitan Co. were supplied by that company alone, but after some years, owing to the action of the Board of Trade, other companies were authorised for some of the same areas. In spite of the competition, and in spite of the reduction of charges, their dividends had increased. He did not quarrel with competition so long as it was fair. Their Willesden station cost in all about £40 per kw. It was a well placed station, adjoining two railways, and a canal, and he could not conceive a more favourable inland site. Coal cost 12s. 9d. a ton last year. They got their water free, with slight exceptions. Mr. Hammond had omitted the Metropolitan Co. from table 15, because he could not show them any advantage by adopting the bulk supply. With regard to Mr. FitzGerald's proposition that if the Metropolitan Co.'s cost of generation was 1d. they could never give a cheap bulk supply, he said the tables had dealt with the costs of the present undertakers for their present supply, but the price at which they could supply to another distributor in the future was an entirely different question.

By Lord SAUNDERSON: The average charge of the Metropolitan Co. for power and heating (1·64d.) was brought about by the fact that the consumers were mostly exceedingly small motor users. The charge was 3d. for the first hour and ¾d. per unit after, but for large power users they had special rates.

By Mr. FITZGERALD: The average price at which the Metropolitan Co. supplied to Acton last year was 1·1d. The price at which they offered to supply in bulk to Marylebone in 1905 might have worked out at 1·7d. under certain conditions. It depended upon what part of the load the undertaker chose to take. The company's bulk supply powers had been a success, as they had enabled the company to reduce its charges very much. His company did not supply any railway, tramway, canal or navigation. He thought they had one 250 kw. user. The Brompton Co.'s income last year was £52,590, of which £1,039 was for power. That company paid 10 per cent. dividend. When the Charing Cross Co. went into the City of London to compete with the City of London Co., the Metropolitan Co. applied for powers to do the same. The Charing Cross Co. had a large area for bulk supply, but were not giving any bulk supply in that area. That was one of the companies, having bulk powers, which he described as being a success. Under the bill the new company might buy up an existing company, and undertake lighting in competition with other existing companies, although the promoters had not provided for sufficient capital to lay the mains that would be necessary for distribution to the consumers. He saw no objection to clause 73 outside London where different conditions prevailed. The purchase clause in the Joint Committee Bill was not on the same basis as that in the London and District Bill. The capital had to be redeemed by the purchasing authority, but at the expiration of the 42 years the whole of the original capital liability would have disappeared by reason of the sinking fund, and the capital raised during the life of the Joint Committee would also be very largely written off. If the undertaking were purchased in 1932 the capital had to be redeemed at a premium—£110 for every £100—and in addition a sum representing the net loss of revenue which might have been earned between 1932 and 1952.

By the CHAIRMAN: Their depreciation was compulsory, at a certain figure, on a 42 years' basis. It was not comparable at all with the scheme of the District Bill, which provided for repayment of capital plus back dividends. If purchased in 1932 the company was bound to have redeemed the premium to that time.

By Mr. FITZGERALD: Their sinking fund only existed after payment of interest and dividends, but if the stock was raised at 4 per cent., which 4 per cent. was guaranteed by the companies, the sinking fund came into operation then, and it was compulsory.

Mr. Cripps having objected to the witness being asked whether the Joint Committee intended to spend £1,000,000, Mr. FITZGERALD said the Chairman of the Charing Cross Co. (Mr. Fladgate) had told his shareholders there was no intention of raising a million at once, and that a few thousand pounds ought to suffice.

Mr. H. B. RENWICK, general manager and secretary of the County of London Electric Supply Co., was examined by Mr. Balfour Browne, and said Mr. Merz, in his evidence on the Administrative Bill, had much overestimated the H.P. demand, and had striven to show that the companies supplied only a very small portion of the demand. The 13 London companies, in July, 1906, decided to make a canvass as to the H.P. demand. This canvass occupied several months and the result was embodied in a report issued in the summer of 1907. The canvass showed motors connected and taking supply, 47,299, all other forms of power installed 55,591, the total power in the 13 areas being 102,890 H.P. To make the information complete, a canvass was also taken in the areas of the borough councils, and showed motors connected and taking supply 26,591, all other forms of power 79,325, or a total of 105,916 H.P. Taking the total, they found that out of the demand of 208,806 H.P., the companies were supplying in their areas 46 per cent., and the local authorities in theirs 25·1 per cent. The canvass had been for the same area and kinds of power as those adopted by Mr. Merz, and every step had been taken to make it as complete and as exhaustive as possible. The figures might be taken as being for 1906–1907, as the canvass was not completed until the spring of 1907. As regarded the progress of the County of London Co., in 1900 their power supply was very small, but it had increased until they now supplied 7,060,482 units and nearly 15,000 H.P. They had 82 consumers taking over 100 H.P., and 6 with over 200 H.P. With the object of securing all the power business, his company were willing to adopt almost any form of charging to suit consumers, whether a flat rate or a standing charge per kw. For a supply to some paper mills they had quoted as low as 0·45d. per unit, they supplied a good deal of energy at ¾d., and a considerable quantity under 1d. The rates for supply had been reduced from time to time, the average rates having come down from 2·3d. in 1903 to 1·25d. in 1907. Their consumers had received the benefit resulting from decreased cost of production, as these figures would show. It was an entire misapprehension to say that the companies did not push the power business. Speaking of the companies as a whole, they did, he knew, push the power business very energetically. In regard to his own company, they had a large staff of canvassers, specially trained, well paid, and well able to deal with the question of power supply from all points of view, particularly as to its cost as compared with gas, steam, and other forms of motive power. A difficulty they had to contend with was that consumers seldom knew their own costs of working, as their records were not complete. To get over that difficulty his company were always prepared to put down plant on trial for 3 or 4 months, free of cost, to show by actual demonstration the advantages of electric driving. They had done this in many cases, and in no case had it resulted other than in securing the consumer. They let motors on rental, sold motors on the deferred payment system, and in some cases had actually given them free of cost in order to get an entry into a particular district. Altogether his company had spent, practically since 1900, no less than £69,356 on these various forms and methods of pushing the power business. In one case, in order to obtain a consumer, they had paid £4,000 for the existing plant. To illustrate the thorough way in

which the company conducted operations to secure power consumers, witness showed the Committee a number of bound volumes of their canvassers' reports for 1907. They had succeeded in getting over 1,500 power consumers. Of course, there were some cases where owing to peculiar instances it would not pay a firm to take electric power supply, and where witness was quite sure no company could supply at a price that would enable the firm to substitute electricity. He referred to timber merchants, who had a large amount of waste as fuel, and in some other cases, such as laundries, brewers, and die works, steam suited them better. The effect of the bills in parliament which had been hanging over the electrical industry since 1905 had been to cause consumers to hold their hands. Consumers had come to believe they were going to get their power, and their lighting also, at ¾d. per unit, and this had made it extremely difficult to obtain consumers during the past three years.

Mr. E. Wilmot Seale, secretary of the Charing Cross, West End and City Electricity Supply Co., examined by Mr. Hutchinson, outlined the progress of his company, and gave some interesting particulars regarding the great development in the use of electric driving in printing works. He said the "Pall Mall Gazette" was the first newspaper to adopt electric driving in 1892. His company's experience was that as printing machinery was made more perfect and up-to-date, this trade became more amenable to the use of electric driving, and many of the large printing works in London were now electrically driven. His company had very energetically pushed their electric power business. Since the advent of the large power bills, however, it had been difficult to obtain consumers. People refused to put down power plants, and in other cases agitated for reduced prices. They had made an exhaustive canvass of their areas, and as a result found that in the company's West End area power to the extent of 527 H.P. was supplied electrically, 470 H.P. by gas, and 569 H.P. by steam; in the company's City area the figures were 15,493 H.P. electrical power, 5,320 H.P. gas, and 5,653 steam. The average demand of the company's power users in the City area was 8·4 kw., and in the West End area 12·3 kw. The company obtained in 1900 powers to supply electricity in bulk to West Ham, Poplar, Bethnal Green, and Stepney, but had not yet given a supply to either. From the introduction of Mr. Merz's bill in 1905 down till about a fortnight ago, witness estimated that the securities of the London companies has depreciated by £3,980,000. Since the present Committee had been sitting there had been a further loss in the value of the various London companies' securities of £186,000. The companies had, therefore, to face not only the threatened competition but the present effect of the bills. The operation of the new power company would tend to force down the value of the present undertakers' shares. He estimated that the new company, if it exercised its full powers under the bill, would take from the present companies £555,000 for power and lighting. As to bulk supply to local authorities, they had offered this in 1902 at 2d. per unit, subject to a revision of price at the end of a term of years. Much more favourable offers had since been made.

Mr. W. Forbes, general manager of the L.B. & S.C. Rly., examined yesterday (Thursday) by Mr. Cripps, said the company's line from London Bridge to Victoria, now being electrified, was nearly finished. They had made very satisfactory arrangements with the London Electric Supply Corp., for supply of power, and he looked forward to eventually electrifying at least 40 miles of track for suburban traffic. The length of track now being electrified was 8 miles 51 chains, and represented the most important portion of the company's suburban line. His arrangement with the London Electric Supply Corp. was for 7 years. If at the end of that time another company could satisfy them on all points there would be no objection to changing the supply, except that under the arrangement they were bound to give the present suppliers first option. The present stage of electrical working was experimental, and they would perhaps only run an electric train once every half-hour at first. The price they had arranged to pay for power varied from a little over 1d. to ¾d., and they had an undertaking with the London Electric Co. that when they had got a load factor of 35 the charge would be reduced to ½d. This was for alternating transformed current, the supply company paying the cost of transforming, and included the laying of duplicate mains. As the supply company was also under certain penalties, amounting to as much as £150 per day, for failure of supply, or stoppage, he considered the terms of supply compared very favourably with those offered by the present bill. Their supply would be at a periodicity of 25, single phase, the promoters' supply would be at 50 periodicity. It was important that there should be duplicate mains.

Mr. A. F. Harrison, secretary of the City of London Electric Lighting Co., and Mr. C. P. Sparks, engineer-in-chief of the County of London Electric Supply Co., were also examined yesterday (Thursday.)

Mr. Balfour Browne made his speech in opposition to the bill, and it was agreed to hold over Mr. FitzGerald's reply to a later date.

The Committee then adjourned to *June 16*, the Chairman suggesting that possibly in the interval the promoting company would be able to come to an understanding as to an acceptable purchase clause to be inserted in the bill.

We shall conclude our report of the proceedings up to the adjournment in our next issue.

THE ATLANTIC CABLES.

In the House of Commons on Tuesday Mr. Joynson Hicks asked the President of the Board of Trade whether he was aware that during the past few days seven or eight Atlantic cables had been cut or otherwise damaged off the west coast of Ireland by steam trawlers, causing interference in commercial business between the United Kingdom and the United States and Canada; whether warnings were issued to the proprietors of steam trawlers as to the exact locations of the cables; and, if not, whether he would take this and any other possible measure to safeguard the commercial interests of the community.

Mr. W. Churchill, in reply, said that he had received representations from several bankers, brokers, merchants and shipowners to the effect that there had been damage to submarine cables off the west coast of Ireland, and the Secretary of State for Foreign Affairs informed him that he had received a similar representation from the American ambassador. He understood that the subject had also been brought before the notice of the Postmaster-General by the companies concerned, and the question had been raised at the International Telegraph Conference. He could not say whether the damage, which took place some 50 miles from the coast, had been caused by the operations of steam trawlers, but he was making inquiries, and was considering, in consultation with the Postmaster-General, whether any steps could be taken under the International Telegraph Convention and the Submarine Telegraph Act, or otherwise, for the protection of the cables, assuming the trawlers to be in fault. He understood that one of the companies concerned had recently substituted a heavier type of cable in the area affected with good results. There were obvious objections to showing the routes of those cables on the Admiralty charts, but H.M. Government would take whatever steps might be possible to safeguard the commercial interests of the community in regard to this matter.

Telegraph Construction Bill.—This bill was read a second time in the House of Commons on Tuesday. The Postmaster General (Mr. S. Buxton) promised to consider amendments designed to prevent the spoliation of the natural beauties of country roads and lanes.

LEGAL INTELLIGENCE.

Rating of Light Railways.

On Friday, a Divisional Court (the Lord Chief Justice and Justices Darling and Sutton) heard an application for a mandamus against certain justices of Lancashire ordering them to hear and determine an application by the Urban Council of Bispham-with-Norbreck for a distress warrant against the Blackpool & Fleetwood Tramway Co. in respect of £594, due on a general district rate. It was represented to the justices that the company, as a railway, was entitled to a three-fourths reduction of net assessment, and that this was the reason the company refused to pay the full rate, and the justices had reduced the rate as asked by the company and refused to grant a distress warrant.

Mr. Palmer, in showing cause against the rule nisi, said sec. 211 of the Public Health Act, 1875, clearly laid it down that a railway was entitled to a three-quarters reduction of the net assessment, and it had been held that a tramway was a railway within the meaning of that section. Further, the part of the tramway in the parish of Thornton, had been held by the Court of Appeal to be entitled to the three-quarters reduction.

Mr. Leslie Scott, in supporting the rule, said it did not follow because the tramway in Thornton had been granted the three-quarters reduction that the part of the tramway in Bispham should have the same reduction, as the tramway in the two parishes had been constructed under different conditions.

The Lord Chief Justice said the Court could not grant a mandamus to order the justices to hear and determine a case which they had already heard and determined.

Justices Darling and Sutton concurred, and the rule was discharged, with costs.

BOOKS RECEIVED.

(Copies of the undermentioned works can be had from *The Electrician* office, post free, on receipt of published price. Add 10 per cent. for abroad or for foreign books.)

"The Electrification of Railways." By Prof. Gisbert Kapp. Two lectures delivered before the Royal Institution of Great Britain, January, 1908. (London: Biggs & Sons.) 1s.

"Die Revision Elektrischer Starkstromanlagen." By Depl.-Ing. Paul Stearn. Vol. XXXVIII. of "Bibliothek der gesamten Technik." (Hanover: Dr. Max Janecke.) M. 3.60.

"Regelung, Umsteuerung und Sicherung der Dampfturbinen fur ortsfeste Betriebe, Land- und Wasserfahrzeuge." By Wilhelm Gentsch. (London: Williams & Norgate.) M. 14.

"Radio-Telegraphy." By C. C. F. Monckton. (London: Archibald Constable & Co.) 6s. net.

"Proceedings of the Royal Society." Vol. LXXX. No. B 539. Series B., Biological Sciences. (London: Harrison & Sons.) 2s. 6d.

"A Study of Splashes." By A. M. Worthington. (London: Longmans, Green & Co.) 6s. 6d. net.

"Beitrage Zur Theorie Der Kabel." By Dr. Ing. Leon Lichtenstein. (Berlin: R. Oldenbourg.) M. 3.

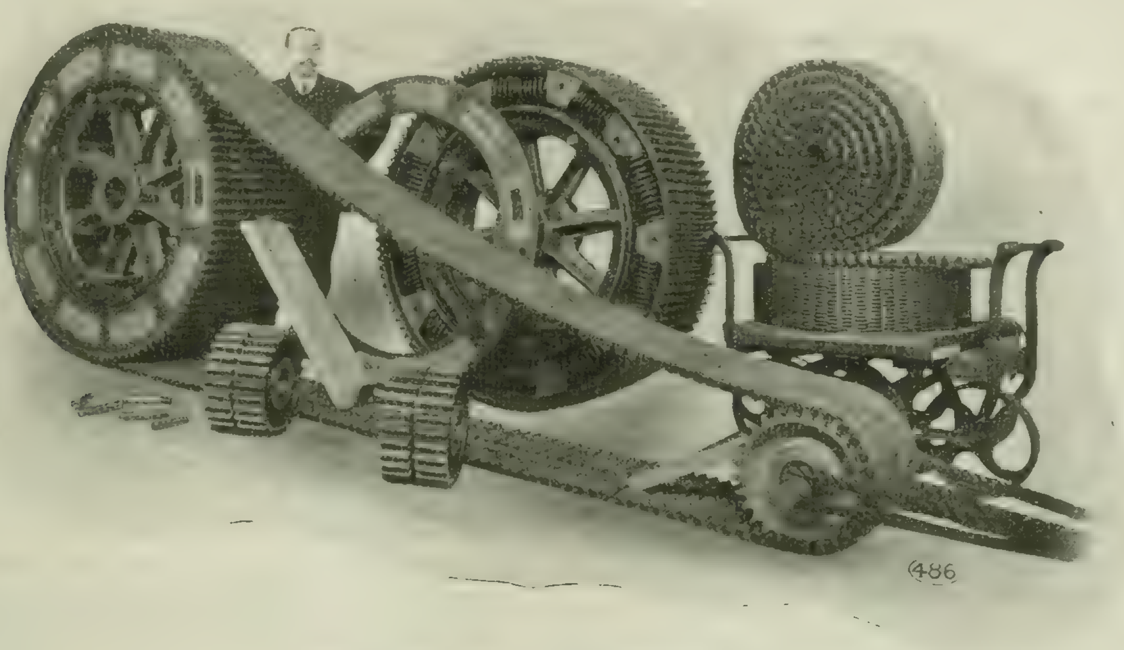
"Report of the Council of the City and Guilds of London Institute for 1907." (London: City and Guilds of London Institute).

TRANSMISSION OF HIGH POWERS BY CHAIN.

The accompanying illustration is of interest as indicating the extended use of chain gearing. Whereas 10 years ago 50 H.P. was considered a fairly heavy drive for chains, it is now quite usual to transmit up to 200 H.P. by this means. Higher powers still may be transmitted by standard chains using several strands, but the difficulty with this method is that the load may not be evenly distributed over all the chains.

Two drives are shown, each designed for transmitting 200 H.P. by two chains, and an even distribution of the load is assured by the special type of driven wheel. This wheel is of the compensating type and consists of three main parts viz., boss with eight arms, two rings bolted to the arms and two outer toothed rings, one for each chain. The outer and inner rings have projecting lugs, between which are fitted suitable springs. The toothed rings are independent of each other and act separately on their own sets of springs, so that if one chain tends to take more load than the other it simply closes its set of springs until the load is equalised. In addition to this compensating effect the springs absorb irregularities in the load, so that there is less wear and tear not only in the chain gear, but also in the electric motor, as the latter is freed from the vibration which would be set up by a train of spur gearing. The cover has been removed from one of the wheels in order to show its construction, and it will be noted that the springs are of two sizes, which are placed alternately; the larger set transmit the power and the smaller soften the recoil.

Messrs. Hans Renold, the designers and makers of the chain drives, say these are the largest spring wheels that have ever been made for chain driving - each weighs about 2 tons. The drives are part of an installation to transmit over 500 H.P. for a coaling plant supplied by Messrs. Head, Wrightson & Co., of Thornaby-on-Tees, for a tidal dock in Japan. The chains shown drive hauling drums from electric motors, and are in use about 140 hours per week.



View of Hans Renold Chain to transmit 200 H.P.

The pinions have 28 teeth, and are $15\frac{3}{4}$ in. diameter; the large spring wheels have 108 teeth, and are 60 in. diameter, the width being $17\frac{1}{2}$ in. The driving wheel makes 286 revs. per min., and the driven 74, so the ratio is practically 4 to 1, and the chain speed 1,170 ft. per minute. The chains are $1\frac{3}{4}$ in. pitch and 8 in. wide, the centre distance being 11 ft. 5 in. Each chain has a breaking load of 70,000 lb., and the total pull on the drive is 5,650 lb., giving a factor of safety of about 25 with the two strands.

MUNICIPAL, FOREIGN & GENERAL NOTES.

APPOINTMENTS VACANT AND FILLED.

The Board of Trade are prepared to receive applications for the post of meter tester and general assistant in the Electrical Standards Laboratory of the Board. Applicants must state their practical experience in instrument-shop and test room work and college training in mathematics, physics, elementary chemistry and electrical testing. Commencing salary £120, rising by annual increments of £7. 10s. to £200 per annum. Applications to the Electrical Adviser to the Board of Trade, 8, Richmond-terrace, Whitehall, S.W. See an advertisement.

A superintendent is wanted for electrical manufacturing shop. Applicants must have had first-class experience in the manufacture of alternating and direct-current machinery of all sizes and shapes and must be thoroughly capable of managing men. Applications to Messrs. Vickers, Sons & Maxim, Sheffield. See an advertisement.

A competent electrician is wanted for erection and wiring. Must be able to take charge of entire plant (d.c.) if required. Applications to Dartford Cement Works (Ltd.), Dartford, Kent. See advertisement.

South Shields Council have appointed Mr. L. E. Harvey, assistant tramway manager at Sunderland, manager of the South Shields tramways. The names of the candidates in the short list were given in our last issue.

Prof. A. M. Worthington, who has been headmaster at the Royal Naval Engineering College, Keyham, for many years, is about to retire, and will be succeeded by Mr. John Crocker, the senior assistant master.

Mr. J. A. Vice, of Gravesend, has been appointed engineer-in charge at Ilford electricity works.

Aberdeen.—Electric current is now supplied to places of worship at 3d. per unit.

Bargoed.—The Rhymney Valley & General Electric Supply Co. are laying mains, and will be prepared to supply electricity in this district by September.

Beckenham.—An inquiry was held here last week into the application of the Council for sanction to borrow £5,107 for extensions of the electricity undertaking.

Cardiff.—At the meeting of the Electrical committee on Monday it was announced that Hill's Dry Dock, in the Bute Docks district, which had become a customer of the electricity undertaking, would take energy to the extent of from 800 H.P. to 2,000 H.P.

Dunfermline.—The consulting engineer (Sir Alexander Kennedy) again recommends the Council to lease their provisional electric lighting order to the Fife Electric Power Co., on the understanding that the undertaking can be purchased at the end of 30 years. Messrs. Gibbings & Chauntler, who had submitted particulars of a scheme for electricity supply, have now withdrawn from the field.

Glasgow.—Recently a report was prepared by the town clerk (Mr. A. W. Myles) and the tramways manager (Mr. Jas. Dalrymple) on the relation of the tramways department to the common good, the financial position of the department, &c.

The report states that the total amount of borrowing powers at May 31, 1907, was £3,100,000. Since then an additional £41,862 had been obtained. As the Tramways committee have subsequently decided to increase the number of cars, and also to put more plant into Pinkston station, it will be necessary at the first opportunity to ask for additional borrowing powers. The gross amount borrowed from the

common good was £2,246,114. 1s. 5d., but by the operation of the sinking fund, &c., this has been reduced to £1,679,974. 0s. 6d. This debt will be entirely wiped off by 1930. The gross amount expended on capital account was £3,104,060. 15s. 9d., so that the department had actually expended £4,060. 15s. 9d. more than the Corporation had powers to borrow. The capital expenditure did not include any portion of the expenditure on the old horse-traction system as the whole of the system which could not be utilised as part of the new electric system had been entirely written off. The revenue of the department had shown a steady increase from year to year, and reached, for the year ended May 31, 1907, £899,352, the average traffic revenue per car-mile for that year being 10·47d. For the current year to date the average was 10·46d. The working expenditure was keeping very steady. The day-to-day maintenance of the permanent way was still higher than was anticipated, and was likely to remain so until some form of construction was devised which would keep the rail in position and enable the track to withstand the grinding of the Glasgow street traffic. The total amount of the depreciation and renewal fund was £1,079,252. 18s. 2d. Considering that the capital expenditure had been over £3,100,000, the reporters consider that the amount provided out of revenue for keeping up the undertaking was just about correct. Owing to the rapid changes in electrical plant it was considered prudent to make ample provision, so that the Corporation might be always in a position to keep the equipment thoroughly up to date.

In regard to the sinking fund, the Scottish Office raised a point in connection with the capital sum expended out of the depreciation and renewals fund. The Office considered that, even although that sum was not actually borrowed from the public, it was necessary to charge revenue with sinking fund upon it. There could be no objection to meet the views of the Office in the matter, and the auditors (Messrs. Kerr, Andersons & M'Leod) suggested that the simplest way to carry it out was to create a debt to the common good by borrowing £876,708. 3s. 2d., which was the amount temporarily drawn from the depreciation and renewals fund as at May 31, 1907, and on the same day investing the amount with the common good at the same rate of interest as was charged on the loan. The effect of those transactions would be to increase the debt from £1,679,974. 0s. 6d. to £2,556,682. 3s. 8d., and on the other side of the balance-sheet the amount invested would be increased by the same figure (£876,708. 3s. 2d.), the net result being an increased sinking fund charge of £17,534. 3s. 3d. This was, of course, assuming that the arrears of sinking fund were not dealt with. If that were done it would mean a charge for past years of £100,093. 6s. 7d., and an increased charge for the current years of £26,374. 2s., but it was not necessary to make the charge retrospective.

The Tramways committee recommend that the wishes of the Scottish Office in regard to a sinking fund on capital temporarily borrowed from the renewal and depreciation funds be acceded to, and be dealt with in the manner suggested by the auditors of the tramways department; the sinking fund in respect of these borrowings was only to take effect as from June 1, 1907; the amount to be set apart out of revenue for the current year being fixed at £17,534. 3s. 3d.; and the interest to be charged by the City Finance committee on the investment of the renewal, depreciation and reserve funds to be at the same rate as that charged from time to time on money borrowed for the tramways department; and further consideration of the relation of the tramways department to the common good and the financial position of the tramways department to be in the meantime delayed.

The receipts of the tramways department for the year ended May 31 were £907,460, compared with £887,381 in 1906-7, an increase of £20,079. The number of passengers carried was nearly 230,000,000, nearly 2,000,000 over last year.

Hammersmith Willesden Tramways.—The new tramway route along the Wormwood Scrubs-road to Hammersmith, linking up Willesden Junction with the Franco-British Exhibition at Shepherd's Bush, was opened on Saturday.

Hanley.—The L.G. Board have sanctioned a further loan of £20,643 for extensions of the electricity undertaking.

At the recent meeting of the Council Mr. Schofield stated that they would have to pay out of this year's income £954, representing payments which would have been made to the sinking fund had loans been raised at the time of the expenditure, and £372 for permanent workmen's wages. They would, however, be able to pay these amounts out of the year's profits. On this occasion nothing will be voted in relief of rates.

Hull.—At the meeting of the Electric Lighting committee last week a report by the chairman (Mr. E. Hanger) and the electrical engineer (Mr. H. Bell) called attention to the increased efficiency of the new metallic filament lamps recently placed on the market, and it was considered it would be wise to postpone the consideration of an extension of the generating station so as to gauge precisely the effect of the new lamps.

Institute of Metals.—In connection with the proposal to found a new institute for copper and brass manufactures, on similar lines to the Iron and Steel Institute, to be called the Institute of Metals, the inaugural meeting will be held on Wednesday, June 10, at 2:30 p.m., at the Institution of Mechanical Engineers, Storey's-gate, Westminster. Sir Wm. White, K.C.B., F.R.S., will preside. The hon. sec. is Prof. H. C. H. Carpenter, the University, Manchester. The temporary acting secretary is Mr. W. H. Johnson, c/o Rd. Johnson, Clapham & Morris, Manchester.

Light Railways.—The Light Railway Commissioners have resubmitted to the Board of Trade an order authorising the Portmadoc, Beddgelert & South Snowdon Railway Co. to reconstruct and work the railways authorised by the company's 1901 and 1904 Acts as a light railway, amending capital and borrowing powers, extending time, &c.

During May seven applications were lodged with the Light Railway Commissioners for light railway orders, but only four were new schemes, and in only one (the Minster-on-Sea scheme, 1¾ miles) is electric traction scheduled.

Municipal Telephony.—Last week the Hull Telephone committee stated that there were now 2,500 instruments connected.

The gross receipts were £9,567, compared with £8,989 for 1906-7, an increase of £578. The working and maintenance charges were £5,596, against £4,842. During the year the expenditure on capital account had been £1,882, making a total of £54,747. In accordance with the requirements of the L.G. Board, the temporary sinking fund (£437) had been applied to reduction of capital debt. After paying interest and loan charges (£2,916) the net profit was £1,055, which has been applied to the following purposes: Preliminary expenses £214, transfer to reserve fund £1,577.

Penny Post to America.—In the House of Commons on Wednesday the Postmaster General made the announcement that America had accepted his proposal for the establishment of a penny post between the two countries. The reform will come into operation on Oct. 1.

Poplar.—To meet the increased demand from the London & India Dock Co. the Council intend to lay new cable and ducts at a cost of £337, existing cable of the value of £215 to be reclaimed. A new sub-station is to be erected.

Presentation.—Mr. J. B. Hamilton, general manager of the Leeds tramways, who has just celebrated his silver wedding has been presented by the staff under his control with a large silver rose bowl, a pair of silver candlesticks and a meerschaum pipe. Practically the whole of the 1,500 employés subscribed to the testimonial.

Councillor R. A. Smithson, deputy-chairman of the Tramways committee, presided at the presentation on Wednesday, in the unavoidable absence of Sir John Ward, chairman, and there were present representatives of all the various departments, who spoke of the good feeling which exists between Mr. Hamilton and his staff.

St Helens.—The Electricity committee have applied for sanction to a loan of £10,426 for extensions of the electricity undertaking.

The total income of the department for the year ended March was £19,476. 12s., and the expenditure (including interest and sinking fund) £19,209. 12s., leaving net profit £267, which has been placed to reserve.

School Lighting.—Beckenham Council have applied for sanction to a loan of £225 for installing the electric light in the Alexandra school and in the cookery and manual training centre.

Sheffield.—An unopposed inquiry was held on Tuesday into the application of the Council for sanction to borrow £20,000 for extensions of the electricity undertaking.

The town clerk (Mr. R. M. Prescott) said that £10,000 was needed for mains and sub-stations. The electrical development had come about in spite of the fact that Sheffield gas was supplied at the remarkably low price of 1s. 4d. per 1,000 for domestic use and 1s. 1d. for power. During the last 8 or 10 years there had been an increasing demand for electrical energy, particularly for power. It was proposed to extend the Neepsend station, opened in 1904, and that was one of the purposes for which more money was required. The L.G. Board might allow the Corporation some little latitude in meeting the demands of their growing undertaking. In practice, if they were to take advantage of their opportunities, it was impossible to keep strictly to the estimate figures.

Councillor Bennett said the total revenue had risen from £24,342 in 1899 to £78,355 during the year just ended. The cost to the consumer had been reduced from 3·88d. per unit to 2·17d. per unit. There were now 1,037 motors installed, representing 9,674 H.P.

South Shields.—At the meeting of the Council on Wednesday the mayor (Councillor G. Wyle), in moving the adoption of the Tramways committee's annual report, said that, notwithstanding a bad summer, there was a balance of £11,700, and, after paying redemption and other charges, there was a net profit of £2,886. It was proposed, in view of the highly satisfactory year's working, to add the name of the present manager (Mr. J. Wilson) to the list of selected candidates for the post of manager of the tramways, but this was rejected by 26 votes to 21.

Spanish Government Telegraph Cable.—The "Madrid Gazette" of May 22 contains an authorisation to the Spanish Government to call for tenders for the construction and installation of a submarine telegraph cable from Cadiz to Teneriffe, thence to Grand Canary, Palmas and Gomera, from the latter island to Hierro, from Grand Canary to Puerteventura and thence to Lanzarote. Tenders will be invited during 1908. The cost, not to exceed 5,000,000 pesetas (about £172,413), is to be distributed over two years. Local representation is necessary to enable firms to tender.

Stepney.—Tenders are to be invited for annual supplies of meters, arc lamp carbons, &c.

Stoke Newington. At the meeting of the council last week, Ald W W Savery gave a sketch of the progress of the electricity department.

He said that for the year ended March, 1907, there was a deficit of £892. 13s. 9d., which, under their agreement with the North Metropolitan Electric Power Supply Co., was refunded to the Council. The half-year ended Sept. last showed a marked improvement, and the account to last March showed a surplus on the half year's working of £847. 13s. 7d. In addition to that the Council had charged £91. 19s. for collection and establishment charges, and therefore there was a surplus of £950. The average cost to the Council of the low-tension current distributed was 2.06d. per unit. The units distributed were 137,486, which on that sum showed roughly that they had received current to the value of £1,150. Therefore, although that was only the second year's working, and although during the first year they paid to Hackney at a much higher rate than now, they were within £200 of being able to say that the undertaking was in such a position that they could, if they liked, take over the risk on their own shoulders, and it might be considered as quite certain that next year's working would show a profit. The number of customers had increased to 156, while the equivalent number of 8 c.p. lamps connected had increased to over 13,000. They were advised by their consulting engineer that if the present rate of increase continued it would be necessary, by Nov. next, either to have in working order their small generating station, the scheme for which had already been approved by the Council, or to put in another motor generator.

Theatre Lighting.—The new Blackburn Theatre Royal, which is being rebuilt by Messrs. J. Parkinson & Sons, of Blackpool, will have a complete electric lighting installation.

Wednesbury.—On Monday the chairman of the Light committee (Mr. Griffiths) said that the L.G. Board had sanctioned the whole loan required in connection with the electricity undertaking, with the exception of about £800 for overhead wires, which was under consideration by the Board of Trade.

The work of laying down the new plant was being pushed forward as fast as possible, and at the earliest possible moment the arrangement by which the Corporation would generate their own electricity would be put into force. He referred to the notice given by the Midland Electric Corpn. for Power Distribution of their intention to lay mains for the supply of electricity, and remarked it was unnecessary to say more than that such a course met with the disapproval of the Corporation.

Wigan.—On Wednesday the Electric Light committee made recommendations for the remodelling of the Wigan and Pemberton electricity works at an estimated cost of £36,500. These recommendations were made on the authority of the consulting engineer and the borough electrical engineer, and, after discussion, were adopted by the Council.

York.—An adjourned inquiry was held on Tuesday into the application of the Corporation for sanction to borrow £31,604 for excess expenditure and for extensions of the electricity undertaking, &c.

The city electrical engineer (Mr. J. W. HAME) said the Corporation paid £1,571 for public electric lighting.

The CITY TREASURER said the total capital expenditure was £125,254. 6s. 4d.

After examining the particulars of expenditure for a series of years, the INSPECTOR asked if the Corporation would care to adopt the alternative of asking for the money for a much shorter period, and not attempt to explain. That course had been followed where it was found impossible to explain, and the period had then varied between five and 12 years. He pointed out that four years' sinking fund was due on over £20,000, which would mean quite £3,000. The capital expenditure was already so high and had been going on for eight years that it was very necessary for him to see that the capital expenditure was kept down, and to see that no items applied for now were other than those properly chargeable to capital. Certain travelling expenses included in the amounts would not be allowed.

Mr. HAME urged that it was to the credit of the Electricity committee that they had something in the way of buildings and machinery to meet future requirements.

The INSPECTOR said it was clear that all the capital expenditure had been incurred before Mr. Hame came to York.

On Wednesday, Mr. HAME, replying to questions, stated that the works cost was 1·07d. per unit, and the capital charges 1·44d., a total of 2·51d., and they sold energy at 2·5d. per unit. The gross revenue for the year ended March 31, 1908, was £15,824, an increase of £2,000 on 1907; the loss on 1908 being £19. They had no depreciation fund. The accumulated deficit on revenue account amounted to £5,000

The INSPECTOR asked for a return to be made of the interest which had been paid on revenue deficits, and for other information, showing the income derived from particular streets and from the service supplied by each distributor.

Ald. MEYER (chairman of the Electricity committee) said the present committee were very much alive to the necessity of keeping their capital expenditure down.

The INSPECTOR pointed out that the amounts to be sanctioned on suspense account were not to be all expended before the account was closed; the accounts must be closed and the unexpended balances carried forward to tide them over the period between the closing of the accounts and obtaining sanction for fresh loans. He would adjourn the inquiry sine die to see if he required to make fresh inquires re certain figures when he had the information relating to two building contracts for which he had asked.

Dinner.—The third-year students of the Central Technical College are holding their annual dinner at the Gaiety Restaurant, London, on 18th inst., at 7:30 p.m. Prof. W. E. Dalby will preside, and all old Central men are invited to attend. Tickets (7s. each) from the hon. sec. (Mr. C. H. Russell), Ingram House, Stockwell, S.W.

ELECTRICITY SUPPLY AND TRAMWAY ACCOUNTS

Aberdeen.—The receipts of the tramways department for the year ended May 31 were £71,078, a decrease of £699 compared with 1906-7. The number of passengers carried was 16,632,304, a decrease of 236,227.

Aldershot—The total income of the electricity department for the year ended March 31 was £3,958. 9s. 1d.

Expenses were £2,209. 10s, 9d, leaving gross profit £1,750. 18s. 4d. Interest absorbed £807. 7s. 8d. and sinking fund instalments £868. 1s. 4d., leaving the net profit £75. 9s. 9d. 214,292 units were sold, and the maximum load was 234 kw. 17 new consumers were added during the year, and the equivalent of 13 632 8 c.p. lamps is now connected. Total works costs were 1·66d., and total costs 2·39d. per unit. Total capital expended is £27,783, an increase of £887. 18s. 5d.

Birmingham.—The accounts of the electric supply and tramways departments were presented to the Council on Tuesday.

The chairman of the Electric Supply committee (Mr. ELLAWAY) said that the chief features of the report were the growth of the output and the further decrease in works costs. The increase in supply for traction was expected, and the figures relating to the year could not be compared with the previous year because the tramway department was only at full work for three months of 1906. He believed the engineer's estimate for the tramway supply had been exceeded by about 1,000,000 units. The estimate was 10,000,000 units, and the figures had worked out at a little over 11,000,000. The increase in private supply for lighting and power was particularly noticeable. In 1906-7 the increase was 30 per cent., but during the past year the increase had been 37 per cent. in units and 25 per cent. in money value. The bulk of the increase had, however, been derived from power supply. The increase in motor connections was 3,491 H.P., comparing with an increase of 2,570 H.P. in the previous year. Two years ago the whole of the motor connections amounted to just over 3,000 H.P., and now the total was over 9,000 H.P. The motors the department had connected up during the year had very largely replaced steam plant. In 1904, when they first spoke of the erection of the Summer-lane station, it was estimated that it would keep the department going until 1914 on the basis of an annual increase of about 10 per cent., but if the increases continued at the rate of 30 and 37 per cent.—and there was reason to think they would—the station would be fully occupied at a much earlier date. In 1906-7 the works costs came out at 1·06d., and last year 0·766d., while they had to pay about £2,000 more for fuel. Works costs compared satisfactorily with those in other large towns. They were rather heavily hit by interest and sinking fund charges. The department generated twice as many units as in the previous year, and, therefore, the expenditure on coal and other fuel, &c. (£21,000) showed that considerable economy had been exercised, as £15,000 was spent in 1906-7. All the figures in the revenue account showed large increases, because last year there was a full year's working for the whole of the Summer-lane station and substations. Repairs and maintenance of mains came to £4,506, against £2,371, and general establishment charges £2,831, against £1,870.

The total revenue of the tramways department was £289,556. 12s. 9d., including £286,254. 12. 7d. net traffic receipts. Total expenses were £168,444. 14s. 7d., leaving £121,111. 18s. 2d. to meet interest, sinking fund, &c. £37,037. 7s. 8d. was placed to reserve, leaving £35,000 for relief of rates.

Mr. HARRISON BARROW, who presented the report, stated that the permanent way had cost £377,320, or £6,800 per mile of single track. Street widenings came to £234,644, but £80,000 had been transferred to public works department, leaving the charge to the tramways department £154,644. The overhead equipment cost £50,798 equal to £1,500 per mile of single track. The total capital expenditure was £943,427. Traffic expenses came to £76,069, comparing favourably with other towns in the cost per car-mile run. The general expenses were £27,089. The amount paid for compensation for accidents was about 2½ per cent. of revenue. General repairs and maintenance amounted to £29,012. The amount spent on permanent way was only £6,628. Traffic receipts from Corporation cars were £324,898, from the Birmingham and Midland Tramways Joint committee for the company's cars running over Corporation lines £31,069, and from sundry traffic receipts £718, total £356,685. From that sum was deducted £70,430 payable to other authorities in respect of Corporation cars running over their lines, leaving the net traffic receipts at £286,254. On the city lines 75,601,195 passengers were carried, and the percentage of working expenses to receipts was 58.

Bridlington.—There was a gross profit of £90 on the past year's working of the electricity department. After making provision for interest and sinking fund the deficit was £270.

Burton-on Trent.—The annual report of the tramways department for the year ended March 31 states that the total income was £15,921. 18s. 5d., compared with £16,329. 6s. 1d. in 1906-7.

Expenses, including interest and sinking fund, were £17,043. 2s., showing a deficit of £1,121. 3s. 7d. 3,221,595 passengers were carried, compared with 3,383,527 in 1906. The car-miles run were 430,913,

against 421,317, and the operating expenses were 5·85d. per car-mile. The general manager (Mr. P. J. Pringle) attributes the drop in traffic receipts to local trade depression and the wet summer. The report also states that there have been practically no cases of personal injury, and only £1. 10s. was paid in claims, this being the lowest figure recorded by the department. The total amount paid during the last three years was £17. 15s. 6d., a figure which was probably a record. Considering their annual mileage in somewhat narrow streets, combined with so many level crossings, Mr. Pringle thinks that their inspectors, drivers and conductors should again be given every credit for having assisted in such a result.

Bury (Lancs.).—The total income of the electricity department for the year ended March 31 was £17,094. 17s., including £16,569. 6s. 4d. net from the sale of electricity for lighting, power and traction.

Working expenses were £7,584. 1s. 3d., leaving gross profit £9,510. 15s. 9d. to meet interest (£2,583. 15s. 6d.) and sinking fund (£2,900. 15s. 9d.). The net profit was £4,026. 4s. 6d., of which £1,000 was applied in relief of rates, and the balance (£3,026 4s. 6d.) transferred to reserve. The total capital expended is £91,492. 0s. 9d., an increase of £6,033. 0s. 4d. on the year. 3,115,656 units were generated, and 3,004,403 units were sold (1,382,529 to private consumers, 1,563,744 to the tramways department and 58,130 for public lighting). The total maximum supply demanded was 1,675 kw., and the load factor 20·5 per cent. (against 16·8 per cent.). There are 510 consumers, with an equivalent of 75,650 8 c p. lamps connected. Steady progress continues to be made in the use of electric motors for industrial purposes. During the year 19 motors, equal to 174 H P., have been hired out, and 32 motors, equal to 310 H.P., have been put in by consumers at their own cost. There are now 69 hired motors, equal to 593½ H.P., and 140 privately owned motors, equal to 936½ H.P., connected, making 209 motors and 1,530 H.P. During the year extensions of mains equal to 1,310 yds. were laid. A 500 kw. steam dynamo (Siemens dynamo and Belliss engine), a Galloway boiler, &c., were added to the generating plant. Generating costs were 0·58d. per unit (against 0 62d.) and total costs 1·02d. (against 1·2d.).

Croydon.—The net profit on the past year's working of the electricity undertaking was £12,242. 0s. 11d., and the total sum available £14,490. 9s. 8d.

The reserve and renewal fund now amounts to £22,410. 8s. 8d. The electricity committee recommend that £12,000 be placed to reserve and renewals, the balance to be carried forward. The reserve and contingency fund is now equal to 10 per cent. of the capital.

Ald. MILLER (chairman of the Electricity committee) paid a high tribute to the work of the chief engineer, Mr. Cramb.

An unopposed inquiry was held here last week into the application of the Council to borrow £13,500 for extensions of the electricity undertaking.

Dundee.—The accounts of the electricity department for the year ended April 30 have just been issued and show a very satisfactory state of affairs. The number of units generated was 4,719,085, an increase of 708,000 over 1906-7, while the revenue is £34,973, an increase of £3,870.

A very large item in this year's accounts is the increase in the coal account which is £3,000 over last year. The gross profit was £15,259, out of which interest and sinking fund absorbs £9,578, while the Electricity committee have again adopted Mr. Richardson's recommendation to reduce the capital debt of the undertaking by transferring £5,380 from the capital account to revenue, the balance, with the amount from last year, leaving a net profit of £1,078. During the last four years nearly £24,000 has been paid out of revenue account, a large part of which has gone to reduce the capital debt, while the balance has been employed for the extensive alterations at the power station. The committee have approved Mr. Richardson's suggestions in regard to the price to be charged to power users (a sliding scale with a maximum of 2½d. per unit, and consumers with a large load factor as low as 0·45d. per unit). The price of current for the tramways has also been reduced from 1¼d. to 1⅛d. per unit. The minimum charge has been abolished, as Mr. Richardson considered it was more an irritant to consumers than of real utility. A new feature of the charges for next year is that for electric signs, which should tend to make this form of advertisement very popular. For the first 200 units the charge is 3½d., and all units above this amount 1½d. per unit. The work of erecting the new generating station is being pushed on with all speed, most of the contracts having now been placed, and it is hoped that everything will be completed, and the station running in time for next winter's load.

Eastbourne.—It was reported to the Council on Monday that there was a net profit of £2,214 on the working of the electricity department for the past year. The Electric Light committee have been instructed to consider the question of extending the public electric lighting.

Leyton.—According to the District Auditor's report, the gross profit on the year's working of the electricity undertaking was £11,106, and after paying interest and sinking fund the balance was £936.

On the tramway undertaking there was a deficit of £6,012.

Luton.—The accounts of the electricity department were adopted by the Council last week. The gross profit was £5,018. 2s. 7d., and after paying interest and sinking fund, the net profit was £1,263. 4s. 9d., out of which £630 has been devoted to relief of rates.

Nottingham.—The annual report of the Electricity committee states that the demand for electric current continues, and several extensions of mains have been carried out during the year.

The city electrical engineer (Mr. H. TALBOT) reports that no additional plant has been required owing to the increased number of consumers who have taken advantage of high-efficiency metallic filament lamps. The capacity of the plant at the three generating stations is as follows: Talbot-street 8,925 H P., St. Ann's 6,040, Eastcroft destructor 720; total 15,685 The number of applications for supply of electricity at March 31, 1908, was 3,462 (compared with 3,257 in 1907), representing the equivalent of 349,699 8 c.p. lamps. There were 841 motors, representing 3,418 H.P., an increase of 99 motors and 484 H.P. The number of units sold during the 12 months was: For lighting 4,112,648, power 1,709,208, traction 5,294,979, total 11,116,835, an increase of 1,586,739 units. 50·95 per cent. of the units used for private lighting were at the reduced rate of 1⅜d. per unit. Sale of current realised £89,380, public lighting £1,541, and meter rent £1,491, total income £92,794. Expenses were £47,087. The balance was £45,706, of which £13,681 went in interest, £12,654 in repayment of loans and £11,500 in aid of general district rate, £5,500 being transferred to reserve.

Southport.—The annual report of the tramways manager, Mr. J. T. Kendrew, states that the gross receipts for the past year have amounted to £18,916 (increase £433) and the expenditure to £11,394 (increase £168). The gross profit was £7,521 (increase £264), and, after paying £3,835 interest on capital and £3,269 to sinking fund, there remains a net profit of £417.

Sunderland.—On the past year's working of the electricity undertaking there was a deficit of £1,908, besides bad or doubtful debts amounting to £2,000. The department had estimated for an output of 10,062,000 units, but, owing to local depression, the actual output was only 8,644,523 units.

Swansea.—It is estimated that the past year's working of the electricity department will show sufficient profit to wipe off the deficit of £150 and to leave a net profit of about £500.

Tunbridge Wells. The net profit on the past year's working of the electricity department was over £1,100.

The total income (less £103 for bad debts) was £14,675 6s. 9d., including £14,108 from the sale of electricity. The expenditure was £[illegible] 15s. 5d., including £5,739 for generation, £1,180 for salaries and management expenses, £752 for distribution, £749 for public lamps and £315 for rents, rates, taxes and insurance. £5,845. 13s. 4d. was carried to net revenue; interest and loan charges absorbed £4,703 15s. 5d., leaving £1,141. 17s. 11d. The capital expenditure is [illegible]

Warrington. On Tuesday the Mayor (Ald. Smethurst) said the profit on the past year's working of the tramways showed an increase of £1,207 over 1906-7, but there was a decrease of revenue in the electricity department of £303, and the working expenses had increased owing to the high price of fuel.

West Hartlepool.—The accounts of the electricity department for the past year were presented to the Council on Tuesday, when Ald. MacFarlane said that, after paying all expenses (including interest and sinking fund, amounting to £3,000) there was a small profit.

TRADE NOTES AND NOTICES.

TENDERS INVITED.

The electricity and tramways department of *Newport* (Mon.) Corporation invite tenders and prices for c.c. and a.c. prepayment meters from 1 to 10 amperes, and for 1d., 6d. and 1s. Particulars and prices to the borough electrical engineer and tramways manager, Mr. H. Collings Bishop, Town Hall, Newport, Mon. See an advertisement.

London County Council invite tenders for the manufacture, supply and delivery of tramway feeder pillars. Tenders, upon official forms, to be obtained from the clerk of the Council, Mr. G. L. Gomme, County Hall, Spring Gardens, S.W., by 11 a.m. on Tuesday, June 23. See also an advertisement.

London County Council also want tenders, by 11 a.m. June 30, for the road work and plate laying in connection with the construction of tramways on the underground conduit system from Dulwich Library, Lordship-lane, to Forest Hill. Forms of tender, &c., from the Chief Engineer, Spring Gardens, S.W.

Ilford Urban District Council invite tenders for supply and erection of surface-condensing plant and cooling tower, steam and feed pumps, boiler feed pump, &c., extensions and alterations to main switchboard. Tenders, addressed to Chairman of Council, Town Hall, Ilford, by noon Wednesday, June 10.

Norwich Electricity committee want tenders by 10 a.m. June 9 for supply and erection of water-tube boiler, mechanical stoker, economiser, &c., and for wiring supplies. Specification, &c, from the City Electrical Engineer.

Portsmouth Corporation want alternative tenders by 10 a.m. June 17 for one and two years' supply of coal for their electricity department.

Willesden Council want tenders by noon June 18 for supply and erection of 300 kw. converting plant. Specifications from the Electricity Offices.

Bradford Corporation want tenders by 10 a.m June 10 for the wiring of the town hall extension. Forms of tender, &c., from the City Architect.

Malvern Council want tenders by 10 a.m. June 29 for supply and erection of 50 kw. steam alternator, exciter, &c. Specification, &c., from the Electrical Engineer and Manager.

Barrow-in-Furness Education Authority invite tenders for supply of apparatus for the physical and mechanical laboratories of the technical school. Tenders to the Town Clerk by 11th inst.

Bradford Guardians want tenders by 6 p.m June 12 for the installation of an electric lighting main cable at the workhouse.

The date for receipt of tenders by the Postmaster-General's Department, *Melbourne*, for supply of a common battery switchboard and telephone apparatus for subscribers' premises is extended from May 26 to 3 p.m. June 23.

Antwerp municipal authorities invite tenders for the supply of 1,600 metres of cable. (A deposit of 2,000 fr. will be required.) Tenders to M. le Bourgmestre de la Ville d'Anvers, Hôtel de Ville, Antwerp, by June 18. Copies of specification may be consulted by British contractors at the Board of Trade, 73, Basinghall street, London, E.C.

TENDERS RECEIVED AND ACCEPTED.

Bermondsey (London) Council have accepted the following tenders:

Babcock & Wilcox, boiler, £2,025 (three tenders received, varying from £1,290 to £2,455); Siemens Bros. Dynamo Works, steam dynamo (Howden engine), £4,828 (48 tenders from 14 firms, varying from £3,868 to £6,942); Deane & Beal, evaporative condenser and cooling tower, at £3,374 (32 tenders from 17 firms, varying from £2,342 to £3,886).

Southwark Council received 18 tenders, varying in amount from £330 to £672, for induced draught plant, and the lowest tender, that of the Electric Construction Co., has been accepted. The electrical engineer's estimate was £475. It is proposed to do the fixing and fitting (estimated to cost £145) with the staff of the electricity works.

Walthamstow Council have accepted the following tenders:—

Siemens Bros. Dynamo Works, two engines and dynamos, £3,595; Babcock & Wilcox, boiler house plant, £7,420; Ledward & Beckett, condensing plant, £2,270. 10s.; Alphons Custodis Co., chimney, £855; Johnson & Phillips, switchboard, £641. 15s.; Paterson Engineering Co., water softening and purifying plant, £425.

Leyton Council have placed an order with the Lancashire Dynamo & Motor Co. for a traction dynamo, at £650; with Bertram Thomas for switchboard extension, at £86. 7s. 3d.; with the Underfeed Stoker Co. for a mechanical stoker, at £434; and with the Oliver Arc Lamp, Ltd., for 24 flame arc lamps.

Gibson, Battle & Co. have contracts for 100 kw. electric plant for coal cutting (Jeffrey cutters), lighting and ventilating at Black Jack Colliery, Gunnedah (N.S.W.), an electrically-driven coke conveyer for the North Bulli Co. and a number of Jeffrey electric locomotives for the Mount Morgan Co. (Queensland).

Bexley Council have placed an order with Babcock & Wilcox to substitute new piping for the whole of the piping on the superheated range at a cost of £280, and with T. Sugden (Ltd.) for a new superheater in substitution for one of the existing superheaters at £145.

Leyton Council have decided to enter into a seven years' contract with Stuart & Moore for supply and maintenance of telephonic communication and electric call bells to firemen's residences (23 bells and four telephone circuits) at £48. 10s.

St. Pancras Guardians have accepted the tender of J. C. Christie for supply of one gross incandescent electric lamps, at 8s. 6d. per dozen. Two other firms each quoted 9s. 6d.

Walthamstow Light Railways committee have accepted the tender of Estler Bros. for supply of 14 sets of patent block system signals, with lamp attachments, at £19. 10s. per set.

Lancaster Council have accepted the tender of the British Thomson Houston Co. for a switch panel and a pressure regulator at £369. 10s.

Hanley Council have accepted the tender of the British Westinghouse Co. for the supply of a 500 kw. steam generating set.

Stoke-on-Trent Council have accepted the tender of Crompton & Co. for supply of electrical instruments.

The tender of H. Leake & Co. has been accepted for the electric light installation at the new King Edward VII. School at Fairhaven.

Rugby Council have accepted the tender of V. Bornand & Co. for 880 yds. of service cable.

Derby Council have accepted the tender of Johnson & Phillips for bitumen cables at £471. 4s.

The Electric Light & Power Supply Corpn. (Sydney) have a contract for the erection and equipment of refuse destructor and electricity works for Balmain Council.

The Pioneer Tin Mining Co. (Tasmania) have ordered electric power plant from Stærker & Fischer, agents for the A.E.G.

The Postmaster-General's Department (Sydney) have accepted the tenders of the International Electric Co. for ear pieces for Ericsson receivers, cords for metal switchboards and for Western Electric receivers, single switching cords, copper wire, &c.; the India Rubber Co. for milliampere meters and resin-cored solder; and R. B. Hungerford for junction and bell switches.

The Postmaster-General's Department (Brisbane) have accepted the tender of the Brisbane Electrical Co. for material and (except where otherwise specified) workmanship for erection of a telegraph line from Geraldton to Harvey's Creek, 26½ miles in length.

Adelaide (S. Australia) Tramways Trust have accepted the tender of Smith & Tymms for the construction of 54 miles of permanent way. It is stated that the amount of the contract exceeds £160,000, and that the whole scheme will cost about £600,000.

BUSINESS NOTICES.

The Leeds offices of Messrs. C. A. Parsons & Co. will, after this week, be removed from Peacock's-buildings, to 65 to 67, Prudential-buildings, Park-row, Leeds.

M. Louis Goichot, electrical engineer, of Montceau-les-Mines, has removed to 20, Rue du Pont du Gat, Valence-sur-Rhône (Drôme), France.

Joseph Douglas Jones and Bennett Jas. Boddington (trading as J. D. Jones, Boddington & Co.), electrical engineers, 150, Finchley-road, London, N.W., have dissolved partnership. Debts by Mr. Jones.

Plant for Sale.—Two Royce compound-wound dynamos and two 14 H.P. gas engines, with flywheels, &c., are advertised for sale. Applications to Mr. Wm. Morton, Grand Theatre, Hull.

Tantalum Lamps.—A new type of wire filament lamp has been placed on the market by Siemens Bros. Dynamo Works (Ltd.), who are introducing a 25 volt "tantalum" lamp for use with automatic transformers and on low-voltage circuits generally. The new lamp is for voltages of 24 or 25, and is supplied in 8 c p. or 16 c.p. Like all other types of "tantalum" lamps, the filament is very strong. The 25 volt lamp may be used for train lighting and for private house installations, especially in connection with small transformers. The bulb is smaller than that of the ordinary carbon filament lamp, but similar in shape. The lamps can be burned in any position, and their price, 2s each, places them within the reach of all.

CATALOGUES, &c.

The Witton Grip.—Some weeks ago we commented upon the introduction by the Armorduct Co. of a special fitting for use on wiring conduit and intended to furnish a cheap and convenient method of making the tubing electrically continuous and mechanically solid. A booklet has now been issued by the company in which the "Witton Grip," as it is termed, is very fully described, and its application to numerous forms of fittings is carefully gone into. The illustrations assist the reader considerably in this latter respect. We may recall the fact that the grip is a simple clip device tightened by a single screw. The clip is made under Pearson's patents.

Blowers.—Lennox & Co., Turnham Green, London, W., are manufacturers of a line of rotary pumps and blowers suitable for direct coupling to electric motors. The entire range of their products in this particular is fully described in a catalogue which is now being issued. The blowers are small in size and are attached directly to the motor frame in place of one of the ordinary end plates.

BANKRUPTCIES, LIQUIDATIONS, &c.

The creditors of J. H. Collcot, electrical engineer, Brockley, Kent, met on Monday. Liabilities £5,191, of which £2,738 is fully secured and £1,941 due to unsecured creditors.

Debtor, who was for many years a civil engineer in the employment of the Government at the Straits Settlements, retired with a pension of £270 per annum in 1902. In April, 1907, debtor took a workshop at Kingsland and commenced business in partnership as an electrical engineer. Afterwards he removed to Kennington, and in March, 1908, his partner removed all the machinery, &c. Debtor presented a scheme for payment of 10s. in the £ out of future pension.—Adjourned.

Ernest Goacher, electrical engineer, &c., Gateford-road, Worksop, has been adjudicated bankrupt.

A receiving order has been made against Albt. Lord, electrical engineer, 134, Deansgate, Manchester.

Walter Wardle, electrician, 14, Osborn-road, Levenshulme, has been adjudicated bankrupt.

Claims against Rowell, Stuart, Kelman & Co. (Ltd.) (in liquidation) by July 10 to Mr. E. H. R. Trenow, Balfour House, Finsbury-pavement, London, E.C.

A meeting will be held at 180, Oxford-street, London, W., on June 23, to receive an account of the winding up of the British Johns-Manville Co. (Ltd.).

The Electric Traction, Construction & Equipment Co. (Ltd.) is being wound up voluntarily. Mr. C. R. Jeeves, assistant secretary of the company, is liquidator.

A meeting will be held on July 1 at 20, Mildmay-chambers, 82, Bishopsgate street, London, E.C., to receive an account of the winding up of the Industrial Storage Battery Synd. (Ltd.)

The Klein Engineering Co. (Ltd.) is being wound up voluntarily. Claims to Mr. A. A. Gillies, 46, Brown-street, Manchester, liquidator, by July 13.

PATENT RECORD.

APPLICATIONS FOR PATENTS.

NOTE.—*The undermentioned Applications (except those marked †) are not open to public inspection until after acceptance of Complete Specifications. Those marked † are open for inspection 12 months after the date attached to them, if they have not been published previously in the ordinary course. Names within parentheses are those of communicators of inventions. When Complete Specification accompanies application, an asterisk is affixed.*

February 10, 1908.

2,893 THAMES AMMUNITION WORKS & TICEHURST. Electric detonator fuze.

2,895 FIDDLER. Secondary batteries.

2,901 STEVENS. Fuse boxes.

2,904 WAGNER. Continuous current machines.

2,910 SCHULTZ & YOUNG. Apparatus for testing and checking the working of the electric ignition device in internal combustion engine.

2,923 KNUDSEN. Coherer for wireless telegraphy and telephony.

2,926 VON MADAYER. Revolving coherer for wireless transmission.

2,927 HOWARD & COUSINS. Luminous electric heaters.

2,938 SMITHERS. Telegraphing or signalling by artificial light.

2,943 PICKARD. Oscillation receivers.*

2,955 FESSENDEN. Wireless signalling. (Date applied for, 11/2/07.)*†

2,968 DEMUTH. Wireless telegraphy and telephony.

2,974 ELWORTHY. Generating ozone. (Date applied for, 31/7/07.)*†

2,994 SCHMOLKA. Pressure-balancing device for turbines.*

February 11, 1908.

3,056 STRUBLE. Relays. (Date applied for, 18/2/07.)*†

3,069 SIEMENS BROS. & CO. & DIESELHORST. Insulators.

3,076 LEON. Incandescent lamps.

3,096 B.T.-H. Co. (A.E.G., Germany.) Control of alternate current motors of the commutator type in driving machine tools, &c.*

February 12, 1908.

3,109 GORTON. Telegraph arrangements.

3,130 BOOTH. Starter, rheostat or controller for electric motors.

3,141 HARTWELL & HARTWELL. Electrical water gauge.

3,154 MUND. Electrical signal apparatus with wireless transmission.

3,160 COWPER-COLES. Cathodes for electro deposition of iron and other metals.

February 13, 1908.

3,200 EVANS. Electric "night and day" sign.

3,204 SUTTON & SUTTON. Fire-alarms. (Patent of Addition to No. 5,087/07.)*

3,229 MALLINSON. Electromagnetic speed gear control.

3,248 HOGE & "Z" ELECTRIC LAMP MFG. CO. Supports for filaments.

3,266 JOHNSON & PHILLIPS & PATERSON. Arc lamps.

3,276 SCULTHORP. Mouth and ear pieces of telephones.

3,282 HOUGH. Automatic switch device.

3,283 ALLGEMEINE ELEKTRICITATS GES. Electrodes for arc lamps. (Date applied for, 16/2/07.)*†

3,284 B.T.-H. Co., ROBERTSON & HOLDEN. Electric power transmission systems.*

3,285 ALLGEMEINE ELEKTRICITATS GES. Rock drills. (Date applied for, 13/2/07.)*†

3,295 MARKS (Johnsen, Denmark.) Generating varying electric currents of high frequency.

February 14, 1908.

3,321 WHITFIELD. Trolley poles.

3,347 FISCHER. Electrodynamic controller.

3,369 THORNTON, CLOTHIER & REYROLLE & CO. Indicating or detecting the existence of high voltage to which a body may be electrically raised.

3,383 HOWELL. Incandescent lamps. (Date applied for, 7/8/07.)*†

3,391 LEITNER. Variable speed dynamo.

February 15, 1908.

3,418 WILKINSON. Brakes for tramway vehicles.

3,447 RICKETTS. Production and application of electrical oscillations.

3,464 ANDERSSON. Arc lamp. (Date applied for, 18/2/07.)*†

3,465 ANDERSSON. Carbon holder for arc lamps. (Date applied for, 18/2/07.)*†

3,504 WENGER. Precipitation of electrolytic copper in sheets or cylinders by iron or other metals. (Date applied for, 9/9/07.)*†

3,505 MERTENS. Current collector for electric vehicles. (Date applied for, 16/2/07.)*†

3,507 PASSBURG. Vacuum drying apparatus for cables.*

February 17, 1908.

3,539 THORPE. Electric light and call apparatus.

3,543 KAHN, trading as F. C. REIN & SON. Bell and watch receivers in telephone installations.

3,547 MITCHELL. Automatic electrical thermostats for producing intermittent illumination.

3,556 GELL. Automatic telegraphic transmission instruments. (Date applied for, 12/8/07.)*†

3,583 SEIBT. Radio telephony. (Date applied for, 28/3/07.)*†

3,588 KNUDSEN. Telegraphs.

3,590 EMONS. Improved safety or catching net for tramcars.*

3,592 GRAMMONT & ROTHEN. Electric servo motors. (Date applied for, 21/2/07.)*†

February 18, 1908.

3,604 HOSKEN. Trolley heads for electric vehicles.

3,626 CROMPTON & CO., MACFARLANE, & BURGE. Rotary electric transformers and motor-generators.

3,646 ROBINSON. Prepayment mechanism for meters.

3,658 COWPER-COLES. Secondary or storage batteries.

3,662 KILROY, NEEDHAM, & EVERSHED & VIGNOLES. Electrical apparatus for the production of sound in air or water.

3,671 DE MARTIS. Batteries.

3,689 MAIR. Push button apparatus for operating or controlling electric lifts. (Application for addition to 5,958/07.)*

3,701 POLYPHOS ELEKTRICITATS G.M.B.H. Transmitting graphic signs, photographs and the like by electric current. (Date applied for, 25/2/07.)*†

February 19, 1908.

3,710 DE HAAS. Electrical starting of syphon of water-closet cisterns.

3,715 WOODE. Electroliers.

3,723 MORRIS & LISTER. Electromagnetic brake.

3,728 GARCIA. Telegraphic transmission of designs, portraits and the like.*

3,753 GUNNING. Apparatus for opening and closing circuits at predetermined time.

SPECIFICATIONS PUBLISHED.

1906 SPECIFICATIONS.

25,865A McCULLOUGH & VAUX. Brake blocks. (Date applied for, 15/5/07.)
28,600 BECK & DEUTSCHE BECK-BOGENLAMPEN GES. Arc lamps.
28,601 BECK & DEUTSCHE BECK-BOGENLAMPEN GES. Arc lamps with supported electrodes.

1907 SPECIFICATIONS.

555 CLARK & VLASTO. Switches.
634 B.T. H. Co. & WEDMORE. Electric distribution systems.
634A B.T.-H. Co. & WEDMORE. Switches. (Date applied for, 9/1/07.)
2,926 ARMOUR. Indicating and recording apparatus for electric pyrometers.
3,025 HOPE. Cut-outs.
3,184 SPIVEY. Treating textile materials by electrolysis.
3,226 HOLMES. Electric heating apparatus.
3,305 REUTER. Electrical brakes for cranes and the like.
3,543 SHELLHAMER. Electric heating pads. (Date applied for, 2/4/06.)
3,740 WOOD, McLEOD & LANCASHIRE DYNAMO & MOTOR CO. Controlling the supply of energy from alternating current generators or mains to alternating current motors.
3,783 LEVY. Transmitting systems for wireless telegraphy.
3,914 REYNOLDS. Electric furnaces.
3,962 RICHMOND. Batteries.
4,026 VOSMAER. Resistance coils for rheostats.
4,031 FYNN. Alternate current motors.
4,055 MEYER. Safety plugs for electric conductor systems.

COMPANIES' MEETINGS AND REPORTS.

West India & Panama Telegraph Co. (Ltd.)

The sixty-second ordinary general meeting was held on Wednesday, Mr. WALTER BISHOP KINGSFORD presiding.

The MANAGER and SECRETARY (Mr. R. T. Brown) read the notice calling the meeting and the Auditors' report.

The CHAIRMAN, having referred to the unusually late date for holding the meeting, said: The total receipts of the half-year under review amount to £37,262, compared with £34,203 for the corresponding half of last year, an increase of £3,059. The actual traffic receipts gave us an increase of £2,074 and the other items on that side of the account produced an increase of £985, making the figure of £3,059 which I have just mentioned. On the expenses side of the account the increase amounts to £1,416, attributable to a larger length of cable having been used in repairs, and to increased expenditure at the stations, the latter chiefly in the item of salaries and wages. Our repairing ship was thoroughly overhauled and passed her first No. 1 survey in accordance with Lloyd's requirements; the cost, amounting to £892, has been charged against her "reserve for depreciation account." During the current half-year we have replenished our stock of cable for repairing purposes by 252 knots, which have been duly landed at St. Thomas. The favourable results of the accounts with which we hare dealing to-day have enabled the Directors to recommend the payment of 26s. per share on account of accrued dividends on the second preference shares. I now move the adoption of the report and accounts and the dividends recommended therein.

Mr. HENRY HOLMES seconded the motion, and said he was glad the Chairman had spoken about the paying off of the arrears on the second preference shares. They were all anxious to do it, and he thought it was their duty to try and get rid of that liability, so that the long-suffering Ordinary Shareholders would receive a dividend again.

The resolution was carried unanimously.

The retiring Director (Mr. G. von Chauvin) and the retiring auditors were then re-elected, and a cordial vote of thanks to the Chairman, Directors and other officials and staff of the Company terminated the proceedings.

ALUMINIUM CORPN. (LTD.)—At an extraordinary meeting on Monday the chairman (Mr. R. S. Portheim) moved a resolution assenting to an application to the Light Railway Commissioners for an order authorising the construction of the Abbey, Dolgarrog and Trefriw Light Railways. He said that the directors considered it necessary to have greater facilities of communication between the L. & N.W. Railway on the Denbighshire side of the river Conway and the Aluminium Co.'s works at Dolgarrog, on the Carnarvonshire side of the river. The resolution was adopted.

ANGLO-PORTUGUESE TELEPHONE CO. (LTD.)—The report for 1907 states that the gross revenue was £39,695, of which operating, management and general expenses absorbed £21,506 and royalties to the Portuguese Government £1,103, leaving gross profit £17,085. After providing for interest (£2,426), sinking fund (£1,155) and income tax (£413), the net profit is £13,089, and £3,655 brought forward makes £16,745. An interim dividend of 3 per cent. has been paid, and the directors now recommend a final dividend of 5 per cent. (tax free), making 8 per cent. for 1907. £5,000 is placed to reserve and £3,745 carried forward.

DURHAM COLLIERIES ELECTRIC POWER CO. (LTD.)—The report for the two years from March 31, 1906, presented at the meeting on Tuesday, stated that gross profit and compensation had sufficed to cover ordinary working expenses. The loss shown by the profit and loss account is attributable to interest on debentures and temporary loans, required in consequence of the subscribed share capital having been insufficient to meet the cost of completing the enlarged undertaking. The results hitherto attained form no adequate measure of those to be expected after the full load provided for by existing contracts is reached. Shortly before the issue of the debentures in 1907 an agreement was entered into with the Newcastle-upon-Tyne Electric Supply Co., by which that company undertook to operate the company's power station on favourable terms for a period of 42 years. On April 1, 1907, the agreement came into force and has since been working satisfactorily, securing a fair rate of gross profit on the output. This arrangement was followed in June, 1907, by an agreement with the Newcastle Company, under which, at its expense, the whole of the Durham Company's plant was to be made capable of working in unison with that of the Newcastle Company by being converted from a periodicity of 50 cycles to one of 40 cycles. The conversion was an operation of considerable magnitude, and although it had been carried on without intermission it was only during Feb. last that the change over of the principal portions of the machinery was completed, and some minor changes had still to be made. The effect of the change of frequency, essential as it was under the altered circumstances of the agreement for working in harmony with the Newcastle Company, instead of in competition with it, was that the electrical plant of the colliery companies, who were and would be the company's largest customers, had also to be converted. While that was being done the increase in the output from the station and the development of a paying load were necessarily kept back, with the result that the growth of the company's revenue had been correspondingly retarded. By way of compensation for the delay the Newcastle Company had paid a sum of £6,000. The Newcastle Company had agreed to instal, at its own expense, generating plant which would almost double the capacity of the company's generating station, and agreements had been made which provided for laying mains to supply the company's customers. An important main was now being laid by the County of Durham Electrical Power Distribution Co., at its own expense, upon the cost of which the Durham Collieries Co. would pay interest. A further agreement had been entered into with the Newcastle Company, under which it would operate the distribution system as well as the generating plant. The agreement was subject to ratification of the shareholders of this company. The result of that and other arrangements made, including a delimitation of area of supply, was that the Newcastle and its associated companies, which might have been formidable competitors, had become powerful allies, and the systems could now be worked as a harmonious whole, to the great advantage of the revenue of all companies concerned and of the efficiency and regularity of supply to consumers. The prospects of a large increase in the company's business in the near future were good, inasmuch as consumers had now nearly completed the adaptation of their plant and were from time to time installing new electrical machines with a view to the more complete electrification of their collieries. The effect was not only to increase the consumption of current, but to greatly improve average load. Inquiries had been received from other neighbouring collieries, and negotiations for the supply of electricity to fresh important undertakings were in progress. A considerable sum of money was required before the company could discharge its existing liabilities, and it was also necessary to make provision for extensions of the plant and distribution system, which would undoubtedly be needed as the business continued to expand. The confidence which the directors felt in the future of the undertaking, provided it was equipped with sufficient funds, was endorsed by the fact that the Newcastle Company and its associated concerns had already undertaken large responsibilities under existing agreements, and that the Newcastle Company was prepared to undertake further liabilities under the agreement for operating the company's distribution system. It was now proposed that an issue of £100,000 6 per cent. 2nd mortgage debentures should be created, and that £50,000 of these should be issued without delay.

At the meeting on Tuesday the Chairman (Sir D. Fox), said that since they last met they had had to deal with difficult circumstances, including the voluntary suspension of their contractors. Arrangements had been entered into for working in harmony with the Newcastle company instead of in competition with it. The Newcastle company would operate the distribution system as well as the generating plant. It had been hoped that before now they would have come into a paying load. At present the load was between 10,000,000 and 11,000,000 units, and it was increasing rapidly each month. When it had reached 18,000,000 units the company would be in a fairly satisfactory position. Owing to the unissued balance of shares not having been taken up, the directors had to make proposals for creating £100,000 6 per cent. second mortgage debentures, of which £50,000 were to be issued without delay.

MADRAS ELECTRIC SUPPLY CORPN. (LTD.)—The directors' report for 1907 states that the construction of the generating station is not so far advanced as expected, owing to delays in obtaining materials. The plant, machinery and appliances are, however, ready for installing. The mains in the compulsory area have been laid with the exception of a small length. The contracts for the tramway generating plant, the feeders and the erection and equipment of the sub-station, necessary for the supply to the tramways, have all been let, and it is hoped the commencement of tramway supply will be made at the beginning of 1909. Consumers, with an equivalent of 3,686 8 c.p. lamps, are already connected and are being supplied from the small temporary plant. Applications have been made for powers for company to supply current in Fort St. George and to the Port Trust in Madras.

NEW COMPANIES, STATUTORY RETURNS, MORTGAGES AND CHARGES.

NEW COMPANIES.

BANKFOOT POWER CO. (LTD.) (98,134.)—Reg. May 28, capital £40,000 in £1 shares, to erect a generating station at Bankfoot, near Crook, Durham, for utilising the gases and waste heat produced by coke ovens to be erected by Pease & Partners, and for generating electrical energy for distribution and sale, to adopt agreements with Pease & Partners and the Newcastle-upon-Tyne Electric Supply Co., and to carry on the business of suppliers of electrical energy in all its branches. First directors, J. T. Merz, F. S. Newall and R. P. Sloan (nominated by the subscribers for the "Newcastle" shares), and A. F. Pease, F. Stobart and T. Y. Greener (nominated by the subscribers for the "Pease" shares). Reg. office, Collingwood-buildings, Collingwood-street, Newcastle-upon-Tyne.

RAILWAY AUDIBLE SIGNAL CO. (LTD.) (98,174.)—Reg. May 30, capital £50,000 in £1 shares, to acquire any patents, inventions, licences, concessions and the like relating to the production, treatment, storage, application, distribution and use of electricity, in particular to certain existing inventions relating to signalling on railways, to adopt an agreement, and to carry on the business of manufacturers of and dealers in signalling apparatus, railway rolling stock, &c. First directors, W. Dawson, H. G. Drury, A. Haes, W. A. Hart and T. Eaton.

STATUTORY RETURNS.

BRITISH POWER CO. (LTD.) In return to Dec. 31 (filed May 14) capital is £250,000 in £10 shares, of which 6,265 have been taken up. £62,650 has been received. Mortgages and charges, £35,900.

CYCLE ELECTRIC LAMP CO. (LTD.)—Return to May 1, 1907 (filed April 29, 1908), gives capital as £30,000 in £10 shares, all of which have been taken up. £10 per share has been called up on 275 and £2,350 has been received, leaving £400 in arrears. £27,250 is considered as paid on 2,725 shares. Mortgages and charges, nil.

ELECTRIC & ORDNANCE ACCESSORIES CO. (LTD.)—Return to May 29 gives capital as £150,000 in £1 shares, all of which have been taken up. £1 per share has been called up and paid on 110,000 and 5s. per share on 40,000. £30,000 (15s. per share) is considered as paid on 40,000 shares. Mortgages and charges, £130,000.

HOVE ELECTRIC LIGHTING CO. (LTD.)—According to return to Mar. 26 capital is £100,000 in 15,000 ordinary and 5,000 preference shares of £5 each, of which 15,000 ordinary and 2,722 preference have been taken up. £5 per share has been called up on 15,000 and £4 per share on 2,722 shares, and £85,888 has been received, in addition to £1,456 paid in advance on preference shares. Mortgages and charges, £44,600.

NEWCASTLE-UPON-TYNE ELECTRIC SUPPLY CO. (LTD.)—The capital in return to March 24 is £1,500,000 in 150,000 preference and 150,000 ordinary shares of £5 each, of which 87,500 preference and 87,500 ordinary have been taken up. £5 per share has been called up on 76,741 preference and 79,529 ordinary, and £781,350 has been received. £93,650 is considered as paid on 10,759 preference and 7,971 ordinary. Mortgages and charges, £737,500. The nominal capital was increased from £1,000,000 to present amount on March 10.

WYCOMBE (BOROUGH) ELECTRIC LIGHT & POWER CO. (LTD.)—In return to April 15 capital is £50,000 in £5 shares, 8,000 of which have been taken up. £40,000 has been received. Mortgages and charges, £40,000.

MORTGAGES AND CHARGES.

BRITISH PROMETHEUS CO. (LTD.)—Issue on May 8 of a £50 5 per cent. debenture, part of series created Oct. 30, 1907, to secure £3,500, charged on company's undertaking and property, present and future, including uncalled capital. No trustees. Previously issued of same series, £2,700.

GOULD STORAGE BATTERY CO. (LTD.)—Issue on May 21 of a £50 6 per cent. debenture, part of series created same date, to secure £5,000, charged on company's property, present and future, including uncalled capital. No trustees.

CITY NOTES.

MEMORANDA (June 4).—Bank rate 2½ per cent. (May 28, 1908). Price of silver 24¼d. per oz. Consols 87⅞–88 for money and 88–88⅛ account. Consols Pay Day, July 1; Stock and Shares Continuation Days, June 10 and 24; Ticket Days, June 11 and 25; Pay Days, June 12 and 26; Mining Share carry-over Day, June 9.

PRICES OF METALS (London). *Copper*, cash, 58–58¼; three months, 58¼–58½. *Lead*, English, 13–13¼; foreign, 12½–12¾. *Spelter*, foreign, 19½–19¾. *Tin*, English, 130–131; foreign, cash, 130–130½, three months, 129½–130. *Iron*, Cleveland, cash, 50/6–50/7; one month, 50/3–50/4½.

ARON ELECTRICITY METER (LTD.)—The transfer books and register of members will be closed from 8th to 20th inst. inclusive.

BRUCE PEEBLES & CO. (LTD.)—The liquidators (Messrs. A. W. Tait and J. Robertson Durham) have prepared a scheme for the reconstruction of the company which, having received the approval of the committee of creditors and bondholders, will be presented to the Court for sanction. Under the scheme holders of the £75,000 debentures will rank first; then the unsecured creditors will receive 7s. 6d. in the £ in new debentures (ranking after the old debentures) and 12s. 6d. in the £ in fully paid shares of the new company to be formed. The present preference shareholders are to be asked to take three new shares of £1 each for every five they hold in the old company and to pay 10s. per share in cash, they receiving the £1 shares fully paid. The ordinary shareholders are to be asked to take one new share of £1 for every £5 held in the company on condition that they pay 10s. per share in cash, the £1 share being then issued to them as fully paid. The capital of the new company will be £250,000 in £1 shares. The 10s. per share which the preference and ordinary shareholders will pay will yield between £40,000 and £50,000, which will form the working capital of the new company. The new board of directors, comprising six or seven members, will represent the creditors, shareholders and debenture holders; those suggested as directors embrace Mr. John Cowan, Mr. C. J. Shiells, C.A., and ex-Bailie M'Kenzie, Edinburgh, Mr. Tait, the liquidator, and Mr. Mountain (of Messrs. Mountain & Gibson).

BUENOS AYRES.—It is announced that the Cie. Générale de Tramways de Buenos Ayres (of Brussels) in which English, Belgian and German financial undertakings are interested, has obtained from the municipality of Buenos Ayres on favourable terms a single concession in respect of all the tramways controlled by the Cie Générale. The various concessions represent a network of 341 miles of line.

CANADIAN GENERAL ELECTRIC CO.—The directors have declared a dividend of 1¾ per cent. on the common stock for the three months ending 30th inst., being at the rate of 7 per cent. per annum. A year ago the dividend was 2½ per cent.

COMPANIES STRUCK OFF THE REGISTER.—The following were removed from the Register of Joint Stock Companies on May 22:—

Ariel Arc Lamp Synd., Beaman & Deas, Electrical Inkless Printing Synd., Electrophone, "Evoy" Patent Adjustment Compass (British & Colonial) and "Evoy" Patent Compass (Parent) Co., Fowler, Lancaster & Co. (reg. Jan. 23, 1894), the Medical Electrical Institute.

STOCK EXCHANGE NOTICE.—The Stock Exchange committee have been asked to appoint a special settling day in and grant a quotation to a further issue of £173,800 4½ per cent. debenture stock of the *Metropolitan Electric Tramways (Ltd.)*.

THE MARCONI ISSUE.—On Saturday morning last, too late for criticism in the weekly issues of the leading electrical and financial journals, subscriptions were invited to the issue of fresh capital in Marconi's Wireless Telegraph Co. (Ltd.). As previously announced in these columns, this takes the form of 7 per cent. cumulative participating preference shares of £1 each, having priority as to dividend over all the previously-issued capital in the company, and having equal voting rights with the 394,190 ordinary shares which have been issued and are described as "fully paid." The directors and their friends (the prospectus states) have applied for £50,000 of the present issue, of which no part, it is also stated, has been or will be underwritten. There are several points in the prospectus which will have struck the cautious investor, but as the lists closed yesterday for the United Kingdom we are only in time to call the attention of the Continental investor to these points, the list for the Continent remaining open till Monday. The amount of £250,000 offered in the prospectus is, as we have said, reduced to £200,000 by the fact that £50,000 is said to be bespoken by the directors and their friends. This is a "bull" point, doubtless, but has not, we think, greatly impressed the public. Looking through the prospectus, and taking into account the particulars of indebtedness at Sept. 30, 1907, as shown by the balance-sheet recently issued by the Marconi Co., it will be seen that a great portion of the present issue is ear-marked to pay off liabilities of a more or less pressing character already incurred. These are (1) loans and overdraft from bankers; (2) sundry creditors; (3) reserve for expenses unpaid, royalties in advance; (4) bills payable, £117,394. 7s. 9d., a big bite out of £250,000. This sum is, of course, subject to at least the ordinary expenses of such an issue, which must be considerable. If the object of the issue is to provide working capital for the extension of the Marconi services between the United Kingdom and Canada and America (two separate services), this object is surely seriously handicapped by the fact that so small a balance remains for the purpose after the pressing liabilities already incurred have been met. How far these liabilities have increased since Sept. 30 last we cannot say, but it is reasonable to presume the increase is very large. It is calculated (in the prospectus) that a revenue "approaching £150,000 per annum" is to be earned on the Clifden-Glace Bay service and the contemplated Poldhu Cape Cod service. It is presumably for this latter undertaking that the bulk of the fresh working capital is required. How far this liberal estimate of revenue (which is calculated after deducting working expenditure) is likely to be reached seems to us to be highly speculative. Investors in Marconi's Wireless Telegraph shares must be left to digest the generalities of the prospectus for themselves. We cannot think, however, that the investing public generally will be attracted to the issue. If the holders of the ordinary shares in the company are disposed to protect their original investments, they may subscribe to the new preference issue, otherwise it seems to us that their original investment is gravely endangered by this new cumulative preference capital, as there does not appear any reasonable probability, under the most favourable circumstances, of any divisible profit being made in which the ordinary shares will participate. And unless the whole of the new shares are subscribed, the company must continue to exist from hand to mouth, for whatever profit is made by the parent company from its share in the ship-to-ship and ship-to-shore business from royalties, and from the manufacture of apparatus at Dalston, will assuredly be swallowed up in meeting the demands of the Trans-Atlantic service, which promises also to absorb the moneys to come from the present issue and a great deal more to follow.

We understand that there has been some demand for the new issue from the Italian banks.

ELECTRIC TRAMWAY AND RAILWAY TRAFFIC RECEIPTS.

Line	Week ended.	Amount.	Inc. or Dec. (a)	Aggregate No. of weeks.	Aggregate Amount.	Aggregate Inc. or Dec. (a)
		£	£		£	£
Aberdeen Corporation	May 31	2,336	+ 531	52	71,079	– 700
Airdrie	,, 22	227	– 3	20	4,185	+ 49
Anglo-Argentine	,, 27	19,708	+ 2,846	21	390,326	+ 43,073
Ayr Corporation	,, 30	266	– 30	2	614	– 88
Baker St. & Waterloo Ry....	,, 30	2,940	+ 524	22	67,395	+ 15,329
Barnsley......	,, 22	182	– 29	20	3,440	+ 183
Barrow	,, 22	213	– 113	20	4,486	– 80
Bath Electric Trams, Ltd...	,, 27	915	– 212	21	13,400	– 1,499
Birmingham Corporation...	,, 30	6,394	+ 640	9	54,816	+ 1,828
Birmingham & Mid.	,, 15	808	+ 14	19	15,310	+ 772
Blackburn Corporation	...	...	...	...	...	...
Blackpool Corporation	,, 28	606	– 1,127	§8	6,052	– 1,488
Blackpool and Fleetwood ...	,, 30	382	– 356	...	...	...
Bolton Corporation......	,, 31	2,427	+ 118	9	20,935	+ 671
Bombay	,, 7	R37,634	+ R9,374	18	R655,713	+ R125,303
Bournemouth Corporation.	,, 27	1,474	– 91	8	13,211	– 1,206
Bradford Corporation......	...	...	...	...	...	...
Brighton Corporation	,, 31	873	+ 57	9	7,155	– 350
Bristol Trams & Carriage...	,, 29	5,014	– 4	27	98,203	– 4,237
Buenos Ayres & Belgrano...	,, 27	4,203	+ 379	21	80,107	+ 671
Burnley Corporation	,, 30	1,260	+ 41	9	11,505	+ 481
Burton Corporation	,, 31	265	– 13	9	2,296	– 238
Bury Corporation	,, 24	1,160	– 353	‡8	9,280	+ 577
Calcutta Tramways Co......	,, 30	R11,522	– R2,931	...	...	...
Camborne-Redruth	...	...	...	...	...	...
Cardiff Corporation	,, 23	2,076	– 483	8	15,988	480
Cavehill......	,, 22	108	+ 2	22	1,560	+ 93
Central London Railway ...	,, 30	7,077	+ 1,297	22	133,888	– 657
Charing C., Euston & H'stead	,, 30	3,345	...	22	70,530	...
Chatham & Dist. Lt. Rys....	,, 28	789	+ 100	§21	14,297	– 84
City & South London Rly...	,, 31	2,823	– 177	22	71,179	+ 6,125
City of Birmingham	,, 22	2,881	– 367	20	54,998	– 75
Colchester Corporation......	,, 27	191	– 9	...	...	...
Cork Electric Trams Co. ...	,, 28	541	+ 22	§21	8,838	– 459
Croydon Corporation	,, 29	1,522	+ 109	9	11,942	– 120
Devonport & Dist. Trams...	,, 22	436	– 86	20	8,733	– 178
Dover Corporation	,, 23	188	– 92	8	1,432	– 326
Dublin & Lucan Railway...	,, 29	130	+ 14	22	2,299	+ 66
Dublin United	,, 29	5,550	– 376	22	105,237	– 1,900
Dudley-Stourbridge	,, 22	820	– 639	20	15,210	– 1,761
Dundee Corporation	,, 27	1,215	+ 81	12	2,112	+ 173
East Ham Council	,, 30	863	– 11	9	7,872	– 628
Exeter Corporation......	,, 29	315	+ 3	9	2,626	– 167
Gateshead & Dist. Trams...	,, 22	968	– 110	20	19,914	+ 120
Glasgow Corporation......	,, 30	18,290	+ 163	52	905,222	+ 14,229
Glossop	,, 30	127	– 19	22	2,656	– 178
Gravesend—Northfleet......	,, 22	211	– 115	20	3,883	– 702
Great Northern & City Rly..	,, 30	1,551	– 149	22	37,743	– 2,464
Gt. Northern, Piccadilly, &c	,, 30	5,500	+ 1,300	22	119,220	+ 34,001
Greenock & Port Glasgow...	,, 22	563	– 179	20	9,870	– 2,765
Hartlepool Tramways	,, 22	225	– 138	20	4,265	...
Hastings Elec. Trams Co....	,, 28	974	– 59	22	17,215	– 603
Hong Kong	,, 30	$7,381	+ $11	...	...	...
Huddersfield Corpn.	...	...	...	...	...	...
Hull Corporation......	,, 30	2,380	+ 39	9	20,860	– 280
Ilford District Council	...	...	...	...	...	...
Ilkeston District Council ...	,, 27	112	+ 18	8	1,259	– 16
Ipswich Corporation	,, 30	374	– 1	9	3,104	– 259
Isle of Thanet Co.	,, 30	452	– 18	35	10,356	– 749
Jarrow	,, 22	110	– 57	20	1,989	– 337
Keighley Corporation	,, 28	175	+ 27	48	7,556	+ 523
Kidderminster & District...	,, 22	101	– 124	30	1,802	– 279
Kilmarnock Corporation ...	,, 30	147	– 2	2	360	– 63
Lanarkshire Trams Co. ...	,, 28	1,287	+ 83	21	26,839	+ 3,293
Lancashire United......	,, 27	1,460	– 425	21	26,196	+ 716
Leamington	,, 22	152	– 107	20	2,811	– 65
Leeds Corporation	...	...	...	...	...	...
Leicester Corporation	,, 30	2,297	+ 58	...	...	...
Leith Corporation	,, 23	525	+ 19	§1	679	– 127
Lincoln Corporation	,, 30	115	+ 15	9	1,057	+ 37
Liverpool Corporation	,, 23	10,976	– 586	21	216,119	– 2,699
Liverpool Overhead Rly. ...	,, 31	1,452	– 28	22	30,688	– 778
*London County Council ...	,, 23	35,478	+ 1,762	†8	250,104	+ 20,240
London United	,, 30	7,962	– 1,464	21	124,811	– 2,667
Lowestoft	,, 30	170	+ 7	35	5,487	+ 97
Maidstone Corporation......	,, 30	194	...	9	1,588	...
Manchester Corporation ...	,, 30	15,487	+ 938	9	129,183	+ 3,766
Mersey Railway	,, 30	1,832	+ 35	22	42,050	+ 1,534
Merthyr......	,, 22	212	– 78	20	4,099	– 60
Metropolitan Dist. Railway	,, 30	9,303	+ 1,014	22	195,727	+ 21,285
Metropolitan Elec. Trams...	,, 22	6,315	+ 703	20	102,319	+ 18,218
Middleton......	,, 22	379	– 53	20	6,621	+ 27
Nelson Corporation	,, 30	149	+ 9	¶8	1,242	...
Newcastle-on-Tyne Corp. ...	,, 30	3,683	– 223	9	32,605	– 3,658
Newport (Mon.)	,, 30	655	– 4	9	5,784	– 213
Northampton Corporation.	,, 29	459	+ 45	¶8	3,684	– 142
Oldham, Ashton & Hyde ...	,, 22	607	– 78	20	11,751	– 82
Oldham Corporation	,, 31	2,061	+ 157	10	19,331	– 12
Perth (N.B.) Corporation ...	,, 27	147	+ 1	2	251	– 13
Perth (W.A.) Elec. Trams...	,, 29	1,413	+ 66	¶22	31,086	– 763
Peterborough	,, 22	127	– 31	20	2,221	– 86
Portsmouth Corporation ...	,, 30	1,912	+ 65	9	15,900	– 1,048
Potteries	,, 22	1,780	– 441	20	36,731	– 7
Preston Corporation	,, 27	703	+ 5	22	15,022	– 462
Rotherham Corporation ...	,, 28	612	+ 85	§8	5,014	– 89
Rothesay	,, 22	204	– 22	20	1,729	– 157
Salford Corpn......	June 1	4,951	+ 647	9	41,256	– 1,539
Sheerness	May 26	57	– 8	20	1,005	– 23
Sheffield Corporation......	,, 31	5,811	+ 566	†10	53,107	– 1,187
Singapore Trams	,, 30	$8,536	– $1,283	...	...	...
Southend Corporation	,, 27	361	– 1	9	2,819	– 74
South Metropolitan	,, 22	898	– 50	20	14,115	– 337
Southport Tramways......	,, 22	265	– 232	20	4,495	– 189
South Staffs......	,, 22	858	– 391	20	17,310	– 636
Stalybdge, Hyde, &c., Jt. Bd.	,, 30	762	+ 5	†9	6,673	– 3 0
Sunderland Corporation ...	,, 31	1,196	– 116	9	9,834	– 2,111
Sunderland and District ...	,, 27	471	+ 17	30	13,603	+ 1,107
Swansea Trams	,, 22	871	– 247	20	17,470	+ 975
Swindon Corporation	,, 27	150	– 15	...	...	...
Taunton	,, 22	37	– 71	20	775	– 42
Tynemouth and District ...	,, 22	197	– 136	20	3,087	– 497
Tyneside Trams Co......	,, 27	378	– 12	22	7,765	– 1,308
Wallasey District Council...	,, 30	901	+ 72	†8	7,345	+ 79
Walsall Corpn	,, 30	528	+ 68	22	11,321	+ 1,068
West Ham Corporation......	,, 28	2,200	– 74	9	19,469	– 2,051
Weston-super-Mare	,, 20	80	– 227	20	891	– 325
Wolverhampton Co.	,, 22	435	– 307	20	8,868	– 516
Wolverhampton Corpn......	,, 27	780	+ 7	51	36,910	...
*Worcester	,, 22	278	– 110	20	4,974	– 160
Wrexham	,, 22	97	– 28	20	1,935	– 25
Yorkshire W.R. Trams	,, 31	1,230	+ 199	22	24,770	...
Yorkshire Woollen District.	,, 22	913	– 250	20	17,881	– 1,006

(a) These comparisons are with the corresponding period last year. § Plus 2 days. ¶ Plus 3 days. * Partly electrical. † Minus 3 days. ‡ Minus 2 days. ‡ Plus 4 days.

ELECTRICAL COMPANIES' SHARE LIST.

Shre.	Last Dividend	Name.	Price Wed., June 3.	Rate % Yield-ed. £ s. d.	Dividend Due.	Business Week to June 5. Highest.	Lowest.
		ELECTRICITY SUPPLY.					
10	9 0	Bournemouth & Poole Elec. Sup. Ord...	10½–11	6 7 0	Mar, Sept,	10⅞	..
10	4 6	Do. 4½ per Cent. Cum. Pref.	9½–10½	4 7 0	Feb, Aug		..
10	6 0	Do. 6 per Cent. Cum. Second Pref. ...	10½–11	5 9 0	Feb, Aug	10⅞	..
St.	4½%	Do. 4½ per Cent. Deb. Stock (red.) ..	102 –105	4 5 6	Jan, July	..	
5	3 6	Bromley (Kent) El. Lt. & Power Shares	4½–6	5 10 0	April, Oct	.	..
St.	4½%	Do. Do. 1st Debs.	94 –97	4 12 9	May, Nov	.	..
5	5 6	Brompton & Kensington Elec. Sup. Ord.	6½–7½	6 13 0	March....	7½	6¾
5	3 6	Do. 7 per Cent. Pref......	6¾–7¼	4 10 0	Mar, Sept		.
St.	4%	†Central Elec. Sup. Co. 4% Guar. Db. Stock	98 –101	4 0 0	June, Dec	..	..
5	2 6	Charing Cross (W. End & City) El. Sup. Co.	3½–4	6 5 0	Feb, Aug	8½	..
5	2 3	Do. 4½ per Cent. Pref.	4⅛–4⅜	4 17 0	Feb, Aug	.	..
St.	4%	Do. 4 per Cent. Deb. Stock (red.)......	96 –99	4 1 0	Jan, July	..	..
5	2 3	Do. City Undertaking 4½% Cm. Pref.	3¾–4½	5 8 6	Jan, July	.	.
5	2/6	Chelsea Electric Supply Ord.	3 –3⅜	6 8 9	March ..	3,	3½
St.	4½%	* Do. 4½ per Cent. Deb. Stock (red.) ...	101 –104	4 6 9	June, Dec	.	
10	7 0	City of London Electric Lighting Ord...	9 –10	6 0 0	Feb, Aug	9⅞	9½
10	6/0	Do. 6 per Cent. Cum. Pref.	12 –13	4 12 0	Jan, July	12,	..
St.	5%	Do. 5 per Cent. Deb. Stock (red.)......	124 –127	3 18 0	June, Dec		.
St.	4½%	Do. 4½ per Cent. 2nd Deb. Stock (red.)	102 –105	4 6 0	Jan, July	104½	..
5	1/10½	County of Durham Elec. P.D. Ord......	2¾–3	3 9 7	April, Oct	..	..
5	5%	Do. 5 per Cent. non Cum. Pref.	3⅜–3⅞	6 13 4	April, Oct	..	..
10	6 0	County of London Elec. Supply Ord......	7¾–8½	6 3 6	Feb, Aug	7½½	..
10	6 0	Do. 6 per Cent. Cum. Pref......	10⅝–10⅞	5 2 0	Mar, Sept	10⅝	..
St.	4½%	Do. 4½% Deb. Stock (all paid) (red.)...	107 –110	4 2 6	Jan, July	..	..
St	4½%	Do. Second Deb. Stock	98 –101	4 9 9	May, Nov	99½	99½
5	3 6	Folkestone Electricity Supply Co. Ord.	4¾–5¼	5 7 0	April, Oct	..	..
5	2 6	Do. 5 per Cent. Cum. Pref.	5 –5½	4 11 0	Mar, Sept	..	..
St.	4½%	Do. 4½ 1st Deb. Stock (red)......	94 –97	4 13 0	Feb, Aug	..	..
5	4 6	Hove Electric Lighting Ord.	6 –6½	6 11 0	April, Oct	.	..
5	5 0	Kensington & Knightsbridge Ord......	7 –8	6 5 0	Feb, Aug	..	..
5	6%	Do. 6 per Cent. 1st Pref.	6 –6½	4 12 0	Jan, July	.	—
St.	4%	Do. 4 per Cent. Deb. Stock (red.)......	96 –99	4 1 0	..	..	..
St.	4%	Kensingtn. & Kngtbg. Co. & Notting Hill Co. (Joint Station) 4% Deb. Stock (red.)	97 –101	3 19 0	April, Oct	..	..
St.	4½%	Kent Elec. Power Co......	88 –92	4 18 3	Jan, July	85	84½
3	1 6	London Electric Supply Ord.	1¼–1½	5 8 0	Mar, Sept		..
5	3 0	Do. 6 per Cent. Pref......	4¼–4¾	6 6 0	Mar, Sept	..	..
St.	4%	Do. 4 per Cent. 1st Mort. Deb.	90 –93	4 8 0	Jan, July	..	..
5	3 6	Metropolitan Electric Sup. Ord.	4½–5	6 10 0	April, Oct	4-	..
5	2 3	Do. 4½ per Cent. Cum. Pref.	4½–5	4 10 0	Jan, July	..	..
St.	4½%	Do. 4½ per Cent. Deb. Stock 1st Mort.	107 –111	4 1 0	June, Dec	108	..
St.	3½%	Do. 3½ per Cent. Mrt. Deb. Stock (red.)	85 –90	3 18 0	Jan, July	..	..
100	4½%	Midland Elec. Corp. for P.D. 1st Mort. Db.	96 –99	4 11 0	June, Dec	..	..
10	4%	Newcastle & Dist. Elec. Ltg. Ord.	7¾–8¼	5 0 0	Feb, Aug	..	—
100	4½%	Do. 4½ per Cent. Deb.	98 –98	4 12 9	Jan, July	..	..
5	8%	Newcastle Elec. Supply Ord.	5⅝–5⅞	6 10 2	Feb, Aug	.	..
5	5%	Do. 5 per Cent. non Cum. Pref.	5¼–5½	4 13 0	Feb, Aug	..	..
100	4%	Do. 4 per Cent. Mort. Deb. red. 1907.	96 –98	4 2 6	Jan, July	..	..
1	3%	Northern Counties Elec. Sup.	—	..	Mar, Aug	..	..
100	4½%	Do. 4½ per Cent. Deb.	95 –97	4 13 9	Jan, July	..	..
10	8 0	Notting Hill Electric Ord......	11½–12½	5 14 0	March ..	..	..
5	4 6	Oxford Electric Ord.	5¾–6¼	5 12 0	March ..	5½	..
St.	4%	Do. 4 per Cent. Deb. Stock	94 –98	4 1 6	Jan, July	..	..
5	5 0	St. James' & Pall Mall Elec. Ord......	7½–8¼	6 1 3	Feb, Aug	7¾	..
5	3 6	Do. 7 per Cent. Pref.	6¾–7¼	4 16 6	Feb, Aug	..	..
St.	3½%	Do. 3½ per Cent. Deb. Stock (red.) ...	85 –90	3 17 9	Jan, July	..	..
5	..	Smithfield Markets Electric Sup. Ord...	½–¾	..	Feb	..	..
St.	4%	Do. 4 per Cent. Deb. Stock......	70 –74	5 8 0	Feb, Aug	..	..
5	4/0	South London Electric Supply Ord......	2¼–2¾	7 6 0	April....	2¼	..
1	0/6	South Metrop'n Elec. Lt. & Power Ord.	⅝–⅞	4 0 0	..	..	..
1	0 8⅔	Do. 7 per Cent. Cum. Pref......	1⅟₁₆–1⅟₁₆	5 6 0	Feb, Aug	..	..
St.	4½%	Do. 4½ 1st Db. Stk. Red......	99 –102	4 8 0	April, Oct	..	..
5	2 6	Urban Electric Supply Ord.	1 –2	12 10 0	April, Oct	..	..
5	2 6	Do. 5 per Cent. Cum. Pref.	1⅝–2⅛	11 14 0	April, Oct	2	1⅞
St.	4½%	Do. 4½ per Cent. 1st Mort. Deb......	87 –90	5 0 0	April, Oct	..	..
5	5/0	Westminster Elec. Sup. Ord.	7½–8	6 5 0	Mar, Sept	7½	7½
5	2/3	Do. 4½ per Cent. Cum. Pref.	4⅞–5⅜	4 4 0	Jan, July	5	5½
		ELECTRIC RAILWAYS, TRAMWAYS, &c.					
St.	4%	Baker St. & Waterloo 4% Perp. Db. St.	88 –91	4 8 0	Jan, July	91	..
1	..	Bath Elec. Trams Pref. Ord.	⅜–⅝	8 0 0	April....	..	—
1	0/6	Do. 5 per Cent. Cum. Pref......	⅝–⅞	5 14 0	Jan, July	..	..
St.	4½%	Do. 4½ 1st Mort. Deb. Stock (red.) ...	85 –90	5 0 0	April, Oct	..	..
St.	4½%	B'ham & Midland Trams 4½ 1st Db. Stk.	93 –96	4 15 0	Jan, July	..	..
10	9%	Bristol Tramways & Carriage Ord.	10 –10½	8 11 9	Feb, Aug	..	..
10	4%	Do. Cum. Pref. (fully paid)......	8 –8½	4 14 0	..	..	..
St.	4%	Do. 4 per Cent. Debs.	99 –100	4 0 0	Feb, Aug	..	..
10	..	British Electric Traction Ord......	1½–1¾	..	June, Dec	.	
10	6/0	Do. 6 per Cent. Cum. Pref......	3¾–4½	..	Feb, Aug	4	4¼
St.	5%	Do. 5 per Cent. Perpetual Debs.	90 –95	5 5 0	April, Oct	94¼	93
St.	4½%	Do. 4½ per Cent. 2nd Deb. Stock	71 –75	6 0 0	May, Nov	73¼	..
St.	3%	Central London Ordinary Stock	81 –84	3 11 3	Feb, Aug	83½	80½
St.	4%	Do. 4 per Cent. Pref. Stock	90 –92	4 7 0	Feb, Aug	92	91
St.	2%	Do. Deferred Stock	64 –67	3 0 0	Feb	67½	63¼
100	4%	Do. 4 per Cent. Debs.	101 –104	3 17 0	Jan, July	.	..
St	4%	Charing X, Euston & Hmpstd Per Db. Stk.	81 –84	4 15 3	Jan, July	84	83
5	2/6	City of Birmingham Trams. 5% Cm. Pref.	4½–4¾	5 5 0	April, Oct	..	..
100	4%	Do. 4 per Cent. 1st Mort. Debs......	97 –100	4 0 0	April, Oct	99¼	99
St.	1¾%	City & South London Rly. Con. Ord. ...	40 –42	5 0 0	Feb, Aug	41½	40¼
St.	5%	Do. 5 per Cent. Perp. Pref. (1891) ...	113 –116	4 6 0	Feb, Aug	..	—
St.	5%	Do. (1896)	112 –115	4 7 6	Feb, Aug	..	..
St.	5%	Do. (1901)	110 –113	4 8 6	Feb, Aug	112¾	..
St.	5	Do. (1903)	105 –108	4 12 6	Feb, Aug	106¼	..
St.	4%	Do. 4 per Cent. Perpetual Debs.	100 –103	3 17 6	May, Nov	102	101
10	7/0	Dublin United Trams. Ord	12¼–13¼	4 10 6	Feb, Aug	..	..
10	6/0	Do. 6 per Cent. Pref......	12½–13½	4 9 0	Feb, Aug	..	—
10	..	Gt. Northern & City Rly. Pref. Ord. (4%)	¾–1¼	..	Feb, Aug	1	..
10	4/0	G. Northern, Piccadilly & Brompton Ord.	6 –7	5 14 0	Feb, Aug	..	..
St.	4%	Do. 4 per Cent. Deb. Stock	88 –91	4 8 0	Jan, July	89½	87¼
5	4/0	Hastings & Dist. Elec. Trams. 6% Cm. Pf.	3¾–4½	7 1 0	Mar, Sept	..	..
St.	4½%	Do. 4½ Db. St.	94 –97	4 12 6	April, Oct	..	..
10	9%	‡ Imperial Tramways Ord......	10½–11½	7 17 0	Mar, Sept	..	..
10	6%	‡ Do. 6 per Cent. Pref	9¾–10¼	5 17 0	Mar, Sept	..	..
St.	4½%	‡ Do. 4½ per Cent. Debs.	93 –94	4 15 9	Jan, July	..	..
5	..	I. of Thanet E. T. & Lt. 5 per Cent. Pref.	⅞–1⅛	..	Mar, Sept	.	..
St.	4%	Do. 4 per Cent. Deb. Stock......	58 –63	6 7 0	Jan, July	..	..
10	6/0	Lanarkshire Tramways	9¾–10	5 10 0	Feb, Aug	..	..
St.	5%	Lancs. Utd. Trams 5% Prior Lien Db. St.	91 –94	5 6 0	Jan, July	..	..
10	..	Liverpool Overhead Railway Ord.	1⅛–1½	..	Feb, Aug	..	..
10	5%	Do. 5 per Cent. Pref.	6¼–6¾	7 10 0	Feb, Aug	..	..
St.	4%	Do. 4 per Cent. Deb.	85 –87	4 11 0	Jan, July	..	..
10	5/0	London United Trams. 5% Cum. Pref. ...	7 –8	6 5 0	Jan, July	7½	..
St.	4%	Do. 4 per Cent. 1st Mort. Deb. Stock	80 –85	4 14 0	Jan, July	82	80½
St.	..	Mersey Con. Ord. Stock	1 –3	—	Feb, Aug.	..	..
St.	..	Do. 3 per Cent. Perp. Pref.	3 –6	—	..	..	..
1	..	Metropolitan Elec. Tramways Def.	½–1	..	April.. .	..	..
1	0/6	Do. 5 per Cent. Cum. Pref.	1⅛–1⅜	6 3 6	Feb, Aug	..	..
St.	4½%	Do. 4½ per Cent. Deb. Stock	94 –97	4 12 6	Jan, July	96	95
St.	½%	Metropolitan Railway Consolidated	43 –44	1 3 0	Feb, Aug	44½	43¼
St.	2¾%	Do. Surplus Lands Stocks	67 –69	4 0 0	Feb, Aug	68¼	68½
St.	3½	Do. 3½ per Cent. Preference	86 –89	3 19 9	Feb, Aug	87	87
St.	3½	Do. 3½ per Cent. "A" Preference	76 –78	4 9 6	Feb, Aug	76	..
St.	3½%	Do. 3½ per Cent. Convertible Pref.	73 –76	4 12 0	Feb, Aug	76	..
St.	3½	Do. 3½ per Cent. Debenture Stock	91 –94	3 14 6	Jan, July	93	..
St.	3½	Do. 3½ per Cent. "A" Ditto	89 –92	3 16 0	Jan, July	91	..

* In calculating the yield allowance has been made for accrued interest but *not* for redemption
† Ex Dividend

ELECTRICAL COMPANIES' SHARE LIST.—*Continued.*

ELECTRIC RAILWAYS & TRAMWAYS — *Continued.*

Share	Last Dividend	Name	Price Wed., June 3	Rate % Yield £ s. d.	Dividend Due	Business Week to June 3 High-est	Low-est
St.	..	Metropolitan District Railway Ord.	14 – 15	..	Feb, Aug	15	13⅞
St		Do. Extension Pref. (5 per Cent.)	23 – 28	..	Feb, Aug	..	..
St.	3½%	Do. Assented Ext. Pref. (Int. Guar. by Und. Elec. Rlys. Co. of London, Ltd.)	44 – 48	7 6 0	Feb, Aug	48	..
St	3%	Do. 3 per Cent. Consoltd. Rent-charge	70 – 75	4 0 0	Jan, July	..	..
St.	4%	Do. 4 per Cent. Midland Rent-charge	100 – 104	3 17 0	Jan, July	..	..
St	1½%	Do. Guar. Stock 4 per Cent.	44 – 49	3 11 0	Mar, Sept	47	44
St	6%	Do. 6 per Cent. Perp. Deb. Stock	120 – 125	4 16 0	Jan, July	123	119
St	4%	Do. 4 per Cent. Ditto	73 – 78	5 3 0	Jan, July	77½	77
5	..	New Gen. Tract. 6 per Cent. Cum. Pref.	½ – ¾	..	May	..	..
1	6/9¾	Potteries Electric Traction Ord.	¼ – ½	8 0 0	April, Oct	..	..
1	0/6	Do. 5 per Cent. Cum. Pref.	¼ – ⅜	6 13 0	Feb, Aug	..	..
St.	4½%	Do. 4½ per Cent. Deb. Stock	91 – 94	4 16 0	May, Nov	92¼	..
1	0 7½	S. Met. Elec. Trams. & Ltg. 6% Cm. Pref.	⅞ – 1	6 0 0	Feb, Aug	..	..
St.	4%	Do. 4 per Cent. Deb. Stock	77 – 81	4 19 0	Jan, July	..	..
100	5%	Sunderland Dist. Elec. Trms. 5% 1st Mt. Db.	73 – 78	6 8 0	Jan, July	..	..
..	5%	Underground Elec. Rys. Co. of London...	39 – 43	11 12 0	June, Dec	40⅜	..
5	..	Yorkshire (W.R.) Elec. Trams. Ord.	1 – 1½	—	March ..	..	..
5	..	Do. 6 per Cent. Cum. Pref.	3⅛ – 3⅝	—	..	..	..
St.	4½	Do. 4½ per Cent. 1st Debs.	84 – 87	5 3 6	Jan, July	..	..

ELECTRIC MANUFACTURING, &c.

Share	Last Dividend	Name	Price Wed., June 3	Rate % Yield £ s. d.	Dividend Due	High-est	Low-est
1	..	Aron Electricity Meter Ord.	⅛ – ⅜	..		..	..
1	1 5/8	Do. 6% Cum. Pf.	⅞ – 1	7 2 0	April, Oct	..	..
1	2/4½	Babcock & Wilcox Ord.	3⅜ – 3⅝	5 3 3	April, Oct	3½	3⅜
1	0/7½	Do. Pref.	1⅜ – 1⅝	3 16 9			
5	6/0	British Insulated & Helsby Cables Ord.	6¼ – 6¾	8 0 0	July, Feb	6	..
5	3/0	Do. 6 per Cent. Pref.	5¾ – 6¼	4 16 0	Jan, July	..	..
St.	4½%	Do. 4½ per Cent. 1st Mort. Deb. (red.)	102 – 105	4 5 6	Jan, July	..	..
St.	4½%	British Thoms'n-Houst'n 4½% 1st Mt. Db.	93 – 98	4 12 0	Mar, Sept	..	..
5	..	British Westinghouse 6 per Cent. Pref...	1¹⁄₁₆ – 1⅛	..	Feb, Aug	1¹⁄₁₆	..
St.	4%	Do. 4 per Cent. Mort. Deb. Stock	45 – 50	8 0 0	Jan, July	..	..
2	..	Brush Electrical Engineering	½	—	March ..	..	..
2	..	Do. 6 per Cent. Pref. non-Cum.	⅛ – ⅜	..	Mar, Sept	..	..
St.	4½%	Do. 4½ per Cent. Perp. 1st Deb. Stock	70 – 75	6 0 0	Mar, Sept	..	..
St.	4½%	Do. Perpetual 2nd Deb. Stock	55 – 60	7 10 0	Jan, July	..	..
5	16 0	†Callender's Cable Con. Ord. xd & bonus	9¾ – 10¾	6 18 0	Jan, July	10	..
5	2/6	Do. 5 per Cent. Cum. Pref.	5¼ – 5¾	4 7 0	Jan, July	..	..
St.	4½%	Do. 4½ per Cent. 1st Mort Debs. (red.)	107 – 109	4 2 0	Nov, May	..	..
1	1/0	†Castner-Kellner Alkali Co.	1⅛ – 1⅜	9 18 0	May, Nov	1¼	..
St	4½%	Do. 4½ per Cent. 1st Mort. Deb. (red.)	101 – 104	4 6 6	Feb, Aug	..	..
1	0 9¾	Chadburn's (Ship) Telegraph Ord.	1⅛ – 1⅜	8 8 0	March ..	..	..
1	0/7½	Do. 6 per Cent. Cum. Pref.	1 – 1⅛	5 6 6	April, Oct	..	..
1	0/8¾	Consolidated Electrical Co.	⅝ – ¾	7 0 0	August ...	..	..
1	1/0	Consolidated Signal Co.	1⅛ – 1⅜	4 5 6	April, Oct	1⅜	..
1	0 7½	Do. 6 per Cent. Cum. Pref.	⅞ – 1⅛	6 4 0	April, Oct	..	..
3	2/..	Crompton & Co. (Nos. 1 to 80,000)	1¾ – 1⅞	8 6 6	Jan, July	..	..
100	5%	Do. 5 per Cent. 1st Mort. Debs. (red.)	92 – 96	5 5 0	Jan, July	..	..
1	0/7½	Davis & Timmins	⅞ – 1⅛		Mar, Sept	..	..
1	2/0	Dick, Kerr & Co. Ord.	1⅛ – 1⅜	7 12 3	Sept	..	..
1	0/7½	Do. 6 per Cent. Cum. Pref.	1 – 1⅛	4 16 0	Sept ...	..	..
St	4½%	Do. 4½ per Cent. Deb. Stock	101 – 104	4 6 6	Jan, July	..	..
1	2/6	Edison & Swan United ("A" Sh.) (£3 pd.)	½ – ⅝	..	Feb, Aug	..	..
1	4/2	Do. (£5 paid)	1½ – 2½	5 0 0	Feb, Aug	..	..
St	4%	Do. 4 per Cent. Mort. Deb. Stock (rd.)	78 – 81	4 19 3	June, Dec	..	..
St	5%	Do. 5 per Cent. 2nd Deb. Stock	85 – 87	5 15 0	Mar, Sept	—	..
1	..	Edmundson's Elec. Corp. Ord.	⅛ – ⅜	..	Jan, July	..	..
1	..	Do. 6 per Cent. Cum. Pref.	⅝ – 1	..	May, Nov	¹⁵⁄₁₆	..
St	4½%	Do. 4½ per cent. 1st Mort. Deb. (red.)	63 – 73	. 2 9	Jan, July	..	..
1	..	Electric Construction Co.	¼ – ½	..	Jan, July	..	..
1	..	Do. 7 per Cent. Cum. Pref.	1½ – 1¾	..	July	..	..
St	4%	Do. 4 per Cent. Perp. 1st Mort. Debs.	64 – 68	5 17 0	Jan, July	..	..
10	5/0	General Electric (1900) 5% Cum. Pref.	7¾ – 8¼	6 1 8	June, Dec	..	..
St	4%	Do. 4 per Cent. 1st Mort. Debs.	87 – 90	4 9 0	Mar, Sept	..	..
1	1/0	Henley's Telegraph Works Ord.	10½ – 11½	6 10 0	Feb, Aug	..	..
1	2/3	Do. 4½ per Cent. Pref.	5 – 5½	4 2 0	Feb, Aug	5½	5
St	4½%	† Do. 4½ per Cent. 1st Mort. Deb. Stock	104 – 106	4 5 0	Mar, Sept	..	..
10	15/0	India Rubber, Gutta Percha, &c., Wrks.	15½ – 16½	6 2 0	Feb, Aug	15⅝	..
100	4%	Do. 4 per Cent. Debs. (red.)	98 – 100	4 0 0	April, Oct	..	..
1	0/0	National Elec. Construction Co.	⅜ – ⅝	..	April	..	..
1	0/6	Richardsons, Westgarth & Co., Ltd. Ord.	⅛ – ⅜	7 2 0	Nov	..	..
1	0/7½	Do. 6 per Cent. Cum. Pref.	⅞ – ⅞	6 17 0	May, Nov	..	..
St	4½%	Do. 4½ per Cent. Perp. Deb. Stock	87 – 91	4 19 0	Jan, July	..	..
1	.	Simplex Conduits Ord.	1⅜	..	..	—	..
1	.	Do. 6 per Cent. Cum. Pref.	6¾	..		..	..
10	3/0	Telegraph Construction & Maintenance	29 – 31	6 11 0	Mar, July	30¼	29
100	4%	Do. 4 per Cent. Deb. Bonds (1909)	101 – 103	3 17 6	Jan, July	101¾	..
1	2 0	Vickers, Sons & Maxim, Ltd., Ord.	1⅛ – 1⅜	8 2 6	..	1⅜	1⅜
1	1/6	Do. 6 per Cent. non-Cum. Preference	1 – 1⅛	4 9 0	..	1⅛	1¹⁄₃₂
St	5%	Do. 5 per Cent. non-Cum. Preferred	102 – 106	4 14 3	..	104¾	..
St	4%	Do. 4 per Cent. 1st Mort. Db. Sk. (red)	100 – 102	3 18 0	June, Dec	101	..
100	4½%	† Do. 4½ per Cent. 2nd Mort. Debs. (red.)	102 – 104	4 7 0	June, Dec	..	..
100	15 6	† Do. 5 per Cent. 2nd Mort. Debs. Perp.	100 – 102	..	..	102	101
1	6 0	J. G. White & Co. 6 per Cent. Cm. Pref.	7¾ – 8¼	7 1 0			
1	1/9	Willans & Robinson Ord.	1¾ – 1¾	4 9 0	Apr, Oct	1¾	..
1	1/0	Do. 6 per Cent. Cum. Pref.	3⅜ – 3⅝	7 15 0	Apr, Oct	—	..
100	4%	† Do. 4 per Cent. 1st Mort. Debs.	70 – 74	5 7 0	May, Nov	..	..

TELEGRAPHS.

Share	Last Dividend	Name	Price Wed., June 3	Rate % Yield £ s. d.	Dividend Due	High-est	Low-est
10	..	Amazon Telegraph	2 – 3	—	June, Dec	..	—
100	5%	Do. 5 per Cent. Debs. (red.)	84 – 87	5 15 0	June, Dec	..	..
St.	15/0	Anglo American	59 – 62	5 11 0	F,My,Ag,N	60½	..
St.	30 0	Do. Preferred	104 – [illegible]	5 13 0	F,My,Ag,N	105	103
St.	1%	Do. Deferred	17 – 17½	5 11 0	F,My,Ag,N	17 7/16	16⅞
St.	4%	Commercial Cable 4 per Cent. Deb. Stk.	84 – 87	4 12 0	Jn,Ap,Jy,O	84½	..
10	6 0	Cuba Submarine Ord.	7½ – 8¼	7 5 0	Feb, Aug	..	..
10	10/0	Do. Preference 10 per Cent.	15¾ – 16¾	6 19 0	Feb, Aug	..	..
5	2/0	Direct Spanish Ord.	3 – 3¼	6 4 0	April, Oct	..	..
5	5/0	Do. 10 per Cent. Cum. Pref.	8 – 9	5 11 0	April, Oct	..	..
100	4½%	Do. 4½ per Cent. Deb.	100 – 103½	4 7 6	Jan, July	..	..
20	4/0	Direct United States Cable	13½ – 14	6 11 6	Ja,Ap,Jy,O	13⅞	13½
100	4½%	Direct West India Cable 4½% Rg. Db. (rd.)	100 – 102	4 8 0	June, Dec	.	..
St	17/0	Eastern Ordinary	130 – 136	5 5 0	Ja,Ap,Jy,O	134	131½
St.	17 6	Do. 3½ per Cent. Pref. Stock	83½ – 86½	4 1 0	Ja,Ap,Jy,O	86	84½
St.	4%	Do. 4 per Cent. Mort. Deb. Stk. (red.)	100½ – 102½	3 18 0	May, Nov	102	100⅝
10	1 6	Eastern Extension	12⅞ – 13½	5 6 0	Ja,Ap,Jy,O	13½	12¾
St.	4%	Do. 4 per Cent. Deb. Stock	100 – 102½	3 18 0	Feb, Aug	101⅞	100¾
100	4%	Eastern & S. African 4% Mort. Deb. 1900	100 – 102	3 18 6	Feb, Aug	..	..
25	4%	Do. 4% Maur. Sub. Deb. (red.)	99 – 101½	3 19 0	May, Nov	..	.
10	[illegible]	G. N. of Copenhagen with Coupon 73	27 – 29	7 0 0	Jan, July	30	28½
100	4½	Halifax & Bermudas 1st Mt. Db. (red.)	100 – 102	4 8 0	June, Dec	..	.
..	6	Indo-European	62 – [illegible]	6 8 0	May, Nov	[illegible]	[illegible]
100	$1	Mackay Companies Common	60 – 70	5 11 6	Ja,Ap,Jy,O	.	.
100	$1	Do. Preference	60 – 70	5 11 0	Ja,Ap,Jy,O	.	..
1		Marconi's Wireless Telegr. Co.	⅞ – [illegible]	..	April	[illegible]	.
100	4	Pacific & European Tel. 4% Guar. Dbs. (red.)	[illegible] – 101½	3 18 6	June, Dec	.	..
[illegible]	1 3	West Coast of America	[illegible]	3 17 0	May	.	..
100	4	Do. 4 per Cent. Debs.	100 – 102	3 18 0	Jan, July	.	..
10		West India & Panama	[illegible]	..	May, Nov	[illegible]	.
10	6 0	Do. 6 per Cent. 1st Pref.	[illegible] – 9	6 13 0	May, Nov	[illegible]	[illegible]
10	20/0	Do. 6 per Cent. 2nd Preference ...	[illegible]	..	May, Nov	[illegible]	.
100	[illegible]	Do. [illegible] per Cent. Debs.	[illegible]	4 16 0	Jan, July	.	
10	[illegible]	Western Telegraph	[illegible]	6 1 0	Mr,Jn,O,D	13½	13
St	4%	Do. 4 per Cent. Deb. Stock (red.)	[illegible]	3 18 0	June, Dec	..	
..	4%	‡Western Union Tel. [illegible] 4% [illegible]	[illegible] – 81	4 19 0	.	..	.

TELEPHONES.

Share	Last Dividend	Name	Price Wed., June 3	Rate % Yield £ s. d.	Dividend Due	High-est	Low-est
100	2⅞	Amer. Telephn. & Telegh. Cap. St.	118 – 122	6 14 6	..	..	..
..	4%	Do. Coll. Trust $1,000 4 per Cent. Bds	87 – 90	4 9 0	Jan, July	..	..
St	5%	Anglo-Portug'se Tel. 5% 1st Mt. Db. Stk.	99 – 102	4 18 0	Mar, Sept	..	..
5	3 0	Chili Telephone	7 – 7½	5 6 6	August ..	..	..
1	0/7½	Monte Video Telephone Ord.	⅞ – 1⅛	6 16 0	Nov	..	..
1	0/6	Do. 5 per Cent. Pref.	1⅛ – 1⅜	5 7 0	May, Nov	..	..
St.	6%	National Co. Pref. Stock	105 – 110	5 9 0	Feb, Aug	111½	105
St.	6%	Do. Def. Stock	110 – 112	5 7 0	Feb, Aug	111½	110½
10	6/0	Do. 6 per Cent. Cum. 1st Pref.	12½ – 12¾	4 15 0	Feb, Aug	..	..
10	6/0	Do. 6 per Cent. Cum. 2nd Pref.	12½ – 12¾	4 16 0	Feb, Aug	..	..
5	2/6	Do. 5 per Cent. non-Cum. 3rd Pref.	5⅝ – 5⅞	4 9 0	Feb, Aug	5½	5⅞
St.	3½%	* Do. Deb. Stock 3½ per Cent. (red.)	99 – 101	3 9 0	June, Dec	99½	99
St	4%	Do 4 per Cent. Deb. Stock (red.)	101½ – 103½	3 17 0	Jan, July	..	..
1	1/0	Oriental	1⅛ – 1⅜	5 7 6	April, Oct	..	..
1	0 7½	Do. 6 per Cent. Cum. Pref.	1⅛ – 1¼	4 16 0	April, Oct	1⅛	..
St.	4%	Do. 4 per Cent. Red. Deb. Stock	90 – 93	4 6 0	Jan, July	91½	..
St.	4½%	Telephone Co. of Egypt 4½% Db. Stk. (red.)	99 – 102	4 8 0	Jan, July	..	..
5	3/0	United River Plate	6¾ – 6¾	5 17 0	July	..	..
5	2/6	Do. 5 per Cent. Cum. Pref.	5 – 5¼	4 11 0	June, Dec	..	..
St.	4½%	Do. 4½ Deb. St. Red.	100½ – 102½	3 18 0	Jan, July	..	..

FINANCIAL, INVESTMENT, &c.

Share	Last Dividend	Name	Price Wed., June 3	Rate % Yield £ s. d.	Dividend Due	High-est	Low-est
5	3/0	Elec. & Gen. Investment 6% Cum. Pref.	3¾ – 4¼	7 1 0	Jan, July	..	..
10	2 0	Globe Telegraph & Trust	10¼ – 10¾	5 2 6	SpDcMrJu	10½	10¼
10	3/0	Do. 6 per Cent. Pref.	13⅝ – 14⅛	4 5 0	SpDcMrJu	13½	13¼
10	6%	Submarine Cables Trust (Cert.)	127 – 130	4 12 0	April, Oct	128½	..

COLONIAL AND FOREIGN ELECTRIC RAILWAYS, TRAMWAYS, &c.

Share	Last Dividend	Name	Price Wed., June 3	Rate % Yield £ s. d.	Dividend Due	High-est	Low-est
5	3/0	Anglo-Argentine 6% Cum. 1st Pref.	6½ – 6¾	4 12 0	April, Oct	6⅝	6½
5	5 0	Do. 10% Non-cum. 2nd Pref.	8⅝ – 8⅞	5 6 6	Jan, July	8⅞	8
St.	6%	Do. Permanent 6% Deb. Stock	140 – 145	4 2 9	June, Dec	143	..
St.	5%	Auckland Elec. Trams. 5% Deb. (red.)	104 – 107	4 13 6	Jan, July	105½	..
5	4 0	Brisbane Electric Trams. Invest. Ord.	3½ – 4¼	4 19 6	May	4⅛	3⅞
5	2 6	Do. 5 per Cent. Cum. Pref.	4½ – 5⅛	4 19 6	May, Nov	4⅝	..
St.	4½%	Do. 4½ per Cent. Db. Prov. Certs.	98 – 102	4 5 0	Jan, July	..	..
St.	8%	British Columbia El. Ry. Df. Ord. x rights	127 – 131	6 2 0	Mar, Sept	132½	131
St.	65 0	† Do. Pref. Ord. Stock ...... xd & rights	108 – 112	5 6 6	May, Nov	..	..
St.	5%	Do. 5% Cum. Perp. Pref. Stock	107 – 111	4 10 0	Jan, July	..	..
40	4½%	Do. 4½ per Cent. 1st Mort. Debs.	99 – 102	4 8 0	April, Oct	..	..
100	4½%	Do. Vancouver Power Debs.	101 – 104	4 6 6	Jan, July	..	..
St.	4½%	Do. 4½% Perp Con. Deb. St.	98 – 101	3 19 0	—		
5	3/0	Buenos Ayres & Belgrano Ord.	4¾ – 4¾	8 1 6	April, Oct	9⅞	9¾
5	3/0	Do. 6 per Cent. "A" Cum. Pref.	4⅞ – 5⅛	5 17 6	April, Oct	..	..
5	3/0	Do. "B"	4⅞ – 5⅛	5 17 6	April	..	..
St.	5%	Do. 5 per Cent. Debs.	110 – 116	4 6 0	Jan, July	..	..
St.	5%	Do. 5 per Cent. 2nd Debs. (red.)	102 – 105	4 16 3	Jan, July	..	..
St.	5%	Buenos Ayres Elec. Trams (1901) Ltd. Deb. St.	95 – 99	5 1 0	Ja, Jul ..	..	..
5	..	Buenos Ayres Grand National Ord.	2¼ – 2⅜	..	..	2⅜	2¼
5	2/6	Do. 5 per Cent. Cum. Pref.	3¼ – 4¼	5 18 0	Feb, Aug	3⅜	3⅜
100	5½%	Do. 5½ per Cent. Pref. Debs.	100 – 104	5 6 9	Jan, July	..	..
100	6%	Do. 6 per Cent. 1st Deb. Bonds.	98 – 102	5 17 0	April, Oct	99½	99⅛
St.	5%	Buenos Ayres Lacroze Trams 1st Mt. Db.	92 – 95	5 5 0	Mar, Sept	93½	..
St.	6%	Buenos Ayres Port & City Tram. 1st Mt Deb. Stock £75 Paid	64 – 68	6 12 0	Feb, Aug	..	..
5	2/6	Calcutta Tramways (1 to 137,610)	6⅜ – 6¾	4 15 0	Mar. Sept	6⅜	5⅞
10	2/6	Do. 5 per Cent. Cum. Pref.	5 – 5⅜	4 13 0	Jan, July	..	..
1	4½%	Do. 4½% 1st Deb. Stock (red.)	103 – 106	4 5 0	Jan, July	..	..
8	..	Cape Electric Tram Shares	⁵⁄₁₆ – ⁷⁄₁₆	..	..	..	—
5	1/3	‡City of Buenos Ayres Trams Co. (1904) Sh.	5½ – 5¾	4 7 0	F,My,A,N	5¹¹⁄₁₆	5½
St.	4%	Do. 4 per Cent. Deb. Stock	98 – 102	3 18 6	June, Dec	..	..
	5%	Colombo Tr. & Ltg. 5% 1st Mt. Db.	85 – 91	5 10 0	May, Nov	..	—
100	5%	†Electric Traction Co. of Hong Kong 5 per Cent. 1st Mort. Debs.	85 – 90	5 10 0	June, Dec	..	..
1	5%	Havana Elec. Ry. Con. Mt. 5% $1,000 50 year Coup. Bds.	80 – 85	5 17 6	Feb, Aug	82¾	82½
1	..	Kalgoorlie Elec. Trams Sh.	[illegible]	..	..	..	.
100	5%	Do. 5 per Cent. "A" Deb. Stock	87 – 91	5 5 9	Jan, July	..	—
1	6%	Do. 6 per Cent. "B" Ditto	71 – 75	7 17 0	Jan, July	..	..
5	1/0	Lisbon Elec. Trams. Ord.	1 – 1¼	4 0 0	July	..	..
100	0/7½	Do. 6 per Cent. Cum. Pref.	1 – 1¼	4 16 0	Jan, July	..	—
St.	5%	Do. 5 per Cent. Reg. Mort. Debs	90 – 95	5 5 0	Jan, July	..	..
St.	5%	Madras Elec. Trams 5% Deb. Stk.	95 – 98	5 2 0	Jan, July	..	..
.	5%	Manila Elec. Ry. $1,000 Gold Bonds	86 – 90	5 11 3	Feb, Aug	.	..
100	$1	Mexico Trams Co. Com. St.	92 – 94	4 5 0	..	94½	
500	5%	Do. Gen. Con. 1st Mort. 5% Gold Bds.	88½ – 89½%	5 11 6	..	89¼	88¾
St.	4½%	Montreal St. Ry. Sterling 4½ per Cent. Debs. (1922)	101 – 103	4 7 6	Feb, Aug	..	..
1	1 0	Perth Elec. Trams Ord.	[illegible]	8 0 0	May	[illegible]	..
St	5%	Do. 1st Mt. Db. Stock	105 – 106	4 14 3	Jan, July	.	—
5	3/0	Rangoon Elec. Trams & Supply Co. 6 Cum. Pf.	5¼ – 5¾	5 4 0	..	..	—
St.	4½	Do. 4½% 1st Mort. Deb. Stk.	97 – 99	4 11 0	..	..	..
.	$2½	Sao Paulo Tramway, Light & Power Co. $100 Stock	129 – 134	6 14 0	..	..	—
	5%	Do. 5 per Cent. 1st Mt. $500 Db.	95 – 97½	5 2 6	June, Dec	[illegible]	96
100	4½%	Toronto Ry. Co. 1st Mt. 4½% Ster. Bonds	98 – 100	4 11 0	Feb, Aug	..	..

COLONIAL AND FOREIGN ELECTRICITY SUPPLY, &c.

Share	Last Dividend	Name	Price Wed., June 3	Rate % Yield £ s. d.	Dividend Due	High-est	Low-est
5	3 0	Adelaide Elec. S'ply Co. 6% Cu. Pr.	4⅞ – 5¼	5 17 0	Mar, Sept	..	—
10	5/[illegible]	Bombay E. S. & T. 6% Cm. Pf.	10½ – 10¾	5 13 0	..	10⅝	..
St.	4½	Do. 4½ per Cent. Deb. Stk. (red.)	93 – 95½	4 14 0	Jan, July	94½	
5	4/9	†Calcutta Elec. Supply Ord.	5⅞ – 6⅛	6 2 0	April, Oct	6⅛	..
100	7/2	Canadian Gen. Elec. Co. Com. St.	85 – 90	7 16 0	..	89¼	..
100	5%	Castner Electrolytic Alkali Co. (of U.S.A.) 1st Mort. Stl. Debs.	94 – 99	5 1 0	Jan, July	.	.
500	5	Elect. Development Co. of Ontario	83 – 86%	5 16 0	..	84	83
5	..	Elec. Ltg. & Trac. Co. of Aust. 6 per Cent. Cum. Pref.	2¼ – 2¾	..	Feb, Aug	..	..
St.	6%	Do. 6 per Cent. Deb. Stock	84 – 88	5 14 0	Jan, July	..	..
St.	5%	Elec. Supply Co. of Victoria 5 per Cent. 1st Mort. Deb. St.	90 – 93	5 7 6	Jan, July		..
St.	6%	Indian Elec. Sup. & Trac. Co. Deb. St. Rd. Prov. Certs.	95 – 98	6 2 0	Jan, July	..	..
1	[illegible]	Kalgoorlie Elec. Power & Ltg. Ord.	⅛ – ¼		..	..	..
1	[illegible]	Do. 6 per Cent. Cum. Pref.	[illegible]	8 0 0	April, Oct	..	..
St.	5%	Madras E. S. Corp. 5 per Cent. Constn. Deb. St.	85 – 90	5 11 0	April, Oct	..	..
500	5%	Mexican Elec. Light Co. 5% 1st Mort. Gold Bonds	81 – 83	6 0 0	..	82	80½
St		Mexican Lt. & Power Co. Cap. St.	[illegible]	..	..	80½	[illegible]
100	5	Do. 5% 1st Mort. Gold Bnds.	[illegible]	5 15 0	..	[illegible]	[illegible]
100	6 2	Montreal Lt. Ht. & Power Co. Cap. St.	98 – 99	6 1 0	F,M,A,N	.	..
1	1/[illegible]	River Plate Electricity Co. Ord.	[illegible]	[illegible] 4 0	April	..	.
1	1 [illegible]	Do. 6 per Cent. non-Cum. Pref.	[illegible] – 1	6 0 0	May	..	..
St.	6%	Do. 5 per Cent. Deb. Stock	96 – 99	5 1 0	Jan, July		..
5	3/0	Rosario Elec. Co. 6% Pref. (1–20,000)	4 – 5¼	5 17 6	April, Oct	..	..
100	[illegible]	Shawinigan Water & Power Co. Cap. St.	71 – 75	5 10 0	..	73	67½
	5	Do. 5 per Cent. Bds.	102 – 104%	4 17 0	Jan, July	102⅜	..
[illegible]	[illegible]	Victoria Elec. Power Co. Pref.	[illegible]	—	Jan, July	..	..

* In calculating the yields allowance has been made for accrued interest but *not* for redemption. † Ex dividend. ‡ The London Stock Exchange Committee have declined to quote these.

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CONTENTS OF THE CURRENT NUMBER.

NOTES.

Power Supply in London.

To the spectator of the evolution of power supply in London the yearly Parliamentary contest as to who shall, and who shall not, supply power in London is interesting, if not profitable. When the subject first came up there seemed to be some reason in the contention that the price of electrical power in the London district was too high for satisfactory commercial development. The very fact, however, that the London supply undertakings were threatened with competition was sufficient to arouse them to every possible effort to reduce their prices and to tackle the question of power supply in a serious spirit. When the London County Council took the matter up we pointed out that the idea of London affording a vast field for power supply, and, further, that this feature had so far received but scant attention, was altogether fallacious. For example, Mr. MERZ at one time stated that the amount of power supplied electrically was only 7 per cent. of the whole, but as the result of an extensive canvass (as stated by Mr. H. B. RENWICK in evidence the other day), the companies found in the spring of last year that the total so supplied by companies and local authorities combined was really over 35 per cent. of the whole, or, in actual figures, nearly 74,000 H.P. out of about 209,000 H.P. in the County of London. Each year, very naturally, finds the present undertakings in a stronger position, and yet each year sees some fresh attempt to provide a "new comprehensive power scheme" for London, although in reality this becomes less and less necessary. In this connection the evidence by Mr. JAMES FALCONER before the Select Committee of the House of Lords now dealing with the London Power Bills is of particular interest. Mr. FALCONER was chairman of the company that promoted the original Administrative County of London Bill. At the time when this Bill was promoted in 1905 the price charged in London for power was about 2d. per unit, and the promoters came to the conclusion that they could supply at an average of ¾d. per unit. Since then, however, much progress has been made—so much so that Mr. FALCONER and his colleagues decided last year not to proceed with the Bill during the present session. They found that the present suppliers were now prepared to supply the larger power consumers at about 1d., and that, therefore, it would be a very much more difficult matter to compete with them. Moreover, the London companies had made agreements with the best consumers for periods up to seven years. The existing undertakers' costs had been so reduced, and were now so low, that the Administrative Company felt they could not safely offer to supply on lower terms. These facts certainly afford good reason for supporting the existing undertakings, as we have always advocated, instead of setting up an entirely new large scheme, for which the need, at any rate within the London area proper, has yet to be proved. The financial aspect of the latest scheme, too, seems to us to be its weakest feature.

Is the Consulting Engineer Necessary?

IN our present issue we publish a letter by Mr. JAMES SWINBURNE, in which he points out some of the difficulties that would be likely to arise if a society of consulting engineers were formed to put a stop to the undesirable

state of affairs which now exists, and which has been discussed in our columns during the past few weeks. Perhaps the main difficulty is that there would be a tendency for the leading consulting engineers to leave the matter severely alone until they were certain the movement was going to be a success, and the very fact of their being disinclined to support such a movement would tend to make it unsuccessful. On the other hand, there might be a rush of less prominent men, among whom would be found many having doubtful qualifications. This difficulty could be surmounted only by deciding very carefully in the first instance what the necessary qualifications should be. We think that membership should depend simply upon the following three main points: (1) Technical qualifications, (2) freedom from manufacturing and contracting interests, and (3) the standard of professional etiquette which the member would undertake to maintain. The last point is, perhaps, the most difficult, because opinions on the subject vary enormously, depending very largely upon the effect of any such code on the individual. In the present issue of *The Electrician* we discuss the subject of professional etiquette at some length in a leading article, which, we hope, may make the position somewhat clearer than it has been, and we shall be glad to have the views of our readers on the opinions there expressed.

The Price of Electricity for Lighting.

ALTHOUGH, as Col. R. E. CROMPTON pointed out in the discussion on Mr. H. HIRST's recent Paper read before the Institution of Electrical Engineers, there are some central stations in which there is but a poor chance of obtaining an increased number of consumers through the virtues of the metallic filament lamp, there is little doubt that in most cases an energetic system of canvassing is the one to be followed; for the introduction of metal lamps has given electrical engineers the opportunity of convincing consumers that substantial economy is possible by the adoption of such lamps in place of incandescent gas. In a report which has recently been prepared by Mr. ARTHUR WRIGHT in connection with the Marylebone electricity supply undertaking, and briefly referred to in a recent issue of *The Electrician*, the opinion is expressed that it is commercially inexpedient to attempt to raise the average price per unit, since the whole question of electric lighting revenue is in a very critical state owing to the introduction of the metal lamp; and that the only chance of obtaining a revenue sufficiently large to meet the existing charges is to encourage in every possible way the increase of the lighting business. With this view we are entirely in agreement, for the proportion of lighting business which up to the present has been obtained by most electricity supply authorities is only a small fraction of the whole, and is certainly incompatible with the undoubted fact that electric lighting is now as cheap as incandescent gas lighting, which is, after all, the main consideration with the majority of householders. The enormous development of electricity supply for power purposes during the last few years shows what can be done when the many advantages of electrical power are combined with that of economy in actual use, and we do not doubt that similarly satisfactory results will follow an energetic campaign for widely extending the present limited use in most towns of electricity for household purposes, whilst small shops, which are usually long hour consumers, and should, therefore, furnish a satisfactory return on the capital outlay, offer an extensive field for more than maintaining the present output of units in many cases.

The "Overshooting" of Tungsten Lamps.

IT is, of course, widely known that metallic filament lamps take, at the instant of switching on, a current equal to several times the normal, due to their comparatively low resistance when cold; and this rush of current causes the filament to attain its full brilliancy almost instantaneously, instead of after an appreciable interval as in the case of carbon filament lamps, where the opposite conditions exist. In a recent issue of the *Electrical World*, Mr. J. B. TAYLOR reports that the initial brilliancy of the tungsten filament lamp is greater for about one-tenth of a second than the normal brilliancy. He first noticed this interesting phenomenon, which he terms "overshooting," visually, and then confirmed it photographically, but he is unable to offer any explanation of it beyond the conjecture that the residual gas in the bulb is attracted to the walls when the lamp is cold, and that, after the lamp is lighted and becomes warm, this gas is driven off, making the vacuum relatively less. The phenomenon, which we might describe as of the nature of a "time-lag" between the resistance and temperature of a tungsten filament, is probably due to the somewhat complicated nature of a lamp from the thermal point of view; the energy radiates less readily at first than subsequently, but Mr. TAYLOR's explanation of how this takes place seems scarcely feasible.

Single-phase Traction on the Midland.

AT length Great Britain can claim an example of single-phase railway working, for the electrified portion of the Midland Railway between Lancaster, Morecambe and Heysham is now in operation, and we give an account of the overhead equipment, to be followed by a description of the rolling stock and generating station in our next issue. The single-phase system is now such an everyday object in other countries that nothing very fundamentally novel can be expected; but our readers will, nevertheless, find many interesting details in this description. It is to be hoped that the directors of the Midland Railway Co. will find the results on this short length of line so satisfactory as to warrant conversion from steam to electrical working on other parts of their extensive system.

Pringle's Skid Brake.—We understand that the first formal inspection of Mr. Pringle's groove skid emergency brake by the Burton Tramways Committee and Corporation officials took place recently. Tests were made on High Bank Hill. The Committee have decided to fit up six cars with this form of brake.

Iron and Steel Institute.—It is announced that the autumn meeting of this Institute will be held at Middlesbrough from September 28th to October 1st inclusive. A provisional programme has been arranged, and those who expect to attend are requested to communicate with the secretary as soon as possible.

Cable Interruptions.	Date of Interruption.
Cayenne–Salinas	May 12, 1908
Las Palmas–Arecife	May 18, 1908
Trinidad–Demerara	June 1, 1908
Dardanelles–Constantinople	June 1, 1908
Jeddah–Suakim	June 9, 1908

Royal Society of Arts.—It is announced that the Albert medal of this Society for the present year has been awarded to Sir James Dewar, F.R.S.

Personal.—Sir William Ramsay, K.C.B., F.R.S., has been nominated, by Her Majesty the Queen of Holland, as a member of the Dutch Academy of Amsterdam, in succession to the late Lord Kelvin.

It is announced that the honorary degree of D.Eng. of Liverpool University is to be conferred, at the graduation ceremony on July 11th, upon the Hon. C. A. Parsons, and that of D.Sc. upon Mr. Francis Darwin and Prof. J. L. Todd.

Wireless Telegraph Notes.—According to the *Electrical World* plans have been completed by the United Wireless Telegraph Co. for the installation of 11 new wireless stations on the Pacific coast. The largest, a 5 kw. station, will be at Ketchkan, Alaska. Seven will be installed on the trans-Pacific steamships and three are to be land stations.

In our issue of the 15th inst. we announced that the United States Signal Corps had carried out some experiments with wireless telegraphy from a balloon. It is now stated that the receiving wire was hung from the basket, the latter being covered with wire netting. With the balloon over Washington, wireless messages from Annapolis were clearly received.

The Corps of Electrical Engineers.—We have already noticed the formation of a Balloon Section in connection with this corps, and we are now informed that this section has obtained the percentage of its establishment necessary for its recognition by the War Office. This recognition has been applied for. In order, however, that the fullest advantage may be taken of the annual training at the Army Ballooning School at Aldershot, it is necessary that the establishment should be fully made up without delay. Recruits are needed for this purpose, and any one desiring further information is requested to apply to H. E. Holtorp at the head-quarters of the Corps, Regency-street, Westminster. Enrolments may be made on Tuesday and Wednesday evenings.

Association of Teachers in Technical Institutions.—The second annual conference of this Association has been taking place in London during the past week under the presidency of Mr. Chas. Harrap, of the St. Bride's Institute. In his presidential address Mr. Harrap referred to the formation of the Imperial College of Science and Technology, and was of the opinion that great care should be taken to ensure its position as a technical college of the highest rank, and that it should not be allowed to develop into a university college of the ordinary type. Its value would be small if this occurred. He drew attention to the increasing need of technical education and to the fact that primary education was not as good as it might be, for the education of students leaving school to-day was certainly no better than it was 30 years ago.

International Telegraph Conference.—The Lisbon Conference has terminated its labours, and the signatures to the *procès verbal* of the Conference were, we understand, officially attached yesterday (Thursday). The subjects dealt with which chiefly affect the public were the regulations referring to the use of code words, and on this subject a modification was made under which code publishers may submit their codes before publication to the telegraphic administrations with a view to official approval being given to such compilations. It is stated by Reuter that a special Board of Control will be appointed, consisting of representatives of England, France and Germany, to which it will be optional to submit such codes for official approval. Although this approval may not be given, or the codes may not be submitted to the Board, they will remain in force, each administration having the right of accepting or refusing the code vocabularies employed with such codes.

A slight modification was also effected by the Conference in terminal rates which, it is stated, will permit of small reductions in the charges for telegrams between Great Britain and some of the more distant countries of Europe.

The world's Press gains by a modification which permits of telegrams sent in foreign languages to journals published in such language enjoying the privilege of Press rates—that is to say, a Press telegram in English to a journal printed in English in any part of the world can, under the modified arrangement, be sent at Press rates.

It was decided to hold the next International Telegraph Conference in Paris in 1915, an extension of the usual period of five years between conferences.

Additional regulations were introduced to include those rules under the Radio-Telegraphic Convention of Berlin which affect the land transit of radio-telegrams received from or intended for ships at sea.

Damage to Atlantic Cables.—At one of the sittings of the International Telegraph Conference at Lisbon formal representation was made by representatives of the Anglo-American, the Commercial and other telegraph companies regarding the serious damage caused to the trans-Atlantic cables off the Irish coast by trawlers. The representative of the Deutsche Atlantische Co. suggested that an alteration in the gearing used by steam trawlers would bring about an improvement and prevent further damage. The delegates of the Contracting States were asked to bring this matter before their respective Governments, with a view to an amendment of the existing law.

One of the repairing vessels sent out to examine the extent of the damage to the submarine cables off the Irish coast has settled any doubt as to the cause of the injury. On one of the picked-up cables the "fault" was found to be entirely due to the steam trawlers' nets, as large pieces of these nets were entangled with the cables at a depth of 250 fathoms. It is considered that the loss caused to the trawlers in the shape of damage to their nets and tackle will help to bring about an improved condition of things, more especially as the Atlantic cable zone off the Irish coast is in no way necessary for deep-sea fishing purposes.

Numerous petitions have been signed throughout the United Kingdom by bankers, shipowners, merchants and trading associations asking that action should be taken to protect the trans-Atlantic cables from the damage caused by trawlers, in view of the serious loss and inconvenience experienced in commercial circles from the interruptions and delays caused by the accumulation of messages.

The cables of the Commercial and Western Union Companies were all repaired and working last week. The cable steamer "John Pender" was employed on these repairs, and the c.s. "Buccaneer" was also on the spot.

Some doubt having been expressed as to the depth at which steam trawlers can operate with their tackle and gear a reply from a ship's draughtsman to the *Glasgow Herald* shows that "winches capable of taking 1,000 fathoms of warp on each drum are sometimes asked for nowadays by owners of large steam trawlers. Such a one was supplied to the trawler 'Le Corsaire,' of Boulogne, built in 1905 at Torry, Aberdeen."

The c.s. "Buccaneer," which remains in the neighbourhood of the cables, reports that between 4:25 a.m. and 2:20 p.m. on June 9th, she hailed four steam trawlers between lat. 51°.54′ and 51°.59′ and long. 10°.45′ and 11°.44′, in which small area at least five of the Atlantic cables are situate worth more than £2,000,000.

University College (London) Union Society.—A large assembly were present last Thursday, June 4th, in the Botanical Theatre of University College to hear the foundation oration, delivered by Mr. J. Lewis Paton, M.A., and entitled "The University and the Working Classes." Previous to the lecture the president made a presentation on behalf of the society to Dr. F. W. Goodbody, who for many years has rendered excellent service in various official capacities. The lecturer, before dealing with the main subject of his oration, made a few introductory remarks, mentioning that University College was looking to its old boys for the solution of its present financial problems. He then quoted a recent speech of a member of Parliament concerning the reckless increase of education at the present time; everyone was becoming skilled, and even the pits were swarming with technically educated men. There were two great diverse forms of learning—first, scientific and technical education, which still seemed to be of a hard, crude, gritty nature, and which was proceeding from below; and, second, literary culture, which suffered from its aloofness. These

forms were now converging in the newer universities. The first was working its way up from the lower schools, whilst the second was still regarded as the privilege of the leisured classes. He was aware that objections would be raised; for example, Have we not scholarships? These only provided the poor boy with means to lift himself from his class, with the result that he was educated out of it, not in it. Thus the working class was being denuded of its possible leaders, and the poor boy was taken to the university, but the university was not brought to the poorer classes. Then there was the university extension movement, which was bringing the university to the people, and good work had been done in this direction by University College. A wonderful record could be shown, especially as it was without financial support, but the movement had not yet reached the right classes, and it still failed to give the necessary contact of soul with soul. The cause of all the trouble was the attitude of the cultured classes towards the poor, who were treated as part of a machine, and, being human, naturally objected to such treatment. There was a smaller gulf between the upper classes of different countries than between the upper and lower classes of the same country. The lecture, which was enthusiastically received, contained many charming quotations and sayings, as typical of which we may quote the lecturer's concluding words: "God must love the working people, for He makes so many of them." After the lecture, an excellent selection of music, instrumental and vocal, was given in the library.

International Congress on Electrical Units and Standards.— In our issue of May 8th we gave the names of the members of the Committee appointed by the Board of Trade to make arrangements in connection with the Congress to be held in London in the coming autumn. The Committee have now fixed Monday, October 12th, as the date for the assembly of the Congress, and they have also prepared the following memorandum, in which the proposals to be laid before the Congress as a basis for their deliberations are set forth :—

The general object of the International Congress on Electrical Units and Standards, which is to meet on the invitation of His Majesty's Government in London in October, 1908, is to consider and advise as to the steps which should be taken to bring about agreement in the definition of electrical units which form the basis of legislation in different countries, and in the methods of constructing and employing the electrical standards necessary to give effect to these definitions.

It is hoped that the delegates to the Congress may find themselves able to embody their conclusions in draft articles which might be commended to the several Governments represented as a basis for uniform legislation and administration in relation to electrical units and standards.

The fundamental units of electrical measurement are the ohm, the ampere and the volt. Of these two are primary units, being independent, and the other secondary or derived. It is generally agreed that the ohm should be accepted as one of the primary units. There is some difference of opinion as to whether the ampere or volt should be the second. This point will be one for the Conference to consider.

Again, the ohm is realised by means of the resistance of a column of mercury of definite dimensions, the ampere by means of the electrolytic deposition of silver, and the volt by aid of a standard cell.

If this method of realising the units be accepted by the Congress, specifications for the ohm and ampere will call for consideration, while the standard cell must be selected and the method of setting it up prescribed.

In view of the scientific questions raised in connection with each of these matters, including also the choice of the two primary units, it will be suggested at an early meeting of the Congress, should such a course appear to be desirable, that the Congress should appoint a small technical commission of experts to discuss the question and report thereon to the Congress.

The Congress will also be asked to consider the best methods of securing uniformity of administration in the future, and for arriving at a decision on any questions left undecided at the close of the Congress.

It is desirable to have some definite questions before the Congress, and with this object the following propositions embodying conclusions arrived at by the representatives of the various National Standardising Laboratories which met at the Reichsanstalt in 1905, and which are also generally in accordance with the decisions of the Chicago Congress held in 1893, will be brought forward as a basis for discussion:

1. That the ohm should be the first primary unit.
2. That the ampere should be the second primary unit.
3. That the volt should be treated as a secondary or derived unit.
4. That the international ohm be defined as the resistance at the temperature of melting ice of a column of mercury of uniform cross-sectional area, having a length of 106·3 cm. and a mass of 14·4521 grammes.
5. That the international ampere be defined as the unvarying electrical current which, when passed through a solution of nitrate of silver in water, deposits silver at the rate of 0·001118 gramme per second.
6. That the international volt be defined as that E.M.F. which, when applied steadily between the ends of a conductor of resistance 1 international ohm produces a current of 1 international ampere.
7. That the Weston cadmium cell be adopted as a convenient standard of E.M.F., having at a temperature of 17°C. an E.M.F. of......... international volts, but that it is undesirable that the number representing the E.M.F. of this cell should be the subject of legislation in any country.
8. That specifications dealing with the methods of setting up mercury standards of resistance, of realising the ampere by the deposition of silver, and of preparing standard cells be issued with the authority of the Congress, and that for this purpose a technical commission be appointed to prepare these specifications.
9. That the Congress consider and advise as to the best method of securing uniformity with regard to the fundamental electrical standards for the future.

INCORPORATED MUNICIPAL ELECTRICAL ASSOCIATION.

As already announced in these columns, the thirteenth annual Convention of this Association will take place at Nottingham from June 30th to July 3rd inclusive. The proceedings will open with a welcome at University College by the Mayor (Mr. Councillor Spalding) and the Sheriff (Mr. Councillor Carey) of Nottingham, and the presidential address will be delivered by Mr. H. Talbot, city electrical engineer at Nottingham. A Paper on "The Experiences of a Convener in the Establishment of an Electricity Undertaking," by Bailie Wightman, convener of the Electricity Committee, Govan, will be read and discussed. At the conclusion of this meeting a luncheon will be held in the Mechanics' Large Hall at the invitation of the chairman (Sir John Turney, J.P.) and the members of the Nottingham Electricity Committee. During the afternoon a visit will be paid to the power station and car sheds in Nottingham, which will also be open for inspection at all times during the Convention. Wednesday will be devoted to an excursion to Dovedale. On Thursday morning the Annual General Meeting will be held at University College, and during the afternoon the following Papers will be read and discussed: "Some Considerations on the Design of a Generating Station," by Mr. H. Richardson, chief electrical engineer, Dundee, and on "The Reconstructions of an Electric Lighting Scheme," by Mr. C. M. Shaw, city electrical engineer at Worcester. During the evening the Annual Dinner will take place at the Exchange Hall, Nottingham. On Friday morning a meeting will be held at University College, during which the following Papers will be read and discussed: "Alternating Current Accumulator Sub-Stations," by Mr. A. M. Taylor, assistant electrical engineer, Birmingham, and "The Work and Equipment of a Testing and Standardising Department," by Mr. H. A. Ratcliff, superintendent of the testing department, Manchester Corporation Electricity Works. During the Convention the Brush Engineering Co.'s works at Loughborough will be open to inspection, as will the generating station of the Derby Corporation. A glance through the above programme will show that the subjects for discussion are of more than ordinary interest to station and supply engineers.

We are, as usual, making special arrangements for giving full reports both of the Papers and discussions, and our issue of July 3rd will contain an account of the proceedings up to a late hour on Thursday, July 2nd.

ARRANGEMENTS FOR THE WEEK.

FRIDAY, June 12th (to-day).

PHYSICAL SOCIETY.

5 p.m. Meeting in the Physics Laboratory of the Royal College of Science, Imperial Institute-road, South Kensington. Agenda: "Experiments on a Directive System of Wireless Telegraphy," by Messrs. Bellini and Tosi; "On the Lateral Vibration and Deflection of Clamped Directed Bars," by Dr. Morrow; "On the Resistance of a Conductor of Uniform Thickness whose Breadth suddenly Changes and on the Shape of the Stream Lines," by Prof. Lees; "On the Self-Inductance of Two Parallel Wires," by Dr. Nicholson; "On Homogeneous Secondary Radiation," by Dr. Barkla and Mr. Sadler; and "Notes on the Motion of a Corpuscle and on Cloud Formation," by Prof. Morton.

THE CADMIUM CELL AT A LOW TEMPERATURE.

BY HENRY TINSLEY.

Among the many contributions which have appeared during the last few years regarding the Weston cell it has been rather remarkable that more attention has not been paid to its behaviour with a varying temperature, more especially at low temperatures.

The recent sudden period of cold weather has impressed on the writer the necessity for taking into account the range of temperature over which a cell should be used, and to which the ordinary temperature correction formula can be applied. During the early part of April the writer made up a batch of cells, keeping to the N.P.L. specification, and on completion they were found to be within three or four parts in 100,000 of standard value when compared against a standard checked at Bushy House. When the cold weather set in about April 18th sudden and extreme variations between this batch of cells and the standard were observed, amounting to as much as 190 parts in 100,000, or nearly 2 millivolts, the temperature being then as low as 3°C. in the test room in which the cells were being used and tested, the temperature in the early part of the month having been about 14°C. in the same place. The whole batch of cells were observed to be in good agreement with each other at both the normal and low temperature, though differing largely from the standard at the lower temperature. This fact did not point to careless manipulation of the chemicals, which would have shown variations between individual cells, the maximum variation of 36 cells being within 10 parts in 100,000.

After observing the same discrepancy of about 2 millivolts at about 3°C. for several cells of the batch, including an extra large one weighing over a pound, it was decided to select a typical cell and take a series of observations as the test room varied its temperature under actual conditions. The master standard and the chosen cell were, therefore, placed in an oil bath with a good thermometer, and instructions given to take a careful test every half-hour or so as the temperature rose. The extreme cold of the night of April 24th rendered a large range of temperature possible, and early on April 25th the tests were started, when the following interesting curve was obtained, the voltage being actually measured to $\frac{1}{100000}$ volt and the temperature 0·1°C.

The curve A was plotted from the known value of the voltage and temperature coefficient of the master cell, whereas B represents the varying voltage of the selected cell. Considering that the points on curve B were taken by more than one observer, the nearness with which they approach the mean must be regarded as very satisfactory.

The lowest temperature was 3·2°C., at which the difference between the two cells amounted to 190 parts in 100,000, which difference gradually decreased till it became zero at 12 deg. From this point the new cell's voltage is in excess of the master cell till about 16 deg., when its curve bends downwards, thus showing a true negative coefficient of the same value as the master cell. Below 15 or 16 the cell B has a positive coefficient, whereas above this temperature its value varies identically with A, and in the proper way it should, according to the N.P.L. formula. It therefore becomes evident that the difference of temperature coefficients can hardly be due to a chemical effect such as an alteration in the solubility of the cadmium sulphate solution, and another explanation must be sought.

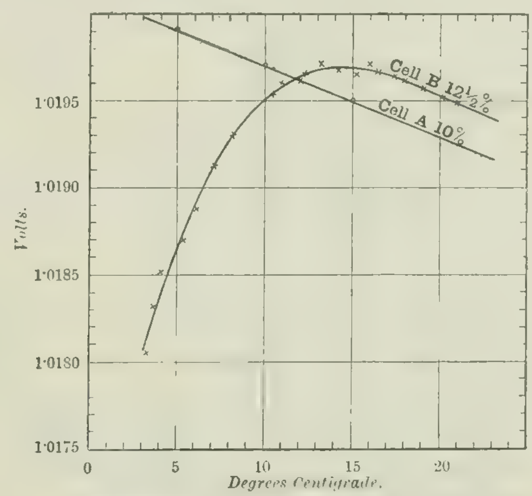
In his excellent Paper on the cadmium cell recently read before the Royal Society,* Mr. F. E. Smith summarises the work of many well-known scientists on this subject, and reference is made in that Paper to the work of Jaeger, Dearlove, Bijl, Puskein and others as having pointed out the necessity of paying attention to the percentage of cadmium metal used in making the amalgam, and he appears to favour the 10 per cent. proportion rather than the 12½ per cent., whereas the tendency with the German workers is to favour a somewhat higher proportion. The suitable amount would probably vary according to the range of temperature over which the cell was to be used, and the 10 per cent. would meet nearly all cases in practice.

* *Phil. Trans.*, Vol. CCVII., pp. 393-420.

Cell A was made with a 10 per cent. cadmium amalgam, whereas cell B was made with 12½ per cent. amalgam. The amalgam in cell A was observed to keep bright throughout the range of temperature and have a surface appearance very similar to pure mercury, whereas at the lower temperatures cell B's amalgam appeared to become solid and lose its bright appearance, becoming like the surface of new galvanised iron. Workers on the cadmium cell will, perhaps, recognise the difference which appear on different amalgams though it is difficult to describe in words.

With the return of warm weather it has been possible to compare some of this batch of cells against the master standard under a natural variation of temperature between about 14°C. and 22°C., and the cells are in excellent agreement with the master standard over this range, several cells which have been compared not varying more than three parts in 100,000 from the master and their mean. The cadmium amalgam has also shown the characteristic appearance of bright mercurial surface and has lost the grey crystalline look mentioned above, which recurs when the temperature gets as low as 12°C.

With all due caution, therefore, and the utmost respect for the observations of other workers, I venture to suggest that the difference observed may be due to the amalgam with the higher percentage of cadmium, becoming solid at the lower temperature, say, below 10°C., and thus departing from its two-phase system of cadmium and mercury.



TEMPERATURE–E.M.F. CURVES OF CADMIUM CELLS.

It is probable that a similar pair of curves might be plotted for a 10 per cent. amalgam with respect to a lower percentage amalgam, only then the bending over of the curve would probably come at a temperature beyond any possible limits of English temperature. In the case of the 12½ per cent. amalgam it would appear that cells need to be used with caution below, say, 10°C., but even with this amalgam at and above this temperature it is not likely that any error would exceed 1 or 2 parts in 10,000.

The above remarks have been written in the few leisure moments of extreme business pressure, so that they have no merit beyond their being actual practical observations, taken under slightly abnormal working conditions, but they may open a new line of work to those who are specially interested in the Weston cell, and with this object in view they are submitted for perusal.

SINGLE-PHASE ELECTRIC RAILWAYS IN EUROPE.

In our issue of March 13th we gave some details, due to M. N. Blakemore, of the electric railways which are being worked or equipped on the single-phase system in America. The increasing use of this method of traction makes any figures in connection with it of considerable interest, and we are, therefore, giving below some information regarding its development in Europe. Instead of 28 lines totalling 966·3 miles, the American figures, there are only 19 totalling 415·5 miles. As several of the lines are of a more or less experimental des-

cription, details as regards motor-car or locomotive equipment and motor horse-power are somewhat meagre, though the total is certainly in excess of 47,120 H.P. Many of these railways have been described more or less fully in the columns of *The Electrician*, and we are simply setting out in the following table information similar to that given in the former article. We have to thank the English representatives of the contracting firms for supplying us with figures and other information given below :—

Name of line.	Length in miles.	Frequency.	Line voltage.	No. of motor-cars with H.P. on each.	No. of locomotives with H.P. on each.	Date of opening.
Bergamo-Valle Brembana	19·0	25	6,000	—	5 300	Dec., '07
Blankenese-Ohlsdorf	41 5	25 25	6,600 6,000	6-250 51 345	—	Jan., '07
Borniage	13·0	40	600	20–80	–	Apr., '05
Compagnie Generale Parisienne de Tramways	1·0	—	500	2-50	—	Exper'l.
Murnau-Ober-Ammergau	15·0	16	5,000	4–160	—	Jan., '05
Spindlersfeld	25·0	25	6,000	2-200	—	Aug., '03
Prussian State Railway	1·5	25	6,600	-		Exper'l.
Rome-Civita-Castellana	34·0	25	6,000	15–80	-	Mar., '07
Stubaital...........	11·75	42	2,500	4–160	–	Aug., '04
Swedish State Railways	12·0	25	6,000 5,000–20,000 6,000–20,000	- — —	2–200 1–330 1-300	Exper'l.
Vienna-Baden ..	17·0	15	10,000 A.C. 500 D.C.	13–100	—	Jan., '07
Locarno-Bignasco	17·0	20	5,500	4–160	—	Sept. '07
Seebach-Wettingen	12·0	15	15,000	—	2-400 1-225	Dec., '07
Midland Railway	16·6	25	6,600	3–350	—	Apr., '08
Brighton Line ...	17·2	25	6,000	—	—	Not yet open for traffic.
Parma Provincial	26·5	25	4,000	17-120 1–60	—	Not yet open for traffic.
Rotterdam-Hague	45·0	25	10.000	20-350	—	Not yet open for traffic.
St. Polton-Mariazell	66·5	25	6.000	—	23–350	Not yet open for traffic.
Tergnier-Anizy ...	20·0	25	3,300	—		Not yet open for traffic.

ELECTRICAL PORCELAINS.*

BY H. W. BRADY.

(Concluded from page 289.)

Properties of Porcelain.

In the low-tension test following manufacture the insulators are turned upside down and filled with water. They stand in water in a shallow tank. A galvanometer shows when some flaw allows connection between the water in any insulator and the water in the tank.

Good porcelain will not absorb water whether glazed or unglazed. Poor quality porcelain approaches ivory in certain respects, and, if very bad, may be detected by adhering to the tongue, or at least showing a tendency to do so. One property that porcelain has to commend it is its low coefficient of expansion compared with that of glass. The coefficient varies a good deal with the composition, but it may be given as about 0·000005.

Additions of felspar raise it and additions of flint reduce it. The mechanical strength of porcelain is much greater than that of the rocks from which it originates. With a compressive stress of 28 to 29 tons per square inch it is doubly as strong as porphyry or granite and about 80 per cent. less than cast iron. It is difficult to get the exact strength in tension owing to the slight distortion of the test pieces during firing. This, though slight, is sufficient to put the test piece under bending stress as well, which, with such an unyielding substance as porcelain, upsets the test. The tensile stress, however, may be given as 10 to 11 tons per square inch, which compares favourably with cast iron. These figures for tension and compression, if taken alone, would give porcelain quite a good place among strong materials, but, of course, it is so inelastic that even the very best of it is not safe under jars or blows.

The electrical resistivities of porcelain and glass are given respectively as 200 × 10^{10} megohms (porcelain) and about 20,000 × 10^{10} megohms (glass) per centimetre cube. There is not much to be gained from figures in this connection, however, for they are very variable both for glass and porcelain, and with substances of such high resistance so much depends on the condition of the atmosphere or any other circumstance affecting the surface of the test piece. Being more or less a silicate, porcelain is a comparatively good conductor when raised to a red heat. What the electrical engineer is concerned with is, first, the surface leakage and the proper design, composition and glazing of insulators to prevent it; secondly, arcing, the prevention of which is also a matter of design; and thirdly, the break down of the substance under electrical pressure. Both the design and the composition have been left very much in the hands of manufacturers, but whether electrical engineers or potters are the designers, there are, apparently, wide differences of opinion as to the lines that should be followed. Sometimes an electrical engineer will inquire for insulators for high-tension work, and on going into his specification it may be found that to satisfy the letter of his requirements the insulator would be some 2 ft. or 3 ft. in diameter, and it is often possible to show him, by tests which imitate the conditions under which the insulator will have to work, that, say, 12 in. diameter is quite sufficient. Attempts at standardisation do not always bring the result that is intended. The Phœnix Fire Office rules, for instance, were soon marred as a standard by other fire offices getting out different rules of their own. Porcelain has been left severely alone by the Engineering Standards Committee, and, as the persons who have the laying down of high-tension plant, and consequently the purchasing of insulators, in their hands do not show any oneness of ideas concerning insulator design, it will be better for the present purpose if, instead of suggesting any sort of standard rule I give the results of two series of tests, one laboratory and one under more work-a-day conditions, and point out what appear to be safe conclusions. The laboratory tests I refer to

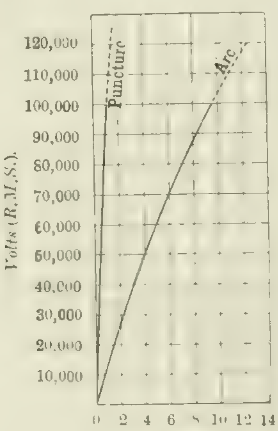


Fig. 11.—Puncture and Arc Curves.

were carried out by Sir William Preece in 1901. An induction coil was used and a sparking gap between brass knobs ½ in. radius used to ascertain the voltage. The following gives the essential features of the tests :—

150,000	volts broke down	2	mm.	thickness of	porcelain.
300,000	,,	5½		,,	,,
345,000	,,	6½		,,	,,
225,000	,,	4½		,,	,,

The voltages are inferred from the length of spark. Thus,

10 cm. = 300,000 volts | 30 cm. = 900,000 volts

There were some score of insulators tested, mostly of ordinary telegraph type.

High-Tension Test.

It may be inferred from the above that a 1 in. spark is produced at ordinary temperatures by a voltage of, say, 75,000, and that porcelain punctures under a pressure of about 1,000,000 volts per inch of its thickness. Manufacturers, however, test their insulators with a step-up and an auto-transformer to give variation of voltage. The effect of frequency, current capacity (as well as voltage), &c., may explain the much lower figures obtained with a big transformer and are questions on which I should like to hear the views of others, but as the result of a good many tests, including the following, it seems safe to take the two curves reproduced herewith in Fig. 11 as a starting point in designing an insulator, arranging the thickness of porcelain and the arcing length to agree with the curves, allowing, of course, some factor of safety. It must be taken into consideration that the upper surface of the upper shed of the insulator under the usual moist condition of the atmosphere is probably alive to its outer edge to such an extent that it may be eliminated from the arcing distance; and the same remark applies to the lower portions of the inner petticoats, some of which must also been eliminated to an extent depending upon the greatest angle of rain-fall which the insulator will probably have to

* Abstract of a Paper read before the Birmingham and District Electric Club.

cope with. It must also be borne in mind with regard to puncturing that it is of no use making the mass of porcelain very thick unless it is done in two or more layers. It would seem that about an inch thickness of porcelain is as much as can be properly vitrified, and even for less thicknesses two pieces are advisable. They may be joined together, either by cement or by glazing, the latter, perhaps, being preferable as the glaze is a better insulator than the cement and, being smoother, it does not encourage the brush discharge which sometimes takes place from the outer surface of the cement.

The following tests were made at the works of Messrs. Callender's Cable Company by Mr. C. J. Greene:

INSULATOR No. 1.—This is a white porcelain insulator (Fig. 12) with two sheds made in two pieces cemented together, and was mounted on a steel pin secured to the insulator by sulphur cement. The minimum thickness of porcelain was 0·9 in. The overall diameter of the insulator 7·65 in., and the overall height 8·3 in.

Test No. 1.—The insulation was first tested in a dry and clean condition. The pressure was applied between the side groove of

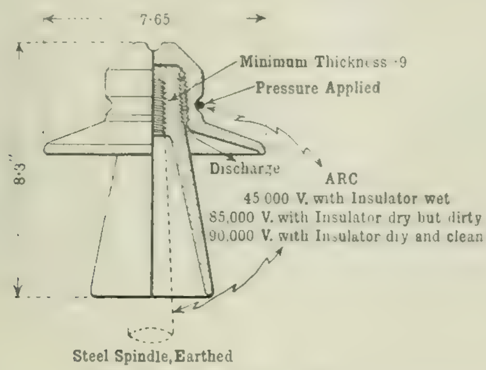


FIG. 12.—INSULATOR NO. 1.

the insulator and the insulator pin, the insulator pin being earthed. The pressure was gradually increased up to 50,000 volts when a distinct discharge seemed to take place from the cement fastening the two pieces together. The first spark jumped over at about 80,000 volts, and at 90,000 volts a permanent arc was set up between the side groove of the insulator and the pin.

Test No. 2.—In this test the insulator was previously dipped in clean water, and its surface was thoroughly wet all over. The first spark jumped across at about 45,000 volts, but as the insulator dried the arcing stopped and the pressure was gradually increased

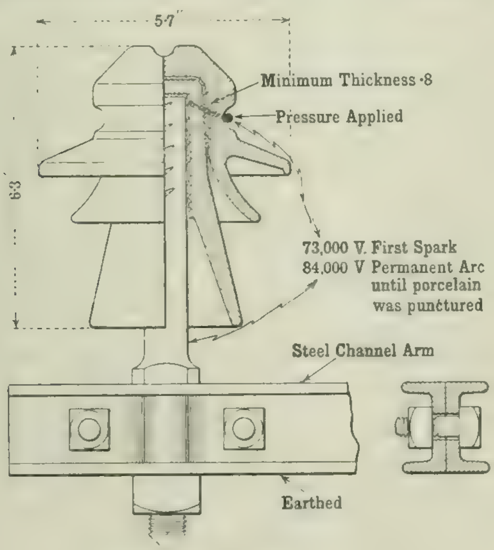


FIG. 13.—INSULATOR NO. 2.

up to 73,000 volts. The arcing started again at every slight increase of pressure and stopped immediately the insulator dried itself. At 90,000 volts, the insulator probably being then quite dry, a permanent arc was set up between the side groove of the insulator and the pin.

Test No. 3.—The whole of the insulator, with the exception of the inside of the inner shed, was then coated with a mixture of coal dust and water. The first spark started again at about 50,000 volts, but the insulator gradually dried and cleaned itself, the discharge from the insulator throwing off the dirt. With the insulator practically dry, but still covered with a certain amount of dirt, a permanent arc was set up at 85,000 volts.

INSULATOR No. 2.—This is a small brown triple-shed insulator manufactured in two parts cemented together (Fig. 13). The minimum thickness of porcelain is 0·8 in., the overall diameter 5·7 in. and the overall height 6·3 in. The pin was cemented into the insulator with sulphur cement, and pressure was applied between the side groove of the insulator and the pin, which was earthed.

Test.—The insulator was tested in a perfectly dry and clean condition. It first sparked over at 73,000 volts, and a permanent arc was set up at 84,000 volts. Immediately afterwards the porcelain was punctured, the puncture curiously taking place from a point near the top of the pin.

INSULATOR No. 3.—This is a white porcelain insulator (Fig. 14) with three sheds and made in two pieces cemented together. The pin is screwed into the insulator and not cemented. The pressure was applied between the side groove of the insulator and the pin, which was earthed. The minimum thickness of porcelain is 0·9 in., the overall diameter 7 in. and the height 7·2 in. It is the standard insulator on one large English power concern for a line pressure of 11,000 volts.

Test No. 1.—The insulator was tested in a perfectly dry and clean condition. The first spark jumped over at 94,000 volts, and a permanent arc was set up at 97,000 volts. At 99,000 volts the insulator punctured right through from the side groove to the insulator pin.

Test No. 2.—Another insulator of exactly the same type was then tested in a dry and clean condition. The first spark jumped over at 81,000 volts and a permanent arc was set up at 99,000 volts. The insulator was not punctured at this voltage.

Test No. 3.—Another insulator of the same type was tested in a dry and clean condition. The first spark jumped over at 82,000

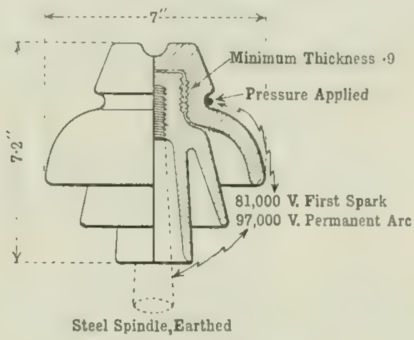


FIG. 14.—INSULATOR NO. 3.

volts, but in this case the permanent arc did not commence until 101,000 volts. The insulator was not punctured at this voltage.

In every case the pressure was applied to the insulators by means of a soft copper wire bound round the side groove.

CONCLUSION.

In summarising the chief features in the English manufacturer's outlook, of course, foreign competition takes the most important place. He has a good deal to dread in the lower wages paid by, and better conditions accorded to, foreign manufacturers; and if he can congratulate himself on producing at present an article of acknowledged superiority, he does not know how long it will be before the foreigner ceases to be content with an advantage in price alone and sets himself to make up his leeway in the matter of quality. There is, however, some consolation in knowing that this would probably necessitate radical and somewhat costly changes in Continental workshops.

With regard to substitutes for porcelain in outdoor line insulation, these are almost extinct in this country. Glass insulators are still used extensively in America for telegraph and telephone line work. Their first cost is less, but on account of breakage due to expansion and contraction the saving is at best doubtful. The coefficient of expansion of porcelain being lower this trouble is avoided by using that material. The loss on glass insulators in Mexico, for instance, is so high that the Government of that country is considering the question of paying the slightly higher prices and adopting porcelain. I believe that in some tropical countries glass has been adopted for large insulators mainly on account of the curious fact that birds will build their nests in an opaque insulator, but not in a transparent one.

Re-constructed granite was once a competitor in third-rail work, but has, I believe, quite disappeared in England. It survives to a surprising extent in America—surprising, because either in the matter of freedom from surface leakage or puncture under high electrical pressure, its merit is but little or nothing. I believe that in the only case in which re-constructed granite was used in England on a really extensive scale, the insulators fired so very frequently that they were soon done away with. What happened was simple. Dust, oil and dirt of all kinds would lodge on the rough surface of the granite, and, when the rain came, sufficient leakage took place to

develop an astonishing degree of heat. At night the insulators could be seen to glow. At any rate, they were all very soon removed, and porcelain insulators substituted. I saw one of these same granite insulators tested to 20,000 volts, alternating, which was the lowest pressure obtainable from that particular transformer, and the appearance of the insulator at the end of half a minute was more like a small volcano than anything else. As the transformer could give no lower voltage I am unable to say just what pressure this type of insulator could stand without puncture.

Most of the so-called porcelain insulators used in or emanating from America are very poor. We cannot disparage the Continental insulators, except on the score of brittleness, but the American production is generally porous and quite dependent on the glaze for insulation. Exception must be made, however, to American high-tension insulators, which are of vitreous substance, though here, again, there is room for criticism, this time on the ground of appearance. They generally look rough and dirty.

Another question coming to the front is *ivory versus porcelain* for articles as switch-bases and other insulators that are protected from mechanical damage and from the weather and intended for low voltages only. For two reasons the British maker advocates the use of porcelain for such articles. First, because it is the best material for the purpose and costs the manufacturer no more to make than ivory. But it is a selfish world, and our manufacturers' second reason is that the ivory switch-base meets with competition from Germany. He cannot beat them in price, but he can and does offer a better article than the chalky German switch-base, which in damp weather has quite a good coefficient of conductivity. Then the question naturally arises, why not supersede ivory ware altogether by porcelain? Only one reason can be given for the persistence of ivory. Many people like its colour better than the lighter colour of porcelain. Then why not apply an ivory glaze? Because this glaze, though it takes well on a porous ivory body, takes very badly on a vitreous body—a difficulty that becomes particularly marked when using a blue glaze on a brown body to produce a black result. Then, again, the British manufacturer is in the awkward position of having customers who would like him to supply insulators in a white vitreous body similar to the German, and other customers who demand the tint of the ivory electric light accessories. This is a difficulty which is more real than apparent. Engineers have come to believe that whiteness and vitrification go together, and that the ivory colour necessarily implies a non-vitreous substance.

As a high-tension insulator there is, perhaps, little to choose between the British and German product, but the British article is certainly not conquered. Some time ago the same British firm who supplied the insulators for the test described above submitted sample insulators for the transmission of power from the Zambesi Falls to the Rand. They were tested to the maximum available pressure, 135,000 volts, and they successfully withstood the test. To do this is not simply a question of making the porcelain thick—it is of no use making porcelain very thick—it is a question of having it made of a body very carefully rendered, thoroughly homogeneous, closely watched in the early stages, and skilfully fired in the oven; very dense and highly vitrified. This country holds its own. Not long ago one British firm despatched from the Potteries a train load of porcelain for abroad, the whole consignment amounting to 68,980 insulators, all part of one contract.

I should like to acknowledge my indebtedness to Sir William Preece for permission to give the results of his tests, and to Mr. Greene and Messrs. Callender's Cable Company, for permission to use their tests; also to the directors of Messrs. Bullers telegraph engineers, on whose porcelains all the above tests were carried out, and who have also kindly supplied me with photographs and drawings and technical information such as they are peculiarly qualified to give, being the only firm in this country that combines engineering with the manufacture of porcelain parts to engage with their other productions.

SINGLE-PHASE ELECTRIC TRACTION ON THE HEYSHAM, MORECAMBE AND LANCASTER SECTION OF THE MIDLAND RAILWAY.

We have from time to time in the columns of *The Electrician* chronicled the advances made in the single-phase system of electric traction. It is regrettable, but none the less true, that all the lines referred to are either in the United States or on the Continent. It is, therefore, with great pleasure that we are at last able to give a description of a single-phase railway which has been in operation on British soil since April 13th last.

The directors of the Midland Railway Co. in August, 1906, decided on the electrical equipment of the short line between Heysham, Morecambe and Lancaster, and at the same time proposed the use of the single-phase system. This line is very advantageously situated for experimental work, and the results, both financial and engineering, will be awaited with interest.

The length of line electrified comprises the double roads between Heysham and Morecambe, Morecambe and Lancaster Green Ayre, and the single line from Lancaster Green Ayre to Lancaster Castle station, the total length of single road being about 21 miles. From the plan given in Fig. 1 it will be seen that the line passes under a large number of overbridges, mostly of the arched shape, and the clearance of these bridges has been a matter of considerable interest.

Overhead Equipment.

The overhead construction has been designed and carried out under the direction of Mr. W. B. Worthington, the chief engineer of the Midland Railway Co., by Mr. J. Sayers, the telegraph engineer of the company, and Mr. Argyle, the northern divisional engineer.

It is similar as regards the type of suspension to that adopted for the electrification of the Hamburg Altona Railway, the patents for which in England are held by Messrs. Siemens Bros., of Westminster, the chief difference being the new type of suspension of the catenary wire, which is the design of Mr. Sayers.

The use of a single bow for travelling in both directions necessitates the bow being symmetrical about the centre line of the coach, and this brings the bow necessarily very close to the structure of the bridge. In order to get through at all it is necessary to take the contact wire well out towards the centre of the arch, so that it may come down low, but yet will be clear of the loading gauge, so that the other side of the bow may clear the structure properly. In addition to the bridges, the Lune Viaduct presented a special problem, as it is on a nine-chain curve and terminates at the end of Lancaster Station, which is also on a curve.

The contact wire is of figure 8 section, and is run in lengths of from 800 yds. to 1,000 yds. It consists of the equivalent of a 000 S.W.G. copper conductor, and is of 70 sq. mm. sectional area. The method of suspension is similar to that generally adopted by Messrs. Siemens, with one or two special variations, the arrangement being shown in Fig. 4, whilst Figs. 2 and 3 show views of parts of the overhead equipment.

One end of each length of the contact wire is fixed through insulators to a terminal gantry, and the other end is attached through suitable pulleys, &c., to a weight equal to about 1,200 lb. The fixed end is always that at which the train enters, and the weighted end that at which the train leaves; the tendency of the bow is, therefore, always to straighten the contact wire. It is worthy of note with regard to the contact wire, which is 70 sq. mm. section, that the tension at first put on was equal to 800 lb., and the horizontal stagger was made equal to 4 ft.; that is, 2 ft. from the centre line of the coach, but the experimental trials which went on for some months before passenger trains were run showed that the total friction of pull offs, &c., was such as to make it necessary to increase the tension to about 1,200 lb. for a length of 1,000 yds., and with this tension the strain is distributed fairly evenly throughout the whole length. It was also found that a 4 ft. stagger for a bow which measured from tip to tip 7 ft. 1 in. was too much for practical purposes for running at high speeds.

The line is situated in a country swept by very violent gales, experiencing the worst of weathers, and it is now considered that a stagger of 2 ft. is a more practicable figure, though part of the line is actually run with 3 ft. stagger at present.

The height of the contact wire from rail level varies from

18 ft. 3 in. in the open to 13 ft. 3 in. under bridges. It is suspended by short loops about 4 in. long from a steel cable called the auxiliary wire. The loops (Fig. 5) are fixed to the contact wire, but are movable on the auxiliary wire. The auxiliary wire, which consists of a 7/13 steel flexible cable, is hung from the main catenary cables, of which there are two, at five points in each catenary cable span, as can be seen in Figs. 2 and 3.

The two catenary cables, each of which consists of seven 16 gauge steel wires, are clipped together throughout their whole length, except for about 3 ft. on either side of the insulator where they divide to pass through the grooves of a ring, these grooves being on opposite sides of the insulators (Fig. 6). The catenary is, therefore, free to move for this distance, and addition, duplicated, and the connection from one contact wire to the section ahead of it is accomplished by means of a short section of switch wire which requires to be connected to the two contact wires before the line is switched through at this point. This arrangement was adopted in order to get a duplicate break, and, what is more important, a short length of line into which a car can run without bridging by means of its bow two sections which it was supposed might require to be isolated. The switches are provided with padlocks. A similar type of switch is in use at the various stations to enable the station staff to earth the overhead wiring in case of emergency.

The gantries are connected together by a separate overhead steel cable, which is earthed every half mile, the same earth

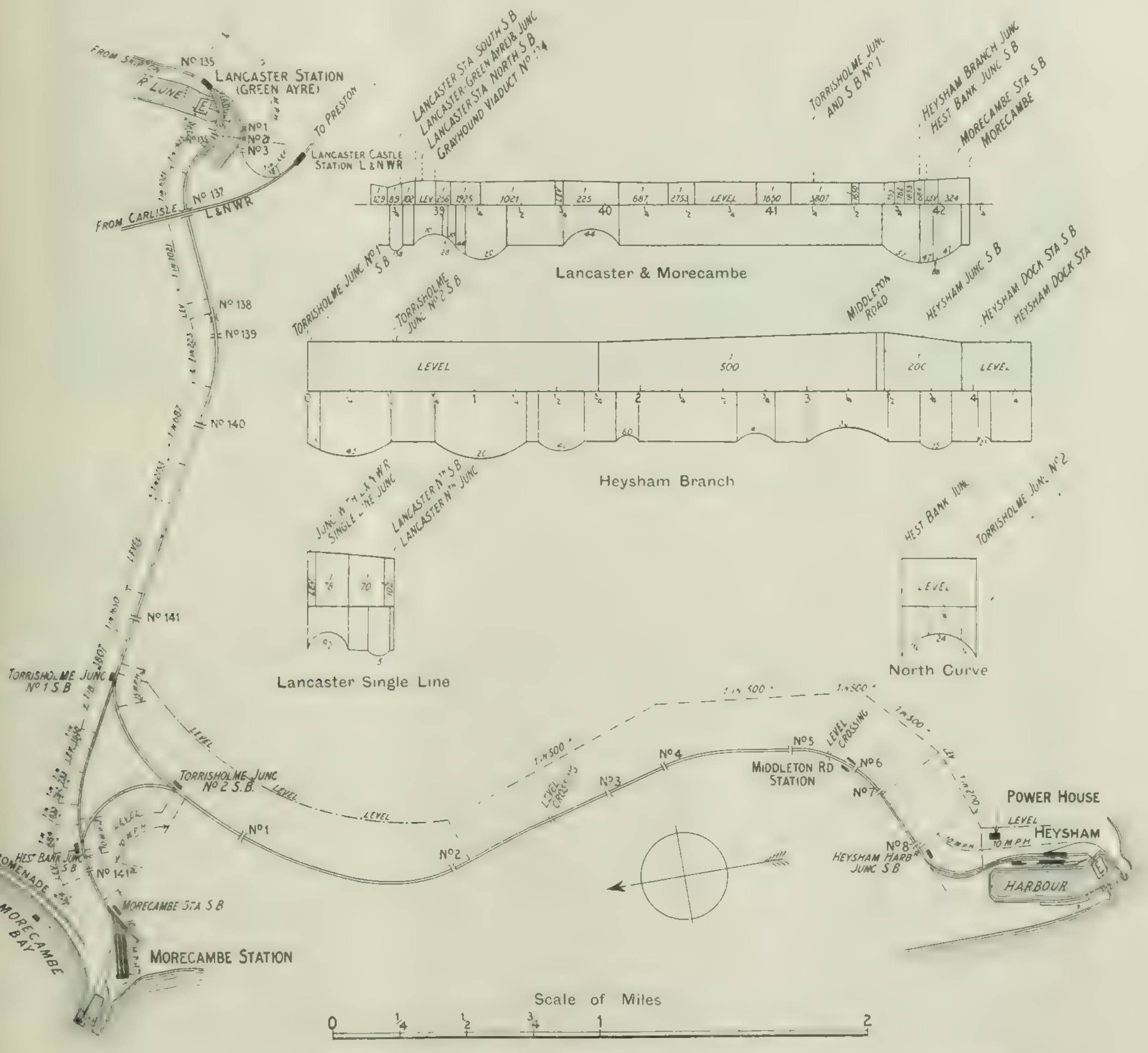


Fig. 1.—Plan and Diagram of Gradients of Electrified Portion of Midland Railway System.

this equalises the stresses in spans due to unequal loading; at the same time it is secure in the case of the breaking of the wire, as has actually been proved by experience. The advantages claimed by Messrs. Siemens for this design of catenary construction are: (1) the number of droppers is reduced by one-half; (2) the tightening and adjustment of the trolley wire is very much facilitated; (3) no distortion of the droppers occurs when the trolley wire is tightened; (4) the maintenance cost is reduced; and (5) if the trolley wire breaks the suspension wires are not pulled down.

Section switches are provided so as to isolate the lengths into which the up and down lines are divided. These switches are of the double-break air pattern and are fixed on the top of the poles supporting the gantries. Each section switch is, in plates being used for lightning arresters of the horn type, the object being to diminish the number of earth plates requiring attention, and thus to give better security from danger due to the poles being charged by a leaky insulator.

This earthed steel cable has been erected in every case between the contact wire and the telegraph wires which are open on one side of the line, and it is believed that its presence has had a great effect in reducing the electrostatic induction from the contact wire to the telegraph wires.

It was the object of the company to avoid, if possible, cabling their telegraph and telephone wires, and so far the results are favourable to the idea that it will not be necessary to put all such open wires underground when high pressure traction systems are erected overhead. At the same time it will cer-

tainly be necessary to provide some sort of high resistance leak on any wire parallel to such a system, as in certain circumstances if the wire became, for instance, thrown out of work by disconnection at the test board, there might be an electrostatic potential between it and earth with a very high voltage which would be very inconvenient for maintenance purposes.

The poles used have been mostly straight creosoted wooden poles, but at Morecambe station, and at one or two other points, it has been necessary to erect lattice steel poles and lattice girder gantries owing to the big spans.

Where wooden poles are used the gantries are made of two angles brought together at the ends, but kept apart for the greater part of their length by distance pieces 1 in. thick, enabling the bolts from the insulator saddles to drop in the gap, so giving a great range of adjustment of the insulator position without any necessity for drilling.

The design of the insulators is clearly shown by the section in Fig. 6. Before getting out the dimensions, the company's staff took advantage, by the kindness of Messrs. Siemens Bros., of the experiments this firm undertook to ascertain what was the minimum distance at which a 6 600 volts, 25 cycle circuit would maintain an arc in the severest weather

Fig. 2.—View of Overhead Construction.

Fig. 3.—View showing Arrangement of Overhead Wires at a Junction.

from an insulator shed. It will be noticed that the steel bolts supporting the insulators are encased with ebonite—a similar arrangement to that adopted by Messrs. Siemens on the Hamburg line with a view to getting practically double insulation earthed at Heysham Harbour in the sea by duplicate copper earth plates. At Morecambe they are earthed at the end of the Midland Railway pier; these plates being of copper again, but for protection they are dropped into a large cast-iron

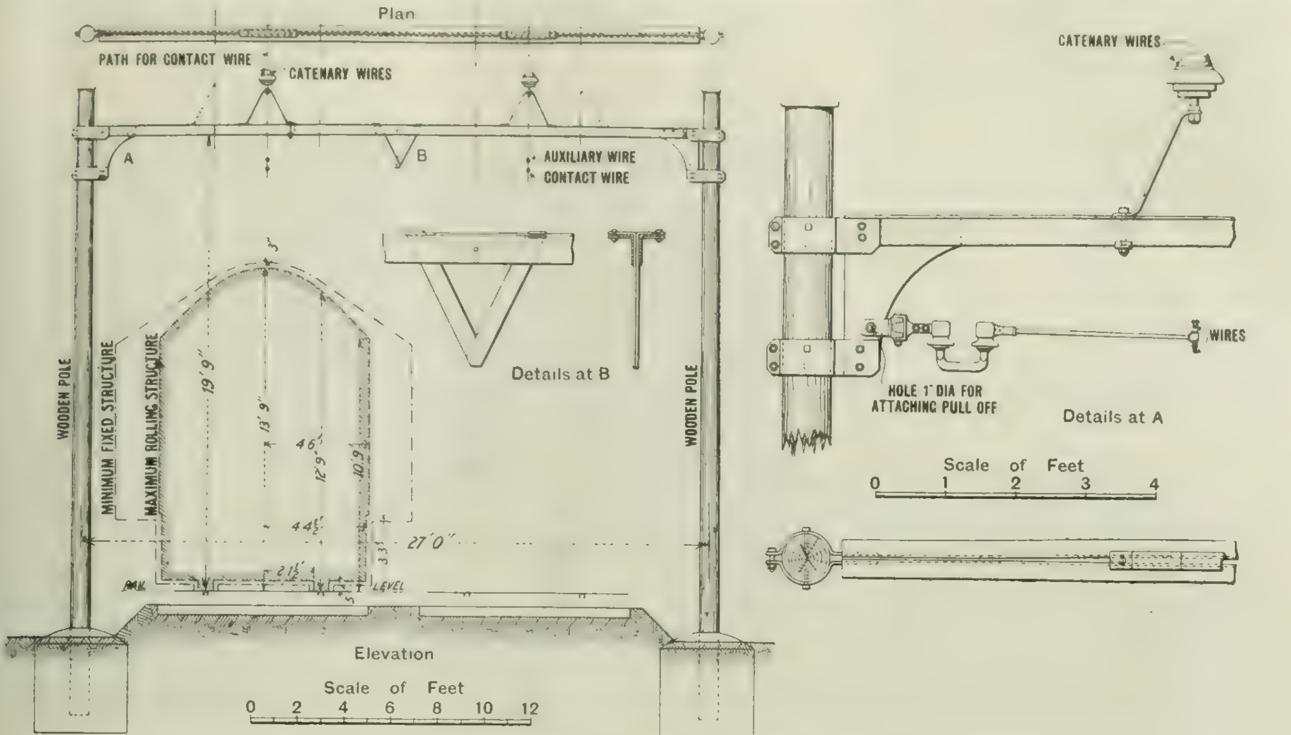


Fig. 4.—Diagram showing Details of Overhead Construction.

with one insulator. In addition to this, however, the Midland Company preferred to make the insulator itself in two portions and to make it very massive. The line is very likely to suffer from damage from stone throwing at the large number of level crossings, and, in addition, will suffer from the worst of weathers. It will be seen that the design of the insulator in combination with the twin catenary cable brings the side strain of the overhead gear below the level of the inside bolt, and there is no point at which the catenary cable itself is being deformed by the pressure of any clamp of any sort, and no point at which the mechanical waves tend to break the wire at a point of reflection.

The outer rail on each line is bonded throughout its length, the bonds being of the Forest City type, in duplicate, and placed under the fishplates. At all crossings and junctions all rails are bonded together for greater continuity with the wheels of the coaches, and these bonds and those used for cross bonding are ordinary copper cable bonds.

Fig. 5.—Loop Shaped Trolley Wire Clip.

Very great care was exercised in bonding the line to prevent any moisture getting into the drilled holes or on to the bond plugs during the process, and in very wet weather the work was abandoned. By means of protective devices it was found possible to go on with bonding in moderately wet or damp weather, but the tests of the resistance of each bond carried out when the whole of the work was finished showed in an interesting manner that although the bonds were absolutely first class, those which were carried out in perfectly dry and fine weather were quite distinguishable, by resistance test, from those which were carried out in damp or misty weather. It will be interesting to note as time goes on whether this difference in resistance is intensified.

As will be seen on the wiring plan of the line, the rails are caisson recovered from an old Midland bridge. At Lancaster the rails are earthed to the cast-iron columns of the bridge, where they rest in the bed of the river, where water is always flowing. Recording ammeters were put in these various

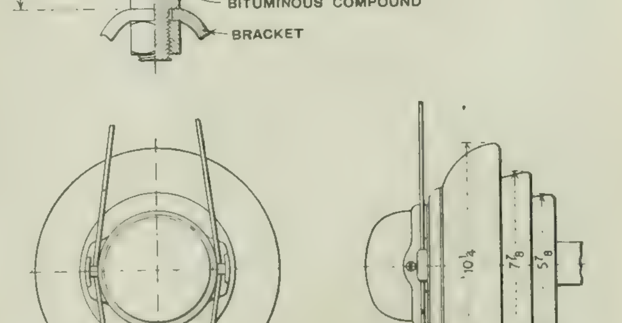


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Fig. 6.—Design of Insulator used for Supporting the Catenary Wires.

earths, with a view of indicating the proportion of current which returns by these routes.

Single-phase alternating current is supplied to the overhead wire at a pressure of 6,600 volts, and a frequency of 25.

(To be continued.)

THE ELECTRICAL EQUIPMENT OF THE ROYAL MINT, LONDON.

There is no one who is not more or less interested in the daily operations at the Royal Mint, the pile of buildings situate within a stone's throw of the Tower of London and the great Tower Bridge. Not only do the various processes through which the raw metal passes, until it is finally turned out as coin of the realm, appeal to the metallurgist and engineer, but the actual history of coinage itself is by no means an unabsorbing subject, for history is reflected in its evolution. Again, the Mint naturally enough rivals even the Bank of England as the personification of wealth, and so appeals to the popular mind.

The above facts, assisted, no doubt, by its antiquity and by the names of the famous men who have held the position of Master, invest the Mint with a certain glamour. It is not in reality, however, an awe inspiring place, for the operations carried on there are very practical, as is but natural, and are at the same time in accordance with the best metallurgical requirements.

The modern history of the Royal Mint starts with the year 1870, when certain changes were made in the *personnel*, and the processes in the operative department were placed on a more up-to-date basis. What was considered modern then soon became rather obsolete, and to bring the machinery, in general, more into line with present practice, in 1882 the modernisation of the operative department was undertaken. Since that time the machines have been driven by a complicated system of shafting and gearing from three marine type engines with a total horse-power of 750. Electricity was used to a small extent, but for lighting purposes only. It was then decided to convert the whole plant to the electric drive, and thus to bring the system into line with present-day methods. A wholesale change-over was not, of course, possible, and it had, therefore, to be spread over a considerable period. It is, however, now quite complete, and in what follows we propose to give some details of general interest in connection with the installation.

The necessary energy for both light and power is obtained from a station, which we illustrate in Fig. 1, situated in the operative department. It contains two Willans-Siemens sets each of 200 kw. capacity. The dynamos are of the continuous current type, compound wound, and provide current for both lighting and power at 110 volts. Steam is supplied from six boilers of the Lancashire type at a pressure of 120 lb. per square inch. The switchboard, which is shown at the back of Fig. 1, was erected by Messrs. E. & F. Moy, and possesses some points of interest. By means of a plugging arrangement either machine can be connected to the 'bus bars through double-pole switches, fuses and an ammeter. From these bars the various circuits are tapped off through double-pole switches. These are, as may be seen, provided with two sets of contacts, one of which allows any circuit to be fed from the modern station, while the other puts it in connection with the older plant, consisting of four 80 H.P. sets, three of which are direct-coupled to Willans steam engines and one belt-driven from a gas engine.

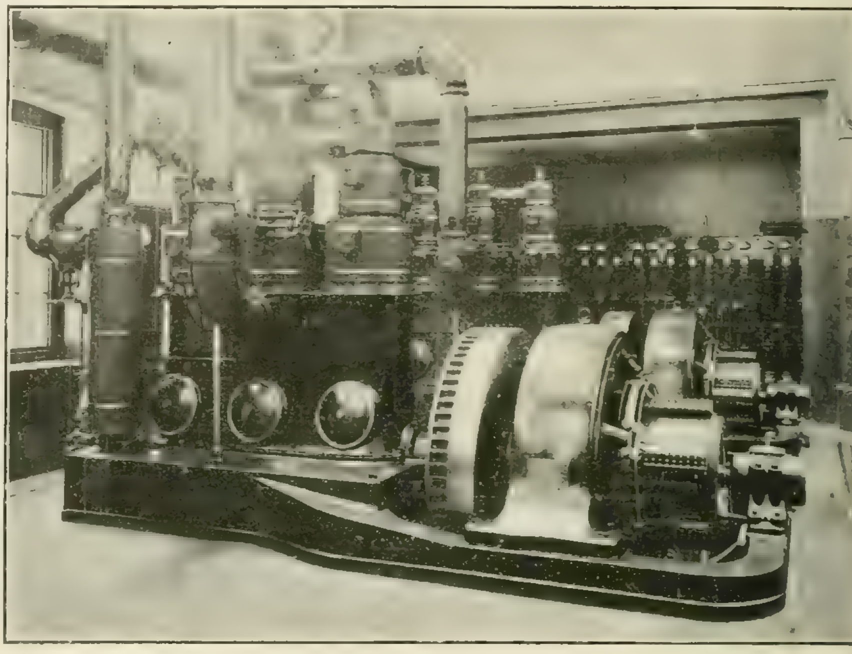

Fig. 1.—View of the New Generating Station at the Royal Mint.

The usual energy meters are provided, while a system of pilot lamps allows an eye to be kept on the smaller plant from the modern station. The fitting of a leakage indicator, whereby the insulation resistance of any circuit can be tested from within the station, is no doubt appreciated at its full value by the staff and, further, prevents excursions having to be made through the rooms. This is an advantage, for normally all doors are kept locked from the time the workmen come in until the bullion has been weighed up at night. On the first floor of each shop are dining rooms, lavatories, &c., so that each is complete in itself.

Fig. 2.—The E.P.S. Batteries.

To allow of the station being shut down at night, and also to obviate the necessity of attendance, two batteries are provided, either of which is capable of taking any load that is likely to come on after hours. These batteries were supplied

by the Electrical Power Storage Co., of 4, Great Winchester-street, London, E.C., and each consists of 58 O K. 25 plate cells in lead alloy lead lined crate boxes. The capacity of each battery is 2,520 ampere hours at a seven hour discharge rate, with a final E.M.F. of 1·85 volts per cell. The lead-lined crates form specially strong and efficient containers, and as they contain no woodwork or similar material they are absolutely indestructible by acid or acid fumes. We illustrate the battery room in Fig. 2; it is especially notable for its ven-

Fig. 3.—View in No. 1 Rolling Room, showing Double Rolls.

tilation, as, instead of windows, very wide openings have been left in the wall at frequent intervals and a free passage of air is thus insured. These batteries are charged from the smaller generating set mentioned above, a special switchboard being fitted with the necessary apparatus. End regulation is effected mechanically from the engine room by means of rods, much on the same principle as a ship's telegraph, while for "milking" purposes a small portable motor-generator mounted on a truck is used.

The compactness of the buildings at the Mint allow of a minimum of cable work, the power and lighting mains for

Fig. 4.—A Group of Machines in the Cutting Room.

most of the shops and offices being carried through the buildings. There are at the present time an aggregate of 2,085 incandescent lamps, in equivalent 8 c.p., installed, together with 66 arc lamps of the enclosed type and consuming 5 amperes, while the total motor horse-power is practically 600. The units generated during 1907 were 235,932, showing an increase over the former 12 months of 48,600.

The operations through which the bullion has to go are briefly as follows: It is assayed, melted in graphite crucibles, and poured into bars 22 in. long and about ½ in. thick, but varying in width according to the coin. These are trimmed at the edges with a circular file, and then pass on to the breaking down rolls. A view of one of these is given in Fig. 3. The room contains eight rolls, one pair driven by a 65 H.P. Siemens' motor and the other six separately by motors of the same type, which are placed in special pits and drive the machinery through Renold chains. As the pits are provided with chequer plates, the motor can, if required, be lifted out without difficulty, while, as they are of a fair size, trimming brushes and other small jobs can be undertaken with ease. This arrangement of the motors has been followed throughout in the mills, and is obviously attended by many advantages. There are eight rolls in this room, varying from 15 in. to 10 in. in thickness, whose object is to break down the rough bars to the requisite thickness.

The fillet is, if necessary, annealed when partially rolled, and when of correct gauge passes on to the cutting room, where the blanks are cut. A view of part of this is shown in Fig. 4. The machinery is divided into two groups, each driven through belts and shafting by a 10 H.P. motor. The machine

Fig. 5.—View of the Washing Machinery for Silver Coins.

contains the cutters which stamp out the blank discs from the fillet, two being usually cut out from one width of fillet and these then pass on to the edge-rolling or marking machine.

Silver coins are annealed in a furnace not only to soften them but also to cover them with a film of copper oxide, which is subsequently removed by warm dilute sulphuric acid, and are washed in the arrangement shown in Fig. 5. After this they are taken to the coining press room, where the impression is put on the blank discs. This room contains 19 coining machines driven by one 40 H.P. motor.

Perhaps the most interesting part of the whole procedure is the weighing room, to which the coins are next sent. This room contains 50 automatic balances driven by gut lines from a small atmospheric engine. This method was adopted, when the steam engine was used, to allow greater steadiness to be attained than was possible with the ordinary drive. The introduction of the electric drive, though greatly improving this, has not absolutely prevented it, so that the atmospheric arrangement is still employed. How essential it is that these machines should work steadily will be realised when it is stated that they reject sovereigns varying by more than one-fifth of a grain from the standard fixed, and this difference up and down, though slight, represents £3,244 in a million sterling.

The equipment described above, though possessing no points of startling novelty, is interesting as showing another conquest for the electric drive.

We are indebted to the Comptroller of the Royal Mint for allowing us to take photographs of the generating station and machinery, to Mr. H. W. L. Evans, of the Operative Department, for explaining the various features of the equipment to us, and to the Electrical Power Storage Co. for providing us with a photograph of the battery room and details of the battery equipment.

SWITCH GEAR CONTROL APPARATUS AND RELAYS FOR ALTERNATING CURRENT CIRCUITS.

BY C. C. GARRARD.

(*Concluded from page 292.*)

DISCUSSION.

Mr. B. Welbourn thought that the author's remarks about the Merz-Price balanced protective gear needed supplementing. In practice, the pilot line was formed of a completely insulated metallic circuit, earthed at one end only—not both as shown—because when a breakdown occurred on any part of the network there was a risk that the consequent earth currents might tend to flow through the pilot cores and operate the relays on a healthy cable. Also the reference to multicore cables was incorrect for practical purposes, since separate pilot cables had always been laid. The author's objections to the Merz-Price system therefore disappeared. At the present time there were 70 feeders, and about 50,000 kw. of plant protected by this gear on the networks controlled by Mr. Merz in the North, and there had not been a single instance of failure to act immediately, although the gear had acted about 20 times in all. Very extensive experience on these large networks had shown that the old systems for the protection of any complicated network were more trouble than they were worth. In the early stages of development at Newcastle, Mr. Merz tried nearly all the overload and reverse current relays then extant, and was soon forced to the conclusion that it was impossible to discriminate with more than two, or at most three, overloads in series under the conditions which exist on the H.T. network at the moment of short-circuit, and that reverse current relays were very erratic in action when surges took place. The facts were that Merz-Price have the only large installation of well-tried protective gear, and they could not do any automatic control, worthy of the name, unless they had this balanced gear. It was fair to claim that the satisfactory results in the 20 cases mentioned could only be obtained with this balanced gear which operated instantaneously, and was especially valuable on circuits involving synchronous plant. Unless he misunderstand the author's proposals, his electrically interlocked reverse relay necessitated a time-limit element, and he (the speaker) did not gather that the instantaneous isolation of a faulty interconnector was claimed. This seemed to be a decided disadvantage on any system containing synchronous machinery. To sum up the case for the Merz-Price gear: (1) It discriminated with certainty in eliminating faulty cables, plant, &c., and was inoperative on healthy sections. (2) It was suitable for use on all possible arrangements of feeders. (3) It was as instantaneous in action as it was physically possible for any cut-out to be. (4) The apparatus was of the simplest possible character, and only required very slight occasional attention to keep it in perfect working order.

Mr. J. G. Statter said that as a maker of, and experimenter with, relays he agreed with the author that solenoid dash pot time lags were useless whether in the relay form or applied directly to the trip coils of circuit-breakers. He felt grateful to Dr. Garrard for calling attention to the laxity of description usually adopted of referring to a time lag as an instrument designed to give a certain number of seconds delay. Such a description conveyed no meaning except when applied to that form of apparatus that gave constant lag for all overloads, which form might be dismissed as obsolete. Specifications for time lags should state, (1) the number of seconds required at a given overload, and (2) the requirements under conditions of short circuit. The first point needed no amplification. As to the second, relays or circuit-breakers provided with time lags and intended for use at generating and sub-stations, and in fact all breakers in series with one another and which were desired to come out in some definite order, must have their time lags so arranged that there still remained a small fraction of time lag even under short circuit conditions. On the other hand, circuit breakers for some purposes, such as the protection of motors, were better arranged to act instantly at a predetermined overload, say two or three times the normal working load of the motor. As to the curves shown in the diagram Fig. 8, it would be seen that there was an appreciable lag with six times the full load and that, although the experiments had not been carried further, it was probable that some lag would remain if the load were increased to 12 times the set load. The curves shown corresponded to those of Fig. 2 in the Paper, but whereas in the latter the settings for each relay were different — one was set for 150, the next for 200 and the last one for 300 amperes — the curves here shown were all taken with the relay set at 8 amperes, or under much more stringent conditions. It would seem from the direction of the last two curves given in the author's diagram that there was some possibility of their meeting, in which case selective action would be at an end. He would have expected rather better results from an induction type. He quite agreed with the author that relays arranged for selective action should have definite positions for the setting of the time-lag curve. In the particular apparatus made by the speaker's firm the relay form of time lag was adjustable as to length of lag by means of four definite positions. Referring to Fig. 1 of the Paper, it was unfortunate that the author had plotted the percentage of load required to operate the relay in watts, which was not what they wished to know. It was value in current that an engineer was concerned with in the case of a reverse-current relay. If current values were plotted instead of watts, the results

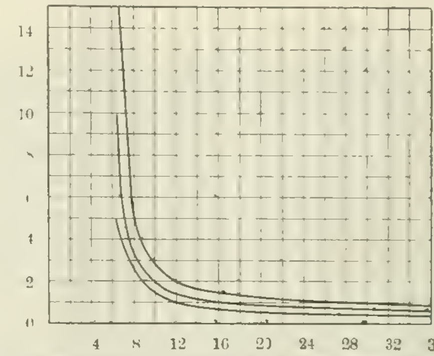

Fig. 8.—Curve Showing Duration of Lag with Statter's Patent Adjustable Overload Relay in Three Positions. Setting for Constant Current at 8 amps.

would be quite different, and would appear to show that the particular wattmeter movement described by the author was not desirable in cases where a reduction exceeding 50 per cent. of the volts might occur; in fact, taking into consideration phase displacement, the reverse current might reach considerable dimensions on a reduction in 'bus-bar voltage of less than 50 per cent.

Mr. E. B. Wedmore said, referring to polyphase relays, one had to distinguish between overloads and faults. There were advantages in having a higher setting on single-phase faults than on three-phase overloads, as it gave the faults a chance to clear. Three-phase faults were serious and should be cut off at once. The figures relating to bellows type relays were misleading owing to the device having been given a spurious rating. The method of improving the characteristic was well known. At the maker's rating the defect described did not appear. The fuse-shunted trip coil far from being an impracticable device was used very extensively on the heaviest service in London and elsewhere with satisfactory results. As mentioned, the time element could be controlled without making material changes in the current setting. There was no demand for fuses of different metals. The last relay curve shown could be reproduced with No. 34 copper wire, abolishing the relay. Cross-connected current transformers had been very extensively used and no complaints had been received on the grounds suggested. Delta-connected transformers had their limitations, but they were not those mentioned in the Paper. Simple devices generally came to stay, and were worth more money than complicated devices answering the same purpose. Simplicity was a feature of importance to the user, and the makers of simple switchgear had their reward. For generator protection he advised a higher setting with lower time limit, as such an arrangement would give better results under the severest emergency conditions.

Mr. Leonard Andrews agreed with Dr. Garrard that it was better to use single-pole relays than compound relays for three-phase circuits, and to insert one relay in each phase rather than depend on two relays only. With reference to the use of reverse current devices for protecting generators driven by steam engines, he considered that the generator should not be cut out of circuit if the steam was entirely shut off, as might occur through the tripping of an emergency governor. On the other hand, he entirely disagreed with the author's suggestion that a generator should not be cut out of circuit if its field failed. It was quite true that the heavy leading current would produce an artificial field tending to keep the faulty generator in synchronism, but the bulk of the leading current would circulate through the healthy generators in which it would become a lagging current, tending to react upon and wipe out their fields, with the result that the pressure on the 'bus bars would almost immediately drop to such an extent as to cause any synchronous motors on the circuit to drop out of step. Numbers of cases had occurred where the failure of a field circuit had led to a complete shut down of the entire installation. He maintained, therefore, that the practice of using reverse power relays, as advocated by the author, was practically useless. He was grateful to the author for having given them Fig. 1, as it enabled him (the speaker) to run to earth a puzzling rumour. He had been repeatedly told that Dr. Garrard's relay would operate upon a reverse current of less than 20 per cent. of the full load current with a potential of only 10 per cent. of the normal potential. He had always maintained that this was impossible. Fig. 1, showing the reverse current expressed in watts, made it clear how the misunderstanding had arisen. It had always been customary to specify the performance of reverse current devices in percentages of the full load current. Fig. 9 showed the author's curve reduced to amperes, and it would be seen from this that the reverse current required to operate the relay when the potential fell to 10 per cent. of normal was about 160 per cent. of the full load current if the device was adjusted to operate with a 10 per cent. reverse

current at normal potential. If adjusted to take 20 per cent. on normal potential it would presumably take over 300 per cent. reverse current on a 10 per cent. voltage. The obvious disadvantage of working with such delicate adjustments was that the device was liable to operate when it should not do so. He thought the Merz-Price system was most ingenious, and it met a long-felt want, as it provided for the protection of ring mains which had not been found possible with reverse current devices. He did not, however, agree with Mr. Clothier that it was the best system of protecting mains under all conditions.

Mr. KENELM EDGCUMBE pointed out the importance of insuring that the selective action, as regards time lag, should hold good up to heavy overloads. The time curves given in the Paper, in common with most others, only carried things up to, say, three times full load. The important question was, What happened when the overload amounted to 10 times the full load, or more? At such overloads as these, many relays on the market gave identical time lags, irrespective of their relative time settings, so that it was impossible to ensure selective tripping. The only really satisfactory arrangements, in the speaker's opinion, were those in which the time lag was adjustable by varying the travel of the tripping mechanism, as in that case the circuit-breakers were bound to come out in a predetermined order, under all conditions. The speaker also disagreed with the author when he tacitly assumed that a reverse relay must of necessity be a reverse power relay. It was the *current* which did the damage, and, in his opinion, the ideal reverse relay was the one on which variations of pressure had the minimum effect.

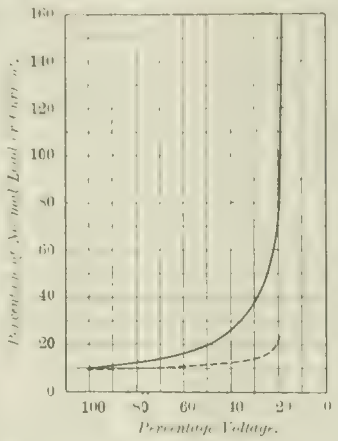

FIG. 3.—A. C. REVERSE RELAY VARIATION OF CALIBRATION WITH VOLTAGE

Mr. B. M. JENKIN had experienced a lot of trouble with reverse currents, more particularly in sub-stations. In utilising protective apparatus, however, care had to be taken that motor cut-outs and feeder cut-outs did not operate together. Time element devices should be so designed as to be certain of action on short-circuits, and beyond that a fixed time limit. Only in that way could automatic cut-outs be used in series.

Mr. H. BEVIS (communicated) remarked that his firm (the General Electric Co.) confirmed the statement that three-phase relays were not good practice and that three separate relays should most certainly be used. They thought that the solenoid relays which Dr. Garrard tested must have evidently been of inferior design, as they noticed that these had 11 volts drop. The author had pointed out that a detrimental feature of the solenoid relays was the variation in the magnetic reluctance of the circuit due to the different positions of the plunger. Relays could, however, be made with the return circuit of air. They did not agree with the criticisms on the solenoid relay put forward, and their experience was that these were very reliable owing to the fact that they had no revolving parts, pivots, or axles to stick, and did not require careful handling. An important point, entirely overlooked by the author, was that a reverse current relay with a wattmeter movement lacked all provision for variations in power factor. They did not consider it good practice to have a time limit on a reverse current relay, and their opinion was that the present tendency was to put in too many automatic devices.

Mr. W. J. P. ORTON and Mr. G. NORTH (communicated) did not think the author's remarks on solenoid relays were quite correct. There was little danger of "floating" with a properly designed relay. It was obvious in both the solenoid and disc types of relay that if the overload came on again in such a short space of time, the mechanism could not re-set itself, and the relay would operate with a very short time limit in the second case. That, however, was, in their opinion, an advantage. Referring to Fig. 1, they would point out that the author's description would lead the reader to believe that the alternate current reverse relay described acted on a drop in voltage without a corresponding increase in current, but this was due to the ordinates being taken as watts. The author's method of protecting interconnector cables had the advantage over the Merz-Price system of employing only one pilot wire, but since from Fig. 1 the reverse relays proposed were dependent solely on the actual power passing through them, it would be possible, when the sub-station voltage fell to a very low value, that the current required to actuate the relays would be so great that the inverse time element maximum relays in series with the fault would act before the relays in question, thus shutting down the whole or part of the supply without isolating the faulty interconnector. The author recommended maximum relays, with varying time elements, in series, and whilst they agreed that this was the best method of protecting distribution in sub-station systems they would point out that it was the subject of Mr. Stillwell's patent.

Dr. GARRARD (in reply) thought that the Merz-Price system was, no doubt, an excellent one, but it was very complicated. The makers appeared to have made it more complicated than necessary, for the original pattern was very simple. The pilot wires, which were essential to that system, entailed extra cables, extra conductors and, in fact tremendous complication. The system he had described only entailed the use of one pilot wire under all circumstances, which was certainly an advantage. For the protection of ordinary feeders he thought the standard system of an inverse time element maximum circuit breaker on the out-going end, and an instantaneous reverse relay at the incoming end was quite satisfactory. In reply to Mr. Clothier's objection, in the case mentioned the interconnector became an out-going feeder and not an interconnector. He would point out that the Merz-Price system alone was unsafe to rely upon for the protection of all feeders, since these were not protected against plain overload; also the protection given only extended to the current transformers, which were generally, and properly, installed on the line side of the switches. Maximum circuit breaking apparatus was a necessity in addition to the Merz Price system. With regard to Mr. Clothier's diagram, five sub-stations as shown were rather a lot, and if two cables broke down at once the whole system would be stopped. Mr. Statter thought the curves in Fig. 2 would cross if the currents through the relays themselves had been plotted. This was not so. The curves were intended to be calibration curves of circuit breakers controlling outgoing feeders, such that the sub-station motor circuit breakers would always open before the feeder circuit breakers. If Mr. Statter would take the curves and divide the horizontal co-ordinates by the ratios of the current transformers used, he would find that he would obtain a similar system of curves to those exhibited by him, and they would never cross one another. Mr. Wedmore thought he could get selective action by using different materials in the fuses, but in a previous Paper read before that Institution it was shown that it was quite impossible to do this, as the curves invariably crossed. He had found the 10 per cent. setting of reverse relays for generators to be satisfactory, and the maximum current was then never dangerous. He did not think it advisable to have a smaller time element than the ½ second thus obtainable. Mr. Andrews was strongly of opinion that the reverse circuit breaker on the generator should cut the generator off if the field current of the generator failed. He did not agree with this, and also in his view the reverse device on a generator should be a reverse power device. As to Mr Andrews' diagram, he could not see the point of the curve at all. He was interested in Mr. Jenkin's remarks regarding the extremely large power which he had found could flow back from sub-stations when a fault developed on a cable system. As he had said in the Paper, the feeder end reverse power relay should be set proportionately higher than the reverse power relay on the generator.

A NEW SYSTEM FOR THE AUTOMATIC PROTECTION OF HIGH-TENSION FEEDERS AND OTHER APPARATUS.

Much interest was aroused during the discussion on Dr. C. C. Garrard's recent Paper on "Switchgear Control Apparatus and Relays for Alternating Current Circuits," read at a meeting of the Institution of Electrical Engineers, in the Merz-Price patent protective gear. The principle of this gear is the protection of any piece of electrical apparatus—such as feeder cables, static transformers, motor generators, rotary convertors or generator windings—by creating a balance under normal conditions between the power which is flowing into a cable and that which is taken from it at the other end. It must be arranged that this balance is disturbed only when leakage takes place between the points of entry and exit due to breakdown.

Thus, in Fig. 1 a method is shown of protecting a simple three-phase feeder cable. A three-core low tension pilot cable is laid in the same trough or trench with the high-tension cable, and is connected up at each end to a three pole relay (or to three single-pole relays) and to the secondary windings of current transformers, the primary windings of which are inserted in series with the cores of the main feeder cable. The relays are simple contact makers, and are designed so that when operated they not only instantaneously close the battery circuit, but also release a falling weight, which in turn short-circuits the contact which has just been made, and so makes this contact doubly sure. It is obvious that any surges in the flow of power cannot, under any circumstances whatever, operate this protective gear.

The ordinary overload and reverse current system is said to be applicable only to the protection of the simplest networks, and difficulties arise whenever two sub-stations are interconnected. The "balanced" system of cut-outs is, moreover, claimed to be the only system which will automatically control complicated networks and isolate a faulty cable without interrupting supply to a larger or smaller number of sub-stations. Also there is no difficulty in protecting an arrangement in which cables are branched without switchgear at the point of junction, in which cases overload and reverse current cut-outs are in many cases quite unsuitable.

From the Merz-Price patents it is seen that the balance under normal conditions may be produced in the following ways:—(1) Equal E.M.F.s may be opposed to one another (as in Fig. 1): (2) equal magnetomotive forces may be opposed to one another in the same magnetic circuit (as in Fig. 2); (3) equal mechanical forces may be opposed to one another in the same piece of apparatus; (4) a combination of any of the above.

There are inherent differences between these alternative methods which render one or other method the most suitable for meeting a given set of conditions. Thus, mechanical balancing may be conveniently used where the energy entering the plant to be protected is in a different form to that leaving it. Experience has shown that E.M.F. balancing is most readily applicable to the protection of feeder cables, whilst magnetic balancing is best suited to the protection of transformers and other station plant. When magnetic balancing is employed, it is possible to combine the protective gear with measuring apparatus—that is to say, the current transformers which control the protective gear may be used for controlling, indicating and integrating instruments also.

In general, balanced protective gear may be applied to any piece of electrical apparatus by applying it to each individual winding and balancing the effect of the currents entering and leaving these windings. Motors are satisfactorily protected by means of fuses or overload cut-outs, as they are not run in parallel, but generators require some discriminating device so that when several machines are running in parallel on common 'bus bars the faulty generator only may be isolated.

As regards design, there is no difficulty in manufacturing current transformers so that the curve connecting the E.M.F. in the secondary windings with the main current in the primary is practically identical for all transformers made to the same design, and the pro-

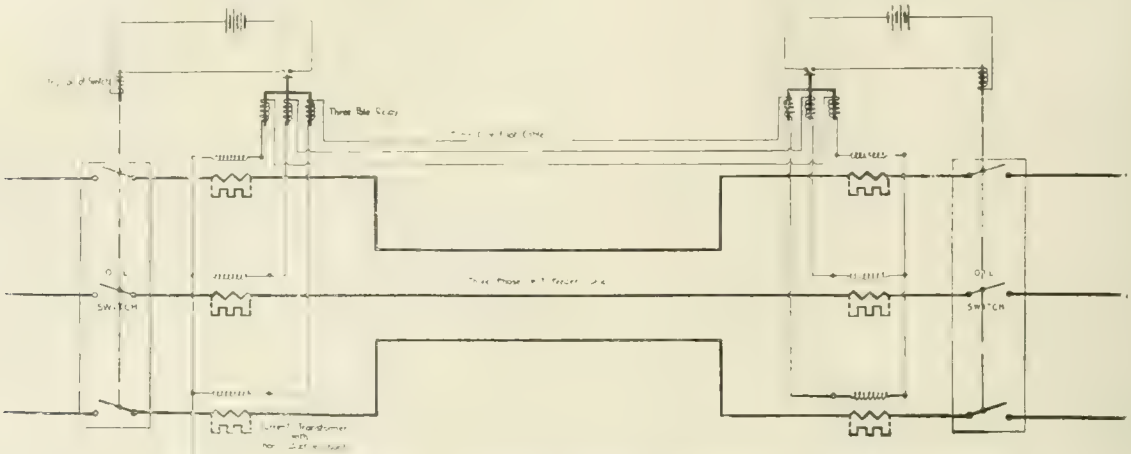

Fig. 1.—Diagram Showing Arrangement for the Protection of a Single Feeder. E.M.F. Balancing.

Fig. 1 shows the simplest arrangement for the protection of a feeder cable by means of E.M.F. balancing with star-connected current transformers. It may be pointed out that it is advantageous to combine the armatures of the contact-makers for each phase into a three-pole instrument, as by this means the sensitiveness is increased under some conditions. The non-inductive shunts across the primary windings of the current transformers are not always necessary, but are shown in Fig. 1 in order to make this complete. It is important that the pilot wire circuit should be earthed at one

tection of step-up and step-down transformers, generators, &c., where the pilot cables are short, is, therefore, a very straightforward matter. Experience has shown, however, that in the protection of cables complications arise in the pilot wire circuit and, although these are readily overcome by careful design, the balance would not be sufficiently good unless special care were taken to prevent the effects of capacity and resonance. The capacity current which flows in the main cable has a very small effect and is readily allowed for in the adjustment of the relays, but the capacity current flowing in

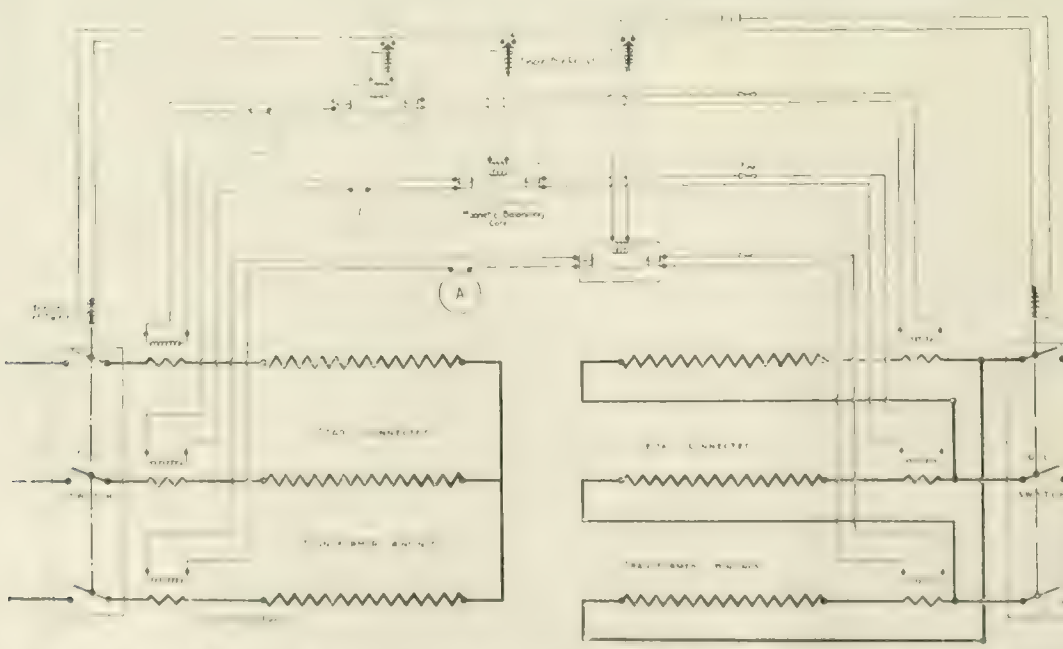

Fig. 2.—Diagram Showing Arrangement for the Protection of a Transformer. Magnetic Balancing.

end only, as otherwise there is a risk that currents flowing in the earth at the moment when a breakdown occurs on some other part of the system may tend to flow through the pilot wires and operate the relays on a healthy cable.

Fig. 2 shows the protection of a transformer by means of magnetic balancing. As under normal conditions the magneto motive forces in the magnetic balancing cores are equal and opposite, the flux is practically zero and the windings are, therefore, practically non inductive. Measuring instruments may, therefore, be inserted in the secondary circuits as shown.

the pilot wire itself is of more importance and must be kept within limits or the relays on healthy cables will be operated by it.

We understand that several further methods of applying the principle have been worked out and tried in practice with satisfactory results by the manufacturers of the gear, the British Insulated & Helsby Cables (Ltd.), from whose publication, the B. I. Handbook, we have obtained the above description, whilst further points in connection with the advantages claimed for this protective gear will be found in the discussion on Dr. Garrard's Paper on p. 330 of this issue.

PHYSICAL SOCIETY.

A special general meeting was held at the Royal College of Science on May 22nd, Dr. C. Chree, F.R.S., president, in the chair, to consider the proposed alterations in the Articles of Association. The principal changes were described by the secretary, and, on the motion of the chairman, seconded by Mr. Mather, a resolution was passed in favour of the alterations.

At the ordinary meeting, which followed the above, Mr. F. P. Sexton read a Paper

"On the Spectrum Top."

The author explains in the Paper the coloured bands which are seen when a Benham top is rotated. The best effects are obtained when the top rotates about six times per second, when the colours from the centre are purple, dull orange, yellow-green and violet blue for an anti-clockwise rotation. When the direction of rotation is reversed the order of the colours is also reversed. The effect depends upon the position of the sector lines and on a contrast. The author assumes that the rates of growth of the colour sensations are in the order red, green and blue, where red is the greatest, and that the rates of decay are in the inverse order. Considering the inner ring with an anti-clockwise rotation, the author explains the colour observed as follows: As the black disappears the first impression will be black lines on a red ground, but this red impression will have somewhat passed to white when the sector lines diappear. Their disappearance also gives a red impression, which in this case is increased by a contrast. Finally, the disappearance of the white will give a bluish impression, not reinforced by contrast. Thus the eye will see red lines on a white ground. In the case of the second ring, the sector lines coming into view give a blue impression depending on the amount of white preceding. When these lines pass from view they are followed by a red impression, depending on the amount of white succeeding. These two impressions combine to give a resultant orange effect. The third and outer rings are explained in a similar way.

Mr. F. E. Smith asked if the author had viewed the top when illuminated with lights of different colours, and, if so, with what result.

The Author replied that experiments had not been tried in different coloured lights, as there was difficulty at the time of obtaining a coloured illumination of sufficient strength. The bands were visible in sodium light; but this did not affect the theory, because sodium light, although practically monochromatic, affected the three colour sensations.

A Paper

"On the Coefficient of Diffusion"

was read by Mr. B. W. Clack. This Paper deals with experiments which have been undertaken to test the practicability of a new method for the determination of the coefficient of diffusion of salts through water, and to find how this coefficient varies with the concentration of the solutions. The apparatus consists of a special kind of flask of about 450 cubic cm. capacity, fitted with a vertical glass tube of known dimensions. In the earlier experiments this was filled with distilled water and suspended by means of a fine wire in the salt solution under investigation, at the temperature of 0°C., from the arm of a chemical balance. Later this arrangement was reversed, and the flask, filled with the salt solution, was suspended in cooled distilled water. In both methods the apparatus was so designed that one end of the vertical tube was maintained in contact with a salt solution of constant concentration, while the other end was kept in contact with distilled water. As the salt diffuses through the tube the weight of the flask varies, and an expression was deduced by which it is possible to find the value of the coefficient of diffusion from this rate of change in weight, which was automatically recorded. The accuracy in weighing was found to be greatly increased by covering the free surface of the liquid by a film of Fleuss pump oil. As the method is complicated by the change in volume which is produced in a liquid when salt is added to it, it was found necessary to experimentally determine the value of this change in volume. The salts experimented upon were NaCl, KCl and KNO_3, and a large number of experiments were carried out in order to find the best relative sizes of the various parts of the apparatus, and the best dimensions for the diffusion tubes.

The general conclusions may be summarised as follows: (1) The method referred to above, of filling the apparatus with the salt solution and suspending it in cooled distilled water, is much more satisfactory than the earlier method from a practical point of view. It enables greater control to be maintained over the working details, and is much simpler in operation. (2) The volume of the liquid in which the suspended apparatus is hung must be considerable. A volume of 7 litres was found to be too small, and in these experiments 13 litres was used. This was found to be sufficient. (3) With these precautions the method gives satisfactory results with a consistency of usually less than 1 per cent. (4) For a diffusion tube of 4 cm. length, no end correction need be applied, even for the widest tubes employed (1·5 cm). (5) The coefficient for NaCl and KCl decreases as the concentration of the solution decreases. (6) For KNO_3 the opposite phenomenon is exhibited. (7) The most trustworthy results, obtained with the precautions mentioned above, for the coefficient of diffusion at 0°C. are:—

KNO_3	10	per cent.	$0·844 \times 10^{-5}$	C.G.S. unit.
	5	,,	0·870	,,
KCl	20	,,	0·972	,,
	10	,,	0·954	,,

Dr. A. Griffiths congratulated the author upon his Paper, and referred to the importance of keeping the temperature constant during the experiments. The effects of temperature changes were very marked. The importance of a deep outer vessel was also surprising, and Dr. Griffiths pointed out how it was possible to place a superior limit to the error introduced by the passage of the salt into the outer vessel. He also suggested the use of a differential method, using two glass vessels, to overcome some of the difficulties encountered in the experiments.

Prof. C. H. Lees said that all who had experience with diffusion experiments would congratulate the author. The idea of using a balance was an old one, but the author had made an old method a thoroughly reliable one. The question was still to be solved whether an increase of concentration increased or decreased the diffusion constant, and he hoped the author would be able to carry on his experiments and settle this point.

Mr. B. S. Cohen read a Paper on

"The Production of Small Variable Frequency Alternating Currents suitable for Telephonic and other Measurements."

As an introduction a summary of the methods used by the author for such currents is given. A new method for producing these currents is then described; this consists of a form of vibrating wire interrupter which operates a make-and-break contact. This is used to put a source of potential on and off a resonating circuit tuned to any desired frequency. The alternating current is taken from a small transformer in the resonating circuit. A series of damped wave trains of any frequency can be produced by this means, the trains following each other with the frequency of the wire vibrations. Severals forms of circuit are described, one of which gives a train of oscillations at each break of the supply circuit. Other circuits give damped waves both on the break and on the make contact, and by a suitable combination of two oscillating circuits worked from one mercury cup and contact it is shown that continuous and fairly uniform oscillations can be produced. The theory of action of the various circuits is briefly entered into, and the Paper concludes with some applications of the waves produced to both telephonic and general electrical measurements. The wave forms given by the various circuits were shown at the meeting by means of a Duddell oscillograph.

Mr. A. Campbell mentioned that with his vibrating-bar microphone hummer he had found it easy to obtain more than one frequency from the same bar by altering the supports to suitable nodal points and tuning the magnet circuit with a condenser. Harmonics of the fundamental frequency were thus produced. He asked if any of the composite wave forms shown gave vowel sounds in the telephone.

Dr. Russell congratulated the author on his interesting and valuable Paper, and thanked him for the instructive demonstration he had given of methods of producing high-frequency currents suitable for telephonic and other measurements. He understood that the author's main object was not the obtaining of currents of excessively high frequency, but obtaining currents having frequencies varying between 100 and 5,000 which followed the harmonic law. Some of the methods described, in particular the author's "double-action circuit" method, seemed well adapted for this end. In some of these circuits there were two free periods of vibration, and it was exceedingly interesting to see the accuracy with which the oscillograph gave the resultant of two slightly-damped trains of high-frequency waves of different periods. Tuning for resonance the author obtained a very perfect sine wave. He thought that the thanks of the meeting were also due to the National Telephone Co. for the facilities they had afforded Mr. Cohen.

Mr. Cohen expressed his interest in Mr. Campbell's statement that it was easy to get more than one frequency from his vibrating-bar hummer. The currents shown, when passed through a telephone receiver, did not produce vowel sounds.

PATENTS IN 1907.

The twenty-fifth report of the Comptroller-General of Patents, which has just been issued, shows that the past year compares favourably with its predecessors. Although the number of applications was somewhat less than in 1906, the number of patents sealed was considerably greater, being 16,272, as compared with 14,707. Those classes which have been particularly active include electric telegraphs, "conducting electricity," electric lamps, electrolysis, signalling, aeronautics, air and gas engines and rotary engines. In what follows we give an abstract of the report, omitting, however, that part in which the novel features of the Patents and Designs Act of 1907 are discussed at some length.

The receipts from patents fees were £265,012, as compared with £255,646 in 1906, an increase of £9,366; from designs fees £5,473, as

compared with £4,344, an increase of £1,129: and from trade marks fees £18,447, as compared with £15,559, an increase of £2,888. The increase in trade marks fees is due partly to the revised scale of fees, which only came into operation in the course of the previous year, and partly to the large increase in the number of trade marks registered. The receipts from the sale of patent office publications (which are paid over to the stationery office) were £11,457, as compared with £10,593, an increase of £864. The total receipts were £300,389, as compared with £286,142, an increase of £14,247.

The total expenditure on behalf of the office amounted to £176,230, as compared with £175,272, an increase of £958.

The new block of buildings at the east end of the Patent Office, with an entrance in Furnival-street, was opened in June. It provides accommodation for 17 groups of the examining staff, consisting of 136 men, and contains on the top storey a new kitchen and dining-room. In spite of this large addition to the office premises, the recent increase of staff has made it necessary to provide rooms outside the office for the accommodation of four groups of examiners and a small body of clerks.

The number of readers who made use of the library in 1907 was 148,198, as compared with 143,750 in 1906, an increase of 4,448 or 3·09 per cent., and the largest number recorded in any one year. The number of volumes added to the library was 6,116, of which 1,227 were volumes of patent specifications or journals (English and foreign) and 331 were trade catalogues.

The library staff has been for some time preparing a new system of classification for indicating by certain marks the relative position of classes of books. The advantage of this system is that the marks, remaining constant in spite of the growth of the collection or its transfer to other buildings, can be given in the printed catalogues, and readers are thus enabled to refer directly to the shelves. The new arrangement has already been applied to the books of reference, and a subject list dealing with this section of the library is now in the press. The further elaboration of the system will occupy about two years, after which it is proposed to publish a complete subject catalogue of the library.

During the year the Statute Law relating to Patents and Designs was consolidated and amended by the Patents and Designs Act, 1907, which received the Royal Assent on August 28, 1907.

PATENTS.

The sum received from renewal fees was £155,127, as compared with £149,142 in 1906, an increase of £5,985; and that from sealing fees was £16,071, as compared with £14,311, an increase of £1,760.

The applications received in 1907 numbered 29,040, as compared with 30,030 in 1906, a decrease of 990 or 3·3 per cent. Of these applications 19,630 were accompanied by a provisional specification, and 9,410 by a complete specification. The applications accompanied by complete specifications continue to increase at a more rapid rate than those accompanied by provisional specifications. The proportion of the latter to the former was, in 1885, 87 to 13; in 1895, 83 to 17; in 1905, 72 to 28; and in 1907, 68 to 32. The number of complete specifications filed after provisional specifications was 9,483. The total number of specifications received was 38,523, as compared with 39,268 in 1906, a decrease of 745, or 1·9 per cent. The largest number of applications received on any one day was 183—on June 29th, and the smallest 49—on January 5th. The applications received from women inventors numbered 560, as compared with 600 in 1906. There were 1,646 applications made by way of communication from abroad of which 828 came from the United States of America, 453 from Germany, 70 from France, 38 from Switzerland, 30 from India, 29 from Canada, 27 from Austria-Hungary, 22 from Italy and 22 from the Transvaal.

The applications made in this country under the provisions of the International Convention of 1883 by inventors living in other States of the Union numbered 2,286, as against 2,044 in 1906. Of these, 819 were received from Germany, 587 from the United States, 548 from France, 91 from Sweden, 79 from Belgium, 56 from Italy, 47 from Switzerland, 26 from Norway, 17 from Denmark, 6 from New Zealand, 5 from Spain, 2 from Portugal, 2 from Australia and 1 from Japan. None were received from Brazil, Ceylon, Cuba, Mexico, The Netherlands, San Domingo, Servia, or Tunis.

An appendix contains a table showing the number of applications received since the beginning of 1884, and in each of the last eight years from the several parts of the United Kingdom, from the various British Colonies and Possessions and from foreign states. It is seen that the number received from persons resident in England and Wales was 17,380 in 1907, as compared with 18,579 in 1906, a decrease of 6·5 per cent.; from Scotland 1,278, as compared with 1,307, a decrease of 2·2 per cent.; and from Ireland 349, as compared with 379, a decrease of nearly 8 per cent. As regards the Colonies, there was a decrease in the number of applications received from every State of the Australian Commonwealth except New South Wales, and also in those from Natal and Hong Kong. The number received from Canada was nearly the same as in 1906, while there was a small increase in those from New South Wales, New Zealand, Cape Colony, Orange River Colony, Rhodesia, the Transvaal and India; and a more substantial increase in those from the West Indies. As regards Foreign States the number from Austria-Hungary, Holland and Switzerland decreased, while those from Belgium, Denmark, France, Germany, Italy, Norway, Roumania, Sweden, China, Japan and the United States increased. The foreign country which supplied the largest number of applications was Germany, from which 3,341 applications were received in 1907 as compared with 3,253 in 1906. The numbers from the United States and France were respectively 3,104 and 1,012, as against 3,003 and 1,062 in the preceding year.

Out of a total number of 16,272 patentees in 1907, 2,792 were resident in the United States of America, 2,608 in Germany, 753 in France, 299 in Austria-Hungary, 178 in Switzerland, 160 in Canada, 138 in Sweden, 128 in Belgium and 112 in Italy.

Patents were sealed upon 16,300, or 54·2 per cent., of the applications made in the year 1906, and 525, or 4·3 per cent., of the patents sealed upon the applications made in the year 1894 were maintained for the full period of 14 years.

The total number of patents which expired during the year was 14,470, and the total number of new patents sealed was 16,272. Thus the number of existing patents was increased during the year by 1,802.

During the 10 years ended in 1907 the number of hearings upon oppositions to the grant of patents was 1,407, and the number of appeals to the Law Officer against the decisions of the Comptroller and his deputies in these oppositions 262, of which 42 were withdrawn or abandoned and 16 are still outstanding, while in one case the application for the patent was abandoned. The number of appeals heard by the Law Officer in these cases during the last 10 years was therefore 203. In 23 of these appeals the decision of the Comptroller or his deputy was reversed, in 60 varied and in 120 supported.

During the same period the number of hearings upon oppositions to amendments in specifications was 72, and the number of appeals 29, of which 2 were withdrawn and 3 are outstanding. In the remaining 24 appeals which were heard by the Law Officer, the decision of the Comptroller or his deputy was supported in 17 instances, varied in 5 and reversed in 2.

There were 888 hearings during the same decade under sec. 94 of the Act, and 24 appeals, of which 3 were withdrawn and 1 is still outstanding. In 16 of the remaining 20 cases the decision of the Comptroller or his deputy was supported, in 2 it was reversed and in 1 it was held that the decision was not subject to appeal. The remaining case was referred back to the Comptroller.

The number of hearings under sec. 1, sub-sec. 6, of the Act of 1902 during the three years that have passed since the section came into operation was 9,815; but 3,859 of these were rendered unnecessary by reason of the abandonment of the application or amendment of the specification by the applicant. In all of the remaining 5,956 cases, formal decisions were given by the Comptroller or his deputies, with the result that in 8 cases only an appeal against the decision was made to the Law Officer. Two of these appeals were withdrawn, while of the 6 which were heard by the Law Officer, the decision was supported in 4 instances, and reversed in 1, and 1 case was referred back to the Comptroller.

Six petitions for the extension of terms were lodged during 1907. In 1 case the patent was prolonged for six years, and of the other cases 1 was withdrawn, 2 were abandoned, 1 was dismissed and 1 is still undecided. There are now 3 patents in force which have been prolonged beyond the normal period of 14 years—viz., 15,159 of 1888, 8,700 of 1892 and 1,272 of 1894.

The names of 7 patent agents were added to the register during the year, the total number on the register on December 31st being 254.

The number of specifications of expired patents reprinted at the cost of the office during the year, under the arrangement recommended by the departmental committee of 1900, was 535, and the net cost was about £1,000. In addition to these some 4,000 specifications were reprinted for official purposes.

The great inventive activity in connection with the motor-car industry, which has produced such a large number of applications for patents in recent years, now shows signs of falling off. The occurrence during the year of several serious railway accidents owing to the failure of signals has caused much attention to be given to automatic electrical systems of signalling, in which the services of signalmen are entirely dispensed with and the signals are given on the engine itself instead of by means of the usual wayside devices. Several applications have also been made for stopping trains automatically when the signals are against them. The occurrence of accidents in lifts has directed the attention of inventors towards the improvement of devices for preventing a mine or lift cage from falling down the shaft in the event of its hoisting cable breaking. Inventions relating to aeronautics were more than twice as many as in 1906, and nearly five times as many as in 1905. A large increase is also observable in the subject of wireless telegraphy, and some attention was given to the transmission of portraits and designs by telegraphic means.

DESIGNS.

The number of designs applied for during the year amounted to 24,219, exclusive of 709 "sets" of designs. In the previous year 21,262 single designs and 739 "sets" were applied for. The term "set" includes any number of articles ordinarily on sale together, irrespective of the varieties of the size or arrangement in which the particular design may be shown on each separate article.

The number of designs refused registration on account of their similarity to designs already registered was 456. During the year, 1,029 applications for registration of designs (including the abovementioned 456) were objected to by the comptroller. The objections, other than those on account of similarity to designs already registered, were chiefly on account of want of subject matter or want of substantial novelty.

TRADE MARKS.

The number of applications made in 1907 for the registration of trade marks (including 172 applications made to the Cutlers' Company of Sheffield) was 10,796, as compared with 11,414 in 1906.

The receipts from various sources on account of trade marks amounted to £18,446, 10s. 2d., including the sum of £3,208 for renewal fees.

The notices of opposition to the registration of trade marks lodged during the year numbered 247, and the number of cases of opposition heard under sec. 14 of the act was 69. There were appeals to the Board of Trade in 11 cases; in 9 cases the appeals were abandoned, and the other 2 cases have not yet been dealt with by the Board.

There were 11 applications for special trade marks under sec. 62. Of these 3 were withdrawn, 4 were allowed to proceed, 1 is being cancelled under sec. 18, and the rest are under the consideration of the Board of Trade.

A branch office has been opened at Manchester, where applications for the registration of textile designs may be received, and a register of such designs, called the Manchester register, is to be kept.

A number of appendixes are attached to the report, and give in tabular form the figures for preceding years, so that a comparison is facilitated.

ON THE PROBABLE EXISTENCE OF A NEW SPECIES OF RAYS (MAGNETIC RAYS) ACCOMPANYING DISCHARGE IN A MAGNETIC FIELD.*

BY A. RIGHI.

As long ago as 1858, Plücker† showed that when a vacuum tube is traversed by a discharge in a sufficiently strong magnetic field, a luminous column is formed which marks out a tube of magnetic force, and comprises exactly all the lines of force cut by the cathode. Eleven years later Hittorf‡ observed the same phenomenon, but accompanied by a sort of luminous helix contained within the tube of force, and constituted by cathode rays curved by the magnetic field.

In more recent times analogous phenomena have been studied and described by various physicists, and a pretty full literature exists on the subject, but it cannot be said that the nature and origin of the luminous column, having sensibly the shape of a magnetic tube of force, have as yet been cleared up.

As a rule, this column is supposed to be constituted by cathode rays, as follows:—

Under the action of a uniform magnetic field, an electron emitted by the cathode in a direction not coinciding with that of the field moves along a helix traced on a cylindrical cylinder parallel to the lines of force, and the radius of this cylinder is inversely as the intensity of the field. But if that intensity is very great, and if the cathode rays are visible on account of the fluorescence they excite in the gas, the helix cannot be clearly made out, and it assumes the aspect of the cylinder on which it is traced, especially if the section of the cathode beam is not small. If the field is not uniform, the cathode rays assume shapes more or less similar to the helix, and describe curves which are wrapped about lines of force the more closely as the field becomes stronger. In that case the true shape of the cathode beam is apt to become indistinguishable, and it may assume the approximate outline of a tube of force. In fact, Plücker's luminous beam would be nothing but a beam of cathode rays of special shape.

However some recent experiments of Villard § suggested to that physicist to abandon that view, and to suppose that besides the cathode rays there exist other rays of unknown nature, to which he proposes to give the rather vague name of "magneto-cathodic rays," and which constitutes Plücker's luminous beam. A careful examination of these experiments shows, however, that they can all be explained (except one, which the author himself describes as doubtful) without abandoning the received opinion. Villard himself admits as much. These experiments comprise one in which the magneto-cathodic rays are deviated by an electric field in a direction normal to the lines of force.||

Even the fundamental characteristic of magneto-cathodic rays, that of originating in accordance with the surface of the cathode, or at any point of a visible cathode ray, is explicable on the ordinary conception, since this luminous beam in the shape of a tube of force, inside which the cathode beam is seen (as in Hittorf's experiment), may be regarded as due to electrons which, owing to collisions, assume such values and directions of speed as to constitute helices of very small radius.

Notwithstanding all this, some of Villard's experiments seem to me to suggest the idea that magneto-cathodic rays are something which differs from the known cathode rays, even without the doubtful experiment referred to, from which it would result that the magneto cathodic rays convey electric charges. This idea has been strengthened in my mind since, having decided to study these very interesting phenomena, I have been able to execute very numerous experiments which are largely new. I am now convinced that if hitherto the magneto-cathodic have been regarded as ordinary cathode rays, that is because hitherto no other explanation was available.

The explanation which I wish to propose here is based upon the following considerations, necessarily vague and general, since they could not be formulated mathematically without undue restrictions.

In a discharge tube we have electrons, positive atoms, neutral atoms, &c., in motion, and, as generally admitted, we have constant exchanges, ionisations and reconstitution of neutral atoms. It has been hitherto assumed that the reunion of an electron with a positive atom gives rise immediately to a neutral atom, which remains such until again ionised by collision. Now, the new hypothesis which I advance is this: that the approach of an electron and a positive atom may, under certain circumstances, result in the production of a system which, though electrically neutral as a whole, differs from an atom, and is constituted by a positive ion and an electron gravitating about it without being closely attached.

A comparison may be useful. The reconstitution of a neutral atom corresponds to the fall of a comet or meteorite into the sun, whereas the formation of the binary system described corresponds to the incursion of a comet external to the solar system, rendered temporarily periodical by the sun.

I suppose, however, that under certain favourable circumstances certain binary systems are produced which resemble a star with its planets, or a double star, systems constituted by a positive ion and an electron, which revolve about the common centre of gravity, in this case practically the centre of the positive ion.

Such a system would, of course, be more easily destroyed by a new ionising collision than an ordinary atom. But if there is a magnetic field, some of these systems might acquire a certain stability.

Consider two simple and extreme cases. The first is that of an electron moving circularly round the positive ion in a plane normal to the direction of the magnetic field, and so that E.M.F. is in the direction of the radius vector. This force will assist the electrostatic force and there will be a smaller orbit, a greater frequency and a greater stability, which will enable the combination to resist the perturbations tending to split off the electron.

Secondly, if the sense of the revolution is contrary to that supposed, there will be less stability. On both suppositions the magnetic field makes for persistence.

Now consider the electrons repelled from the cathode and remember the fact that in the discharge tube there are positive ions which move in the same direction as the cathode rays, having been reflected by the cathode. Along the track of these the binary systems described may be formed, and the helical paths of the cathode rays will assist their formation. Such systems, following the lines of force, would precisely constitute the so-called magneto-cathodic rays.

If this is the nature of those rays, it is evident that they resemble electrodynamic solenoids, or very flexible magnetic solenoids. Hence the name "magnetic rays," which I intend to apply to the new rays, appears sufficiently justified.

Experiments now in hand, which will form the subject of a future publication, have not yet brought any rigorous proofs of the hypothesis above sketched out, but they have yielded various hints which go to support it. Thus, if the magnetic field is not uniform, but decreases away from the cathode, it will tend to retard the translational motion of these systems, and to draw them back into the regions of greater intensity. Some of my experiments actually indicate the existence of such retrograde magnetic rays. But in strictness it must be admitted that the view hitherto adopted accounts for the facts up to a certain point.

The same cannot, however, be said of other experiments of mine, which appear clearly to prove the presence of these positive ions accompanying the electrons until they form magnetic rays with them, but liberated again in less strong parts of the field, where the binary systems are gradually disintegrated.

* Translated from the *Rendiconti dei Lincei*.

† *Pogg. Ann.*, 103, pp. 88 and 151, 1858.

‡ *Pogg. Ann.*, 136, p. 213, 1869.

§ *Le Radium*, April, 1906.

|| *Comptes Rendus*, 138, p. 1594, 1904.

An Electrostatic Method of Measuring Small Quantities of Electricity.—In order to increase the sensitiveness of electrometers, and thus to permit of their employment for measuring small quantities of electricity, A. Einstein in the *Physikalische Zeitschrift* proposes the use of an electrostatic machine made up of any number, n, of influence machines, analogous in principle to the Thomson replenisher, connected in cascade. Under these conditions, if P_1 is the potential of the armature of the first machine, that of the collector of the nth which is connected to the electrometer will be $P_n = a^n P$, a being a constant greater than unity, for instance, in one case it was 10. Owing to this arrangement, charges of low potential, P_1, can be detected on the electrometer when they themselves would be insufficient to deflect it.

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PROFESSIONAL ETIQUETTE.

Professional etiquette, like a religious belief, is generally looked upon as a subject that should be left somewhat severely alone, a matter for inner rumination rather than for public discussion. Often a time comes, however, when it is well to remove all trace of mystery, and to look upon a subject in broad daylight; and we feel that the present occasion is opportune to consider what professional etiquette really is, what are its essentials, and whether it is of real value to the electrical industry.

Etiquette is defined by WEBSTER as the "observance of the proprieties of rank and occasion," from which it may be gathered that etiquette is a question of fashion. In regard to professional etiquette, however, such a definition requires some qualification, for ethical questions also are involved. Let us for a moment turn to the code issued by the Institution of Electrical Engineers.

It is now six years ago since the Council of the Institution decided that it would be to the advantage of the profession if a standard of professional etiquette for consulting electrical engineers were decided upon, and the following code was drawn up, and duly published:

1. No consulting engineer should solicit employment as consulting engineer verbally, by letter, by agent paid by commission or otherwise, or by any other means.

2. No consulting engineer should answer advertisements for consulting engineers.

3. No consulting engineer should advertise for employment.

4. No consulting engineer should pay by commission or otherwise anyone who introduces clients.

5. No consulting engineer should receive trade or other discount, or surreptitious commissions or allowances in connection with any works which he superintends.

6. A consulting engineer who is also directly or indirectly interested in any contracting or manufacturing business should inform his client in writing what his connection is with such contractor

The American Institute of Electrical Engineers more recently issued what was termed a code of ethics, dealing at much greater length, though in a more general way, with what the engineer should and should not do. We gave some account of this code in our issue of July 12, 1907. As indicating its scope, we may mention that Section A deals at some length with the desirability of standardisation; Section B deals with the relations of the electrical engineer with his employer, and with financial questions; Section C is concerned with questions of ownership of records; and Section D deals with such a general topic as the relation of the engineer to the public. The American Institute thus considered the question of engineers generally rather than of the consulting engineer in particular.

In looking over the code proposed by the Institution of Electrical Engineers, it is seen at once that the rules are drawn up for one class only. It is a code of etiquette for the consulting engineer and for the consulting engineer alone. There is no such thing as a code of etiquette, or even the suggestion of one, for the manufacturer or the contractor.

Further, it is noticeable that professional etiquette may be divided into two parts—namely, (1) moral or ethical, and (2) conventional. However opinions may differ, there cannot be any question about the first, or ethical, part of the subject. The consulting engineer, to be worthy of the name, should certainly be unbiased. He should, therefore, have no interest in the manufacturer or contractor supplying the plant. If he is interested in such a way, he should inform his client of this fact, as required by clause 6; we think we may go so far as to say that if his interest is considerable in this direction he should not be a consultant at all. There is, however, rather a fine distinction between the consulting engineer who is interested in a firm and a manufacturing firm who profess to be consulting engineers. Apparently one is permissible and the other is not. Yet all gradations can be found. The consulting engineer may have, say, £100 invested in a firm supplying plant to his specification; is he to be classed with the consultant who has a seat on the board? Obviously not; hence the meaning of "directly and indirectly interested" requires careful definition.

With regard to clause 5 there is also no question that the acceptance of surreptitious commissions is contrary to all the laws of what may be termed honest business, and, in fact, it surely comes well within the penalty clauses of a recent Act of Parliament dealing with such abuses. With regard to clause 4 also, it will no doubt be generally felt that an agent cannot be openly employed by a consulting engineer, and, that being the case, commissions should not be given for introductions, as they would almost partake of the nature of secret commissions.

When, however, we come to the conventional part of professional etiquette—that is to the other three clauses, it is much more difficult to decide what is desirable. Let us, for example, take the question of advertising, not because it is necessarily the most important point, but rather because it is a simple matter, and more or less typical of others. Is there any legitimate reason why a consulting engineer should not advertise? There is nothing immoral about advertising, and it is really purely a question of fashion. We can well imagine that in, say, the Celestial Empire, it would be quite a natural thing for the consulting engineer to advertise, and that it would be looked upon as altogether unseemly for the contractor to suggest, by means of an advertisement, that his electrical generators were the latest and best thing on the market. It is a matter of custom. In this respect consulting engineering has followed those other professions in which "consulting" is a recognised feature. Thus the dentist, as a rule, does not advertise. Undoubtedly there are dentists, nevertheless, who rejoice in a shop window full of artificial teeth, and there are those members of the general public who would think but little of a dentist who did not make such a display. Most of us, however, while realising that the dentist behind the shop window *may* be perfectly capable, honest and altogether desirable, recognise the fact that the work done by the man with the small and sober brass plate, though more expensive, is likely to give more satisfaction. Similarly the doctor does not advertise; or if he does advertise we consider that he is a quack and we generally leave him severely alone. Again, the barrister and the solicitor do not advertise; indeed, there would be great astonishment if they did so.

That being the case, one may, perhaps, ask why there should be any difficulty in the engineering profession if such codes work well in other professions. We think the difficulty is due to two causes: firstly, the consulting engineer does not form so distinct a class as does, for example, the doctor, who cannot be a maker of surgical instruments to-day and a doctor to-morrow, but must be a doctor or not a doctor, and must have definite qualifications; and, secondly, it is impossible to impose a conventional code of etiquette on consulting engineers in such a way that it is to the advantage of practically all those concerned to adhere to it. The object of the consultant, like that of most other men, is to earn a living. Any code that lessens the livelihood of the scrupulous, perhaps over-scrupulous, engineer, and transfers the bread and butter to the engineer with a less tender conscience, must be fundamentally wrong somewhere. So far, this has been very much the effect of the code issued by the Institution of Electrical Engineers. The leading consulting engineers adopted the code without any ill-effect, because they were sufficiently well known for work to come to them without any such aids as the answering of advertisements. But as regards engineers of the second rank, the man who cared nothing for professional etiquette, or at least for the conventional part of it, was placed at a great advantage compared with his competitors who desired to maintain the good status of the profession by adhering to the code. The Institution has practically no power to deal with offenders, and thus the offenders are really those who benefit by any code that is issued. It is not the code that is wrong, but the fact that it cannot be enforced.

If there is to be a code at all for consulting engineers, it will generally be agreed that there should be one for manufacturers and contractors also. If the consultant is to agree to avoid certain things which might bring him work, then he is entitled to protection corresponding somewhat to the limitations that are imposed upon him. We think

that no manufacturer should advertise himself as a consulting engineer. Such a course is quite indefensible, and transgresses the ethical part of any code. On the other hand, there is nothing morally wrong in some contractors suggesting to clients that the services of a consulting engineer are unnecessary, and that the work can be done perfectly well by the contractor alone without an intermediary; but is it expedient? We do not find that barristers try to carry on the work of solicitors, or that solicitors attempt to appear in court to carry on cross-examinations—doubtless because the powers that be have decided that it would be inexpedient for them to do so.

If, then, it is a question of expediency and of fashion, we think that engineers would do well to follow the motto—"In things essential, unity; in things doubtful, liberty." Consulting engineers should themselves come together and decide what is desirable, not merely for those who are fortunate in being leaders of the profession, but for all grades alike. There would be no question about accepting the moral part of the Institution code, but there would probably be many different opinions as to the conventional part. Outright advertising is, perhaps, the simplest item of this part of a code, and there are few who would be anxious to avail themselves of such means, though there is the standing difficulty that insurance companies advertise for consulting work as a matter of course, and it would be difficult to bring them into line. The soliciting of employment is not so easily put on one side; it certainly is not immoral, though it may not be dignified. But there are probably many who feel that it is better to be undignified with work than dignified with an empty pocket. Similarly, there are, no doubt, many engineers who consider that the leaving unanswered of an advertisement for a consulting engineer is simply forcing bread and butter into the mouths of the undesirable. These and other points should be discussed in a common-sense way, having regard to the limitations inseparable from the profession, and any code should be the result of unanimous, or nearly unanimous, action. It might, for example, be decided that advertising is not permissible, and the soliciting for employment and the answering of advertisements might be left open questions. In that case, if a consultant felt so inclined, he would answer any advertisement, but if he felt such a course to be undignified he would leave them severely alone. Only by restricting the code to essentials, and treating other points as matters of opinion, do we think a code, under present circumstances, can be obtained of true value to consulting engineers and to the electrical industry.

REVIEWS.

(Copies of the undermentioned works can be had from *The Electrician* Office, post free on receipt of published price. Add 5 per cent. for abroad or for foreign books.)

The Evolution of the Submarine Boat, Mine, and Torpedo.

By Commander Murray F. Sueter, R.N. (Portsmouth: J. Griffin & Co. Pp. xxiv 370. 21s. net.

The development and extended use of submarine boats for naval purposes is so recent, and the details of their construction have been kept so secret, that the man in the street knows practically nothing of them, and few engineers have more than a slight acquaintance with their working. Capt. Sueter's book has exceptional interest at the present time. It is an historical and descriptive work, rather than a technical one, and it is not to be expected that a naval officer would be allowed to publish anything which could assist a designer; but the principles on which a submarine boat is navigated, and the purpose it is designed to fill, are so unfamiliar that the elements of the subject will be new to most of us.

Students of naval history are familiar with the attempts of the American Bushnell in the war of 1775, and of the Confederate "Davids" in the Civil War, to sink the enemy's ships by means of explosives conveyed and attached to them by submarine boats, and with the wonderful courage of the American crews, who volunteered for these vessels after repeated disasters. The general problem of submarine warfare could have been stated then pretty much as it would be now, but new methods and resources have made relatively easy what was then impossible or excessively difficult. Electric motors have replaced manual labour in the propulsion of the submerged boat, and the discharge of the Whitehead replaces the difficult operation of fixing a mine under the bottom of a ship. An engineering journal is more concerned with the technical side of a problem than with its history, and the problems connected with submarines are peculiarly interesting. The main, and practically the only object, of a submarine is to discharge a Whitehead torpedo within range of a hostile ship, and its other functions are accessory to this. The only advantage of its being submersible is that it is able to approach its object without being seen, or if detected without being exposed to shell fire. For this purpose the submarine requires motive power sufficient for high speed, if possible high enough to overtake any ship she may attack, and available for use when submerged; close regulation of depth and direction; and means of taking observations when submerged. The supply of air for the crew, regulation of buoyancy, longitudinal stability, the discharge of the Whiteheads, the construction of the periscope, the regulation of depths, have been difficult problems to be solved, presented often by the occurrence of deplorable accidents. Some account of all these, and of many others, is given by Captain Sueter, but in every case the reader will desire more information. There is no space in a review to refer to the numerous matters of interest in this book, but a few may be noticed. A good deal of information is given on the Whitehead torpedo, and especially on the Obry gyroscope, by means of which a torpedo discharged in any direction indifferently will pick up and maintain a predetermined course automatically, and figures of some interesting results obtained in the United States with this apparatus are given. Admiral Boiresen's rudder deflector is described, which combined with the Obry gyroscope brings the torpedo when discharged from a lateral tube not only on the boat's course, but actually in its own line ahead of it, so that the exact striking point is fixed as well as its course.

One of the greatest difficulties in the management of these boats was to maintain an even depth, due to the small longitudinal stability. The exact arrangement of the rudders and hydroplanes is not clearly explained, and perhaps it is a point on which the writer would not be allowed to give much information, though it is a very interesting one. The Lake boats are always maintained on an even keel, and dive by oblique motion. The Holland boats, on the other hand, sink or rise by directing the axis of the moving boats upwards or downwards. Attempts, formerly common, to regulate depth by changing the displacement have been abandoned now, and every submarine is constructed to rise to the top, under any circumstances, when at rest, being able to sink only by setting itself in motion.

Two points have especial electrical interest, namely, the use of storage cells, and the possibility of aetherial telegraphy to control torpedoes.

Ordinary storage cells have proved to be one of the most serious dangers for submarines. When salt water reaches an accumulator chlorine gas is given off. Chlorine is so painful and deadly a poison that the necessity of using the present storage cells is deplorable, and it is greatly to be hoped that the Edison cells in which the electrolyte is caustic potash may become available before long. There can be few more distressing ways of meeting death than by the inhalation of chlorine.

The use of aetherial telegraphy to direct the movements of a

locomotive torpedo may be of considerable interest in the future. Its use is limited of course to the range of sight of a telescope, and a hostile ship should be able to render it useless by destroying the antenna with shell, if it can be detected. But it would seem to be a great advance on the Brennan torpedo.

This book will not assist experts, but evidently is not compiled for them. The lavishness of illustration gives it a very great advantage from the point of view of the general reader.

Les Industries Electrochimiques. By JEAN ESCARD. (Paris: Ch. Béranger.) Pp. viii. + 793. 25fr.

This is one of the most satisfactory books on the subject of electrochemistry and electrometallurgy which we have yet seen. It is written in an interesting style, and the scheme is well developed.

The book, as is the case with most books nowadays, commences historically, the first chapter deals with electrochemical phenomena in general, and the first experiment given is the decomposition of copper sulphate. In view of the fact that the ancient Egyptians seemed to know how to coat iron objects with copper, as is evidenced by the finding of such articles in the coffins of embalmed mummies, from an historical point of view a better example could not have been chosen. The subject is gradually developed by Faraday's laws, and then the consideration of the ionic theory of Arrhenius is brought in. Having given a general insight into electrochemical and electrical phenomena, the author describes the theory of the dynamo, but naturally, as the book is not one on electrical engineering, the matter is by no means fully discussed, only sufficient material being included to make it clear how electrical energy is induced by means of the dynamo. A short account, in fact rather too short an account, of the accumulator, is then given, followed by influence machines, resistances, &c.

The second chapter deals with the non-metallic elements and compounds, and commences with a description of the various methods employed in the industrial electrolysis of water in order to obtain oxygen and hydrogen. Then follows the electrolytic preparation of fluorine, the electrolysis of sulphuric acid and the preparation of persulphuric acid and of the persulphates. As already mentioned, this chapter is supposed to deal with the metalloids, but one can hardly reconcile lead oxide and the oxidation of chromic solutions, and, furthermore, the preparation of white lead and zinc white under this heading. It is not a matter of great importance, but we think the author would have been better advised in placing the salts of metals along with the metals, although, of course, one can say that oxygen and carbon-dioxide belong to the metalloids, and, therefore, the compounds produced are the metals with the *metalloids*.

The chapter upon the electrical oxidation of atmospheric nitrogen is particularly good, and the diagrams explanatory of the process are very clear.

Chapter VI. deals with the production of the alkali metals, all the various methods tried and suggested—good, bad and indifferent—are included. In a text-book on electrochemistry, or any other subject, is it really necessary to describe all the various suggested processes and all the patents which sanguine people have taken out, without taking into account their actual practical importance? Even if the book is made a little shorter, we are inclined to think it would be better to deal mainly, at any rate, with those processes which have stood the test of actual experience. There are cases, of course, where the suggestiveness of a method is quite a sufficient reason for describing it, even if it has not been actually successful when tried on a commercial scale. We are not making these remarks in a carping spirit or particularly in reference to the book under review, as it is no worse in this respect than other books of the same kind; but we really think that the description of so much which can never under any circumstances develop in commercial processes is misleading to those who are unable to judge and to separate the possible from the impossible.

The book itself, for those who have a certain knowledge of electrochemistry, is one of great value, and we heartily congratulate the author upon the appearance of this work. Apparently many of the diagrams have been specially drawn for the book, and they are very much clearer than we have seen in a good many books recently published.

Coal. By JAMES TONGE. (London: A. Constable & Co.) Pp. viii. + 275. 5s. net.

As long as the station engineer, or even the man-in-the-street for that matter, can buy his coal at a sufficiently cheap rate, he is supremely indifferent to the various processes of formation which have enabled him to employ this substance for the generation of power or for domestic purposes. Lest it should be thought that the Miner's Bill is in any way referred to, we hasten to state that only natural processes are meant, and that no hidden political meaning is intended. To those, however, who care to pursue the matter further, and we can assure them it is a most fascinating subject, we recommend Mr. Tonge's book, confident that it will supply their need, and that they will not be bored by it.

After dealing with what may be termed the theoretical side of the subject in chapters on history, occurrence, mode of formation of coal seams, fossils of the coal measures, botany of the coal measure plants, he takes up the question of British and foreign coal fields. In these two chapters very useful statistics of the different kinds of coal present in the various fields, together with their estimated capacity, are given.

Purely practical features are then dealt with and of these the chapters on the valuation of coal, foreign coals and their values and the production of heat from coal should be of special interest to electrical engineers in their official capacities. The book concludes with chapters on preparation of coal for the market, and coaling stations of the world.

Mr. Tonge's intention, however, is to appeal to a wider circle of readers, than those included in purely professional circles. For this purpose the book should be admirably adapted. It is clearly written and the technical explanations are lucid. A word of praise is also due to the publishers, and to the printers, who both in the letterpress and illustrations have shown what can be done by the exercise of modern methods. When we consider the way in which the production of coal and the prosperity of this country are inseparably bound up, there is no doubt that a deeper study of the subject, even by those only remotely interested in it from a business point of view, would be generally advantageous.

THE DRYSDALE WATTMETER.

Our illustration herewith depicts a large double wattmeter which has been made by Mr. H. Tinsley, of Beckenham, and was exhibited at the Physical Society's meeting on March 27th, when Dr. Drysdale read his Paper on wattmeters. It is a development of the wattmeters described in *The Electrician* of March 15, 1901, and made on the lines then laid down by Dr. Drysdale. It stands practically alone as a fine example of the double wattmeter instrument which can be used for testing power in a single, double or three-phase circuit. The two separate wattmeters are combined in one instrument, both the pressure coils and current coils being easily joined in any desired combination. The capacity of this particular instrument is 200 amperes per phase, and by means of additional resistances which can be placed in series with the pressure coil, it may be used on circuits from 10 up to 3,000 volts per phase.

A series of commutators is provided with this instrument by means of which the separate windings of each current coil can be put in series or parallel so as to increase the torque when on a low current circuit. By this means a complete rotation of the torsion head, 500 mm., can be obtained with only 20 amperes flowing in the main coils of this 200 ampere instrument, and much lower currents can be made to give the same deflection by increasing the current in the pressure coils. The standard set of commutators supplied with this instrument gives 500 mm. torsion, with 20, 40, 100 or 200 amperes respectively with normal current in the volt coil.

Owing to the large current capacity of this instrument the copper 'bus bars have been mounted on a separate stand adjoining the instrument, so that the latter can be easily removed if necessary without disturbing the somewhat heavy cables; the latter have been soldered direct to these bars. In other instruments that Mr. Tinsley is making the commutators and bars are all combined on the base of the wattmeter.

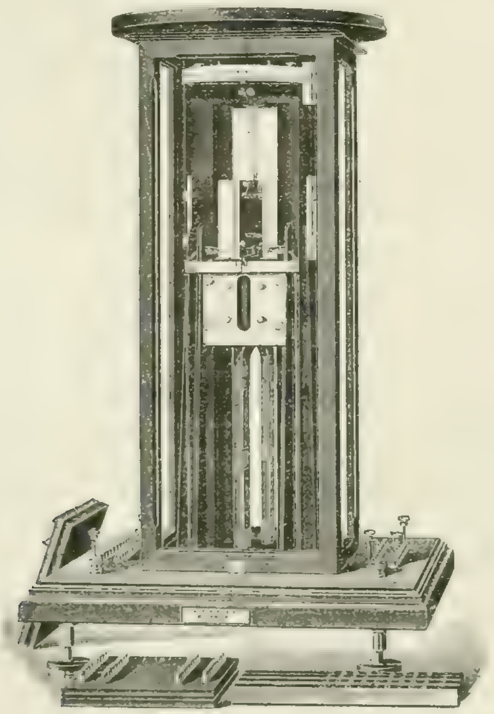
Some idea of the great utility of such an instrument may be gathered from a table showing on what circuits it may be used:—

1. Single-phase up to 200 amperes.
2. Single-phase up to 400 amperes.
3. Two-phase up to 200 amperes.

4. Three-phase up to 200 amperes.
5. Continuous current of either 200 or 400 amperes.
6. Power in a continuous-current circuit up to 200 amperes can be balanced against power in an alternating-current circuit up to an equal amount.

When it is remembered that in each of the above cases the voltage can be practically anything up to 3,000 volts or even higher, the enormous range and advantage of such a piece of apparatus can be realised. The large disc at the top serves to bring the needle to zero against the action of the spring when current is flowing, a deflection of 0·1 mm. or 0·2 mm. being quite readable. The zero index and torsion head are easily observable through the glass case, and come into line with the eyes when on an ordinary bench, thus making the manipulation extremely convenient. The zero can be set without removing the glass cover by lifting off the large disc.

This wattmeter has been made for use in Dr. Drysdale's laboratory at the Northampton Institute, and it was found on testing that Mr. Tinsley's calibration agreed with that obtained by Dr. Drysdale within two or three parts in 10,000.



View of Wattmeter and Commutating Arrangement.

A complete series of these wattmeters is being made by Mr. Tinsley, covering the ranges of current usually obtained in practice, and we hope shortly to give a description of some tests made with one of these, and of its use in the practical measurement of power, phase displacement and other applications.

CORRESPONDENCE.

IS THE CONSULTING ENGINEER NECESSARY?

TO THE EDITOR OF THE ELECTRICIAN.

Sir: There are, broadly, three large branches of electrical consulting engineering work: Putting down generating stations, tramways and systems for local authorities, and extending them subsequently; putting in plants for owners of factories, private houses in the country and similar work; and purchasing plant for clients abroad.

As I am not specially interested in any one of these branches, I have much pleasure in complying with your request for my ideas on the subject.

Dealing with large municipal work first, there is no doubt the early consulting engineer did some harm by assuming rather the attitude of a man called in to invent a system than a purchaser of the best obtainable in the market; and this naturally caused friction with the contractor. There was another influence at work very soon; and that was that it is not etiquette for consulting engineers to ask for work, and a number of people, some of them very poorly qualified, others highly competent, solicited work and obtained it, and thus built up very good practices at the expense of those who regarded the traditions of the dignity of the profession, and who have gone to the wall in consequence. Now, however, there is little new municipal work to be done, and the extensions are carried out by the resident engineers. Whether this is a good plan or not depends on the resident engineer and the consulting engineer. The work is rather outside the experience of a station engineer, but many of the station engineers are men of great ability, and an extension is better put down by them than by a consulting engineer whose only qualification is that he is directly or indirectly a good canvasser. But the object of employing the station engineer is not generally to get better plant, as an electrical committee regards one engineer as being as good as another. The idea is generally to save a percentage by burdening an already overworked and underpaid engineer with additional work and responsibility. I do not think it is worth discussing any possible remedy for the present state of municipal consulting work, as there is not enough of it left.

The consulting engineer ought to be in the same position as an architect; but he has never taken this position. No one would think of asking an insurance company or its inspector to act as an architect for a new house on the ground that it insured houses. Neither would anyone employ a builder who advertised himself as "builder and architect." Again, a builder would not sell bricks, doors, mantelpieces or wall papers to an architect at a discount.

The only proper course seems to me to form a body of consulting engineers, or, at any rate, of consulting electrical engineers. At present there is in reality no such profession. In your own Directory the heading "Electrical Engineers (Consulting, &c.)" seems to include the whole trade, a boiler insurance company, limited, standing out in bold capitals. Under "Engineers (Consulting)" the same concern appears. The difficulty is in forming a society. There will be a tendency among the bigger men to hang off until they see what is going to happen, while there will be a rush of smaller fry, many of whom may not be at all competent. There will always be difficulty as to who is qualified and who is not. Such a society must not be a sort of combination of a small number of people for their own common benefit.

It might be possible to form a society of consulting engineers with a professional code which all members would adopt. Admission would be settled by a council. Such a society would depend entirely on its own merits. If it took care to include all the good men and none of the bad ones, it would take up its position naturally in a few years, and the public would in time learn to look upon membership as a necessary hall mark for a consulting engineer. Such a body would be in touch with contractors, and would be open to consider all sorts of suggestions for the good of the industry. Whether such a scheme is practical or not remains to be seen. There are very many difficulties in the way.—I am, &c.,

82, Victoria street, S.W., June 10. J. Swinburne.

TO THE EDITOR OF THE ELECTRICIAN.

Sir: With reference to this subject I consider much is to be said for and against the employment of consultants. I must say I partially agree with the remarks of previous writers on this subject.

I think that a proper standardisation of consultants is necessary in order to protect the public from the would-be individual, and I think your readers will agree with me that a competent person should, of necessity, be one who can not only briefly specify the requirements of the specific case, but also check by his independent estimates the estimates of the various competing contractors. Any man also of reasonable experience would naturally confine himself to modern standard English practice (in England) and not add expensive fads, which do not increase the efficiency, and certainly increase the capital cost, besides departing from standard practice.

I think that foreign competitors should compete, at least in England and her colonies, on English standards and English modern practice.

Under such conditions the consulting engineer is undoubtedly

a necessity to client, manufacturer and contractor alike, and could, in my opinion, bring about a condition which would boom "the electrical engineering industry generally." Opinions differ somewhat as regards the knowledge required by a consulting engineer. He not only requires knowledge and experience as an electrician in all branches, but must have the same knowledge and experience as a mechanical engineer, the matter not being overlooked that besides these qualifications he requires commercial and constructional experience. In the Australian Commonwealth and New Zealand, as well as South Africa and India, the electrical representatives of machinery agents (engineers or otherwise) are too frequently called upon to advise undertakings as to how to proceed with a scheme, and it frequently ends in "smoke," for after a careful investigation of affairs nothing is done, owing to ill-advice. It is only lately they have awakened to the fact that it is cheaper to import an English consultant, paying all expenses, &c. Until recently foreigners have been doing a large business with the colonies under these conditions, but this tendency is gradually fading, and patriotism is gradually increasing towards the mother country. The state of things just referred to tends to show that, after experience, the public are beginning to gradually realise the want of the unbiased consulting expert, and I am pleased to see at this juncture that the subject has been brought before your readers, and I shall read with much interest the various opinions expressed through your valuable columns. It appears that the Board of Trade might suitably take up the subject and issue licences to consulting engineers in this branch of the profession, in a similar way to that in which the Australian and New Zealand colonies grant licences to borough engineers, surveyors and boiler inspectors, thus guarding the interests of the public.—I am, &c.,

London, June 9. E. W. WYNDHAM-WESTWOOD.

MARCONI'S SYSTEM OF WIRELESS TELEGRAPHY.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: Despite Mr. Charles Bright's kindly expressed words adverse to my idea that certain incorrect daily Press statements would tend to mislead, and to needlessly frighten cable shareholders, I cannot, I fear, alter my opinion in this regard, and for the following reasons:—

1. A few hours after I had read Mr. Bright's letter to *The Electrician*, I happened to meet a City accountant, who assured me, as positive fact, that these daily newspaper statements exercised a marked influence on cable shares.

2. We all remember how cable shares fell in value when, some years ago, the subject of trans-ocean radiotelegraphy first came into prominence. That fall was mainly due to highly exaggerated statements in the daily Press.

3. Last autumn I happened to be in New York, where I was, so to speak, in the thick of the slump caused in "Mackays," and cable shares generally, by the news spread far and wide by the daily Press, almost without exception, that the Marconi Company had, during the first 24 hours of regular trans-Atlantic service, successfully dealt with 14,000 words.

Of course, it afterwards transpired that, somehow or other, one little cipher, meaning nothing by itself, but so much when tacked on to other figures, had—perhaps by some too enthusiastic pressman accustomed to regard all circumstances from a double-convex-lens point of view—been added, making 14,000 instead of 1,400. It took some time to correct these winged figures telegraphed past recall to the four quarters of the globe. Meantime they did much harm among the *gobemouche* section of the investing public.

With regard to Mr. Bright's remark that "the duplex-automatic system" is "for long distances only applicable to wire telegraphy at present," I fancy radio-telegraphy can justly claim to have progressed considerably farther towards perfection than these words would lead one to suppose. Firstly, automatic transmission is already in use for "wireless," though this fact is not necessarily any criterion of high working speed. A punched-paper-strip apparatus working, on local circuit, a well-insulated electromagnetic make-and-break radio-transmitter is an excellent arrangement for obviating too much donkey work in the way of monotonous manipulation and hand repetition of messages when trouble comes on in the form of "Xs"—*i.e.*, atmospheric electric disturbances. For the perforated strip can be passed through over and over again, if necessary, at any speed, fast or slow.

Secondly, as regards duplex. This has already been effected, with waves 1,200 metres long, between the Poulsen station at Lijngby, near Copenhagen, and the steamer "Hellig Olav," at a distance of 1,250 miles. With a difference of wave-length of 3½ per cent. it was possible both to receive and send messages at the same time. A difference of 1 per cent. is said to be sufficient for this purpose. (See *Elektrotechnik und Maschinenbau*, quoted in the *Electrical Engineer*, May 29, 1908.)

Lastly, as to the occasions mentioned by Mr. Bright when the *Morning Post*, the *Daily Telegraph* and the *Daily Graphic* representatives desired to obtain his opinion as to Mr. Marconi's claims, all this I can well understand in view of the name Mr. Bright has made for himself as an authority on matters such as those under discussion. It is, then, all the more regrettable that the *Morning Post* did not deem it opportune to act in a similar broad-minded manner by accepting my original letter rectifying the *Morning Post's* under-statement of cable working speeds, as by so doing it would have prevented the genesis of those who aver that non-publication might have been closely connected with certain financial advertisements then about to appear.

I submit, Sir, the above considerations to your good pleasure.—I am, &c., E. RAYMOND-BARKER.

12, Edge-hill, Wimbledon, June 9.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: Referring to your Editorial Note in regard to my letter of last week, I think I should have limited myself to the opinion that there is a tendency to over-estimate the influence of incomplete or inaccurate statements in the lay Press respecting wireless telegraphy. I can but also express surprise that any cable shareholder should be so foolish as to dispose of what have for many years been rightly regarded as gilt-edged securities, and are certainly not less so now than before the days of wireless telegraphy.

I am convinced that any apparent bias on the part of the Press is more due to ignorance than anything else; and certainly most of the important daily journals have evinced a desire to give the other side of the picture. In my own experience alone, apart from the representatives sent to interview me on the subject by the *Morning Post*, *Daily Telegraph* and *Daily Graphic*, I wrote two long articles for *The Times* Engineering Supplement on February 5th and 12th entitled "Submarine Cables and Radio-Telegraphy," wherein I endeavoured to fairly state the case from both standpoints.—I am, &c., CHARLES BRIGHT.

Parliament Chambers, Westminster, June 9.

LONDON POWER BILLS.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: The publication of the results of some of our work on the City Lighting makes me wonder whether it will be the occasion of more antagonism between those who are interested in gas and those who are interested in electricity. Personally I am a greater advocate of going to bed when it is dark than of either gas or electric light, and as I desire above all to promote unity among men rather than discord, I will ask you to allow me to say a word to both parties in this discussion. When one observes the terrible waste of human life and material that is taking place, a waste that does not arise so much from the want of technical knowledge as from its neglect; when one looks upon the terrible farce that is proceeding once more before a Committee of Parliament, and when one carefully examines the cause of these dreadful things, one is led irresistibly to the conclusion that they arise from want of unity among men. Instead of adding one to one and making two, we are everlastingly subtracting one from one and making worse than nothing. This madness has proceeded so far that recovery is probably a difficult

matter—we are like people bound by some magic spell. Yet delivery from this spell must come sooner or later, and when trade is bad is the best time to stop and think, for when trade is good few of us will ever think of what we are really doing.

Now, both gas and electric light people are public servants fulfilling the same task in different ways. It is quite easily ascertainable as a matter of fact, and not as an opinion, that electricity can be under most circumstances cheaper for lighting and gas cheaper for heating; but even supposing this were not so, and that the fact were quite different, why should not both unite to do that which is best, and find some reasonable basis of agreement by which both should get a fair return for the services they render?

Of course, the suggestion of a combination between the gas and electric light people is enough to make the hair of the average trader stand on end, and justly so, if a superficial view of the case is taken. As buyers we all know the apparent advantages of price cutting, but try and trace out the whole system of trade competition, and we shall find that we gain 1d. in one pocket and lose 2d. out of the other, and that the whole thing is madness, which is bringing us to destruction. If we are going to admit that one man will not properly serve another man unless a third man is waiting to eat him up if he does not, then disaster is already complete. But I will not believe it, and I say the time is now ripe for men to take a more serious and simple view of what is proceeding and endeavour to stop the madness that is now destroying us.

I venture to send you a short piece from a report about the electric supply bills for London. The unity that I ask for among all parties interested in the electric supply of London I would like to see extended to those interested in gas, and as a practical man having the good of all the people of London at heart I do not believe that there would be a great deal of difficulty in preparing a scheme which would satisfy Parliament if we all tried to be reasonable.—I am, &c.,

Dorking, June 6. A. A. VOYSEY.

P.S.—It may be thought that there is an argument against what I have urged in the fact that the gas mantle, the metal filament lamp and the flame arc lamp have possibly been developed as the result of competition between gas and electricity, but it is no argument against me. Do we not all know that the great discoveries which have advanced the consciousness of man have been made for the love of truth and not for the love of self? Is not my own experience like that of all men, that the less I think of the size of my salary the better my work becomes? If we were not madly trying to eat each other up we might now be considering a scheme for the partial conversion of gas works to join with the electric light works in endeavouring to give London the cheapest possible light with a reasonable profit, instead of wasting our money over propositions for further waste and chaos.

[We regret that lack of space prevents us from reproducing the interesting extract to which Mr. Voysey refers.—ED. *E.*]

RE "LIMIT INDICATORS."

TO THE EDITOR OF THE ELECTRICIAN.

SIR: I am unwilling to intrude on your space, but would like to correct a mistake that has occurred in the report given in your issue of the 5th inst. of the discussion at Glasgow on the recent Paper by Mr. Handcock and myself.

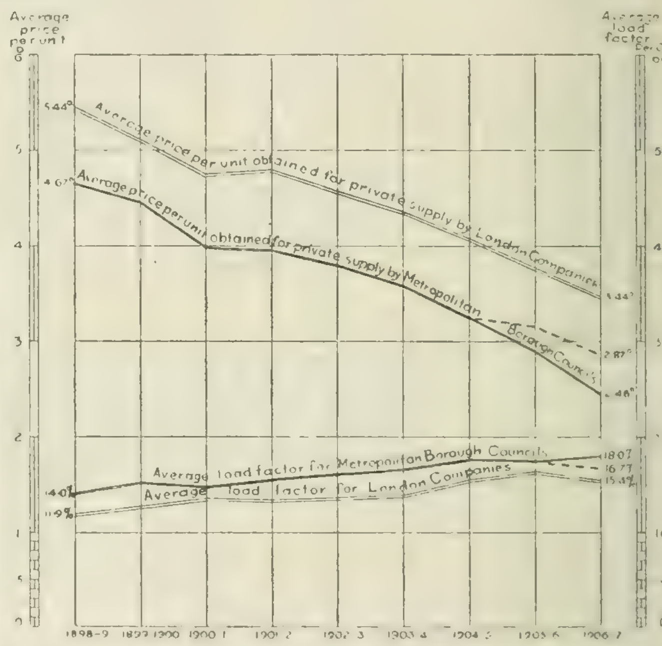
Mr. Lackie suggested that the Limit Indicators would be of no use for arc lighting, and in my reply I am made to say that the "Limit Indicator was not made for arc lamps." What I did say was: "I did not think arc lighting would present any difficulty, as even if the excess current caused the indicator to act, it merely lowered the voltage somewhat until the arc was struck."—I am, &c., A. H. DYKES.

Canadian Electric Power. The report of the Canadian Section of the International Waterways Commission advises that all companies developing electric power from the Niagara Falls should be compelled to supply the Canadian demand proportionately and at reasonable rates, and should only be allowed to export the surplus to the United States. The report also advises that export be controlled by the Federal Government.

ELECTRICITY SUPPLY IN AND AROUND THE COUNTY OF LONDON.

We have received a copy of the annual return issued by the London County Council Local Government and Statistical Department for the year 1906-7, in connection with electricity supply in and around the County of London. It shows the various authorities and their areas, together with an analysis of the accounts for the year ended March 31, 1907 (or December 31, 1906), in respect of each undertaking, and also miscellaneous statistics relating to the area of supply, capacity, output, charges, average prices obtained, &c. Separate tables are given in all cases for the London undertakings and the extra-London undertakings, the figures for the borough councils and the companies being kept distinct.

The returns made show that the total plant capacity of the London borough council undertakings is 58,124 kw. and the equivalent number of 8 c.p. lamps connected 2,494,246, this figure including 24,345 H.P. of motors; whilst the London companies' plant capacity is 190,599 kw. and the equivalent 8 c.p. lamp connections 8,440,978. Owing to four of the companies not supplying the required figures, the total horse-power of motors is not ascertainable, but the total for the companies of which particulars are given is 47,211 H.P. For the extra-London undertakings, company and municipal, the complete totals are 55,549 kw., 1,812,083 lamps and 11,646 H.P. respectively.



The broken line (----) shows the average for the Metropolitan Borough Councils, including St. Marylebone.

CURVES SHOWING STATISTICS OF LONDON ELECTRICITY UNDERTAKINGS FOR THE LAST NINE YEARS.

The total number of units sold by the London municipal undertakings is 53,716,756, including 13,316,427 for power and heating, and by the company undertakings 115,723,894, including 20,648,982 units for power and heat, 10,323,294 for traction supply, and 585,231 for bulk supply. The average load factor for the former undertakings works out at 16·73 per cent., or 18·05 if St. Marylebone is excluded, and for the company undertakings 15·36 per cent. The complete totals for the extra-London undertakings are 47,169,140 units and 17·09 per cent. load factor, the former figure including 5,826,093 units for power and heating, 16,938,824 for traction and 181,597 for bulk supply.

Under the heading finance, the accounts of the various undertakings are analysed, and the figures show that the total capital expenditure of the London municipal electricity undertakings is £5,741,527, and of the companies £13,140,095, these figures working out in each case at £99 per kilowatt of plant installed, or £45 and £55 respectively, if mains, meters, &c., are excluded. The revenue totals are £624,749 and £1,554,748 respectively, the equivalent average price per unit sold being 2·79d. and 3·23d., whilst the corresponding average figures for the total costs per unit sold are 1·39d. and 1·55d. respectively. The financial results are that the municipal undertakings required £10,909 assistance from the rates, although £310,053 was available for debt charges, whilst £843,697 profit was available for interest, &c., in connection with the company undertakings. All the above figures relate only to the London undertakings, the figures for the extra-London undertakings are, however, given in the return.

Refuse destructors are worked in conjunction with six of the council electricity undertakings, and 5,537,368 units of electricity were generated by such destructor steam, the amounts charged to the electricity accounts averaging 0·35d. per unit generated, the balance charged to the general rate account being 3s. 4½d. per ton of refuse destroyed

Comparative statistics are given for the metropolitan borough councils and London companies for the past nine years as regards (1) the average price obtained for private supply, and (2) the load factor; and we reproduce herewith the curves given in the return showing these particulars in graphical form.

TESTS ON 220 VOLT JUST-WOLFRAM LAMPS.

The struggle at present going on between carbon and metallic filament lamps on the one hand, and between high and low-voltage lamps of the latter class on the other, is of great interest to every electrical engineer. Figures relating to the life and efficiency of the high-voltage metallic filament lamp have, for commercial reasons, been somewhat meagre, and we, therefore, take this opportunity of recording some tests on the subject which have recently appeared in the *Elektrotechnische Zeitschrift*:—

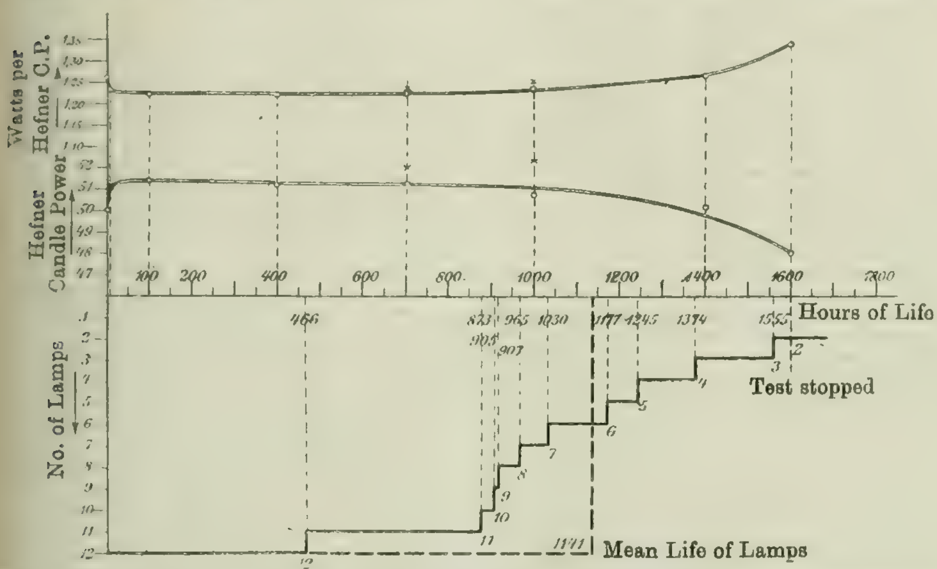


FIG. 1.—RESULTS OF LIFE TESTS ON 12 220 V. 50 HEFNER C.P. JUST-WOLFRAM LAMPS CARRIED OUT BY THE PHYSIKALISCH TECHNISCHE REICHSANSTALT ON CONTINUOUS CURRENT.

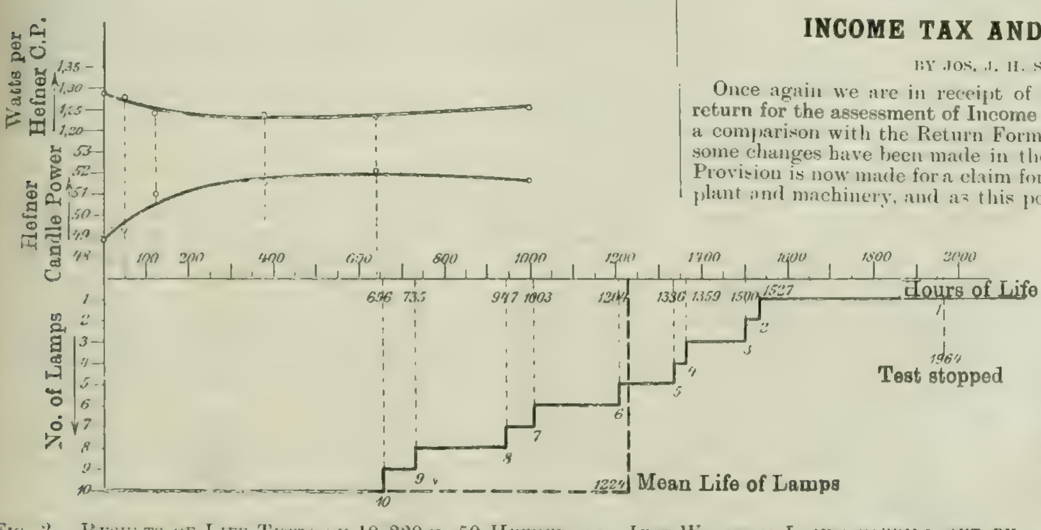


FIG. 2.—RESULTS OF LIFE TESTS ON 10 220 V. 50 HEFNER C.P. JUST-WOLFRAM LAMPS CARRIED OUT BY THE WOLFRAM LAMPEN A.G. ON ALTERNATING CURRENT.

The Wolframlampen A.G., of Augsburg, who showed one of their 220 volt lamps at the Annual Meeting of the Vereinigung der Elektrizitätswerke at Stettin last year, have further improved their methods of manufacture, and now send us (*E.T.Z.*) the results of some tests carried out on 12 of these lamps at the Physikalisch-Technische Reichsanstalt and on 10 in their own laboratories. The former were connected to direct current and the latter to alternate current circuits. The results of these tests, which are set out in Figs. 1 and 2, show that the high-voltage lamp is very little inferior to the low-voltage lamp as regards efficiency, and not at all as regards durability and length of life. The progress of the tests, both in candle-power and efficiency, is well shown in the two accompanying curves.

During these tests the filaments of certain lamps burnt through and then re-welded. This re-welding occurred with two lamps tested by the Reichsanstalt and, on account of the shortening of filament so produced, caused a considerable rise in candle-power. The candle-power of these lamps, from that time onward, was not taken into account in estimating the mean values. One lamp also re welded during the tests made in the company's laboratory, but this did not alter the candle-power, and its further values are included in the tests.

Figs. 1 and 2 show the relations between candle-power and efficiency, the number of lamps under tests, and the time at which certain of these burnt out. The crosses on the Reichsanstalt curve show the values that would have been reached had the re-welded lamps been taken into account.

The life tests at the Reichsanstalt were continued for 1,600 hours. Two lamps remained unbroken at the end of this period, while the mean life of the whole was 1,141. The mean candle-power remained constant for 1,400 hours, while the mean current during the same time increased 1·5per cent., giving an average efficiency of 1·23 watts per Hefner candle-power. In the laboratory tests the last photometric measurement was made at 1,000 hours, when seven lamps were still burning. The candle-power was at that time about 6 per cent. higher, and the efficiency 1·25 watts per Hefner candle-power, about 1 per cent. less than at the start. Those lamps which had not burnt out at 1,000 hours were left in circuit, and one of these was still burning at the close of the test, 1,964 hours. The mean life for the 10 lamps was 1,224 hours.

INCOME TAX AND DEPRECIATION.

BY JOS. J. H. STANSFIELD.

Once again we are in receipt of the familiar Form for making a return for the assessment of Income Tax under schedule D, and from a comparison with the Return Forms of previous years it is seen that some changes have been made in the direction of greater simplicity. Provision is now made for a claim for an allowance for depreciation on plant and machinery, and as this point is of considerable interest to those engaged in electrical, as in other, professions, I will deal with the deductions that may be claimed and allowed for the wear and tear of machinery and plant. But before doing so it will be of interest to explain the method of assessment at present in force.

At the commencement of the financial year it is the duty of the local assessor of each parish to prepare a list of persons who are, in his opinion, liable to assessment under schedule D, and to issue a form of return to be sent back to him containing particulars of the profits chargeable under that schedule. At the same time there is also sent to employers a further form for entry thereon of the names and remuneration of persons solely in their employ who are in receipt of more than £160 per annum, together with the names and remuneration of those partly employed even if the sum paid to them is less than that amount. On receipt of the forms the assessor completes the list, giving his estimate of the profits or income chargeable in cases where no return has been made.

From the list furnished by the assessor the clerk to the General Commissioners prepares the assessment, giving, for purposes of comparison, particulars of the amounts returned and assessed in each of the three preceding years, and the assessment is then delivered to the Surveyor of Taxes who makes a further application to those who have not made any returns. He checks the correctness of the entries, inquires into doubtful cases, enters the amount of assessable profit as ascertained from the accounts of public companies, and notes for the information of the Additional Commissioners particulars of insufficient returns, omissions and undercharges of which he may have cognisance.

The Additional Commissioners (who are appointed by the General Commissioners) then fix the assessments (their meetings being attended by the Surveyors of Taxes), which assessments are delivered to the General Commissioners who, after an interval of 14 days, cause notices of charge to be issued to the persons assessed, giving the dates of meetings fixed to hear appeals. The notice of appeal must be given or sent to the Surveyor not less than 10 days before the date of hearing, accounts in evidence of the grounds of appeal being also required to be furnished to the Surveyors before that date. This evidence is examined, and the Surveyor in many cases interviews the Appellant, as a result of which interviews the bulk of the appeals are settled out of Court. Should the case go to appeal the Surveyor attends on behalf of the Crown, and the General Commissioners fix the liability. From such determination there is no further appeal except to the High Court on a question of law.

In practice it has been found hitherto that a large number of persons have failed to make the necessary returns, and the law has recently been materially strengthened on this point. Under sec. 22 of the Finance Act, 1907, it is enacted that every person to whom a form of return is sent must make the return *whether he is chargeable or not*, failing which he is, if subject to the payment of income tax, liable to a penalty under sec. 55 of the Income Tax Act, 1842, of £20 and treble duty if sued before the Commissioners for the district, and £50 and treble duty if sued before the Courts; the latter remedy being necessary in default of prosecution within 12 months, the final date of prosecution being limited to a period of two years. In the case of a person proving that he is not liable to assessment, the penalty is now limited by the Finance Act of 1907 to a sum not exceeding £5.

These penalties are also chargeable in the case of an incorrect return being made, and as there is a distinct appearance that the future will see a much more drastic use made of the powers allowed by the law, it will be well not to be caught napping.

In the Income Tax Acts of 1845 and 1853 no specific provision was made for a deduction to cover depreciation in capital value due to deterioration not made good by repairs; the actual costs of repairs of premises, plant and machinery, and of the supply or repair of implements and utensils only being allowed. The practice became, however, gradually more liberal than the letter of the law, and the expression "the supply or repairs or alterations of any implements, utensils and articles employed for the purpose of trade, manufacture, &c.," was after a time interpreted to mean renewals, and in 1878 legislative sanction was formally given for such allowances, the act of that year stating that the General and Special Commissioners may "allow such deduction as they may think just and reasonable as representing the diminished value by reason of wear and tear during the year of any machinery or plant used for the purposes of the concern."

The exact meaning of the words above quoted from the enactment of 1878 has given rise to more than one dispute being carried to the Courts for interpretation, as it is not clear whether the words mean anything more than that loss by depreciation may be allowed, even though no expenditure has been incurred during the year for repairs in keeping the plant and machinery in a working condition, or whether it means that, after all damage by wear and tear has been made good by repairs short of actual renewal a further allowance may be made in respect of the imperceptible and irremediable deterioration due to age. In the case of the Caledonian Railway Co. *v.* Banks it was held that an allowance could not be claimed on newly added rolling stock which had not required any repairs, and that "deduction for wear and tear" means "deduction for diminished value as a means of earning income and not as a ratable subject," which is obviously a very important difference as reducing considerably the amount which can be deducted before the net assessment for income tax is arrived at. It needs little argument to prove that, whilst the earning capacity of the plant and machinery may, by repairs and maintenance from time to time be very little reduced the difference in value between the new plant and plant once put into use is very considerable, and increases rapidly with age.

It was clearly laid down in 1881 in the case of Coltness Iron Co. (Ltd.) *v.* Black that it is vain to speculate what would be the fairest and most equitable mode of levying income tax. The object of those who frame a taxing act is to obtain a revenue, and when any enactment can bear two interpretations it is reasonable to put that construction upon them which will produce that effect. On this reading the interpretation of the section in the 1878 Act quoted that should be followed is the one that will produce the most revenue, but fortunately for taxpayers the opinion of the Board of Inland Revenue and the practice of most Commissioners and Surveyors follows the latter and more liberal reading, and the practice is yearly becoming more favourable to the manufacturer. Indeed, notwithstanding this decision it is stated in a letter to the secretary of the Association of Chambers of Commerce in 1897, that as the law now stands, the actual expenditure in repairs and maintenance may be properly claimed and allowed in addition to, and not in substitution of, an allowance for depreciation.

A further legislative step in the direction of making allowances was taken in 1894, when, by the Finance Act of that year, a deduction of one-sixth from the rack rent value of buildings was authorised as an allowance to meet the cost of maintenance and repairs. It is not so stated specifically, but it would appear that the eventual replacement of the buildings was covered as the allowance was granted on a recommendation by Mr. Hubbard in 1861, in which he stated that he had adopted this figure of one-sixth as being calculated "to cover the ultimate revenue of the fabric when decayed by age as well as current repairs." This allowance was, however, withdrawn from owner-occupiers of trade premises by sec. 9 of the Finance Act, 1898, which directed that in estimating the amount of profits chargeable under schedule D only the net assessments under schedule A should be allowed instead of the full annual value, and thereby limiting the allowances for wear and tear of buildings to the actual expenditure charged in the accounts.

In 1897 the concession in respect of wear and tear of machinery was carried somewhat further when, in the letter to the secretary of the Association of Chambers of Commerce before referred to it was stated that where a claim is made in respect of the introduction of more modern machinery into a factory no objection is to be taken to an allowance of so much of the cost of replacement as is represented by the existing value of the machinery replaced. In other words it was definitely laid down that an allowance might in future be made within the discretion of the Commissioners for the replacement of obsolete machinery, it being understood that any excess in the cost of the new machinery over and above the actual present value of the machinery replaced, was not to be included as being an addition to the capital and, therefore, not properly to be regarded as a charge upon revenue for income tax purposes. This is, in effect, a partial allowance for obsolescence, as the letter was written in consequence of the representations of Leicester hosiery manufacturers, who had found it necessary to replace certain machinery for more up-to-date plant in consequence of competition, and though it appears that the principle has been followed pretty largely in many other districts, it does not seem to have been held to apply to heavy plant, the allowance being somewhat arbitrarily confined by the Commissioners to light and running machinery.

This is not a full acceptance of the principle of an allowance being properly claimable for obsolescence, as it does not apply unless machinery is actually replaced, and in the case of Burnley Steamship Co. *v.* Aiken, decided in 1894 in the Scotch Courts, it was held that the Act of 1878 did not cover depreciation through obsolescence, the Lord President stating that the words "diminution of value through wear and tear in a year" plainly pointed to the physical deterioration going on in the subject which is being considered, and that to bring in under these words the fact that a ship is relatively of less value because during the year other people have built better ships seemed to strain the language of the section in a way which was entirely unwarranted.

As regards the depreciation of plant and machinery, no precise scale of allowances has been fixed, although certain rates have been established in various districts on different classes of machinery, concessions under this head having grown from £4,100,000 in 1893-4 to £12,700,000 in 1902-3. These rates are contained in an appendix to the report of the Departmental Committee on Income Tax issued in 1905.

The statement is in a Blue Book, and therefore not commonly accessible, but it is of considerable value to all who are financially interested in the use and running of plant and machinery and so is given here in part, together with the names of the districts in which the rates have been definitely established.

Tramways.—4½ per cent. average over all divided in detail as follows: 2 per cent. poles and rosettes and depot fittings; 3 per cent. cables, ducts, and section boxes; 5 per cent. telephones, electric power and sub-station plant, rolling stock, and furniture; 7½ per cent. car works, machinery, permanent way plant and punches (Glasgow).

Boot Trade.—7½ per cent. on full value (Leicester).

Breweries, Collieries and Coal Exporting Plant.—5 per cent. on written down value (Cardiff).

Dyers and Trimmers.—7½ per cent. on full value and 10 per cent. if justified on inquiry (Leicester).

Engineers.—7½ per cent. on full value (Leicester) and 5 per cent. on written down value (Cardiff).

Hosiery.—7½ per cent. on full value, higher if justified (Leicester), and 5 per cent. on fixed machinery (Nottingham).

Lace Making.—5 per cent. on full value or 7½ per cent. on written down value (Nottingham).

Looms and Spinning Machinery.—5 per cent. on motive plant; 7½ per cent. on spinning, dyeing, carding and finishing machinery (Huddersfield); 5 per cent. on engines, boilers and gearing, and 7½ per cent. on spinning machines (Oldham).

Newspaper and Printing.—10 per cent. on printing machinery running double shifts (Dundee); 6 per cent. on ruling and book binding machines, type, linotype machines, &c., or 7½ per cent. to include the renewal of type not charged to revenue (Glasgow); 8½ per cent. on written down value (Nottingham); 5 per cent. on written down value; 7½ per cent. on written down value for newspaper printing machines and 15 per cent. on type (Cardiff).

Sewing Machines.—10 per cent. on machines used in clothing factories, replacements being all charged to capital (Glasgow); 10 per cent. without that provision (Nottingham).

Ship Repairing and Shipbuilding Plant.—5 per cent. on written down value (Cardiff).

Spinning and Woolcombing Machinery.—7½ per cent. on written down value when running night and day but reduced where heavy amounts are charged for repairs and renewals (Bradford).

Weaving.—5 per cent. on looms (Bradford); 5 per cent. on fixed boilers, engines and machinery, and 7½ per cent. on loose machinery, &c. (Blackburn); 7½ per cent. on spinning, weaving, carding, finishing

and condensing machinery, and 5 per cent. on motive plant, shafting, &c. (Huddersfield).

An examination of the foregoing will show a great want of uniformity, partly because the law is not definite on the point and partly because each trade is considered on its merits by the District Commissioners acquainted with the local conditions of running, &c., it being left to them to decide what is just and reasonable, there being, as previously stated, no appeal to the High Court except on a question of law. It has frequently been suggested that the rates should be made uniform, but the Board of Inland Revenue consider that there are too many classes of machines, too great differences in the durability of the plant and machinery and too great variation in the usage to permit of the adoption of a rigid rate allowance to be fixed by statute.

Up to last year it was a grievance that where the year's business resulted in a loss, or in a profit not sufficient to cover the allowance claimed for wear and tear, the deficiency could not be taken into account in succeeding years; but by sec. 26 of the Finance Act, 1907, this has been remedied. It is, however, important to remember that yearly application must be made for this allowance, even if no profit or an insufficient profit has been made. This change of the law is of special importance to those interested in electric power and lighting undertakings, in view of the fact that the earlier years of working so often result in a loss or a comparatively small return on the capital invested.

It is not clear whether it is intended that the section shall apply retrospectively. If it does not, the lapse of three or four years from the passing of the Act will overcome this difficulty.

The evidence on which the additional allowance is based seems to bear out the conclusion that the allowance may be carried over for more than the one, three or five years of average as the case may be, according to the nature of the undertaking or trade. Certainly, if it does not, the hardship will not have been fully met. Take, for instance, a business in which for the first 10 years no profit, or insufficient profit, has been made to allow for the full rate of depreciation. If in the 11th year a profit is made sufficient to meet, say, six years' depreciation, and only three can be allowed, some considerable dissatisfaction and inconsistencies would be caused. The words of the subsection read shortly as follows:—

"Where as respects any trade full effect cannot be given to the deduction for wear and tear in any year owing to there being no profits chargeable with income tax that year, or owing to the profits so chargeable being less than the deduction to which effect has not been given, as the case may be, shall, for the purpose of making the assessment for the following year, be added to the amount of the deduction for wear and tear for that year and be deemed to be part of that deduction, or if there is no deduction for that year, be deemed to be the deduction for that year, *and so on for succeeding years*."

The exact meaning of the words "plant and machinery" in the Act of 1878 is not yet decided. It was recommended by Sir Thomas Hewitt, K.C., in his memorandum of evidence to be laid before the Departmental Committee which sat in 1905 that the principle to be adopted should be to allow a depreciation on all plant, machinery, furniture and other materials *which are used for the purpose of making the income to be taxed*. This broad principle has not, however, so far been accepted. As, for instance, in the allowance for depreciation for wear and tear on mining plant a deduction is made in respect of machinery, boilers, engines, shaft fittings, including headgear, ropes, pulleys, balance apparatus, steam pipes, gas fixtures, weighing machines, signalling apparatus and the like, whilst no depreciation is allowed for wear and tear on pit shafts, water lodges, buildings, excavating, embankments and brickwork for railways, tunnels and main roads; railway and bridge rails, coal tipplers, carts, pit tubs, railway waggons and the like, a distinction which is not by any means easily obvious.

It is, however, so far satisfactory to find that the principle of making an allowance to cover the depreciation in the capital value of assets due to deterioration not made good by repairs, and an allowance in part in the case of obsolete machinery is now definitely established.

PURE SCIENCE AT THE FRANCO-BRITISH EXHIBITION.

The arrangement of a purely scientific exhibit at such an exhibition as that now being held at Shepherd's Bush must be a difficult task, and the promoters are, therefore, to be congratulated on the way they have acquitted themselves. They have, we think, done right in limiting the exhibits mainly to subjects of historical interest, which will nevertheless appeal with greater force to "the man in the exhibition" than would some highly complicated, but more modern, and at the same time more incomprehensible, mechanism. The range of the exhibits is very wide, stretching from Astronomy to Anthropology, and it would take a longer time than we had at the private view on Wednesday to inspect and fully assimilate all the objects of genuine interest. We shall, therefore, content ourselves with simply referring to those exhibits akin to electrical matters.

The Wheatstone Laboratory of King's College, London, are showing some apparatus belonging to the late Sir Charles Wheatstone, including the original Wheatstone bridge, and also Clerk Maxwell's dynamical model for illustrating primary and secondary circuits. Prof. J. A. Fleming has two examples of his well-known cymometers, and Dr. P. E. Shaw an electric micrometer capable of measuring to 10^{-8} in. Sir Wm. Preece has an interesting telegraph exhibit, including some articles of Diamond Jubilee interest, several examples of early submarine and other telegraph cables and early railway telegraphic instruments. The Postmaster-General also shows historical apparatus dealing with telegraphy and telephony; among these is the apparatus used in the experiments with the electromagnetic induction system of wireless telegraphy between Lavernock and Flatholm in 1897. Historical telegraph apparatus is also shown by Mr. George Neale. Among the most interesting exhibits are doubtless those shown by Mr. Marconi. They consist of a complete series of coherers from 1895 to the present day, early and modern magnetic receivers, early multiple and enclosed spark gaps, and the revolving discharger first used at Poldhu, early transmitting jiggers and aerial tuning inductances and early receiving jiggers and a modern multiple tuner. Prof. A. Gray shows apparatus used by the late Dr. Kerr in his experiments on the rotation of the plane of polarised light by a magnet and the historical apparatus of Joule. The recent development of the metallic filament lamp makes Sir J. W. Swan's exhibit of peculiar interest. It consists of a number of early electric lamps which, compared with those of the present day, show a number of wide differences. The same remark applies to Profs. Ayrton and Perry's exhibit, which includes a number of historical measuring instruments. These are the "Rockets" of electrical measurement, and, though out of date now, have laid the foundations for the modern instruments, and are, therefore, not lightly to be passed over. Mr. Shelford Bidwell shows some selenium cells and apparatus dealing with telegraphic photography. Of course, in such an exhibition the Cambridge Scientific Instrument Co. could scarcely be left out, and the best way of describing their products is to invite our readers to go and see them. Most modern precision instruments are represented, including delicate galvanometers due to Ayrton and Mather, Broca, Einthoven, Dolezalek and Duddell. An oscillograph, thermo-ammeter and magnetic standard due to Duddell, standard resistances and cells are also found. Electricity is also represented in the section devoted to oceanography, where the most interesting exhibits are those of the Eastern Telegraph Co., showing a model of the bed of the Atlantic, the first submarine message, and cables covered with various extraordinary growths. The National Physical Laboratory have taken this opportunity of bringing their work before the public, a special section being devoted to it. It is mainly of the illustrated description, showing by means of photographs the new laboratories already described in *The Electrician*. There is, however, a great deal of apparatus, including Mr. Campbell's inductance standard, the Clark and Weston cadmium cells, and the Ayrton-Jones current weigher.

PARLIAMENTARY INTELLIGENCE.

LONDON ELECTRIC SUPPLY BILLS.

ERRATUM.—In our report of Mr. E. Wilmot Seale's evidence before the Committee on Wednesday last, in the 15th line the figures 527 H.P. should read "5,720 H.P. was supplied electrically."

In our last issue the report of the proceedings before the House of Lords Committee on the London & District Electricity Supply Bill was continued up to the end of Mr. Forbes' evidence on Thursday morning, June 4th. The remaining portion of the evidence in opposition to the bill is given below.

Mr. A. F. HARRISON, secretary of the City of London Electric Lighting Co., said his company had done everything possible to push power supply, and had continuously reduced their prices. They had 1,048 power consumers, with an average demand, excluding heating, of 9·83 kw. Excluding the 28 largest consumers, the average fell to 4·45 kw. Four consumers took over 200 kw., and from these the company derived a revenue of £11,879. Some of their consumers were being supplied at ¾d. per unit. The total units sold for power purposes represented 27·19 per cent. of their present load. The promoting company would compete for £29,296 of his company's revenue in respect of railway companies, public lighting, and users of over 250 kw. As mentioned by Mr. H. B. Renwick, of the County of London Company, an exhaustive canvass had been made by the present undertakers in 1906-7 to obtain figures as to the total horse-power demand. In the case of the City of London Company's area, the canvass showed a total of 25,722 H.P. of various kinds. Of this, his company supplied 10,500 H.P., and 3,950 H.P. was supplied by other companies, making 14,450 H.P. of electric power, or 56 per cent. of the total power in use in the company's area. Since the canvass had been made, the use of electric power within the area had greatly increased, and the total now supplied was 19,899 H.P., or over 77 per cent. of the total horse-power within the area.

Mr. C. P. SPARKS, engineer-in-chief of the County of London Electric Supply Co., questioned the accuracy of the tables put in by the promoters. Tables 10 and 10A were based on an insufficient knowledge of what his company had been doing during the last two years. The promoters estimated that his company's increased output would cost ½d. per unit. Witness computed it would not cost his company more than 0·36d. This figure was based upon his actual knowledge of the diminished cost at which increased units had been produced. By taking their supply from the promoting company, his company would lose £34,973 at the estimated prices, or £69,820 at the maximum prices. This was instead

of saving £29,899, as given in the promoters' tables. He considered the chance of the promoters inducing authorised distributors to take energy was very remote. His company could extend more cheaply than the cost would be to the new company. New machinery could be purchased at a price not exceeding £12 per kw. It would cost the promoting company for machinery and distributing mains about £30 per kw. In regard to the proposed station at Barking, Bankside was a large station on the side of the river with similar facilities. The coal was sea borne, and the water was drawn direct from the river. The stations at Dartford, Blackwall and Wandsworth were similarly well situated.

Mr. BALFOUR BROWNE, K.C., then summed up the case against the bill. The preamble, he contended, had not been proved, and he would ask their lordships to say that the preamble had not been proved. Although the supply of electrical energy was at the present time in the hands of various local authorities and authorised companies, each respectively having powers to supply in certain limited areas, necessitating a large number of separate generating stations and thus causing the supply to be unduly expensive, not a tittle of evidence had been brought before them to show that electrical energy was so expensive as to limit its use; indeed everybody who had been called before them had said that they were getting current from one or other of the companies or local authorities at a moderate rate. Of course, each of them had said that if they could get it cheaper they would like to have it. The position of the companies had, he thought, been put fairly well before their Lordships. They had embarked a large amount of capital in their enterprises for supplying light and power to London. Although at one time those companies were merely electric lighting companies he thought their Lordships would now be convinced that power supply had become a very important part of their business, and that they had done their very best to foster and encourage that business, and had succeeded as well as anybody could expect to do in London. There were certain power users who would not take electricity until their steam plant was worn out. In the City they were already supplying 84 per cent. of the power used in the area. When Mr. Merz's bill was first introduced it was stated that the existing concerns only supplied something under 7 per cent. of the power used in the London area. That was a startling statement, and led to more than one well-known public man expressing the opinion that something ought to be done and done quickly to cheapen electricity for power purposes. He thought their Lordships would be satisfied that sufficient evidence had been put forward by the companies to entirely refute Mr. Merz's statement. Over the whole area of London the companies were supplying 46 per cent. of the possible maximum load and the local authorities 25 per cent. The companies opposed the present bill because in the first place they said that to introduce a new power company into London was a breach of a Parliamentary bargain; secondly, they said it was a competitive scheme with the existent companies, as it would go far to take away from them their best customers, as the companies covered practically all the ground there was to be covered; thirdly, they submitted that there was no one in any of their areas who could not get a supply at a reasonable price, and that therefore there was no room for this new company; fourthly, that the scheme could not succeed financially; and fifthly, that no return could be made by the promoting company to investors for years except out of capital, and that could be done by any purchasing authority. He submitted that the problem of supplying cheap electricity to London, instead of being solved by the passing of this bill, would be postponed indefinitely and the progress of the existing companies would be stayed, and neither party would be able to proceed owing to the difficulty of getting new capital for so many concerns. He asked their Lordships first to consider the matter in the light of the Parliamentary bargain. They had been authorised by Parliament to supply in certain districts, being at the same time put under certain restrictions, which to some extent crippled the industry, and the companies considered that they were entitled to the protection of Parliament, Parliament had always been unwilling, after having given a concession, to take that concession away, either directly or by granting powers for a competing concern in the same industry. It was true that the 1888 Act did allow a certain amount of competition, but such competition, he submitted, was intended only to be between the two kinds of current, the lighting companies then supplying alternating current, which at that time was not considered suitable for power users. The powers of the companies were restricted under their orders and they were prohibited from getting a supply from a neighbour, but if they were given the extended powers sought so that they could make arrangements with all the small companies outside the area to turn their stations into large power stations, utilising the present stations in the area as peak load stations, they would be able to practically carry out all the present bill sought to do. Competition had been found to be disadvantageous in the case of gas supply for London, why therefore should it be brought into being in the case of electricity supply. If the new company came in what became of the existing companies' 42 years' term, the period for which they were to have the power to supply free of competition. It would be a serious thing, quite outside electricity supply, if it were once understood that Parliament, having once granted a concession for 42 years, and capital having been raised on the strength of that term, should do anything to injure or prejudice that capital. Competition brought in at this stage would, he urged, be unfair competition. On the strength of the 42 years' concession free from competition they had raised the very large sum of £14,000,000. The promoters of the present bill said they did not want the actual consumers, but they would supply in bulk the authorised distributors. It was absurd, however, to think that the authorised distributors would take current from the new company to enable them to compete more perfectly with themselves. Unless the authorised distributors took current the new company would never get on its legs, so that would it not be the height of folly for the authorised distributors to take current to enable a new competing company to get on its legs. The new company would, therefore, have to rely on individual consumers, and it was evident that they would have to get them from the existent concerns. Their only chance would be to compete for the large users—that is, of over 250 kw., and if the authorised authorities lost their largest consumers they would have to increase the price to the small consumers. The Charing Cross Company had power to supply in bulk in Bow and other districts, but had absolutely failed to get a local authority to take current in bulk from them. The new company would compete against the existing companies for every class of their work. They would compete for public lighting for instance, which was a valuable load. He represented there eight companies, and some of them were not so prosperous as others. It was possible that the new company under their powers in clause 73 might buy out one of those companies and would then come into direct competition with the other companies. As to finance, he did not think the promoters, if they got the bill through, would be able to get their capital, but what they would have would be something to negotiate with the existing companies. If the bill went through and the promoters could not get their capital it would harm the existing companies as it would prevent them raising additional capital with such a competitive bill hovering over their heads. It had been admitted in evidence that the promoters could not get their capital unless they had contracts to justify such a capital, and he thought he had shown that they would not be able to get such contracts.

Mr. CLEASE, interrupting, asked permission to state at that point the position with regard to the London County Council from the financial standpoint. The Council was anxious that their Lordships should be satisfied that the bill, if it was to go through, should solve the question of power supply for London effectively, and that the capital should be guaranteed in such a way that it was sure to be raised.

The CHAIRMAN said the point was that the financial guarantees should be ample to enable the company to go forward with its work.

Mr. BALFOUR BROWNE, continuing, said he thought there was little chance of the company raising its capital, and that the bill, if it passed, would fail to be carried out. The real solution of the question of power supply for London would be shown in the bill which he would have the honour of presenting later on. There would be no difficulty in their getting the £1,000,000 required if their bill went through alone, but it could doubtless be raised even if the present bill were passed and the promoters of that measure were also in the market for money.

The Committee then adjourned to the 16th inst., the Chairman intimating that in the interim the promoters might possibly be able to come to an arrangement with the county councils as to a mutually acceptable purchase clause.

A Science Museum.—In the House of Commons last week Sir Wm. Anson asked the President of the Board of Education whether, having regard to the insufficiency of the present temporary buildings at South Kensington for the housing and display of the collections of scientific instruments and apparatus belonging to the Government, and to the importance of making these collections useful to teachers and students of science, and to the Imperial College of Science and Technology, he would consider the advisability of erecting a suitable building for a science museum on the site of the existing temporary galleries.

Mr. MCKINNON WOOD, who replied, said he thought it would be eminently desirable that there should be a science museum properly housed in immediate proximity to the Imperial College of Science and Technology, and if the Commissioners of the 1851 Exhibition were in a position to co-operate, he would bring the matter under the notice of the Chancellor of the Exchequer; but any steps requiring financial assistance from the Government could only be undertaken with due regard to the general calls upon the Exchequer.

LEGAL INTELLIGENCE.

Workmen's Compensation.

Last week the Court of Appeal (the Master of the Rolls and Lords Justices Buckley and Kennedy) heard an appeal in the case Fitzgerald *v.* W. G. Clarke & Son, by the applicant for compensation from a decision of Judge Smyly, at Bow (London) County Court. It appeared that Fitzgerald was a workman in respondents' factory to fill boxes with biscuits. On the premises there was a crane to lift sacks of material to the different floors, and one morning, while at work on the ground floor, he heard one of the workmen say: "Let's hang him." At the same moment he felt the hook at the end of the chain attached to the crane slipped under his necktie, and he was whirled upward. When the crane had lifted him about 50 ft. from the ground the necktie gave way; he was dashed to the ground, and so badly injured that he was a cripple for life. The judge found that there had not been an "accident," because the men only intended to play a practical joke upon him.

For respondents it was said that the men had been prosecuted and convicted of doing the applicant grevious bodily harm.

After hearing legal argument for applicant, and without calling on counsel for respondents, the MASTER OF THE ROLLS said he thought they were bound by Armitage *v.* Lancashire & Yorkshire Railway Co. to dismiss the appeal, and to hold that the employers were not liable for the tortious act of applicant's fellow workmen. The accident could not be said to arise out of his employment, but was the result of a cruel practical joke and had no relation to his employment.

The Lords Justices concurred.

MUNICIPAL, FOREIGN & GENERAL NOTES.

APPOINTMENTS VACANT AND FILLED.

A superintendent is wanted for electrical manufacturing shop. Applicants must have had first-class experience in the manufacture of alternating and direct-current machinery of all sizes and shapes and must be thoroughly capable of managing men. Applications to Messrs. Vickers, Sons & Maxim, Sheffield. See an advertisement.

An engineer is required for a company now forming. Salary £400 rising to £700, to a thoroughly capable and qualified man. German and French advantageous. See an advertisement.

Carlisle Corporation require a station superintendent for their electricity works. Salary £130. Applications to City Electrical Engineer by June 15.

The Governors of the Northern Polytechnic Institute, London, invite applications for the position of head of the physics and electrical engineering department. Salary £300 per annum. Applications to the Clerk by June 29.

At their last meeting Liverpool City Council confirmed the recommendation of the Tramways and Electric Power and Lighting committee to appoint Mr. C. W. Mallins, A.I.E.E., general manager of the Corporation tramways.

Mr. Mallins has been connected with the Liverpool tramways for upwards of 34 years, and became traffic manager when the Corporation took over the undertaking from the Liverpool United Tramways & Omnibus Co. in September, 1897. Since this time an enormous development has taken place in connection with the tramways. The passengers carried have increased from 38,409,084 to 124,043,239, the receipts from £290,743 to £572,822, the car mileage from 6,013,182 to 12,?71,799, vehicles in service 267 to 505. £162,662 has been handed over to relief of rates, and £975,173 set aside towards redemption of capital and to reserve, renewal and depreciation account. Mr. Mallins has placed several of his inventions at the disposal of the Corporation, notably his patent sanding device, which has been the means of preventing numerous accidents and inspiring the drivers with greatly increased confidence in handling their cars on steep gradients; also his patent ticket punch, with which the Liverpool tramway service has been equipped. This is giving every satisfaction, resulting in considerable financial gain to the department. Since the death of the late Mr. C. R. Bellamy, Mr. Mallins has practically carried out the duties of general manager, and his appointment may be said to be the natural outcome of his services in that capacity.

Sunderland Corporation have appointed Mr. V. A. Mundella, M.A., B.Sc., head of the Physics and Electrical Engineering department of the Northern Polytechnic Institute (London, N.) as principal of Sunderland Technical College, at a salary of £500 per annum. Dr. Baker, the acting principal of the College, was also a candidate for the principalship, but some of the members thought the principal should be a physicist and not a chemist, and consequently the recommendation of the Sunderland Education committee to appoint Mr. Mundella was approved at the Council meeting on Wednesday.

Mr. C. Olsson, acting electrical engineer of the New Hillgrove (N.S.W.) Proprietary Mines, has been appointed instructor in electricity at the New Hillgrove Technical College, in succession to Mr. H. J. Wright, who has vacated that position, as well as the post of electrical engineer to the company, in order to assist in carrying out an electric power scheme in Victorian mines.

Mr. G. L. Kirk has been appointed engineer and manager of the Sheerness & District Electric Power & Traction Co., in succession to Mr. A. A. Watkins, who goes to Musselburgh.

EDUCATIONAL NOTICE.

East London College.—A course of three lectures on "Recent Developments in Electric Lighting" will be given by Prof. J. T. Morris, M.I.E.E., at 8 p.m. on Mondays, June 15, 22 and 29. Admission free by tickets. Application to the Registrar of the College. Sir Wm. H. White, K.C.B., F.R.S., will preside at the first of the three lectures.

Australasia.—The new plant at the Zeehan (Tasmania) electricity works is now complete.

The plant includes an underfired multi-tubular boiler capable of evaporating from 2,500 lb. to 3,000 lb. of water per hour, a 2 H.P. electric feed pump, a 165 B.H.P. Alley & Maclellan high-speed engine direct coupled to Parker dynamos, giving 110 kw. at 220 or 440 volts, a 222 cell 203 ampere-hour Tudor battery, a balancer booster outfit, consisting of four machines, each balancer being of a capacity of 31 amperes at 220 volts and the boosters 36 amperes, 75 volts, and a Silician marble switchboard. Six miles of additional feeders have been erected and 50 additional consumers connected. A demand is developing for motors, electric irons and fans, &c.

Electricity works are to be erected at Camperdown (Victoria), a town of 2,000 inhabitants.

Broken Hill (N.S.W.) Council were authorised in 1905 to purchase electric lighting plant, but the ratepayers have now refused to vote for a special lighting rate, so that the plant which has been purchased cannot be used.

The "Australian Mining Standard" states that the final arrangements were recently completed for the purchase by Sydney City Council of the undertaking of the Strand Electric Light Co. at £45,000.

The Arcadia Co.'s undertaking is also being acquired by the Corporation.

Bacup.—The Electricity sub committee have been instructed to prepare and submit particulars of a scheme of electricity supply for the district.

Barking.—Negotiations are said to be proceeding between the Electricity committee and the promoters of the London and District Electricity Supply Bill with regard to the transfer of the Council's electric lighting undertaking.

Bath.—The documents in connection with the sale of the municipal electricity works to Mr. E. Schenk have been exchanged, and a cheque for the amount of the deposit (£22,500) has been received by the Town Clerk. The sale is subject to the consent of the Board of Trade.

Bournemouth Tramway Accident.—The Board of Trade inquiry into this accident was concluded on Wednesday.

Driver WILTON stated that he was 30 years of age, had been in the employment of the Corporation for over five years as cleaner, conductor, and then as driver. On the day of the accident he took over the car from driver Allen, but the latter said nothing about the car, and he assumed it was all right. He did not notice there were three magnetic shoe brakes working instead of four. He usually used the hand brake only on level routes, and the magnetic brakes on gradients and emergencies. On the journey to Poole he commenced descending Constitution Hill with the magnetic brake applied, and increased it to four notches, keeping the car to four or five miles an hour.

The INSPECTOR: What did you do to the handles of No. 1 controller at the Poole terminus?—I took them off in the ordinary way.

Did they slip at all?—I had no difficulty. I took them off at the first time, in the ordinary way.

You had your large handle in the off position before you reached the terminus?—Yes, and when I stopped I simply pulled the reversing key, or the smaller handle, from the forward position into the off position, and lifted them off together.

Did you use the magnetic brakes at all on the return journey from Poole till you came to this hill?—No, sir.

Was it a good rail?—Yes. In places where the water cart had been it was a bit greasy.

When you started from the brow of the hill, what happened?—The hand brake was in use, and was applied before I started. I started the car to run about 3 to 4 miles an hour, then I knocked off the power and applied three notches of the magnetic brake.

What was the effect of the application of the brakes?—Nil; there was no work on the brakes.

You had then three notches?—Yes, and then noticing it had no effect I applied another notch. By the time the car had run a car's length I had found that the motors did not seem to make the usual humming noise. Generally the humming noise comes after a car's length.

Did you by that time know that the brake had failed?—No. I thought it had missed contact on one of the notches. I still worked more notches of the magnetic brake and was using sand, but with no effect.

What was the speed?—10 to 12 miles an hour, or perhaps a little more.

You then brought the handle round into the off position to let it run free round the curve?—Yes.

And stop it on the opposite side of the curve?—I knew very well I could not stop it on the curve.

How were you going to stop?—I was applying my magnetic brake notches again as I was going round the corner.

You made a second attempt to stop the car as it got round the corner?—Yes. Soon after I pulled back my reversing lever into the backward position and worked my power notches.

What was the result?—Nil. Instead of checking, as I was confident it would on the curve, it was nil. Instead of pulling up it pushed me forward.

What was the speed the car had got up then?—It must have been 20 to 25 miles an hour. My hand brake was on as hard as it was possible, but it did not check the car.

At the conclusion of the driver's evidence several witnesses were recalled to correct or maintain statements previously made, and Mr. P. S. Turner, electrical engineer, British Westinghouse Co., gave details of the construction of the electric controllers supplied to the car.

At the adjourned inquest yesterday (Thursday) the jury returned the following verdict: "Accidental death, caused by the car getting out of control owing to the defective controller." The driver was exonerated from blame. The jury recommended that more practical supervision should be exercised over the cars before leaving the depot.

Chester.—The Corporation recently decided, on the recommendation of the Lighting committee, to supply consumers of more than 25,000 units per annum for power with energy for lighting at power rates, provided the consumption for lighting does not exceed 10 per cent. of the demand for power.

Colchester.—Some time ago an action was commenced against the Corporation to restrain an alleged nuisance by vibration, &c., at the electricity works.

The matter was before the Council in committee last week, when it was proposed to establish an auxiliary generating station. The con-

sulting engineers and architect, and the Council in committee, recommended the Council to authorise the preparation of a scheme. The Electricity Supply committee stated that a special report had been prepared by the consulting engineers (Messrs. Lacey, Sillar & Leigh) on the question of an auxiliary station, and they recommended that application be made to the L.G. Board for sanction to borrow moneys for the cost of the works. Messrs. Lacey, Sillar & Leigh would prepare plans, specifications and estimates, and supervise the work at 5 per cent. on the capital expenditure inclusive of the quantities which they would take out.

The Council have postponed consideration of the matter and further expert advice is to be obtained.

The Lighting committee have considered the special report of the borough surveyor as to the cost of converting 691 incandescent gas lamps and 316 Nernst and incandescent electric lamps to osram lamps. The conversion of 691 gas lamps to osrams would cost £2,295. 11s. 11d.; conversion of 316 Nernsts to osrams, £371. 6s.; maintenance per annum of 691 incandescent gas lamps would cost £1,799. 9s. 7d.; estimated cost if replaced by osrams, £2,073; cost per annum of maintenance of 316 electric lamps, £1,250. 12s. 6d.; and estimated cost if replaced by osrams, £1,082 10s. It has been decided that the present Nernst lamps be replaced by osram lamps as renewals become necessary; and that as an experiment new 210 volt single 60 c.p. osram lamps be fitted to (*a*) the existing 16 c.p. incandescent electric lamps and (*b*) six lamps now lighted by Nernst lamps.

Electricity in Mining.—The new electric power station at the Randfontein Estates, South Africa, will have a capacity of about 10,000 kw. The plant will include Parsons turbo-generators and Babcock & Wilcox boilers. The first section of the plant is reported to be nearing completion.

Electricity Supply in Belgium.—"Engineering" states that the Belgian Government has granted concessions for large power stations in Brussels, Antwerp, Ostend and Charleroi. The concessions are for 25 years, at the expiration of which period the whole plant will become the property of the Government, which reserves the right of supervision and earlier purchase. The light railways are to be converted to electric traction, and the State contractors will have the privilege of supplying current to the Government and the railways.

Gillingham.—Some time ago an inquiry was held on behalf of the L.G. Board into the application of the Council for sanction to borrow £5,000 for extensions of the electricity undertaking, but the Board now intimate that, in view of the report of their inspector (Major Stewart) they consider it desirable that there should be a thorough investigation into the matter before any further loan is sanctioned, and that Inspector Hooper has been instructed to make such investigation.

Glasgow.—Last week the Corporation adopted a report of the Finance committee and the special committee on Telephones recommending that the whole of the deficiency (about £16,000) which had arisen in connection with the transfer of the Corporation telephone undertaking to the Government be paid out of the revenues of the Common Good, liquidation of the deficiency to be spread over a period of five years.

This decision is subject to a provisional order being obtained to legalise the course adopted; otherwise the deficiency will have to be made good out of the rates.

Treasurer STEVENSON said he thought there was nothing extraordinary in the recommendation of the committee. When the inquiry was held shortly before they obtained their telephone licence there were 4,700 subscribers and 44 call offices. When they sold their telephone undertaking there were in Glasgow 40,177 telephone and 1,355 call offices. That number was greatly in excess of the total number of telephones in the five chief towns of England, leaving out London. He thought he was entitled to say that the Common Good—that was to say the good of the whole city—benefited enormously by the action of the Corporation in the matter, and that the trifling payment of £16,000 was very little in comparison with the benefit received.

Mr. KING moved that the minute be sent back for further consideration, as the £16,000, he contended, was a bad debt.

Mr. MYLES, town clerk, was asked to give his opinion, and said that all expenses incurred in connection with the exercise of the telephone licence—that was, the deficiency, barring the preliminary expenses—should not be charged to the Common Good, but were chargeable, according to law, against the rates.

The LORD PROVOST said it was obvious they were in a difficulty. The Corporation was perfectly willing that this sum, seeing it was not a very large sum, should be paid out of the Common Good rather than be charged on the rates, but they were confronted with the opinion of the town clerk, which he accepted. He thought, however, they might well pass the minute to-day, subject to the approval of Parliament being obtained.

Govan.—The Council decided on Monday to apply for increased borrowing powers to the extent of £23,000 for extensions of the electricity department during the next four years. The capital expenditure to date is £125,186. 7s. 7d.

India.—"Indian Engineering" says the East Indian Railway Co. now supply portable electric fans to travellers on their lines during the hot weather.

Stone & Co.'s electric carriage lighting apparatus to the value of £1,200 has just been received by the same railway company.

Institute of Metals.—A meeting was held at the Institution of Mechanical Engineers, London, on Wednesday, to inaugurate the formation of an Institute of Metals. The meeting was well attended, and Sir William White presided. (Particulars of the steps already taken to form this Institute were published in *The Electrician* for March 20, p. 890, and May 22, p. 230.)

Sir WM. WHITE said he thought it would be no breach of confidence to say that the proposed formation of the society was warmly welcomed by the mechanical engineers, who would give it hearty support. The proposed field of work must have a common frontier with the Institute of Mining and Metallurgy, and they had Prof. Garland with them in full sympathy—the immediate past president of the Institute, which clearly indicated the attitude of that Institute. The truth was that, as knowledge increased, it became absolutely necessary to form these specialist societies. 200 years ago the Royal Society dealt with all branches of pure science, and dealt with them adequately, but now they had a number of other societies created out of the Royal Society, but still closely related to it and carrying on independent investigation. It was exactly the same with regard to applied science. The Institution of Civil Engineers was for a time sufficient, but there came a time when, in a somewhat violent manner, there was created the Institution of Mechanical Engineers, which asserted its independence and its right to an independent existence. Each firm or individual who joined the Institute would retain their individual rights of discretion in deciding to what extent works should be visited. The Institute was not established to attempt to capture trade secrets. He moved a resolution to the effect that in view of the widely recognised need for a medium of communication and the advancement of knowledge in connection with the production, manufacture and use of non-ferrous metals, a society to be called the Institute of Metals should be constituted.

Sir FORTESCUE FLANNERY seconded, and, after discussion, the resolution was carried unanimously, and Sir William White was elected first president.

The annual subscription is £2. 2s., with no entrance fee at present.

Islington (London).—It has been decided to spend £3,560 on the extension of the electricity undertaking, and the L.C.C. is to be asked to sanction a loan for this amount.

Johannesburg.—The "British and South African Export Gazette" states that Mr. W. A. Harper, consulting engineer to Messrs. Beardmore & Co., guarantors for the Johannesburg electricity works gas engine contract, has intimated that Messrs. Beardmore intend to put the gas plant in working order immediately, and he is of opinion that the gas-producing portion of the plant is everything that can be desired, with slight modifications, to suit the Transvaal coal. The engines have been damaged by "dirty, tarry gas." The Council's attitude on the matter has not been made public.

Light Railways.—The report of the Light Railway Commissioners and of the proceedings of the Board of Trade under the Light Railways Act, 1896, for the year ended Dec. 31 has been issued.

At Dec. 31, 1906, 16 orders were before the Board awaiting confirmation; 11 of these were confirmed in 1907, one has since been confirmed and four are held over. During 1907 22 fresh orders were submitted to the Board by the Light Railway Commissioners for confirmation. 14 of the orders submitted during 1907, in addition to the 11 above referred to, making 25 orders in all, were confirmed by the Board in the course of the year. In no case did the Board refuse to confirm an order.

The Light Railway Commissioners state that a total of 565 applications for orders to authorise light railways (including 82 applications for amending orders) have been made since the commencement of the Act. In respect of 351 applications orders have been submitted to the Board of Trade for confirmation; eight other applications, in respect of which orders are under settlement, have been approved by the Commissioners and 194 applications have been rejected or withdrawn. The decisions with respect to three applications have been deferred, and nine new applications made in November last remain to be considered.

Penny Post.—Last week we announced the advent of penny postage for letters to the United States of America on Oct. 1. It is now announced that wherever the British Post Office maintains an agency in Morocco, as and from the 15th inst., the postage will be 1d. per oz. This applies to Alcazar, Casa Blanca, Fez, Larache, Mazagan, Mequinez, Mogador, Rabat, Saffi, Tangier and Tetuan.

Personal.—The principal prize of 200 guineas offered by the American Co-operative Electrical Development Association for a canvasser's handbook dealing with data concerning electric light, heat and power useful to canvassers and central station managers, has been awarded to Mr. R. Borlase Matthews, Wh.Ex., A.M.I.C.E., the only successful English competitor. There were between 50 and 60 manuscripts submitted.

Presentations.—The staff of the Sheerness & District Electric Power & Traction Co. made a presentation to Mr. A. A. Watkins (late manager) and Mrs. Watkins, on Mr. Watkins's departure for Musselburgh.

The members of Halifax Council have presented an oak roll top desk to Mr. F. Spencer, late tramways manager.

Provisional Order Transfer.—Formal notice has been given of the intention of Bath Corporation to transfer to the Bath & District Electric Supply Co. (Ltd.) their powers, works, &c., under their electric lighting order, 1896. The transfer is to be for 30 years.

and after that period in perpetuity, provided there has been no breach of covenant. The pecuniary consideration is £162,939, of which £22,500 has been paid, the remainder being payable by 30 annual instalments with 3½ per cent. interest on the unpaid balance. The present scale of charges for current is to be the maximum, and after payment of 4 per cent. dividend the company are bound to apply the surplus profits to reducing the price from 5d. to 4d., and they are bound to spend £30,000 in 18 months on extensions, £[illegible],000 being on works in the City of Bath.

Rochdale.—Sanction has been received to a loan of £21,550 for electricity supply, including £4,182 for excess expenditure.

Rotherham.—An unopposed inquiry has been held into the application of the Corporation to borrow £5,300 for extensions of the electricity undertaking.

The borough electrical engineer (Mr. E. Cross) said it was very urgent that the proposed extensions should be made to cope with the additional load of the coming winter. The capacity of the works at present was 1,20[illegible] kw., and the maximum load last year was 862 kw. for traction and lighting. The number of consumers of electricity for lighting was growing, there were several applications for energy in bulk, and the tramway system was being extended. The committee recommended the installation of [illegible]500 kw. direct current turbo-generator, with condensing plant.

St. Anne's-on the Sea.—The Council have applied for sanction to a loan of £3,500 for extensions of mains, &c.

Southgate.—Negotiations are proceeding between the Council and the North Metropolitan Electric Power Supply Co. in regard to the supply of electricity in this district. The company's chief engineer (Mr. E. T. Ruthven Murray) will submit alternative schemes to the committee of the Council dealing with the matter.

Swindon.—The Council have applied for sanction to a loan of £8,000 for additional generating plant.

Tasmania.—The municipal electricity department of Devonport (Tasmania) accounts for 1907 show total capital expenditure £10,500, upon which the year's gross profit amounted to 7½ per cent.

The engineer (Mr. G. H. Lofts, A.M.I.E.E.) reports that the average cost per unit for lighting was 5·629d., against 5·7724d. in 1906, and the average charge for lighting 6·6d. (6·94d.). Current supplied for power and heating shews fair increase, due to the adoption of electric irons. Mr. Lofts believes the department will shortly be able to manufacture radiators. There has been no failure in the supply of current during four years, and no customer has reverted from the use of electricity to any other illuminant.

The report also states that no metallic filament lamp quite suitable for the Corporation's system has yet appeared.

Wadebridge.—A syndicate is being formed to establish electricity supply in this town. It is proposed to employ overhead wires, and the Council have been asked to support the scheme.

Walthamstow.—During 1908-9 1½d. per unit is to be charged for current supplied to the tramways undertaking.

Wimbledon.—A sub committee is to report upon the present system of street lighting.

Woolwich.—Tenders are to be invited for coal-handling plant at Globe-lane electricity works.

The Council urge the L.C.C. to proceed with the work of constructing tramways from Beresford square to Greenwich.

Workhouse Lighting.—The City of London Guardians have decided to adopt electric lighting at their new workhouse and infirmary at Homerton.

The architect had prepared estimates of the cost of both electricity and gas, based on figures supplied by the electrical engineer to the borough of Hackney (Mr. L. L. Robinson) and the Gas Light & Coke Co. The comparative total cost would be as follows:

	Electricity.	Gas.
Initial cost	£1,000	£289 7 9
Annual cost of illumination	150	233 16 8
Annual cost of maintenance	60	82 15 0
Total of last two items	£210	£366 11 8

The total candle-power given for the gas scheme was more than double that of the electricity scheme, but it was pointed out by the architect that the latter had a greater variation in the illuminating power of the lamps, and one 8 c.p. lamp would be used in a position only requiring a small light, whereas in the same position a gas lamp would be using a 60 c.p illuminant.

Electric current will be supplied by Hackney Council.

Faraday House.—The fourth annual dinner of the Old Students' Association will be held at the Queen's Hotel, Leicester-square, London, W., on June 18, at 7 for 7:30 p.m., Mr. Gerald W. Partridge, M.I.E.E., M.I.C.E., president, in the chair.

Callender's London Office Staff Outing.—This function was celebrated on May 30 at Brighton, when 60 members of the staff and several visitors from the works and offices sat down to luncheon at the Royal York Hotel, Mr. James O. Callender in the chair.

After luncheon Mr. CALLENDER proposed "The Callender Company," and regretted that Mr. T. O. Callender, the managing director, had been unavoidably called to Hamburg on important business in connection with the German Callender Company. In a brief and witty speech the chairman expressed his pleasure at being present, and thanked the visitors for attending. He complimented the hon. sec. (Mr. J. M. Dunkley) and the committee on the way the outing had been arranged, and, on behalf of the staff, presented Mr. Dunkley with a smoker's companion. Mr. ALLNUTT proposed a vote of thanks to Mr. Callender for occupying the chair. This was seconded by Mr. MACMASTER, and received musical honours. Mr. GOODMAN (of the works) replied to a toast on behalf of the members of the works staff. The health of Mr. T. O. Callender was also drunk with musical honours. The outing proved a very enjoyable one.

A GROUP OF "CALLENDERS" AT BRIGHTON.

A very successful photograph was taken of a group during the afternoon, and this we reproduce.

ELECTRICITY SUPPLY AND TRAMWAY ACCOUNTS

Bath.—The accounts of the electricity undertaking, which is to be sold to a syndicate promoted by Mr. Schenk (*see* p. 268 of our issue for May 29), show total capital expenditure £159,424, an increase of £1,513 during the year ended March last.

The year's revenue was £20,594. Expenditure was £10,907. Gross profit was £9,672, which falls short by £383 of the amount required to meet sinking fund and interest. This amount, together with the debit balance of £893 from 1907, makes a total deficit of £1,276. 1,851,173 units were generated, 401,478 supplied to public lamps, 7,787 by contract and 1,059,270 by meter. The total maximum load was 1,072.

Batley.—For the year ended March there was a net profit of £121 on the working of the electricity department, compared with £494 in the preceding year. There was a considerable increase in the actual revenue, but the expenses showed a great increase on the previous year.

Blackburn.—For the year ended March 25 the total income of the electricity department was £34,760. 17s. 6d.

The total expenses were £17,743. 4s. 4d. The gross profit was £17,017. 13s. 2d., and after paying interest, sinking fund charges, &c., the net profit (£1,443. 5s. 5d.) was transferred to reserve. Total capital expenditure is £261,780. 4s. 10d., an increase of £8,903. 5s. 3d. on the year. 4,142,011 units were sold, including 340,381 units supplied to the public lamps, 2,023,577 for traction and 1,778,053 for private lighting and power. There are over 1,700 consumers, and the equivalent of 158,600 8 c.p. lamps is connected. During the year 75 motors of 403 H.P. were connected. There are 207 arc and 470 incandescent lamps for public lighting. The total maximum supply demanded was 2,400 kw.

The total receipts of the tramways department were £59,821. 14s. 10d. Working expenses were £38,197. 3s. 3d., and after paying interest, sinking fund charges, &c., there was a net profit of £804. 11s. 4d. (against £511). 10,877,155 passengers were carried (against 10,094,027 in 1906-7) and 1,104,073 car-miles were run (against 1,002,372). The parcels system has proved a success, the receipts increasing by £220. 2s. 8d. over the previous year. The gross capital expenditure is £325,527.

Blackpool.—The accounts of the electricity department for the year ended March 31 show capital expenditure £198,651 (increase £9,556).

The year's revenue was £36,565. Expenses were £16,140. Gross profit was £20,425 (against £19,902). After providing £6,539 for interest and £5,430 for sinking fund and instalment of loan, there was a net profit of £8,456 (£8,229). £5,436 (£4,000) is to be transferred to general district fund and £3,000 (£4,229) to electric light reserve fund. 3,704,150 units were generated (against 3,404,311 in previous year), and there were 1,176 (1,108) private consumers. The maximum load was 2,602 kw., and the plant capacity 4,450 kw.

The income of the tramways department was £53,740. 9s 3d., and the expenditure £32,418. 17s. 8d. Gross profit was, therefore,

£21,321. 11s. 7d. The number of passengers carried was 9,079,274 (previous year 8,304,218), car-miles run 943,268 (958,836). The reserve fund is now £7,788. 19s. 8d.

Colchester The report and accounts of the tramways department were presented to the Council last week.

After paying expenses and providing for interest and sinking fund, there was a deficit of £2,[illegible]. 10s. 5d. About 2,300,000 passengers have been carried.

Devonport.—The total income of the electricity department for the year ended March 31 was £17,522. 17s. 3d.

After paying expenses the gross profit was £6,789. 19s. 8d. The capital charges amount to £6,856. 10s. 4d., and the net surplus transferred to reserve £3. 14s. 4d.

Dudley.—There was a net profit of £336 on the past year's working of the electricity department. The gross profit was £5,977, but there was an increase of £465 in interest and sinking fund charges, which amounted to £5,641. The total capital expended is £86,808, an increase of about £5,400 on the year. The most prominent feature of the year's work was the great increase in the demand for electric power.

Finchley.—There was a deficit of £292. 5s. 2d. on the past year's working of the electricity department, due mainly to the increased price of coal. The gross income for the year was £11,560, against £10,032 in 1906-7.

Grimsby.—At the meeting of the Council last week it was reported that there was an available profit of £2,085 on the past year's working of the electricity undertaking.

The borough electrical engineer (Mr. W. A. Vignoles) recommended that the whole amount be carried forward to next account, as he is carrying out an improvement for which the L.G. Board would not sanction a loan, and which must be met out of revenue. After discussion, however, it was agreed to allocate £500 to relief of rates.

The total income of the department for the year ended March 31 was £16,257. 19s. 9d. The total expenses were £7,853. 8s. 1d. and the gross profit was £8,292. 2s. 5d. After paying interest (£3,302. 10s. 3d.), instalment of loans (£2,493. 6s. 3d.), &c., there was a net profit of £2,442. 12s. 8d. Taking into account various items, the net balance was £2,083. 2s. 1d. There are 595 consumers, and the total connections are equivalent to 72,039 8 c.p. The maximum load was 1,225 kw., compared with 907 kw.

Mr. Vignoles considers the year's results satisfactory in view of the increased price of coal and the continued replacement of the old form of lamp by the metallic filament type. Working costs (0·912d. per unit, against 1·062d.) show a reduction in every item except coal. The total horse-power of motors now amounts to 915, against 787 last March, an increase of 16 per cent., while the energy sold has increased 35 per cent. (from 226,332 to 304,859 units). 23 motors, aggregating 305 H.P., are supplied with power on the time-switch system. There are also a large number of motors connected to the railway company's mains on the docks not included in this return. These aggregate some hundreds of horse-power, and include motors in engineering and other works in addition to the capstans and coal-handling plant belonging to the company.

The salary of the borough electrical engineer (Mr. W. A. Vignoles) has been increased from £400 to £500 per annum.

Lancaster.—The income of the electricity department for the year ended March 25 was £9,722. 14s. 4d.

Expenses were £5,411. 6s. 10d., gross profit £4,311. 7s. 6d. After paying interest (£1,215. 4s. 3d.), sinking fund charges (£1,513. 6s. 10d.), &c., the net profit was £1,078. 13s. 3d., of which £500 was placed to district fund, £500 to special stock redemption fund, and £78. 13s. 3d. to reserve. Capital expenditure is £63,221, against £63,276 in 1907, 927,200 units were generated, 424,428 units were sold to private consumers by meter, and 26,225 by contract, 236,393 were supplied to the Tramways committee, and 74,826 to public lamps. The equivalent of 43,556 8 c.p. lamps is connected to the mains for lighting and there is also 424 H.P. in motors. The total cost per unit sold is 1·5d., against 1·47d. in 1907.

The total revenue of the tramways was £5,202. 14s. 3d. Working expenses were £5,173. 16s. 4d., interest came to £1,512. 11s. 6d., and sinking fund to £1,265. 15s. 5d., leaving a deficit of £2,749. 9s., against £2,836. 19s. 7d. in 1906-7. The capital expended is £41,338. 12s. 3d. 1,2[illegible] passengers were carried, 163,652 car-miles run, and the percentage of working expenses to receipts is [illegible].

Lincoln.—The capital expenditure of the electricity department at March 31 was £64,726, an increase of £1,829 on the year.

The year's revenue was £11,565, expenditure was £6,505, gross profit £5,[illegible], and net profit £1,517, compared with £3,[illegible] in previous year. £1,000 has been devoted to relief of rates. 1,665,094 (against 1,485,[illegible]) units were generated, 65,270 (65,460) supplied to public lamps, 1,221,183 (1,047,005) to private consumers and 167,369 (169,961) for traction. The maximum loads were 734 kw. for lighting and 135 kw. for traction compared with a total of 750 kw. last year. There are [illegible] consumers and the equivalent of 63,334 (55,935) 8 c.p. lamps connected, including public lighting. Total costs were 1·06d. ([illegible]) per unit, or 1·[illegible]d. (1·62d.) including interest and sinking fund. The average price received was 1·94 (2·169d.) per unit. The increased cost was entirely due to increased price of coal.

The capital expenditure on tramways is £52,848 (increase £1,000). Total receipts were £6,04[illegible] (against £5,845), total expenses £5,692 (£5,[illegible]). Gross profit was £35[illegible] (equal to ½ per cent. on capital), and after payment of dividends on stock (£1,473) and instalment to consolidated loans fund (£1,032) there was a deficit of £76, which has been met out of the profit on the electricity department. 145,235 (137,186) car-miles were run, 1,494,324 (1,437,946) passengers carried and 160,874 (164,314) units of electrical energy were used at 1¼d. per unit, or 1·108 (1·197) units per car-mile. Traffic revenue per car-mile was 9·8d. (10·04d.), total revenue 10d. (10·22d.), working expenses, with power, 6·1d. (6·69d.).

Mr. Clegg claims, in his report, that the total cost of 6·10d. per car-mile for 145,235 car-miles compares well with the cost of 6·09d. at Wolverhampton (the only other surface contact system of which he has been able to obtain records), where nearly a million car-miles were run.

The accounts of the electricity and tramways departments were adopted at the meeting of the Council last week.

Northampton.—For the year ended March 31 the total income of the municipal tramways was £21,940. 1s. 11d., including £21,363. 6s. 1d. from traffic receipts.

The total expenses were £11,823. 17s. 3d. Taking figures for the omnibus department into account, gross profit was £9,576. 14s. 7d. After paying interest (£4,218. 13s. 10d.) and sinking fund (£3,729. 7s. 11d.), the net profit is £1,771. 12s. 10d.; of this £500 has been voted to relief of rates, and the balance (£1,271. 12s. 10d.) placed to reserve. Net capital expenditure is £124,873. 13s. 8d., 5,175,069 passengers were carried and 538,939 car-miles run.

Plymouth.—For the year ended March 31 the income of the tramways department was £32,931. 17s. 10d., against £32,453. 17s. 10d. in 1906-7.

Expenses were £24,550. 0s. 11d., compared with £23,049. 10s., leaving a gross profit of £8,381. 16s. 11d., against £9,404. 7s. 10d. The total net revenue was £9,639. 6s. 11d., against £10,661. 17s. 10d. After payment of interest and sinking fund (£8,865. 12s.) the net profit was £772. 14s. 11d., against £1,352. 11s. 2d.

Rathmines and Rathgar.—There was a deficit of about £50 on the past year's working of the electricity department, owing to the increased price of coal. The demand for electric current continues, and the increased income from private lighting was about £1,000.

Taunton.—There is a net profit of £281 on the past year's working of the electricity department, after paying all charges, including interest and redemption of loans.

Of this amount £265 has been carried to the motor purchase fund, which has now all been paid for out of revenue. The chairman of the committee (Dr. Macdonald) said the electricity undertaking had been criticised, but, if considered as an ordinary business with invested capital, they would even this year have been able to pay the shareholders a dividend of 5 per cent. and put by a fair balance.

Several members of the Council congratulated the borough electrical engineer (Mr. E. B. Thornhill) and the committee on the satisfactory report, and Ald. Lewis pointed out that in addition to the £2,100 standing to reserve, £17,456 had been paid in interest and sinking fund since they acquired the works.

West Bromwich.—The annual report of the borough electrical engineer (Mr. W. A. Jackson) for the year ended March 31 states that 1,824,887 units were sold (against 1,799,353 in 1907), including 1,010,875 (1,080,443) for traction, 283,457 (277,265) for lighting, 421,900 (334,721) for power, and 108,655 (106,924) for public lighting.

Mr. Jackson states that it is in the supply for power he expects the greatest development. Although there has been an increase in the number of lighting consumers (26) the sales for lighting have not maintained the expansion of previous years, this result being mainly due to the use of metallic filament lamps. There are 308 consumers, and the total connections of all consuming devices, including public lighting, are equal to 44,673 8 c.p. lamps. There are 117 motors with a total H.P. of 921. The maximum load on the lighting and traction feeders was 1,000 kw.; the combined load factor for lighting and traction is 20·8 per cent. (increase 1·5 per cent.), the lighting and power load is 14·4 per cent. (increase 1·1 per cent.), and traction 14·5 per cent. (decrease 1·0 per cent.). The total works costs were 0·88d. per unit, against 0·85d. per unit. The total capital expended was £71,147. 14s. 7d., revenue £12,793. 7s. 9d., working costs £6,736. 15s. 5d., gross profit £6,056. 12s. 4d., and net profit £2,030. 8s. 11d. (against £2,623. 17s. 9d.). The total number of hire purchase installations is 122, against 132 in 1907; there are 78 motors (of 429 H.P.) on hire, an increase of 9 motors (120 H.P.); there are also 101 arc lamps (increase of 9) and 39 Nernst lamps (decrease 10) on hire.

Wolverhampton.—The total income of the tramways department for the year ended March 31 was £44,431. 18s. 9d., and the working expenses were £26,460. 8s. 4d.

Interest required £7,074, repayment of capital £3,988, income tax £1[illegible], leaving net profit of £6,76[illegible], of which £4,[illegible] is to be placed to renewals fund, and £1,292 applied in wiping off deficit on previous year's account. The balance of net profit (£392) has been carried to reserve. While the year's income shows an increase of over £500 compared with that of 1907, working expenses last year were increased by over £1,500.

Woolwich.—The annual report of the district auditor (Mr. A. Carson Roberts) on the accounts of the electricity undertaking for the year ended March 31 was presented to the Council on Thursday last week.

In connection with the revenue position it is explained by Mr. Roberts that a loss of £15,744 for the year is shown, but the loss would have amounted to nearly £17,000 if loans had been raised to cover the capital

expenditure as it was incurred, and the proper share of their redemption charged in the year. The rates will have to provide rather more than the loss earnings of the undertaking, which, apart from the charges for rating and motors, amounted to £16,824. The rates raised in aid of the undertaking yielded £9,794, but the deficiency brought forward at March 31, 1906, exceeded this amount by over £1,000, and the accounts show a deficiency at March 31, 1907, of £16,835. This, however, falls short of the true deficiency at that date, as no account had been taken of the proportion of standing charges which had accrued but not fallen due for payment, bringing the revenue deficiency up to £21,200. In the year just closed, Mr. Roberts says he was informed that the rates raised in aid of the undertaking have averaged over 9d. in the £, and have yielded £29,771—a sum sufficient to cover the arrears of deficiency, including accrued proportions, and to provide £8,571 towards the loss on the year's working. Loans have been raised sufficient to cover the capital outlay for the time being.

Yarmouth. The total receipts of the tramways department for the year ended March 31 were £24,777, and the expenses £16,350, leaving gross profit of £8,127. After paying interest and sinking fund charges there was a net profit of £1,605, of which £1,500 has been placed to renewals fund, the balance being carried forward.

TRADE NOTES AND NOTICES.

TENDERS INVITED.

The Electricity Supply committee of *Stepney* (London) Council invite tenders for supply, during the year ending June 30, 1909, of (1) ampere-hour meters, demand indicators and time switches; and (2) arc lamp carbons. Specifications, &c., from the borough electrical engineer and manager, Mr. W. C. P. Tapper, A.M.I.E.E., 27, Osborn-street, Whitechapel, where tenders must be delivered by noon of Monday, June 29. See also an advertisement.

The Guardians of the parish of *Fulham* (London) invite tenders for a vertical high-speed engine and 20 kw. steam dynamo, both British made. Form of tender of specification from the clerk, Mr. E. J. Mott, 129, Fulham Palace-road, Hammersmith, W., to whom tenders by Thursday, July 2. See also an advertisement.

London County Council invite tenders for the manufacture and delivery of high-tension main switchgear and low-tension auxiliary switchgear, to be erected at the Council's generating station at East Greenwich. Tenders, on official forms to be obtained from the clerk of the Council (Mr. G. L. Gomme), County Hall, Spring-gardens, S.W., by 11 a.m. on Tuesday, July 7. Further particulars are given in an advertisement.

London County Council also invite tenders for the manufacture, supply and delivery of tramway feeder pillars. Tenders, upon official forms, to be obtained from the clerk of the Council, Mr. G. L. Gomme, County Hall, Spring Gardens, S.W., by 11 a.m. on Tuesday, June 23.

London County Council also want tenders, by 11 a.m. June 30, for the road work and plate laying in connection with the construction of tramways on the underground conduit system from Dulwich Library, Lordship-lane, to Forest Hill. Forms of tender, &c., from the Chief Engineer, Spring Gardens, S.W.

Melbourne City Council invite tenders for supply of 5,000 yds. of insulated copper cable. Copies of specification, conditions of contract and form of tender from the agents for the Council (Messrs. McIlwraith, McEacharn & Co. Proprietary, Ltd.), Billiter-square-buildings, London, E.C., to whom tenders by noon of Friday, July 3. See also an advertisement.

The electricity and tramways department of *Newport* (Mon.) Corporation invite tenders and prices for c.c. and a.c. prepayment meters from 1 to 10 amperes, and for 1d., 6d. and 1s. Particulars and prices to the borough electrical engineer and tramways manager, Mr. H. Collings Bishop, Town Hall, Newport, Mon.

Manchester Electricity committee want tenders by noon June 19 for 12 months' supply of d.c. motors and motor starters, ampere-hour and watt-hour meters and fuse boxes. Specifications, &c., from Mr. F. E. Hughes, Town Hall, Manchester.

Manchester Tramways committee want tenders by 9 a.m. June 23 for erection of electric car depot, &c. Forms from Mr. J. M. MElroy.

Oldham Electricity committee want tenders by first post June 22 for supply of steam coal for electricity department. Specifications, &c., from Mr. S. Wilmott Newington.

Portsmouth Corporation want alternative tenders by 10 a.m. June 17 for one and two years' supply of coal for their electricity department.

Willesden Council want tenders by noon June 18 for supply and erection of 300 kw. converting plant. Specifications from the Electricity Offices.

Gillingham Council want tenders by noon June 22 for 12 months' supply of coal for their electricity works. Specifications from the Borough Electrical Engineer.

Croydon Council want tenders by 11 a.m. June 23 for lighting of swimming bath, Scarbrook-road. Specification from the Borough Engineer.

Gravesend Electricity committee want tenders before June 27 for supply and erection of yellow-flame arc lamps, columns, &c. Specifications from the Borough Electrical Engineer.

Gravesend Electricity committee also require tenders by June 26 for coal. Specification from the Borough Electrical Engineer.

Ilford Council want tenders by noon June 23 for wiring Seven Kings library and hall. Specifications from Mr. A. H. Shaw.

St. Anne's-on-the-Sea Council want tenders by June 27 for laying a feeder cable. Specification from the Electrical Engineer.

The Société Nationale des Chemins de Fer Vicinaux, 14, Rue de la Science, *Brussels*, want tenders by June 16 for overhead equipment and rail bonding of the Brussels-Grimberghen section of Brussels-Humbeek Railway. Specifications from the Société, price 2fr. Plans 24fr.

The Deputy Postmaster-General, *Adelaide* (S. Australia), wants tenders by noon July 1 for telephone and telegraph instruments, switchboards and telephone line material, 6,000 corks, 5,000 tubes, 6,000 leads and 9,000 zincs (Meidinger Line), 6 tons sulphate of magnesia and 1 ton crushed sal-ammoniac. Specifications, &c., from the Commonwealth offices, London.

The Bulgarian Government Railways and Ports Department, *Sofia*, want tenders by 3 p.m. June 20 for supply and installation of electrical apparatus. Specification and list of local agents can be seen at 73, Basinghall-street, London, E.C.

The Spanish Government Public Works Department, *Madrid*, want tenders (on more favourable terms than one which has been submitted by the Cia de Tranvias de la Coruña) for constructing and working an electric tramway from La Coruña to Burgo. The "Madrid Gazette" of May 26 contains further information.

Tenders will be received until noon June 27 for supply of a 42 ton electric travelling crane, with bridge, for the *Trollhattan* (Sweden) canal and water works undertaking. Specification may be seen at 73, Basinghall-street, London, E.C.

The Deputy Postmaster-General, *Sydney*, N.S.W., wants tenders by 2:30 p.m. Aug. 5 for 63 tons h.d. copper wire, 1 ton copper binding tape and 15,000 porcelain insulators. Specifications, &c., from the General Post Offices, Sydney, Melbourne, Adelaide and Brisbane and (when received) from the Commonwealth offices, 72, Victoria-street, London, S.W. Deposit of 5 per cent. on amount of tender.

TENDERS RECEIVED AND ACCEPTED.

Salford Council have accepted the following tenders for annual supplies:—

General Electric Co., pure rubber solution, 1s. 5d. per lb., white tape, 1s. 2½d. per lb. and carbon filament glow lamps; W. T. Henley's Telegraph Works Co., black tarred tape, 9d. per lb.; Johnson & Phillips, tinned copper binding and fuse wire; Callender's Co., tinned copper strip, 1s. 2d. per lb.; J. Bassett, fine solder, 9½d. per lb., plumber's metal, 8½d. per lb., tinfoil, 2s. per lb.; L. Andrew & Co., mica sheets, 4s. 3d. per lb., rubber gloves, 5s. 3d. pair, rubber over shoes, 4s. pair, and rubber caps; Doulton & Co., stoneware troughs, covers, bridges and cable bearers and protectors; Adamant & Asphalte, bitumen, £5 per ton; Key Engineering Co., fibre pipes; Howard Asphalte Troughing Co., asphalte bridges; C. Jennings & Co., wood troughing, bends, &c.;

J. H. Tucker & Co., house service cutouts; Edison & Swan Co., gravity type ammeters: Whipp & Bourne, circuit-breakers: New Brotherton Tube Co., steel conduits; Ward & Goldstone, cutouts; Baxendale & Co., tumbler and link switches; Sloan Electrical Co., arc lamp carbons, 20 mm. by 10 mm., cored, 48s. 6d per 1,000; 13 mm. by 10 mm., solid, 20s. 6d. per 1,000: Andrew & Suter, arc lamp carbons: General Electric Co. and Veritys Limited, low and high-speed electric motors; W. H Mitchell, corrugated brass joint rings, ½d. per inch, and flake graphite, 1s. 3d. per lb.; United Asbestos Co., boiler gauge glasses, single feed glasses, sight feed glasses and sight feed glass rings, asbestos gland packing, 11d. per lb., asbestos multiple packing, 2s. 3d. per lb., asbestos powder, 10s. cwt.; Clyde Rubber Works Co., rubber insertion, 1s. per lb., rubber insertion rings, 2s. per lb., pure asbestos millboard, 2d. per lb.

Woolwich Borough Council received 11 tenders (from 10 firms) for the supply of a motor alternator, and the tender of the British Thomson-Houston Co., at £784. 10s., has been accepted. The highest tender was £995 and the lowest £754. In reporting on the tenders the Electricity committee stated that the chief factor in determining the selection of the machine was efficiency, as it was required for long-hour running, generally at the lower loads, and the guaranteed efficiency of the British Thomson-Houston Co., the accepted tenderers, was the highest.

Stockport Council have accepted the following tenders:—

Doulton & Co., porcelain troughing 5d. per yard, and bridges 11s. 2d. per gross; W. T. Glover & Co., cables, £525. 17s. 5d.; J. & W. S. Briscoe, repairs and renewals to tramway routes, £599. 10s.; Walter Scott (Ltd.), rails, fishplates and anchors; Bayliss, Jones & Bayliss, tie bars, bolts and lock nuts.

Holborn (London) Council have accepted the tender of J. W. Singer & Sons for supply of electrical fittings for the new Council offices at £368. 17s. 6d. There were six tenders (from five firms), varying in amount from £368. 17s. 6d. to £542. 15s.

Croydon Corporation have accepted the tender of Chas. Pullan for electric lighting installation at the new mental hospital buildings at £428.

Swindon Council have accepted the tenders of W. T. Henley's Telegraph Works Co and Johnson & Phillips for service joint boxes, and that of the British Insulated & Helsby Cables for fuse boxes.

Dewsbury Council have placed an order with the Haste Pump Co. for condensing plant, and with the Midland Engineering Co. for a cooling tower.

Walsall Electricity committee have accepted the tender of Willans & Robinson at £2,775 for a condenser with three-throw air pump, cooling tower, separator and purifier.

Tonbridge Council have accepted the tender of the Western Electric Co. for a year's supply of cable.

Worthing Council have accepted the tender of the Midland Engineering Co. for supply of condensing plant at £830.

Durban Council have placed an order with C. A. Parsons & Co. for a steam turbine a 750 kw. c.c. traction generator and a 200 kw. two-phase alternator and exciter.

The A.E.G. Electrical Co., of South Africa have in hand a 700 kw. dynamo for Knight's Central (Ltd.), Transvaal.

Johannesburg Municipality have placed orders with the British Westinghouse Co. for seven 70 kw. single-phase transformers; with the A.E.G. Electrical Co. for 350 10 ampere single phase a.c. meters; with Rintoul & Davies for six 25 ampere, six 50 ampere and six 100 ampere meters; and with the Western Electric Co. for 380 yds. of 3 sq. in. concentric cable.

BUSINESS NOTICES.

Messrs. Kennedy & Jenkin announce that they have taken into partnership Messrs. John MacFarlane Kennedy and Sydney Bryan Donkin. The name of the firm remains unaltered.

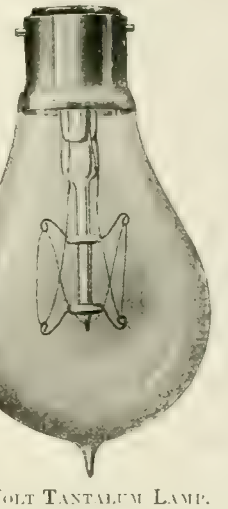
The partnership between Frederic Simpkin, Wm. Arthur Wilkinson and Christopher Gibson (trading as Simpkin, Wilkinson & Gibson), electrical and mechanical engineers, 66, Kirkstall-road, Leeds, has been dissolved so far as concerns W. A. Wilkinson. Debts by Messrs. Simpkin & Gibson, who continue under the old style.

Arc Lamps (Ltd.) are about to remove their works from St. Paul's-road, Camden Town, to St. Albans, and after the 20th inst. the address of the works will be Sphere Engineering Works, St. Albans, Herts.

Sale by Auction. Messrs. Horne & Co., 8, Delahay-street, Storey's-gate, Westminster, S.W., will sell by public auction at the Royal Arsenal, Woolwich, on Tuesday, June 23, at 11 a.m., unserviceable and obsolete stores, including quantities of iron, steel, brass, copper, gunmetal, mixed metals, lead, zinc, aluminium, phosphor bronze, &c., electric cable, telegraph instruments, lamps (electric, ship signalling, &c.), machinery, lathes, &c. May be viewed at the Royal Arsenal, Woolwich, on the Friday and Monday previous to and on morning of sale. Catalogues at the War Office, Whitehall; Ordnance Office, Tower; and Ordnance Office, Royal Arsenal, Woolwich. Further particulars are given in an advertisement.

Plant for Sale.—Two Royce compound-wound dynamos and two 14 H.P. gas engines, with flywheels, &c., are advertised for sale Applications to Mr. Wm. Morton, Grand Theatre, Hull.

CATALOGUES, &c.

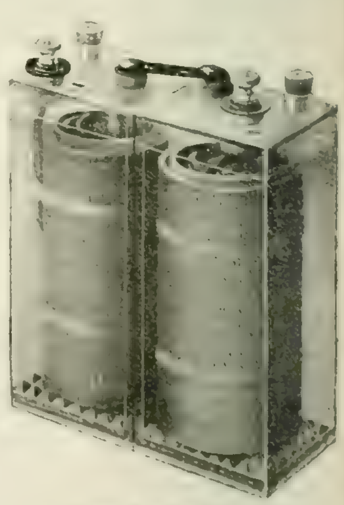


25 Volt Tantalum Lamp.

Tantalum Lamps.—Consumers of a.c. electrical energy will be interested in a new type of metallic filament lamp which has been placed on the market by Siemens Bros. Dynamo Works (Ltd.), namely, a 25 volt tantalum lamp for use with small auto.-transformers and low voltage circuits generally. The new lamp is for voltages of 24 or 25, and is supplied in 8 or 16 c.p. sizes. It resembles other types of tantalum lamps, in that the filament is strong and may be burned in any position. The 25 volt tantalum lamp may be used for train lighting and private house installations. The bulb is smaller than that of the ordinary carbon filament lamp, but similar in shape. The price of the new tantalum lamp (which we illustrate) is 2s each.

Pumps.—The pump is a very useful part of engineering economy, but we prefer it electrically driven. As an ordinary rule the Pulsometer Engineering Co., of Reading, do not require a motor, for their well-known pulsometer pump is essentially adapted for steam working. Nevertheless, their catalogue contains a great deal of interesting information regarding their pump, which we believe, though our physiological knowledge is not wide, acts on the same system as the heart. This pump is, it is claimed, especially adapted for pumping liquids containing mud or grit, can be used when slung from a chain, and, having no exhaust, can be employed in circumscribed areas. The company make other types of pumps with which a motor can be used.

"Fors" Accumulator.—This type of accumulator, which is being manufactured by Richard Pape (Ltd.), possesses distinctive features which single it out from other accumulators on the market. The positive plate is separated from the negative by a special porous pot, and the design of the plates provides for an exceptionally large surface area of active material. It is claimed that the reduction of weight thus made possible amounts to 50 per cent. Other advantages claimed are impossibility of internal short-circuits, of buckling, capability of standing rough treatment and absence of sulphating. The cells are entirely of British manufacture, and the address of the company is, Albion House, New Oxford-street, London, W.C.



Fors Accumulator.

Travel.—The rest and recreation seeker is considering his plans for the coming holiday season, and the occasion is made the most of by the principal railway companies of the United Kingdom by the preparation of some really excellent guides, both for our own country and for places of interest on the Continent. We have received several of these guides, and we can commend the care and attention to details which characterise them. The London & South Western Railway Co., the Great Western, the South Eastern & Chatham, the Great Eastern, the Great Central, the Great Northern, the Midland and the London & North Western companies have all provided most excellent literary compilations for the convenience and instruction of tourists and travellers. All the guides are very fully illustrated, and contain numerous maps which will serve as excellent pocket companions to the motorist, the cyclist and the pedestrian. These guides, which are published at a few pence each, can be obtained at the railway stations, at most of the railway booking offices and at the railway bookstalls. Mr. Percy Lindley has, as usual, prepared the guide issued by the Great Eastern Co., and for the small sum of 6d. a book is obtainable, which, whether one travels or not, is entertaining reading.

BANKRUPTCIES, LIQUIDATIONS, &c.

In the bankruptcy of Wm. Wardle, electrician, 14, Osborn-road, Levenshulme, Manchester, the first meeting of creditors will take place on June 17 at the O.R.'s, Byrom-street, Manchester, and the public examination on July 3 at the Court House, Manchester.

In the bankruptcy of Albert Lord, electrical engineer, 134, Deansgate, Manchester, the first meeting of creditors will take place on June 18 at the O.R.'s, Byrom-street, and the public examination on July 3 at the Court House, Manchester.

In the bankruptcy of Ernest Goacher, electrical engineer, &c., Gateford-road, Worksop, the first meeting of creditors will take place on June 19 at the O.R.'s, Figtree-lane, Sheffield, and the public examination on June 25 at the County Court Hall, Sheffield.

Claims against the Brockie Pell Arc Lamp (Ltd.) by July 6 to Mr. Hy. McLellan, 6A, Devonshire-square, London, E.C.

Claims against Aublet, Harry & Co. (Ltd.) by July 17 to Mr. C. Comins, 50, Cannon-street, London, E.C.

Claims against the Alsop Flour Process (Ltd.) by July 13 to Mr. J. Abernethy, Dashwood House, New Broad-street, London, E.C.

A preliminary meeting of the creditors of the Kevan Electric Co. (Ltd.) was held on Wednesday to decide whether the business should be closed or whether certain contracts, the largest of which was one for 5,000 lamps, should be completed. A winding-up order was made on June 2.

It was decided not to continue the business, the creditors being unwilling to find the necessary funds. Several creditors said they would undertake to execute some of the contracts for the benefit of the estate. Reckoning the profit on the contract for 5,000 lamps as 10 per cent., it was estimated that £50 would accrue to the estate if that contract were completed. The Electrical Co. was stated to be the largest creditor, and it was suggested that they should buy back the stock they had supplied. The representative of the company, however, declined to give an undertaking to this effect until he had consulted his principals. The Official Receiver was asked to sell the stock as soon as possible. A statutory meeting will be held in due course.

With reference to the voluntary liquidation of the Hart Secondary Battery Synd. (Ltd.) the secretary of the Hart Accumulator Co. writes:—

Some misunderstanding having arisen through the notice published relative to the winding up of the Hart Secondary Battery Synd. (Ltd.) I should like to state that this liquidation in no way affects the Hart Accumulator Co., beyond the fact that the latter have purchased the foreign patents of the syndicate with the intention of further developing their foreign and Colonial trade in accumulators.

The notice referred to above was not published in *The Electrician*.

A meeting will be held on July 8 at 138, Salisbury House, London, E.C., to receive an account of the winding up of the Gardner Electric Drill & Hammer Co. (Ltd.).

A meeting will be held on July 6 at 92 and 94, Paul-street, Finsbury, London, E.C., to receive an account of the winding up of May Oatway Fire Appliances (Ltd.).

Imports.—The following are official values of electrical machinery, material, and apparatus imported into this country (*a*) during May, 1908, and (*b*) during the current year from Jan. 1 to May 31, with the increases or decreases compared with the corresponding periods of 1907:—

Electrical machinery (*a*) £53,695 (increase £7,939); (*b*) £284,820 (increase £39,744); telegraph and telephone cables (*a*) £9,769 (decrease £11,483); (*b*) £57,463 (decrease £85,459); telegraph and telephone apparatus (*a*) £13,702 (decrease £9,691), (*b*) £88,451 (decrease £17,999); other electrical wires and cables, rubber insulated (*a*) £6,657 (increase £673), (*b*) £33,452 (decrease £7,960); with other insulations (*a*) £9,118 (increase £5,823), (*b*) £51,595 (increase £16,850). The following were not separately enumerated last year: Carbons (*a*) £13,155; (*b*) £73,933; glow lamps (*a*) £25,608, (*b*) £102,435; arc lamps and electric searchlights (*a*) £362, (*b*) £1,563; parts of arc lamps and searchlights (other than carbons) (*a*) £3,251, (*b*) £22,355; primary and secondary batteries (*a*) £4,542, (*b*) £21,311. Total of electrical goods and apparatus, other than machinery and telegraph and telephone wire (*a*) £97,455 (decrease £21), (*b*) £502,200 (decrease £44,752).

Exports.—The exports of electrical machinery, material, &c. (*a*) during May, 1908, and (*b*) during the current year from Jan. 1 to May 31, and the increases or decreases compared with the corresponding periods of 1907, are as follows:—

Electrical machinery (*a*) £95,660 (increase £17,565), (*b*) £556,393 (increase £175,317); telegraph and telephone cables (*a*) £32,716 (increase £3,712), (*b*) £224,191 (decrease £65,142); telegraph and telephone apparatus (*a*) £17,448 (increase £3,492), (*b*) £63,196 (increase £10,035); other electrical wires and cables, rubber insulated (*a*) £26,495 (increase £10,611), (*b*) £119,483 (increase £6,037); with other insulations (*a*) £25,258 (decrease £7,285), (*b*) £112,996 (increase £18,334). The following were not separately enumerated last year: Carbons (*a*) £1,010, (*b*) £3,175; glow lamps (*a*) £4,885, (*b*) £19,476; arc lamps and searchlights (*a*) £4,349, (*b*) £9,668; parts of arc lamps and searchlights (other than carbons) (*a*) £992, (*b*) £6,275; primary and secondary batteries (*a*) £5,000, (*b*) £22,388. Total of electrical goods and apparatus, other than machinery and telegraph and telephone wire (*a*) £153,040 (increase £20,706), (*b*) £733,822 (decrease £34,157).

BOOKS RECEIVED.

(Copies of the undermentioned works can be had from *The Electrician* office, post fee, on receipt of published price. Add 10 per cent. for abroad or for foreign books).

"Science Abstracts." May, 1908. Vol. XI. Part 5. Section A.—Physics. Section B.—Electrical Engineering. (London: E. & F. N. Spon.) 1s. 6d. each.

"Proceedings of the Royal Society." Vol. LXXX. No. A 540. Series A.—Mathematical and Physical Sciences. (London: Harrison & Sons.) 3s.

COMPANIES' MEETINGS AND REPORTS.

ANGLO-PORTUGUESE TELEPHONE CO. (LTD.)—At the meeting last week the chairman (Mr. H. Allen) explained the various items in the accounts and said their business was in no way impaired by the recent political events in Portugal. The national excitement arising out of the terrible tragedy of February last gave their staff plenty of work and put a severe strain upon their service generally, but they were quite equal to the occasion. They had taken out policies at Lloyds covering themselves as far as possible against every conceivable risk of loss arising out of any political events that may occur in Portugal, and they had also covered themselves against risk of damage from earthquake and loss of revenue from any suspension of service from such a cause. Their expenses compared favourably with those of other Anglo-foreign telephone companies. Having regard to all the circumstances under which the business of the company was conducted, he did not think it would be prudent to anticipate, over any appreciable period, a lower ratio of expenses than about 50 per cent. of the receipts. The extension of the underground work in Lisbon had been put in hand. During the year they had again spent nearly £9,000 on capital account without encroaching in any way upon their reserve working capital of £10,000. The principal work completed during the year was the extension of the switchboards at Lisbon and Oporto, giving an increased capacity for 900 subscribers in the former city and 240 in the latter. By the end of the current year further extensions will have to be made. The total number of calls recorded during the year in both cities was about 7,750,000.

ARON ELECTRICITY METER (LTD.)—For the six months ended March 31 the net profit, after providing for general charges and depreciation, was £11,485. 15s. 7d., making, with balance from last account of £6,228. 8s. 7d., a total available profit of £17,714. 4s. 2d. The directors recommend payment of a further dividend of 7 per cent. on the preference shares (£8,742. 14s. 5d.) and the transfer to reserve towards goodwill and patents of £5,000, carrying forward £3,971. 9s. 9d. The directors record further progress in all the company's branches. They ascribe the satisfactory results during the half-year to an increased demand in all European countries for the company's meters and clocks. The factories continue to be fully employed and have again been added to in order to cope with the increased business. The company have recently placed on the market a taximeter which has been approved by the Commissioner of Police and passed by the National Physical Laboratory, and it is hoped that this new enterprise may prove an additional source of income.

BIRMINGHAM & MIDLAND TRAMWAYS (LTD.)—The total revenue for 1907 was £83,837. 14s. 1d., compared with £92,582. 1s. 4d. for 1906, the latter figure including the receipts for the first six months of the year of the Dudley-road tramway in Birmingham, which has since passed into the hands of the Corporation. Expenses were £38,652. 18s. 11d., compared with £44,951. 19s. Out of £44,236. 18s. 5d. remaining debenture interest takes £15,765. 12s. 4d., preference dividend £11,537. 18s., and the directors propose to place £3,550 to debenture redemption and to pay a dividend on the preferred ordinary shares of 4 per cent., less tax. Gross receipts from the tramways were £44,440. 19s 8d., against £58,081. 2s. 11d., while expenses show a reduction of about £6,000. Gross receipts from lighting and power were £8,303. 4s. 11d., an increase of nearly £1,000. Expenses were £5,251. 12s 3d., an increase of £122. 6s. 9d. Total capital expenditure was £24,820. 8s. 8d. The supply of current to power and lighting consumers has increased, and the equivalent of 51,763 8 c.p. lamps is now connected for lighting, power and traction, against 37,786 8 c.p. Since the close of the financial year the company has acquired a controlling interest in the Shropshire, Worcestershire and Staffordshire Power Acts, 1903, 1905 and 1906, but the arrangements are still incomplete. Negotiations with Oldbury Council have been completed for the transfer to the Shropshire Power Co. of the Oldbury electric lighting order, 1898.

BRUSH ELECTRICAL ENGINEERING CO. (LTD.)—The directors' report for the year to Dec. 31, 1907, just issued, is in abstract as follows:—

Capital Account.—The amounts standing to credit of general reserve and depreciation reserve funds, as well as the balance of profit brought forward from 1906, have been absorbed. The patents and goodwill account is now represented by the round figure of £100,000, while the company's investments, which were entered in the 1906 balance sheet at £161,522 10s. 6d., now stand at £101,335, 8s. 9d.

Profit and Loss.—Gross profit was £63,294. 9s. After debiting general charges and maintenance and paying debenture and other interest the net balance is £10,229. 9s. 6d. The directors recommend that this balance be applied to initiate a new general reserve fund.

General.—The output from the works during 1907 was the largest in the history of the company, but the directors regret that profits realised have not been commensurate, chiefly due, it is stated, to the fact that competition in the electrical engineering industry continues to be very keen, while the after effects of the strike at the Lough-

borough works have been severely felt. The company has also suffered from lack of adequate working capital. The contracts upon which it has been engaged have involved a large lock-up of money while in progress, and this situation has had to be met by temporary loans from bankers and others. A portion of these loans was obtained from the British Electric Traction Co. without security and, as part of the arrangement then made, the directors have waived their option to call upon the British Electric Traction Co. to accept £2 ordinary shares at par in satisfaction of the advance of £30,740 made by that company in 1901, and have agreed to repay the said advance by 12 half-yearly cash instalments commencing in January, 1909, and carrying interest at the rate of $3\frac{1}{2}$ per cent. per annum. With a view to placing the Brush Co. in a position to carry on its business under more favourable and economic conditions, the directors put forward in January last a scheme to consolidate the existing £250,000 first and second debenture stocks, and to make a further issue of £100,000 $4\frac{1}{2}$ per cent. debenture stock. This proposal, however, was not supported by the first debenture stockholders, and the directors have now arranged to make an issue of £125,000 5 per cent. prior lien debenture stock, which will be specifically secured upon the freehold and leasehold lands, buildings and fixed plant of the company at Loughborough. In order to arrive at a more marketable denomination of the preference and ordinary shares of the face value of £1. 6s. 8d. it is proposed to sub-divide these into shares of 6s. 8d. each, and to consolidate every three of the latter into one £1 share, thus giving the shareholders four £1 shares for every three shares at present held. Similarly the unissued 74,268 ordinary shares of £2 each will be converted into 148,536 ordinary shares of £1 each. An extraordinary meeting will be held to adopt resolutions to give effect to this sub-division.

The directors have decided to give the preference shareholders the right to convert 25 per cent. of their holding into ordinary shares.

MADRAS ELECTRIC SUPPLY CORPN. (LTD.)–On Wednesday Mr. A. M. Waldron told the shareholders that the contractors (Messrs. Crompton & Co.) had practically completed the plant and machinery for the main generating station, and it had been waiting some time to be shipped, but the building in Madras was not ready to receive it. Great delay had been caused by a scarcity of bricks.

SHEERNESS & DISTRICT ELECTRIC POWER & TRACTION CO. (LTD.)—The receipts from the light railways for the year 1907 were £3,160. 13s. 9d., and from the electricity supply to £3,228. 12s. 2d. Expenses (including interest) amounted to £6,713. 4s 8d., leaving a loss of £300. 4s. 2d. Adding this to the debit balance of £676. 4s. 10d. from last account, there is a debit of £976. 9s. to be carried forward.

UNITED ELECTRIC TRAMWAYS OF MONTEVIDEO (LTD.)—The directors' report for the year ended March 31 states that the results of the operation of the tramway systems of La Sociedad Comercial de Montevideo for the year to Oct. 31, 1907 (including those of the Union system, which the company acquired in 1906), are as follows: Gross receipts $935,474 (increase $324,587), operating expenses $619,660 (increase $168,464), net receipts $315,814 (increase $156,114), or at exchange of $4.7 to the £, £67,194 (increase £33,216). 21,358,943 passengers were carried (increase 7,517,385) and 4,716,906 car-miles were run (increase 1,444,106). These increases show the expansion of traffic arising from the conversion to electric traction, which is being rapidly accomplished, and amply justifies expectations of largely increased takings when animal traction shall have been entirely superseded. The gross receipts subsequent to Oct. 31, 1907, show continued increase, the actual increase to April 30 last being $93,703 (£19,937). The total length of single track to be electrified under the construction contracts is 80 miles. Nearly 75 miles are now completed, of which $50\frac{1}{2}$ miles were in actual operation at March 31 last. Animal traction will probably be completely superseded in the course of the next three months. The debenture and share capital of La Sociedad Comercial de Montevideo has been increased in respect of the expenditure on electrification, and the whole amount thereof is held by this company. The amount received from La Sociedad Comercial in respect of dividend on share capital and debenture interest was £71,152. 11s. 7d. The credit balance for the year is £46,537. 9s. 8d., against £17,221. 16s. 5d. Adding £690. 14s. 10d. brought forward, the total is £47,228. 4s. 6d. After paying preference dividend, &c., the directors recommend a dividend on the ordinary shares of 5 per cent. (less tax) for the year to March 31 (£13,917. 10s.), leaving £11,963 to be carried forward.

At the forthcoming meeting resolutions will be submitted for splitting each preference and ordinary share of £10 into two similar shares of £5 each.

URBAN ELECTRIC SUPPLY CO. (LTD.)—At the meeting last week, the chairman (Mr. P. D. Tuckett) said the progress made, while not as rapid as might be wished, was substantial. There was an increase of £3,323, or about 10 per cent. in the gross profit. The directors were doing all they could to discourage the locking up of capital in free wiring, which, however, had its advantages, especially at places where houses were commonly taken on three years' agreements, and consequently some assistance had to be given in wiring premises to secure the adoption of electric lighting. With regard to the company's future, there was no question of the ability of Edmundsons's Electricity Corpn. to meet the guarantee of dividends up to 1910. A rough approximation of the position in 1911 was as follows: Assuming gross profits to increase by £1,000 a year and head office expenses to be £2,500, and taking the additional capital charges at £17,500, there was likely to be £2[illegible],000 available for depreciation and preference dividend in 1911, which left no prospect of an ordinary dividend in that year; but the business was sound and progressive, based upon definite concessions of increasing value, and it was only a question of time to see dividends earned on the ordinary shares.

NEW COMPANIES, STATUTORY RETURNS, MORTGAGES AND CHARGES.

NEW COMPANIES.

C. LARKINS & CO. (LTD.) (98,233).—Reg. June 4, capital £1,500 in £1 shares (1,400 preference), to adopt an agreement with S. O. Hoad and F. P. Spicer for the acquisition of the business carried on by them as C. Larkins & Co., and to carry on the business of electrical and general engineers and contractors, &c. First directors, S. O. Hoad and F. P. Spicer (both permanent). Reg. office, Bush-lane House, Cannon-street, London, E.C.

MAGNETA TIME CO. (LTD.) (98,242).—Reg. June 4, capital £30,000 in £1 shares, to take over the business of manufacturers and installers of and dealers in synchronised time systems carried on by the Magneta Fabrik Electrische Uhren Actien Gesellschaft (of Zurich) at London and elsewhere (but only in the U.K.) as the Magneta Co., also to acquire for a certain period the services of Mr. A. R. Upward. First directors, A. R. Upward and one or two others to be nominated by the subscribers. Reg. office, Millbank House, London, S.W.

ORLING'S TELEGRAPH INSTRUMENTS SYND. (LTD.) (98,244).—Reg June 4, capital £1,500 in £1 shares, to acquire the benefit of certain provisional protections in respect of improvements in electro-capillary apparatus for the transmission of a series of electric impulses along land lines or cables, and for improvements in cable telegraphy, to adopt an agreement with A. Orling, and to carry on the business of electrical and mechanical engineers, manufacturers of electrical and other apparatus, &c. Reg. without articles of association by W. T. Moore, 24, Budge-row, London, E.C.

PREMIER ELECTRIC HEATERS (LTD.) (98,245).—Reg. June 4, capital £2,000 in £1 shares, to adopt an agreement with G. H. Collins and H. F. Collins for the acquisition of the business of the Premier Electric Heating Co., and to carry on the business of manufacturers and sellers of electrically-heated appliances, resistances for heaters, controllers and regulators, &c. First directors, G. H. Collins, H. F. Collins and A. J. Collins. Reg. office, Ashley-street, Birmingham.

MORTGAGES AND CHARGES.

GOULD STORAGE BATTERY CO. (LTD.) Issue on May 22 of £450 6 per cent. debentures, part of series created May 21, 1908, to secure £5,000, charged on company's property, present and future, including uncalled capital. No trustees. Previously issued of same series, £50.

STATUTORY RETURNS.

COUNTY OF DURHAM ELECTRICAL POWER DISTRIBUTION CO. (LTD.)—Return to March 24 gives capital as £500,000 in 50,000 preference and 50,000 ordinary shares of £5 each, all of which have been taken up and paid for in full. Mortgages and charges, £219,643.

WITNEY ELECTRIC SUPPLY CO. (LTD.)—In return to May 11 capital is £10,000 in 5,000 preference and 5,000 ordinary shares of £1 each, of which 2,849 preference and 2,802 ordinary have been taken up. £4,629. 2s. 6d. has been received, including £3. 2s. 6d. paid on 25 forfeited shares and leaving £21. 17s. 6d. in arrears. Mortgages and charges, £3,500.

ALDERLEY & WILMSLOW ELECTRIC SUPPLY (LTD.)—The capital in return to May 12 is £30,000 in 20,000 ordinary and 10,000 preference shares of £1 each, of which 5,009 have been taken up. £5,009 has been received. Mortgages and charges, £5,000.

CITY NOTES.

MEMORANDA (June 11).—Bank rate $2\frac{1}{2}$ per cent. (May 28, 1908) Price of silver $24\frac{5}{8}$d.–$24\frac{11}{16}$d. per oz. Consols $87\frac{5}{8}$–$87\frac{3}{4}$ for money and $87\frac{11}{16}$–$87\frac{13}{16}$ account. Consols Pay Day, July 1; Stock and Shares Continuation Days, June 24 and July 13; Ticket Day, June 25; Pay Days, June 12 and 26; Mining Share carry-over Day, June 23.

PRICES OF METALS (London).—*Copper*, cash, $58\frac{1}{4}$–$58\frac{3}{4}$; three months, 59–$59\frac{1}{4}$. *Lead*, English, 13; foreign, $12\frac{5}{8}$–$12\frac{3}{4}$. *Spelter*, foreign, 19–$19\frac{1}{8}$. *Tin*, English, 129–130; foreign, cash, $129\frac{5}{8}$–$129\frac{7}{8}$, three months, $129\frac{7}{8}$–$130\frac{1}{8}$. *Iron*, Cleveland, cash, 51/$0\frac{1}{2}$–51/$3\frac{1}{2}$; one month, 50/4–50/6.

CITY OF LONDON ELECTRIC LIGHTING CO. (LTD.)—The transfer books and register of holders of the 5 per cent. first debenture and $4\frac{1}{2}$ per cent. second debenture stock will be closed from 17th to 30th inst. inclusive.

MEXICAN LIGHT & POWER CO.—A dividend of 1 per cent. has been declared on the outstanding ordinary shares, payable July 15.

SAO PAULO TRAMWAY, LIGHT & POWER CO. (LTD.)—A quarterly dividend of $2\frac{1}{4}$ per cent. is payable on 1st prox.

STOCK EXCHANGE NOTICES.—The Stock Exchange committee have been asked to appoint a special settling day in and grant a quotation to a further issue of 20,000 £5 fully and partly-paid ordinary shares of the *United River Plate Telephone Co. (Ltd.)*, to appoint a special settling day in 37,520 £1 fully paid ordinary shares of the *Aluminium Corpn. Ltd.*, and to allow 250,000 $100 shares of the *Rio de Janeiro Tramway, Light & Power Co. (Ltd.)* to be quoted (renewed special application.

WESTERN UNION TELEGRAPH CO.—This company has declared a quarterly dividend of $\frac{3}{4}$ per cent.

ELECTRIC TRAMWAY AND RAILWAY TRAFFIC RECEIPTS.

Line	Week ended.	Amount.	Inc. or Dec. (a)	Aggregate No. of weeks.	Aggregate Amount.	Aggregate Inc. or Dec. (a)
		£	£		£	£
Aberdeen Corporation	...	...	...	...	...	...
Accrington	May 29	225	− 12	21	4,710	+ 38
Anglo-Argentine	June 3	17,855	+ 1,303	22	408,181	+ 44,376
Ayr Corporation	" 6	235	+ 12	3	910	− 75
Baker St. & Waterloo Ry.	" 6	2,9[illegible]0	+ 460	23	70,305	+ 15,789
Barnsley	May 29	173	+ 29	21	3,613	+ 212
Barrow	" 29	225	− 50	21	4,714	− 130
Bath Electric Trams, Ltd.	June 3	793	− 165	22	14,254	− 1,[illegible]
Birkenhead Corporation	" 7	1,174	+ 129	...	...	...
Birmingham Corporation	" 6	6,651	+ 720	10	61,568	+ 2,550
Birmingham & Mid.	May 22	822	− 366	20	16,131	+ 406
Blackburn Corporation	...	...	...	...	...	...
Blackpool Corporation	June 4	664	− 46	§9	6,716	− 1,532
Blackpool and Fleetwood	" 7	472	+ 64	...	...	...
Bolton Corporation	" 7	2,375	+ 48	10	23,310	+ 719
Bombay	" 14	R37,228	+ R8,626	20	R692,940	+ R133,932
Bournemouth Corporation	" 3	1,499	+ 2	9	14,710	− 1,204
Bradford Corporation	May 30	4,8[illegible]0	+ 526	9	40,477	+ 2,022
Brighton Corporation	June 7	936	+ 98	10	8,091	− 251
Bristol Trams & Carriage	" 5	5,294	+ 342	28	103,497	− 3,895
Buenos Ayres & Belgrano	" 3	3,699	− 282	22	83,806	+ 389
Burnley Corporation	" 6	1,235	+ 62	10	12,740	+ 513
Burton Corporation	" 7	302	+ 7	10	2,598	− 230
Bury Corporation	May 31	1,260	− 43	‡9	10,540	+ 1,019
Calcutta Tramways Co.	June 6	R15,978	− R562	...	...	...
Camborne Redruth	...	...	...	...	...	...
Cardiff Corporation	May 30	2,147	+ 78	9	18,136	− 401
Cavehill	" 29	103	+ 13	21	1,663	+ 105
Central London Railway	June 6	6,556	+ 765	23	140,444	+ 104
Charing X, Euston & H'stead	" 6	3,320	...	23	73,850	...
Chatham & Dist. Lt. Rys.	" 4	887	+ 192	§22	15,184	+ 108
City & South London Rly.	" 7	3,148	+ 46	23	74,327	+ 6,171
City of Birmingham	May 29	2,907	− 5	21	57,905	− 60
Colchester Corporation	June 3	214	+ 18	...	...	...
Cork Electric Trams Co.	" 4	531	+ 49	§22	9,369	− 409
Croydon Corporation	" 5	1,618	+ 236	10	13,561	− 384
Devonport & Dist. Trams	May 29	450	+ 4	21	9,183	− 134
Dover Corporation	June 6	219	+ 3	10	1,980	− 201
Dublin & Lucan Railway	" 5	134	+ 22	23	2,433	+ 82
Dublin United	" 5	5,839	+ 116	23	111,076	− 1,794
Dudley-Stourbridge	May 29	789	+ 30	21	16,000	− 1,731
Dundee Corporation	June 3	1,313	+ 234	13	3,426	+ 397
East Ham Council	" 6	891	+ 11	10	8,138	− 619
Gateshead & Dist. Trams	May 29	972	+ 15	21	20,885	+ 136
Glasgow Corporation	June 6	18,687	+ 1,467	1	18,687	+ 1,467
Glossop	" 6	137	+ 10	22	2,793	− 168
Gravesend − Northfleet	May 29	203	− 24	21	4,092	− 726
Great Northern & City Rly.	June 6	1,557	− 200	23	39,300	− 2,664
Gt Northern, Piccadilly, &c	" 6	5,305	+ 995	23	124,525	+ 24,596
Greenock & Port Glasgow	May 29	575	− 190	21	10,445	− 2,955
Hartlepool Tramways	" 29	252	+ 5	21	4,523	− 971
Hastings Elec. Trams Co.	June 4	1,014	+ 109	23	19,258	− 641
Hong Kong	" 6	$7,214	+ $154	...	...	...
Huddersfield Corpn.	...	...	...	...	...	...
Hull Corporation	" 6	2,473	+ 102	10	23,333	− 178
Ilford District Council	...	...	...	...	...	...
Ilkeston District Council	" 3	143	+ 17	9	1,408	+ 2
Ipswich Corporation	" 6	447	+ 60	10	3,552	− 142
Isle of Thanet Co.	" 6	583	+ 73	36	10,939	− 176
Jarrow	May 29	100	− 9	21	2,089	− 346
Keighley Corporation	June 4	173	+ 21	49	7,730	+ 341
Kidderminster & District	May 29	101	+ 4	21	1,903	− 275
Kilmarnock Corporation	...	...	...	...	...	...
Lanarkshire Trams Co.	June 1	1,364	+ 211	22	28,203	+ 3,[illegible]04
Lancashire United	" 3	1,421	+ 317	22	27,624	+ 1,036
Leamington	May 29	165	− 3	21	2,976	− 68
Leeds Corporation	" 30	6,747	+ 807	9	55,651	− 28
Leicester Corporation	June 6	2,407	+ 138	...	...	...
Leith Corporation	May 30	525	+ 18	§2	1,105	− 109
Lincoln Corporation	June 6	114	− 4	10	1,171	+ 31
Liverpool Corporation	May 30	11,169	+ 105	22	227,288	− 2,594
Liverpool Overhead Rly.	June 7	1,412	− 22	23	32,100	− 8[illegible]
*London County Council	May 30	35,692	+ 4,882	†19	285,796	+ 25,122
London United	June 6	7,843	− 1,209	22	132,654	− 1,459
Lowestoft	" 6	200	+ 26	36	5,683	+ 122
Maidstone Corporation	" 6	211	...	10	1,798	...
Manchester Corporation	" 6	15,625	+ 1,255	10	144,898	+ 5,347
Mersey Railway	" 6	1,899	+ 60	23	43,949	+ 1,594
Merthyr	May 29	215	+ 10	21	4,313	− 40
Metropolitan Dist. Railway	June 6	9,108	+ 820	23	201,835	+ 22,105
Metropolitan Elec. Trams	May 29	6,119	+ 1,552	21	108,438	+ 19,780
Middleton	" 29	382	− 170	21	7,002	− 145
Nelson Corporation	June 6	154	+ 22	¶9	1,396	− 117
Newcastle-on-Tyne Corp.	" 6	3,780	− 246	10	36,385	− 3,943
Newport (Mon.)	" 6	701	− 803	10	6,486	− 1,015
Northampton Corporation	" 5	492	+ 78	¶9	4,176	− 65
Oldham, Ashton & Hyde	May 29	591	− 98	21	12,343	− 180
Oldham Corporation	June 7	2,035	+ 142	11	2[illegible],365	+ 130
Perth (N.B.) Corporation	" 3	160	− 16	3	411	− 30
Perth (W.A.) Elec. Trams	" 5	1,358	+ 3	¶23	32,444	− 791
Peterborough	May 29	125	+ 10	21	2,348	− 66
Portsmouth Corporation	June 6	2,109	+ 130	10	18,008	− 808
Potteries	May 29	1,746	− 85	21	38,477	− 92
Preston Corporation	June 3	775	+ 73	23	15,797	− 389
Rotherham Corporation	" 4	611	+ 51	§9	5,6[illegible]	− 57
Rothesay	May 29	154	+ 6	21	1,882	− 151
Sheerness	" 27	55	− 1	21	1,060	− 25
Sheffield Corporation	June 7	5,811	+ 170	†11	59,218	− 1,017
Singapore Trams	" 6	$9,550	+ $293	...	...	...
Southend Corporation	" 3	401	+ 66	10	3,259	− 9
South Metropolitan	May 29	885	+ 114	21	15,000	− 224
Southport Tramways	" 29	404	+ 14	21	4,898	− 576
South Staffs	" 29	853	+ 66	21	18,193	− 5[illegible]
Stalybridge, Hyde, &c., Jt Bd.	June 6	810	+ 78	†10	7,183	− 252
Sunderland Corporation	...	...	...	...	...	...
Sunderland and District	" 3	504	+ 83	31	14,107	+ 1,190
Swansea Trams	May 29	953	+ 90	21	18,423	+ 1,065
Swindon Corporation	June 3	154	+ 1	...	...	...
Taunton	May 29	39	− 2	21	814	− 45
Tynemouth and District	" 29	205	+ 15	21	3,294	− 483
Tyneside Trams Co.	June 3	400	+ 13	23	8,166	− 1,[illegible]95
Wallasey District Council	" 6	937	+ 1[illegible]0	†19	8,[illegible]3	+ 209
Walsall Corpn	...	...	...	...	...	...
Warrington Corpn.	" 4	383	...	9	3,[illegible]	+ 47
West Ham Corporation	" 4	2,316	+ 177	10	21,816	− 1,552
Weston-super-Mare	May 27	89	− 15	21	933	− 371
Wolverhampton Co.	" 29	442	+ 27	21	9,310	− 4[illegible]0
Wolverhampton Corpn.	June 3	852	+ 52	52	37,764	...
*Worcester	May 29	272	+ 3	21	5,246	− 157
Wrexham	" 29	101	+ 5	21	2,036	− 22
Yorkshire W.R. Trams	June 7	1,397	+ 190	23	26,166	...
Yorkshire Woollen District	May 29	934	+ 63	21	18,815	− 834

(a) These comparisons are with the corresponding period last year. § Plus 2 days. ¶ Plus 3 days. * Partly electrical. † Minus 3 days. ‡ Minus 2 days. Plus 4 days.

ELECTRICAL COMPANIES' SHARE LIST.

Share.	Last Dividend	Name.	Price Wed., June 10.	Rate % Yield-ed. £ s. d.	Dividend Due.	Business Week to June 10. Highest.	Lowest.
		ELECTRICITY SUPPLY.					
10	9 0	Bournemouth & Poole Elec. Sup. Ord.	10½−11	6 7 0	Mar, Sept,	10	..
10	4 6	Do. 4½ per Cent. Cum. Pref.	9½−10½	4 7 0	Feb, Aug	.	..
10	6/0	Do. 6 per Cent. Cum. Second Pref.	10½−11	5 9 0	Feb, Aug	10½	..
St.	4½%	Do. 4½ per Cent. Deb. Stock (red.)	102 −105	4 5 6	Jan, July	.	.
5	3 6	Bromley (Kent) El. Lt. & Power Shares	4½−5	5 10 0	April, Oct	..	..
St.	4½%	Do. Do. 1st Debs.	94 −97	4 12 9	May, Nov	.	..
5	5 6	Brompton & Kensington Elec. Sup. Ord.	6½−7½	6 13 0	March....	7	..
5	3 6	Do. 7 per Cent. Pref.	6¾−7¾	4 10 0	Mar, Sept		..
St.	4%	†Central Elec. Sup. Co. 4% Guar. Db. Stock	98 −101	4 0 0	June, Dec	..	..
5	2 6	Charing Cross (W. End & City) El. Sup. Co.	3½−4	6 5 0	Feb, Aug	..	..
5	2 3	Do. 4½ per Cent. Pref.	4⅜−4⅝	4 17 0	Feb, Aug	..	..
St	4%	Do. 4 per Cent. Deb. Stock (red.	96 −99	4 1 0	Jan, July	..	..
5	2,3	Do. City Undertaking 4½% Cm. Pref.	3⅞−4⅛	5 3 0	Jan, July	..	..
5	2/6	Chelsea Electric Supply Ord.	3 −3½	6 8 9	March ..	4	4
St.	4½%	* Do. 4½ per Cent. Deb. Stock (red.)	101 −104	4 6 9	June, Dec	..	..
10	7,0	City of London Electric Lighting Ord.	9½ −10½	5 18 6	Feb, Aug	9⅞	.
10	6/0	Do. 6 per Cent. Cum. Pref.	12 −13	4 12 0	Jan, July	..	..
St.	5%	Do. 5 per Cent. Deb. Stock (red.)	124 −127	3 18 0	June, Dec	.	.
St.	4½%	Do. 4½ per Cent. 2nd Deb. Stock (red.)	102 −105	4 6 0	Jan, July	103½	..
5	1/10½	County of Durham Elec. P.D. Ord.	2¾−3	3 9 7	April, Oct	..	..
5	5%	Do. 5 per Cent. non Cum. Pref.	3⅝−3⅞	6 13 4	April, Oct	..	..
10	6 0	County of London Elec. Supply Ord.	7¾−8¼	6 3 6	Feb, Aug	7¾	..
10	6 0	Do. 6 per Cent. Cum. Pref.	10½−11	5 9 0	Mar, Sept	10¾	10¾
St.	4½%	Do. 4½% Deb. Stock (all paid) (red.)	107 −110	4 2 6	Jan, July	..	..
St.	4½%	Do. Second Deb. Stock	93 −101	4 9 9	May, Nov	..	..
5	3 6	Folkestone Electricity Supply Co. Ord.	4½−5½	5 7 0	April, Oct		−
5	2 6	Do. 5 per Cent. Cum. Pref.	5 −5½	4 11 0	Mar, Sept	..	..
St.	4½%	Do. 4½ 1st Deb. Stock (red)	94 −97	4 13 0	Feb, Aug	..	..
5	4 6	Hove Electric Lighting Ord.	6 −6½	6 11 0	April, Oct	6½	..
5	5/0	Kensington & Knightsbridge Ord.	7 −8	6 5 0	Feb, Aug	..	..
5	6%	Do. 6 per Cent. 1st Pref.	6 −6½	4 12 0	Jan, July	..	−
St.	4%	Do. 4 per Cent. Deb. Stock (red.)	96 −99	4 1 0	..	..	..
St.	4%	Kensingtn. & Kngtbg. Co. & Notting Hill Co. (Joint Station) 4% Deb. Stock (red.)	97 −101	3 19 0	April, Oct	..	..
St.	4½%	Kent Elec. Power Co.	88 −92	4 18 3	Jan, July	.	..
3	1 6	London Electric Supply Ord.	⅞−1⅛	5 8 0	Mar, Sept	..	..
5	3 0	Do. 6 per Cent. Pref.	4½−4¾	6 6 0	Mar, Sept	..	..
St.	4%	Do. 4 per Cent. 1st Mort. Deb.	90 −93	4 8 0	Jan, July	4	..
5	3,6	Metropolitan Electric Sup. Ord.	4½−5	6 10 0	April, Oct	4	..
5	2/3	Do. 4½ per Cent. Cum. Pref.	4½−5	4 10 0	Jan, July	..	..
St.	4½%	Do. 4½ per Cent. Deb. Stock 1st Mort.	107 −111	4 1 0	June, Dec	..	..
St.	3½%	Do. 3½ per Cent. Mrt. Deb. Stock (red.)	85 −90	3 18 0	Jan, July	..	..
100	4½%	Midland Elec. Corp. for P.D. 1st Mort. Db.	96 − 99	4 11 0	June, Dec	..	−
10	4%	Newcastle & Dist. Elec. Ltg. Ord.	7¾ −8¼	5 0 0	Feb, Aug		−
100	4½%	Do. 4½ per Cent. Deb.	98 − 98	4 12 9	Jan, July	97½	..
5	8%	Newcastle Elec. Supply Ord.	5⅝−5⅞	6 19 2	Feb, Aug	..	..
5	5%	Do. 5 per Cent. non Cum. Pref.	5¼−5½	4 13 0	Feb, Aug	..	..
100	4%	Do. 4 per Cent. Mort. Deb. red. 1907.	97 −99	4 1 8	Jan, July	..	..
1	3%	Northern Counties Elec. Sup.	−	..	Mar, Aug	..	..
100	4½%	Do. 4½ per Cent. Deb.	95 −97	4 13 9	Jan, July	..	..
10	8,0	Notting Hill Electric Ord.	11½ −12½	5 14 0	March ..	..	..
5	4,6	Oxford Electric Ord.	5¾−6¼	5 12 0	March ..	..	..
St.	4%	Do. 4 per Cent. Deb. Stock	94 −98	4 1 6	Jan, July	..	..
5	5/0	St. James' & Pall Mall Elec. Ord.	7½−8¼	6 1 3	Feb, Aug	7½	..
5	3/6	Do. 7 per Cent. Pref.	6½ −7½	4 16 6	Feb, Aug	..	..
St.	3½%	Do. 3½ per Cent. Deb. Stock (red.)	85 −90	3 17 9	Jan, July	..	..
5	..	Smithfield Markets Electric Sup. Ord.	¼−¾	..	Feb	..	..
St.	4%	Do. 4 per Cent. Deb. Stock	70 −74	5 8 0	Feb, Aug	..	..
5	4,0	South London Electric Supply Ord.	2½−2¾	7 6 0	April ...	..	..
1	0/6	South Metrop'n Elec. Lt. & Power Ord.	⅜−⅝	4 0 0	..	..	..
1	0/8⅖	Do. 7 per Cent. Cum. Pref.	1⅟₁₆−1⅟₁₆	5 6 0	Feb, Aug	..	..
St.	4½%	Do. 4½ 1st Db. Stk. Red.	99 −102	4 8 0	April, Oct	..	..
5	2,6	Urban Electric Supply Ord.	1 −2	12 10 0	April, Oct	..	..
5	2 6	Do. 5 per Cent. Cum. Pref.	1⅞ −2⅜	10 12 0	April, Oct	..	..
St.	4½%	Do. 4½ per Cent. 1st Mort. Deb.	87 −90	5 0 0	April, Oct	.	..
5	5,0	Westminster Elec. Sup. Ord.	7½−8	6 5 0	Mar, Sept	7⅞	7
5	2/3	Do. 4½ per Cent. Cum. Pref.	4⅞ −5⅜	4 4 0	Jan, July	..	.
		ELECTRIC RAILWAYS, TRAMWAYS, &c.					
St.	4%	Baker St. & Waterloo 4% Perp. Db. St.	89 −92	4 7 0	Jan, July	..	..
1		Bath Elec. Trams Pref. Ord.	⅜−⅝	8 0 0	April....	..	−
1	0/6	Do. 5 per Cent. Cum. Pref.	⅝−⅞	5 14 0	Jan, July	..	..
St.	4½%	Do. 4½ 1st Mort. Deb. Stock (red.)	85 −90	5 0 0	April, Oct	.	..
St.	4½%	B'ham & Midland Trams 4½ 1st Db. Stk.	93 − 96	4 15 0	Jan, July	94¼	94
10	9%	Bristol Tramways & Carriage Ord.	10 −10½	8 11 9	Feb, Aug	..	..
10	4%	Do. Cum. Pref. (fully paid)	8 −8½	4 14 0	..	..	..
St.	4%	Do. 4 per Cent. Debs.	99 −100	4 0 0	Feb, Aug	..	..
10	..	British Electric Traction Ord.	1½−1¾	..	June, Dec	1⅝	.
10	6/0	Do. 6 per Cent. Cum. Pref.	4 −4½	..	Feb, Aug	4¼	3¾
St.	5%	Do. 5 per Cent. Perpetual Debs.	91 −96	5 4 0	April, Oct	.	..
St.	4½%	Do. 4½ per Cent. 2nd Deb. Stock	73 −77	5 18 0	May, Nov	74½	..
St.	3%	Central London Ordinary Stock	81 −84	3 11 3	Feb, Aug	82	81½
St.	4%	Do. 4 per Cent. Pref. Stock	90 −92	4 7 0	Feb, Aug	..	..
St.	2%	Do. Deferred Stock	64 −67	3 0 0	Feb		..
100	4%	Do. 4 per Cent. Debs.	102 −105	3 16 0	Jan, July	103	..
St	4%	Charing X, Euston & Hmpstd Per. Db. Stk.	81 −84	4 15 3	Jan, July	84	..
5	2/6	City of Birmingham Trams. 5% Cm. Pref.	4½ − 4¾	5 5 0	April, Oct	..	..
100	4%	Do. 4 per Cent. 1st Mort. Debs.	97 − 100	4 0 0	April, Oct		..
St.	1¾%	City & South London Rly. Con. Ord.	40 −42	5 0 0	Feb, Aug	41½	40½
St.	5%	Do. 5 per Cent. Perp. Pref. (1891)	113 −116	4 6 0	Feb, Aug	..	..
St.	5%	Do. (1896)	112 −115	4 7 0	Feb, Aug	113	..
St.	5%	Do. (1901)	110 −113	4 8 6	Feb, Aug	..	..
St.	5	Do. (1903)	105 −108	4 12 6	Feb, Aug	..	..
St.	4%	Do. 4 per Cent. Perpetual Debs.	100 −103	3 17 6	May, Nov	102	..
10	7/0	Dublin United Trams. Ord	12½ −13½	4 10 6	Feb, Aug	..	..
10	6/0	Do. 6 per Cent. Pref.	12½ −13½	4 9 0	Feb, Aug	..	−
10	..	Gt. Northern & City Rly. Pref. Ord. (4%)	½−1½	..	Feb, Aug	..	..
10	4/0	G. Northern, Piccadilly & Brompton Ord.	6 −7	5 11 0	Feb, Aug	..	..
St.	4%	Do. 4 per Cent. Deb. Stock	89 −91	4 8 0	Jan, July	89¾	89¼
5	4/0	Hastings & Dist. Elec. Trams. 6% Cm. Pf.	3½−4½	7 1 0	Mar, Sept	..	..
St.	4½%	Do. 4½ Db. St.	94 −97	4 12 6	April, Oct	..	..
10	9%	‡ Imperial Tramways Ord.	10½ −11½	7 17 0	Mar, Sept	..	..
10	6%	‡ Do. 6 per Cent. Pref.	9½ −10½	5 17 0	Mar, Sept	..	..
St.	4½%	‡ Do. 4½ per Cent. Debs.	93 − 94	4 15 9	Jan, July	..	..
5	..	I. of Thanet E. T. & Lt. 5 per Cent. Pref.	⅞ − 1⅛	..	Mar, Sept	..	..
St.	4%	Do. 4 per Cent. Deb. Stock	58 −63	6 7 0	Jan, July	..	−
10	10/0	Lanarkshire Tramways	9½ 10	5 10 0	Feb, Aug	..	..
St	5%	Lancs. Utd. Trams 5% Prior Lien Db. St.	91 −94	5 6 0	Jan, July	..	..
10	..	Liverpool Overhead Railway Ord.	1⅛−1½	..	Feb, Aug	..	..
10	5%	Do. 5 per Cent. Pref.	6¼−6¾	7 10 0	Feb, Aug	..	−
St.	4%	Do. 4 per Cent. Deb.	85 − 87	4 11 0	Jan, July	..	..
10	5 0	London United Trams. 5% Cum. Pref.	7½−8½	6 2 0	Jan, July	8	7¹³⁄₁₆
St.	4%	Do. 4 per Cent. 1st Mort. Deb. Stock	81 −86	4 13 0	Jan, July	82	..
St.	..	Mersey Con. Ord. Stock	1 −3	−	Feb, Aug.	..	..
St.	..	Do. 3 per Cent. Perp. Pref.	3 −6	−	..	..	..
1	..	Metropolitan Elec. Tramways Def.	[illegible]	..	April.. .	[illegible]	..
1	0/6	Do. 5 per Cent. Cum. Pref.	¹¹⁄₁₆−¹³⁄₁₆	6 3 6	Feb, Aug	¾	..
St.	4½%	Do. 4½ per Cent. Deb. Stock	95 −98	4 12 0	Jan, July	96	..
St.	4%	Metropolitan Railway Consolidated	42 −43	1 4 0	Feb, Aug	43½	42⅝
St.	2½%	Do. Surplus Lands Stocks	68 −70	3 10 0	Feb, Aug	..	.
St.	3½	Do. 3½ per Cent. Preference	86 −89	3 19 9	Feb, Aug	..	86½
St.	3½	Do. 3½ per Cent. "A" Preference	75 −78	4 9 6	Feb, Aug	..	.
St.	3½%	Do. 3½ per Cent. Convertible Pref.	73 −76	4 12 0	Feb, Aug	..	..
St.	3½	Do. 3½ per Cent. Debenture Stock	91 −94	3 14 6	Jan, July	92½	..
St.	3½	Do. 3½ per Cent. "A" Ditto	89 −92	3 16 0	Jan, July	90¼	..

* In calculating the yield allowance has been made for accrued interest but *not* for redemption
† Ex Dividend

ELECTRICAL COMPANIES' SHARE LIST.—*Continued.*

ELECTRIC RAILWAYS & TRAMWAYS *Continued.*

Share	Last Dividend	Name	Price Wed., June 10	Rate % Yielded £ s. d.	Dividend Due	Business Week to June 10 Highest	Lowest
St.	..	Metropolitan District Railway Ord.	13¾–14⅛	–	Feb, Aug	14 1/16	14
St	.	Do. Extension Pref. (5 per Cent.)	23–28	..	Feb, Aug	..	..
St.	3½%	Do. Assented Ext. Pref. (Int. Guar. by Und. Elec. Rlys. Co. of London, Ltd.)	44–48	7 6 0	Feb, Aug	45⅛	45
St	3%	Do. 3 per Cent. Consolid'd Rent charge	70–75	4 0 0	Jan, July	.	..
St.	4%	Do. 4 per Cent. Midland Rent charge	100–104	3 17 0	Jan, July	.	..
St	1¾%	Do. Cent. Stock 4 per Cent.	44–49	3 11 0	Mar, Sept	47	4 ½
St	6	Do. 6 per Cent. Perp. Deb. Stock	120–125	4 16 0	Jan, July	123	.
St.	4%	Do. 4 per Cent. Ditto	73–78	5 3 0	Jan, July	.	..
5	..	New Gen. Tract. 6 per Cent. Cum. Pref.	¼–½	..	May	½	–
1	0/9¾	Potteries Electric Traction Ord.	½–¾	8 0 0	April, Oct	..	–
1	0/6	Do. 5 per Cent. Cum. Pref.	⅝–¾	6 13 0	Feb, Aug	..	..
St	4½%	Do. 4½ per Cent. Deb. Stock	91–94	4 16 0	May, Nov	93	92
1	0/7½	S. Met. Elec. Trams. & Ltg. 6% Cm. Pref.	¾–1	6 0 0	Feb, Aug	..	..
St.	4%	Do. 4 per Cent. Deb. Stock	77–81	4 19 0	Jan, July	..	..
100	5%	Sunderland Dist. Elec. Trms. 5% 1st Mt. Db	73–78	6 8 0	Jan, July		..
	5%	Underground Elec. Rys. Co. of London	39–43	11 12 0	June, Dec	41¼	..
5	..	Yorkshire (W.R.) Elec. Trams. Ord.	[illegible]–1⅜	–	March	..	..
5	..	Do. 6 per Cent. Cum. Pref.	3⅛–3⅝	–	..	..	..
St	4½	Do. 4½ per Cent. 1st Debs.	84–87	5 3 6	Jan, July	84½	..

ELECTRIC MANUFACTURING, &c.

Share	Last Dividend	Name	Price Wed., June 10	Rate % Yielded £ s. d.	Dividend Due	Business Week to June 10 Highest	Lowest
1	..	Aron Electricity Meter Ord.	[illegible]	..	..	..	..
1	1/2⅞	Do. 6% Cum. Pf.	[illegible]	7 2 0	April, Oct	..	..
1	2/4½	Babcock & Wilcox Ord.	3¾–4	5 0 0	April, Oct	3[illegible]	3[illegible]
1	0/7½	Do. Pref.	1 7/16–1 9/16	3 16 9	..	..	..
5	6/0	British Insulated & Helsby Cables Ord.	5¾–6¼	8 0 0	July, Feb	..	..
5	3/0	Do. 6 per Cent. Pref.	5¾–6¼	4 16 0	Jan, July	..	..
St.	4½%	Do. 4½ per Cent. 1st Mort. Deb. (red.)	102–105	4 5 6	Jan, July	105	..
St.	4½%	British Thoms'n-Houst'n 4½% 1st Mt. Db.	93–98	4 12 0	Mar, Sept	..	..
5	..	British Westinghouse 6 per Cent. Pref.	[illegible]–11/16	..	Feb, Aug	7/16	..
St.	4%	Do. 4 per Cent. Mort. Deb. Stock	45–50	8 0 0	Jan, July	..	..
2	..	Brush Electrical Engineering	½	–	March	..	..
2	..	Do. 6 per Cent. Pref. non-Cum.	[illegible]–7/16	..	Mar, Sept	..	..
St.	4½%	Do. 4½ per Cent. Perp. 1st Deb. Stock	70–75	6 0 0	Mar, Sept	..	–
St.	4½%	Do. Perpetual 2nd Deb. Stock	55–60	7 10 0	Jan, July	..	..
5	16/0	†Callender's Cable Con. Ord. xd & bonus	9¾–10¾	6 18 0	Jan, July	10 1/16	..
5	2/6	Do. 5 per Cent. Cum. Pref.	5¼–5¾	4 7 0	Jan, July	..	..
St.	4½%	Do. 4½ per Cent. 1st Mort Debs. (red.)	107–109	4 2 0	Nov, May	..	..
1	1/0	†Castner-Kellner Alkali Co.	1¼–1⅜	9 18 0	May, Nov	..	..
St	4½%	Do. 4½ per Cent. 1st Mort. Deb. (red.).	101–104	4 6 6	Feb, Aug	..	..
1	0/9⅗	Chadburn's (Ship) Telegraph Ord.	1 1/16–1 3/16	8 8 0	March	..	..
1	0/7½	Do. 6 per Cent. Cum. Pref.	1–1⅛	5 6 6	April, Oct	..	..
1	0/8[illegible]	Consolidated Electrical Co.	[illegible]–½	7 0 0	August	[illegible]	..
1	1/0	Consolidated Signal Co.	1½–1¾	4 5 6	April, Oct	1[illegible]	..
1	0/7½	Do. 6 per Cent. Cum. Pref.	⅜–[illegible]	6 4 0	April, Oct	..	..
3	5/0	* Crompton & Co. (Nos. 1 to 85,000)	1½–1¾	8 6 6	Jan, July	..	..
100	5%	Do. 5 per Cent. 1st Mort. Debs. (red.).	92–95	5 5 0	Jan, July	..	..
1	0/7½	Davis & Timmins	⅞–1⅛	..	Mar, Sept	..	..
5	2/0	Dick, Kerr & Co. Ord.	1 1/16–1 5/16	7 12 3	Sept	..	..
5	0/7½	Do. 6 per Cent. Cum. Pref.	1–1¼	4 16 0	Sept	..	..
St.	4½%	Do. 4½ per Cent. Deb. Stock	101–104	4 6 6	Jan, July	..	–
5	2/6	Edison & Swan United ("A" Sh.) (£3 pd.)	[illegible]–¾	..	Feb, Aug	..	..
5	4/2	Do. (£5 paid)	1½–2½	5 0 0	Feb, Aug	..	–
St	4%	Do. 4 per Cent. Mort. Deb. Stock (rd.)	78–81	4 19 3	June, Dec	..	..
St.	5%	Do. 5 per Cent. 2nd Deb. Stock	85–87	5 15 0	Mar, Sept	–	..
5	..	Edmundson's Elec. Corp. Ord.	¼	..	Jan, July	⅛	..
5	..	Do. 6 per Cent. Cum. Pref.	½–1	..	May, Nov	⅝	..
St.	4½%	Do. 4½ per cent. 1st Mort. Deb. (red.)	63–73	[illegible] 2 9	Jan, July	63¼	..
2	..	Electric Construction Co.	½–½	..	Jan, July	..	..
2	..	Do. 7 per Cent. Cum. Pref.	1¼–1¾	..	July	..	..
St.	[illegible]	Do. 4 per Cent. Perp. 1st Mort. Debs.	6[illegible]–68	5 17 0	Jan, July	..	..
10	5/0	General Electric 1900 5% Cum. Pref.	7¾–8¼	6 1 8	June, Dec	..	..
St.	4%	Do. 4 per Cent. 1st Mort. Debs.	87–90	4 9 0	Mar, Sept	..	–
5	10/0	Henley's Telegraph Works Ord.	10½–11½	6 10 0	Feb, Aug	..	..
5	2/3	Do. 4½ per Cent. Pref.	5–5½	4 2 0	Feb, Aug	5	..
St	4½%	† Do. 4½ per Cent. 1st Mort. Deb. Stock	101–106	4 5 0	Mar, Sept	..	..
10	15/0	India Rubber, Gutta Percha, &c., Wrks.	16½–16½	6 2 0	Feb, Aug	16½	..
100	4%	Do. 4 per Cent. Debs. (red.)	98–100	4 0 0	April, Oct	99¼	..
1	2/0	National Elec. Construction Co.	⅜–⅝	..	April	..	..
1	0/9¾	Richardsons, Westgarth & Co., Ltd. Ord.	[illegible]	7 2 0	Nov	..	..
1	0/7½	Do. 6 per Cent. Cum. Pref.	¾–⅞	6 17 0	May, Nov	..	..
St	4½%	Do. 4½ per Cent. Perp. Deb. Stock	87–91	4 19 0	Jan, July	..	..
1	..	Simplex Conduits Ord.	1½	..	..	–	–
5	..	Do. 6 per Cent. Cum. Pref.	5¾	..	..	..	
12	30/0	Telegraph Construction & Maintenance	29½–31½	6 13 3	Mar, July	30½	29⅝
100	4%	Do. 4 per Cent. Deb. Bonds (1909)	101½–103½	3 17 6	Jan, July	..	..
1	2/0	Vickers, Sons & Maxim, Ltd., Ord.	[illegible]	8 2 6	..	1[illegible]	1[illegible]
1	0/6	Do. 5 per Cent. non-Cum. Preference	1–1⅛	4 9 0	..	1[illegible]	1[illegible]
St	5%	Do. 5 per Cent. non-Cum. Preferred	103–107	4 13 6	..	103	..
St	4%	Do. 4 per Cent. 1st Mort. Db. Sk. (red)	100–102	3 18 0	June, Dec	102	..
100	4½%	† Do. 4½ per Cent. 2nd Mort. Deb. (red.)	102–105	4 6 0	June, Dec	..	.
100	15/6	‡ Do. 5 per Cent. [illegible] Mort. Debs. Perp	100–102	..	..	101½	[illegible]1
1	6/0	J. G. White & Co. 6 per Cent. Cm. Pref	7½–8½	7 1 0		..	..
5	1/0	Willans & Robinson Ord.	[illegible]–1¼	4 0 0	Apr, Oct	1[illegible]	..
5	7/0	Do. 6 per Cent. Cum. Pref.	3⅝–3⅞	7 15 0	Apr, Oct	–	..
100	4%	† Do 4 per Cent. 1st Mort. Debs.	70–74	5 7 0	May, Nov	..	..

TELEGRAPHS.

Share	Last Dividend	Name	Price Wed., June 10	Rate % Yielded £ s. d.	Dividend Due	Business Week to June 10 Highest	Lowest
10	.	Amazon Telegraph	2–3	–	June, Dec	..	–
100	5%	Do. 5 per Cent. Debs. (red.)	84–87	6 15 0	June, Dec	..	..
St.	15/0	Anglo American	59–62	5 11 0	F,My,Ag,N		..
St.	[illegible]	Do. Preferred	101–10[illegible]	5 13 0	F,My,Ag,N	10[illegible]	10[illegible]
St.	1%	Do. Deferred	17½–17⅞	[illegible]	F,My,Ag,N	[illegible]	10[illegible]
St.	4%	Commercial Cable 4 per Cent. Deb. Stk.	84–87	4 12 0	Ja,Ap,Jy,O	8[illegible]	8[illegible]
10	[illegible]	Cuba Submarine Ord.	7½–[illegible]	[illegible] 5 0	Feb, Aug	..	..
10	10/0	Do. Preference 10 per Cent.	16½–16¾	5 19 0	Feb, Aug	..	..
5	2/0	Direct Spanish Ord.	3–3½	[illegible] 4 0	April, Oct	..	..
5	5/0	Do. 10 per Cent. Cum. Pref.	8–9	5 11 0	April, Oct		..
St	4½%	Do. 4½ per Cent. Deb.	[illegible]–103	4 7 6	Jan, July	.	
20	4/0	Direct United States Cable	13½–14	6 11 6	Ja,Ap,Jy,O	13¾	13[illegible]
100	4½%	Direct West India Cable 4½% Rg. Db. (rd.	10[illegible]–102	4 8 0	June, Dec		..
St	12/0	Eastern Ordinary	13[illegible]–136	5 3 0	Ja,Ap,Jy,O	[illegible]	13[illegible]
St.	17/6	Do. 3½ per Cent. Pref. Stock	84½–8[illegible]	4 1 0	Ja,Ap,Jy,O	[illegible]	[illegible]
St.	4%	Do. 4 per Cent. Mort. Deb. Stk. (red.)	10[illegible]–10[illegible]	3 18 0	May, Nov	1[illegible]	101½
10	6/6	Eastern Extension	1[illegible]–13½	5 6 0	Ja,Ap,Jy,O	1[illegible]	1[illegible]
St.	4%	Do. 4 per Cent. Deb. Stock	10[illegible]–10[illegible]	3 18 0	Feb, Aug		..
100	4%	Eastern & S. African 4% Mort. Deb. 1900	10[illegible]–102	3 18 0	Feb, Aug	..	..
25	4%	Do. 4% Mauritius Sub. Debs. (red.)	[illegible]–101½%	3 19 0	May, Nov	.	.
10	30/0	Gt. Northern Copenhagen [illegible] Coupon 73	[illegible]	6 14 0	Jan, July	2[illegible]	[illegible]8½
100	4½	Halske & E[illegible] 1st Mt. Db. (red.)	10[illegible]–102½	4 8 0	June, Dec	..	
	[illegible]	Indo-European	[illegible]	6 3 0	May, Nov	[illegible]	[illegible]
100	$1	Mackay Companies Common	[illegible]	5 11 0	Ja,Ap,Jy,O	6[illegible]	
100	$1	Do. Preferred	6[illegible]–71	5 11 0	Ja,Ap,Jy,O	6[illegible]	.
1		Marconi's Wireless Telegraph Co.	½–		April		
100	4	Pacific & European 4% Guar. Debs. (red.)	[illegible]–10[illegible]	3 1[illegible] 6	June, Dec		–
[illegible]	1 3	West Coast of America	1⅛–1[illegible]	3 1[illegible] 0	May	..	..
100	4	Do. 4 per Cent. Debs.	99–102	3 18 0	Jan, July	..	.
10		West India & Panama	⅜–½	..	May, Nov		
10	6/0	Do. 6 per Cent. 1st Pref.	[illegible]	6 13 0	May, Nov		
10	[illegible]	Do. 6 per Cent. 2nd Pref. [illegible]	9½–1[illegible]	..	May, Nov	..	
100	5	Do. 5 per Cent. Debs.	101–104	4 16 0	Jan, July		
10	8/0	Western Telegraph	1[illegible]–1[illegible]	6 1 0	Mr,Jn,O,D	1[illegible]	13¼
St	4	Do. 4 per Cent. Deb. Stock (red.)	10[illegible]–10[illegible]	3 18 0	June, Dec	101½	10[illegible]
..	4%	‡ Western Union Tel. Co. $1,000 4% Bonds	7[illegible]–81	4 10 0	..	.	..

TELEPHONES.

Share	Last Dividend	Name	Price Wed., June 10	Rate % Yielded £ s. d.	Dividend Due	Business Week to June 10 Highest	Lowest
100	$8	Amer. Telephn. & Telegh. Cap. St.	118–122	6 11 6	..	8[illegible]½	87¾
..	4%	Do. Coll. Trust $1,000 4 per Cent. Bds	88–91	4 8 0	Jan, July	..	–
St.	5%	Anglo-Portug'se Tel. 5% 1st Mt. Db. Stk.	99–102	4 18 0	Mar, Sept	..	–
5	3/0	Chili Telephone	7–7½	5 6 6	August	..	–
1	0/7½	Monte Video Telephone Ord.	29/32–1 1/32	6 16 0	Nov	1	..
1	0/6	Do. 5 per Cent. Pref.	[illegible]	5 7 0	May, Nov	..	..
St.	6%	National Co. Pref. Stock	108½–11[illegible]½	5 8 0	Feb, Aug	10[illegible]	108¾
St.	6%	Do. Def. Stock	111½–113½	5 5 0	Feb, Aug	112⅛	111
10	6/0	Do. 6 per Cent. Cum. 1st Pref.	11½–12½	4 13 0	Feb, Aug	..	..
10	6/0	Do. 6 per Cent. Cum. 2nd Pref.	11½–12½	4 16 0	Feb, Aug	10[illegible]	1[illegible]
5	2/6	Do. 5 per Cent. non-Cum. 3rd Pref.	5⅜–5⅝	4 9 0	Feb, Aug	5[illegible]	[illegible]
St.	3½%	* Do. Deb. Stock 3½ per Cent. (red.)	99–101	3 9 0	June, Dec	99½	..
St	4%	Do 4 per Cent. Deb. Stock (red.)	102½–104½	3 17 0	Jan, July	..	..
1	1/0	Oriental	1[illegible]–1[illegible]	5 7 6	April, Oct	..	..
1	0/7½	Do. 6 per Cent. Cum. Pref.	1⅛–1¼	4 16 0	April, Oct	..	..
St.	4%	Do. 4 per Cent. Red. Deb. Stock	90–93	4 6 0	Jan, July	..	..
St.	4½%	Telephone Co. of Egypt 4½% Db. Stk. (red.)	99–102	4 8 0	Jan, July	..	–
5	3/0	United River Plate	6[illegible]–6⅞	5 16 6	July	6¾	..
5	2/6	Do. 5 per Cent. Cum. Pref.	5–5⅛	4 11 0	June, Dec	..	.
St.	4½%	Do. 4½ Deb. St. Red.	100½–102½	3 18 0	Jan, July	..	..

FINANCIAL, INVESTMENT, &c.

Share	Last Dividend	Name	Price Wed., June 10	Rate % Yielded £ s. d.	Dividend Due	Business Week to June 10 Highest	Lowest
5	3/0	Elec. & Gen. Investment 6% Cum. Pref.	3¾–4¼	7 1 0	Jan, July	–	..
10	2/0	Globe Telegraph & Trust	10[illegible]–10⅞	5 1 6	Sp De Mr Ju	10 1/16	1[illegible]
10	3/0	Do. 6 per Cent. Pref.	13⅝–14⅛	4 5 0	Sp De Mr Ju	13¾	.
10	6%	Submarine Cables Trust (Cert.)	127–130	4 12 0	April, Oct	..	..

COLONIAL AND FOREIGN ELECTRIC RAILWAYS, TRAMWAYS, &c.

Share	Last Dividend	Name	Price Wed., June 10	Rate % Yielded £ s. d.	Dividend Due	Business Week to June 10 Highest	Lowest
5	3/0	Anglo-Argentine 6% Cum. 1st Pref.	6¼–6½	4 12 0	April, Oct	6[illegible]	6⅜
5	5/0	Do. 10% Non-cum. 2nd Pref.	8 1/16–8 [illegible]/16	5 17 0	Jan, July	8½	8[illegible]
St.	6%	Do. Permanent 6% Deb. Stock	140–145	4 2 9	June, Dec	143	..
St.	5%	Auckland Elec. Trams. 5% Deb. (red.)	104–107	4 13 6	Jan, July	105½	10[illegible]
5	4/0	Brisbane Electric Trams. Invest. Ord.	4⅛–4⅜	4 11 6	May	4[illegible]	4[illegible]
5	2/6	Do. 5 per Cent. Cum. Pref.	4 13/16–5 1/16	4 19 6	May, Nov	4[illegible]	..
St.	4½%	Do. 4½ per Cent. Db. Prov. Certs.	98–102	4 8 0	Jan, July	100¾	
St.	8%	British Columbia El. Ry. Df. Ord. x rights	125–130	6 3 0	Mar, Sept	..	
St.	65 0	† Do. Pref. Ord. Stock ...xd & rights	108–112	5 6 6	May, Nov	110¼	11[illegible]
St.	5%	Do. 5% Cum. Perp. Pref. Stock	107–111	4 10 0	Jan, July	..	.
40	4½%	Do. 4½ per Cent. 1st Mort. Debs.	99–102	4 8 0	April, Oct	102	..
100	4½%	Do. Vancouver Power Debs.	101–104	4 6 6	Jan, July	..	..
St.	4½%	Do. 4½% Perp. Con. Deb. St.	98–101	3 19 0	..	..	
5	3/0	Buenos Ayres & Belgrano Ord.	4¾–4⅞	8 1 6	April, Oct	[illegible]	..
5	3/0	Do. 6 per Cent. "A" Cum. Pref.	4⅝–5⅛	5 17 6	April, Oct	4 1/16	..
5	3/0	Do. "B"	4⅝–5⅛	5 17 6	April	..	..
St.	5%	Do. 5 per Cent. Debs.	110–116	4 6 0	Jan, July	–	..
St.	5%	Do. 5 per Cent. 2nd Debs. (red.)	102–105	4 15 3	Jan, July	..	..
St.	5%	Buenos Ayres Elec. Trams (1901) Ltd. Deb. St.	95–99	5 1 0	Ja, Jul	..	.
5	..	Buenos Ayres Grand National Ord.	2¼–2¾	..	..	2½	..
5	2/6	Do. 5 per Cent. Cum. Pref.	3¾–4¼	5 18 0	Feb, Aug	..	..
100	5½%	Do. 5½ per Cent. Pref. Debs.	100–104	5 5 9	Jan, July	..	..
100	6%	Do. 6 per Cent. 1st Deb. Bonds.	99–103	5 16 3	April, Oct	..	..
St.	5%	Buenos Ayres Lacroze Trams 1st Mt. Db.	92–95	5 5 0	Mar, Sept	–	..
St.	6%	Buenos Ayres Port & City Tram. 1st Mt. Deb. Stock £75 Paid	64–68	6 12 0	Feb, Aug	..	..
5	2/6	Calcutta Tramways (1 to 137,010)	[illegible]	4 15 0	Mar, Sept	..	5[illegible]
100	2/6	Do. 5 per Cent. Cum. Pref.	5–5¼	4 13 0	Jan, July	..	..
1	4½%	Do. 4½% 1st Deb. Stock (red.)	103–106	4 5 0	Jan, July	104½	10[illegible]
St.	..	Cape Electric Tram Shares	[illegible]–7/16	..	..	..	–
5	1/3	City of Buenos Ayres Trams Co. (1904) Sh.	5½–5¾	4 7 0	F,My,A,N	[illegible]	5[illegible]
St.	4%	Do. 4 per Cent. Deb. Stock	98–102	3 18 6	June, Dec	100¼	10[illegible]
	5%	Colombo Tr. & Ltg. 5% 1st Mt. Db.	85–91	5 11 0	May, Nov	..	–
100	5%	†Electric Traction Co. of Hong Kong 5 per Cent. 1st Mort. Debs.	8[illegible]–90	5 10 0	June, Dec	..	..
1	5%	Havana Elec. Ry. Con. Mt. 5% $1,000 50 year Coup. Bds.	80–85	5 17 6	Feb, Aug	..	.
1	..	Kalgoorlie Elec. Trams Sh.	[illegible]	..	..	[illegible]	.
100	5%	Do. 5 per Cent. "A" Deb. Stock	87–91	5 8 9	Jan, July	..	–
[illegible]	6%	Do. 6 per Cent. "B" Ditto	71–75	7 17 0	Jan, July	..	..
5	1/0	Lisbon Elec. Trams. Ord.	1–1¼	4 0 0	July	..	..
100	0/7½	Do. 6 per Cent. Cum. Pref.	1–1¼	4 16 0	Jan, July	..	–
St.	5%	Do. 5 per Cent. Reg. Mort. Debs	90–95	5 5 0	Jan, July	..	..
St.	5%	Madras Elec. Trams. 5% Deb. Stk.	95–98	5 2 0	Jan, July	..	..
	5%	Manila Elec. Ry. $1,000 Gold Bonds	86–90	5 11 3	Feb, Aug	.	.
100	$1	Mexico Trams Co. Com. St.	95–97	4 2 0	..	95	9[illegible]
500	5%	Do. Gen. Con. 1st Mort. 5% Gold Bds.	88¼–89¼	5 11 0	..	89½	88
St.	4½%	Montreal St. Ry. Sterling 4½ per Cent. Debs. (1922)	101–103	4 7 6	Feb, Aug	..	..
1	1/0	Perth Elec. Trams Ord.	¾–⅞	5 0 0	May	..	..
St	5%	Do. 1st Mt. Db. Stock	103–106	4 14 3	Jan, July	.	–
5	3/0	Rangoon Elec. Trams & Supply Co. 6% Cum. Pf.	5¼–5¾	5 4 0	..	..	–
St.	4½	Do. 4½% 1st Mort. Deb. Stk.	97–99	4 11 0	..	..	..
..	$2½	Sao Paulo Tramway, Light & Power Co. $100 Stock	130–135	6 2 0	..	..	–
	5%	Do. 5 per Cent. 1st Mt. $500 Db.	[illegible]–97	5 2 6	June, Dec	..	..
100	4½%	Toronto Ry. Co. 1st Mt. 4½% Ster. Bonds	98–10[illegible]	4 10 0	Feb, Aug	..	..

COLONIAL AND FOREIGN ELECTRICITY SUPPLY, &c.

Share	Last Dividend	Name	Price Wed., June 10	Rate % Yielded £ s. d.	Dividend Due	Business Week to June 10 Highest	Lowest
5	3/0	Adelaide Elec. S'ply Co. 6% Cu. Pr.	4⅝–5[illegible]	5 17 0	Mar, Sept	..	–
10	5/2[illegible]	Bombay E.S. & T. 6% Cm. Pf.	1[illegible]–1[illegible]	5 13 0	..	..	..
St.	4½	Do. 4½ per Cent. Deb. Stk. (red.)	9[illegible]–9[illegible]	4 11 0	Jan, July	..	
5	4/9	†Calcutta Elec. Supply Ord.	5½–6½	6 2 0	April, Oct	.	..
100	7 2	Canadian Gen. Elec. Co. Com. St.	85–90	7 16 0	..	8[illegible]	8[illegible]
100	5%	Castner Electrolytic Alkali Co. (of U.S.A.) 1st Mort. Stl. Debs.	94–99	5 1 0	Jan, July		
500	5%	Elect. Development Co. of Ontario	85–88	5 11 [illegible]	..	86½	85
5	..	Elec. Ltg. & Trac. Co. of Aust. 6 per Cent. Cum. Pref.	2¼–2¾	..	Feb, Aug	..	..
St.	5	Do. 5 per Cent. Deb Stock	84–88	5 14 0	Jan, July	..	..
St	5%	Elec. Supply Co. of Victoria 5 per Cent. 1st Mort. Deb. St.	90–93	5 7 6	Jan, July		..
St	6%	Indian Elec. Sup. & Trac. Co. Deb. St. Rd. Prov. Certs.	95–98	6 2 0	Jan, July	..	..
100	[illegible] 3	Kalgoorlie Elec. Power & Ltg. Ord.	½–¾		.		..
1	[illegible]7½	Do. 6 per Cent. Cum. Pref.	[illegible]	8 0 0	April, Oct	..	–
St.	6%	Madras E.S. Corp. 6 per Cent. Constn. Deb. St.	85–90	5 11 0	April, Oct	..	..
500	[illegible]	Mexican Elec. Light Co. 5% 1st Mort. Gold Bonds	[illegible]	[illegible] 6	..	[illegible]	[illegible]
St		Mexican Lt. & Power Co. Cap. St.	[illegible]	.	..	[illegible]	[illegible]
[illegible]	5	Do. 5% 1st Mort. Gold Bonds	[illegible]–88½	[illegible] 13 0	..	88½	
10	[illegible]	Montevideo Elec. Lt. & Power Co. Cap. St.	[illegible]	6 1 0	F,My,A,N		..
1	[illegible]	River Plate Electricity Co. Ord.	[illegible]	[illegible] 4 0	April		
1	1	Do. 6 per Cent. non-Cum. Pref.	[illegible]	[illegible] 0 0	May	1[illegible]	..
St	5%	Do. 5 per Cent. Deb. Stock	96–[illegible]	[illegible] 1 0	Jan, July	9[illegible]	..
5	3/0	Rosario Elec. Co. 6% Pref. (1–20,000)	4[illegible]	5 17 6	April, Oct	4[illegible]	..
100	$1	Shawinigan Water & Power Co. Cap. St.	71–[illegible]	5 10 0	..	[illegible]	71
.	5	Do. 5 per Cent. Bds.	102–104½%	4 17 0	Jan, July	103	10[illegible]
..	7/[illegible]	Victoria Falls Power Co. Pref.		–	Jan, July	..	..

* In calculating the yields allowance has been made for accrued interest but not for redemption. † Ex dividend. ‡ The London Stock Exchange Committee have declined to quote these

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CONTENTS OF THE CURRENT NUMBER.

NOTES.

Board of Trade Audit of Electricity Accounts.

It will be remembered that some little time ago the Board of Trade decided to dispense to a large extent with the system, adopted up to that time, of carrying out an independent audit of the accounts of electricity supply companies in addition to any audit which the supply companies themselves carried out. The result of the old system was necessarily a great waste of time, energy and money, and since the audit of the Board of Trade was practically conducted by Government clerks and not by trained auditors, the result was not altogether satisfactory. The Board of Trade saw that little was to be gained by this duplication of work, and they decided to appoint official auditors, who might or might not be the auditors already employed by the various companies in question. A good deal of criticism was passed by certain sections of the daily Press upon this suggestion, on the ground that the public interest would not be sufficiently protected, and this criticism has again been aroused by the issuing of the official audit of last year's accounts of the South London Electric Supply Corporation, and their consideration by the Finance Committee of the Lambeth Borough Council. In the eyes of the *Daily Chronicle* the state of affairs disclosed is so bad that the editor has thought it necessary to deal with the subject in articles bearing the heading "Betrayed by the Board of Trade," and sub-headings announcing "Exposures" and the Sacrifice of Public Interests to those of Private Companies.

From such introductory titles a great deal might be expected, but further perusal shows that practically all the "grievous" trouble is due to a single item of £941 on account of salaries which have been charged to capital account instead of to the revenue account. It is contended that no such allocations should be made. Upon inquiry, however, we find that the proportion of salaries so allocated is concerned merely with extensions—that is, with the handling of capital—and we fail to see what objection there can be to such a course. Apart from this, however, it is a curious fact that the same item, or rather its equivalent, was passed by the official auditor of the Board of Trade last year—that is, before this change in procedure—and then gave rise to no such stormy comments as in the present instance. It is evident, therefore, that what is allowable by the hand of the Board of Trade auditor is not permissible, in the eyes of certain critics, when passed by the auditors of the company. It is quite clear that there ought not to be any difficulty about such audits. Auditors deal with facts, and if the facts are properly disclosed, the Board of Trade can form their own opinion, though that opinion cannot be enforced. It may, nevertheless, be remarked that a local authority would not be permitted to allocate any such proportion of salaries to capital account, as has been done by the South London Electric Supply Corporation, and is indeed done by every other company engaged in electricity supply. This, no doubt, is the case, and we think it is often a legitimate grievance, and one which, moreover, local authorities have sought to remove. But this, in itself, is no reason for objecting to any private company following the course which the local authorities themselves desire to follow, but cannot at present.

Another point raised by the *Daily Chronicle* is the question of depreciation. The sum to be provided must necessarily depend upon circumstances, and in the present case we notice that the auditors are not dissatisfied with the amount. The *Daily Chronicle*, however, is anxious that

the sum set aside for depreciation should be as high as possible. Unfortunately this is a subject of some difficulty. As mentioned by Mr. R. STEWART BAIN in a letter to the *Daily Chronicle*, the terms of purchase of an electric lighting undertaking by a local authority under the Electric Lighting Acts will be based on the fair market value at the time of purchase, without any addition in respect of goodwill or other considerations. Consequently, from the purchase point of view the amount of capital expended is immaterial, but we think it will be agreed that if a large sum has been set aside for depreciation this fact will be used as a strong argument to depreciate the value of the undertaking at the time of purchase.

Stand-by Losses.

THE dense fog, or rather darkness, which descended upon the City of London last Wednesday morning must have caused many anxious moments to the engineers of the electricity supply companies; but, fortunately, notwithstanding the fact that we are within a day or two of midsummer—that is, when the loads on the generating stations have dropped to their lowest limits—boilers and engines proved equal to the emergency. That the occurrence was of an exceptional character may be gathered from the fact that the load on the mains of the Charing Cross Company increased by no less than 8,000 H.P. in 25 minutes. This is certainly an unusual experience for mid-June, and great credit is due to the Company, for the pressure throughout this period did not fall below its normal value. This excellent record means, of course, that throughout the greater part of the year the London companies have to maintain a large proportion of their boilers continually under steam, merely as a stand-by for such exceptional loads. The consequent stand-by losses are so great as to call for some other solution of the problem, possibly by the further development of the internal-combustion engine.

The importance of the stand-by losses and the comparative insignificance of small increases in the efficiency of a large proportion of the prime movers installed in generating stations in London can be gathered from the curve reproduced in our Parliamentary columns in connection with the Bill promoted by the London electricity supply companies and now under consideration by a Select Committee of the House of Lords. It will be seen that, with a typical load, two-tenths of the plant required to deal with the maximum load generate two-thirds of the total number of units, and that three-tenths of the plant generate practically 80 per cent. of the whole of the units supplied; so that small improvements in the efficiency of the remaining seven-tenths of the plant would only affect the cost of production of 20 per cent. of the units, and are of small importance in comparison with the losses due to keeping such plant ready to run at any time throughout the year. The curve also shows that a plant of capacity equal to one-tenth of the maximum load could be run with a yearly load factor of 92·5 per cent., whilst the remaining nine-tenths of the plant would be run with a load factor of 15·5 per cent. Such considerations indicate the difficulties under which electricity supply has to be given. It is interesting in this connection to notice that the proposals of the Companies include an estimate for 12,000 kw. of gas-driven plant, which Mr. J. S. HIGHFIELD remarked would show considerable economies if utilised for the steady load throughout each 24 hours. This suggestion approaches the subject from the opposite point of view to that indicated above, and serves to indicate the somewhat complicated nature of the problem. At any rate it would seem that finality as regards power station design is by no means reached, and very possibly the proposals for large steam turbo-generator stations may, within a few years, be considered quite out of date.

Wireless Telegraph Note.—A correspondent writes that the Committee appointed in connection with rebuilding of the Russian Navy has decided to utilise the public contributions which have been subscribed for the purpose of rebuilding the warships in establishing wireless telegraph stations at 18 points on the Baltic coast line. Orders, it is said, have already been given for the equipments.

Royal Society.—Among the Papers read before this Society yesterday afternoon were: "An Electrical Method of Counting the α Particles from Radio-active Matter" and "The Change and Nature of the α Particle," by Prof. E. Rutherford, F.R.S., and Dr. Hans Geiger; also a Paper on "The Electrolytic Properties of Dilute Solutions of Sulphuric Acid," by Messrs. W. C. D. Whetham, F.R.S., and H. H. Paine.

Physical Society.—As we mention under "Arrangements for the Week," the next meeting of this Society will be held, by the kind invitation of Dr. R. T. Glazebrook, F.R.S., at the National Physical Laboratory, when it is proposed to show a series of demonstrations of the work in progress at the laboratory. The Director requests Fellows of the Society intending to be present at this meeting to inform him by postcard, as far as they conveniently can, by Monday, June 22nd.

Colour Correction in Mercury Vapour Lamps.—The *Western Electrician* describes a system, due to C. Fish, of supplying the necessary red and yellow rays in the mercury vapour lamp. The rays from the latter are projected on to a glass reflector in such a way that the reflected rays mingle with light passed directly through the light-transmitting reflector from a source placed on the opposite side. The red and yellow rays are usually supplied by ordinary incandescent electric lamps.

Single-phase Electric Railways in Europe.—With reference to a short article on this subject, which appeared on p. 321 of our last issue, we are informed by Mr. Philip Dawson that the details relating to the London, Brighton & South Coast Railway require correction. The length of line when reduced to single track is approximately 25 miles, the line voltage is 6,700, and there are 16 motor coaches each of 500 H.P. Mr. Dawson also informs us that this line will probably be put into operation in August next though, not for public use for some time later.

Electricity or Elity. The *Elektrische und Maschinelle Betriebe* publishes a letter by Dr. L. C. Wolff, of Magdeburg, asking that the term Elity, or its equivalent according to the language used, be substituted for Electricity. Dr. Wolff's argument may be summarised as follows: The word electricity, borrowed from the Greek ἤλεκτρον, is of no value, as it explains neither philologically or historically the mysterious force which it is supposed to designate. The word Elity is convenient in many ways. It is shorter and easier to pronounce, thus offering advantages both in written and spoken language. A short list, showing the corresponding alterations in several languages is given. These, as in English, consist for the most part in the removal of the two middle syllables.

Cable Interruptions and Repairs.

	Date of Interruption.	Date of Repair.
Cayenne–Salinas	May 12, 1908 ...	—
Las Palma–Arrecife	May 18, 1908 ...	—
Trinidad–Demerara	June 1, 1908 ...	June 15, 1908
Dardanelles–Constantinople	June 1, 1908 ...	June 10, 1908
Jeddah–Suakim	June 9, 1908	June 11, 1908

Atlantic Cables.—At the meeting of the Council of the London Chamber of Commerce on Friday last it was agreed to make representations to the Postmaster General with the object of ensuring due protection being given to telegraph cables off the West Coast of Ireland, which, it was reported to the Chamber, had been seriously damaged and interrupted by trawlers.

The companies owning the cables damaged by trawlers are still prosecuting their search for the trawler whose net was found entangled in one of the broken cables during the recent repairing operations by the s.s. "John Pender." Notices have been posted along the English coast where trawler crews are usually found offering a reward of £100 for information that will procure the apprehension and conviction of those responsible for the damage to the cables.

Fire on the City & South London Railway.—On p. 243 of our issue for May 29th we gave a categorical denial, supported by Mr. P. V. McMahon, of the statement that the fire which recently occurred at the Clapham Common station of the City & South London Railway was due to electrical causes. The report just issued by Mr. A. P. Trotter, of the Board of Trade, fully bears out this view. Mr. Trotter says that the current had been shut off, and the staff had left several hours before the fire occurred. There seems to be no evidence that the fire was due, either directly or indirectly, to electric causes. If any servants of the company had been present when the fire first broke out it could have been extinguished in a few minutes, but, being allowed almost to burn itself out, it afforded an interesting and satisfactory test. The wooden platform showed no traces whatever of anything extraordinary having occurred, and the only signs that there had been a fire were a little smoke on the roof, some split tiles and the partial burning of a few feet of wood moulding round some advertisements. The complete escape of a carriage coupled to the locomotive is a point in favour of separate locomotives. The cause may have been a lighted match thrown down by a man just before leaving, or the emergency oil lamp, which may not have been extinguished, or spontaneous firing of oily waste in a cupboard. No large amount of oily waste is kept on the locomotives, and spontaneous firing, Mr. Trotter believes, does not occur with small quantities.

Electric Traction in Sweden.—It will be remembered that for some time past experiments relative to the adoption of electric traction on the State railways have been carried out in Sweden. In a recent number of the *Annalen der Elektrotechnik* M. Defverholm gives some details of the equipment which is being used. There are at present two trains maintaining a service between Stockholm and Jaerfven. One of these is made up of four cars, the first and last of which are equipped with two 115 H.P. compensated repulsion motors of the A.E.G. type. The second train is driven by a Westinghouse locomotive fitted with two single-phase 150 H.P. motors. On the A.E.G. train the trolley voltage of 6,000 volts is stepped down to 750, and thence by steps of 75 volts to 375 volts. On the Westinghouse locomotive the trolley voltage can be stepped down to between 270 and 150 volts. In addition to this section of main line a light railway from Keockricke to Borensberg has also been converted to electric traction. It is 5 miles long, the gauge is 2 ft. 10 in., and the stiffest gradient 1 in 60. The power is supplied from a power station at Näos, about ½ mile from Borensberg, while the system used is to be single-phase alternating current at a pressure of 10,000 volts—*i.e.*, the same as that employed on the main lines. The motor cars are fitted with two 18 H.P. motors; the maximum weight of the train is 35 tons, at which a speed of 20 miles an hour can be reached, while with a weight of 25 tons the maximum speed attainable is 28 miles per hour. The charge for power is £2. 6s. per horse-power per year, and, taking as a basis seven trains a day in each direction, the annual cost of working is £600.

University of Cambridge.—Lord Rayleigh, O.M., P.R.S., was formally installed as Chancellor of the University of Cambridge on Wednesday last. A number of honorary degrees were conferred, including those already announced in *The Electrician.* In the course of a luncheon at Caius College after the ceremony, Sir Andrew Noble announced that a number of Lord Rayleigh's friends who are non-resident members of the University had decided to offer to the University a fund large enough to provide an annual award, to be associated with the name of the Chancellor, in those branches of knowledge in which Lord Rayleigh's name is pre-eminent.

It was very fitting that the first act performed by Lord Rayleigh, as Chancellor of this University, should be the opening of a new wing of the Cavendish Laboratory, the building of which was made possible by his own munificence. It will be remembered that Lord Rayleigh presented the proceeds of the Nobel prize to the University, and with this donation the extension has been built. The new wing was opened on Tuesday last, Lord Rayleigh being accompanied by Lady Rayleigh and attended by a large number of heads of colleges and professors. The Chancellor briefly recapitulated the steps which had led up to the foundation of the laboratory and the appointment of Clerk-Maxwell as its first Director. He mentioned his own work in this connection and paid a glowing tribute to the assistance he received from Lord Kelvin in the investigation of electrical units. Since his own resignation the work had been ably carrried on by Prof. J. J. Thomson, and the fame of the Cavendish laboratory had spread far and wide. It was doubtless owing to Prof. Thomson's influence that the increasing number of students had made these extensions necessary.

Recent Developments in Gas Turbines.—A recent issue of *Cassier's Magazine* contains an interesting article by M. A. Barbezat on this subject, which begins by describing a small turbine of the De Laval type, used for experimental work. The general principle of this machine involves the delivery of air under pressure into a pear-shaped chamber lined with refractory material, and provided with an expanding nozzle through which a uniform flow of gases can impinge upon the blades of the wheel. In the centre of the air nozzle is arranged an axial tube with a pulveriser at the inner end, through which the liquid fuel is forced into the chamber. An electric sparking device enables the fuel to be ignited on starting, after which the high temperature of the chamber maintains the combustion indefinitely. The high temperature of combustion naturally increases the volume of the indrawn air, and this, together with gaseous products of combustion, flows at high velocity through the expanding nozzle on to the blades of the wheel. The combustion chamber is lined with carborundum backed with asbestos to allow for expansion, and the nozzle is made of the same material. The chamber is also surrounded by a water jacket, the water from which is sprayed into the gas just before they enter the nozzle, and is then converted into steam. This has the effect of lowering the gases to a temperature at which they will not damage the turbine blades. It is found that it is necessary for the compressed air to be generated by some form of rotary pump, in contradistinction to the reciprocating type, preferably so arranged that it can be coupled to the turbine itself. Tests are now in progress on such a machine, in which a multiple turbine compressor is an integral part. A 120 H.P. turbine of this type runs at 1,000 revs. per min., with an expansion ratio of 8·4. Its weight alone is about 1·3 lb. per horse-power, and of the whole apparatus about 5·5 lb. per horse-power.

ARRANGEMENTS FOR THE WEEK.

TUESDAY, June 23rd.

FARADAY SOCIETY.

7:45 p.m. Annual General Meeting at the Institution of Electrical Engineers, 92, Victoria street, to be followed at

8:15 p.m. by an Ordinary Meeting, when the following Papers will be read: "Recent Developments of the Kjellin and Rochling-Rodenhauser Electric Induction Furnaces," by Mr. J. Harden; and "New Applications of Electrometallurgical Alloys," by Mr. Adolphe Jouve.

THURSDAY, June 25th.

INSTITUTION OF ELECTRICAL ENGINEERS.

8:30 p.m. Conversazione at the Natural History Museum, Cromwell-road, S.W.

FRIDAY, June 26th.

PHYSICAL SOCIETY.

3:30 p.m. Meeting at the National Physical Laboratory, Bushy House, Teddington.

ELECTRIC TRACTION ON RAILWAYS.*

VI.—GENERAL COMPARISON OF CONTINUOUS AND ALTERNATING-CURRENT TRACTION.

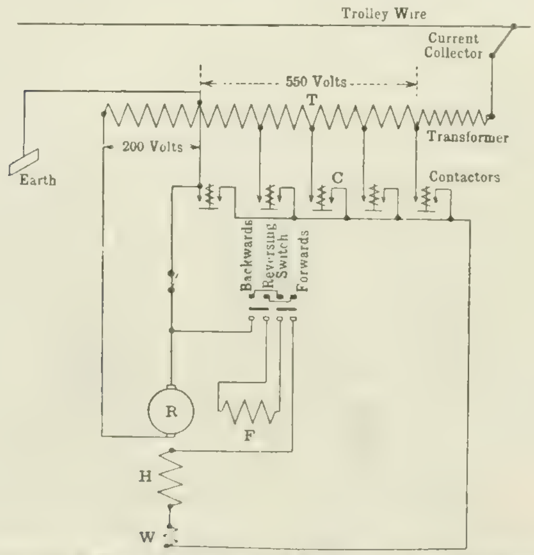
BY PHILIP DAWSON.

(Continued from page 282.)

Summary.—The author, having discussed the characteristics of continuous-current and three-phase traction motors in previous issues, passes on to the consideration of the single-phase motor. After summarising the development of this motor from the historical point of view the author gives particulars of the Westinghouse, Oerlikon, Siemens-Schuckert, General Electric, Eichberg and Felten-Guillaume-Lahmeyer motors and Ward-Leonard locomotives.

The success of the single-phase motor in small sizes has caused all the manufacturers who have been successful with it in the past to attempt the manufacture of larger motors, the limit at present reached being in the neighbourhood of 350 H.P.

In this regard, and before considering more in detail, some of the special characteristics of these motors, a few words as to the motor introduced by Messrs. Lahmeyer Felten & Guillieaume may be of interest. A diagram showing the connections of what this firm designates as their "double-fed series motor" is given in Fig. 47, and it is claimed for this machine that it has exactly the same characteristics as the ordinary continuous current tract on motor, *i.e.*, of variable speed according to torque. This machine consists of a stator which, when the motor is started, is short-circuited and induces currents in the rotor, current being supplied to the rotor; it will therefore be seen that at starting the machine is of the plain series type with short-circuited field. When once started, pressure is gradually applied to the terminals of the stator winding by means of taps from a transformer, T, operated by means of contactors, C, the pressure at the rotor terminals remaining constant at 200 volts; it will thus be seen that in this motor as in the Eichberg arrangement previously described, the heavy currents, which are those which in the Eichberg case flow through the armature short-circuited brushes and in this case are supplied to the armature from a transformer, have not to be switched, this being a great advantage as regards operation and maintenance of contactors; and furthermore, the pressure at the stator terminals can be much greater than that necessitated by commutation requirements at the armature terminals.



T Transformer. R Rotor or armature. H Compensating coils. W Commutating coils. F Main magnetising coils. C Contactors.

FIG. 47. DIAGRAM OF CONNECTIONS OF FELTEN GUILLEAUME-LAHMEYER DOUBLE-FED SINGLE-PHASE SERIES MOTOR.

The reversing is effected by reversing the current in the field or stator winding by the reversing switch shown in Fig. 47; the motor is also fitted with compensating and commutating coils in series with the main magnetising coils similar to the methods generally adopted in the case of all single-phase motors already described.

Figs. 48 and 49 give an idea of a traction motor of this type operating on a tramway near Frankfurt-on-Main.

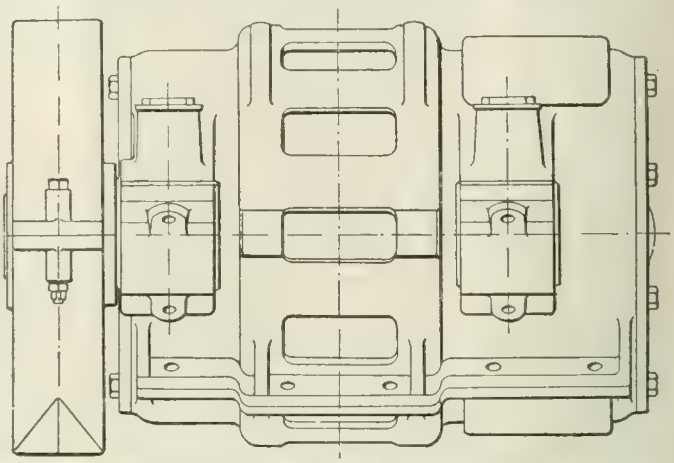


FIG. 48.—FELTEN-GUILLEAUME LAHMEYER SINGLE-PHASE TRACTION MOTOR.

In comparing generally the two classes of plain series and compensated repulsion motors, the conditions under which they will have to operate will considerably influence both the design and the selection of the type best suited to any individual case.

In this connection the three special service conditions which according to circumstances the electric traction motor have to meet in practice may be summarised as follows:—

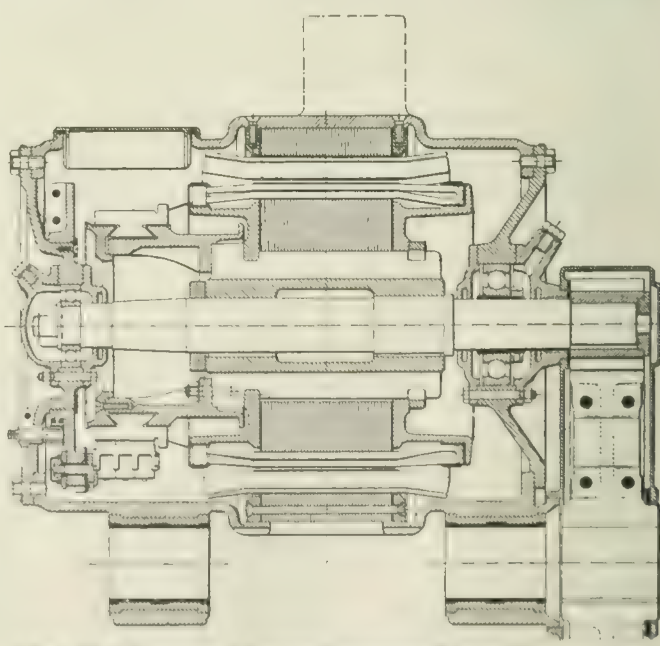


FIG. 49.—HORIZONTAL SECTION THROUGH FELTEN-GUILLEAUME LAHMEYER SINGLE-PHASE TRACTION MOTOR.

(1) Long distance service with considerable distances between stations where acceleration is of little importance, and where the motors have to work continuously for long periods of time.

(2) Suburban service with short distances between stops, where acceleration is of the greatest importance, and where motors constantly start and stop.

(3) Shunting operations as met with in goods yards, where acceleration does not matter, but where heavy starting overload recurs at brief intervals are the rule.

The whole question of single-phase motors was discussed at the last summer meeting of the German Institution of Electrical Engineers held at Hamburg, full particulars of which will be found in the *Elektrotechnische Zeitschrift* in the numbers which appeared during July, August, and September, 1907.

One of the features of the compensated repulsion motor is that, theoretically at least, it is possible to run with it and obtain a power factor equal to unity, and for certain running conditions this result is actually obtained in practice. The Winter-Eichberg type of motor has the advantage that, owing to its methods of regulation, the torque exerted is practically dependent only on the current, and the speed for a given current can be varied between considerable limits. In this characteristic they resemble continuous current traction motors, but are superior to these in that the amount of energy taken from the line at starting is proportionally much smaller in their case than in that of continuous current machines.

The great difficulty, as already pointed out, has been to so design a single phase commutator motor as to run practically without sparking. The fact that under all circumstances, owing to static induction, produces an electromotive force in the motor coils which are short-circuited through the brushes on the commutator, single phase motors must be worse off than continuous current machines. All efforts have therefore been directed to compensate for this by introducing another electromotive force, and furthermore to create a further suitable electromotive force in order to reduce the commutating current.

It is impossible to create a compensating field by static induction, because in that case the effect of the working conductors would be compensated for, and must therefore be produced by rotation, and the resulting magnetic field must have a lag of 90 degrees behind the main magnetic field. It results from this that at starting the conditions as regards sparkless running will be at their worst, and therefore the windings per commutator segment must be reduced as much as possible. In this connection it must be noticed that those brushes which are at right angles to the short-circuiting armature brushes are not subjected to sparking under any conditions. The difficulties met with as regards commutation decrease as the periodicity of the alternating current is reduced; indeed, in some cases, as in the case of experimental single-phase Oerlikon motors, 16 cycles per second have been adopted, and it is towards this limit that many American engineers appear to look in the future. But there are disadvantages which arise if so low a periodicity is adopted, and experience in Europe would seem to indicate that the usual frequency for single-phase traction would eventually be 25 periods per second, and this is the one which has been adopted both in the case of the Hamburg and the London, Brighton & South Coast Railway installations.

A result of this careful study of single-phase motors of the various types described shows clearly the remarkable progress that has been made in this direction during the last four years, which is the short time that commercially successful single-phase traction dates from, and everything tends towards the belief of a yet greater development and improvement in this type of motor during the next few years. The results obtained with both the series type and the compensated repulsion type are exceptionally good, and working conditions alone can decide which type of motor is best in any individual case.

The main difference which at present exists between these two types of motors may be summarised as follows:—

Items.	Series Motor.	Compensated Repulsion Motor.
Voltage at motor terminals in volts.	250–300.	600–800.
Resistances in circuit between armature conductor and commutator.	Practically universal.	Are not needed.
Sparking at principal brushes.	Non-existant.	Very slight.
Max. power factor limit.	Less than unity.	Unity.
Relation of torque-current and speed.	Closely connected	Torque only depends on current; nearly independent of speed.
Possibility of direct operation off high tension circuits	Practically impossible.	Possible with exception of small exciting transformer, but not commercially recommended.
Number of poles	As numerous as possible.	Less in number than required by series motor.

We now come to the last form in which single-phase current has been used for traction purposes, and although there is only one practical example of heavy traction on this system, still it has in times past aroused so much attention, and has, either as it stands or slightly altered, proved such a boon in other fields, such as for mining and rolling mill purposes, that reference must be made to it here. It is, of course, what is known as the Ward-Leonard system which is referred to.

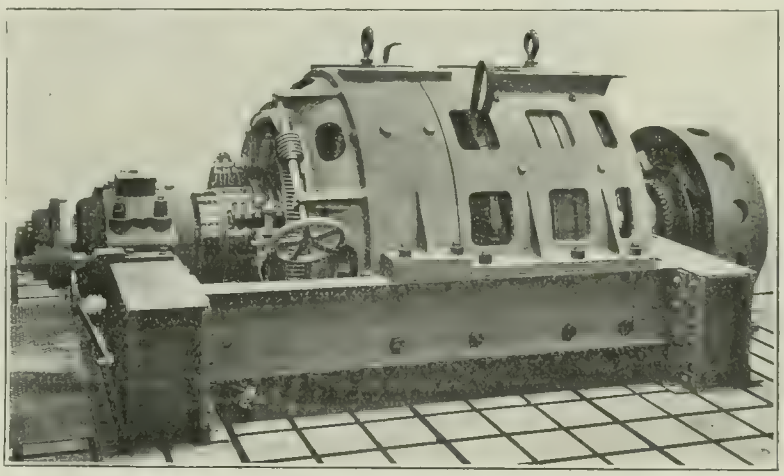


Fig. 50.—Ward-Leonard Group Manufactured by the Oerlikon Co., Consisting of Continuous-current Generator, Single-phase Motor and Exciter.

This system consists in having a constant speed single-phase motor, driving a continuous current generator with variable excitation, which supplies the current for the continuous current motors driving the axles.

In the case of the locomotives operated on this system constructed by Maschinenfabrik Oerlikon, the connections are diagrammatically shown in Fig. 51. From this diagram it will be seen that the single-phase current drives the asynchronous single-phase motor, the rotor of which is short-circuited; this is mounted on the same shaft with the continuous current generator, which in this case has been built with commutator poles, and further on the same shaft is fitted to a continuous current exciting machine, and with a supply periodicity of 25 cycles per second; the speed of this set of machines is 73 revs. per min. The machinery is

started by means of the exciter brushes, all of which are connected to the secondary of a small transformer, the magnetism of the exciter being brought about by a small winding put in series with the armature brushes of the commutator; in other words the exciter at starting up the motor operates like an ordinary series single-phase motor.

By this means the single-phase motor already mentioned is brought up to speed, and when this is reached the stator is switched on to the line. At the same time that this is done the series winding of the exciter is cut out and a shunt winding substituted, so that the exciter is now driven as a shunt wound machine, and the field of the continuous current generator is magnetised from it. Besides exciting the continuous current generator the current from the exciter also excites the continuous current motors driving the speed winding of the exciter, which is used as a speed regulator.

The reversing of the motors is effected by reversing the exciting current in their field magnets. At starting, the locomotives and motors require a large current at a low voltage; this is obtained by regulating the field of the generator by means of the resistances already referred to; as the speed rises the excitation of the generator is gradually increased until when it reaches full speed full voltage is applied at its terminals, and it then sends full current through the motors driving the axles against the maximum electromotive force, in other words the voltage at the motor terminals is varied by the varying excitation of the continuous current generator. This system is quite reversible and can be arranged so as to return energy to the line by braking, but this portion of the subject will not be considered here, because the whole question of what may be called regenerative control may be gone into later on.

Fig. 51 as already referred to gives diagrammatically the connections for this traction system and Fig. 50 shows a group consisting of single phase motor continuous current motor, continuous current generator, and exciter.

A drawback to this interesting system is the complication and abundance of machinery which has to be carried, for, besides motors driving the axles, a train must carry what practically amounts to complete station plant, including a motor able to drive a generator having an output sufficient to supply energy to the motors driving the axles, and it is, therefore very questionable whether the advantages which this system undoubtedly offers theoretically will be sufficient to induce engineers to place on a train practically three times the amount of machinery actually necessary for driving it.

In this connection it is true that single-phase series or compensated repulsion motors are heavier than the continuous current machine, and that beyond this they have to carry static transformers; but such additional weight could in no way compare with that involved by the adoption of the Ward-Leonard system.

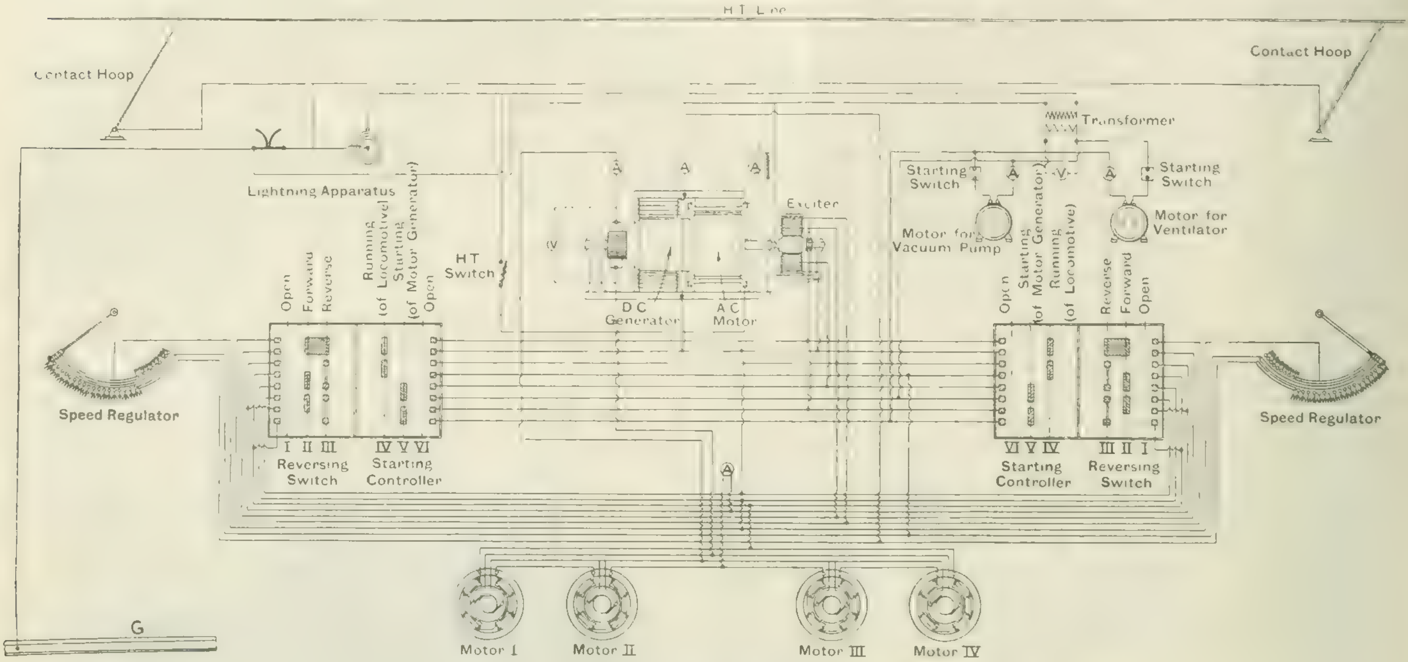
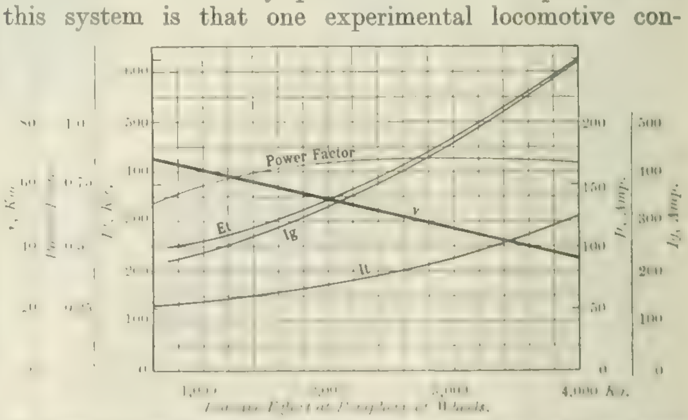


Fig. 51.—Diagram of Connections of Ward-Leonard Single-phase Motor Locomotives, Oerlikon Co.

Under any circumstance this latter could only come into consideration in the case of locomotives being used, although locomotives and motor cars could work together, but it would be impossible for the motor cars to work without locomotives. The only practical traction experience for this system is that one experimental locomotive constructed by the Oerlikon Co., and mentioned above. Fig. 52 gives characteristic curves of this system.



Ig = Intensity of continuous current in amperes at 900 volts. It = Current supplied from overhead line in amperes at [illegible] volts. Et = Energy taken from line in kilowatts. v = Speed of train in kilometres per hour.

Fig. 52.—Characteristic Curves of Ward-Leonard-Oerlikon Single-phase Locomotive.

The following comparison of the weights of two Oerlikon locomotives, one on the Ward-Leonard system, and the other equipped with plain series motor, is interesting:—

	Ward Leonard.		Single phase series motor.
Total weight of locomotive complete	46 tons.	...	40 tons
Electrical equipment	24 tons.	...	16.5 tons

(*To be continued.*)

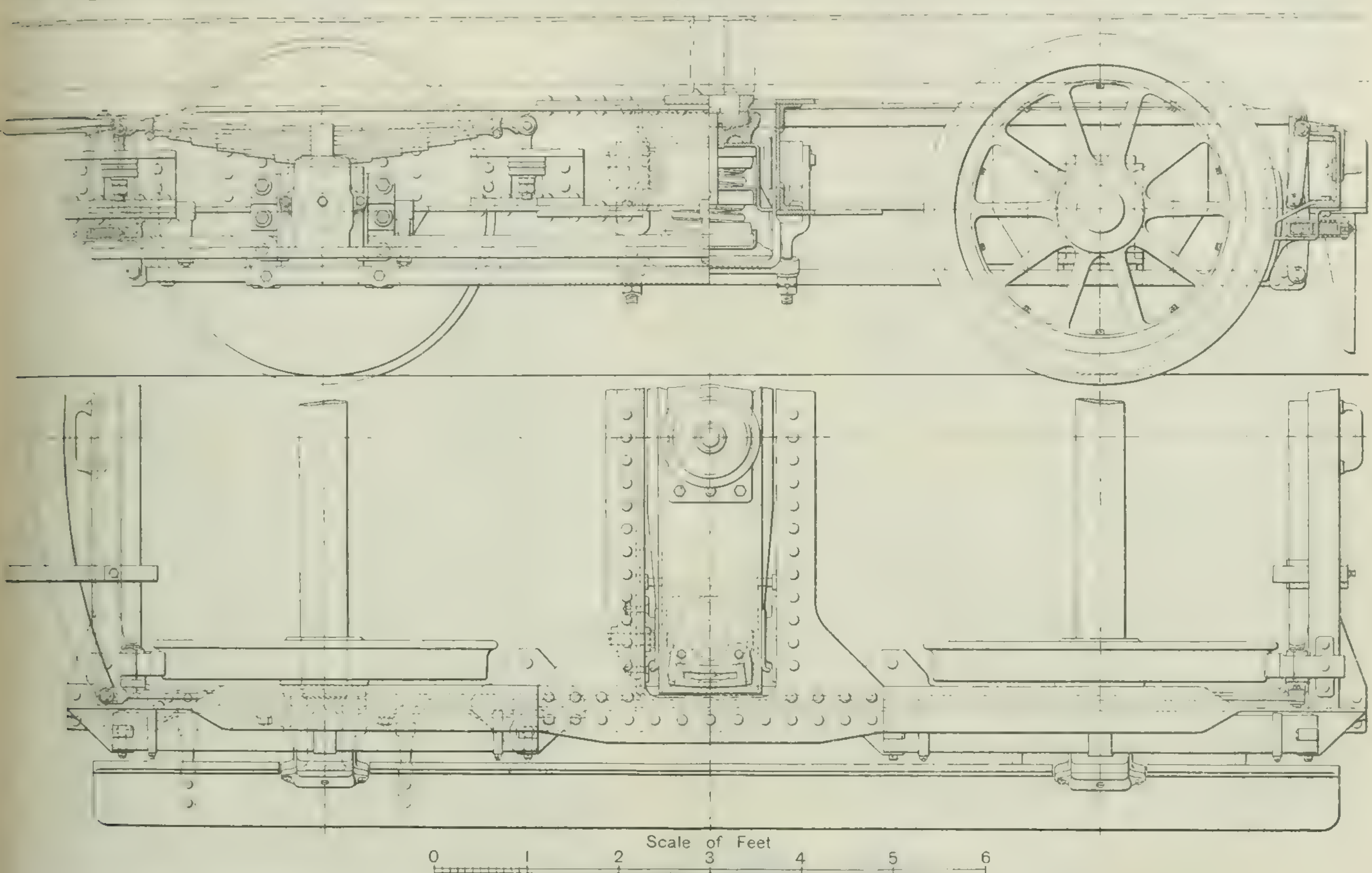
SINGLE-PHASE ELECTRIC TRACTION ON THE HEYSHAM, MORECAMBE AND LANCASTER SECTION OF THE MIDLAND RAILWAY.

(*Continued from page 327.*)

ROLLING STOCK.

The general scheme for the electrification, the equipment of the power station and the driving equipments of the rolling stock were originated and planned by Mr. R. M. Deeley, locomotive superintendent of the Midland Railway Co., and his assistant, Mr. J. Dalziel, and the rolling stock has been built by the Midland Railway Co. in their carriage and wagon shops at Derby, to the designs of Mr. D. Bain, the carriage and wagon superintendent of the company, who has been assisted by Mr. P. Ellis, the carriage and wagon department chief draughtsman.

The rolling stock consists of three trains, there being three motor cars, two equipped by Siemens Bros. Dynamo Works and one by the British Westinghouse Co. It may be mentioned here that the determining cause of the order being thus divided was purely that Messrs. Siemens were supplying all-electric control, which was preferred by the railway company, whereas the Westinghouse Company preferred to adhere to their electro-pneumatic control apparatus; otherwise the proposals were equally acceptable. In addition to the motor cars four trailer cars have been specially built, while one or more old bogie coaches will be utilised for carrying workmen, luggage, &c., particularly between Morecambe and Heysham. Each end of each of the trailers and of the motor cars is equipped with driving apparatus, this being necessary as the trains will vary considerably in length owing to the traffic being very variable from season to season, and also as the coaches are liable to reversal in the way they head, owing to the triangular junction, near one apex of which Morecambe station lies.



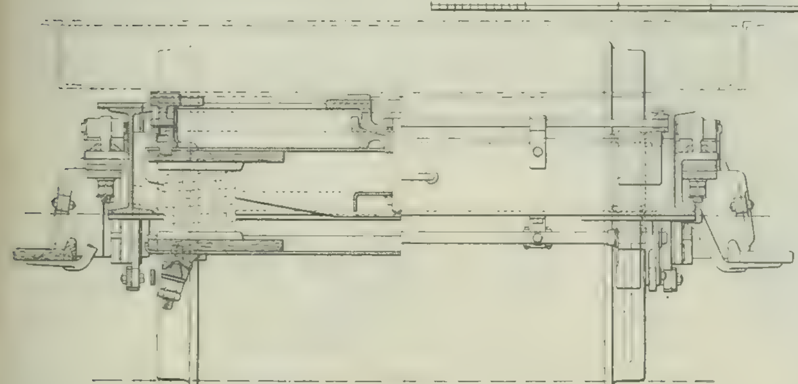


FIG. 7.—GENERAL ARRANGEMENT OF MOTOR BOGIE.

It will be seen from the plan (Fig. 1) given in our last issue that the distance from Heysham to Morecambe is 5 miles and from Morecambe to Lancaster 4 miles. There will be practically no direct running from Heysham to Lancaster. There is also a short extension of about ¾ mile from Lancaster Green Ayre to Lancaster Castle. The distances, except the last-mentioned one, have all been increased by about ¼ mile since the scheme was decided upon, by the alteration in position of the new station at Morecambe, as compared with the old. The services for which the trains are contemplated to be capable are a 20 minutes continuous service between Heysham and Morecambe, and a 15 minutes service between Morecambe and Lancaster, using a single train in each case. The trains will, however, not be worked up to anything like this service throughout the day. There are no gradients of any importance on any section of the line except between the two Lancaster stations. There are, however, a number of speed restrictions near each of the three terminals of the line.

The motor cars are open central corridor type, and have a total length over end panels of 60 ft., and an extreme width of 9 ft.; there are three compartments with a total seating capacity

of 72 passengers, the vestibule compartment at each end being reserved for the accommodation of driver and guard. Of the passenger compartments, the middle one with a length of 25 ft. has the seats arranged transversely, while the other two compartments, each 13 ft. 5 in. long, have longitudinal seats to allow of trap doors in the floor for easy access to the motors, &c. Hand straps have been provided throughout all the vehicles for safety and support of passengers whilst standing, and when entering or leaving.

Efficient ventilation is provided by means of drop lights in the upper part of the side windows and "torpedo" air extractors in the roof. The lighting of the cars is from the power current throughout; the motor cars are also electrically heated from the same source, but the trailers have not yet been fitted with heaters, as their extensive use during the winter months is not anticipated. The interior finishing and decorating has been carried out with regard to facility in keeping the cars clean; the roof is covered with millboard and painted white; the cabinet work is of polished oak, and the seats are covered with perforated sycamore. The underframe is constructed of Z and channel section steel, with angle knees and gusset plates, and well supported with truss rods to sustain the electrical equipment, as seen in Fig. 7. The trailing bogie is of the Midland Railway Co.'s standard type, composed of pressed steel members. The wheel base is 8 ft. and the wheels are 3 ft. 7½ in. diameter on tread.

All the cars are fitted with both hand and power brakes, under easy control of the driver, who can work at either end of the vehicle, of both motor cars and trailers; the power brake is of the vacuum type, obtained by pumps driven from independent motors, and each trailing bogie wheel is braked on both sides.

The trailer cars have a length over end panels of 43 ft. and extreme width of 9 ft.; they consist of one long compartment with a driver's vestibule at each end. The seats are placed transversely throughout and will accommodate 56 passengers. The interior finish, ventilation and lighting is similar to that of the motor cars. The underframing is of light construction, as it has no electrical equipment to sustain; but the two bogies are interchangeable with the trailing bogie of the motor car, with the exception of the springs, which are of lighter construction.

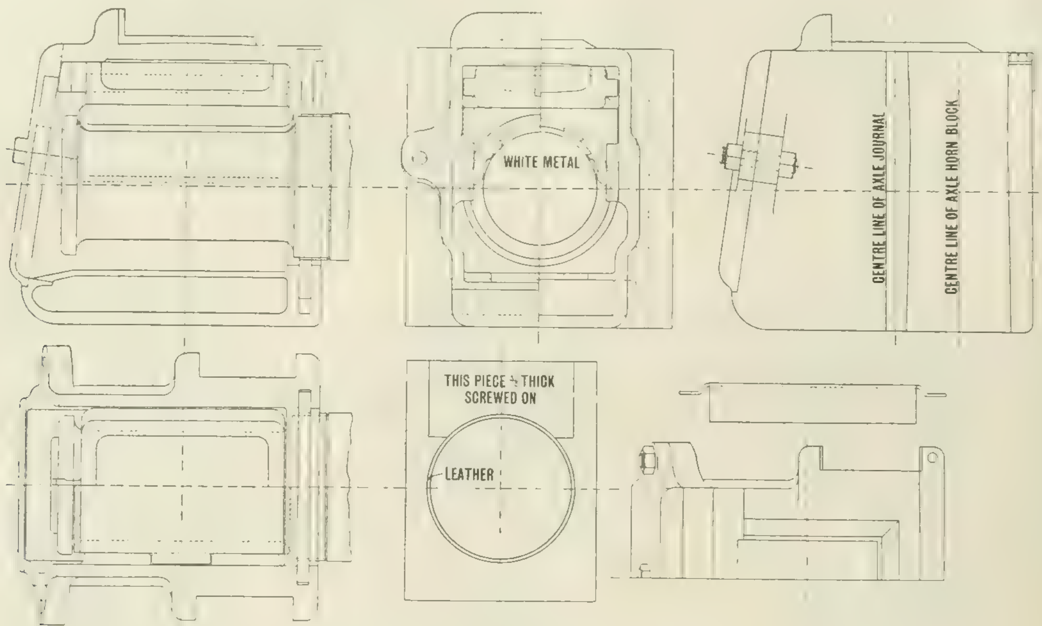


Fig. 8.—Details of Axle Box. Scale 1 : 8.

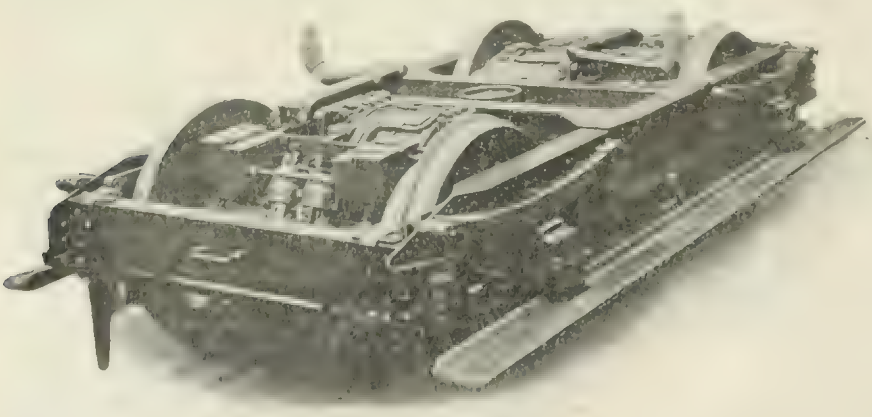


Fig. 9. Motor Bogie with Siemens Equipment.
The oil pumps are seen at the near end, and the ventilation tubes at either side.

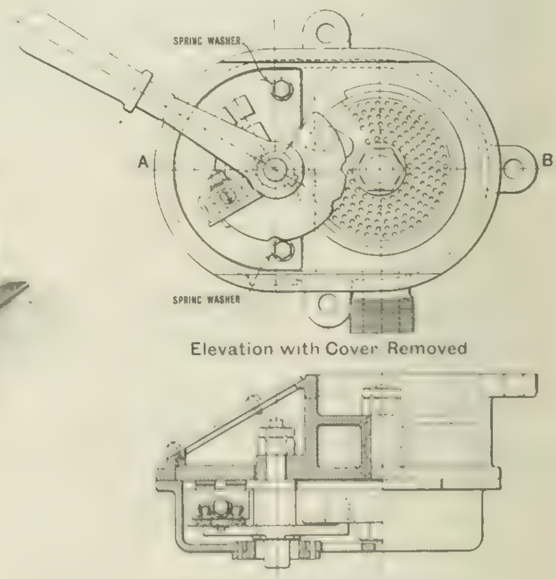


Fig. 10.—General Arrangement of Valve and Switch for Vacuum Brake. Scale 1 : 5.

The motor bogies were constructed by the company's locomotive department, and, owing to the small number required, have been specially built up of rolled sections and plates. The axles are of forged steel 6¼ in. diameter parallel between the wheels, and reduced to 4¾ in in the axle bearing, the length of the journal being 9 in. The wheel base is 8 ft. 6 in., and the driving wheels are 3 ft. 7½ in. diameter on the tread when

new. As only a few cast steel wheels were required an existing tender wheel pattern was made use of for the wheel centre, and consequently the wheels are considerably heavier than is really necessary. The centres are of cast steel and the tyres of mild steel ordinary rolled tyre section, in fact the wheels are practically standard tender wheels. The tyres are 5¼ in. wide and are shrunk on the centre and held by screws through the rim.

As will be seen from Fig. 7 the steel side frames are of rolled joist section 14 in. by 6 in., the end frame being 10 in. by 4 in. channels, and the transom, or centre cross frame, being built up of plates and angles. It is of box section, the bolster lying inside between the webs. The top plate and gussets on both sides of the centre pin are in this case in one complete piece slotted out of the solid. The bottom plates are, as usual, in two pieces, one each side of the centre, the gusset plate being combined with the cross flange in this case also.

Owing to the necessary length of bolster being too great to get in between the flanges of the side frames a certain amount

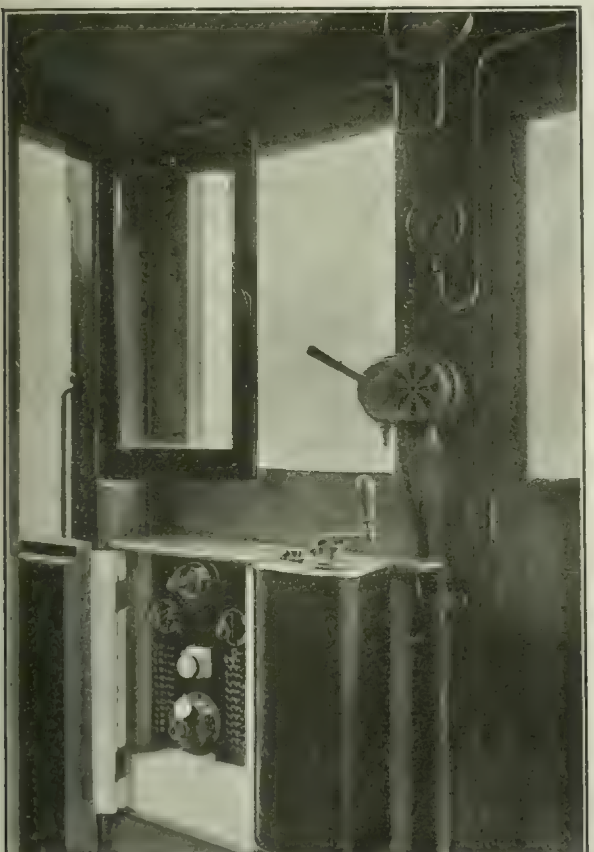


Fig. 11.—View showing Interior of Driver's Cab.

had to be cut from the inside of the top flanges of these, and as this necessitated doubling plates on the top of these flanges and their combination with the top flanges of the centre cross-frame the making of the top plate in one piece as above described followed naturally; incidentally, this construction gives a very stiff and rigid backbone to the bogie. The swinging bolster is of pressed steel, and is similar to that of the trailing bogie, except for the heavier springs.

The axleboxes are of a special pattern built for these bogies, though they are very similar to the standard carriage axleboxes suitably altered to act as driving boxes. Their construction is shown in Fig. 8, and it will be seen that the brasses which are white-metalled subtend a slightly larger angle than the usual carriage brass, being about the same angle as loco motive brasses. Lubrication is effected entirely from the pad at the bottom supplied from the usual oil well, the brasses being well chamfered away at each side so as to ensure an ample feed of oil into the journal and its formation into a proper lubricating film. The top of the box casting forms a seating for the ordinary laminated steel bearing springs. The horn blocks are cast steel bolted with the usual fitted bolts to the framing.

The box is, of course, a good sliding fit in the blocks longitudinally, but across—*i.e.*, lengthwise of the axle it only actually fits the blocks a distance of about 1½ in. at a point opposite to the centre of the bearing area, being tapered out the remainder of its length both ways to the extent of about ⅛ in., this obviating any tendency for the axle to be nipped during running at the throat of the journal.

The bearing springs are laminated steel plate springs such as ordinarily used for this purpose, but considerably heavier than the standard carriage springs of ordinary type.

The brakes, as is usual in electric motor trucks, act only on one side of the wheels, lack of space making it impossible to adopt the standard railway practice of two brake blocks per wheel. The blocks are hung from brackets on the bogie end frames, and are actuated by levers connected to bars running lengthwise under the inside top flange of the side frames. An arc shaped cross bar connects these bars together, and is coupled to the brake pull rod through a shackle and roller arrangement, which allows for the swivelling of the bogie on curves without affecting the brake gear adjustment.

The weight of the whole bogie is 6½ tons, the extra weight of the wheels, however, accounting for about 1 ton of this. A view of the motor bogie with Siemens equipment is shown in Fig. 9.

Before going on to deal with the actual driving equipment of the cars the other accessory apparatus, which may be of interest, may be shortly described. Each motor car has two brake cylinders, that for the motor bogie having special levers giving the cylinder greater purchase than usual. The trailer cars have only a single brake cylinder, operating brakes on both bogies. The vacuum is obtained from a Gresham & Craven vacuum pump supplied through the electrical equipment contractors, Messrs. Siemens Bros. Dynamo Works, by the Vacuum Brake Co. The pump is motor driven with a worm speed reduction running in an oil bath. A sing'e brake pump is used on each motor car.

The control gear for the pumps is arranged so as to give a high speed and a low speed, the latter being ¼ of the higher. The pump runs at the low speed throughout the operation of the train, and whether the brakes are being applied or not, excepting when put on to the high speed in order to take off the brakes rapidly. The action thus corresponds exactly with the operation of the large and small ejectors on a locomotive. The pump control gear has been specially arranged with a view to making it practically impossible for a train to be moved without proper vacuum having first been obtained, as follows:—

The driver's brake valve is of special construction as shown in Fig. 10, and is combined with a switch which operates the contactors controlling the pump. Current is fed up to this switch through one contact of a three-way plug, of which one of the remaining contacts is the feed wire from the auxiliary transformer, and the third goes to the master controller, it is, therefore, impossible to move the car by means of any of the controllers unless this plug is inserted, and its insertion automatically operates one of the pump contactors and starts it working at either the high or the low speed; most probably the former as the driver's brake valve handle is removable, but can only be removed in full pump speed position. The use of this plug also ensures that only one controller throughout the train can be used at a time.

There is, of course, a driver's brake valve in every driving compartment, but it will be clear that only the valve and switch in that compartment which is being used for driving, and in which the driving feed plug is inserted, is operative for starting and varying the speed of the pump, but the brake can be applied by the guard or other authorised person who is in possession of a handle at either end of every coach.

There is also fitted to each motor car an additional switch controlled by the vacuum, which will trip the main circuit-breaker in the event of the vacuum falling below about 15 in., this being decided upon principally in connection with emergency applications of the brake by a guard who will thus be given full control over the train, an advantage, seeing that there is only one motorman. This switch also ensures that

motormen cannot start the train before taking off their brakes. A general view of the brake valve and control apparatus in the driver's cab is shown in Fig. 11.

A horn, which takes the place of a locomotive steam whistle, is carried on each end of each motor car, and is electrically operated, the sound being produced by the vibration of a diaphragm by means of apparatus similar, but of greater power and more substantial construction, to the ordinary trembling

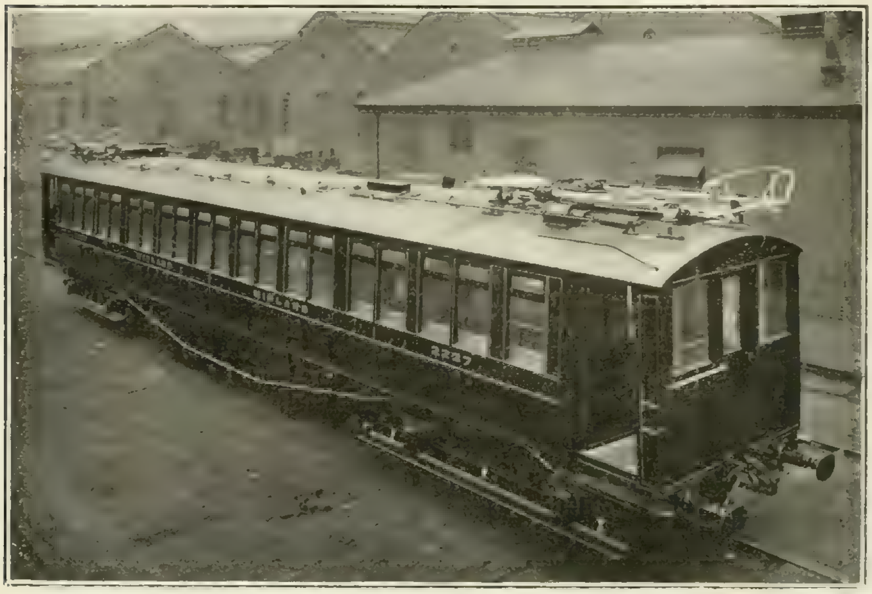


Fig. 12.—Siemens Train for Midland Railway.

bell, a surprisingly loud and clear note being obtained in this way. The sound is multiplied considerably by use of properly-designed trumpets obtained from Messrs. Boosey & Co., and a very satisfactory sound is produced at an expenditure of far less power and much less complication than would be the case with a vacuum-operated horn; in fact, the electric horn compares well with a horn operated by compressed air, which was not available on these cars. The vibrators were supplied by Messrs. Marples, Leach & Co., and are operated by a small 12 volt set of secondary batteries, the train wire for operating them being carried through the train in the ordinary train cable and through the jumpers.

The lighting is carried out by groups of six 24 volt lamps in series from the 150 volt auxiliary transformer control main. The two side tail lights, however, which are electric, are each direct on the 150 volt mains, the lamps being carried inside ordinary tail lamp lanterns, which are detachable and carry an ordinary water-tight plug, the socket being fixed on the end of the coach, just above the lamp iron. Lamp irons, plugs and plug sockets are provided at each end of each coach. The lamp in the driver's compartment is specially shaded so as to throw only a narrow beam of light on the vacuum gauge and ammeter, thus allowing the driver to get a good view of the road outside, his compartment being practically dark. The shade is arranged so as to be opened when occupied as a guard's and luggage compartment, or as entrance vestibule.

The window on the left or near side of the train is that through which the driver views the road, and, in order to clear the outside of this window from snow and rain, a special scraper has been arranged with a handle inside the compartment, so that by throwing this handle up and down the window is cleared. The scraper consists of a squeegee made of flat rubber on edge.

The driving equipment of two of the motor-cars has been supplied by Messrs. Siemens Bros. Dynamo Works, and of the third by the British Westinghouse Company. The specification of the equipments called for two motors per car, both to be carried on one bogie, it being considered both the more economical and the more mechanical arrangement to concentrate the motor power and reduce the number of parts as much as possible, while with single-phase traction and voltage step control there is, of course, no necessity to consider series paralleling.

From the profile of the line, which was given in our last issue (Fig. 1), the running conditions will be seen. The normal train was specified to consist of a motor car and two trailers, the weight of these being, without any of the electric apparatus or the mountings for the same, 25 tons for the motor car and 17½ tons for each of the trailers. The motor car seating 72 passengers and the trailers 54, the respective standing capacity being 58 and 36, giving a total maximum capacity, without encroaching on the vestibules, of 310, with a total of 180 seats. As has been already noted, the trailers are considerably shorter than the motor cars.

Since the original specification was issued ¼ mile has been added to the respective lengths between stations owing to the moving of Morecambe Station previously mentioned. It was specified to the contractors that they would be permitted to run at 25 miles per hour round the speed restricted curves, and on this basis the trains were to be capable of working a 20 minutes' service from either end as between Heysham and Morecambe with a single train, and a 15 minutes' service as between Morecambe and Lancaster under similar conditions.

The capacity of the motor car was to be such as to enable it to take on occasions two additional main line coaches weighing 26 tons each, and was also to be capable of climbing with its train the gradient from Lancaster Green Ayre to Lancaster Castle occasionally. The additional length to Morecambe can

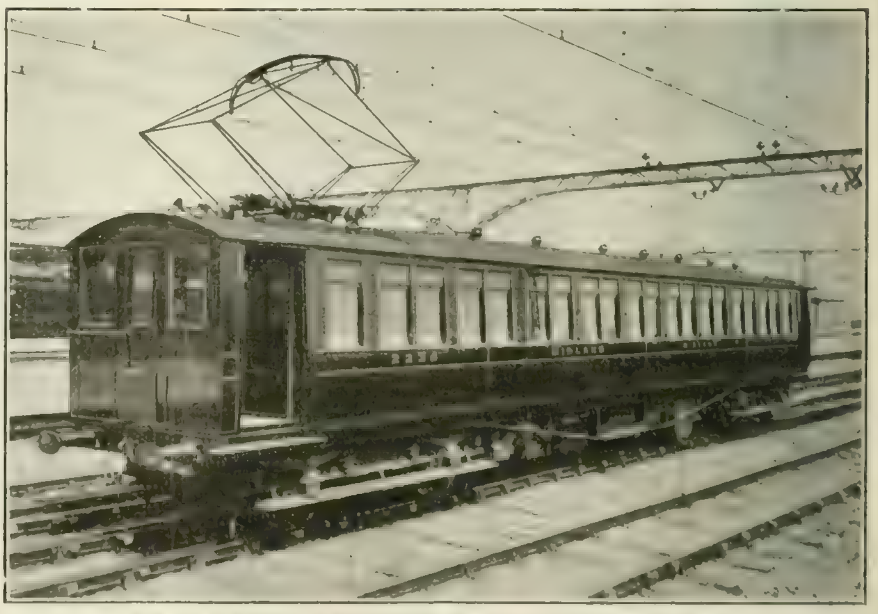


Fig. 13.—British Westinghouse Train for Midland Railway.

probably still be covered for the 20 minutes service if the cars be run at 25 miles per hour round the curves at the cost of a rather greater consumption of energy.

The specification also called upon the contractors, should the order for the coaches be divided, to make their equipments capable of being worked from the same master controllers, and though considerable difficulty had to be got over in order to meet this condition it was found possible to work the

Siemens equipments in conjunction with the Westinghouse one in this way.

It was considered by the railway company that two 150 H.P. motors per motor coach would satisfactorily carry out the they were also required to have a temperature rise not exceeding 90°F. on any portion after having run the three coach train for six double trips as per the schedule above mentioned from Heysham to Morecambe, Morecambe to Lancaster, and

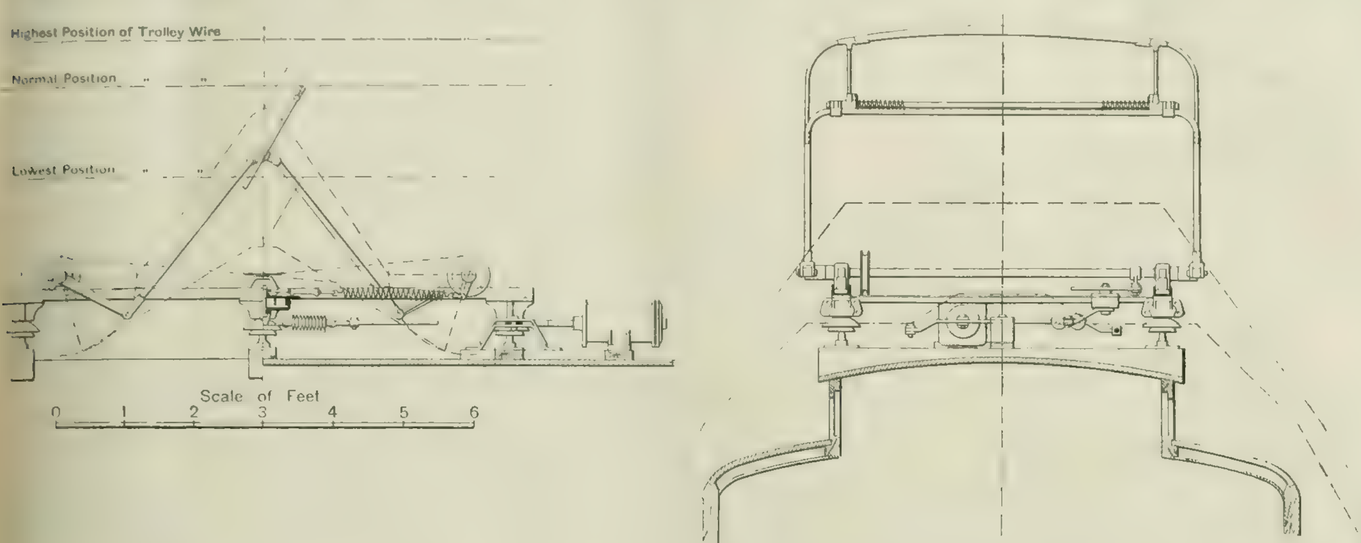


FIG 14.—STANDARD TYPE OF SIEMENS BOW COLLECTOR WHICH IS IN USE ON SEVERAL ELECTRIC RAILWAYS.

work, and the respective contractors supplied motors of their nearest standard sizes to this, the Siemens' motors being nominally of 180 H.P. and the Westinghouse motors of 150 H.P. The specification called for the motors being capable of delivering, when tested on the stand with single-phase alternating current of the proper frequency, their declared output for one hour with a temperature rise not exceeding 135°F., and return. Overload and other similar tests were also specified. Figs. 12 and 13 show the general appearance of the Siemens and Westinghouse cars respectively.

The control gear was specified to be preferably all-electric multiple unit type. The Westinghouse car has, however, been accepted with their standard electro-pneumatic control modified as necessary to enable it to work with the Siemens car which

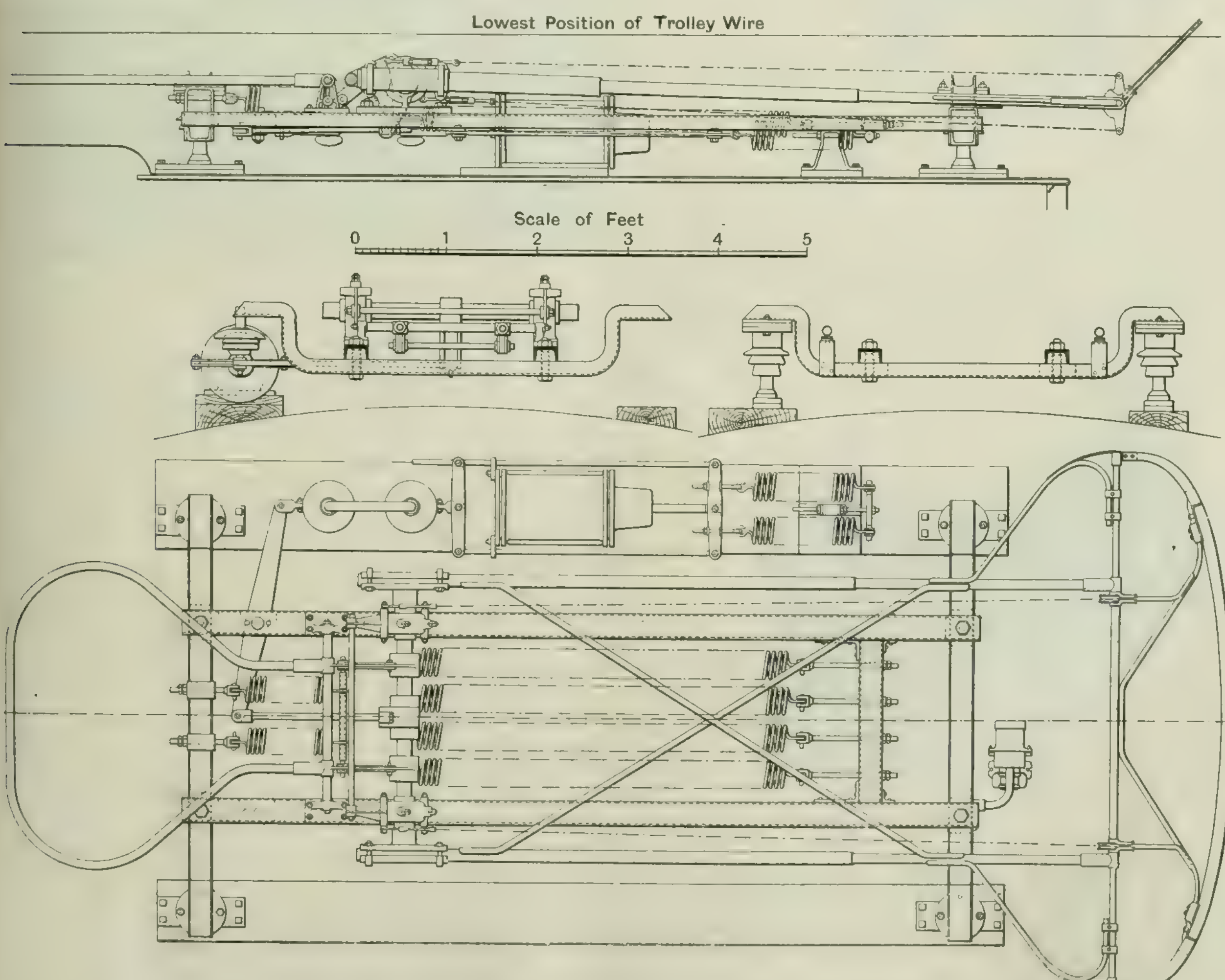


FIG. 15.—BOW FITTED TO THE SIEMENS CARS IN USE ON THE MIDLAND RAILWAY. Scale 1 : 25.

is all-electric. Stringent guarantees of efficiency, energy consumption in watt-hours per ton-mile, and general performance were required to be given.

The main transformer was required to conform to the same test conditions for heating as the motors, an auxiliary transformer being specified to provide for the supply of current for lighting, heating and working the control apparatus and brake pump, this transformer having a three-hour test specified, it being subject to continuous working.

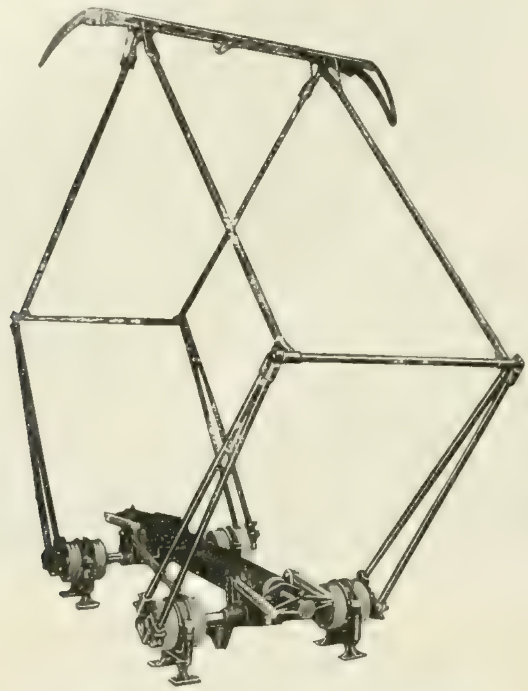


Fig. 16.—British Westinghouse Bow Collector.

The Siemens cars are provided with two collector bows, it being considered by the firm best to ensure continuous contact as far as possible. It was found impossible to get the firm's standard bow (which is of inverted pantagraph type, as shown in Fig. 14) into the restricted space at disposal between the coach roof and over-bridges, and a type of bow has been adopted somewhat similar to the Continental tramway type of bow, but

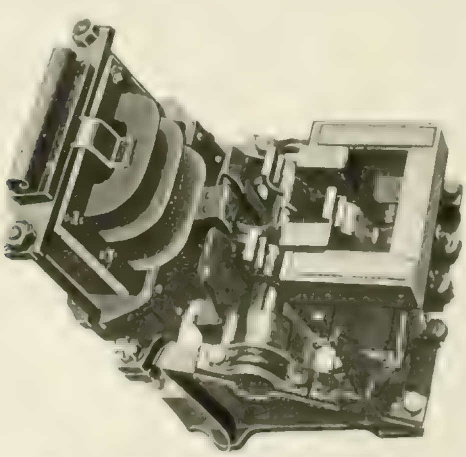


Fig. 17.—View of a Siemens Contactor.

having a small auxiliary bow at the end controlled by parallel motion (Fig 15). This bow, while appearing somewhat simpler than the standard bow, and requiring less room, and while fairly satisfactory in working, has the disadvantage that it requires balancing by a wind screen.

The Westinghouse bow is of their standard pantagraph type (Fig. 16), a single bow only being used, and this goes into the available space fairly well. We may mention, however, that the bow used on the Midland Railway has the bow considerably more curved than is shown in the illustration, as will be noticed in Fig. 13. Both makers' bows are purely spring controlled so far as their working is concerned; the Siemens bow, however, is lowered by a master spring, which can be thrown out of action by a vacuum cylinder.

The Westinghouse master spring is controlled, as regards raising and lowering, by compressed air, a special compressor being installed by that company in connection with their control gear. A small hand pump has been installed in each case for raising the bows when first starting out in the morning, or at similar times when no compressed air or vacuum is available. The two Siemens bows can be raised or lowered separately, and the vacuum for holding them up is obtained from the train pipe through a ball valve, so that when the brakes are operated the vacuum remains on the bows.

The essential difference between the action of the Siemens bow and that of the Westinghouse Company is that while the former is normally down the latter is normally up. The Westinghouse bow is pumped down by air, but when once down is retained by a catch. This catch is controlled by a very small cylinder, and hence to raise the bow it is merely necessary to admit air to this small cylinder. The bow is then carried up and held up by springs. Aluminium is the metal used for the shoe on the Siemens bow, while that of the Westinghouse Company consists of a flat piece of galvanised iron 6 in. in width with the edges turned down. This shoe has a groove of semi-circular section running throughout its length, in which the lubricating substance is placed. It weighs only

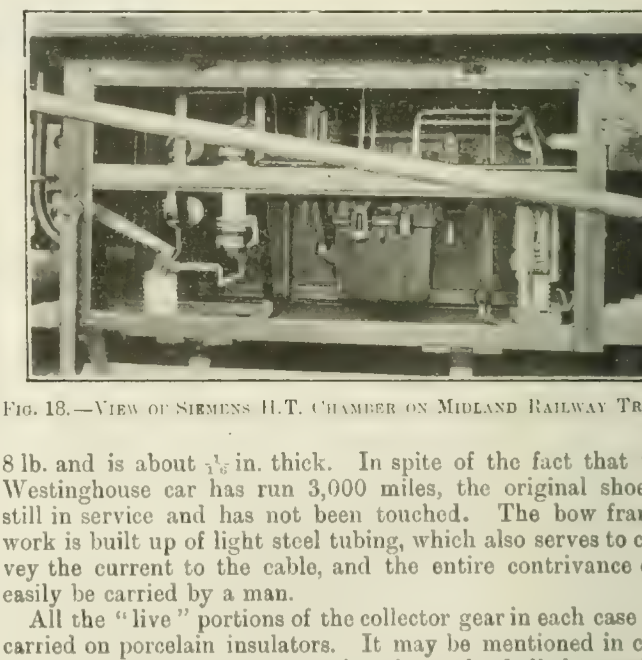


Fig. 18.—View of Siemens H.T. Chamber on Midland Railway Train.

8 lb. and is about $\frac{1}{16}$ in. thick. In spite of the fact that the Westinghouse car has run 3,000 miles, the original shoe is still in service and has not been touched. The bow framework is built up of light steel tubing, which also serves to convey the current to the cable, and the entire contrivance can easily be carried by a man.

All the "live" portions of the collector gear in each case are carried on porcelain insulators. It may be mentioned in connection with the collector gear that the roofs of all the coaches have been covered with an "earthed" wire netting so as to throw out the station circuit-breakers in the event of the overhead wire coming down on the roof. The efficacy of this has been actually and satisfactorily tested in practice.

The high-tension wiring on the Westinghouse car is carried in lead-covered cable which, on the roof, is protected with a further metal covering. It is carried down about the centre of the car through a heavy section brass tube, the lead covering of the cable being sweated solid on to this tube at the top. This tubing is, of course, substantially "earthed." The further high-tension wiring to the two transformers on this car is also in lead-covered cable, which again in its turn is protected in metal tubing both heavily "earthed." The cables are rubber-insulated.

Except for the short length down through the coach the high-tension wiring on the Siemens cars is, from the bow down through the high-tension chamber to the main transformer, all bare wire, being carried on porcelain insulators on the coach roof and underneath the coach. The vertical tube through the coach itself is of brass and in this case made removable, being practically part of the wiring. The cable is paper insulated lead covered terminating above and below in bitumen

sealing chambers with porcelain insulator fittings. There is about $\frac{3}{16}$ in. air space between the lead covering and the inside of the tube. Both lead covering and tube are heavily "earthed."

On the Siemens cars the high-tension wire proceeds into the high-tension chamber, the door of which is mechanically interlocked with the bows so that it cannot be opened unless the bows are down.

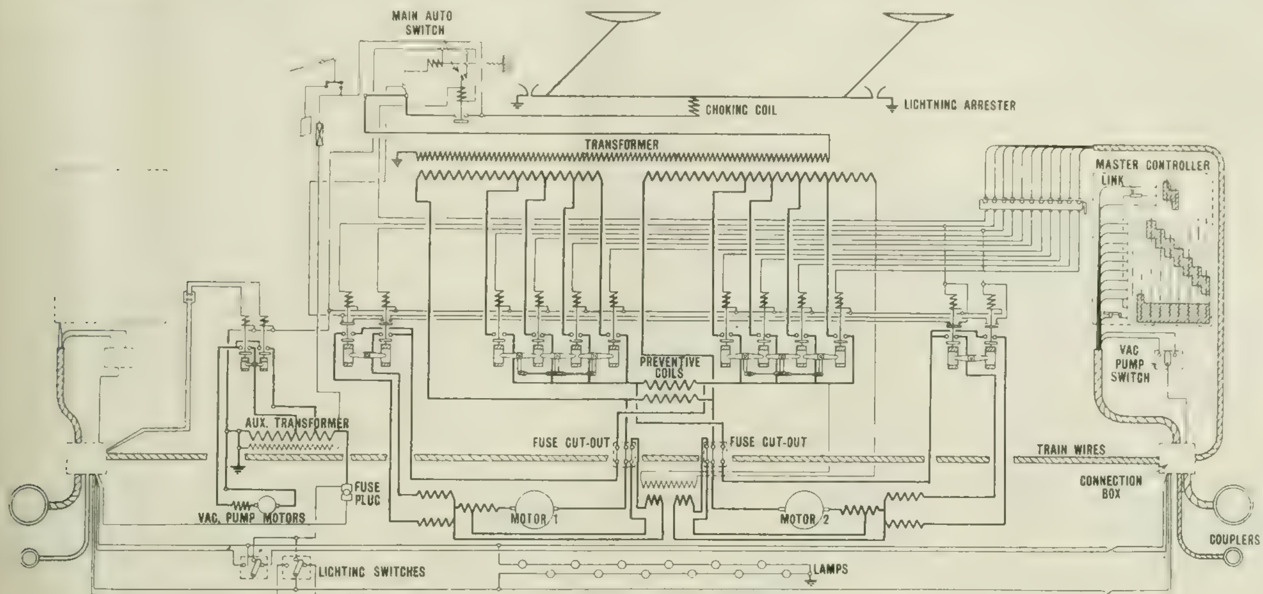


Fig. 19.—Diagram of Connections for Siemens Control.

The low-tension wiring, though low voltage, has proved little more difficult to instal than the ordinary 600 volt wiring. Longitudinally it is carried between the two girders forming the centre members of the underframe, and it is supported between these two members in wooden frames spaced about 18 in. apart. The low-tension cables themselves are not carried in metal tubing, as probably eddy current troubles would arise if they were, but they are substantially surrounded with metal, and the coach body and its frames are all covered with sheet iron and asbestos wherever cables are run underneath. Where these cables require to go cross-wise they are carried between the tops of the girders and the floor and spread out fan-wise.

The train cable is carried along the outside of the coach alongside the sole-bar in a metal tube, being carried round the bends in flexible metallic tubing. The train cable, couplers and master controllers, for the whole of the motor cars and trailers, as well as all the pump motors and their control gear have been supplied by Messrs. Siemens Bros. Dynamo Works.

The Siemens high-tension apparatus and their contactors, a view of one of which is given in Fig. 17, are contained in sheet iron cases, which have been been made by the Railway Company. The supporting of these and of the transformers, auxiliary transformer, preventive coil and other apparatus has involved the provision of a good deal of special girder work on the underframe, which has added considerably to the weight of the latter, and which, as the coach had to be proceeded with before the final details of the electric equipments could be decided upon, could be considerably lightened in a future case. A view of a Siemens H.T. chamber on one of the trains is shown in Fig. 18.

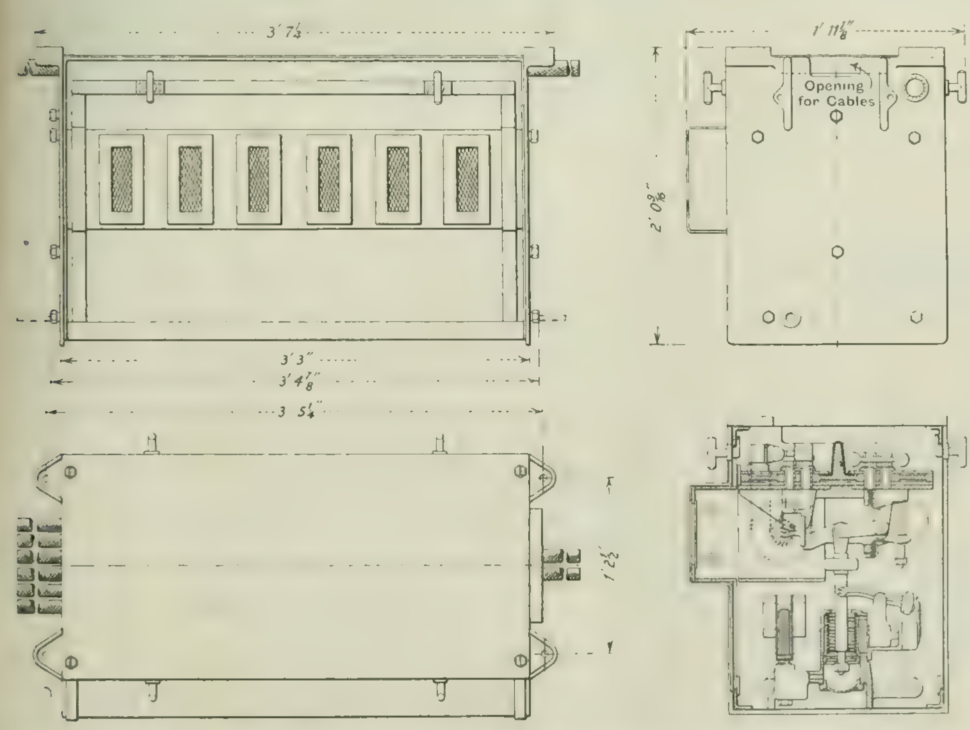


Fig. 20.—General Arrangement of Westinghouse Multiple Control Unit Switch Group. Scale 1:16.

The Westinghouse apparatus is more self-contained, though the supports for it also could probably be arranged at less expense in weight.

The Siemens equipment consists of the two motors, the main transformer, the auxiliary transformer, preventive coil and commutating transformer, high-tension circuit-breaker and fuse in the main transformer circuit, high-tension fuse in the auxiliary transformer circuit, contactors, motor fuses which also act as motor cut-outs, and low-tension fuses in the circuit feeding the control, and also a low-tension fuse in the circuit feeding the fan.

There is intentionally no fuse placed in the brake pump main circuits, the cables for which are carried in special heavy section tubing, so that if anything goes wrong on the pumps the main high-tension fuse will be blown, and it will be impossible to work the car.

The respective weights of the two motor coaches are as follows :—

	Siemens. T. cwt. qr.				Westinghouse. T cwt. qr.		
Carriage body work	13	5	0	......	13	5	0
" bogie	4	10	0	....	4	10	0
Special supports	1	6	0	....	0	17	0
Motors with gear and gear case	6	5	0	......	5	11	0
Main transformer	2	14	2	......	2	11	0
Aux. com. transformer & preventive coil	0	19	2	......	0	9	2
Pumps and compressors	0	9	2	......	0	16	0
Contactors and chambers	1	2	2	......	0	9	3
Other sundries, including bows, blowers, controllers, &c.	3	7	0	......	2	9	3
Motor bogie	6	11	0	......	6	11	0
	40	10	0		37	10	0

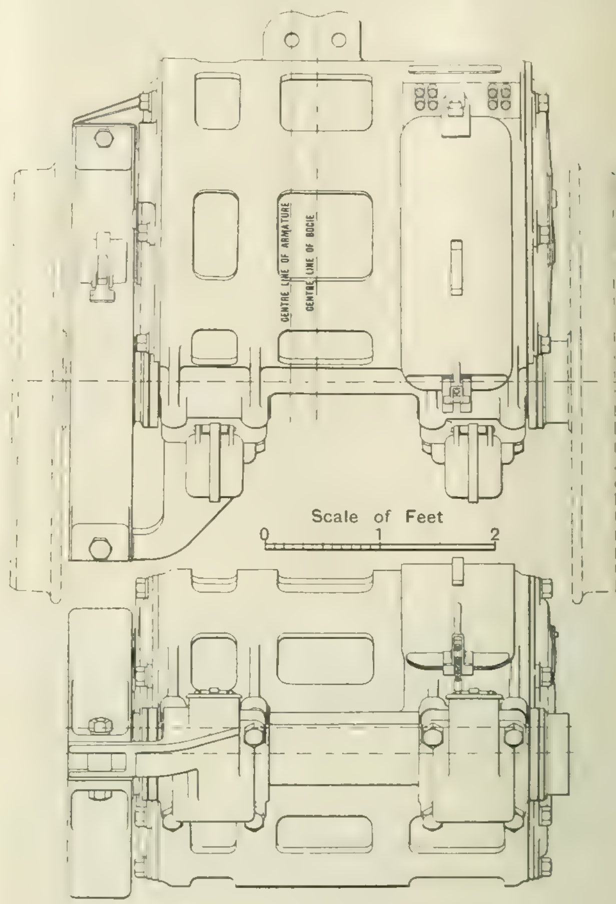
The apparatus was very stringently tested at the makers' works, with results satisfactory in every way. At 180 H.P., and with forced draught, the motors were very much under their guaranteed temperature rise, and did not exceed this temperature rise when tested at this horse-power, with natural ventilation on the stand. With forced draught, and with only 300 volts on their terminals (the full voltage being 340), they tested under the specified temperature rise at 200 H.P., corresponding at full voltage to fully 225 H.P. They were also tested for continuous operation, giving at 250 volts, which was chosen as being a mean operating voltage, 105 H.P. for five hours, with a temperature rise of only 115°F., so that at full voltage, allowing nothing for the improved ventilation at the higher speed, the machine can give continuously nearly 150 H.P.

The sparking tests were equally satisfactory, there being no objectionable sparking at a current of 1,100 amperes at 300 volts, which corresponds at full voltage to 350 H.P., and a torque of fully 2½ times that at the rated horse-power of 180.

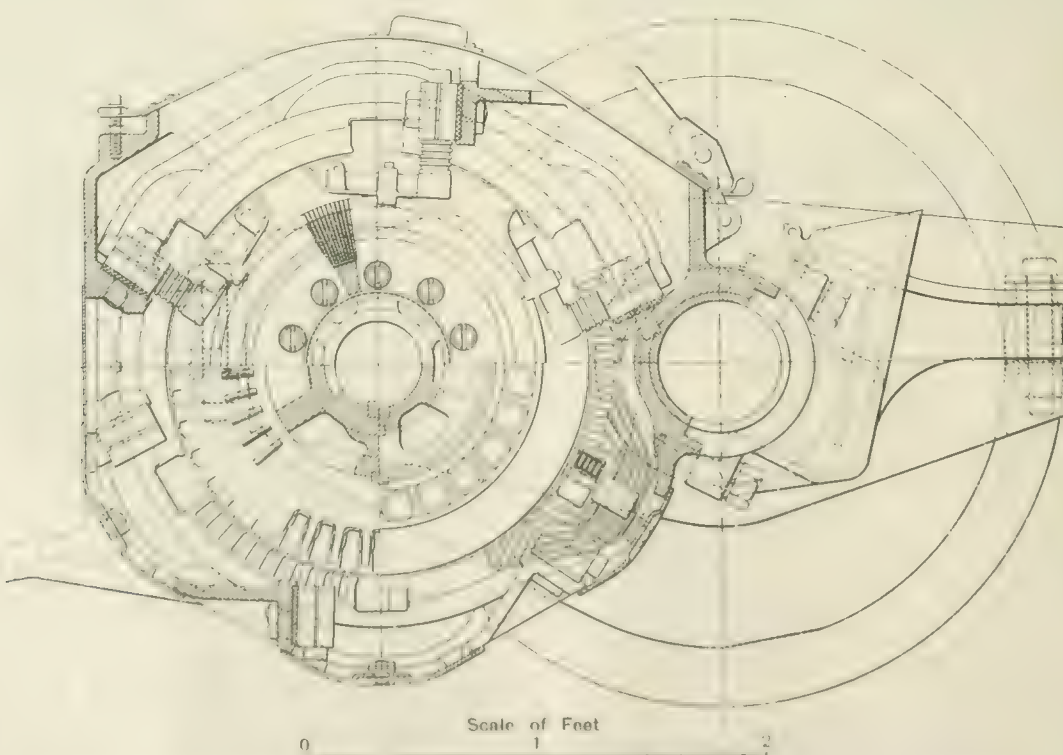
The commutating transformer, while apparently an additional complication, probably pays its way in effectiveness, as the sparking of these Siemens' motors, both on test and during actual running on the line, has proved to be quite as good as that of any, and better than that of many, direct current traction motors ; in fact, during the testing on the line, currents of over 1,000 amperes per motor have been frequently applied without any sparking at the commutators, even at starting, the brushes on the latter portion of the acceleration and during free running being absolutely dark.

The operation of the contactors is also perfectly satisfactory, and gives none of the trouble that has been prophesied in various quarters for single-phase contactors in the direction of humming and chattering, excessive size, &c., though they are more liberally designed than will probably be adhered to as standard practice.

The master controllers are, it may be mentioned, of fly-back



Outline Elevation. Scale 1 : 20.



Cross Section. Scale 1 : 10.

Fig. 21. Views showing Construction and Outline Elevation of Westinghouse Single Phase Motor.

or dead-man handle type, being, however, somewhat different from the usual design, inasmuch as the release of forward pressure on the handle by the driver trips the whole of the contactors at once, no matter on what stop the driver may be working at the moment, and without his allowing the handle to come back to the "off" position. This practically ensures the obtaining of the maximum amount of safety that can be obtained from a handle of this type, though the occasional sudden throwing off of heavy loads in this way is a somewhat severe tax on the regulating properties of the power station. A diagram of the control is given in Fig. 19.

On the Westinghouse motor car current is conducted by means of a lead-covered rubber-insulated cable from the pantagraph bow collector on the roof through a heavy brass conduit to the main circuit-breaker. This circuit-breaker is electro-pneumatically operated and breaks contact under oil. It opens automatically on overload and is closed again from the driver's cabin by moving the master controller to the first notch. The current then passes to the high-tension end of an oil-insulated self-cooling auto transformer, the other end of the winding of the transformer being securely earthed. The low-tension tappings from this transformer are connected to the six switches which form the electro-pneumatic switch group The switch group, which is shown in Fig. 20, measures only $43\frac{1}{4}$ in. by $24\frac{1}{2}$ in. by 23 in. and weighs 845 lb. The switches are provided with electric interlocks which ensure their closing in the proper sequence. Powerful magnetic blow-out coils are fitted between each pair of switches which effectually destroy the arc made on breaking the heavy currents. In Fig. 21 the equipment is shown in position.

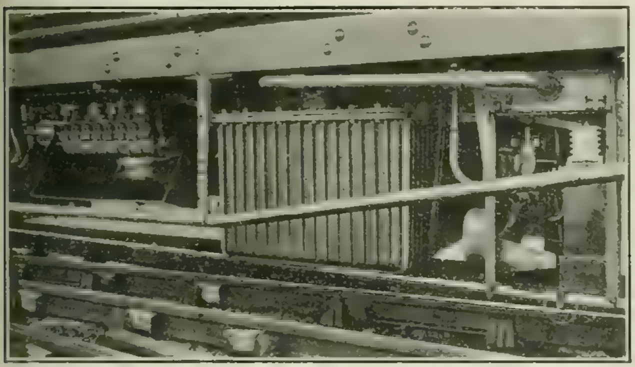


Fig. 22.—View showing (from left to right) Reverser, Main Transformer and H.T. Circuit-Breaker on British Westinghouse Train.

From the electro-pneumatic switch group the current passes to the two terminals of the preventive coil, from the centre point of which the lead to the reverser is taken. The reverser is of the drum type and is electro-pneumatically operated. The magnet valves on the reverser are interlocked with those on the main switch group so that it is impossible to close any of the switches in the latter until the reverser is set in the right position. Cut-out switches are fitted in the reverser case so that either of the two motors may be disconnected if desired. A diagram of connections is givan in Fig. 23.

The motors are of the Westinghouse Company's standard series compensated type arranged for forced ventilation. The cross-section of a motor is given in Fig. 21, in which it will be seen that the motor has six poles and six sets of brushes. The field core is made up of laminations having six inwardly projecting poles and being enclosed in a cast-steel shell. Each pole is surrounded by a former-wound field coil, which can be readily removed if required. Semi-closed slots in the pole faces are provided for carrying the compensating winding, which is connected in series with the armature.

Air is admitted to the motor for forced ventilation at openings over the pinion end and passes through the motor and out through the perforated commutator cover. This method of cooling the motors, which was first introduced by the Westinghouse Company on the Metropolitan Railway, has proved very effective in service and materially increases the capacity of the machine. With the construction adopted by the Westinghouse Company it is not necessary to have any complicated system of forced lubrication, both the armatures and axle bearings on this motor being equipped with simple oil and pad lubrication.

The above equipment was designed for operating in regular service a train weighing 82 tons, including passengers. Owing, however, to the sound mechanical construction of the motors and their large overload capacity, it has been possible to operate much heavier trains than this. A train made up of seven ordinary vehicles and this motor car, giving a total weight of 161 tons, has been run between Lancaster and Morecambe. On starting with this load each motor takes about 1,050 amperes, and this current is commutated quite satisfactorily without the motor showing any signs of distress. The train accelerated rapidly and smoothly, reaching a speed of about 50 miles an hour.

The equipment also was tested at the makers' works with highly satisfactory results, the temperature rise at the end of an hour's full load of 150 H.P. with single-phase current being well within the limit, while overloads up to 1,200 amperes were applied without causing injurious sparking.

In order to reduce any tendency to spark, the commutators of the Westinghouse motors are slotted in a direction parallel

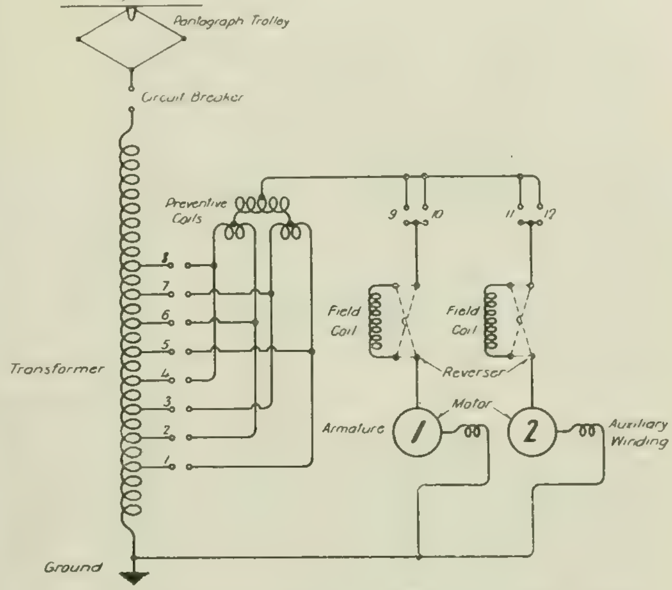


Fig. 23.—Diagram of Connections of Westinghouse Two-Motor Equipment.

with the axle. This is effected by removing mica insulation from between the segments to a depth of about $\frac{1}{16}$ in. Even when very severely overloaded these machines display no tendency whatever to spark, and they have now covered a distance of over 3,000 miles without giving the least trouble.

(To be concluded.)

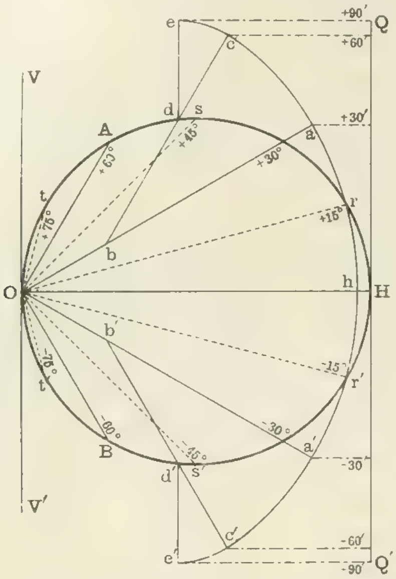
A NEW GRAPHIC METHOD FOR DETERMINING THE MEAN SPHERICAL INTENSITY OF A LAMP.*

BY A. E. KENNELLY.

The "Rousseau diagram" method, for determining the mean spherical intensity of a luminous source, when the curve of mean luminous intensity in altitude, or briefly, the polar curve, has been obtained is well known. Briefly, a circle is described on the diagram about the luminous source as centre, and horizontal lines are drawn at successive angular distances, from the zenith to the nadir. Along each horizontal line the mean azimuthal intensity for the corresponding angular distance is laid off, by measurement of the given curve, all horizontal distances being taken from a common vertical. The outlying ends of the various horizontals are then joined by a broken line, and the area contained between the broken line and the vertical is measured. The horizontal length of that rectangle which on the same vertical base contains an area equal to the measured area is the mean spherical intensity of the source to the scale of the original polar curve.

* Abstracted from the *Electrical World*.

The new method here described has the advantage of yielding the mean spherical intensity as the length of a certain vertical straight line, or as a one-dimensional quantity. This dispenses with the use of a planimeter or equivalent surface measuring device. It consists essentially in determining graphically from the given polar curve an evolute, and the involute of the same, and then projecting this involute upon a vertical line. Half the length of the projection is



equal to the mean spherical intensity, to the same scale as the original polar curve. The entire process requires only an angle protractor and a pair of compasses.

The new method may best be explained by reference to the diagram, which shows its application to the case of a simple circular polar curve, OAHB, say, for an incandescent lamp. The mean horizontal intensity would be OH, the diameter of the circle, and corresponding, say, to 10 c.p. The construction is shown adapted to zones of 30 deg. Find the radii of the midzones—*i.e.*, at +75 deg., +45 deg., +15 deg., −15 deg., −45 deg., −75 deg. Mark these by the dotted lines O*t*, O*s*, O*r*, O*r*′, O*s*′, O*t*′, respectively.

With radius O*r* and centre O, describe the arc *hra*, through an angle of 30 deg. Draw the radius O*a* at the end of the arc. Measure from *a*, along *a*O, a distance *ab*, equal to O*s* the second midzone radius. With centre *b*, and radius O*s*, describe the arc *ac* through an angle of 30 deg., so that *bc* makes an angle of 60 deg. with the horizontal OH. Draw the line *bc* at the end of this arc. From *c* towards *b* mark off a distance, *cd*, equal to O*t*, the third midzone radius. With centre *d* and radius O*t* describe the arc *ce* through an angle of 30 deg., so that *de* makes an angle of 90 deg. with the horizontal OH. Draw the line *de*.

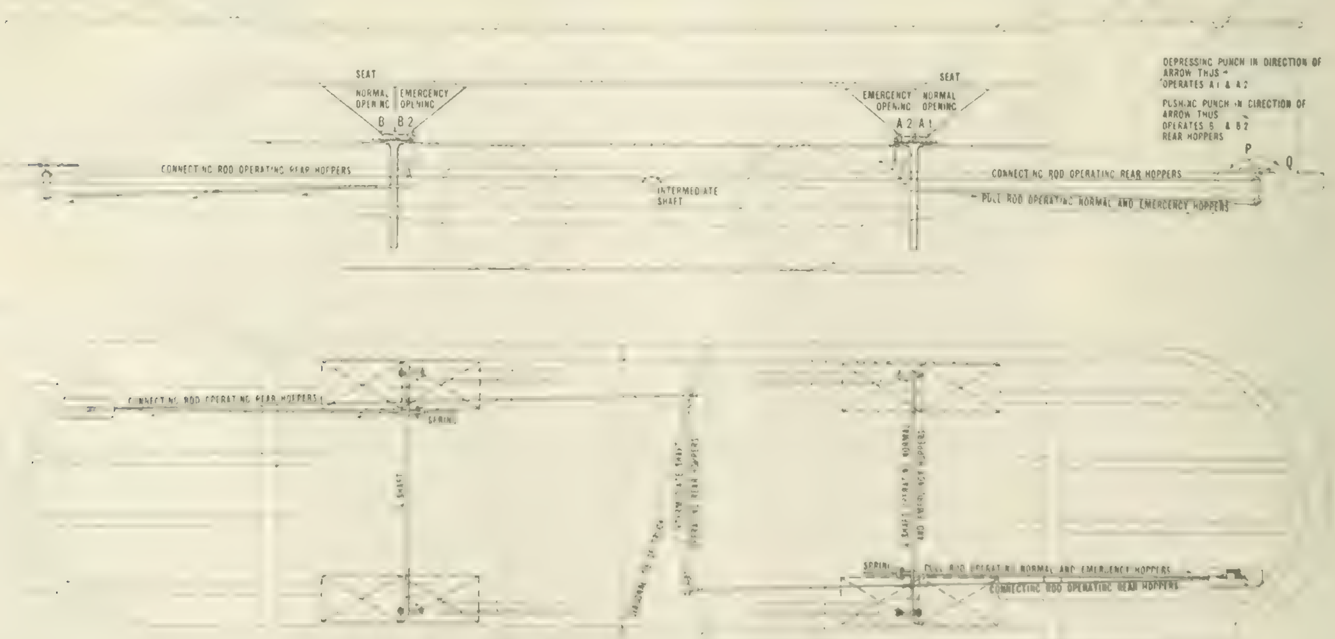
Extend the arc *ha′c′e′* from the horizontal to the vertical beneath in the same manner as above, by steps of 30 deg., with centres O, *b*′ and *d*′ and radii O*r*′, O*s*′ and O*t*′ respectively. The curve *ecarr′a′c′e* will now be continuous and complete. Draw a vertical line, QQ′, through the convenient point H, and project horizontally the points *e*, *c*, *a*, *a*′, *c*′ and *e*′ upon the same. Then half the distance, QQ′, between the end projections will be equal to the mean spherical intensity of the lamp. In the case considered this is seen to give a spherical reduction factor of 0·776, as compared with the correct value 0·785 obtained theoretically, showing an accuracy sufficient for many purposes. For higher accuracy, rectification can be made at 10 deg. zones, but 20 deg. is recommended by the author as usually giving the most satisfactory results. It should be noted that HQ is the upper hemispherical intensity, and HQ_1 the lower, their arithmetic mean thus giving the mean spherical intensity.

The line of projection, QQ′, not only gives the mean spherical intensity on bisection, but it also indicates at a glance the flux of light per azimuthal radian in any zone. Thus, in the above figure, the line H+30′ scales 4·8 in terms of OH = 10. Consequently, we know that this lamp emits a luminous flux of 4·8 candle-lumens in the zone 0 deg. to 30 deg. per radian of azimuth, or per equatorial radian. Since there must be 2π radians in a complete circle of latitude, the total flux of light emitted in this 0 deg. + 30 deg. zone will be $2\pi \times 4{\cdot}8 = 30{\cdot}2$ candle-lumens. By the same reasoning, the total flux emitted by the lamp will be $2\pi \times QQ' = 2\pi \times 15{\cdot}76 = 99{\cdot}0$ candle-lumens. In other words, in order to find how much light is emitted by the lamp between any two zonal angles, multiply by 2π the distance between the projections of those angles on the line QQ′.

A comparison is made with the Rousseau diagram in this and other cases where the distribution is not symmetrical, showing that the new method gives at least as great a degree of accuracy.

THE BRAKE PROBLEM AS AFFECTED BY EFFICIENT SANDING APPARATUS.

During the last few months we have described two new types of ramcar brakes which have been designed to minimise the risk of tramway accidents caused by cars getting out of control. These types were the Maley electro-mechanical track brake, which is being fitted on the cars of the Leeds Corporation, and the groove skid-brake, designed by Mr. Pringle for use on the Burton-upon-Trent tramway system, whilst many other types have been brought forward during recent years. The brake problem is, however, being dealt with on different lines in the case of the Liverpool Corporation tramways, and instead of adopting an additional brake, Mr. C. W. Mallins, the general manager, has paid attention to the rendering of existing brakes more efficient. With this object in view



MALLINS' IMPROVED SANDING APPARATUS.

he has introduced a greatly improved sanding apparatus, which should render it practically impossible for the motorman to skid the wheels by violent application of the brakes. It is known that if the electric controller is switched rapidly over to the highest braking notch whilst the car is running at a high speed and a rapid emergency stop is required, the wheels skid on the rails when the usual sanding arrangements are adopted. Mr. Mallins, however, has designed his sanding apparatus so that the rate at which sand is deposited on the rails can be doubled in the case of an emergency stop. We briefly referred to this apparatus in our issue of April 12, 1907, and are now able to give further particulars concerning its operation.

It will be seen from the diagram herewith that a pawl, Q, limits the downward movement of the sand pedal P in normal operation, a sliding shutter allowing the sand to pass only into the discharge funnel from the hopper A_1. If, however, the motorman kicks the pawl to one side, a further downward movement of the pedal is possible, causing the shutter to uncover a second opening for the discharge of sand from hopper A_2. In the arrangement illustrated both discharges of sand are made into the same funnel; a modified form, however, is now being adopted, in which two funnels are fixed and each shutter discharges independently.

A point where most sanding apparatus fails is in providing for the case of a car running backwards downhill. When such an occurrence takes place, the motorman is practically helpless, since sand can only be applied in front of the descending car wheels from the conductor's platform, on which the sanding apparatus is usually rendered inoperative by the removal of the operating pedal. It will be seen, however, from the diagram illustrating the sanding gear now being fitted on the Liverpool Corporation cars that a further movement of the sand pedal is possible; thus it may be pressed forward as indicated by the dotted line. This movement as will be seen, opens the shutters of the rear sand hoppers and enables the motorman to apply sand under the wheels of the car should the latter start to run backwards. This is a most important provision and the simplicity of the arrangement is one of its most striking features.

We were recently permitted by Mr. C. W. Mallins to witness some tests carried out on two of the most severe gradients on the Liverpool tramway system. The rails on which the tests were made were in a greasy condition and the car was allowed to run both forwards and backwards. The braking was exceedingly powerful, the car when running downhill at about 18 miles an hour being brought to rest in about 20 ft. This was accomplished by switching the controller on to the highest braking notch and applying sand at the greatest possible rate. Although the retardation was obviously very high, we were unable to observe any skidding of the wheels, which apparently was prevented by the large amount of sand applied.

So satisfactory has this sanding apparatus proved in practice, that the whole of the Liverpool Corporation cars, 500 in number, have been so fitted, and it is hoped that by this means the number of accidents will be considerably reduced.

THE RESISTANCE OF ALLOYS.*

BY W. GUERTLER.

The resistance of metallic alloys and its temperature coefficient depends upon the presence or absence of crystalline structures within the mixture of the two metals. If there is no chemical combination between the metals, and no mixture-crystals are present, the resistance is, within narrow limits, the arithmetic mean of the resistances of the two constituents present. Its dependence upon temperature and concentration may be represented by the diagram (Fig. 1, *a*). At the absolute zero of temperature the resistance is supposed to become zero.

When the alloy is capable of forming mixed crystals (*Mischkrystalle*), without, however, giving rise to definite chemical combinations, a secondary "crystalline" resistance is added to the mean resistance shown in Fig. 1, *a*. This crystalline resistance is independent of the temperature, and is connected with the concentration by a parabolic curve having a maximum at the point where the constituents become equal. The resulting surface is shown in Fig. 1, *b*. The temperature coefficients have the same relation with the concentration as have the resistivities.

Lastly, when there is chemical combination, neither of these rules can be applied. The resistance of each combination acts, so to speak, for itself, and the combination must be regarded as a new substance embedded in a mixture. That being understood, the above rules can be safely applied.

The author next proceeds to examine the laws formulated by other experimenters for the resistance of alloys. One of these is due to Matthiessen,† and another to Barus.

* Abstracted from the *Physikalische Zeitschrift*.
† *Poggendorff's Annalen*, 122, 19; 1864

Matthiessen's law is as follows: In every alloy the deviation of the resistance from the arithmetic mean is the same as the deviation of the temperature coefficient. In other words, the temperature coefficients of resistance of alloys vary as to resistivities themselves. Numerically, Matthiessen defines the temperature coefficient as the percentage loss of conductivity on increasing the temperature from 0°C. to 100°C.

Barus* replaced Matthiessen's law by another, applying to one metal at a time in combination with not more than 10 per cent. of one other metal. The law is embodied in the formula

$$c \quad \frac{a+m}{n}$$

where c is the conductivity, a the temperature coefficient and m and n constants characteristic of the original pure metal. (In platinum m is $2{\cdot}548 \times 10^{-4}$, and n is $376{\cdot}4 \times 10^{-4}$.)

The results so far available are in accordance with both formulæ. Barus operated with platinum alloys, and Matthiessen with various alloys of gold, silver and copper.

The author shows that the two equations can be harmonised by omitting the constant m as unessential, and substituting for n the ratio of a set of observed values a/c of the temperature coefficient and the conductivity. Barus' equation, then, comes to represent a special and simplified case of Matthiessen's.

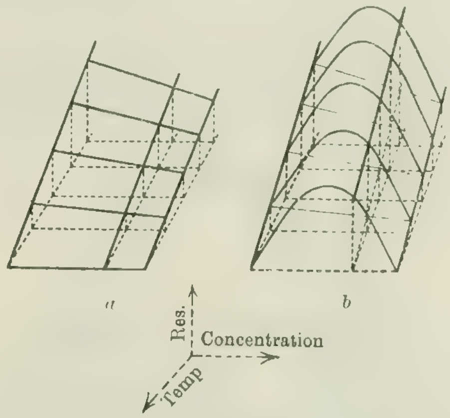


FIG. 1.

All the four metals hitherto studied (platinum, gold, silver, and copper) have the faculty of forming mixed crystals with all other metals. The question now arises whether the formula of Barus remains valid when there are no such crystals. In that case, as exhibited above (Fig. 1, *a*), both c and a vary linearly with the volume concentration, and, therefore, have a linear relation to each other. But no relation could be formulated which, with the same original metal, would give the conductivities of its alloys, whether they formed mixed crystals or not. It happens unfortunately that the four metals studied by Barus are all very active in forming mixed crystals. It must, therefore, be concluded that, while Barus' formula furnishes the shortest expression for the conductivity in certain special cases, that of Matthiessen has the wider application of the two. The author is now engaged in putting it into a still more comprehensive form.

Tests on 3,500 kw. Parsons Turbines.—According to *Elektrotechnik und Maschinenbau*, some time ago two turbines of the Parsons type, equipped with surface condensers and coupled to single-phase generators, were installed in the municipal electricity works at Frankfort. "Depreciation" tests have recently been made on these machines with the following results: Power on the electrical side was measured with an accurate wattmeter standardised by the Reichsanstalt, while the steam consumption was determined by weighing the condensed water. The temperature of steam on no occasion fell below 258°C. At full load (3,521 kw.), with a steam pressure of 10 atmospheres and a 73·3 cm. vacuum, the steam consumption was 13·7 lb. per kw.-hr. At something less than half load (1,542·5 kw.), a steam pressure of 9·9 atmospheres and a 74·1 cm. vacuum, the steam consumption was 15·6 lb. per kw.-hr. The speed of the turbines was 1,360 revs. per min. The condensing machinery took at full load 2·9 per cent. and at half load 2·5 per cent. of the dynamo output.

* *American Journal of Science*, 36, 427; 1888.

NEW APPARATUS BY MESSRS. FERRANTI.

Among the essentials of modern switchboards are the current and potential transformers for operating the wattmeters, instruments and controlling gear, which are, of course, in conformity with modern practice, all at low potential, no matter what the voltage of the board itself may be. As is well known, Messrs. Ferranti, of Hollinwood, have specialised in this matter, and their standard current and potential transformers now enjoy a high reputation for thorough reliability. A recent product of the transformer and instrument department of Messrs. Ferranti consists of a 6,000 volt three-phase 150 volt-ampere potential transformer complete with primary high-tension fuses. This transformer is contained in a sheet-steel tank, oil immersed, and is designed to have a negligible pressure drop so that it can operate a number of instruments, wattmeters, synchronising gear, and so forth.

Another recent product of the same department is the portable ampere-hour meter illustrated in Fig. 1. The meter itself is of the well-known standard Ferranti type (Hamilton patent). It is contained in a polished mahogany case with leather carrying handle, and flap for protecting the front glass. It is provided with lock and key and rubber supporting feet, and also with exterior terminals arranged with winged nuts for ease of making the connections. This portable meter should be very useful for testing house service meters in situ, and for testing motors about the works, &c.

Fig. 2 illustrates another interesting article made by the same firm. It is a double reverse current relay for continuous currents, designed by Dr. C. C. Garrard. This relay is intended for protecting the continuous current side of synchronous motor-generator sets. These sets are started from the continuous current

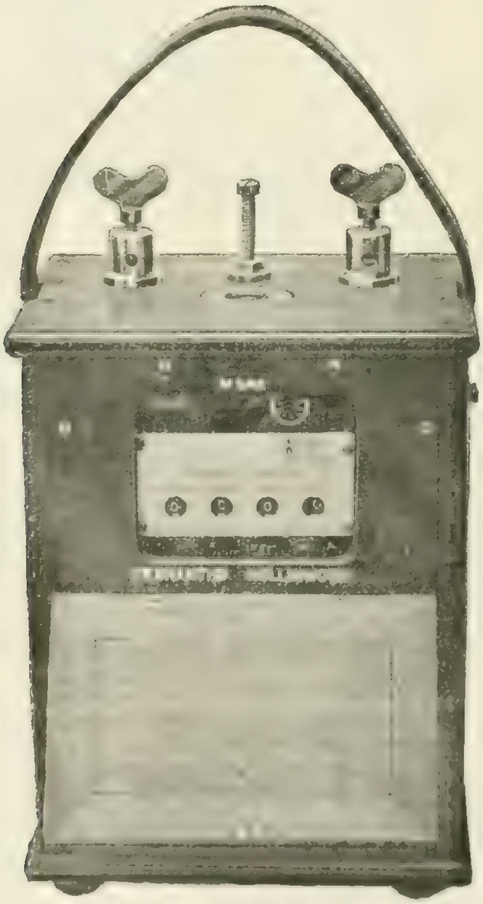


Fig. 1.—Portable Ampere-hour Meter.

side with a current equal to, say, 25 per cent. of the normal full-load current, the starting current being of course, in the reverse direction to the normal. It is necessary for the machine to be protected against taking too large a starting current. With the machine running, however, as a generator, its circuit breaker should be opened if a reversal of very much smaller magnitude than the starting current occurs. The relay, therefore, is provided with two scales. The reverse current at which it operates is given by the sum of the two readings on the scales. Ordinarily, one scale is on zero and the other scale set to, say, 10 per cent. of the full load current. In starting up from the continuous current side, the setting of the relay is increased by means of the second scale, the resultant setting being given by the sum of the two readings less 100 amperes. It is necessary to subtract this amount of 100 amperes from the sum of the two readings owing to the constant friction, which, of course, is allowed for in the calibration of each individual scale, but naturally comes in twice when the sum of the two scale readings is

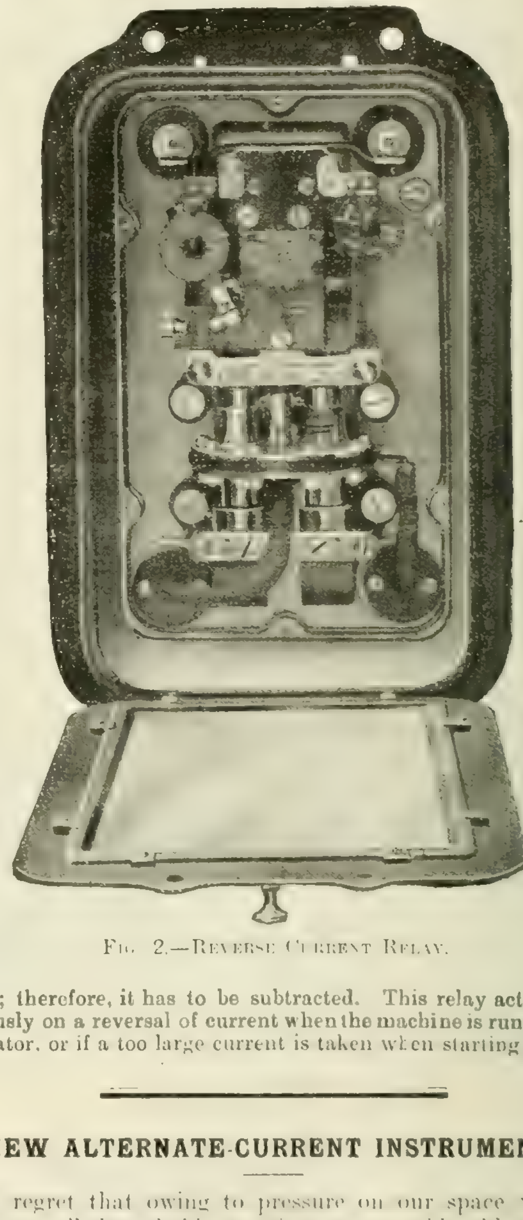


Fig. 2.—Reverse Current Relay.

taken; therefore, it has to be subtracted. This relay acts instantaneously on a reversal of current when the machine is running as a generator, or if a too large current is taken when starting up.

NEW ALTERNATE-CURRENT INSTRUMENTS.

We regret that owing to pressure on our space we have been compelled to hold over for some considerable time the following abstract of the discussion which took place at a meeting of the Birmingham Local Section of the Institution of Electrical Engineers, when Dr. W. E. Sumpner and Mr. J. W. Record read their Paper on the above subject. As this discussion is of considerable interest, we feel that it is better to give it, late as it is, rather than to omit it altogether. The Paper had previously been read and discussed in London, an abstract of it appearing in our issues of March 20th and 27th, and of the discussion in our issue of April 3rd. After the discussion at Birmingham the use of the instruments was shown, and a demonstration was also given of the use of the oscillograph.

DISCUSSION.

Dr. Sumpner, in introducing the Paper, said that the type of instrument to which their Paper referred was one in which the magnetic field was strong and quite independent of the varying properties of iron so that it was possible to get at the same time both accuracy and sensitiveness. The magnetism was controlled by the voltage and the complicated relation between magnetism and magnetising current did not at all affect the accuracy of the instrument. To secure this result it was necessary simply to make the resistance of the magnetising or volt coil small compared with its impedance. The winding was of stout copper and the reluctance of the gap reduced in every way possible. Only one air gap was used and the area of the opposed pole faces was exceptionally large. In this way it was possible to secure a magnetic field which was exactly propor-

tional to the voltage. Although this field was in quadrature with the voltage it was possible to get over quite readily any difficulties which arose through this circumstance and to utilise the instrument as wattmeter, voltmeter, capacity meter, &c. The current for the moving coil of these instruments required to be supplied from some type of quadrature transformer. The phase meter was an instrument having a polyphase winding producing a strong rotating magnetic field in an air gap in which a moving coil having inappreciable control was allowed to swing. The theory of such phase meters could be given simply in terms of the double wattmeter method of measuring three-phase power. If the two wattmeters in such a measurement were imagined to be mounted on a common spindle then the needle attached to this spindle would take up a position in which the forces on the two moving coils were equal and opposite, and it was easy to see that this position of balance could only depend on the phase difference to be measured.

Mr. A. M. Taylor referred to the fact that at the previous meeting, when these instruments were first shown by Dr. Sumpner, various forms of electromagnet had been used, including some placed in series with the main circuit. He asked whether the authors still recommended this type.

Mr. J. P. Kemp wished to know whether they had given any attention to wattmeters of the integrating type. Could existing current transformers be used when applying these instruments, or was it essential that they should use the particular type shown by Dr. Sumpner? In view of the very small amount of room available for instruments on modern switchboards, he asked whether these instruments could be made up in the edgewise pattern.

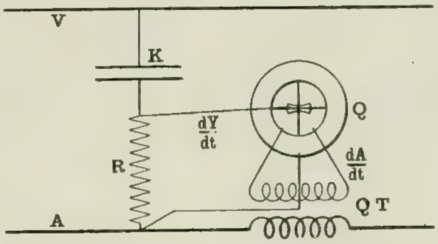
Mr. J. D. Coales asked Dr. Sumpner if he would give some idea as to how much current could be taken from the secondary of a quadrature transformer without appreciably reducing the phase-difference between the primary and secondary currents below 90 deg. He had tried the experiment of connecting the main coil of an ammeter transformer in series with the current coil of a wattmeter, and the secondary winding to the pressure coil of the wattmeter. On sending current through the transformer the wattmeter gave a considerable reading, thus showing that the primary and secondary currents were in this case not in quadrature. The secondary winding of the transformer had several hundred turns and the wattmeter pressure coil a resistance of several thousand ohms.

Dr. D. K. Morris referred to an explanation given previously by Dr. Sumpner of the action of his phase meter which appeared to be more simple than the theory now given. It was clear that a coil carrying alternating current and placed in a revolving field, but otherwise not subject to control, could only take up a position such that at the moment of maximum current flowing in the coil the field where the coil found itself was zero. If the coil were in any other position then it would naturally tend to be deflected into that position. This theory seemed quite simple, but as Dr. Sumpner did not give it, he would like to know if he regarded it as unsound. He also asked if the indications of these phase indicators or power-factor meters depended upon the wave form, so that calibration would be erratic at certain particular phase indications.

Mr. J. W. Record referred to the instrument when used as a capacity meter, and said that it had this great advantage over other methods of measuring capacity that the leakage current, if any, through the condenser had no effect whatever on the indication of the instrument. In cases where the capacity was small it was desirable to use a dividing method by which high pressure was used on the capacity to secure sufficient capacity current and low pressure on the instrument.

Mr. W. Brew said that the instruments described by the authors were of both the switchboard and portable type, and, although it might be argued that little difference need exist in these two classes of instruments, in practice the duty expected of them might differ considerably. Considering switchboard types of instruments, such as were required by alternate-current stations working at extra high pressure, it was to be noted that the instruments of primary importance at the power station were those to record pressure of supply and units generated, and from a purely commercial point of view it was of great importance that the power station be equipped with voltmeters and wattmeters giving readings reliable within 1 to 2 per cent. under all working conditions. Since upon measurements of power depended bonus, payments or heavy penalties to contractors, extra expense should not be grudged if really reliable instruments could be obtained. The wattmeters described by the authors were of the directly indicating type. The usual practice hitherto in the equipment of alternating-current stations had been to provide watt-hour meters upon each generator, such instruments possessing the advantage of indicating at once the units generated in any given interval. The powerful and positive action of the wattmeters described by the authors, combined with the fact that they were unaffected by wave form, frequency, &c., should specially fit them for service as recording instruments or watt-hour meters. As regards ammeters for indicating amperes per phase on each generator or the approximate share of the load when one or more units were running in parallel, the practical conditions were not so exacting, and consequently cheaper and less accurate instruments could generally be employed. The same remark held good to probably a greater extent as regards ammeters upon feeder panels. An accurate and reliable type of synchroniser was, however, of great importance, and here again expense should not be spared. The application of measuring instruments to extra-high-pressure switchboards, as sometimes carried out at present, was from the station engineer's point of view not altogether an unmixed blessing, the chief cause of uneasiness arising from the necessity of a number of high-pressure connections to 'bus bars, the integrity of which the engineer could not afford to endanger. Standardisation with regard to instrument transformers was most essential. With extra-high-pressure supply at, say, 10,000 or 20,000 volts it was almost impossible to prevent static discharges between some portions of the switchgears insulators &c., and the consequent production of ozone to some extent. The disastrous effect of ozone upon the rubber cable connection generally used for instruments had of recent years been proved in many instances, so that such connections should be avoided as far as possible upon extra-high-pressure switchboards.

Prof. E. Wilson (communicated) presented the accompanying diagram, representing a wattmeter, devised by one by his old students (Mr. W. H. Wilson), of the electro-static type. The moving system of the electrometer Q is connected to the ends of a non-inductive resistance, R, which is in series with a condenser, K, across the supply mains. The quadrants of the electrometer are connected to the terminals of the secondary circuit of a quadrature transformer, QT. He showed that, provided V and A were sine functions of the time, this wattmeter and Dr. Sumpner's had equivalent quantities impressed upon them for torque production. He thought Dr. Sumpner was to be congratulated, because he was able to apply his knowledge of mathematics to a problem without making any experiments at all, and therefore he thought the younger members of the Institution ought to keep their mathematics well before them, and look upon them as a very valuable tool which could be brought to bear upon problems in time of need. He emphasised the following points in connection with the working of the instruments: (1) Comparing quadrature with



ordinary current transformers, the safety with which the secondary circuit could be broken in the first case, but not in the second. Also the simplicity of construction and adjustment of the quadrature transformer was in its favour, especially for ordinary laboratory use. (2) The combination of a wattmeter with a voltmeter was valuable, especially in the case of a portable instrument, and it might be noted that the range as a voltmeter could be easily varied by charging the capacity of the condenser. (3) The instrument was easily adapted for the comparison of capacities and mutual inductions.

Dr. Sumpner, in reply to the discussion, said that with reference to Dr. Morris's remarks he had ultimately given up the simple theory of the phase motor dependent on the assumption of a true rotating field, because it was not found accurate enough. All phase motors for three-phase circuits were quite correct on all wave forms if they were properly calibrated, and if the three line currents were equal. They were also correct on all frequencies. With regard to Mr. Coales' remarks, it was unfortunate that wattmeters generally got the blame for the considerable errors which really arose through the current transformers. In practice it was often the case that it did not much matter whether a good or bad wattmeter was used, since the current transformer would introduce far more serious errors. Replying to Mr. Kemp, they had not yet got edgewise instruments or an integrating wattmeter on the market. Ordinary current transformers could be used with the new instruments to supply current to the quadrature transformer, which latter must be regarded as the current coil of the wattmeter. Replying to Mr. Taylor, the result of four years' experience was such that they could not recommend the use of series electromagnets for wattmeters. He claimed for the instruments that they were more robust than any alternating instruments having the same accuracy. He thoroughly agreed with Mr. Brew's communication. The remarks about the commercial importance of accurate measurements on alternate-current circuits were very much to the point.

BOOKS RECEIVED.

(Copies of the undermentioned works can be had from *The Electrician* office, post fee, on receipt of published price. Add 10 per cent. for abroad or for foreign books).

"Natural Sources of Power." By Robert S. Ball. (London: A. Constable & Co.) 6s. net.

"Electro-Metallurgy." By J. B. C. Kershaw. (London: A. Constable & Co.) 6s. net.

"Telephones: Their Construction, Installation, Wiring, Operation and Maintenance." By D. H. Radcliffe and H. C. Cushing. (London: Crosby, Lockwood & Son.) 1s. 6d. net.

"The Engineering Index for 1907." (London: "The Engineering Magazine.") 10s.

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SINGLE-PHASE TRACTION.

Less than eight years ago an important Paper on "The Supersession of the Steam by the Electric Locomotive" was read by the late Mr. W. E. LANGDON before the Institution of Electrical Engineers. To-day we see the partial realisation of Mr. LANGDON'S hopes, and it is interesting to observe that this has been brought about on the very railway with which he was so long associated. True it is that the mode of accomplishment is very different from that forecasted, but still it cannot be denied that the working of some 21 miles of single track on a single-phase system is one of the greatest advances which has yet been made in this country in the supersession of the steam locomotive. Mr. LANGDON'S scheme involved three-phase generation, with sub-stations for conversion to continuous current, to be used on a third rail. Subsequent experience has shown that this plan, while suited to short underground lines, is out of the question for the great trunk lines of this country. Indeed, this fact was predicted by speakers in the discussion. At that time, of course, the single-phase motor suitable for running trains was not within the range of practical politics, but patient experiment and research have at last provided a machine which appears to possess all the required qualifications to an admirable degree. The fact is that the system works well in practice, and ultimately that is the true test of efficiency.

Last week we referred in an Editorial Note to the single-phase working of the Heysham-Morecambe-Lancaster section as being the first example of its kind in this country. There are, however, many instances in America and on the Continent of Europe, while the London, Brighton & South

Coast Railway is now at work upon the conversion of a portion of its suburban lines. In fact, the directors of the London, Brighton & South Coast Railway decided on the adoption of the single-phase system some considerable time before the Midland Company made known their intentions, but it will be appreciated that the difficulties in electrifying a London suburban railway are enormous as compared with those of a terminal line in open country. Moreover, the equipment is necessarily much more extensive for handling this suburban traffic than in the case of the Heysham line. Thus it is that the electrified section of the London, Brighton & South Coast Railway Co. will not be operated for, say, another two months, whereas the Midland Railway Co. has got to work and has brought to fruition the seed sown by its late telegraph engineer eight years ago. For this reason, the results achieved on the line will be noted with special interest. At present it is too early to expect exhaustive test details, as all concerned have been working at high pressure merely to get the line running, but some rough figures will serve as a guide. Dealing first with acceleration, there is nothing left to be desired. On the level, and with a train of average weight, the acceleration is as high as 3 ft. per second per second, which is probably about three times as good a figure as that obtained under similar conditions with steam. At Lancaster station there is a very severe gradient—about 1 in 100—combined with a curve of 10 chains radius; here it becomes a matter of extreme difficulty—sometimes of impossibility—for an ordinary train to start with its own single locomotive. On the other hand, an electric train having a total weight of 165 tons, about equal to that of a steam train, started at this point and moved off with an acceleration of about 1 ft. per second per second. This performance is at least twice as good as that of a steam locomotive. But it is by no means certain that great and continued acceleration is desirable on this electrified portion of the line. This is not merely because there are no stations intermediate between Heysham, Morecambe and Lancaster, but from the point of view of economy. Under normal working conditions it is found that by bringing the controller up to the sixth (top) notch it is possible to switch off entirely exactly half-way between Heysham and Morecambe, the total distance being 5 miles. The brake has to be applied when rounding the curve into Morcambe station in order to keep within the speed limit, but otherwise no braking is done until the train enters the platform. This method gives high acceleration throughout the first part of the journey, and if velocity be plotted against time we get a curve having a fairly sharp peak, and very nearly, but not quite, symmetrical. If now, instead of going up to the sixth notch, the controller be taken up to the fourth or fifth notch only, and the power kept on after passing the half-way point, we obtain a curve having a distinctly flatter peak. It remains to be seen whether the latter method will prove the more economical of the two, and there is reason to believe that it will.

No exhaustive tests of energy consumption have yet been made, but it is likely, judging from rough approximations, that it will not exceed 30 watt-hours per ton-mile, the maximum speed being about 55 miles per hour. This is, of course, a very low figure and is of the utmost importance. Indeed, so far as main line working is concerned, it is far more important than high acceleration.

Looked at from a broad point of view, and admitting the superiority of single-phase over any other existing form of traction in relation to bare running costs, so far as main lines are concerned, there still remains the great problem of first cost. Railways are, after all, business concerns, often burdened with enormous capital upon which it is a matter of no little difficulty to pay a satisfactory dividend. Is it likely that railway directors will risk increasing the capital in order to secure improved working conditions? The answer largely depends upon the result of the Midland Railway's experiment, for experiment it must be designated. Both from an engineering aspect and from the financial aspect it is experimental. Nevertheless, the scheme has evidently been designed as the basis of a permanent experiment. Much depends on its success or failure—to the engineer its success is apparent, while to the financier it is still a matter of doubt. While we offer most hearty congratulations to the Midland Railway on its courage in attacking a difficult problem, perhaps we might suggest that the financial outcome could have been more definitely assured. It is proverbial that English railway companies always build and construct on the principle that their buildings and constructions are erected for all time—that is to say, that everything they do is of a permanent nature. This is obviously an excellent rule, but it is sometimes capable of being carried too far. It is possible that the Midland Company have overstepped the mark in the way of their overhead construction. After making all allowances for the severe weather conditions which are often experienced in the Morecambe district, there is still reason to think that the work might have been carried out with no less efficiency and at much less expense. This is a matter of the greatest importance, for the expenditure involved in the construction of the overhead work must and will have a very marked influence on the development of the system, not only on the Midland Railway, but also on other lines. In many instances side-bracket construction might have been employed, and probably half the lattice girder work might have been dispensed with by raising the standards 3 ft. or 4 ft. and making the spans greater. Naturally, opinions differ regarding matters of this kind, but, on the whole, it will probably be agreed that more money has been spent on the overhead construction than was absolutely necessary.

This, however, can scarcely be said of the generating plant which gives evidence of much forethought and is most excellently suited to the purpose. The motor-generators are really beautiful machines, as will be gathered from the description which we shall give of them, and from the conditions laid down in the specification which they fulfil.

With regard to the rolling stock there is little to be said beyond what appears in our description. The chief difference is that in the cars supplied by Messrs. Siemens Bros. Dynamo Works the control is entirely electric, whereas in that of the Westinghouse Co. it is electro-pneumatic. In both cases series motors with compensating winding are employed, and their freedom from sparking while running under exceedingly severe conditions is remarkable. The temperature has not been known to reach the limit laid down in the specification, not even on Whit Monday, when the cars

were in service almost continuously for 18 hours. Everything depends, of course, on the behaviour of the motors, and those at present in use do not give rise to the least apprehension.

A point of importance in connection with this new system is that of danger to human life. Obviously, elaborate precautions have been taken to prevent mishap, and it is probable that the arrangements are such as to make the working safer than it would have been if low-tension continuous current with a third rail had been employed. In the first place, there is no third rail at all, and, therefore, no danger to platelayers in walking along the line, or to the public at level crossings. Secondly, if any work has to be done on the electrical gear of the car it is merely necessary to lower the bow, and everything is dead at once. Hence, all apparatus below the car can be inspected without the least fear of coming into contact either with a live third rail on the ground, or with anything alive on the car itself. A detail of interest is the large brass tube which carries the high-tension conductor from the bow to the transformer. This tube is exposed to the touch of passengers inside the car, and although it is thoroughly earthed yet we should prefer it to be out of reach.

In conclusion we would emphasise the importance of this undertaking, the opening of which marks an epoch in the history of English electrical engineering. It is typical of the kaleidoscopic changes which have taken place in electric railway and tramway practice, and probably many will feel that it sounds the death knell of the continuous current third-rail system for railways of this class.

REVIEWS.

(Copies of the undermentioned works can be had from *The Electrician* Office, post free on receipt of published price. Add 5 per cent. for abroad or for foreign books.)

Flying Machines. By A. W. Marshall and Henry Greenly. (London: Percival Marshall & Co.) 1s. net.

This little volume purports to give a popular account of flying machines, dirigible balloons, and aeroplanes. Considering the large amount of interest which is being taken at the present moment in aeronautics this little work should be widely read. The student of the subject might do worse than keep it as a general guide to the work which has been done in this fascinating branch of science. We fear that electricity as a motive power does not figure to any great extent in the descriptions of machines dealt with apart from the matter of ignition. The great portion of this little book is devoted to machines heavier than air. By giving so much space to this type of machine we think the authors have acted wisely. They have, moreover, confined themselves to actual work accomplished, and have not been carried away by certain exaggerated statements, which so frequently become associated with flying machines. Full credit appears to have been given to the best known men who are working in this field. The references to Prof. Langley give one the impression that that eminent scientist is still living. It is also stated that a man carrying machine was successfully flown by the late lamented professor. We were under the impression that nothing heavier than a model had made free flight, a fact which is confirmed by the stated weight of the machine, which is given at 30 lb. Obviously it is the model which is referred to. Since the publication of the book a great deal of experimental work has been carried out by numerous aero-engineers, but doubtless particulars of these will be included in a future edition. The publishers have earned the gratitude of all aero experimenters by collecting so much useful information within so small a compass and publishing it at a popular price.

Lezioni di Elettrotechnica. By Luigi Lombardi. Vols. I. and II. (Naples: F. Giannini & Figli). Pp. xv. 555 Pp. xvii. 563.

This work is based on a course of lectures delivered by Professor Lombardi in the higher polytechnic school of Naples to a class of electrical engineers. The first volume contains the lectures on generators, continuous and alternating; and the second those on transformers, motors, accumulators, electric lighting, and traction. They are large octavo volumes exceedingly well printed and got up in limp bindings.

Professor Lombardi's style is scholarly and lucid. The illustrations are only diagrams, and there is little algebra, and that simple. The whole is a connected account of the subject, somewhat in the form of a series of essays. The author disclaims any originality of treatment or method, and the list of authors consulted or referred to is very brief.

A few years ago so clear and comprehensive an account as this of its subject could hardly have been written, and the work is a good example of the old doctrine that the progress of a science is marked by improvement in its elementary treatises; and though this adds little to the equipment of a professional engineer, it is an excellent handbook for college students who require a connected survey of the whole matter. We have read with care the chapters on some of the more difficult questions, which may be regarded as test subjects of a treatise, such as those on commutation, armature reaction, and the different properties of shunt, series, and compound wound motors. With progress of time, methods of teaching the subject will be improved, and opportunities for advance are clear enough; but it would be difficult at the present day to point to a work of the same scope much better than this of Prof. Lombardi.

Handbuch für den Bau und die Instandhaltung der Oberleitungsanlagen Elektrischer Bahnen. By Arthur Ertel. Vol. XLII. of "Bibliothek der Gesamten Technik." (Hanover: Dr. Max Janecke) Pp. vi.-334. M.4·20.

A large amount of useful and reliable information of a practical character will be found in this pocket-book on the erection and maintenance of the overhead equipment of electric tramways. The subject matter is clearly and concisely explained with the aid of a large number of excellent diagrams. There are 12 chapters, of which the first two are of an introductory character giving a slight historical sketch of the subject, and a cursory outline of the different systems of traction. The various sections are preceded by the rules of the different German authorities bearing on the subject under discussion. The determination of the conductor resistance, rail resistance, drop, and load at any point from the route diagram are contained in Chapters III. and IV., which also include useful remarks on the data required for planning an overhead system, and on the selection of the method of suspension of the line conductor.

The method of construction of the overhead conductor, which is chiefly discussed, is the span wire construction for the sliding bow collector, so largely in vogue on the continent, although the differences in construction for the trolley system are explained and illustrated. Chapter V. is of special interest on account of the very complete manner in which this subject of span wire construction is handled. Worked out examples and diagrams are given which greatly assist in the application of the necessary formulæ included in this section. Chapter VI. is on the line material—poles, bracket arms, rosettes, ears, pull-offs, to enumerate only a few. The line and return feeders are next dealt with in Chapter VII. which also gives information on feeder pillars, junction boxes, feeding points and cognate matters. Chapters VIII. and IX. explain various protective devices for safeguarding telegraph and telephone wires and special line construction. Chapter X. is divided into two main sections—the erection of the overhead equipment, and its maintenance in which are given useful practical hints on the erection of poles, supports, brackets; on the suspension, adjustment and soldering of the overhead conductor, installation of turn-outs, crossings, lightning arresters; on insulation testing, inspection and methods of procedure in case of accidents, together with descriptions of tower wagons and the various tools used in constructional work. Chapter XI. is a short one

containing some details of special overhead work used on the continent in connection with high speed railways, and the final chapter gives tables of moments of inertia for different sections of iron masts. The book has an index and a detachable set of forms for the entry of notes relating to the track.

It forms a useful addition to the literature of the subject.

Town Gas and its Uses. By W. H. Y. Webber. (London: A. Constable & Co.) Pp. viii + 275. 6s. net.

At first sight it would appear that for an electrical engineer to review this book, with the calm judgment which should always be present when works of this kind are taken up, would be frankly impossible. And we wondered a little, on receiving it, at Messrs. Constable's temerity in thus placing their heads in the lion's mouth. On reading the book, however, our opinion changed, for very little controversial matter is introduced. Certain figures, it is true, might lead to heated arguments, but, as the author remarks, a comparison of gas and electric light admits of no general answer.

Mr. Webber treats his subject in an exhaustive manner and the result is an eminently readable book. After dealing with the history and manufacture of town gas and the bye-products of gas manufacture, various forms of fittings and apparatus are described. The chapter on practical gas lighting, takes up the question of illumination, and is well worth study, being applicable also in many ways to electric lighting. Chapters on the cost of gas lighting, heating and warming by gas, and cooking by gas follow, while concluding chapters deal with the healthfulness and safety of gas, gas for power generation, and the legal position of gas suppliers.

The chapter on healthfulness and safety of gas puts forward the views of hygienists of the Prof. Vivian-Lewes type, who believe that the combustion of gas improves the ventilation of a room. Far from vitiating the atmosphere, it is said that carbon dioxide exercises a purifying effect, though it cannot be expected that electrical engineers will altogether endorse this opinion. The book can be recommended to those who are anxious for fuller information of the doings "in the enemy's camp." It is, however, not altogether technical, and may be looked upon as a contribution to the active propaganda now being prosecuted by gas engineers.

Ruhende Umformer (Transformatoren). By Victor Bondi. Vol. XL. of "Bibliothek der gesamten Technik." (Hanover: Dr. Max Jänecke.) Pp. 142. M.2.

This is an excellent, up-to-date little treatise on the principles, design and construction of alternate current transformers, in which the subject has been treated in a simple and practical manner.

The book is divided into two main sections, of which the first, under the heading "Introduction," is devoted to theoretical considerations of an elementary character dealing with the magnetic field, the production of an E.M.F., three-phase currents, self-induction, phase displacement and alternating current power of single, two and three-phase circuits. The necessary equations and usual vector diagrams are given, and this part of the subject is contained in the first five chapters.

The actual matter dealing with transformers is given in the second portion of the book. It starts with Chapter VI., in which the fundamental idea of a transformer, the ratio of transformation, and the shell and core types of transformers are briefly explained.

Chapter VII. discusses the behaviour of a single-phase transformer on open circuit, on non-inductive and on inductive loads; the effect of a stray field and short circuit; and the methods of calculating the iron and copper losses and the efficiency. Chapter VIII. is on three and two-phase transformers. In the two following chapters the construction, calculation and design are given, and in Chapter XI. a three-phase lighting transformer of the core type is worked out in detail. The remaining three chapters contain further information on transformer connections, special transformer types and the erection of transformers in buildings, in the open, in transformer kiosks, pits and sub-stations. The book is profusely and well illustrated and should prove of considerable value.

POLYPHASE INDUCTION MOTORS: THE CHOICE OF TYPE.*

BY G. STEVENSON.

Summary.—The author describes the characteristics and operation of "squirrel-cage" and "slip-ring" induction motors, showing that in most cases, by suitable mechanical arrangements, the former type of motor can be satisfactorily installed. He also considers the regulations issued by supply authorities in connection with "squirrel-cage" motors.

Experience in the industrial application of electrical energy has shown that, so far as possible, it is desirable (1) to eliminate all energy consuming links between the motor and its work; (2) to adopt standard sizes of motors; (3) to use as few such sizes as is consistent with economy in the initial outlay and in the ultimate operation of the plant. These considerations are now universally recognised. There is, however, a fourth point worthy of more careful study—namely, the attainment of greater simplicity in the electrical part of the equipment. This can now be more easily attained, on account of the greatly extended use of two and three-phase motors. There are two classes of induction motors to choose from: (*a*) those with short circuited or "squirrel-cage" rotors; (*b*) those with slip-ring or wound rotors.

The advantage, as regards cost, lies with the "squirrel-cage" type, more particularly as if starting gear is included. With respect to relative weights there is not much difference, the squirrel-cage machine being only about 3 per cent. lighter. The efficiencies, power factors, and overload capacities, however, are slightly higher for the squirrel cage type, but the outstanding feature in the general comparison is undoubtedly the extreme simplicity of the revolving element, which consists of nothing more than a number of copper bars parallel to and surrounding the shaft and embedded in an iron core, with their ends connected by rings. As compared with class (*b*) rotor, it will be seen that the absence of moving contacts in class (*a*) machine—which makes it absolutely sparkless, and therefore specially suited for operation in mines, or mills where dangers from explosive mixtures or gases exist—is a conspicuous advantage. Moreover, the robust construction of the rotor, due to the entire absence of coils and their attendant insulation, is a characteristic of this class of motor which appeals strongly to the mechanical engineer. It would, therefore, appear that class (*a*) motor should be installed in every case; but, unfortunately, it has the serious disadvantage that unless suitable precautions are taken on starting up, a somewhat excessive current is drawn from the line, and, if the starting current is reduced, then the starting torque is diminished in proportion. There are several excellent methods of reducing the starting current, but it is still the practice of some supply authorities to prohibit entirely the connection to their system of squirrel-cage machines, except in the very smallest sizes.

The author some time ago made a series of tests to determine for standard motors (1) the current taken from the line at starting in terms of the full-load current, (2) the resulting torque. The machines tested were all built for operation on a 500 volt 50~, three-phase circuit. With the stators delta connected, a 2·5 H.P. motor showed a starting current equal to six times full-load current, the figures for 5, 11 and 33 H.P. being 3·75, 5·75 and 4·55 respectively. Thus, for motors above 10 H.P., switching direct on the line is out of the question. Moreover, the power factor under these conditions is of the order of 0·4.

In an appendix to the Paper the circle diagram is worked out for the 33 H.P. motor, and it is seen that the starting torque will be about 1·13 times the full-load torque, and this with a starting current equal to 4·55 times full-load current. These figures may be taken as being fairly representative of good modern machines, although by a special design of rotor it is possible to improve very considerably the results given above. The author then considers to what extent the defects of squirrel-cage machines can be overcome. He considers one of the most attractive methods of starting induction motors, when the operating conditions of the driven machinery permit, where the installation includes the generating plant, is to keep all the motors coupled up to the line and start them simultaneously with the engine and generator. It would appear advisable to have separately driven exciters, in order that the main generator may be started from rest with full voltage on the field. Facilities for starting any individual motor would also have to be provided. So far as the author knows, the system has not been adopted in this country; the only example which he has heard of being that of a cotton mill in Georgia, U.S.A.

From the standpoint of simplicity, perhaps, the next best method of starting class (*a*) machines is that patented by H. S. Meyer. The method adopted in the case of two-phase motors is to connect the stator windings in series at starting, so that the voltage per phase is only half of the line voltage, and the starting current and torque are

* Abstract of a Paper read before the Glasgow Local Section of the Institution of Electrical Engineers.

reduced to one quarter the value they would have if full voltage were impressed at the motor terminals. After the machine has run up to speed the switch is thrown over to the running position, when each phase receives its full pressure. In the case of three-phase motors they are designed for running normally on delta connection, the starting being effected by switching on to the line with the windings connected in Y grouping. By this means the voltage per phase at starting is only 58 per cent. of the line voltage, the starting current and torque being, of course, also reduced. The author has used these methods for two and three-phase machines up to 50 H.P. with excellent results. The switch is of the air-break type for motors up to 20 H.P. on a 500-volt circuit. Above this size it is good practice to use an oil break switch.

It is interesting to notice that power users are at last beginning to realise the effect of shafting and other frictional losses, and in new equipments at all events, high-class roller bearings are taking the place of the old solid pattern, with an estimated saving of from 10 to 25 per cent.

The commonest method of starting squirrel-cage machines is the use of the so-called compensator or auto-starter, which is then described. To meet various requirements, compensators for standard motors of 5, 10 and 15 H.P. are usually provided with taps for starting the motor at 40, 60 and 80 per cent. of the line voltage, with respective line currents equal to 16, 36 and 65 per cent. of the current that would be taken by the motor if no compensator were used. For larger motors compensator taps should be provided giving potentials equal to 40, 68, 70 and 85 per cent. of the line voltage, and respective currents equal to 16, 34, 50 and 72 per cent. of the current that would be taken by the motor if it were started direct from the line. The proper tap for giving maximum starting effort without causing an objectionable voltage variation in the supply circuit may readily be ascertained by trial, and permanently connected, at the time of installation.

A defect of the ordinary pattern of compensator fitted with the usual throw-over switch is that the motor may be switched straight on to the line by a careless attendant, thus causing a rush of current, which it is the object of the compensator to avoid. One type is provided with a catch so arranged that the lever at "Off" can be thrown only into the starting position (backward), and can be thrown from thence into the running position (forward) only by a quick throw of the lever. The starting switch, as a rule, is fitted in the case containing the auto-transformer, and is connected direct thereto. By separating the switch from the coils, a number of motors may be started from one auto-transformer, thus saving the expense of installing individual compensators. A throw-over switch is provided for each motor to be started, and a three-pole compensator magnetising switch. The chief objection to the compensator as a starting device is its excessive cost, this being usually about one-third the cost of the motor. Furthermore, it has been found that under actual working conditions cases frequently occur of coils being burned out, due to the switch being left in the "starting" position. Some makers use a resistance in the stator circuit for starting up, but the method is not advisable, since the current is only reduced in proportion to the reduction in the voltage, while the torque is reduced as the square of the voltage.

Numerous attempts have been made to increase the starting torque per ampere, or "specific" starting torque of class (*a*) motors, while preserving its characteristic features of simplicity and robust construction. Among the more interesting may be mentioned: Boucherot's* three methods—use of component rotors, movable stator, and phase transformer; Hobart* (utilisation of skin effect); Zani* (use of inductance coils). More recently Hunt† has devised a cascade arrangement. None of these methods, however, with the possible exception of the last named, appear to have attained to any degree of commercial importance, in this country at least; and, in the author's view, the problem ought to be approached from the opposite standpoint—that is to say, that, instead of designing the motor to suit the conditions, arrangements should be made to permit the installation of the ordinary simple squirrel-cage machine, for example, by a friction clutch, a coil type of which is described.

The author's experience in mining work leads him to affirm without hesitation that the squirrel-cage motor, whenever the conditions permit of its application, is superior to any other type. Of course, there are difficulties in the way of its application to the various power requirements of a coal mine, but they can generally be overcome by suitable mechanical arrangements. Take, for example, the case of haulages. The three systems in general use—that is, direct haulage, main and tail haulage and endless rope haulage—can all be operated quite satisfactorily by means of squirrel-cage machines in combination with suitable clutches. Of these three systems the last named is the easiest to operate in this way, because it is not necessary to start and stop at frequent intervals. The speed of the motor can also be kept constant, since the gear is usually designed for a uniform rope-speed of about 2 miles per hour. The best position for the clutch is direct on the haulage drum, because the motor can then be quickly relieved of its load should the tubs chance to come off the road. Examples of the application of squirrel-cage motors to direct and endless-rope haulage systems are shown.

* Hobart, "Electric Motors," pp. 256-[illegible]

† *Journal* I.E.E., Vol. XXXIX., p. 648, 1907.

The various types of pumps in use for mining purposes can also be readily arranged for driving by this class of motor. In the case of three-throw pumps, a bye-pass valve can be fitted, thus enabling the motor to start up light. With respect to centrifugal pumps, which are now coming so rapidly to the front for high-lift duty, it is quite a simple matter to make provision for starting the motor under light load. All that is necessary is to insert a sluice valve in the rising main near to the discharge side of the pump. By closing this valve, starting may be effected with about one-quarter to one-third of full-load torque. The author has used this method with motors of the squirrel-cage type up to 100 H.P. As regards coal-cutting machinery this class of work is probably the most difficult to tackle by any type of motor, not merely on account of the requirements at starting, but also because of the excessive vibration and overloads and rough usage generally to which such machines are subject. The squirrel-cage motor is peculiarly suited for these conditions, and is now largely used for driving the various types of coal-cutter. As regards the starting arrangements, some makers rely on the ordinary compensator only, without making provision for relieving the motor of load. Others adopt a suitable device to enable the motor to start up light. Any arrangement which permits the rotor to make several revolutions before taking up the load will help to reduce the evil effects on the supply voltage due to an excessive rush of current at starting. Such an arrangement has been devised by Holiday.*

In some cases it is found that the ordinary form of low resistance rotor with copper bars does not meet the requirements. It can be shown that the starting torque of an induction motor is increased by an increase in the resistance of the rotor windings. Hence by making the rotor bars of higher resistance, the specific starting torque may be increased. To take for example the 33 H.P. motor, to which reference has already been made, by making the rotor with 66 per cent. higher resistance, the starting current would be reduced by 3 per cent., and the starting torque would be increased to 1·75 times full-load torque. The increase in the resistance of the rotor naturally causes greater C^2R losses, so that this means a lower efficiency, but the difference is such as in many cases to be well worth the advantage gained in respect to the starting qualities of the machine. In the case under discussion, the efficiency would be reduced by 2 per cent. The power factor would be slightly increased, so that the reduction in the apparent efficiency—which is the really important point—would be slightly less than 2 per cent. A larger starting torque can be obtained by temporarily inserting resistances in the rotor. In class (*b*) motor the revolving element consists of a laminated iron core with a polar winding insulated and arranged similarly to the stator winding. The rotor coils are usually Y connected, and their terminals taken through a hollow shaft to connector rings on which rest carbon brushes supported by the usual spring holders. By means of a rheostat, external to the motor, suitable resistances can be inserted in each phase at starting. The available starting torque with this type of motor can be anything up to the maximum, that is, normally about twice the full-load value, but in special cases up to three times. In those cases in which no speed regulation is required, provision is usually made to short-circuit the winding in itself, instead of through the brushes and rheostat leads, so soon as the motor has reached normal speed. In some cases a brush lifting device is also provided with the object of reducing the wear and tear on brushes and rings. In the author's view, however, this latter refinement is unnecessary for most ordinary purposes, and usually gives more trouble than it is worth. In fact, practically the only trouble the author has had with polyphase motors during some five years' experience has been due to slip rings and their accessories. One advantage possessed by the slip-ring machine is the ease with which its speed may be regulated. The method, however, is analogous to inserting resistances in the armature circuit of a continuous-current motor, and is open to the same objection on the score of its inefficiency. Furthermore, any change in the load is accompanied by a corresponding change in the speed. It will be seen from the foregoing considerations that the adoption of the squirrel-cage type of motor, whenever the conditions permit, would be entirely in accordance with the dictates of good engineering. The choice of type, however, depends sometimes on the supply authority; the author has, therefore, obtained the rules of the principal companies and corporations supplying polyphase current. Some of the figures are given in a table, and show great diversity. As a matter of fact, however, the author has found that the rules of the various power companies need not be too rigidly interpreted. The table shows that the power companies are more favourably disposed towards the adoption of class (*a*) motors than are the various local authorities, and in this respect, and speaking purely from the power user's standpoint, they would seem to be doing better work. Among anomalies in the way of rules which the author has encountered are:—(1) The power factor of any motor must not fall below 0·8, (2) before

* *Journal* I.E.E., Vol. XXX., p. [illegible]57, 1901.

any application for power can be accepted the name of the maker of the motor must be stated. With reference to (1), the power factor is a function of the load, and with respect to (2) it is surely not within the province of the supply authority to interfere in this connection.

It is important to choose a motor which shall not be too large for its work, because the power factor falls off very rapidly with reduction in load. The overall power factor for an installation depends on the amount of attention which is given to these considerations in the initial stages of the scheme. In actual practice it is customary to assume a figure of 0·8 for general industrial plants and 0·75 for mining installations. The author's experience tends to show that it takes a load of a very steady nature, together with a very well laid-out plant, to attain a figure of 0·80 in actual every-day operation. This is probably only attained under the most favourable circumstances in a textile or similar plant. In conclusion, the author ventures to affirm that electrical engineers in general are too apt to attempt a solution of each and every problem by electrical means and without sufficient consideration of the case in its mechanical aspects.

An appendix contains the experimental determination of the circle diagram for a 33 H.P. induction motor and a note on the measurement of watts and current at "standstill."

DISCUSSION.

Mr. C. McMillan thought that, for purposes of comparison, Mr. Stevenson might have added a third type of motor—the internal-resistance motor. He admitted that the most important point about the squirrel-cage type was the small amount of copper and resultant decrease in cost. Commenting on the coil friction clutch, he emphasised the fact that the most important point in the design of such was some method of dissipating the heat generated by the gradual application or engagement of the clutch.

Dr. Nicholson stated that he had recently been carrying out some experiments in the James Watt Laboratory with a 10 H.P. motor, and found that the saving, using ball bearings as against ordinary, was 10 per cent. Taking into account the total friction, the saving with ball bearings with shafting would be at least 25 per cent. The circle diagram which Mr. Stevenson made use of was, he thought, unreliable.

Mr. W. B. Hird said squirrel-cage motors undoubtedly were superior to the slip-ring type, not only from the maker's, but also consumer's, point of view. They also had a better power factor. He had no experience of clutches, but, if he took common report to be correct, he fancied it was just as well. He also drew attention to Mavor's patent "Spinner" motor, in which the stator winding was free to rotate until full speed was attained, when the load was gradually applied. This type was, in his opinion, a very much simpler and better arrangement of motor.

Mr. W. J. Belsey thought the power factor was a very difficult thing to obtain, and, when obtained, could not be considered reliable, whereas the efficiency was easily obtained.

Mr. T. I. Craig thought Mr. Stevenson was too severe in his criticism of the slip-ring motor, and he thought the brush-lifting device, which Mr. Stevenson found so much fault with, was quite reliable.

Mr. W. H. Tittensor was of opinion that the regulations drawn up by some local authorities were too severe. He also drew attention to the difficulty consumers had in arranging plant which allowed of easy extension.

Mr. Stevenson, in reply to Mr. Tittensor, said the Y∆ motor got over the difficulty so far as easy extensions were concerned, and, besides that, it was cheaper in first cost. In reply to Mr. Craig, he pointed out that it was, of course, quite out of the question to use slip ring motors for mining work.

CORRESPONDENCE.

MARCONI'S SYSTEM OF WIRELESS TELEGRAPHY.

TO THE EDITOR OF THE ELECTRICIAN.

Sir: Mr. Raymond-Barker takes exception to my remark that "the duplex automatic system is, for long distances, only applicable to wire telegraphy at present," and says that "radio-telegraphy can justly claim to have progressed considerably further towards perfection than these words would lead one to suppose." He goes on to inform us (1) that "automatic transmission is already in use for wireless," and (2) "secondly, as regards duplex, this has already been effected." I was aware of both these facts. Mr. Raymond-Barker, however, omits to mention the distance at which automatic transmission is in successful practical operation with wireless telegraphy—which is, after all, the only point at issue. But perhaps this is because he is conscious that I have already supplied the necessary information in *The Times* Engineering Supplement of February 12th.

The rest of Mr. Raymond-Barker's remarks are on matters purely of opinion, in which he is quite likely to be right and I wrong; but no one can know with any certitude what effect over-statements in the Press have had on the public.—I am, &c.,

Westminster, June 16. Charles Bright.

THE KEARNEY HIGH-SPEED RAILWAY.

Last Saturday afternoon representatives of the daily and technical Press were invited to inspect a model of what the inventor hopes will prove to be the high-speed railway of the future. Mr. E. W. C. Kearney has, after much experimenting, designed a system in which cars are run on a mono-rail laid on the ground and are steadied by wheels running under an overhead rail. The centre of gravity of the car is kept low by the motors, and the pressure on the top guide rail is, therefore, not very considerable. On curves the position of this rail is altered to suit the speed at which the train is intended to travel round such curves, and it is also more strongly supported.

The inventor claims that derailment is impossible, although the design scarcely inspires confidence for speeds of 200 miles, such as are suggested. It is, however, to tube railways that he hopes first to apply the principle, and in such cases a rigid support for the top guide rail is provided by the roof. He also intends to do away with the necessity of lifts by bringing the trains to a platform just below the street level, from whence the train will run down a gradient of 1 in 7, so that within 20 seconds of leaving the platform a speed of 50 miles an hour will have been reached. During this time it is stated that the passengers will be unconscious of sitting on an inclined plane, owing to the forces due to acceleration exactly counterbalancing the effect of the gradient. For bringing the train to rest it has to ascend a similar gradient of 1 in 7 to each station, so that braking is practically done away with.

View showing a Model of the Kearney High Speed Railway.

Mr. Kearney claims that the cost of tubes built on his system will not exceed £250,000 per mile as compared with £500,000 for ordinary tubes, and it is stated that Parliamentary powers are to be sought next session to construct a tube in London on this system. A scheme has also been sketched out for applying the Kearney system to elevated street railways, it being claimed that, as there is only a single-bearing rail, the whole system may be reduced to a skeleton, leaving the sky view practically unobstructed. It seems to us, however, that with trains at high speeds the security provided by the overhead rail with such a construction is quite insufficient, when it is considered that the cars are continually in a state of unstable equilibrium, in contrast to that of the Behr mono-rail, where the position is stable. Also much difficulty is likely to be experienced from a gale of wind blowing against one side of the carriages.

The accompanying illustration shows a view of the model car which was run on an experimental track in the temporary buildings on the east side of Aldwych, where a public demonstration has also been given during the present week.

Such schemes are always interesting, but we fear that Mr. Kearney has considered only a small part of the subject he has undertaken to reform.

H. K. LEWIS'S SCIENTIFIC LIBRARY.

The number of text books and technical subjects is now so vast that students and engineers in every branch of applied science must welcome any assistance rendered them in the selection of standard works and text books on the subjects in which they are interested. The average lending library is liable to be deficient in the classification of its stock of technical books, unless this is specially looked after by a librarian with some technical experience. For this reason there seems a distinct need for a catalogue or list to which a student or engineer may turn and find a satisfactory and easily accessible classification of the best known technical books.

We have received from Mr. H. K. Lewis, of 136, Gower-street, London, W.C. (close to University College), a copy of the complete catalogue of his Medical and Scientific Circulating Library. Apart from the fact that this is a volume of some 500 pages, substantially bound in cloth, it will be found to be a singularly complete book of reference to the best-known books on general scientific and medical subjects. The greater portion of the book is devoted to an alphabetical index of authors and their works, an arrangement of great assistance to the reader. The majority of principal technical writers are well known by name and are easily referred to on that account. The alphabetical authors' index is followed by a classified index of subjects, and it is an easy matter to find the particular book required.

The applied science side of the library is very complete, and will bear the close inspection of engineers and electricians. Electrical engineering and allied books have been brought up to date, and we understand that every effort is made to include the latest books immediately upon publication. We notice that the Steam Turbine has received special attention, and that under this particular subject nearly a dozen books are entered. Wireless Telegraphy is also fully represented. Students of physics will find a plentiful selection of well-known books, and the subject of the microscope is well looked after. The books on Mining include recent works on the uses of electricity in this province, and there is also a good list of works on mechanics.

We may remind our readers that by the payment of a merely nominal subscription the student can borrow any of the best-known scientific books from Mr. H. K. Lewis's library. It frequently happens that students, and even engineers, are not in a position to purchase expensive books, which are, however, extremely necessary in the work which they have taken up. Lewis's Circulating Library will be found of immense service to them in removing this difficulty. The facilities at the disposal of the directors of the library are somewhat exceptional, and this fact will prove of great value to those who require information on the subject of standard technical works. Not the least interesting feature of the library, which will appeal especially to London readers, is the reference section, where any books listed in the catalogue can be inspected. The library itself is conveniently situated, and is in touch with the main railway termini, the tubes and the Metropolitan Railway, the Gower-street station practically adjoining the library. The new catalogue is issued at 2s. to subscribers and 5s. to non-subscribers. The annual subscription to the library is from one guinea per annum and can be commenced at any date.

PARLIAMENTARY INTELLIGENCE.

LONDON ELECTRIC SUPPLY BILLS.

THE LONDON ELECTRIC SUPPLY (JOINT COMMITTEE) BILL.

On Tuesday Lord Cromer's Committee commenced the consideration of the second of the three bills submitted to Parliament this session, THE LONDON ELECTRIC SUPPLY (JOINT COMMITTEE) BILL, which proposes to confer upon a joint committee of the Brompton & Kensington, Central, Charing Cross, Chelsea, City of London, County of London, Kensington & Knightsbridge, London, Metropolitan, Notting Hill, St. James', South London, South Metropolitan and Westminster Companies, with representatives thereon of the L.C.C., powers to purchase, lease, &c., the stations and works of any of the London electric supply companies or any distributing authorities, acquire land for extensions, purchase or sell electrical energy, &c., and make agreements for the taking over by the Committee of any generation stations and works, such agreements to be subject to the approval of the Board of Trade. The whole or any part of the consideration payable by the Committee by agreement with any of the companies may be satisfied by the issue to such company of the stock of the Joint Committee, such Committee, in the event of its taking over the undertaking of any company or distributing authority, to have all the rights and privileges in regard to same as the company or authority from which it is transferred. The Committee also seeks powers to supply energy to any authorised distributor, to lay mains, lines or works for such purpose and to purchase or erect and equip transforming stations. The Committee are to be compelled to give, on and after Jan. 1, 1910, supply of energy to any authorised distributor requiring same at a point within the latter's area at which it may reasonably be required at a price not exceeding £5 per annum per kilowatt of maximum demand, and 0·35d. per unit at high pressure, measured at the point of delivery at the end of the Committee's mains, the agreement to be for not less than seven years, and the annual payment to be not less than 20 per cent. per annum on the amount of capital expenditure incurred by the Joint Committee in making provision for such supply (exclusive of generating plant and of any main already laid). It is further provided that the act shall give the L.C.C. or the Joint Committee, or any company or authority supplied by the Joint Committee, the right to make at the expiration of seven years a representation to the Board of Trade that the price or method of charge should be altered, and the Board shall have the right to order an alteration. The bill empowers the Committee to give supply of energy for haulage or traction, and for lighting vehicles or boats propelled by electricity, to railways, tramways, canals, navigations, docks, waterworks, &c., and gives similar powers to each of the combining companies. Except to the extent provided by the bill, neither the Electric Lighting Acts, 1882 and 1888, nor the schedule to the Electric Lighting (Clauses) Act, 1899, shall apply to the Joint Committee or to its undertaking. Further, the Committee shall not give nor be bound to give supply to distributors in areas outside the County of London in which the North Metropolitan and the Kent Electric Power Companies, or the Metropolitan, Charing Cross or South Metropolitan Companies have authority to supply to authorised distributors, except by the consent of the said companies. The financial clauses limit the amount of capital to be raised to £1,000,000 at 5 per cent. interest, and such capital is to be redeemed by the purchasing authority at a premium of 10 per cent. if the purchase takes place in 1932 or at par if purchased in 1952, and the Joint Committee may, if they think fit, issue such stock on the condition that any additional stock which may be issued under a subsequent act will rank pari passu. The Joint Committee is to make a sinking fund to provide for the redemption of any stock issued within 42 years from the dates of issue; the Committee's revenue is to be devoted to (1) payment of interest on stock outstanding, (2) payments to sinking fund, (3) repaying to companies guaranteeing interest on the Committee's stock any moneys paid by them in fulfilment of the guarantee of the stock and (4) formation of and making payments to a reserve fund. After these provisions are satisfied any balance up to 2 per cent. of the Joint Committee's capital expenditure shall be divisible between the companies guaranteeing the stock, in proportion to their guarantee, and any balance then remaining will be divisible as to one-third to the companies and two-thirds to the distributors taking supply from the Committee. The several London electric supply companies or any distributing authorities shall give supply for power at a maximum price of £4. 10s. per annum per kilowatt and ½d. per unit. At the date of purchase (up to 1952) by the L.C.C., or other authority authorised by Parliament, the realisable value of the investments representing the sinking fund shall be deducted from the purchase price. It is also provided that any of the London electric supply companies may enter into agreements to give and take supplies from one another, to combine in erecting new or extended stations or in laying mains, cables, &c., in the management and working of undertakings, in the appropriation and division of receipts, and in the provision of capital or any matters incidental to any of these purposes.

The first members of the Joint Committee and the companies they represent are Sir Irving Courtenay (Chelsea Co.) and Messrs. J. R. Beeton (Brompton & Kensington), W. F. Fladgate (Charing Cross), J. B. Braithwaite (City of London), R. P. Sellon (County of London), R. Stewart Bain (London Electric), W. H. Cripps (Metropolitan), and H. St. John Winkworth (South Metropolitan).

MR. BALFOUR BROWNE, K.C., in opening the promoters' case, submitted a set of tables prepared on their behalf, which gave information or calculations on the following matters:

Table I. *Particulars of the Six Principal Stations of the Joint Committee Companies.*

Site of station.	Owning company.	Area of site. Acres.*	Present capacity in kw.	Additional kw. possible in existing buildings.
Bow	Charing Cross Co. ...	7·1	16,000	10,000
Bankside	City of London Co......	3·0	21,900	nil
Wandsworth ..	County of London Co.	1·8	8,500	10,000
Deptford .	London Electric Co. ..	3·5	17,250	4,000
Willesden ...	Metropolitan Co.	18·0	16,500	7,500
Blackwall Point	South Metropolitan Co.	2·75	6,000	3,000
		35·15	[illegible]	34,500

Average present capacity, 14,860 kw.

* Of which 14½ acres is now unoccupied by buildings.

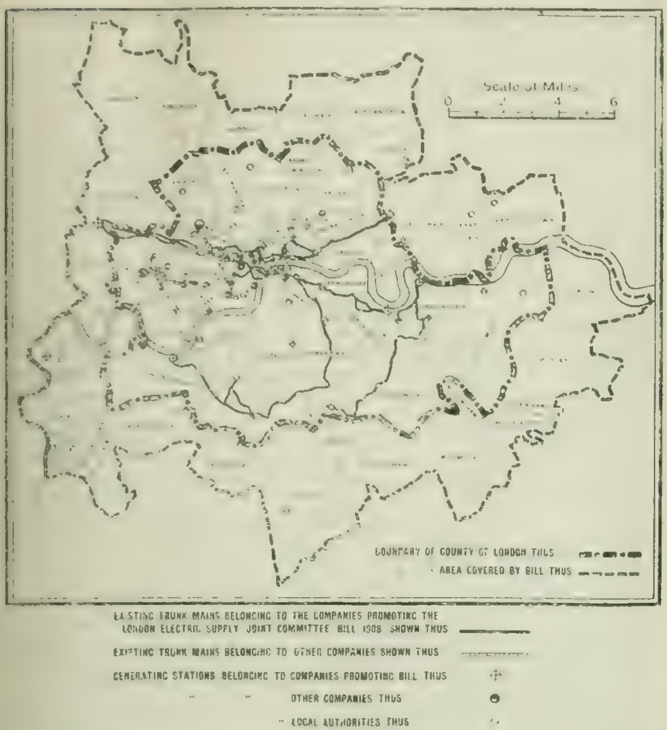
Table II.—Capacity of the plant in the generating stations at Bristol, Glasgow, Liverpool, Leeds and Manchester. 22 stations, total capacity 146,750 kw., average capacity 6,670 kw.

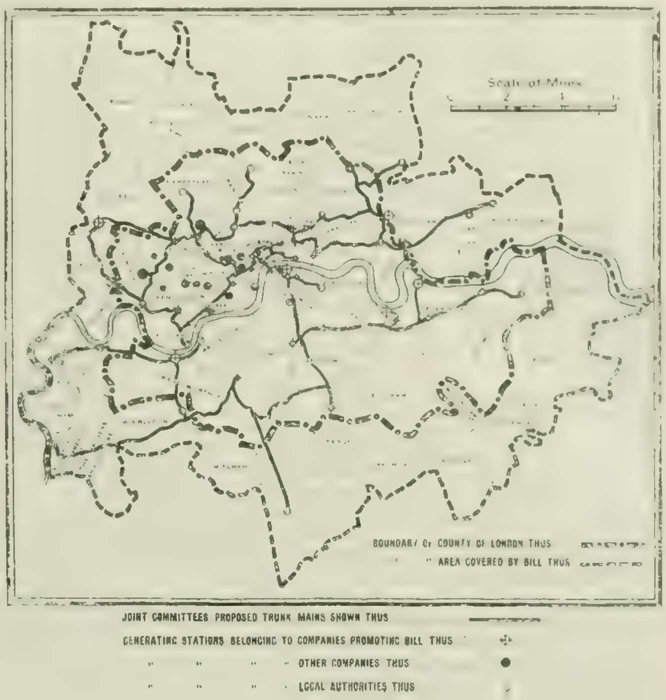
III.—Average proportions which the various items of cost bear to the total cost of supplying consumer, taken from accounts of 17 authorised distributors in London, of which works costs are 27·6 (including coal 16·2).

IV.—Comparative capital costs of plant and mains for load of 25,000 kw. from steam turbine plant (A) erected on Barking site by a new company (total £1,137,630) and (B) by means of six 5,000 kw. sets on existing sites of present companies (total £843,658).

V.—Comparative working costs of the two schemes in Table IV., the figures for (A) being taken at rates proportional to the estimated figures in the London & District Co.'s Table XXIII., although correct for 60,000 kw. the promoters of the Joint Committee Bill estimate that they would be exceeded at 25,000 kw.: (A) £197,283, (B)

SKETCH MAPS SHOWING (1) EXISTING MAINS OF LONDON SUPPLY COMPANIES AND (2) THE PROPOSED MAINS OF THE LONDON ELECTRIC SUPPLY JOINT COMMITTEE.





178,866. Cost per unit delivered as untransformed energy (A) 0·486d., B, 0·441d.

VI.—Capacity and capital cost of Joint Committee's scheme for load of 25,000 kw.: Existing plant available in companies' stations 10,000 kw., new steam plant 20,000 kw. Capital cost: New steam plant £240,000, transmission system £376,002, total £616,002. Total, with engineering, contingencies and preliminary expenses £692,202 = £23·1 per kilowatt.

VII.—Ditto at later stage for load of 34,000 kw. supplied by the addition of 12,000 kw. of gas-driven plant, latter costing £204,000, and making total capacity 42,000 kw. Total capital cost (with additions to transmission system and engineering and contingencies) £934,030 = £22 2 per kilowatt.

VIII.—Working costs of Joint Committee's new plant with load of 25,000 kw., 10,000 kw. being generated by gas and 15,000 kw. by new steam plant. Total (including £65,380 to cover interest, depreciation and reserve fund and £2,500 extra depreciation on gas engines) £155,300 0·383d. per unit (untransformed), against 0·485d. per unit from London & District Co.'s Barking station.

IX.—Proportion of energy generated by each section of the plant required for running the total load under typical conditions. In connection with this Table, the diagram, Fig. A, was given, and shows

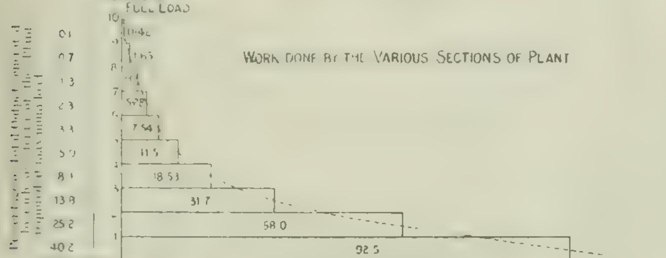


Fig. A.

that plant capable of dealing with one-tenth of the maximum demand could be run with a load factor of 92·5 per cent. under the typical conditions of load represented by the dotted curve. This section of the plant would generate 40·2 per cent. of the total units, the remaining 59·8 per cent. being generated by the remaining nine-tenths of the plant with a load factor of 15·3 per cent. Similarly taking two-tenths of the plant, this would generate 65·4 per cent. of the units with a load factor of 75·25 per cent. The figures for the entire plant show a 23·03 per cent. load factor.

X.—Maximum prices at which power consumers can obtain low-tension direct current, with load factors varying from 15 to 90, and with average hours of use of maximum demand per annum varying from 1,314 to 7,884, prices varying from 1·5628d. to 0·5355d. per unit in the case of the L.C.C. 1907 Bill (£6. 15s., plus 0·33d.), and from 1·322d. to 0·637d. in the present bill (£4. 10s., plus 0·5d.).

Mr. Balfour Browne, continuing, said the promoting companies represented three-fourths of the capital invested in electricity supply in London. If the bill were passed, the undertaking would be a semi-public one, and public interest would be safeguarded. The Joint Committee would be under obligation to supply at certain prices. A temporary supply to the Joint Committee was provided for, because they would not at first have the works to generate electricity themselves. There was power to require the companies to erect plant within five years sufficient to supply 27,000 kw. for the Joint Committee, and the companies were to be paid by the Committee for working that plant. Two companies alone had put at the disposal of the Joint Committee unoccupied land sufficient to take plant up to 11,000 kw. The £1,000,000 capital was guaranteed by six companies. The promoters asked that the sinking fund should be upon the basis of 42 years, and that it should be made after paying interest on stock and before any profit went to any of the companies. The authorised distributors would get in reduction of price the two-thirds of the surplus profits referred to in the bill. They thought they had secured 46 per cent. of the total supply, and the demand could be met by additional plant of 23,000 kw. If any railways wanted current of a special kind it would be provided by special plant. They had not much hope of getting the tramway load, as the three large systems each supplied themselves, so that practically the Joint Committee's output would consist of part of the load of the existing distributors. The rate of increase in demand was decreasing, and the increase was partially provided for by the companies and the local authorities, and the problem was how best to provide for the future increase at less capital cost than it could be done under the existing restrictions and at the same time reduce the cost to the consumers by economical generation. There had been distinct prohibition of combination, but the principle was now looked upon as wrong, for in a bill introduced by the Board of Trade in April, 1905, which was not passed, it was provided that clauses in previous orders and acts prohibiting combination should not be construed as prohibiting the taking or giving of a supply in bulk. The effect of the present bill would be to concentrate the generation of the solid load at six large stations and to use the smaller stations in the outlying districts as peak load stations. At present each company had to depend on its own plant and had to have spare plant that would not be necessary if it could have the spare plant of other companies to use in times of emergency. The present scheme would relieve 17,000 kw. of plant which was at present standing in reserve, and that would result in production at a cheaper rate. The question of generating in bulk at large stations had been taken up very early by the various companies. The Metro-

politan, Charing Cross, the St. James' & Westminster and the Kensington & Notting Hill companies had equipped stations with this object, and the result was that electricity was now being produced at rates much cheaper than at the time of Merz's bill of 1905.

Referring to Table I. counsel said a new company coming into the field would not have the advantages shown therein to assist them in producing current economically. Some people thought London was in arrear in this matter, but Table II. showed that the average capacity of the stations in six of the largest towns was only 6,670 kw., compared with the average of the six London stations mentioned of 14,860 kw. The local authorities in the area had a capacity of 52,027 kw. and a large amount of surplus capacity, and if the Joint Committee could relieve them of the necessity of holding spare machines in reserve or having duplicate plant it would enable them to utilise their capital to the fullest extent. The companies' stations were supplying direct, and the losses caused by supplying from a long distance were avoided. Bulk supply had the disadvantage of the loss of about 15 per cent. in transmission and transformation to contend with, and large economies would have to take place before the present supply could be succeeded by bulk supply. If an existing station took supply either from the Joint Committee, or any other bulk supply, all the saving would be its own coal bill, and they would, of course, still have to pay a coal bill to the bulk suppliers in the price for electricity, and their capital charges and other running charges would still have to be paid. If a station were shut down all the saving that could be effected would be some reduction in the works costs (given as 27·6 in Table III.), and the effect would be a reduction of only 5·5 per cent. to the consumer. It was proposed to lay trunk mains to connect the various stations, capable of carrying 30,000 kw., and to employ the three-phase system, with 50 cycles and at 10,000 volts pressure. The expenditure proposed and the buildings and plant at their disposal would be ample for five or six years. The plant capacity in London was 206,750 kw., and the demand in 1906 was 122,750 kw., so that there was spare plant for 83,990 kw. Those figures referred to the area in the present bill, and they showed the enormous amount of spare plant, which was all waste. Their Lordships had heard from some manufacturers that electricity was not the power they wanted, and the increase in the demand for electric light would certainly be less in the future, and they had also heard that only one-third of the energy consumed by carbon filament lamps would be required to give the same light by metallic filament lamps. If he admitted that the London & District Co.'s figures for the 60,000 kw. were correct, for the 25,000 kw. the Joint Committee's was the cheapest method of supply for the 25,000 kw.

In reply to Lord Welby, Mr. Balfour Browne said the Joint Committee calculated that with the guarantee of the six big companies they could get their money at 4 per cent., but that the London & District Co. would not be able to obtain money under 8 or 10 per cent. It would (he said) be rash to provide for a scheme for anything like 60,000 kw. or 120,000 kw.

Counsel continued: They did not at present know the last of economical generation of electricity. By the use of economical oil engines the cost of generating had been found to work out at as low as 0·339d., against the District Co.'s figure of 0·48d. Other engines had also given good results. The Joint Committee would be prepared to supply 52,000 kw. by means of the works which would be carried out under their scheme, and they asked the Committee to modify the purchase power that existed over certain of the companies' works at present.

In reply to questions by the Chairman, Mr. Balfour Browne said they were not asking a farthing more for the companies' concerns at 1932 than what they would get under the general act of 1888, but with regard to the £1,000,000 capital, if the purchaser came in at 1932 they asked to be recouped for the profit they would have made between 1932 and 1952, and that would be decided by arbitration. The local authorities could only purchase undertakings within their district, and the Joint Committee proposed to make purchasable the unpurchasable parts. Any station transferred to the Joint Committee would cease to be the property of the company, and would be purchasable under the bill. If the L.C.C. or other body were constituted the purchasing authority the promoters did not want to take away from the local authorities the right to purchase the distributing portions of the undertaking, and the bill would simplify this. If local authorities chose to become guarantors of the Joint Committee's stock they would have the privilege. If such a scheme as the London & District Co. had put before the Committee ultimately proved to be the best the companies would be in a position to carry it out. The question of obsolete plant did not arise in their case, as the sinking fund provided for that. The purchase would be at the "then value," whether purchased in 1932 or 1952. He asked the Committee to say that this was a practicable scheme.

Mr. J. S. Highfield, chief engineer to the Metropolitan Electric Supply Co., examined by Mr. C. A. Cripps, K.C., said a large number of power users in the London area already took electricity, but about 200,000 H.P. was still unsupplied. To supply this demand of 200,000 H.P., which would not all be required at one time, 32,000 kw. would, he estimated, suffice. The companies had sufficient plant for the growth of the demand in the immediate future. This growth in the area covered by the bill was on an average 9,799 kw. per annum for the three years 1904-1906. In 1907 it was 8,464 kw. The difference between 9,799 kw. and the figure of 13,500 kw. given by the London & District Co. was probably due to the difference in the area. The effect of the present scheme would be to give a larger margin of distributing mains for power supply. He had calculated that the average loss if they had one large centre for generation and carried the energy long distances would be 15 per cent., and great economy would be necessary to overcome loss of that character. The first thing to be considered was whether the economy in generating would make up for the loss in transmission. Works costs (27·6) in Table III. was the only item in which economies could be introduced, except a slight saving in management. The total load in the area, apart from the other bulk supplies, was 206,750 kw., and the surplus plant was too large having regard to the load. He thought they could reduce the working expenses and provide for additional demands at a lower price than could be done under existing conditions. The first map he now handed in (see p. 383) showed the positions of existing mains and the second map the mains which the Joint Committee proposed to lay. Some of the existing mains went through the areas of local authorities, and supplies required by the local authorities would be given from those mains. Additional plant could be put in the existing stations, which would bring the supply up to 34,500 kw., and a third stage would include the erection of new buildings and plant on existing sites, and would provide for supplying 52,000 kw. in all. The South Metropolitan, the Bankside and the Wandsworth stations were on the river, and would be in the same position in that respect as Barking station. He estimated the Joint Committee's scheme would show a large saving compared with the London & District scheme. The working costs (Table V.) of the Joint Committee's scheme for 25,000 kw. would be 0·441d. per unit for untransformed energy, against 0·486d. under the London & District scheme. They had put capital charges at 7 per cent. in one case and 8 per cent. in the other. Their capital cost would be £23·1 per kilowatt. If three 12,000 kw. units were adopted, as in the London & District scheme, one would be wanted as spare. There was, in his view, a good deal of doubt as to the best method of generation in the future, and there was no question that gas engines would come into use for electric supply purposes. The Charing Cross Co. were putting down engines for driving by heavy oil. The figures he had obtained from that company showed the cost of generation by oil engines to be under 0·4d. per unit, which was very low. Mr. Parshall had given the estimated coal used with steam plant at 2·5 lb. per unit. He (witness) estimated the coal used with gas engines at 1·7 lb. per unit, and they also got a bye product. The use of gas engines would reduce the cost per unit delivered as untransformed energy to 0·383d. per unit, compared with the new company's estimate of 0·486d. About 65 per cent. of coal would be consumed with gas engines compared with turbines. There would be no difficulty in linking together the six large stations in Table I., and they would supply through the existing mains. With the solid load economy in working was more important than the question of capital charge, and cost of distribution was of more importance than cost of coal. Their scheme would give sufficient security, because every district would be able to get supply from two stations.

By Mr. Rigg, K.C. (for City of London): He thought the public were satisfied with what the companies were doing, but the Joint Committee could do better, as they would be able to supply at a lower price.

By Mr. Williams (for Stepney): The companies represented on the Joint Committee had opposed all the power bills in the last five years on the ground that a power company should not be allowed to come in and compete with them. With regard to the power asked for by the Joint Committee in clause 35 to supply current to railways, tramways and docks, the local authorities could not supply railways for haulage or traction.

By Mr. Talbot, K.C. (for the promoters of the London & District Bill): The Joint Committee intended to supply in the whole of the area shown in the maps, except that they could not supply in areas where bulk supply powers were already in existence without the consent of the body having such powers. Up to 25,000 kw. the London & District Co. could not compete with the Joint Committee's prices.

On Wednesday, Mr. Wedderburn, K.C. (for Croydon) said he did not propose to cross-examine Mr. Highfield nor to take any part in the preamble, as the promoters of this bill did not propose to compete in any area without the consent of the local authority.

Mr. Highfield's cross-examination by Mr. Talbot was then continued. He said it was not proposed that all the six stations should be in a position to supply in any part of the area. Each district could be supplied from two stations. He thought three phase the best system for the purpose. He agreed that linking up was a misleading term. They could go on some time without enlarging the stations. He could not say when the plant would be put in at each of the stations. Large gas engine sets were successfully run in parallel at the Westinghouse works and in Guernsey. He was not quite au fait with the Johannesburg undertaking, where the gas system had been given up. The authorised distributor could demand current at £5 per kilowatt and 3·35d. per unit, and the consumer would get it at £4. 10s. and 0·5d. The distributor would make a profit, because a diversity factor of 4 had to be taken into consideration. Gas plant in units of about 1,000 H.P. would probably be erected at Willesden and Bow. The plant at Bankside was suitable for bulk supply in the immediate neighbourhood.

Cross-examined by Mr. Harper (for Middlesex County Council): He was not entirely responsible for the selection of the area. They had excluded the area in which bulk supply powers existed. They could not supply in the bulk companies' areas without the companies' consent. The West Middlesex bulk undertaking of the Metropolitan Co. could not be purchased by anybody. The Joint Committee's undertaking, if the bill were passed, could be purchased by the L.C.C., and there would also be the company's distributing undertaking in London.

Re-examined by Mr. Balfour Browne: The 12,000 kw. units would not be so economical as the 5,000 kw. units. Deptford and Wands-

worth had every advantage that Barking possessed by being situated on the river, and, assuming the District Co.'s scheme were found at the end of six years to be the right one, the Joint Committee would be in a better position than the company to carry it out.

In reply to the Chairman, Witness said it was proposed at first to add plant for supply in the companies' own areas and afterwards to lay mains for extensions outside. They would require about £700,000 in the first three or four years.

Mr. JOHN CONACHER (general manager of Metropolitan Electric Supply Co.) examined by Mr. Tyldesley Jones, said the hitherto existing prohibition of combination had resulted in a large number of separate undertakings, and this biil afforded the best means of unificati n of the supply for London. It would utilise to the fullest extent the present means of generation, and would share the benefit with the public through the authorised distributors. Two seats on the Joint Committee were offered to the L.C.C., and means were also provided by which any distributor might be represented upon it. Clause 29 did not appear to restrict the Joint Committee to acquiring stations authorised by Act of Parliament. They would be able to take over any station. Agreements had been entered into by five companies to place at the disposal of the Joint Committee plant of an aggregate of 10,000 kw. The County of London Co.'s agreement (a typical example) agreed to supply 3,000 kw. in 1909, 3,000 kw. in 1910 and 2,000 kw. in 1911. The Joint Committee might call upon the company at any time within five years to erect 5,000 kw. of turbine machinery. There was room for a further 10,000 kw. in all in the County Co.'s works. He thought they would certainly be able to raise the £1,000,000 capital at 4 per cent. Of course, the guaranteeing companies would take care the capital was raised as cheaply as possible. The bill had been approved by the shareholders of the companies. Central Electric Supply Co.'s debenture stock, guaranteed in a similar way, was a 4 per cent, debenture stock, and on April 30 last was quoted 98-101, or practically par. In regard to the application of the revenue of the Joint Committee derived from the authorised distributors to whom supply was given, the first charge was in payment of the interest on the Joint Committee stock; second, sinking fund on the 42 years' basis; third, repayment to the guaranteeing companies of interest on moneys paid by them in fulfilment of their guarantee; and, after forming a reserve fund, any balance of revenue up to 2 per cent. upon the capital expended by the Joint Committee would be divisible between the companies guaranteeing the stock. Any excess beyond the 2 per cent. would be divided in the proportion of one-third to the guaranteeing companies and two-thirds to the authorised distributors taking a supply of energy from the Committee. He considered purchase at 1932 too short a period to enable the necessary capital to be raised, and had, therefore, fixed the purchase at 42 years from January 1, 1910, but had preserved the 1932 purchase on special terms as regarded the Committee's undertaking. They proposed to confer the purchase powers on the London County Council or any other public authority authorised by Parliament. It had long been recognised that the general powers of purchase under the Electric Lighting Act, 1888, required some alteration, and the scheme propounded in their purchase clause would enable them, at the periods mentioned, to hand over to the purchasing authorities a unified system of generation and distribution. In regard to clause 35, providing for the supply of energy for railways, &c., this had been inserted in a large number of acts to provide for the case of a railway partly within and partly without the area of supply of the company dealt with, and was in the acts of the North Metropolitan, the County of London and the Metropolitan companies. Clause 42 imposed upon existing authorised distributors a reduced maximum price for the supply of power. At present there was an ordinary maximum price in London for all kinds of supply, and they proposed substituting a maximum of £4. 10s. per kilowatt and 0·5d. per unit for the existing maximum so far as power was concerned.

Cross-examined by Mr. FITZGERALD: There were 14 companies in London, including the Central Electric Supply Co., and about 26 distributing authorities, and under the bill the Joint Committee might consist of as many as 40 members. If there was any disagreement the matter went to arbitration.

By Mr. CLEASE: Clause 33 provided for supply to authorised distributors at the lowest maximum ever inserted in any supply act, and clause 42 provided for a fair and reasonable selling maximum. The existing companies could meet the demand by extending their works, but in 1906 the Select Committee had said that there should be one large controlling body, and their scheme was, in his opinion, the best for providing one large and comprehensive system such as the Select Committee indicated in their report. Under the present bill a cheaper supply of energy could be given, and be given more securely, than under the scheme of the London & District Supply Bill with the station at Barking.

Yesterday (Thursday) Mr. CONACHER, cross-examined by Mr. Cane, agreed that there had in the past been a disinclination on the part of local authorities to take electrical supply. They offered an opportunity to the local authorities to be represented on the Joint Committee in order that any distrust might be obviated. The same representation was given to all local authorities, large or small.

By Mr. MORTEN: The Charing Cross Co. had powers to supply West Ham Corporation. He accepted counsel's statement that the approval of West Ham Corporation had had to be obtained and that this was given on the understanding that the company would not compete with the local authority. He did not see how, under the present scheme, they would be authorised to compete. In regard to clause 35, he did not think they could undertake not to give a supply to any railway, tramway, &c., within the borough, but he thought they would be willing to exclude a dock which was situate entirely within the precincts of the borough. In regard to railways running through the borough, there was no difference between giving a supply outside the borough and giving the supply at convenient points in the borough.

By Mr. WILLIAMS: In regard to the lighting of vehicles or boats drawn or propelled by electricity, this was an essential part of the scheme for supplying railways, &c. They would not be able to compete for the lighting of any building, station, &c. Out of the charge of £4. 10s. per kilowatt Stepney would have to provide for cost of distribution, which might go up to 50 per cent. of the actual cost. He was not prepared to strike clause 42 out of the bill.

By Mr. HARPER: The North Metropolitan Co. adequately served the portion of the area situate in Middlesex. They desired to supplement the supply of the North Metropolitan Co., with the company's consent. He thought the districts outside London on the North would be well served by the Willesden and West Ham stations.

Re-examined by Mr. Tyldesley Jones: If the local authorities wanted a voice in the appointment of the first standing arbitrator, by giving notice in time they would be represented at the first meeting. The six companies would have six representatives with one vote each. There might be more local authorities than companies represented, and if so, as they would also have one vote each, they would actually be in a majority. Clause 42 was different to clause 35 of the L.C.C. 1906 bill, which enabled the price for power supply to be altered from time to time at the instance of the Council. Their clause 42 proposed to fix a price for power throughout London, and they stated the price in the bill. The present bill had been prepared before they heard of the London & District bill. Whatever the fate of the other bill, his promoters had every intention of proceeding with their bill. He did not think there would be any friction on the Joint Committee.

Mr. J. B. BRAITHWAITE (chairman of the City of London & County of London Electric Lighting Cos., &c., also gave evidence yesterday, and was followed by Mr. W. F. FLADGATE (chairman of the Charing Cross, West End & City Electric Lighting Corpn., &c.), whose evidence was concluded, and the Committee adjourned until this (Friday) morning. The remainder of yesterday's evidence will be given in our next issue.

BOARD OF TRADE AUDIT OF ELECTRIC LIGHTING ACCOUNTS.

In the House of Commons last week, Mr. CHIOZZA-MONEY asked if the Board of Trade had decided in future to accept the audit of electric lighting companies' own auditors as sufficient for the purposes of a "public audit" under the Electric Lighting Act; and, if so, upon what grounds such decision had been made.

In reply, Mr. W. CHURCHILL said there was some misapprehension as to the action taken by the Board of Trade in regard to the audit of the accounts of electric lighting companies. The Board continue to carry out their statutory duty of appointing official auditors, who are specially instructed to direct their attention to the protection of the interests of the consumers and of the possible purchasing authority, and who are responsible for this audit to the Board of Trade. The official auditors appointed by the Board to audit the accounts of electric lighting companies for 1907 are professional accountants who are in a good many cases, but by no means in all, identical with the shareholders auditors. This practice had not, however, been adopted in any case where the local authority was empowered to purchase the undertaking at a price dependent on the amount of capital expenditure. He would watch the progress of the arrangement carefully in case it should be necessary to make any change.

LEGAL INTELLIGENCE.

Reynolds v. Lanarkshire Tramways Co.

Last week in the Court of Session, Edinburgh, Lord Dundas delivered judgment in this action by plaintiff to recover from defendants £500 damages for personal injuries.

It appeared that about 5:30 a.m. of August 3, 1907, pursuer boarded one of defenders' cars between Cambuslang and Motherwell. The platform was crowded with passengers and pursuer was thereby compelled to stand partly on the platform and partly on the step. His left hand was on the brass rod at the rear of the car. His fare was collected while standing there, and he averred that immediately after he received a severe electric shock which rendered him unconscious, and he fell on to the roadway and was seriously and permanently injured. Defenders denied fault and stated that pursuer was injured through falling when attempting to board the car while in motion. They further alleged that the injuries were grossly exaggerated. The car was a workmen's car with cheap fares, and they pleaded that compensation by a passenger on such a car was limited to £100.

Lord DUNDAS assoilzied defenders, and found them entitled to expenses. His Lordship said he should be prepared to find that pursuer did receive some kind of slight shock on the car, but that it was not such as had been described by him or his witnesses. Pursuer's averments of negligence were vague, and the case had not been made out at proof. The pursuer could not recover damages unless he proved defenders at fault, as the fact of the accident did not per se prove fault. Defenders had, in his judgment, satisfactorily proved that all proper precautions were taken against accident. It might

be matter for regret that pursuer should have met with an accident, although upon the evidence his Lordship did not think it was shown to have been a severe one or to have been the cause to any considerable extent of the present unsatisfactory state of his health and nervous system. It would, his lordship thought, give rise to grave injustice if a company like defenders were to be held liable in damages for every accident which might occur in the course of their business, even if no fault was proved, and they had taken all reasonable pains to provide for the safety of their passengers. In the view which he took of the case it was not necessary to consider or decide a separate ground of defence based upon an alleged infringement by the pursuer of the terms of the company's bye-laws.

Workmen's Compensation.

At Taunton County Court on Tuesday Judge Beresford heard arguments in the application of Clara Escott (widow, Minehead) for an award against the Minehead Electric Supply Co. (Ltd.) in respect of the death of James Escott, a labourer employed by the company, husband of applicant. It was alleged that Escott's death was due to carbon monoxide poisoning in the course of his employment. The claim was for £156.

It was stated that at the Minehead Electric Supply Co.'s station there was gas producer plant, and it was alleged by applicant that respondents did not provide a proper exhaust to carry away the fumes; that carbon monoxide accumulated gradually in deceased's system by inhalation extending over a long period, leading to his death, which was certified as being due to "carbon monoxide poisoning and hemorrhage." Since the occurrence the company had had (it was alleged) an exhaust pipe carried through the room.

Mr. Clarke (for applicant) contended that death was due to an accident which came under the act, and that applicant was entitled to compensation.

Mr. Wethered (for the Company) submitted that it had not been shown that death was occasioned by any disease scheduled under the statute. The doctor's opinion was that it was quite impossible to fix any date on which deceased was poisoned. Carbon monoxide was not mentioned in the schedule.

Mr. Clarke contended that carbon monoxide might be classed with carbon bi-sulphide, which was scheduled.

Mr. Wethered argued that there was no evidence to show that the generation of electric current included the production of carbon monoxide.

His Honour said he would like to have a medical opinion whether carbon monoxide might be classed with carbon bi-sulphide. He was sorry for the widow, but he was afraid he must decide against her.

Mr. Clarke asked that the matter should stand over until the next court, and if in the meantime he (Mr. Clarke) ascertained from a chemist that carbon monoxide did not come within the schedule he would accept his honour's decision.

This suggestion was adopted.

MUNICIPAL, FOREIGN & GENERAL NOTES.

APPOINTMENTS VACANT AND FILLED.

The Electrical committee of the City of Bristol invite applications for the position of charge engineer at their Avonmouth substation. The plant consists at present of two 500 kw. and one 300 kw. Peebles-La Cour motor-converters (6,000 volts three phase). Preference will be given to applicant who has had experience with similar plant. Salary 25s. per week, rising to 35s. per week. See an advertisement.

An engineer is required for a company now forming. Salary £400 rising to £700, to a thoroughly capable and qualified man. German and French advantageous.

An engineer in charge is wanted to superintend boilers and heating apparatus, electric wiring installation, lifts, telephones, bells, &c. at the Charing Cross Hospital, Agar-street, W.C. Applications to the Secretary by 24th inst. See also an advertisement.

A draughtsman is required for wireless telegraph and telephone apparatus. Salary $112 per month. Applications to the National Electric Signalling Co., Brant Rock, Massachusetts, U.S.A. See advertisement.

Worcester Education committee require a headmaster to take charge of the Victoria Institute evening and continuation schools. Salary £200 per annum, rising by annual increments of £12. 10s. to £250. Applications to the Secretary for Higher Education by June 22.

Mr. J. E. Donoghue, chief assistant electrical engineer to Sydney (N.S.W.) Council, recently resigned to take up a position with the new Balmain Lighting Co., and the city electrical engineer (Mr. Mackay) recommended the appointment, on six months' trial, of the senior assistant (Mr. Vine Hall) as his successor, but the Electric Lighting committee decided to invite applications from other persons in the Commonwealth and New Zealand.

Mr. Arthur E. Cotterell, assistant provincial superintendent for the Midlands of the National Telephone Co., will at an early date be leaving Birmingham for London to take up a similar position of wider responsibility in the southern province. Mr. John Scott, at present district manager of the company at Manchester, will succeed Mr. Cotterell in Birmingham.

Mr. A. V. Mason, who has been manager of the Devonport & District Tramways Co. for 2½ years, has been appointed general manager of the South Metropolitan Electric Tramways & Lighting Co.'s tramways at Sutton. At Devonport Mr. Mason will be succeeded by Mr. C. W. Durnford, engineer to the South Metropolitan Co.

EDUCATIONAL NOTICES.

Faraday House.—A series of lectures on "The General Principles involved in the Economical Production of Electrical Power" will be delivered by Mr. H. M. Hobart, M.I.C.E., to the students of Faraday House, commencing on June 18th.

Heriot Watt College, Edinburgh.—At this college there is theoretical and practical training for mechanical, electrical and mining engineers, technical chemists, &c. The training for engineers consists of three years in the college and a three years' apprenticeship on the "sandwich" system in a local engineering works. The total cost, including apprenticeship premium and fees at college, is from £120 to £200. There are complete courses of instruction, extending over four years, for students studying for the fellowship of the Institute of Chemistry. The classes are recognised by the University of Edinburgh as qualifying for science degrees. Full information may be obtained from the Principal, Mr. A. P. Laurie, M.A., D.Sc.

University of London (University College).—Mr. H. Deans has been re appointed to lecture on railway engineering; Mr. A. T. Walmisley on waterways, docks and maritime engineering; and Mr. W. N. Blair on roads, street paving and tramways, during the session 1908-9. An Andrews entrance scholarship in science (£30) has been awarded to Mr. B. A. Keen, of Southend Technical School.

Argentina.—The "Review of the River Plate" states that the Cia. Alemana Transatlantica de Electricidad have presented the plans of their works, &c., in accordance with the terms of the concession granted to them by Buenos Aires Municipality.

The plans show four stations of 29,490 kw. capacity and 17 substations (10 on tramway company's buildings), the converters being capable of dealing with 13,600 kw. and six batteries with a capacity of 11,976 ampere-hours. The cables in use are 1,839,055 yds. in length, there are 1,696 distributing boxes, 14,434 installations in private houses, 19,964 meters and various other apparatus, including 1,081 items. There are also 100 transformer stations, capable of dealing with 10,323 kw.

Australasia.—The water-driven electric power plant in the Eleanora mine of the New Hillgrove Proprietary Mines (N.S.W.), said to have been the first installation of the kind in the State, has proved in every way satisfactory, and has materially lowered the power costs, although the generator has been working on less than half load. It is intended to extend the use of electric power to the mill and pumps, and to adopt electric lighting and probably an electrically driven compressor.

The "Australian Mining Standard" says:—

The plant ordered for the Pioneer Tin Mining Co., Bradshaw's Creek, Tasmania, from Staerker & Fischer, agents for the A.E.G. (referred to on p. 311, of our issue for June 5), includes three 400 kw. 6,500 volt 50 cycle three phase water turbo generators (Voith turbines) with direct coupled exciters and a Thury regulator. Power will be transmitted by bare overhead conductors to the mine a distance of 4 miles. The machinery to be driven electrically includes large pumps on barges, for which two 400 H.P. motors will be used.

A.E.G.-Voith water turbine-driven generators are also being supplied to the Cobungra (Victoria) mines of the Cassilis Gold Mining Co.

The new city electrical engineer of Sydney (Mr. Forbes Mackay) has presented a report on the generating plant, which, if a turbine set and a Stirling boiler are kept in reserve, can only deal with a demand up to 4,700 kw., while Mr. Mackay estimates a peak load of 7,100 kw. during the winter of next year. The transforming plant at the Town Hall would also be unable to cope with the demand. As he considers it would be impossible to procure the necessary plant in time for use during the winter of 1909, Mr. Mackay recommends the installation of a storage battery, which could be charged at times of light load at a cost of about 0.35d. per unit. The high-pressure mains and the low-pressure feeders will also have to be increased, the present total capacity of the trunk mains being 5,000 kw. During 1907 the increase in consumers was 654, and in units sold 2,168,082, the total demand for the year being over 6,000,000 units. The average price obtained was 2.14d.

The Oxford-street Electric Lighting Co. have agreed to take £15,500 for their undertaking, and Sydney City Council have been recommended by their Electric Lighting committee to take it over at that price.

Beckenham.—The Council have given notice to the two local gas companies that after Sept. 29 next they may change over com

pletely from gas to electricity for street lighting. It is probable that the Council will use metallic filament lamps for lighting some of the thoroughfares.

Bexley. The Council have sealed the conveyance of the tramways in High-street, Plumstead, to the L.C.C. Negotiations are proceeding with the Council and Erith Council as to inter-running.

Brighton The Tramways committee recommend the Council to authorise them to enter into negotiations with Messrs. Stephen Sellon & Partners who propose to construct electric tramways from the eastern boundary of the borough down St. James's street, up North-street and along Western-road. The promoters also wish to construct lines through Hove into Worthing. So far as Brighton is concerned, the promoters would take supply of electricity from the Corporation works, pay the entire cost of obtaining powers and also pay £2,500 a year to be applied to relief of rates or for road widenings. They ask for a concession for 35 or 42 years.

Cape Town.—At present there are five electricity generating plants in operation in this town, three owned by the Corporation and two by the Government. The "South African Review" announces that it is now proposed to do away with the Government lighting plants and to hand the business over to the Corporation. In connection with a scheme of extensions which will follow upon this reorganisation, the city electrical engineer (Mr. W. F. Long) will shortly proceed to England, with the object of purchasing more machinery.

Carlisle.—The Council have received sanction to a loan of £5,000 for extensions of mains, &c.

Customs Duties.—According to recent decisions incandescent lamp holders are subject under the New Zealand tariff to import duty (as electric appliances, n.o.e.) of 30 per cent ad val. (British goods 20 per cent.) and electric detonator fuses and electrician's portable testing sets (consisting of testing generator and ohmmeter) are duty free.

Under the new British Honduras tariff electrical machinery and parts thereof and batteries are admitted free, instead of being subject as hitherto to a duty of 10 per cent. ad val. as "goods unenumerated."

Darwen.—Application has been made for sanction to a loan of £4,300 for mains extensions.

East Africa.—The total mileage of overhead telegraphs opened for traffic in the East Africa Protectorate at Dec. 31 last was 2,168½ miles, the longest route being that from Mombasa to Port Florence (three wires) 1,752 miles. The total does not include telegraph lines in Uganda, nor the telephone system which extends over 38 miles in the Protectorate.

In Uganda there are 458 miles of telegraph lines, and telephones are in general use between Government offices in Entebbe and Kampala. It is hoped that the telephone system will soon be perfected to admit of use by the general public.

Electrification of Railways.—Mr. Chiozza-Money, M.P., to whom every subject comes alike, has given notice in Parliament that he will ask the President of the Board of Trade on Tuesday next whether his attention has been directed to the fact that the Prussian State Railways Administration is about to electrify some parts of its system; if, in the interests of British trade and locomotion, he can direct the attention of British railway companies to the fact; and if, in the event of British railway companies neglecting to avail themselves of electrical power, he will, in the public interest, introduce legislation to nationalise British railways in order to make them as efficient and as economical as those possessed by our greatest commercial rival.

German Electrical Industry.—A report has just been issued on the trade of the consular district of Berlin during 1907. Considerable space is given to particulars of the electrical industry. Summarised, it is reported that 1907 witnessed a considerable growth in the trade of the electro-technical industry, and that the financial results shown by the reports of the joint stock companies engaged in electrical enterprise were very satisfactory.

The adoption of automatic machinery to take the place of discontented manual labour is exemplified in the case of the A.E.G., which, despite an increased business, reduced the number of employés in 1907 to 30,667, compared with 33,906 in 1906. The development of the electric locomotive and the turbine is particularly noted, and the increasing use of electrical methods in smelting works and in the textile industry is observed, as is also the increased employment of electrically driven reversible rolling mills. The electrification of a number of railway lines throughout Germany, and the extensions to the elevated and underground railways of Berlin and Hamburg in particular, are commented upon, the electrification of the Berlin Metropolitan Railway being predicted.

The utilisation of Germany's water power in the development of electrical energy is the principal development of the near future, and the State control of the water power in the German Empire is regarded as certain.

The introduction of a new insulating material called "Tenacite" is referred to.

Tables A and B give some interesting information :—

A.—Consumption of Electric Current in Berlin (in kilowatt hours).

—	1907.	1906.	1905.	1904.
Private lighting	28,524,790	24,817,983	20,139,869	16,727,266
Public lighting	3,376,513	2,808,339	2,318,525	2,016,797
Manufactories	48,932,247	43,049,036	36,687,516	30,326,974
Accumulators	5,088,784	4,522,829	3,798,969	3,245,878
Tramways	53,196,218	50,952,760	47,287,808	45,166,449
Consumption at elec. power stations	3,833,264	1,952,901	1,340,095	1,018,040
Total generated ..	142,921,816	128,103,848	111,572,782	98,501,404

A table showing the number and capacity of electric motors used in Berlin in various trades shows a steady development in the use of these machines over a wide range of industry.

Handsworth.—An inquiry was held here on Tuesday into the application of the Corporation for permission to borrow £22,300 for the electricity supply undertaking.

Of the amount asked for £18,200 has been expended upon the generating station, £3,100 is being spent upon additional plant to meet the increased demand expected during the ensuing winter, and £1,000 is scheduled for a scheme of hire-purchase wiring.

Evidence was given by the clerk to the council (Mr. Ernest Ward) and the consulting engineer (Sir Alexander Kennedy). The latter explained the plans and specifications, and stated that from the beginning it was decided to have only one generating station for lighting and tramway purposes, and the plant was so arranged that a number of dynamos could be used for both purposes.

Mr. Ward said the scheme of hire-purchase wiring had received careful consideration, and having regard to the character of the houses in Handsworth, and what had been done in other towns, the Council had decided to try it.

Mr. F. A. Nixon, the electrical engineer to the Council, also gave evidence.

Honduras.—The electric lighting of the streets of Tegucigalpa, which had been for many years under consideration, was inaugurated in September last with 70 arc lights. Private lighting from the same generating plant is also being adopted.

India.—The Government's local Executive Engineer, is inquiring into the possibility of utilising the falls of Ani-Sakan or other water power near Maymyo for generating electrical energy for lighting the Pasteur and Vaccine Institutes, the barracks and other Government buildings at Maymyo.

"Indian Engineering" states that the electric lighting fans and lifts for the Bombay High Court will cost about R.86,000 (£5,375).

The Bombay Government have sanctioned an expenditure of about R.20,500 (£1,281) for electric lighting and motors for the Yeravda prison.

B.—Germany's Foreign Trade in Electro-technical Products during 1907 in Metre Tons.

—	Imports.		Exports.		Imports from U.K.	Exports to U.K.
	Met. tons.	£	Met. tons	£	Met. tons.	Met. tons.
Dynamos, motors, transformers, converters and reaction coils.	1,326·6	94,450	22,350·2	1,716,400	.	2,308·1
Electric cables	1,462·7	76,050	32,289·5	2,260,250	926·1	3,630·0
Arc lamps	19·7	4,200	682·9	145,100	5·3	90·7
Complete cases for arc lamps..........	1·3	200	150·5	20,700	...	18·7
Reflectors, search lights	4·1	2,450	224·1	134,450	...	41·9
Incandescent lamps	88·6	53,150	698·5	419,100	..	150·9
Telegraph appliances, telephones..........	92·8	58,450	1,530·5	765,250	..	195·8
Appliances for illumination, transmission of power..........	262·7	43,200	5,593·7	922,950	40·0	514·0
,, for surgical and dental purposes	9·3	3,700	168·1	67,250	1·2	19·8
Measuring, counting and registering apparatus	69·3	27,700	980·2	392,100	..	55·6
Galvanic and dry batteries and thermo-electric couples..........	10·3	1,050	386·5	38,650	...	92·8
Insulating appliances of earthenware, porcelain, glass	232·1	8,700	539·1	20,200	40·0	171·0

The Howrah section of the Calcutta Tramway Co.'s system was opened on 10th inst.

The tramway system of the Delhi Electric Tramways & Lighting Co. has been opened for traffic.

Ince.—The transfer of the electric lighting order to Wigan Corporation has been sealed by Ince Council.

Islington (London).—Further distributing mains are to be laid at a cost of £320.

Liverpool.—By 8 votes to 4 the Tramways committee have decided to institute on the Garston–Pierhead route a six months' experimental service of first-class trams at fares double those at present charged.

The tramways manager (Mr. C. W. Mallins), in a report, suggested that no additional cars be provided, but that seven trams, either upholstered as first class carriages or furnished with rattan seats, be substituted for seven of the cars at present in use. The seven cars will provide a quarter hourly service from either terminus.

Lowestoft.—An unopposed inquiry was held last week into the application of the Council for sanction to borrow £1,000 for "free" wiring and £661 for mechanical stokers.

For insuring the "free" wiring installations of the Council the offer of the Sun Fire Office to insure at a premium of 5s. per cent. up to an amount of £2,000 has been accepted.

Onchan (Isle of Man).—The Onchan Village commissioners have entered into a contract with the Manx Electric Railway Co. to supply electric current and to maintain the lamps for lighting King Edward's-road at a price below the present cost of gas.

Paignton.—The Council have approved the plans of the proposed electricity works which have been prepared by the engineer (Dr. J. A. Purves) of the Paignton Electric Light & Power Co. It is proposed to use producer gas plant.

Presentations.—On Thursday last, at the Westinghouse Works, Mr. W. Perren Maycock, M.I.E.E., was presented with a cheque as a token of esteem on the occasion of his leaving the service of the Westinghouse Co.'s publishing department after 4½ years' work as technical editor and sub-manager. The presentation was made on behalf of some 60 of the principal members of the managerial, engineering and commercial staffs. We understand that Mr. Maycock intends to devote his attention chiefly to private literary work for some time to come.

The staff of Dublin Corporation electricity works have made a presentation to Mr C. H. M'Keown (senior shift engineer) on his marriage. The presentation was made by the city electrical engineer (Mr. Mark Ruddle).

Provisional Orders Revoked.—The Board of Trade have revoked, as from June 3, the Crompton Electric Lighting Order, 1901, and the Brynmawr Electric Lighting Order, 1904.

Rotherham.—The salary of the assistant electrical engineer (Mr. J. Williams) has been increased to £175 per annum.

Stoke Newington (London).—On Monday an inquiry was held into the Council's dust destructor and electricity scheme.

It is proposed to utilise the waste steam of the dust destructor for the generation of current, the cost being estimated at £3,280.

Ald. SAYLEY stated that under the Council's agreement with the North Metropolitan Electric Power Supply Co. they could not suffer any loss, but might make a profit, and as a matter of fact a profit had been made.

The scheme was opposed on the ground that the borough was already sufficiently burdened by rates and loans, and should not embark on speculative undertakings.

The Electric Lighting committee have decided, on the recommendation of the consulting engineers (Messrs. Talbot & Stevenson), to provide a series booster to obviate the fluctuations of load on the Palatine road feeder and the consequent unsteadiness of the light in that neighbourhood during performances at the Stoke Newington Theatre. The estimated cost is £410.

Wakefield.—The city electrical engineer (Mr. H. A. Neville) reported to the Council on Tuesday that the net financial result of the past year's working of the electricity department was not so good as last year, owing to heavy increased expenditures, but that the position of the undertaking was sound, and future results would again show net profits as in the past.

Willesden.—The Council have received sanction to a loan of £13,727 for additional plant, mains, services and meters.

Wolverhampton.—On Monday the Corporation decided to apply for sanction to a further loan of £6,000 for extensions of the electricity works, including additional boilers, induced draught fan, coal conveying plant, &c.

The Electricity committee reported that the additional plant was necessary in view of the steadily increasing demand for electric power. When the recent extensions were carried out provision was made in the boiler house for supply by Messrs. Bayliss, Jones & Bayliss, and for a probable further increase in demand of about 600 kw., the total additional boiler capacity being equal to about 1,600 kw. The actual increase in load during last winter, exclusive of Messrs. Bayliss' requirements, was 430 kw., and as their demand was approximately 1,000 kw., the additional boiler power provided was almost already accounted for. Since Christmas the committee have made arrangements to supply a further 200 kw., and are in negotiation with other potential customers.

Outing.—The staff of the Linolite Co. held their annual outing on 13th inst. at Clandon, where luncheon was taken. The party was accompanied by Mr. A. S. E. Ackermann (engineer and manager of the company), Mrs. Ackermann and Mr. R. L. Matthews (assistant manager). After lunch the annual cricket match, Office v. Works, was played, the Works eleven proving victorious.

Jubilee of J. H. Holmes & Co.—The silver jubilee of J. H. Holmes & Co., Newcastle-on-Tyne (founded 1883), was celebrated on the 6th inst. by the partners of the firm inviting their staff to an excursion to "Glen Allen," the country house of Mr. J. H. Holmes (the founder of the firm), near Whittingham. The party, which included a number of ladies, arrived at Alnwick, and drove to "Glen Allen," where, in splendid weather, the party spent some delightful hours before their return to Newcastle.

ELECTRICITY SUPPLY AND TRAMWAY ACCOUNTS.

Bexhill.—The total net income of the electricity department for the year ended March 31 was £9,700. 11s. 10d.

Total expenses were £5,249. 2s. 7½d. Gross profit was £4,451. 9s. 2d. and after paying interest (£1,619. 6s. 1d.) and instalments of principal (£1,814, 7s. 5d.), and writing off £131. 3s. 1d. to depreciation, the net profit was £886. 12s. 7d. Total capital expended is £61,371, an increase of £5,239 on the year. Working costs per unit sold is 2·26d. per unit (against 2·52d.) and total costs 3·74d: (against 4·08d.). There are 696 consumers, with an equivalent of 36,072 8 c.p. lamps connected. The maximum supply demanded was 443 kw. 662,300 units of energy were generated; 556,816 units were sold.

The electrical engineer (Mr. W. T. Le Feuvre) reports that the use of tantalum and other metallic filament lamps for street lighting has proved a success; that the candle power of the public lighting has been increased by about 6,000 without extra cost to the Council; and that the general use of these lamps for street lighting is advisable. A 500 kw. dynamo (by the British Westinghouse Co.) coupled to a Belliss engine, a Babcock & Wilcox boiler and superheater, steam piping, &c., were added during the year.

Brighton.—The total income of the tramways department for the year ended March was £47,200. 14s. 1d., the traffic revenue being £45,286. 6s. 2d.

Working expenses were £34,559. 5s. 4d., interest absorbed £8,902. 3s. 2d., and sinking funds £5,125. 9s. 10d., leaving a deficit of £969. 4s 10d. The gross capital expenditure was £274,905. 0s. 6d. During the year 9,945,574 passengers were carried (against 10,759,310) and 1,075,555 car-miles were run (1,118,590), 1,889,871 units of electricity were used (1,798,905). The percentage of working expenses to receipts was 73·21 (68·11). The report of the general manager (Mr. Wm. Marsh) states that the department is paying £1,638 more per annum for current than it ought to pay (the total for 1907-8 was £11,811. 13s. 11d.).

Coventry.—For the year ended March 31 the net profit on the electricity undertaking was £5,647. 4s. 6d., of which £1,000 has been voted to relief of rates.

Devonport.—The total income of the electricity department for the year ended March 31 was £17,522. 17s. 3d., including £16,081 11s. 9d from the sale of current.

The gross profit was £6,789. 19s. 8¾d. After paying interest and sinking fund charges there was a net surplus of £3. 14s. 5d. 2,111,390 units were generated and 1,695,289 sold (453,318 for private lighting, 26,722 for public lighting, 1,193,447 for traction and 21,802 units for power). Capital expenditure is £119,707.

The borough electrical engineer (Mr. J. W. Spark) points out that Devonport's electricity supply has from the commencement been of a somewhat peculiar nature. Starting first with purely traction work, the general supply business, which commenced a year later, consisted largely of temporary supplies to the Government dockyards and contractors. The policy of the Electricity committee, while these contracts lasted, was to keep down capital expenditure and extensions in order to avoid a sudden drop in output and consequent idle plant. During the last two years the policy had changed, and considerable mains extensions had been carried out and advertising freely indulged in. In the autumn of the year under review an exhibition was held, with the result that, although the increase in the number of consumers had been larger than at any other period, the existing consumers were educated to the advantages of metal filament lamps, and some 70 per cent. are now using these lamps. This, coupled with the fact that prices were reduced from 4½d. and 2½d. to 4d. and 1¾d. per unit for lighting and power respectively, has produced a considerable drop in revenue. The rise in coal has increased costs, while distribution and capital charges have increased with the larger area covered by supply mains and services. The general supply business is not likely to again undergo what would appear a retrograde movement, and the year's work, which has resulted in practically an equal balance, may be considered of a pioneering nature.

Ealing.—Last week the Council passed a resolution congratulating the borough electrical engineer (Mr. J. D. Knight) on his annual report.

The chairman of the Electricity committee (Ald. Peal) said that, although there had been considerable extra expense, the net profit was £2 100. It was not proposed to reduce the charge for current for lighting, but the price of energy for power and heating would be reduced from 2d. to 1½d. per unit.

Glasgow.—For the year ended May 21 the gross revenue of the tramways department was £916,566, and the total expenditure £509,995, leaving a profit of £406,571. It is proposed to set aside £188,603 for renewal and depreciation, and after making other reductions to appropriate the net balance (£38,830), as to £4,061 for special depreciation and carrying forward £34,769 to general reserve.

Gravesend.—The annual report of the Electricity department was presented to the Council last week.

1,175,976 units of electrical energy were generated, against 1,087,650 in 1906-7; sold to tramway company 410,411 (419,492), to private consumers 361,817 (288,716), public lighting 169,975 (152,630). Total costs amounted to £4,912, against £4,639, or 1·25d. per unit sold, against 1 29d. Revenue from private consumers increased from £4,115 to £4,688, notwithstanding a reduction of ½d. per unit during the last two quarters of the year. Gross profit was £4,261, against £4,209 in the previous year, and the net profit increased from £244 to £435.

Newcastle on-Tyne.—The report of the tramways department for the year ended March 31 states that the total traffic receipts were £205,322. 6s. 5d., an average of 11·17d. per car-mile, against £205,261. 16s. 6d. (or 11·56d. per car mile) in 1906 7.

Street lighting receipts were £4,351. 15s. (£3,417. 10s. 9d.), public building lighting £1,019. 2s. 6d. (£714. 14s. 6d.); rents and sundry receipts brought the total to £211,318. 9s. 3d. (11·50d. per car-mile), against £209,891. 15s. 6d. (11·81d. per car-mile). Traffic expenses were £58,583. 4s. 11d. (3·19d. per car-mile), against £56,004. 1s. 5d. (3·15d. per car-mile), general expenses £17,609. 2s. 7d. (against £16,535. 18s. 2d.), general repairs and maintenance £22,570. 6s. 1d. (against £20,481. 7s. 4d.), power expenses £12,345. 13s. 4d. (against £10,096. 18s. 6d.), for maintenance and repairs at power and substations £16,615. 18s. 2d. (against £13,060. 3s. 7d.). Total working expenses were £116,852. 6s. 4d. (6·36d. per car-mile), against £107,318. 19s. 9d. (6·04d. per car-mile). After paying interest, sinking fund, &c., £19,477. 12s. 4d. has been placed to reserve and renewals fund.

Nottingham.—The total income of the electricity department for the year ended March 31 was £92.793. 19s. 10d.

Expenses were £46.988. 7s. 11d. Gross profit was £45,706. 9s. 2d. Interest absorbed £13,696. 12s. 2d., contributions to sinking fund £2,355. 15s. 9d. and instalment for repayment of loans £12,654. 10s. 2d. £11,500 was appropriated in aid of general district rate, leaving £5,499. 11s. 1d. for reserve. The total capital expenditure was £450,945. 3s. 5d. (an increase of £4,406. 7s. 11d. on the year), outstanding loans, &c., amounting to £361,091. 12,005,704 units were generated; 11,116,835 units were sold, including 10,951,354 by meter and 165,481 supplied to the public lamps. The total maximum demand was 6,156 kw., against 5,765 kw.

St. Pancras (London).—During the quarter ended March 2,431,591 units were sold (against 2,204,247 in 1907), including 383,939 units for power (against 292,921), 1,768,137 for lighting (1,597,750), and 663,454 for public lighting. The total receipts were £24,072 (against £22,460). There are 2,934 consumers. The maximum demand was 6,478 I H.P. (against 6,136 I.H.P.).

The Electricity committee has decided in favour of the Council undertaking wiring and fitting of consumers' premises. The committee do not suggest that the Council should carry out the wiring by the staff of the electricity department, but that the work should be let out to contract, under competition, for stated periods, at an accepted schedule of prices.

The following clause, which has never been enforced, is to be deleted from the conditions of contract with power consumers: "Provided always that in consequence of the special price charged—viz , 1d. per unit—the Council are at liberty to discontinue the supply of current each day at any time upon notice being given to the consumer that the current is required by the Council's ordinary consumers for lighting purposes; for the carrying out of any necessary repairs to the mains, plant and machinery; further, in the event of any unforeseen accident or interruption of the supply, the Council will not be liable for loss or damage occasioned thereby." The committee point out that in the bills before Parliament during the last few years a point has been made, to the disadvantage of the Council, that no large power user would take a supply with such a condition imposed.

Stepney (London)—The accounts of the electricity department for the year to March 31 show capital expenditure £287,961 (an increase of £22,888 on the year). £8,346 of capital expenditure has been written off out of profits, £547 having been thus dealt with during the year.

Revenue was £41,449 (against £36.992), including £32,887 (£29,246) from private consumers, £5,769 (£5,323) for street lighting and £2,355 (£2,004) for maintenance of public lamps. Expenditure was £24,347 (£21,C66), including coal £9,247 (£6,651) and destructor steam £2,314 (£2,507). Gross profit was £17,102 (against £15,926), and net profit (including £1,219 charged to net revenue account in respect of interest accrued on capital account) was £3,147 (£2,394), this increase being secured notwithstanding a decrease of 7 per cent. in the average price received per unit (1·62d. against 1·74d.). 6,438,592 units (5,277,898) were generated, 2,793,025 (2,528,228) supplied for private lighting, 1,833,130 (1,229,000) for power and 1,086,523 (993,954) for public lighting. Fuel cost per unit sold was 0 486d. (0·463d.), works costs 0 701d. (0·702), total expenditure 0·924 (0·963), and interest, sinking fund, &c., 0·602 (0·696). Total 1·526d. (1·659d.). Average prices received were for private lighting 2·205d. (2·307d.), power 0·945d. (0·966d.) and public lighting 1·274d. (1·285d.). The connections during the year in equivalent 8 c.p. lamps, were: For private lighting 16,390 (12,685), power 41,776 (19,636) and public lighting 282 (448), the total connections now amounting to 245,581 8 c.p.

The report of the borough electrical engineer and manager (Mr. W. C. P. Tapper) calls attention to the fact that the revenue per unit (1·62d.) compares favourably with the average of all the companies and local authorities in London (2 86d.). The maximum load was 2,831 kw. (2,414 kw.). The opening of the Blyth's Wharf station will check the increase of units used in distribution, as the transmission losses will be less than under former conditions when the eastern end of the borough had to be supplied from Osborn-street. A large proportion of the consumers have adopted metallic filament lamps, and Mr. Tapper estimates the saving of energy to the consumer at from 50 to 75 per cent., and states that, with the extremely low prices in Stepney, lighting by metallic filament lamps is undoubtedly cheaper to long hour consumers than gas for equal candle-power. The reduced increase in sales for lighting is attributable to the use of metallic lamps.

Sunderland.—The traffic revenue of the tramways department for the year ended March was £68,797. 17s. 2d. (against £72,054), and the total revenue was £69,023. 16s. 10d

Working expenses were £40,817.3s 9d. Interest absorbed £8,511.13s.8d., income tax £758, and repayment of loans £9,380. £5,677. 10s. was placed to reserve and renewals and £3,347. 15s. 8d. in aid of rates. Capital expenditure stands at £298,711. 16,987,898 passengers were carried and 1,534,584 car-miles run. The average working expenses per car-mile were 4·371d. excluding power (1,834,029 units at 1·18d.) which was 2·016d. per car-mile.

TRADE NOTES AND NOTICES.

TENDERS INVITED.

Dublin Corporation invite tenders for 12 months' supply of machinery oils for the Corporation electricity works. Copies of specification, with conditions of contract, can be obtained from the town clerk, Mr. Hy. Campbell, and tenders must reach his office by 29th inst. See also an advertisement.

Salford Electricity committee invite tenders for re-wiring the Royal Technical Institute. Specifications and forms of tender may be obtained from the borough electrical engineer, Mr. V. A. H. M'Cowen, electricity works, Frederick-road, Pendleton. Tenders by noon of July 1. See also an advertisement.

The Electricity Supply committee of *Stepney* (London) Council invite tenders for supply, during the year ending June 30, 1909, of (1) ampere-hour meters, demand indicators and time switches; and (2) arc lamp carbons. Specifications, &c., from the borough electrical engineer and manager, Mr. W. C. P. Tapper, A.M.I.E.E., 27, Osborn-street, Whitechapel, where tenders must be delivered by noon of June 29.

The Guardians of the parish of *Fulham* (London) invite tenders for a vertical high-speed engine and 20 kw. steam dynamo, both British made. Form of tender of specification from the clerk,

Mr. E. J. Mott, 129, Fulham Palace-road, Hammersmith, W., to whom tenders by July 2.

London County Council invite tenders for the manufacture and delivery of high-tension main switchgear and low-tension auxiliary switchgear, to be erected at the Council's generating station at East Greenwich. Tenders, on official forms to be obtained from the clerk of the Council (Mr. G. L. Gomme), County Hall, Spring-gardens, S.W., by 11 a.m. on July 7.

London County Council also invite tenders for the manufacture, supply and delivery of tramway feeder pillars. Tenders, upon official forms, to be obtained from the clerk of the Council, County Hall, Spring Gardens, S.W., by 11 a.m. on June 23.

London County Council also want tenders, by 11 a.m. June 30, for the road work and plate laying in connection with the construction of tramways on the underground conduit system from Dulwich Library, Lordship-lane, to Forest Hill. Forms of tender, &c., from the Chief Engineer, Spring Gardens, S.W.

Tenders are wanted for an electric light and power installation for the new engineering laboratory, Heriot-Watt College, *Edinburgh*. Specifications from the Superintendent of Works. Tenders to the Clerk to the Heriot Trust, 20, York-place, Edinburgh, by 10 a.m., July 3.

Woolwich Council want tenders by noon, July 23, for supply and erection of coal handling plant at Globe-lane electricity works. Specification from the Borough Electrical Engineer.

Manchester Corporation want tenders by 10 a.m., June 24, for laying underground telephone pipes. Specification, &c., from the City Surveyor.

Manchester Tramways committee want tenders by 9 a.m., June 23, for builder's work at car depot. Forms of tender, &c., from the General Manager.

Birmingham Corporation want tenders by June 24 for stores for the electricity department. Particulars from the City Electrical Engineer.

Ealing Corporation want tenders by noon June 27 for supply of oils, waste and stoneware pipes to the electricity department. Forms from the Borough Electrical Engineer.

Taunton Council want tenders by June 30 for 12 months' supply of Welsh steam coal for the electricity department.

Melbourne City Council invite tenders for supply of 5,060 yds. of insulated copper cable. Copies of specification, conditions of contract and form of tender from the agents for the Council (Messrs. McIlwraith, McEacharn & Co. Proprietary, Ltd.), Billiter-square-buildings, London, E.C., to whom tenders by noon of Friday, July 3.

The Deputy Postmaster-General, *Melbourne*, Victoria, wants tenders by 3 p.m., Aug. 4, for telegraph and telephone material for the ensuing year. Specifications may be seen at 73, Basinghall-street, London, E.C.

The Postmaster-General's Department, *Perth*, W. Australia, want tenders by Sept. 7 for common battery switchboard (nine sections) for Fremantle, 600 wall and 150 subscribers' table sets, 800 protectors, 90 extension switch and bell sets, 60 subscribers' switchboards and 20 wall and 10 table sets for party lines.

The Postmaster-General's Department, *Sydney*, N.S.W., want tenders by Aug. 12 for branching metallic multiple magneto switchboard for Mosman telephone exchange.

TENDERS RECEIVED AND ACCEPTED.

Lambeth General Purposes committee having considered quotations for the installation of telephonic communication between the various departments in the new offices, report that the most satisfactory and cheapest course to adopt will be for the Council to purchase from the General Electric Co the necessary materials and instruments and to execute the work by the Council's own staff. The Council have sanctioned the necessary expenditure.

Heywood Council have accepted the following tenders:—

Browett, Lindley & Co., steam dynamo, condensers, &c.; British Insulated & Helsby Cables, tramway feeder cable; Thos. Hill & Sons, boiler, &c.; Whipp & Bourne, switchboard; Blakeley & Wild, extensions to electricity station buildings; Liverpool Hennebique Ferro Concrete Contracting Co., cooling tower.

Bermondsey (London) Council has accepted the tender of Crompton & Co. for supply of an arc lamp column, with double carbon arc lamp and lowering gear, at £26. 13s. 3d. The British Insulated & Helsby Cables have agreed to guarantee cables to be supplied by them for two years instead of one year at an increase of 1 per cent. above contract price.

Bristol Corporation have accepted the tender of Jones & Horsfield for boiler and pipe covering at Avonbank at £238; that of the Princess Royal Colliery Co. coal to the Temple Back works for 12 months ending March 25, 1909 estimated value £1,640; Oliver Arc Lamp Ltd., a.c. and d.c. flame arc lamps (value £1,3[illegible]); and Sykes & Sugden, joint and junction boxes (1908-9) at £386. 11s. 8d.

Royce Limited have been favoured with orders from Galloways Limited for two 40-ton three motor electric overhead cranes and gantry for their boiler works, Ardwick, and also one 5-ton three-motor electric overhead crane and steel gantry 700 ft. long for Farnworth & Jardine, timber merchants, Seaforth, Liverpool. Both the above are repeat orders.

Gravesend Council have accepted the tender of the Tudor Accumulator Co. for a storage battery at £1,295 (with £112 for maintenance), and that of the Switchgear Co. for regulating switches at £316.

Wolverhampton Corporation have accepted the tender of Babcock & Wilcox for supply and erection of new boilers at the electricity works.

Marylebone (London) Council received 25 tenders for supply of coal to the electricity works and that of W. Cory & Son has been provisionally accepted.

Marylebone Baths committee has placed an order with Maple & Co. for supplying and fixing 11 new battery wall telephones for £10. 18s.

Bradford Council have accepted the tender of Roberts Bros. for the electric light installation at the Town Hall at £1,420.

Southport Council have accepted the tender of the Mirrlees Watson Co. for a surface condenser at £910.

The Postmaster-General's Department, Melbourne, Victoria, have accepted the tender of R. B. Hungerford for 30 metallic circuit 100 line switchboards at £1,378.

Staerker & Fischer, of Melbourne and Sydney, agents of the A.E.G., have secured an order for 3,400 ft. of special armoured signal cable for the Great Boulder Proprietary Mine, W. Australia.

The Postmaster-General's Department (South Australia) have accepted the tender of the Western Electric Co. for a common battery switchboard for Port Adelaide at £1,526, 325 wall set telephones at £2. 9s. each and 75 table set telphones at £2. 8s. each and 400 protectors at 2s. 9d. each.

Only one tender has been received by Buenos Aires Municipality for the construction of tube railways, and this was submitted by Supervielle & Co., representatives of the Consortium d'Entrepreneurs du Metropolitain de Paris, in which the French Thomson-Houston Co. are interested. The tender proposes, alternatively: (1) Two lines, 1·67 metre gauge, with tunnels lined with brick, \$18,520,598 gold; (2) gauge 1·44 metre, tunnels lined with brick and iron rings, \$17,520,929 gold; and (3) gauge 1·44 metre, lined with brick, \$16,412,045 gold. The tenderers offer to accept obligations to finish the work in $3\frac{1}{2}$ years, and to submit to a fine of \$10,000 a week for delays in finishing the work.

BUSINESS NOTICES

Messrs. Dorman & Smith are removing their London office and stock room from Charing Cross-road to more commodious premises at 17, Victoria-street, Westminster, S.W. The new office will be in charge of Messrs. Sambidge and Ward, both of whom are engineers who have had much experience of both the technical and business sides of electrical work. These gentlemen will be assisted by an efficient staff, and will have charge of the South Coast district as well as that of Greater London.

Messrs. L. E. Wilson & Co., 20, Cross-street, Manchester, announce that, in order to deal effectively with their increasing business in the Liverpool district, they have decided to open a branch establishment at New York-buildings, 67, Stanley-street, Liverpool (Telegrams: "Telephony Liverpool"; Telephone: Central 67). They have appointed Mr. F. L. Monkhouse, M.I.E.E. (late manager in Liverpool for the Walsall Electrical Co.) as managing engineer.

Mr. Philip D. Ionides, now and for some eight years manager in Scotland for the British Westinghouse Co., will resign that position in the autumn to join Mr. Wilfrid L. Spence, M.Inst.C.E., Assoc.M.Inst.C.E., 31, St. Vincent-place, Glasgow, in his consulting practice, the business thereafter being carried on under the name of Spence & Ionides. Mr. Ionides, after some years of American experience, following a British training went to Glasgow in 1900 to instal the Corporation electric tramway plant, and has since then handled all the Westinghouse Scottish business. Mr. Spence, prior to opening his own office, was for $5\frac{1}{2}$ years engineer and managing director of the British Electric Plant Co., Alloa, whose works, with the bulk electric power station, he designed, built, equipped and operated during that period.

Owing to the Government having purchased 5, Great George-street under the Public Offices Sites (Extension) Bill, 1908, Messrs. Bramwell & Harris are moving into new offices at 11, Great George-street, Westminster, S.W., at the end of this month.

Geo. Hy. Hanson and Albt. Edwd. Martin (trading as G. H. Hanson & Son and as the British Telephone Supply Co.), 17, Bloomsbury street, Birmingham, have dissolved partnership. Mr. G. H. Hanson will in future carry on both businesses in partnership with Mr. Wm. Chas. Carter.

Mr. J. E. Lea, the inventor of the "Lea" water recorder recently described in *The Electrician*, has changed his address from Brown-street to 28, Deansgate, Manchester. Telephone number 5,040, telegraphic address as before, "Recording, Manchester."

In order to avoid possible confusion with other companies, the title of the British General Electric Co., of 17, Hatton Garden, E.C., will in future be the British Central Electrical Co. Telegrams: "Attilеur London"; telephone, Holborn 4552.

Geo. & Hy. Makin Morris (trading as Morris & Morris), electricians, &c., 59, Railway-road, Leigh, Lancs., have dissolved partnership. Debts by Mr. H. M. Morris, who continues in his own name.

Plant for Sale.—Two Royce compound-wound dynamos and two 14 H.P. gas engines, with flywheels, &c., are advertised for sale. Applications to Mr. Wm. Morton, Grand Theatre, Hull.

Rotary Incandescent Filament Lamp.—An advertisement contains some particulars of this lamp, the British and Foreign rights of which are for sale, or working licences thereunder would be granted. Applications to K., The Dell House, Ropley, Hants.

British Agencies Required.—The electrical department of the Norddeutsche Maschinen und Armaturen-Fabrik, Bremen-Hastedt, Germany, advertise that they require agents for their new line of electrical apparatus and specialities.

Westinghouse Magnetic Brake.—As a result of the successful performance of Westinghouse magnetic brakes on the Dunedin and Wellington (N.Z.), Sydney, Bendigo, Ballarat, Fremantle and East Fremantle tramways (Australia), the municipal authorities of Adelaide have placed an order with the British Westinghouse Co. for 120 magnetic brake equipments of the latest improved type, similar to the brakes in use on all the London County Council tramcars. The inventors of this brake have recently developed improvements which are claimed to eliminate wheel skidding on the worst condition of track and on any gradient.

Brown-Boveri Steam Turbines.—The A.-G. Brown, Boveri & Cie, Baden, Switzerland, have recently concluded a licence agreement with the German Admiralty, whereby the latter have acquired the right of building marine steam turbines on the Brown-Boveri system in the Imperial shipyards. The Imperial shipyard at Kiel has already been instructed by the Admiralty to equip the new cruiser "Ersatz Sperber" with a set of turbines on this system.

CATALOGUES, &c.

Battery Fans.—Although the majority of our cities and towns have a supply of electrical energy there still remains the great number of country places in which battery power must be resorted to for the driving of so useful an article as an electric fan. Pamphlet No. O1,082 just issued by the General Electric Co. describes and illustrates a wide range of portable battery-driven electric fans. It also gives details of both dry and wet batteries suitable for the operation of these fans. The sets are extremely light and neat, and, in addition, their outward appearance has been carefully studied.

G.E.C. Publications.—We have to acknowledge a number of publications from the General Electric Co., including the "General" Progress Sheet for June, 1908. Probably the most interesting item of this is the "Fynn" patent single-phase commutator motor. There is a cheap electric kettle, listed at 8s. 6d., and a 4 lb. 250 watt domestic flat iron with detachable shoe at 15s. 6d. Section C of the company's general catalogue deals with enamelled conduits ("Geekoduct") and all fittings and accessories. This will bear close inspection by wiring contractors, both as regards the boxes and general accessories of the system, as well as the tools which will be found useful in wiring work. "Freezor" electric fans are described in Section E of the catalogue. These fans are made in a large range of sizes, and are suitable for bracket, ceiling, wall and desk use. There is also a line of "Freezor" electric porthole fans described and priced.

"*Organisation.*"—This is the title of the official publication of the Stolzenberg specialities. Engineers anxious to set the office side of their business in order will find numerous useful hints.

Flange Expander.—A useful list reaches us from Mr. O. N. Beck, 11, Queen Victoria-street, London, E.C., describing his universal pipe flanging expander. The principal advantage of the tool is that it can be employed on different diameters of pipes. It is stated that for the flanging of pipes from 2 in. to 16 in. bore only two of these machines are required. A copy of the list will be forwarded to all interested engineers.

A.C. Motors—Messrs. Wright & Wood, Century Works, Halifax, have just issued their list, No. 24, which gives general prices of their two and three-phase induction motors. These machines are standardised for 50 cycle working, and have an overload capacity of 25 per cent. for one hour, and 50 per cent. momentary. According to the list a large stock is carried and quick deliveries can, therefore, be made.

BANKRUPTCIES, LIQUIDATIONS, &c.

Claims against the St. Albans & District Electric Supply Co. (Ltd.) by July 31 to Mr. J. McLeod, 101, Finsbury-pavement, London, E.C.

In the Manx Chancery Court on Wednesday the accounts of the liquidator (Mr. W. H. Walker) of the Isle of Man Tramways & Electric Power Co. (Ltd.) were passed. There was £6,308 for distribution, and it was proposed to pay a final dividend to the creditors of 1s. 0$\frac{3}{4}$d. in the £. The total of admitted claims was £115,618. 12s. 6d. Previous dividends to creditors of 12s. 6d. in the £ had been paid. The shareholders, whose capital exceeded £250,000, received nothing back.

A meeting will be held on July 21 at 5, New-court, Lincoln's Inn, London, E.C., to receive an account of the winding-up of the Electric Traction Construction & Equipment Co. (Ltd.).

Bishop's Cluster Co. (Ltd.) is being wound up voluntarily. Mr. G. Teale, 14, Golden lane, London, E.C., is liquidator.

Deed of Assignment.—A deed of assignment has been executed by Ernest E. Prestwich & Ernest C. Lea (trading as Prestwich & Burt), electrical engineers, South-lane, Kingston-on-Thames. Claims to Mr. G. E. Corfield, Balfour House, Finsbury-pavement, London, E.C., by June 25.

PATENT RECORD.

APPLICATIONS FOR PATENTS.

NOTE.—*The undermentioned Applications (except those marked †) are not open to public inspection until after acceptance of Complete Specifications. Those marked † are open for inspection 12 months after the date attached to them, if they have not been published previously in the ordinary course. Names within parentheses are those of communicators of inventions. When Complete Specification accompanies application, an asterisk is affixed.*

February 19, 1908.

3,764 LUKS. Operating switches or the like.*
3,770 BLUEMEL, BLUEMEL, BLUEMEL & SHILL. Electrically-controlled pneumatic dispatch tubes, cash railways and the like.*
3,778 PORTER. Electromagnets.
3,792 LAGELBAUER. Apparatus for intensifying electric or sound waves*

February 20, 1908.

3,823 LOGAN. Safety guard for tramcars and other vehicles.
3,830 DENIEPORT. Electric condensers.*
3,850 MANNING. Conduit tramway continuous current supplier.
3,860 MARKS. Switches. (Electrical Mfg. Co., U.S.)*
3,862 JACQUES. Production of electrical energy and apparatus therefor.
3,894 BURGESS. Electric railway signalling system.*

February 21, 1908.

3,941 HENSLEY. Combined high and low-tension change-over switch.
3,947 LINES. Incombustible articles used for electric fittings.*
3,950 JOHNSTON. Operating brakes of self-propelled vehicles.
3,985 B.T.-H. Co. & HOPPS. Electric ignition devices.
3,986 ALLGEMEINE ELEKTKICITATS GES. Electrically-driven rolling mills. (Date applied for, 22/2/07.)*†

February 22, 1908.

3,995 MORDEY & FRICKER. Electricity meters.
4,021 MOUNTAIN & GIBSON, & TOLKIEN. Track brake-operating mechanism for tramcars.
4,030 TIDNAM. Telegraph pole. (Date applied for, 9/7/07.)*†
4,043 DAVY. Disinfecting devices for telephones and like instruments.
4,052 HERRENSCHMIDT. Processes of melting in electric furnaces and their application to the extraction of metals. (Application for addition to 24,517/07. Date applied for, 23/2/07.)*†
4,066 EXLEY & LEITNER. Series parallel electric circuits.

February 24, 1908.

4,082 TAYLOR. Compound automatic electric fog signal.
4,087 JONES. Resistances.
4,096 RANDALL. Electrically automatically switching on or off the supply mains transformers and the like.
4,110 BAINES. Electro-therapeutic methods and apparatus.
4,111 SIEMENS BROS. DYNAMO WORKS, DALZIEL, BROOKS, & JENKIN. Recording apparatus for use with electrical measuring instruments.*
4,112 SIEMENS BROS. DYNAMO WORKS. (Siemens Schuckertwerke G.m.b.H., Germany.) Section insulating arrangements for overhead construction of electric railways or tramways.*
4,113 FAIRWEATHER. (Allmanna Svenska Elektriska Aktiebolaget, Sweden.) Polyphase induction machines. *
4,133 VON KUBIN. Apparatus for reading Morse and similar signals.
4,137 BOSCH. Apparatus for starting internal combustion engines by electrical ignition. (Date applied for, 28/10/07.)*†
4,139 BLOXAM. (Markische Maschinenbauanstalt Ludwig Stuckenholz A.-G., Germany.) Lifting magnets for cranes.*
4,145 GREENBAUM. Coupling talking machines with transportable circuit-making and breaking devices.*
4,161 ORLING. Electro-capillary apparatus.
4,166 EVANS. Electricity meters.*

SPECIFICATIONS PUBLISHED.

1907 Specifications.

4,085 Coleman. Electric alarm apparatus.
4,123 Stone. Wireless telegraphy. (Date applied for, 27/2/06.)
4,125 Cabot. Wireless signalling. (Date applied for, 10/3/06.)
4,128 & 4,134 Cabot. Wireless signalling systems. (Date applied for, 10/3/06.)
4,132 Peck. Systems of electrical distribution.
4,137 Cabot. Wireless signalling systems. (Date applied for, 10/3/06.)
4,181 B.T.-H. Co. (G.E. Co., U.S.) Preventing electrolysis.
4,211 Crompton & Co., Macfarlane & Burge. Rotary transformers and motor-generators.
4,333 Webb. Selective continuous wave telegraphy.
4,397 Eckstein & Heap. Construction of automatic circuit-breakers.
4,425 Scott. Time limit circuit-breakers.
4,470 Lautenbach. Electric power-generating plants.
4,593 Marconi & Marconi's Wireless Telegraph Co. Transmitting apparatus for wireless telegraphy.
4,832 Christensen. Voltaic cells.
4,833 B.T.-H. Co. & Garton. Regulation of motor-generator sets.
5,012 Cook. Electrical protective apparatus.
5,100 Cote & Pierron. Electric furnace for continuous extraction of zinc.
5,437 Callender's Cable & Construction Co. & Brennan. Friction clutches.
5,506 Lamme. Alternating current dynamo-electric machines of the commutator type. (Date applied for, 15/3/06.)
5,506a & 5,508a Lamme. Operation as generators of alternating current commutator type motors having series characteristics. (Date applied for, 2/8/06, and under Rule 13, 7 3 07.)
5,836 Franklin & Seyfert. Alternating current commutator motor.
6,289 Walter. Controlling electric currents.
7,048 B.T.-H. Co. (G.E. Co., U.S.) Magnetic wedges for dynamo-electric machines.
7,180 B.T.-H. Co. (G.E. Co., U.S.) Resistances.
7,410 Haigh. Marine electric steering gear.
7,432 Cooper. Electric contact makers.
7,982 Blackmore. Electricmagnetic separators.
8,173 Milton. Inductor alternators. (Rights not granted.)
8,206 Graham. Trams, engines, or any machinery that runs on rails for open and fixed stationary points of rails or trolley wires, or any rails or wires requiring points.
8,284 Thiellet & Denard. Accumulators. (Date applied for, 12/4/06.)
8,934 Hookham & Holden. Electricity meter.
9,172 Ingram & Hunt. Arc lamps.
9,572 B.T.-H. Co. (G.E. Co., U.S.) Electric lamps having incandescing bodies of refractory elements.
9,591 Gross. Guiding and supporting carbons or electrodes in pairs in arc lamps.
9,923 Roberts. Electric switching mechanism for sending a predetermined number of current impulses.
10,861 Punga. Direct current armatures with multiple circuit multiple winding.
11,177 Haddan. (Polyphos Elektrizitäts-Ges.) Holding and compressing objects during exposure to Röntgen rays.
12,374 Lake. (Hallock.) Dynamo-electric generators of the inductor type.
12,973 B.T.-H. Co. (G.E., Co. U.S.) Brake leverage systems.
13,072 White. Electric controllers. (Date applied for, 6/6/06.)
13,195 B.T.-H. Co. (A.E.Ges.) Signalling systems for railways.
13,354 Driver. Attaching filaments to leading-in wires of incandescent lamps.
13,361 Earlam & Wild. Brake blocks for tramcars and the like.
13,983 Little. Storage batteries.
14,752 Scott. Preventing inductive disturbances in telephone, telegraph and other circuits. (Date applied for, 9/7/06.)

COMPANIES' MEETINGS AND REPORTS.

British Electric Traction Co. (Ltd.)

The directors' report for the year ended March 31 states that, in view of the fact that nearly the whole of the capital of the company is invested in a large number of associated companies, the directors consider it desirable, in order to make the position clear to the shareholders, to submit not only particulars of the company's interests in the associated companies, but also many particulars concerning the associated companies. Much of the information has been tabulated in schedules to the report. The amount standing at credit of reserve is £567,420. 7s. 11d. The question of utilising the reserve to write down the assets appearing on the opposite side of the balance sheet has been considered, but in the opinion of the directors no good purpose would be served by adopting this course at present. In addition, reserves have been made out of profits against loss or depreciation of specific assets, of which reserves a balance of £41,116. 19s. 10d. is unappropriated. The various associated companies have created depreciation and reserve funds of their own, which amounted at Dec. 31, 1907, to £902,728. The associated companies have recently, on the recommendation of the B.E.T. Co., adopted resolutions with a view to increase their provision against depreciation and also to define more clearly the purposes of their reserve funds. The resolutions are to the effect that the companies should make minimum provisions before payment of dividends for permanent way renewals, redemption of capital and general depreciation purposes. Some of the companies have acted on these resolutions in respect of their accounts for the past year, and endeavours will be made to give full effect to them in future years.

During the past year a satisfactory reduction has been made in the liabilities of the company, which amounted to £278,550 in March, 1907, while at the corresponding date this year they amounted to only £59,193. Of the latter amount £46,623 was in respect of debenture interest accrued at March 31 last, since paid. *Investments and Undertakings* form the chief item in the balance-sheet, and consist of shares and debentures in associated tramway, electricity supply, manufacturing and other companies, Consols and sundry securities and undertakings, made up as follows: Consols of par value of £200,000 standing at £196,373. 18s. 5d.; debentures in various companies of par value £395,251 standing at £378,558. 14s. 1d.; shares in various companies of par value £4,485,590 standing at £4,283,398. 1s. 7d.; capital expended at Barrow, Brighton and Mumbles £143,372. 3s. 5d. Total £5,007,702. 17s. 6d. Investments standing in the books at £3,275,178 were revenue earning during the past year and produced an average return of 4·7 per cent. Investments standing in the books at £1,589,152 earned no revenue during the year. The total investments are less this year by £103,669 than at March 31, 1907, securities representing £243,776 having been sold at a profit of £10,882, and securities standing in the books at £140,107 having been added. The amount of sundry debtors and debit balances has been further reduced during the year. At March 31, 1907, the amount stood at £631,632, compared with £545,801 at March 31, 1908. The item *Expenditure on Acts of Parliament, &c.*, has been written down to £17,528. 15s. 7d., and represents expenditure on promotion of Acts of Parliament, light railway orders and other rights and powers, surveys, negotiations, &c., in connection with schemes which may not be proceeded with. This amount is being written down annually by 20 per cent. *Stock* stands at £10,341. 7s. and represents stock of cars on hire to the associated undertakings, electrical equipments, paving setts and general stores, and is being gradually reduced by sales. Provision is made annually for any depreciation in value. *Lands and Buildings* stand at £19,930. 16s. 8d. and show an increase of £8,067. *Furniture* stands at £3,098. 13s. (Both these last-mentioned items it is proposed to transfer to the British Electrical Federation.) *Goodwill* stands at £1,000, and is the balance of a larger amount.

Profit and Loss.—Gross profits for the year 1907-8 amount to £250,539. 3s., while expenses (including £73,682 interest on 5 per cent. and £23,802 on 4½ per cent. debenture stock for the year) amount to £144,829. 9s. 1d., leaving a balance of £105,709. 13s. 11d. Adding £13,115 from preceding year there remains £118,824. 14s. 8d. The gross profits include £49,954 on the Bombay undertaking and £10,882 net profit on sale of investments. The expenses include £17,500, reserved to meet depreciation of undertakings worked by the company (apart from investments), buildings, doubtful debts and expenditure on undertakings not proceeded with. The directors have given the question of the distribution of the balance of profit their earnest consideration. They recognise the desirability of paying the full dividend on the preference shares. They feel, however, that this question is at present governed by the importance of making further provision for depreciation, and by the advisability of keeping ample funds in hand to assist the company to enter upon new enterprises when opportunity offers. Every effort is being made to increase the income on the existing investments; meanwhile, the other available source of increased profits is from the initiation and development of new undertakings. On the question of the dividend, the directors are unanimously of opinion that, in advising the preference shareholders to agree to a postponement of a part of their dividend, they are recommending a course which will materially strengthen the position of the company, and by improving the prospects of increased profits, offer future compensation to both classes of shareholders for their present sacrifices. The directors, therefore, recommend that the full dividend on the preference shares, at the rate of 6 per cent. per annum, be paid for the six months ended Sept. 30, 1907 (being at the rate of 3 per cent. for the financial year). This will absorb £48,431. 2s., and that there be added to general reserve (increasing same to £602,420) £35,000, leaving £35,393. 12s. 8d. to be carried forward. The directors consider that the dividend on the preference shares, at the rate of 3 per cent., may be regarded as a minimum distribution for the current financial year, and they propose that this shall be paid in two equal instalments on Aug. 15 and Feb. 15 next, and they hope that increased profits will in the near future enable the arrears of preference dividend to be paid off.

The weather during the greater part of the financial year was very unfavourable, and traffic receipts upon most of the tramways and light railways in which the company is interested were adversely affected. Efforts were made during the past year to improve the position of the undertakings by increasing the fares, by shortening the fare stages and by eliminating unremunerative services. The increases of fares were not made till the second half of the year, and it must take some time before the full effects of the changes can be ascertained. Meanwhile, the average fare for the past year has fallen to 1·21d. per passenger. The general charges and expenses of administration appear in the accounts in a form which does not compare easily with previous years. This is due to the expenses for the last nine months of the year having been discharged on a co-operative basis by the British Electrical Federation, but the directors are able

to report a further reduction in expenses. The management and general expenses are being reduced in larger ratio than the profits.

Another matter which has an important bearing on the profits made by the associated tramway undertakings is the price paid for the electrical energy for working the cars. This is a very large item in the working expenses, and in many cases, where the local authority was an electricity supply station, an obligation has been placed upon the company to take current at what is now a high price, the local authority supplying other and much smaller consumers at considerably lower prices. Where, however, the companies have been free to make the best arrangements for purchase or to generate their own current, the cost is less. The matter is receiving the attention of the directors with a view to securing better terms from the local authorities.

Electricity Supply.—The associated companies have, when the circumstances have been favourable, undertaken the supply of electricity in the districts served by their tramways, with a view to securing additional business for their power stations and the economies ensuing from combined administration. With few exceptions the separate electricity supply undertakings have now passed the pioneer stage, and are more than covering expenses, and their returns are steadily improving.

British Electrical Federation.—A Federation of all the companies and undertakings associated with the B.E.T. Co. was formed in July, 1907 (in succession to the Advisory Committee for associated companies formed in 1902), for co-operation and joint action in matters of common interest. About 60 undertakings have thus been federated for co-operative purposes, and a council has been constituted, consisting of the chairman or managing director of each of the federated undertakings. Many important matters nave been dealt with by the Federation, including joint head office accommodation, collective purchase of stores, and mutual insurance against third-party risks. The Federation has been constituted on the basis of making no profit, and the expenses are distributed among the various companies in proportion to the services required by each.

Parcels Delivery. Parcels delivery systems have been established on twelve routes of tramways and light railways, and the business is being gradually extended with every prospect of fair profits being earned.

The directors regret that owing to the constant pressure put upon tramway companies to reduce fares and to increase facilities, the important services rendered by the associated companies to the public are not adequately rewarded. As a result also of the legislative and municipal burdens placed upon electrical enterprise in this country and of the severe competition of foreign producers with English manufacturers—a competition which has reduced prices of electrical apparatus to such an extent that profits have practically vanished—electrical undertakings are not as remunerative in this country as might be expected, and consequently many of the assets of the company have suffered severe depreciation in value. Nevertheless, the Directors are of opinion that the market prices of the company's share and debenture capital are lower than the circumstances warrant, and this is, in a measure, to be ascribed to the prevalent industrial depression and to the general stagnation on the stock and share market.

ALUMINIUM CORPN. (LTD.)—At the first annual meeting on Tuesday Sir Jas. Sivewright said that in March the first furnace was tapped at Newcastle-on-Tyne, and they had been gradually adding to their furnaces there. The aluminium produced was of very high quality; in no case had it fallen under 99 per cent. of the pure metal. One carbon furnace was in full operation, and there would be three of those furnaces. In North Wales the works had been prosecuted with great vigour, and at the beginning of August they would be turning out aluminium at Dolgarrog to the extent of about 1,500 tons per annum. When the company was brought out aluminium was selling at from £180 to £200 per ton. The figures in the prospectus were based on aluminium selling at £120 per ton, but it was now about £80 per ton. Still, the directors viewed the situation with perfect equanimity, and he had no hesitation in saying, after the experience they had had, that when their works in North Wales were in operation, and when their other works were completed, the Aluminium Corpn. would be in a position, even with aluminium at £80 per ton, to make good profits, and to pay substantial dividends on its capital.

ARON ELECTRICITY METER (LTD.)—Mr. Hugo Hirst presided at the meeting on Tuesday, and said the report for the past six months bore out their prognostications. They had had a record six months in their history. After explaining the various items in the accounts, Mr. Hirst said that the Board of Trade had passed their prepayment meter for alternating currents—up to the present the only alternating current prepayment meter on which that distinction had been conferred—and if they might be so sanguine as to hope that that system of metering would become as popular for electric light as it had become in certain quarters for gas, it was bound to prove a good think for them in the future. The system of prepayment had not hitherto been much in demand for electric light; but now, with the cheapening of the supply and the advent of the Osram and other metallic filament lamps, which saved from 50 to 70 per cent. of current, electric lighting bade fair to become the poor man's illuminant as well. Dr. Aron had been successful in producing a taximeter which had met with the approval of the authorities of Scotland Yard, and had been passed by the National Physical Laboratory. A great many cab owners and cab trade societies had tested and tried it, and had given them considerable orders, but there were still difficulties in the way of its immediate use.

BIRMINGHAM & MIDLAND TRAMWAYS (LTD.)—At the meeting last week the chairman (Mr. C. S. B. Hilton) said their income was derived from tramways, electricity supply and from investments in subsidiary companies. During the past year their capital expenditure had been increased by £25,000, less £644 realised by sales. £8,714 had been spent on the tramways and £16,105 on electricity supply. Investments had been increased by £3 500, and were represented by debentures in the Motor Omnibus Co. The traffic receipts showed a decrease of £13,640, mainly due to the lease of the Dudley line having expired. Expenses showed a decrease of £4,200 on working account and a total decrease of £6,000. The receipts from the sale of electricity by meter had increased by £2,200, while supply for traction had declined by £1,200, due to the loss of the supply to the lines in Birmingham, but there was a net gain in receipts of £1,000, whereas expenses had only increased by £122. That side of their business continued to show a marked and satisfactory increase, while station costs, owing to the largely increased output, continued to fall. No agreement had been arrived at with Dudley Corporation respecting the lease of the lines in Dudley. The terms sought to be imposed by the Corporation on the companies interested were so onerous that to accept them would probably mean in some instances that no dividend could be paid and in others that the dividends would be reduced. Since the close of the year the company acquired a controlling interest in the Shropshire & Worcestershire Electric Power Co. Negotiations had been concluded with Oldbury Council for the transfer of their lighting order to the Shropshire Co., the right of purchase being deferred for 42 years.

BRUSH ELECTRICAL ENGINEERING CO. (LTD.)—At the meeting on Tuesday, Lord Vaux of Harrowden, after explaining the present position as to the capital of the company and various items in the balance sheet, said the output from the works for the year was a record one, but unfortunately a good deal of the business had to be taken at very low prices, and profits had been quite disproportionate to the amount of work turned out. That unsatisfactory result was due to strenuous competition, the after-effects of the strike of some of their workmen and insufficient working capital. Signs were not wanting in the electrical engineering industry of a desire on the part of manufacturers to hold out for better prices, and prices which would at least give some reasonable prospect of a living profit being earned. Owing to the falling off in orders for tramway cars, they had been obliged to turn their attention to contracts for main line rolling stock. It had been found only possible to carry on their business by borrowing on a considerable scale, and very high rates of interest were current. As their scheme for consolidating the debenture stocks and for the issue of new stock had not been approved, the directors had decided that the only course left open to them was to make an issue of £125,C00 5 per cent. prior lien debenture stock, and the underwriters will shortly offer these to the public. In the meantime, every means possible to economise on working expenses and establishment charges by concentration and otherwise were being taken. In conclusion, he announced that he proposed to resign the chairmanship of the company, and that Mr. Emil Garcke had consented to take a seat on the board and to accept the office of chairman for the present.

At a subsequent extraordinary meeting the following resolution was passed: "(1) That each of the 150,000 fully-paid non-cumulative 7 per cent. preference shares of £1. 6s. 8d. each be subdivided into four fully-paid non-cumulative 7 per cent. preference shares of 6s. 8d. each. (2) That each of the 105,732 fully paid ordinary shares of £1. 6s. 8d. each be subdivided into four fully-paid ordinary shares of 6s. 8d. each."

BUENOS AYRES GRAND NATIONAL TRAMWAYS CO. (LTD.)—For the year ended March 31 the gross receipts of the lines operated by the company (consisting of the lines of the company and those of the Buenos Ayres New Tramways Co.) amounted to £380,969. 6s, compared with £321,256. 9s. for 1906-7. Working expenses amounted to £242,117. 19s. 9d., compared with £220,389. 8s. 4d.; the net receipts were £138,851. 6s. 3d., against £100,867. 0s. 8d The Grand National Co.'s share of the net receipts under the agreement amounted to £91,446. 18s. 8d., compared with £68,405. 14s. 4d. After payment of London expenses, interest, &c., there remained £37,840. 15s. 11d., from which £3,502 has been transferred to debenture reserve funds and £3,726. 3s. to income bondholders' interest account, £11,250 as interim dividend of the 5 per cent. cumulative preference shares, leaving £19,362. 12s. 11d., which the directors recommend should be appropriated in payment of the balance preference dividend (on Aug. 1), £3,293. 8s. 11d. to contingency fund and the balance (£4,819. 4s) forward. Since the last meeting continued progress has been made with the work of converting for electric operation the joint system of the company and of the Buenos Ayres New Tramways Co. and of constructing further lines authorised by concessions from the Buenos Ayres Municipality. At March 31 there had been converted a total length of 85¾ miles, of which about 81 miles were being operated.

ELMORE'S GERMAN & AUSTRO-HUNGARIAN METAL CO. (LTD.)—After paying all charges, the net profit for 1907 is given as £863. 19s. 11d, against £267. 14s. 10d. in 1906. A considerable sum was expended during the year in additions to buildings and plant, and the directors believe that these additions, with improvements in the management at Schladern which have been instituted, will further lessen the cost of production and result in increased profits. The demand for the company's products continues to increase in a gratifying manner, and during the whole year the company was offered more work than it could accept. The amount standing to credit of profit and loss in the Austrian company's balance-sheet, added to £223. 9s. 9d. standing to credit of preference shareholders' reserve, is sufficient to pay a dividend of 2½ per cent. to the preference shareholders; and in view of the improved financial position of the company, and of the anticipated increase in the profits of the Metall Co., the directors recommend that such dividend, tax free, be declared.

UNITED ELECTRIC TRAMWAYS OF MONTE VIDEO (LTD.)—Mr. G. A. Touche, who presided at the meeting on Monday, said the report was satisfactory both as regarded the actual results which it showed and the indications for the future. Sections of the company's lines were opened for electric working as they were completed, beginning with only 9¼ miles of single track and gradually increasing to 29½ miles at the end of the half-year, and to 47 miles at the end of the year to October last. That was a long way short of the total of 80 miles of single track which they hoped ultimately to operate by electric traction. The average mileage in daily operation under electric traction during the year was only a little over 27. The electrical equipment of the Union y Maronas system was now prctically complete. The car mileage was 4,716,906, and of that 2,435,999 was by electric traction. Of the 21,358,943 passengers carried 11,954,288 were carried by electric traction. The gross receipts were £199,037 (increase £69,059), of which £91,537 was from animal traction and £107,500 from electric traction. Operating expenses had been 66·24 per cent., against 73·86 per cent. The net receipts showed an increase of £33,216, from £33,978 to £67,194. Nearly 75 out of the 80 miles of single track had now been equipped electrically, and they expected to supersede animal traction entirely in about three months. The gross receipts for the six months to April, 1908, were £126,778, compared with £106,841 last year. The net receipts were £52,507, against £39,936. On the Union system they looked for good results when the line was completed electrically. The various advices received from Monte Video all stated that large increases might be looked for. During the year they had expended £259,248, making the total amount charged to the electrification account over £800,000.

NEW COMPANIES, STATUTORY RETURNS, MORTGAGES AND CHARGES.

NEW COMPANIES.

ELECTRIC PREPAYMENT METERS (LTD.) (98,255.)—Reg. June 5, capital £5,000 in £1 shares, to acquire from the Electrical Apparatus Co. (Ltd.) the benefit of certain existing inventions relating to improvements in meters for recording the supply of electricity, to adopt certain agreements and to carry on the business of manufacturers of electricity meters, suppliers of electric light and power, mechanical and electrical engineers, &c. First directors, B. Bernheim, W. H. Fowler and J. T. Jervis. Reg. office, Caxton House, Tothill-street, Westminster.

ELECTRO-MECHANICAL BRAKE CO. (LTD.) (98,276.)—Reg. June 6, capital £10,000 in £1 shares, to acquire the benefit of certain existing inventions referred to in an agreement with J. B. Hamilton, A. W. Maley, G. Conaty and G. Law, jun., and to carry on the business of brakemakers, electrical and mechanical engineers, manufacturers of and dealers in tramway carriages, trucks, motors, accumulators, dynamos, &c. First directors, J. B. Hamilton, A. W. Maley, G. Conaty, G. Law, jun., and J. Hamblet. Reg. office, Eagle Works, Moor-street, West Bromwich.

ELECTROCAB DEVELOPMENT CO. (LTD.) (98,362).—Reg. June 13, capital £100 in £1 shares, to carry on the business of electrical, mechanical and general engineers, manufacturers of and dealers in electrocabs, electro-omnibuses and other electric vehicles, motor cars, &c.

LEEDS & BRADFORD DISTRICT ELECTRIC RAILWAYS (LTD.) (98,262.) Reg. June 5, capital £60,000 in £1 shares (40,000 preference) to adopt an agreement with the Railway & Tramway Trust relating to the transfer to the company of the Morley and District Light Railway Order (1901), &c., and to carry on the business of tramway, railway, omnibus, &c., proprietors, carriers of passengers and goods, electrical engineers, suppliers of electricity, &c.

LONDON ELECTROCAB CO. (LTD.) (98,355).—This company was reg. June 13, capital £100 in £1 shares. Other particulars as in Electrocab Development Co. (Ltd.) (q.v.).

McLAUGHLIN & BLAIR (LTD.) (5,326.)—Reg. in Dublin June 12, capital £5,000 in £1 shares, to acquire and carry on the business of electrical engineers, plumbers and furnishers, &c., carried on as McLaughlin & Blair at Belfast. First directors, J. McLaughlin, W. Blair and E. Lowden. Reg. office, 20, Waring-street, Belfast.

STATUTORY RETURNS.

BATH ELECTRIC TRAMWAYS (LTD.)—Return to April 28 gives capital as £230,000 in 75,000 preference, 150,000 preferred ordinary and 30,000 deferred ordinary shares of £1 each, of which 75,000 preference, 75,606 preferred ordinary and 30,000 deferred ordinary have been taken up. £1 per share has been called up on 75,000 preference and 75,606 preferred ordinary and £150,606 has been received. 30,000 deferred ordinary shares are considered as fully paid. Mortgages and charges £[illegible].

BROWETT, LINDLEY & CO. (LTD.)—In return to April 10 capital is £120,000 in 60,000 preference and 60,000 ordinary shares of £1 each, of which 50,000 preference and 50,000 ordinary have been taken up. £1 per share has been called up on 42,000 preference and 25,478 ordinary and £[illegible] has been received. £[illegible] is considered as paid on 8,000 preference and [illegible] ordinary. Mortgages and charges £50,000 debentures [illegible].

ELECTRIC LIGHT INSURANCE & MAINTENANCE CO. (LTD.)—Capital in return to May [illegible] is £[illegible],000 in £1 shares. [illegible] shares taken up. £1 per share called up on [illegible]. [illegible] has been paid; £[illegible] is in arrear. Nothing called up on the remaining [illegible] shares. Mortgages and charges, nil.

FOLKESTONE ELECTRICITY SUPPLY CO. (LTD.)—Return to April 3 gives capital as £100,000 in 20,000 shares of £5 each, all of which have been taken up and paid for in full. Mortgages and charges £90,000.

GLOUCESTERSHIRE ELECTRIC POWER SYND. (LTD.)—According to return to Dec. 31, 1907 (filed May 16, 1908) capital is £7,530 in 75 ordinary shares of £100 each and 600 deferred shares of 1s. each, of which 31 ordinary and 424 deferred have been taken up. £3,121. 4s. has been received. Mortgages and charges £850.

HAYWARDS HEATH ELECTRIC SUPPLY CO. (LTD.)—The capital in return to Jan. 14 is £1,000 in £1 shares, of which 7 have been taken up. No calls have been made. Mortgages and charges, nil.

MADRAS ELECTRIC TRAMWAYS (1904) (LTD.)—Capital in return to April 9 is £150,000 in 15,000 preferred ordinary and 15,000 deferred ordinary shares of £5 each, of which 15,000 preferred ordinary and 11,452 deferred ordinary have been taken up. £5 per share has been called up on £5,000 preferred ordinary shares and £25,000 has been received. £89,760 is considered as paid on 17,952 shares. Mortgages and charges £64,800.

ROUNDHAY & DISTRICT ELECTRIC LIGHTING CO. (LTD.)—Return to April 30 gives capital as £20,000 in 1,200 ordinary and 800 preference shares of £10 each, of which 789 ordinary and 225 preference have been taken up. £10 per share has been called up on the ordinary and £4 per share on the preference and £8,690 has been received, leaving £100 in arrears. Mortgages and charges, nil.

WASTE HEAT & GAS ELECTRICAL GENERATING STATIONS (LTD.)—In return to Feb. 26 capital is £150,000 in £1 shares, of which 64,652 have been taken up and paid for in full. Mortgages and charges nil. (A further 1,000 shares were allotted, payable in cash, on or after March 9 and 2,750 were allotted on the same terms on or after April 23.)

WINDERMERE & DISTRICT ELECTRICITY SUPPLY CO. (LTD.)—In return to April 11 capital is £50,000 in 5,000 preference and 5,000 ordinary shares of £5 each, of which 5,000 preference and 3,000 ordinary have been taken up. £5 per share has been called up on 3,040 preference and 1,730 ordinary and £23,850 has been received. £16,150 is considered as paid on 1,960 preference and 1,270 ordinary. Mortgages and charges £20,000.

MORTGAGES AND CHARGES.

COWANS LIMITED.—Particulars of £3,000 debentures, created by resolution of May 29, 1908, have been filed pursuant to sec. 14 (4) of the Companies' Act, 1900. Property charged: Company's assets, present and future, including uncalled capital. No trustees.

ELECTRIC LIGHT INSURANCE & MAINTENANCE CO. (LTD.)—Issue on May 27 of £2,440 5 per cent. debentures, part of series created May 11, 1908, to secure £2,500, charged on company's undertaking and property, present and future, including uncalled capital. No trustees. No previous issue of same series.

CITY NOTES.

MEMORANDA (June 18).—Bank rate 2½ per cent. (May 28, 1908). Price of silver, 25[illegible]d. per oz. Consols 87[illegible]—87[illegible] for money and 87⅛—87⅜ account. Consols Pay Day, July 1; Stock and Shares Continuation Days, June 24 and July 13; Ticket Days, June 25 and July 14; Pay Days, June 26 and July 15; Mining Share carry-over Day, June 23.

PRICES OF METALS (London). *Copper*, cash, 58[illegible]—58¾; three months, 58¾—59. *Lead*, English, 13; foreign, 12⅝—12⅞. *Spelter*, foreign, 19—19⅜. *Tin*, English, 127½—128½; foreign, cash, 127—127½, three months, 127¾—128¼. *Iron*, Cleveland, cash, 51/0—51/3; one month, 49/11—50/3.

BUENOS AYRES GRAND NATIONAL TRAMWAYS CO. (LTD.)—The directors recommend a final dividend at the rate of 2s. 6d. per share, less tax, making 5 per cent. for the year to March 31, on the £5 5 per cent. cumulative preference shares.

CHADBURN'S SHIP TELEGRAPH CO. (LTD.)—The directors have declared a dividend on the ordinary shares of 8 per cent. per annum for the half-year ended March 31, making 8 per cent. for the year.

COUNTY OF LONDON ELECTRIC SUPPLY CO. (LTD.)—The transfer books and register of holders of the first debenture stock will be closed from 17th to 30th inst. inclusive, preparatory to payment of interest due July 1.

INTERNATIONALE ELEKTRICITATS GESELLSCHAFT (VIENNA).—For the past year a dividend of 8 per cent. has been declared.

METROPOLITAN TRAMWAYS HOLIDAY TRAFFIC.—The Whitsuntide traffics on the Metropolitan Electric Tramways (Ltd.) show some striking figures. On Whit Monday the number of passengers carried was 334,806, and receipts were £2,383, or over £12 per car, or 25·99d. per car-mile.

STOCK EXCHANGE NOTICES.—The Stock Exchange committee have been asked to grant quotations to $5,650,000 additional 5 per cent. first mortgage 30 year $500 gold bonds of the [illegible] fully paid, for $1,5[illegible] 30 year 5 per cent. gold bonds of the [illegible], a further issue of 10,000 £5 fully paid 6 per cent. cumulative preference shares of the [illegible] and Supply Co. (Ltd.), and a further issue of [illegible] first mortgage 30 year 5 per cent. gold bonds of the [illegible] Light and Power Co. (Ltd.).

ELECTRIC TRAMWAY AND RAILWAY TRAFFIC RECEIPTS.

Line	Week ended.	Amount.	Inc. or Dec. (a)	Aggregate No. of weeks.	Aggregate Amount.	Aggregate Inc. or Dec. (a)
		£	£		£	£
Aberdeen Corporation	June 10	1,426	– 51	2	1,975	– 449
Airdrie	,, 5	240	+ 22	22	4,950	+ 60
Anglo-Argentine	,, 10	18,806	+ 2,284	23	426,987	+ 46,660
Ayr Corporation	,, 13	270	– 16	4	1,180	– 92
Baker St. & Waterloo Ry.	,, 13	3,080	+ 590	24	73,386	+ 16,379
Barnsley	,, 5	184	+ 28	22	3,797	+ 240
Barrow	,, 5	260	+ 19	22	4,973	– 111
Bath Electric Trams, Ltd.	,, 10	1,143	+ 363	23	15,396	– 1,203
Birkenhead Corporation	...	...	...	...	...	...
Birmingham Corporation	,, 13	7,444	+ 1,369	11	69,012	+ 3,919
Birmingham & Mid.	May 29	814	+ 73	21	16,946	+ 479
Blackburn Corporation	...	...	...	...	...	...
Blackpool Corporation	June 11	1,878	+ 1,194	§10	8,694	– 297
Blackpool and Fleetwood	...	...	...	...	...	...
Bolton Corporation	,, 14	2,493	+ 335	11	25,807	+ 1,054
Bombay	May 21	R35,833	+ R8,239	20	R728,773	+ R142,171
Bournemouth Corporation.	June 10	2,068	+ 502	10	16,778	– 701
Bradford Corporation	,, 13	5,807	+ 906	11	51,113	+ 306
Brighton Corporation	,, 14	1,209	+ 363	11	9,300	+ 101
Bristol Trams & Carriage	,, 12	7,002	+ 1,898	29	110,499	– 1,997
Buenos Ayres & Belgrano	,, 10	3,906	+ 237	23	87,712	+ 626
Burnley Corporation	,, 13	1,460	+ 199	11	14,260	+ 742
Burton Corporation	,, 14	318	+ 29	11	2,916	– 202
Bury Corporation	,, 7	1,163	+ 26	‡10	11,704	+ 1,046
Calcutta Tramways Co.	,, 13	R48,042	– R2,320	...	...	...
Camborne Redruth	,, 13	186	+ 76	24	2,929	+ 182
Cardiff Corporation	...	...	...	...	...	...
Cavehill	,, 5	116	+ 51	22	1,779	+ 156
Central London Railway	,, 13	7,223	+ 1,411	24	147,667	+ 1,515
Charing C., Euston & H'stead	,, 13	3,920	...	24	77,770	...
Chatham & Dist. Lt. Rys.	,, 11	1,116	+ 308	§23	16,299	+ 415
City & South London Rly.	,, 14	3,119	+ 50	24	77,446	+ 6,221
City of Birmingham	,, 5	2,937	+ 141	22	60,842	+ 61
Colchester Corporation	,, 10	441	+ 233	...	...	...
Cork Electric Trams Co.	,, 11	520	+ 32	§23	9,869	– 378
Croydon Corporation	,, 12	1,972	+ 483	11	15,533	+ 99
Devonport & Dist. Trams	,, 5	495	+ 41	22	9,678	– 93
Dover Corporation	...	...	...	...	...	...
Dublin & Lucan Railway	,, 12	190	+ 56	24	2,623	+ 138
Dublin United	,, 12	6,244	+ 87	24	117,320	– 1,684
Dudley-Stourbridge	,, 5	835	+ 14	22	16,835	– 1,717
Dundee Corporation	,, 10	1,217	+ 59	14	4,644	+ 462
East Ham Council	,, 13	1,079	+ 173	11	9,217	– 171
Exeter Corporation	,, 12	420	+ 107	11	3,275	– 135
Falkirk and District	,, 10	266	...	.	.	..
Gateshead & Dist. Trams	,, 5	1,000	+ 8	22	21,886	+ 144
Glasgow Corporation	,, 13	17,079	– 1,024	2	33,527	– 5,422
Glossop	...	...	...	...	...	...
Gravesend—Northfleet	,, 5	222	– 1	22	4,314	– 727
Great Northern & City Rly.	,, 13	1,523	– 208	24	40,828	– 2,872
Gt. Northern, Piccadilly, &c	,, 13	5,415	+ 815	24	129,940	+ 35,911
Greenock & Port Glasgow	,, 5	548	– 60	22	11,033	– 3,015
Hartlepool Tramways	,, 5	249	– 21	22	4,772	– 992
Hastings Elec. Trams Co.	,, 11	1,354	+ 313	24	20,612	– 328
Hong Kong	,, 13	$6,536	+ $1,807	...	...	...
Huddersfield Corpn.	,, 13	2,072	+ 424	11	17,987	+ 676
Hull Corporation	,, 13	2,589	+ 111	11	25,923	– 66
Ilford District Council	...	...	...	...	...	...
Ilkeston District Council	,, 10	183	+ 57	10	1,466	+ 60
Ipswich Corporation	,, 13	513	+ 136	11	4,095	– 14
Isle of Thanet Co.	,, 13	987	+ 370	37	11,926	– 306
Jarrow	,, 5	108	– 2	22	2,197	– 348
Keighley Corporation	,, 11	204	+ 35	50	7,934	+ 380
Kidderminster & District	,, 5	105	+ 3	22	2,008	– 272
Kilmarnock Corporation	,, 13	144	– 31	4	652	– 93
Lanarkshire Trams Co.	,, 11	1,313	+ 50	23	29,516	+ 3,554
Lancashire United	,, 10	1,501	+ 171	23	29,126	+ 1,235
Leamington	,, 5	192	+ 40	22	3,168	– 28
Leeds Corporation	,, 13	7,881	+ 1,155	11	70,369	+ 1,554
Leicester Corporation	,, 13	2,770	+ 438	...	...	...
Leith Corporation	,, 6	527	+ 14	§3	1,732	– 94
Lincoln Corporation	,, 13	141	+ 30	11	1,311	+ 64
Liverpool Corporation	,, 6	11,328	+ 340	23	238,616	– 2,255
Liverpool Overhead Rly.	,, 14	1,607	+ 94	24	33,707	– 706
*London County Council	,, 6	36,708	+ 5,184	†10	322,505	+ 30,207
London United	,, 13	10,977	+ 4,034	23	143,631	+ 2,575
Lowestoft	,, 14	268	+ 76	37	6,956	+ 198
Manchester Corporation	,, 13	17,340	+ 2,466	11	162,148	+ 7,412
Mersey Railway	,, 13	2,097	+ 149	24	46,046	+ 1,743
Merthyr	,, 5	216	+ 28	22	4,530	– 12
Metropolitan Dist. Railway	,, 13	9,025	+ 403	24	213,861	+ 22,508
Metropolitan Elec. Trams	,, 5	6,546	+ 2,166	22	114,984	+ 21,946
Middleton	,, 5	397	+ 94	22	7,400	– 51
Nelson Corporation	,, 13	156	+ 1	¶10	1,552	– 116
Newcastle-on-Tyne Corp.	,, 13	3,929	– 131	11	40,314	– 4,075
Newport (Mon.)	,, 13	938	+ 122	11	7,454	– 894
Northampton Corporation	,, 12	780	+ 348	¶10	4,956	– 283
Oldham, Ashton & Hyde	,, 5	618	+ 70	22	12,961	– 110
Oldham Corporation	,, 14	1,946	+ 141	12	23,311	+ 271
Perth (N.B.) Corporation	,, 10	164	+ 5	4	579	– 24
Perth (W.A.) Elec. Trams	,, 12	1,265	– 60	¶24	33,709	– 856
Peterborough	,, 5	137	+ 32	22	2,483	– 34
Portsmouth Corporation	,, 13	2,634	+ 718	11	20,643	– 90
Potteries	,, 5	1,843	+ 31	22	40,320	– 61
Preston Corporation	,, 10	1,032	+ 297	24	16,829	– 92
Rotherham Corporation	,, 11	842	+ 232	§10	6,468	+ 194
Rothesay	,, 5	178	+ 4	22	2,051	– 147
Salford Corpn.	,, 15	6,241	+ 1,681	11	52,211	+ 23
Sheerness	,, 3	62	+ 4	22	1,122	– 21
Sheffield Corporation	,, 14	6,589	+ 1,051	†12	65,807	+ 34
Singapore Trams	,, 13	$9,091	– $523	...	...	...
South Metropolitan	,, 5	1,032	+ 227	22	16,032	+ 3
South Staffs	,, 5	887	+ 50	22	19,081	– 520
Southend Corporation	,, 10	599	+ 222	11	3,850	+ 211
Southport Tramways	,, 5	286	– 1	22	5,155	– 577
Stalybridge, Hyde, &c., Jt. Bd.	,, 13	966	+ 159	†11	8,449	– [illegible]
Sunderland Corporation	,, 14	1,470	+ 25	11	12,482	– [illegible]
Sunderland and District	,, 10	663	+ 211	32	14,775	+ 1,301
Swansea Trams	,, 5	952	+ 124	22	19,374	+ 1,189
Swindon Corporation	,, 19	186	+ 17	...	...	...
Taunton	,, 5	42	+ 2	22	856	– 41
Tynemouth and District	,, 5	225	+ 26	22	3,519	– 457
Tyneside Trams Co.	,, 10	482	+ 44	24	8,655	– 1,151
Wallasey District Council	,, 13	1,118	+ 273	†11	9,40[illegible]	+ 183
Walsall Corpn.	,, 13	718	+ 205	24	12,593	+ 1,332
Weston-super-Mare	,, 3	105	+ 11	22	1,092	– 360
Wolverhampton Co.	,, 5	444	+ 22	22	9,759	– 468
Wolverhampton Corpn.	,, 10	1,334	+ 497	1	1,334	...
*Worcester	,, 5	305	+ 32	22	5,551	– 125
Wrexham	,, 5	104	+ 9	22	2,140	– 13
Yorkshire W.R. Trams	,, 11	2,417	+ 924	21	28,183	...
Yorkshire Woollen District	,, 5	313	+ 19	22	19,757	– 803

(a) These comparisons are with the corresponding period last year. § Plus 2 days. ¶ Plus 3 days. * Partly electrical. † Minus 3 days. ‡ Minus 2 days. ‖ Plus 4 days.

ELECTRICAL COMPANIES' SHARE LIST.

Share	Last Dividend	NAME.	Price Wed., June 17.	Rate % Yielded. £ s. d.	Dividend Due.	Business Week to June 17. Highest.	Lowest.
		ELECTRICITY SUPPLY.					
10	9/0	Bournemouth & Poole Elec. Sup. Ord.	10½–11	6 7 0	Mar, Sept,	10½	..
10	4/6	Do. 4½ per Cent. Cum. Pref.	9½–10½	4 7 0	Feb, Aug	..	..
10	6/0	Do. 6 per Cent. Cum. Second Pref.	10½–11	5 9 0	Feb, Aug	..	..
St.	4½%	Do. 4½ per Cent. Deb. Stock (red.)	102–105	4 5 6	Jan, July	..	..
5	3/6	Bromley (Kent) El. Lt. & Power Shares	4½–5	5 10 0	April, Oct	..	..
St.	4½%	Do. Do. 1st Debs.	94–97	4 12 9	May, Nov	..	
5	5/6	Brompton & Kensington Elec. Sup. Ord.	6¾–7¼	6 9 0	March....	7¼	7..
5	3/6	Do. 7 per Cent. Pref.	6¾–7¾	4 10 0	Mar, Sept	..	..
St.	4%	Central Elec. Sup. Co. 4% Guar. Db. Stock	98–101	4 0 0	June, Dec	..	..
5	2/6	Charing Cross (W. End & City) El. Sup. Co.	3½–4½	6 1 0	Feb, Aug	..	..
5	2/3	Do. 4½ per Cent. Pref.	4¼–4¾	4 17 0	Feb, Aug	4½	..
St.	4%	† Do. 4 per Cent. Deb. Stock (red.)	95–99	4 1 0	Jan, July	95½	..
5	2/3	Do. City Undertaking 4½% Cm. Pref.	3⅞–4⅜	5 3 0	Jan, July	..	..
5	2/6	Chelsea Electric Supply Ord.	8–8½	6 5 9	March ..	[illegible]	[illegible]
St.	4½%	* Do. 4½ per Cent. Deb. Stock (red.)	101–104	4 6 9	June, Dec	.	..
10	7/0	City of London Electric Lighting Ord.	9¾–10¼	5 16 6	Feb, Aug	9½	9¾
10	6/0	Do. 6 per Cent. Cum. Pref.	12–13	4 12 0	Jan, July	12½	..
St.	5%	Do. 5 per Cent. Deb. Stock (red.)	124–127	3 18 0	June, Dec	.	
St.	4½%	Do. 4½ per Cent. 2nd Deb. Stock (red.)	102–105	4 6 0	Jan, July	103½	..
5	1/10½	County of Durham Elec. P.D. Ord.	2¾–3	8 9 7	April, Oct	..	..
5	5%	Do. 5 per Cent. non Cum. Pref.	3⅝–3⅞	6 13 4	April, Oct	..	..
10	6/0	County of London Elec. Supply Ord.	7¾–8¼	6 3 6	Feb, Aug	.	..
10	6/0	Do. 6 per Cent. Cum. Pref.	10½–10¾	5 10 6	Mar, Sept	10½	..
St.	4½%	Do. 4½% Deb. Stock (all paid) (red.)	107–110	4 2 6	Jan, July	..	..
St.	4½%	Do. Second Deb. Stock	98–101	4 9 9	May, Nov	98¾	..
5	3/6	Folkestone Electricity Supply Co. Ord.	4¾–5¼	6 7 0	April, Oct	..	—
5	2/6	Do. 5 per Cent. Cum. Pref.	5–5½	4 11 0	Mar, Sept	..	..
St.	4½%	Do. 4½ 1st Deb. Stock (red)	94–97	4 13 0	Feb, Aug	..	..
5	4/6	Hove Electric Lighting Ord.	6–6½	6 11 0	April, Oct	..	..
5	5/0	Kensington & Knightsbridge Ord.	7–8	6 5 0	Feb, Aug	..	..
5	6%	Do. 6 per Cent. 1st Pref.	6–6½	4 12 0	Jan, July	..	—
St.	4%	Do. 4 per Cent. Deb. Stock (red.)	96–99	4 1 0	..	..	..
St.	4%	Kensingtn. & Kngtbg. Co. & Notting Hill Co. (Joint Station) 4% Deb. Stock (red.)	97–101	3 19 0	April, Oct	..	..
St.	4½%	Kent Elec. Power Co.	88–92	4 18 3	Jan, July	..	..
3	1/6	London Electric Supply Ord.	⅞–1⅛	5 8 0	Mar, Sept	..	..
5	3/0	Do. 6 per Cent. Pref.	4½–4¾	6 6 0	Mar, Sept	..	..
St.	4%	† Do. 4 per Cent. 1st Mort. Deb.	89–92	4 7 0	Jan, July	4⅛	4¼
5	3/6	Metropolitan Electric Sup. Ord.	4½–5	6 10 0	April, Oct	..	..
5	2/3	Do. 4½ per Cent. Cum. Pref.	4½–5	4 10 0	Jan, July	109¾	..
St.	4½%	Do. 4½ per Cent. Deb. Stock 1st Mort.	107–111	4 1 0	June, Dec	8½	..
St.	3½%	Do. 3½ per Cent. Mrt. Deb. Stock (red.)	85–90	3 18 0	Jan, July	..	..
100	4½%	Midland Elec. Corp. for P.D. 1st Mort. Db.	96–99	4 11 0	June, Dec	..	—
10	4%	Newcastle & Dist. Elec. Ltg. Ord.	7¾–8¼	5 0 0	Feb, Aug	..	—
100	4½%	Do. 4½ per Cent. Deb.	96–98	4 12 9	Jan, July	..	..
5	8%	Newcastle Elec. Supply Ord.	5⅝–5⅞	6 19 2	Feb, Aug	.	..
5	5%	Do. 5 per Cent. non Cum. Pref.	5¼–5½	4 13 0	Feb, Aug	..	..
100	4%	Do. 4 per Cent. Mort. Deb. red. 1907.	97–99	4 1 8	Jan, July	..	..
1	3%	Northern Counties Elec. Sup.	—	..	Mar, Aug	..	..
100	4½%	Do. 4½ per Cent. Deb.	95–97	4 13 9	Jan, July	..	..
10	8/0	Notting Hill Electric Ord	11¾–12¼	5 14 0	March ..	..	..
5	4/6	Oxford Electric Ord.	5¾–6¼	5 12 0	March ..	..	..
St.	4%	Do. 4 per Cent. Deb. Stock	94–98	4 1 6	Jan, July	..	..
5	5/0	St. James' & Pall Mall Elec. Ord.	7¾–8¼	6 1 3	Feb, Aug	8	..
5	3/6	Do. 7 per Cent. Pref.	6¾–7¼	4 16 6	Feb, Aug	..	..
St.	3½%	Do. 3½ per Cent. Deb. Stock (red.)	85–90	3 17 9	Jan, July	..	..
5	..	Smithfield Markets Electric Sup. Ord.	¼–¾	..	Feb	..	..
St.	4%	Do. 4 per Cent. Deb. Stock	70–74	5 8 0	Feb, Aug	..	..
5	4/0	South London Electric Supply Ord.	2¼–2¾	7 6 0	April ...	..	..
1	0/6	South Metrop'n Elec. Lt. & Power Ord.	⅜–⅝	4 0 0	..	.	..
1	0/8⅖	Do. 7 per Cent. Cum. Pref.	1 1/16–1 3/16	5 6 0	Feb, Aug	..	..
St.	4½%	Do. 4½ 1st Db. Stk. Red.	99–102	4 8 0	April, Oct	..	..
5	2/6	Urban Electric Supply Ord.	1–2	12 10 0	April, Oct	..	..
5	2/6	Do. 5 per Cent. Cum. Pref.	1⅞–2⅛	10 12 0	April, Oct	2	..
St.	4½%	Do. 4½ per Cent. 1st Mort. Deb.	87–90	5 0 0	April, Oct	.	..
5	5/0	Westminster Elec. Sup. Ord.	7½–8	6 5 0	Mar, Sept	7⅞	7½
5	2/3	Do. 4½ per Cent. Cum. Pref.	4⅞–5⅜	4 4 0	Jan, July	..	..
		ELECTRIC RAILWAYS, TRAMWAYS, &c.					
St.	4%	Baker St. & Waterloo 4% Perp. Db. St.	90–92	4 7 0	Jan, July	91½	..
1		Bath Elec. Trams Pref. Ord.	¼–½	8 0 0	April	¼	—
1	0/6	Do. 5 per Cent. Cum. Pref.	⅝–⅞	5 14 0	Jan, July	..	..
St.	4½%	Do. 4½ 1st Mort. Deb. Stock (red.)	85–90	5 0 0	April, Oct	..	..
St.	4½%	B'ham & Midland Trams 4½ 1st Db. Stk.	93–96	4 15 0	Jan, July	..	..
10	9%	Bristol Tramways & Carriage Ord.	10–10½	8 11 9	Feb, Aug	..	..
10	4%	Do. Cum. Pref. (fully paid)	8–8½	4 14 0	..	..	..
St.	4%	Do. 4 per Cent. Debs.	99–100	4 0 0	Feb, Aug	..	..
10	..	British Electric Traction Ord	1⅜–1⅝	..	June, Dec	1½	..
10	6/0	Do. 6 per Cent. Cum. Pref.	4⅛–4⅝	..	Feb, Aug	4½	..
St.	5%	Do. 5 per Cent. Perpetual Debs.	92–97	5 3 0	April, Oct		..
St.	4½%	Do. 4½ per Cent. 2nd Deb. Stock	74–78	5 14 6	May, Nov	75½	..
St.	3%	Central London Ordinary Stock	77–80	3 15 0	Feb, Aug	81½	78¼
St.	4%	Do. 4 per Cent. Pref. Stock	90–92	4 7 0	Feb, Aug	91	90¼
St.	2%	Do. Deferred Stock	59–62	3 4 6	Feb	61½	59
100	4%	Do. 4 per Cent. Debs.	103–106	3 15 6	Jan, July	103½	103¼
St.	4%	Charing X, Euston & Hmpstd Per. Db. Stk.	82–85	4 14 0	Jan, July	..	..
5	2/6	City of Birmingham Trams. 5% Cm. Pref.	4¼–4¾	5 5 0	April, Oct	..	..
100	4%	Do. 4 per Cent. 1st Mort. Debs.	97–100	4 0 0	April, Oct		..
St.	1¾%	City & South London Rly. Con. Ord.	39–41	4 18 0	Feb, Aug	40	..
St.	5%	Do. 5 per Cent. Perp. Pref. (1891)	113–116	4 6 0	Feb, Aug	..	—
St.	5%	Do. (1896)	112–115	4 7 0	Feb, Aug	113	..
St.	5%	Do. (1901)	110–113	4 8 6	Feb, Aug	..	..
St.	5	Do. (1903)	105–108	4 12 6	Feb, Aug	..	..
St.	4%	Do. 4 per Cent. Perpetual Debs.	100–103	3 17 6	May, Nov	..	..
10	7/0	Dublin United Trams. Ord	12¼–13¼	4 10 6	Feb, Aug	..	..
10	6/0	Do. 6 per Cent. Pref.	12½–13½	4 9 0	Feb, Aug	..	—
10	..	Gt. Northern & City Rly. Pref. Ord. (4%)	¾–1¼	..	Feb, Aug	..	..
10	4/0	G. Northern, Piccadilly & Brompton Ord.	6–6½	6 3 0	Feb, Aug	6¼	6½
St.	4%	Do. 4 per Cent. Deb. Stock	89–92	4 7 0	Jan, July	90½	89¾
5	4/0	Hastings & Dist. Elec. Trams. 6% Cm. Pf.	3¾–4¼	7 1 0	Mar, Sept	4	..
St.	4½%	Do. 4½ Db. St.	93–96	4 13 9	April, Oct	..	..
10	9%	‡ Imperial Tramways Ord.	10½–11½	7 17 0	Mar, Sept	..	
10	6%	‡ Do. 6 per Cent. Pref.	9½–10½	5 17 0	Mar, Sept	..	..
St.	4½%	‡ Do. 4½ per Cent. Debs.	93–94	4 15 9	Jan, July	..	..
5	..	I. of Thanet E. T. & Lt. 5 per Cent. Pref.	⅞–1⅛	..	Mar, Sept	..	..
St.	4%	Do. 4 per Cent. Deb. Stock	58–63	6 7 0	Jan, July	..	..
10	6/0	Lanarkshire Tramways	9½–10½	5 9 0	Feb, Aug	10	10
St.	5%	Lancs. Utd. Trams 5% Prior Lien Db. St.	91–94	5 6 0	Jan, July	..	..
10	..	Liverpool Overhead Railway Ord.	1⅛–1½	..	Feb, Aug	..	..
10	5%	Do. 5 per Cent. Pref.	6¼–6¾	7 10 0	Feb, Aug	..	..
St.	4%	Do. 4 per Cent. Deb.	85–87	4 11 0	Jan, July	..	..
10	5/0	London United Trams. 5% Cum. Pref.	7¾–8¼	6 2 0	Jan, July	8	7¾
St.	4%	Do. 4 per Cent. 1st Mort. Deb. Stock	81–86	4 13 0	Jan, July	..	..
St.	..	Mersey Con. Ord. Stock	1–3	—	Feb, Aug.	..	..
St.	..	Do. 3 per Cent. Perp. Pref.	3–6	—	..	..	..
1	..	Metropolitan Elec. Tramways Def.	¼—	—	April..	..	..
1	0/6	Do. 5 per Cent. Cum. Pref.	1⅛–1⅜	6 3 6	Feb, Aug	.	..
St.	4½%	Do. 4½ per Cent. Deb. Stock	95–98	4 12 0	Jan, July	96	.
St.	½%	Metropolitan Railway Consolidated	41½–42½	1 3 6	Feb, Aug	42⅞	41¾
St.	2½%	Do. Surplus Lands Stocks	68–70	3 13 0	Feb, Aug	68	[illegible]
St.	3½%	Do. 3½ per Cent. Preference	86–89	3 19 9	Feb, Aug	..	86½
St.	3½%	Do. 3½ per Cent. "A" Preference	75–78	4 9 6	Feb, Aug	..	..
St.	3½%	Do. 3½ per Cent. Convertible Pref.	73–76	4 12 0	Feb, Aug	..	.
St.	3½%	Do. 3½ per Cent. Debenture Stock	91–94	3 14 6	Jan, July	93¾	93½
St.	3½	Do. 3½ per Cent. "A" Ditto	89–92	3 16 0	Jan, July	90½	..

* In calculating the yield allowance has been made for accrued interest but *not* for redemption
† Ex Dividend

Last Dividend	Name	Price Wed., June 17.	Rate % Yield. £ s. d.	Dividend Due.	Business Week to June 17. High-est.	Low-est.
	ELECTRIC RAILWAYS & TRAMWAYS—Continued.					
..	Metropolitan District Railway Ord.	13 —14	--	Feb, Aug	14	13
..	Do. Extension Pref. (5 per Cent.)	23 —28	..	Feb, Aug	23½	..
3½%	Do. Asserted Ext. Pref. (Int. Guar. by Und. Elec. Rlys. Co. of London, Ltd.)	44 —48	7 6 0	Feb, Aug	..	..
3%	Do. 3 per Cent. Consoltd. Rent-charge	70 —75	4 0 0	Jan, July	72½	..
4%	Do. 4 per Cent. Midland Rent-charge	100 —104	3 17 0	Jan, July	..	..
1½%	Do. Guar. Stock 4 per Cent	44 —49	3 11 0	Mar, Sept	..	..
6%	Do. 6 per Cent. Perp. Deb. Stock	120 —125	4 16 0	Jan, July	..	..
4	Do. 4 per Cent. Ditto	73 —78	5 3 0	Jan, July	..	..
..	New Gen. Tract. 6 per Cent. Cum. Pref.	½ —¾	..	May	..	--
0/9¾	Potteries Electric Traction Ord.	½ —½	8 0 0	April, Oct	..	..
0/6	Do. 5 per Cent. Cum. Pref.	⅜ —⅜	6 13 0	Feb, Aug	..	..
4½%	Do. 4½ per Cent. Deb. Stock	93 —96	4 14 6	May, Nov	..	..
0 7½	S. Met. Elec. Trams. & Ltg. 6% Cm. Pref.	¾—1	6 0 0	Feb, Aug	..	..
4%	Do. 4 per Cent. Deb. Stock	77 —81	4 19 0	Jan, July	79½	79½
5%	Sunderland Dist. Elec. Trms. 5% 1st Mt. Db.	77 —82	6 8 0	Jan, July	76½	..
5%	Underground Elec. Rys. Co. of London...	39 —43	11 12 0	June, Dec	41	..
..	Yorkshire (W.R.) Elec. Trams. Ord.	⅞ —1⅛	--	March ..	..	..
..	Do. 6 per Cent. Cum. Pref.	3⅜ —3⅝	--	..	..	..
4½	Do. 4½ per Cent. 1st Debs.	84 —87	5 3 6	Jan, July	..	..
	ELECTRIC MANUFACTURING, &c.					
..	Aron Electricity Meter Ord.	⅜ —⅝	..	..	..	..
1 2⅞	Do. 6% Cum. Pf.	⅝ —⅞	7 2 0	April, Oct	..	..
2/4½	Babcock & Wilcox Ord.	3¾ —4	5 0 0	April, Oct	4⅛	3⅞
0/7⅛	Do. Pref.	1⅛ —1 3/16	3 16 9	..	..	..
6/0	British Insulated & Helsby Cables Ord.	6¼ —6½	8 0 0	July, Feb	..	..
3 0	Do. 6 per Cent. Pref.	5⅞ —6⅛	4 16 0	Jan, July	..	..
4½%	Do. 4½ per Cent. 1st Mort. Deb. (red.)	102 —105	4 5 6	Jan, July	..	..
4½%	British Thoms'n-Houst'n 4½% 1st Mt. Db.	93 —98	4 12 0	Mar, Sept	..	..
..	British Westinghouse 6 per Cent. Pref...	1 —1⅛	..	Feb, Aug	--	..
4%	Do. 4 per Cent. Mort. Deb. Stock	46 —50	8 0 0	Jan, July	..	..
..	Brush Electrical Engineering	⅛	--	March ..	..	..
..	Do. 6 per Cent. Pref. non-Cum.	⅜ —⅞	..	Mar, Sept	..	..
4½%	Do. 4½ per Cent. Prep. 1st Deb. Stock	73 —75	6 0 0	Mar, Sept	..	..
4½%	Do. Perpetual 2nd Deb. Stock	55 —60	7 10 0	Jan, July	..	..
10 0	Callender's Cable Con. Ord.	9½ —10⅜	6 18 0	Jan, July	10⅛	9¼
2/6	Do. 5 per Cent. Cum. Pref.	5¼ —5⅜	4 7 0	Jan, July	..	..
4½%	Do. 4½ per Cent. 1st Mort Debs. (red.)	107 —109	4 2 0	Nov, May	..	..
1/0	Castner-Kellner Alkali Co.	1¼ —1⅜	9 18 0	May, Nov	1⅛	..
4½%	Do. 4½ per Cent. 1st Mort. Deb. (red.).	101 —104	4 6 6	Feb. Aug	1 3	..
0 9⅞	Chadburn's (Ship) Telegraph Ord.	1⅛ —1 3/16	8 8 0	March ..	..	..
0/7½	Do. 6 per Cent. Cum. Pref.	1 —1⅛	5 6 6	April, Oct	..	..
0/8½	Consolidated Electrical Co.	¾ —½	7 0 0	August ...	..	..
1/0	Consolidated Signal Co.	1⅛ —1¾	4 5 6	April, Oct	..	..
0/7½	Do. 6 per Cent. Cum. Pref.	1⅝ —1¾	6 4 0	April, Oct	..	..
3/0	* Crompton & Co. (Nos. 1 to 30,000)	1⅜ —1⅝	8 1 6	Jan, July	1½	..
5%	Do. 5 per Cent. 1st Mort. Debs. (red.).	92 —95	5 5 0	Jan, July	1½	1⅜
0/7½	Davis & Timmins	⅞ —1⅛	..	Mar, Sept	..	..
2/0	Dick, Kerr & Co. Ord.	1 1/16 —1⅜	7 12 3	Sept	..	..
0/7½	Do. 6 per Cent. Cum. Pref.	1 —1⅛	4 16 0	Sept	..	--
4½%	Do. 4½ per Cent. Deb. Stock	101 —104	4 6 6	Jan, July	..	--
2/6	Edison & Swan United ("A" Sh.) (£3 p.l.)	¾ —⅞	..	Feb, Aug	..	..
4/2	Do. (£5 paid)	1⅞ —2⅛	5 0 0	Feb, Aug	..	..
4%	Do. 4 per Cent. Mort Deb. Stock (red.)	78 —81	4 19 3	June, Dec	..	..
5%	Do. 5 per Cent. 2nd Deb. Stock	85 —87	5 15 0	Mar, Sept	--	..
..	Edmundson's Elec Corp. Ord	⅜ —⅝	..	Jan, July	..	..
..	Do. 6 per Cent. Cum Pref.	¾ —1	..	May, Nov	..	..
4½%	Do. 4½ per cent. 1st Mort. Deb. (red.)	63 —73	6 2 9	Jan, July	..	..
..	Electric Construction Co.	½ —⅝	..	Jan, July	..	..
..	Do. 7 per Cent. Cum. Pref.	1¼ —1⅜	..	July	..	..
4%	Do. 4 per Cent. Perp. 1st Mort. Debs.	63 —67	6 19 3	Jan, July	63	..
5/0	General Electric (1900) 5% Cum. Pref...	7¾ —8¼	6 1 8	June, Dec	..	..
4%	Do. 4 per Cent. 1st Mort. Debs	87 —90	4 9 0	Mar, Sept	..	..
0/0	Henley's Telegraph Works Ord.	10½ —11½	6 10 0	Feb, Aug	11	10⅞
2/3	Do. 4½ per Cent. Pref.	5 —5½	4 2 0	Feb, Aug	..	..
4½%	Do. 4½ per Cent. 1st Mort. Deb. Stock	101 —106	4 5 0	Mar, Sept	..	..
5/0	India Rubber, Gutta Percha, &c., Wrks.	15¼ —16¼	6 2 0	Feb, Aug	15⅞	..
4%	Do. 4 per Cent. Debs. (red.)	98 —100	4 0 0	April, Oct	98⅞	98½
2/0	National Elec. Construction Co.	⅜ —⅝	..	April	..	..
7/8½	Richardsons, Westgarth & Co., Ltd. Ord.	⅞ —1⅛	7 2 0	Nov	..	..
7½	Do. 6 per Cent. Cum. Pref.	⅞ —⅞	6 17 0	May, Nov	..	..
4½%	Do. 4½ per Cent. Perp. Deb. Stock	87 —91	4 19 0	Jan, July	..	--
..	Simplex Conduits Ord.	1¼	..	..	..	--
..	Do. 6 per Cent. Cum. Pref.	5¼	..	..	--	..
0/0	Telegraph Construction & Maintenance	31 —32	6 10 0	Mar, July	31½	31
4%	Do. 4 per Cent Deb. Bonds (1909)	102 —104	3 16 6	Jan, July	..	..
2,0	Vickers, Sons & Maxim, Ltd., Ord.	1¼ —1⅜	8 1 6	..	1⅜	1⅜
3/6	Do. 5 per Cent. non-Cum. Preference	1 —1⅛	4 9 0	..	1⅜	..
5%	Do. 5 per Cent. non-Cum. Preferred	103 —107	4 13 6	June, Dec	..	..
4%	Do. 4 per Cent. 1st Mort. Deb. Sk. (red.)	101 —103	3 17 6	June, Dec	..	..
4½%	Do. 4½ per Cent. 2nd Mort. Deb. (red.)	102 —105	4 6 0	June, Dec	103⅞	101½
5,6	Do. 5 per Cent. 3rd Mort. Debs. Perp	100 —102	..	..	101½	101⅞
5,0	J. G. White & Co. 6 per Cent. Cm. Pref.	7½ —8½	7 1 0	..	..	..
/0	Willans & Robinson Ord.	¾ —1½	4 0 0	Apr, Oct	--	..
/0	Do. 6 per Cent. Cum. Pref.	3⅛ —3⅜	8 5 0	Apr, Oct	--	..
%	Do. 4 per Cent. 1st Mort. Debs.	70 —74	5 7 0	May, Nov	70	..
	TELEGRAPHS.					
..	Amazon Telegraph	2 —3	--	June, Dec	..	--
%	Do. 5 per Cent. Debs (red.)	84 —87	5 15 0	June, Dec	..	..
5/0	Anglo American	59 —62	5 11 0	F,My,Ag,N	..	--
0,0	Do. Preferred	104 —105	5 14 0	F,My,Ag,N	104⅞	104
%	Do. Deferred	16½ —17	5 18 0	F,My,Ag,N	17⅛	16⅞
%	Commercial Cable 4 per Cent. Deb. Stk.	84 —87	4 12 0	Jn,Ap,Jy,O	85½	81½
0	Cuba Submarine Ord.	7½ —8½	7 5 0	Feb, Aug	..	..
0/0	Do. Preference 10 per Cent.	16⅜ —16⅞	5 19 0	Feb, Aug	..	..
/0	Direct Spanish Ord.	3 —3½	6 4 0	April, Oct	..	..
/0	Do. 10 per Cent. Cum. Pref.	8 —9	5 11 0	April, Oct	..	..
½%	Do. 4½ per Cent Deb.	00 —103	4 7 6	Jan, July	..	..
,0	Direct United States Cable	13½ —14	6 11 6	Ja,Ap,Jy,O	13½	13½
½%	Direct West India Cable 4½% Rg. Db. (rd.	10 ½ —102½	4 8 0	June, Dec	..	..
5/0	Eastern Ordinary	131 —136	5 3 0	Ja,Ap,Jy,O	135½	133⅞
7 6	Do. 3½ per Cent. Pref. Stock	81½ —86	4 1 0	Ja,Ap,Jy,O	86	81½
%	Do. 4 per Cent. Mort. Deb. Stk. (red.)	100½ —102½	3 18 0	May, Nov	102⅞	103
,6	Eastern Extension	12¼ —13¼	6 6 0	Ja,Ap,Jy,O	13	12
%	Do. 4 per Cent. Deb. Stock	10½ —102½	3 18 0	Feb, Aug	101⅞	..
%	Eastern & S. African 4% Mort. Deb. 1900	1 ½ —102½	3 18 0	Feb, Aug	..	..
%	Do. 4% Mauritius Sub. Debs. (red.)	99½ —101½%	3 19 0	May, Nov	..	..
0 6	G. N. of Copenhagen, with Coupon 73	28 —31	6 12 0	Jan, July	29¼	28⅞
4%	Halifax & Bermuda 4½% 1st Mt. Db. (red.)	10 ½ —102½	4 8 0	June, Dec	..	..
7 6	Indo-European	64 —67	5 19 0	May, Nov	64½	64½
1	† Mackay Companies Common	60 —70	5 11 0	Ja,Ap,Jy,O		..
1	† Do. Preferred	60 —70	5 11 0	Ja,Ap,Jy,O	..	..
	Marconi's Wireless Teleg. Co.	--	..	April		
	Pacific & European Tel. 4% Guar. Db. (red.)	100 —102	3 18 0	June, Dec		--
,3	West Coast of America	1 —1	3 15 0	May	1	..
--	Do. 4 per Cent. Debs.	99 —102	3 18 0	Jan, July	.	..
	West India & Panama	⅜ —⅜	..	May, Nov	..	..
/0	† Do. 6 per Cent. 1st Pref.	8¼ —8⅞	6 17 0	May, Nov	8	..
6,0	Do. 6 per Cent. 2nd Pref. ex. div. & coupon	8 —9	..	May, Nov	..	..
	Do. 5 per Cent. Debs.	101 —104	4 16 0	Jan, July	..	..
0	Western Telegraph	13⅜ —13⅞	6 1 0	Mr,Jn,O,D	13⅜	13⅜
	Do. 4 per Cent. Deb. Stock (red.)	100 —102	3 18 0	June, Dec	102⅛	..
	Western Union Telegh. $1,000 4% Bonds	79 —81	4 19 0	..	..	..

Shares	Last Dividend	Name	Price Wed., June 17	Rate % Yield. £ s. d.	Dividend Due.	Business Week to June 17. High-est.	Low-est.
		TELEPHONES.					
100	2½	Amer. Telephn. & Telegh. Cap. St.	120 —124	6 12 6	..	89½	87¾
..	4%	Do. Coll. Trust $1,000 4 per Cent. Bds	89 —92	4 7 0	Jan, July	..	..
St.	5%	Anglo-Portug'se Tel. 5% 1st Mt. Db. Stk.	99 —102	4 18 0	Mar, Sept	..	--
5	3 0	Chili Telephone	7 —7½	5 6 6	August ..	7⅜	--
1	0/7⅛	Monte Video Telephone Ord.	1⅛ —1⅜	6 16 0	Nov	..	..
1	0/6	Do. 5 per Cent. Pref.	1⅛ —1⅜	5 7 0	May, Nov	..	..
St.	6%	National Co. Pref. Stock	108½ —111½	5 8 0	Feb, Aug	110½	108⅞
St.	6%	Do. Def. Stock	113 —115	5 4 0	Feb, Aug	114½	112½
10	6/0	Do. 6 per Cent. Cum. 1st Pref.	11½ —12½	4 16 0	Feb, Aug	11⅞	11⅞
10	6/0	Do. 6 per Cent. Cum. 2nd Pref.	10½ —12½	4 16 0	Feb, Aug	..	..
5	2/6	Do. 5 per Cent. non-Cum. 3rd Pref.	5⅜ —5⅞	4 9 0	Feb, Aug	5½	5⅜
St.	3½%	* Do. Deb. Stock 3½ per Cent. (red.)	99½ —101½	3 9 0	June, Dec	100	..
St.	4%	Do. 4 per Cent. Deb. Stock (red.)	102½ —104½	3 17 0	Jan, July	..	..
1	1/0	Oriental	1¼ —1⅜	5 9 0	April, Oct	1⅛	..
1	0.7½	Do. 6 per Cent. Cum. Pref.	1⅛ —1¼	4 16 0	April. Oct	..	..
St.	4%	Do. 4 per Cent. Red. Deb. Stock	90 —93	4 6 0	Jan, July	..	..
St.	4½%	Telephone Co. of Egypt 4½% Db. Stk. (red.)	99 —102	4 8 0	Jan, July	..	..
5	3/9	United River Plate	6⅜ —6⅞	5 16 6	July	6½	..
5	2/6	Do. 5 per Cent. Cum. Pref.	5 —5½	4 11 0	June, Dec	..	..
St.	4½%	Do. 4½ Deb. St. Red.	100½ —102½	3 18 0	Jan, July	101½	101½
		FINANCIAL, INVESTMENT, &c.					
5	8/0	Elec. & Gen. Investment 6% Cum. Pref.	3¾ —4¼	7 1 0	Jan, July	--	..
10	2 0	Globe Telegraph & Trust	10⅜ —10⅞	5 1 0	Sp,De,Mr,Ju	10⅞	10⅞
10	3/0	Do. 6 per Cent. Pref.	13⅜ —14⅜	4 5 0	Sp,De,Mr,Ju	13⅞	13⅞
10	6%	Submarine Cables Trust (Cert.)	127 —130	4 12 0	April, Oct	..	..
		COLONIAL AND FOREIGN ELECTRIC RAILWAYS, TRAMWAYS, &c.					
5	3/0	Anglo-Argentine 6% Cum. 1st Pref.	6¼ —6½	4 12 0	April, Oct	6⅜	6⅜
5	5/0	Do. 10% Non-cum. 2nd Pref.	8⅞ —9⅜	5 14 0	Jan, July	8⅞	8⅞
St.	6%	Do. Permanent 6% Deb. Stock	141 —146	4 2 0	June, Dec	..	..
St.	5%	Auckland Elec. Trams. 5% Deb. (red.)...	101 —107	4 13 6	Jan, July	..	..
5	4/0	Brisbane Electric Trams. Invest. Ord.	4⅜ —4⅝	4 10 6	May	4⅜	4⅜
5	2/6	Do. 5 per Cent. Cum. Pref.	4⅞ —5⅛	4 17 6	May, Nov	..	..
St.	4½%	Do. 4½ per Cent. Db. Prov. Certs.	99 —1 3	4 7 6	Jan, July	100½	..
St.	8%	British Columbia El. Ry. Df. Ord.	125 —130	6 3 0	Mar, Sept	126½	..
St.	65 0	Do. Pref. Ord. Stock	108 —112	5 6 6	May, Nov	110½	110⅛
St.	5%	Do. 5% Cum. Perp. Pref. Stock	107 —111	4 10 0	Jan, July	..	..
40	4½%	Do. 4½ per Cent. 1st Mort. Debs.	99 —102	4 8 0	April, Oct	104	..
100	4½%	Do. Vancouver Power Debs.	101 —104	4 6 6	Jan, July	100⅞	--
St.	4½%	Do. 4½% Perp Con. Deb. St.	99 —102	4 3 0	..	..	..
5	3/0	Buenos Ayres & Belgrano Ord.	4¾ —4⅞	8 1 6	April, Oct	..	..
5	3/0	Do. 6 per Cent. "A" Cum. Pref.	4⅜ —4⅝	5 17 6	April, Oct	..	..
5	3/0	Do. "B"	4⅜ —5⅜	5 17 6	April	..	..
St.	5%	Do. 5 per Cent. Debs.	110 —116	4 6 0	Jan, July	--	..
St.	5%	Do. 5 per Cent. 2nd Debs. (red.)	102 —105	4 15 3	Jan, July	..	..
St.	5%	Buenos Ayres Elec. Trams (1901) Ltd. Deb. St.	95 —99	5 1 0	Ja, Jul ..	..	..
5	..	Buenos Ayres Grand National Ord.	2¼ —2⅜	..	..	2⅛	2⅛
5	2/6	Do. 5 per Cent. Cum. Pref.	3⅜ —4⅜	5 14 0	Feb, Aug	4⅜	..
100	5½%	Do. 5½ per Cent. Pref. Debs.	101 —105	5 4 9	Jan, July	..	..
100	6%	Do. 6 per Cent. 1st Deb. Bonds.	100 —104	5 14 6	April, Oct	102	101½
St.	5%	Buenos Ayres Lacroze Trams 1st Mt. Db.	91 —94	5 6 6	Mar, Sept	--	..
St.	6%	Buenos Ayres Port & City Tram. 1st Mt. Deb. Stock £75 Paid	64 —68	6 12 0	Feb, Aug	..	..
5	2/6	Calcutta Tramways (1 to 137,610)	6⅜ —6⅞	4 15 0	Mar, Sept	6	5⅞
100	2/6	Do. 5 per Cent. Cum. Pref.	5 —5⅜	4 13 0	Jan, July	..	..
1	4½%	Do. 4½% 1st Deb. Stock (red.)	103 —106	4 5 0	Jan, July	105½	--
St.	..	Cape Electric Tram Shares	1⅛ —1⅛	..	..	..	..
5	1/3	City of Buenos Ayres Trams Co. (1904 Sh.	5⅛ —5⅜	4 6 6	F,My,A,N	5⅛	5⅛
St.	4%	Do. 4 per Cent. Deb. Stock	99 —103	3 17 6	June, Dec	..	..
	5%	Colombo Tr. & Ltg. 5% 1st Mt. Db.	85 —91	5 10 0	May, Nov	..	..
100	5%	Electric Traction Co. of Hong Kong 5 per Cent. 1st Mort. Debs.	85 —90	5 10 0	June, Dec	..	..
1	5%	Havana Elec. Ry. Con. Mt. 5% $1,000 50 year Coup. Bds.	82 —87	5 14 6	Feb, Aug	85½	85
1	..	Kalgoorlie Elec. Trams Sh.	⅛ —⅜	..	..	..	..
100	5%	Do. 5 per Cent. "A" Deb. Stock	85 —87	5 12 0	Jan, July	..	--
5	6%	Do. 6 per Cent. "B" Ditto	69 —73	8 4 0	Jan, July	..	--
5	1/0	Lisbon Elec. Trams. Ord.	1 —1¼	4 0 0	July	..	--
100	0/7½	Do. 6 per Cent. Cum. Pref.	1 —1¼	4 16 0	Jan, July	..	--
St.	5%	Do. 5 per Cent. Reg. Mort. Debs.	90 —95	5 5 0	Jan, July	..	..
St.	5%	Madras Elec. Trams. 5% Deb. Stk.	95 —98	5 2 0	Jan, July	..	..
	5%	Manila Elec. Ry. $1,000 Gold Bonds	86 —90	5 11 8	Feb, Aug	..	..
100	$1	Mexico Trams Co. Com. St.	100 —102	8 18 0	..	101¾	99⅞
500	5%	Do. Gen. Con. 1st Mort. 5% Gold Bds.	90 —91%	5 10 0	..	91⅞	89⅞
St.	4½%	Montreal St. Ry. Sterling 4½ per Cent. Debs. (1922)	101 —103	4 7 6	Feb, Aug	..	..
1	1/0	Perth Elec. Trams Ord.	⅛ —⅜	8 0 0	May	..	..
St.	5%	Do. 1st Mt. Db. Stock	103 —106	4 14 3	Jan, July	..	..
5	3/0	Rangoon Elec. Trams & Supply Co. 6% Cum. Pf.	5½ —5⅞	5 4 0		..	..
St.	4½	Do. 4½% 1st Mort. Deb. Stk.	97 —99	4 11 0	..	..	..
..	$1	Sao Paulo Tramway, Light & Power Co. $100 Stock	132 —137	6 11 6	..	136	133
	5%	Do. 5 per Cent. 1st Mt. $500 Db.	93 —98	5 2 0	June, Dec	95⅞	95⅞
100	4½%	Toronto Ry. Co. 1st Mt. 4½% Ster. Bonds	98 —100	4 10 0	Feb, Aug	..	..
		COLONIAL AND FOREIGN ELECTRICITY SUPPLY, &c.					
5	3/0	Adelaide Elec. S'ply Co. 6% Cu. Pr.	4⅞ —5⅛	5 14 0	Mar, Sept	..	..
10	5/2½	Bombay E. S. & T. 6% Cm. Pf.	10½ —10⅞	5 11 6	..	10⅞	..
St.	4½	Do. 4½ per Cent. Deb. Stk. (red.)	94 —96	4 14 6	Jan, July	..	..
5	4/9	Calcutta Elec. Supply Ord.	5⅞ —6⅛	6 2 0	April, Oct	..	..
100	7,2	Canadian Gen. Elec. Co. Com. St.	88 —90	7 16 0	..	90	89
100	5%	Castner Electrolytic Alkali Co. (of U.S.A.) 1st Mort. Stl. Debs.	94 —99	5 1 0	Jan, July	..	..
500	5	Elect. Development Co. of Ontario	83 —83½	5 16 0	..	83½	81
5	..	Elec. Ltg. & Trac. Co. of Aust. 6 per Cent. Cum. Pref.	2¼ —2¼	..	Feb, Aug	..	..
St.	5%	Do. 5 per Cent. Deb Stock	84 —88	5 14 0	Jan, July	..	..
St.	5%	Elec. Supply Co. of Victoria 5 per Cent. 1st Mort. Deb. St.	90 —93	5 7 6	Jan, July		..
St.	6%	Indian Elec. Sup. & Trac. Co. Deb. St. Rd. Prov. Certs.	95 —98	6 2 0	Jan, July	..	..
100	0 3	Kalgoorlie Elec. Power & Ltg. Ord.	⅛ —¼	..	..	..	..
1	0,7½	Do. 6 per Cent. Cum. Pref.	⅜ —¾	8 0 0	April, Oct	..	--
St.	6%	Madras E. S. Corp. 6 per Cent. Constn Deb. St.	85 —90	6 11 0	April, Oct	..	..
500	5%	Mexican Elec. Light Co. 5% 1st Mort Gold Bonds	82 —83	6 0 0	..	84	82½
St.	..	Mexican Lt. & Power Co. Cap. St.	58 —60	..	..	60⅜	58½
500	5%	Do. 5% 1st Mort. Gold Bnds	87 —88	5 11 0	..	88⅛	88⅛
100	6%	Montreal Lt. Ht. & Power Co. Cap. St.	96 —100	6 1 0	F,M,A,N	--	..
1	1/-	River Plate Electricity Co. Ord.	1	6 4 0	April		.
1	1 2½	Do. 6 per Cent. non-Cum. Pref.	⅛ —1	6 0 0	May	--	..
St.	5%	Do. 5 per Cent. Deb. Stock	96 —99	5 1 0	Jan, July	..	..
5	3/0	Rosario Elec. Co. 6% Pref. (1 20,000)	4⅞ —5½	5 17 8	April, Oct	..	..
100	$1	Shawinigan Water & Power Co. Cap. St.	71 —73	5 10 0	..	72	71⅞
..	5%	Do. 5 per Cent. Bds.	102 —104	4 17 0	Jan, July	103½	103
..	7 57d	Victoria Falls Power Co. Pref.	.. ..	--	Jan, July	..	..

In calculating the yields allowance has been made for accrued interest but *not* for redemption † Ex dividend. ‡ The London Stock Exchange Committee have declined to quote these

THE ELECTRICIAN:

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CONTENTS OF THE CURRENT NUMBER.

NOTES.

The Institution of Electrical Engineers.

Some years ago the Institution of Electrical Engineers purchased a site in Tothill-street, Westminster, on which it was proposed to erect a building as a permanent home for the Institution as soon as funds would permit; but hitherto the Council have not felt themselves in a position to complete this scheme, and thus the members still find themselves with a lodging rather than with a home. Considering the extent of the membership, it is, perhaps, a little surprising that the Institution should still have such comparatively small quarters, though we think the best course has undoubtedly been followed, and that it is useless to attempt a home on a large scale before the Institution can afford it. A proposal is now under consideration to purchase the Medical Examination Hall, belonging jointly to the Royal College of Physicians and the Royal College of Surgeons. As will be seen from an illustration which we give on page 409, the building is of an imposing character, and stands in a fine situation on the Victoria Embankment, near Waterloo Bridge. In some respects it may seem a pity to leave that part of Westminster associated particularly with engineering institutions, but, on the other hand, many members are occupied in parts of London remote from Victoria-street, and, from the point of view of general accessibility from all suburbs, the site of the Medical Examination Hall is as convenient as could be wished. It appears that the theatre is rather small, but its size could be increased without serious expense, and it is certainly an advantage to obtain a building which can be used practically as it stands. With regard to the financial aspect of the scheme, it is difficult to express an opinion upon the information that has so far become available. It is proposed—and, so far, it is nothing more than a proposal, as there is nothing binding on either side—that the lease of this building for 76 years should be purchased for £50,000, the ground rent being £2,201 per annum. This seems a somewhat heavy burden for the Institution to undertake in its present financial position, and will require careful consideration. Doubtless on Tuesday next, for which date, at 5:30 p.m., the special general meeting has been called to consider the matter, the Council will give detailed information as to ways and means.

The London Power Bills.

We have become so accustomed to wholesale slaughter of power bills in Parliament at this time of year that it comes as a surprise that the Select Committee of the House of Lords should have found the preambles proved of all three of the power bills which they are now considering. The various clauses still have to be considered, and there may be many modifications. So far, however, the London and District Electricity Supply Bill has got into smoother water than might have been expected, although it will be gathered that the Committee do not feel the financial position to be quite as good as it might be. The London (Joint Committee) Electric Supply Bill has also found favour to a certain extent. As far as "linking up" is concerned, the principle is accepted, but the idea of a Joint Committee has not proved acceptable. Undoubtedly, the linking-up part of the project is the most important, and it is difficult to understand why it has not been admitted before. The joint control of certain matters is certainly desirable from many points of view, but possibly the Bill in its modified form will effect most of what the companies desire. The principle of linking up having been admitted, it is only natural that the Committee should find the preamble of the third Bill proved—namely, that of the London (Westminster and Kensington) Electric Supply. There now remains to be seen what will happen

when the Bills come before the House of Commons, and whether the old adherents of the policy which created the scheme of the London County Council will prove sufficiently strong to delay or reject the proposals of private enterprise.

The Glasgow Tramway Accident.

In commenting on this accident in our issue of January 17th, we referred to the fact that the car in question had been allowed to be run without the motorman having more than two of the four possible methods of braking under his control. It now appears from the report by Col. H. A. Yorke to the Board of Trade, an account of which will be found elsewhere in this issue, that not only was this the case, but, owing to the reversing handle having been left in the forward position at the rear end of the car, the magnetic track brake was probably rendered inoperative, so that the motorman, although he was unaware of the fact until his car had attained a dangerous speed, had really only his hand brake upon which to depend. This certainly seems the most probable solution of the occurrence, for Col. Yorke draws attention to the fact that if, in taking the controller handle off the controller at No. 1 end of the car whilst at the terminus, it were moved very slightly, say only from ¼ in. to ⅜ in., in the direction of the braking notches, it would be impossible, so long as the reversing handle at No. 1 end was in the forward position, to operate the electric brake from the controller at No. 2 end. This can, of course, be guarded against, as the Inspector suggests, by an arrangement whereby the controller handle can only be removed or put on in the correct "off" position. As a matter of fact, such an arrangement is employed on most controllers, and should certainly be adopted as an essential precaution.

The question of "emergency" as against "service" brakes is again raised by Col. Yorke, who is strongly opposed to any form of "power" brake being regarded as an emergency brake, on account of the likelihood of its being wrongly applied or failing at a critical moment; and he believes that motormen should be instructed to use the most powerful brake at their disposal at all times. We ourselves have from time to time given expression to the same views, for with the increased speed and congestion of traffic any hesitation on the part of a motorman is of the greatest consequence, and there is no doubt that the only way to reduce the number of accidents to a minimum is to accustom the motormen to depend in all cases upon one brake, the application of which would be varied to suit the circumstances. Another point to which Col. Yorke refers in his report is that of efficient sanding apparatus. It seems that the sanding apparatus on the Glasgow tramcars is only arranged to distribute sand on one rail, and as this is obviously a defect we hope that one of the results of the inquiry will be the fitting of additional sand hoppers on all the cars at Glasgow.

L.C.C. Tramway Finances.

In our issue of March 27th last we commented on the report by Messrs. Peat and Pixley on the accounts of the London County Council tramways. As was only to be expected, the report is still a bone of contention between the two parties into which the Council is divided, and it is evident that a settled policy with regard to tramway finance is still far from being reached. During the past week the Finance Committee have submitted their report to the Council upon the recommendations made by Messrs. Peat and Pixley, and, after a lengthy discussion, this report was adopted. There can be no doubt that the recommendation of the Finance Committee to write off the whole of the loss on the displaced assets of the horse system by March 31, 1929, is sound, and it is in close agreement with the period of 25 years which we ourselves suggested. As regards the renewals fund, the basis of two-thirds of a penny per car-mile which has been adopted (the Committee concurring in the view of the officials that this is sufficient) seems to us to be scarcely satisfactory when compared with the amounts set aside by other municipalities who have had a longer experience in this respect. We notice, however, that the question is to be reconsidered after five years, and that, meanwhile, any surplus available after the renewals fund has been brought to the full amount on the above basis is to be paid into a general reserve fund, so that for the next few years the ratepayers are not likely to receive any of the profits which some authorities have led them to expect.

Junior Institution of Electrical Engineers.—The summer meeting of this institution will be held in France from June 27th to July 11th. Paris, Creusot and Havre will be among the places visited.

Physical Society.—We are informed that, owing to the sudden death of Prof. W. R. Cassie, M.A., one of the honorary secretaries of this Society, the meeting which was to have been held to-day at the National Physical Laboratory has been cancelled.

Electric Traction in the Alps.—An electric railway is being built on the Zugspitze, the highest peak in the Alps, on Bavarian territory. Its height is about 10,000 ft. The railway will run to the summit, while a hotel will be built at the 7,000 ft. level.

Electric Traction on the New York Central Railway.—According to the *Electrical World*, this company have announced that the electrification of their lines within the limits of the metropolitan district will be completed by July 1, and after that date no steam locomotives will be run through the tunnel.

Electrical Engineers (Royal Engineers).—Lieut.-Col. and Hon. Col. John Arthur Hughes, from the Severn Division (Electrical Engineers) Royal Engineers (Volunteers), has been appointed, with the rank of lieut.-colonel and hon. colonel, to command the Royal Engineers of the Welsh Territorial Division.

University of Oxford.—It is announced that the Drapers' Company have offered a sum of £22,000 to provide for the building and fitting up of an electrical laboratory at this University. It is proposed that the laboratory should form part of the University Museum, which will have to be extended for the purpose.

Electrical Equipment of the Royal Mint.—With reference to our article on this subject which appeared on p. 328 of our issue for June 12th, we are informed by the Magneta Co. that their electrical clock system is installed throughout the Royal Mint. The master clock is fitted up in the official building, and we understand that the dials have shown themselves to be quite unaffected by the vibration of the rolling and stamping machinery, or by the proximity of the electric light and power cables.

Cable Interruptions.	Date of Interruption.
Cayenne–Salinas ...	May 12, 1908
Las Palmas–Arrecife ...	May 18, 1908

Royal Society.—Among the Papers read before this Society yesterday were "The Emission and Transmission of Röntgen Rays," by Mr. G. W. C. Kaye, and "Further Note on a Luminous Glow generated by Electrostatic Induction in an Exhausted Vessel made of Silica," by Rev. F. J. Jervis-Smith, F.R.S.

"Electric Railway Journal."—We have received the first issue of this journal which incorporates the *Street Railway Journal* and the *Electric Railway Review*. The former of these has been in existence for 24 years, while the latter dates back to 1891; this was first known as the *Street Railway Review*, changing its name to the above title in 1906.

Electric Traction on Bavarian State Railways.—In our issue of May 29th we dealt at some length with a report that had been issued on this subject and gave some account of the estimated costs on one particular branch of the Bavarian railways. A recent number of the *Neue Freie Presse* states that sums have now been voted for this section, viz., the railway from Salzburg to Bad Reichenhall and Berchtesgaden. The cost of this work is given at £188,500, and will join the new railway to be worked electrically from Berchtesgaden to Königsee. Votes have also been passed for the conversion of certain other lines.

Obituary.—We regret to record the death of Mr. W. R. Cassie, M.A., Professor of Physics at the Holloway College, Egham, which occurred suddenly on Monday last. Prof. Csssie was born in 1861 and was educated at Aberdeen University and Trinity College, Cambridge. He held, from time to time, numerous scholastic appointments, including a Cambridge University Extension Lecturership and a Clark Maxwell Studentship of Experimental Physics in the same University. He was appointed to the position of professor at Holloway College in 1894. Since 1906 he was one of the Honorary Secretaries of the Physical Society of London.

A New System of Alternate Current Regulation.—In a recent number of the *Elektrotechnische Zeitschrift* M. Seidner deals with this problem, which consists in devising a method for making the exciting current dependent on the strength and phase of the main current. To do this the exciter current and a "regulating" alternating current are allowed to flow at the same time in an iron resistance serving as the shunt regulator of the exciter set. The regulating alternating current is obtained from the mains through transformers which are so arranged that this current drops as the load increases or the power factor decreases. The resistance works on the same principle as the "ballast" resistance used in the Nernst lamp. The current flowing through this resistance is the geometrical sum of the exciting and regulator currents, so that when the latter decreases the former rises, thus giving the necessary regulation.

"The Electron."—We have received the first number of a magazine bearing this title, whose appearance rather belies its name, and which is issued under the *ægis* of Messrs. Siemens Bros. Dynamo Works at Stafford. Its modest object is "to be the literary hub of the busy Siemens' world," and we wish it well in its career. The editor plaintively appeals, in a manner sometimes not unknown to editors, for "matter"; but if the first number be any criterion there should be no lack of that while Siemens continues to be. The presidential address of the Siemens Stafford Engineering Society makes good reading, and the history of the formaation of the Institute is interesting, as most domestic histories are. The Institute has recently made another step forward, for new buildings have been purchased and adapted for social uses. The air of Stafford must be specially bracing, as the clubs and societies run by the members of the Institute are quite too numerous to mention.

Damaged Atlantic Cables.—Last week the Bristol Chamber of Commerce considered the question of the damage done to submarine telegraph cables off the west coast of Ireland by steam trawlers. The discussion arose out of a communication from the Liverpool Chamber who suggested that representations should be made to the President of the Board of Trade, urging him to hold a full inquiry into all the circumstances in order to adjust fairly the various interests involved; the more so, as it was believed that the Fishery Organisation desired to avoid wilful damage to the cables. It was suggested that a zone be defined within which trawling should be prohibited, or other efficient regulations might be made applicable. It was decided to adopt the course suggested and to act in concert with the Liverpool Chamber on the subject.

The Commercial Cable Co. learn from New York that "Chambers of commerce, exchanges, and trade associations throughout the United States are adopting resolutions and forwarding memorials to the Government at Washington appealing for protection for submarine cables against damage by trawlers off the Irish coast. Many prominent bankers and business houses have made representations on the subject to Secretary Root and to the British Consul-General in New York."

Wireless Telegraph Notes.—Reuter states that it has been announced officially that from July 1 the German Government telegraph department will undertake a wireless telegraph service, including (the report states) "coastal, ship and ordinary tariffs."

It is stated in the *Giornale d'Italia* that Mr. Marconi (in an interview with a representative of that journal) announced that from the wireless station at Coltano, which will be working in the autumn, tests will be made to establish communication with North America, to be followed by similar tests for communication with Erythrea and South America; which, in turn, will be followed "in a few years" by communication with China and India.

At Palermo (Sicily) a wireless telegraph station is being established to effect communication with Naples and Cagliari (Sardinia). A wireless station is already in operation between Messina and Calabria for railway-signalling purposes, and a station erected by the Marconi Company forms a part of the naval semaphore station at Cozzo Spadaro (Syracuse).

A wireless station has been erected on the highest point of the Alcazaba, the old Moorish castle overlooking the port of Almeria (Spain). The station communicates with Melilla on the opposite African coast, and has been erected by the Spanish Ministry of War. It is to be in operation in the course of next month.

ARRANGEMENTS FOR THE WEEK.

FRIDAY, June 26th (to-day).

PHYSICAL SOCIETY.

The Meeting announced for this date has been cancelled (*see* Note).

TUESDAY, June 30th.

INSTITUTION OF ELECTRICAL ENGINEERS.

5:30 p.m. Special General Meeting in the Lecture Theatre, Medical Examination Hall, Victoria Embankment.

THURSDAY, July 2nd.

ROYAL SOCIETY OF ARTS.

9 p.m. Annual Conversazione at the Natural History Museum, South Kensington.

INCORPORATED MUNICIPAL ELECTRICAL ASSOCIATION.

TUESDAY, June 30th.

10 a.m Meeting at University College, Nottingham. Presidential Address by Mr. H. Talbot. Paper on "The Experiences of a Convener in the Establishment of an Electricity Undertaking," by Bailie Wightman.

12:45 p.m. Luncheon at the Mechanics Large Hall, Nottingham.

2:30 p.m. Visit to the St. Ann's Power Station and to the Trent Bridge Car Sheds and Repair Shops in Nottingham.

WEDNESDAY, July 1st.

8:40 a.m. Excursion to Dovedale.

THURSDAY, July 2nd.

10 a.m. Annual General Meeting at University College, Nottingham.

2:30 p.m. Meeting at University College, Nottingham. Papers on "Some Considerations on the Design of a Generating Station," by Mr. H. Richardson, and on "The Reconstruction of an Electric Lighting Scheme," by Mr. C. M. Shaw.

7:30 p.m. Annual Dinner at the Exchange Hall, Nottingham.

FRIDAY, July 3rd.

10 a.m. Meeting at University College, Nottingham. Papers on "A.C. Accumulator Sub-Stations," by Mr. A. M. Taylor," and on "The Work and Equipment of a Testing and Standardising Department," by Mr. H. A. Ratcliff.

THE DESIGN OF A CONTINUOUSLY ADJUSTABLE RESISTANCE.

BY J. T. MORRIS, R. MILWARD ELLIS AND F. STROUDE.

In connection with a research now proceeding at the East London College, it became necessary to design a reliable piece of apparatus which should vary continuously the current through a coil from a maximum value to an equal value in the opposite direction, and which should allow the experimenter entire control of the speed. It was also highly desirable that the apparatus should be mechanically sound and compact.

This article describes the various arrangements the authors applied to this purpose, the difficulties they met with and the arrangement they finally adopted. It is divided into three sections :—

1. Liquid resistances.
2. Carbon resistances.
3. Wire and strip resistances.

I.—Liquid Restances.

A liquid resistance would appear at first sight to be particularly suited to the requirements of the case, as contact

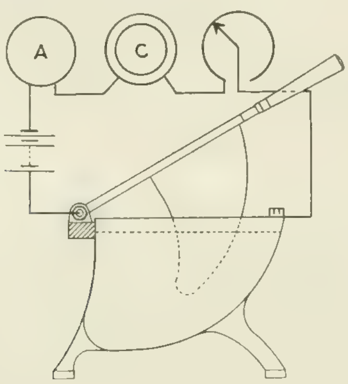


Fig. 1.

difficulties are eliminated and the adjustment is absolutely continuous.

The first apparatus tried was an ordinary liquid starting switch, arranged as in Fig. 1, consisting of a cast-iron tank containing soda solution, into which an electrode could be gradually lowered, finally short-circuiting the whole of the resistance. As the short-circuiting occasioned an abrupt

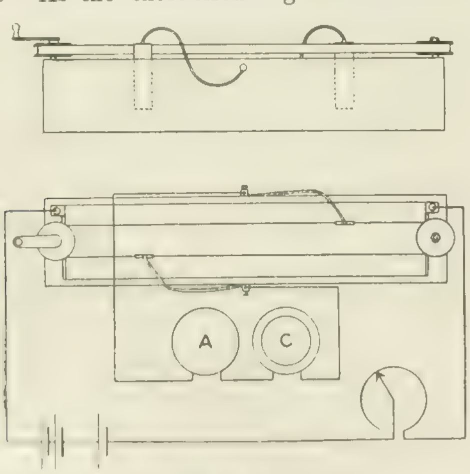


Fig. 2.

change in the current it became necessary to work with a lower resistance electrolyte. This could not be accomplished sufficiently well by the use of soda nor by copper sulphate, and, consequently, dilute sulphuric acid was tried. A direct consequence of the decrease of resistance now became apparent in an abrupt change of the current immediately the electrode entered the liquid. To a certain extent it would have been possible to diminish this by using a finer pointed electrode. Eventually, however, this method was abandoned, because, in addition to the objections already enumerated, it only permitted a current variation from a maximum value to zero or vice versa.

To overcome these difficulties and thus enable a complete reversal to be accomplished in one operation, an arrangement somewhat similar to the Ewing & Hopkinson liquid reverser was devised. This is illustrated in Fig. 2. It consists of a wooden trough having two lead plates fixed at its ends, and two others which can be traversed along the tank in opposite directions by means of a belt. The first electrolyte to be used was soda solution, but as its resistance could not be reduced sufficiently to permit of a reasonably large final current, dilute sulphuric acid was substituted.

Polarisation of the moving plates now occasioned an abrupt reversal of the current as they passed, and although this effect was greatly diminished by substituting moving plates of carbon for those of lead, it could not be eliminated sufficiently to render smooth regulation possible.

A fairly satisfactory arrangement for dealing with large currents was obtained by using two large water resistances in place of the carbon rheostats shown in Fig. 3. The handwheels operating the electrodes were geared together, so that the electrode of one resistance was raised while that of the other was lowered.

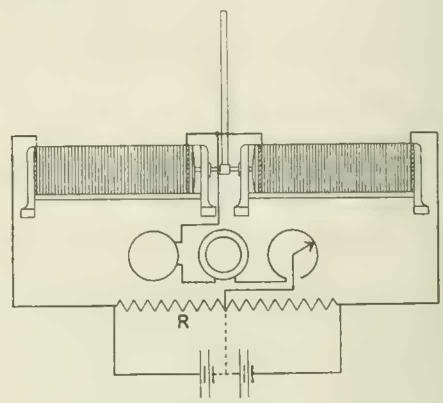


Fig. 3.

In addition to the particular objections stated above, the following general disadvantages of liqud resistances may be mentioned : They are neither portable or compact, are untidy, wasteful of current and, owing to evaporation, are not permanent.

II.—Carbon Plate Resistances.

The next method to be utilised was one first suggested by Dr. D. K. Morris,* and is illustrated in Fig. 3. Two carbon plate rheostats are mounted in line, having a common tightening screw which can be rotated by means of a lever; thus tightening one and loosening the other. It was found, however, that the resistances of the rheostats were extremely uncertain unless they were well tightened, in which case the total current necessary was very large in comparison with that actually employed. This waste current was much reduced by removing the resistance R (Fig. 3) and connecting to the centre point of the battery, as shown by the dotted line. To reduce still further this waste current, the connections shown in Fig. 4 were devised. In this arrangement each carbon rheostat is divided into two portions by insulating plates, the connections

Fig. 4.

* "Testing of Transformers and Transformer Iron." Morris and Lister, April 25, 1906.

being arranged in a similar way to those of a Wheatstone bridge. The same variation in tightness now produces practically double the variation of the current through the test coil. Even then the waste current was objectionably large, and, also, in order to afford smooth regulation, the rheostats had to be so tight that it became difficult to obtain sufficient variation of resistance.

III.—Wire and Strip Resistances.

Liquid resistances having proved unsuccessful the authors next turned their attention to wire resistances. The arrangement shown in Fig. 5 was the first to suggest itself. This consists of two ordinary wire rheostats of 8 ohms each, which were connected in series as shown. The test coil was connected across the sliders. The sliders could be traversed by means of a lathe slide-rest. This arrangement was found to be fairly satisfactory. The chief objections were as follows:

1. The current steps were rather too large to give smooth regulation.
2. The slider contacts were somewhat variable.
3. The current-carrying capacity of the wire was insufficient.

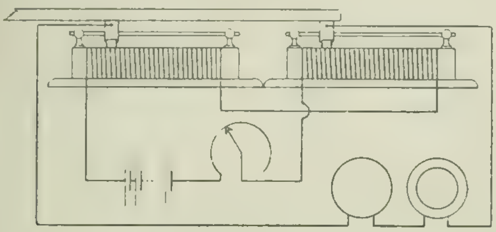


Fig. 5.

It also shared the objection already mentioned in connection with the arrangement shown in Fig. 1—viz., it only permitted current variation from maximum to zero.

The rheostat shown in Figs. 6 and 7 was next constructed of No. 16 S.W.G. Eureka wire wound with a pitch of $\frac{1}{8}$ in. on a piece of slate 33 in. long and 2 in. by 1 in. cross-section. The sliders were traversed by screws which were rotated by means of a gear wheel and pinions so that 90 turns of the handle were necessary for a complete reversal. The total resistance of the wire was 9 ohms and its final temperature rise about 100°C. with a current of 5 amperes. This rheostat was found to be very satisfactory when dealing with currents up to 1 ampere; but for much stronger currents the adjustment as the sliders approached one another became less and less continuous. Further, the arrangement was rather bulky and also somewhat noisy owing to the considerable length of the traversing screws. Also, notwithstanding the fact that its adjustment under limited practical conditions was sufficiently

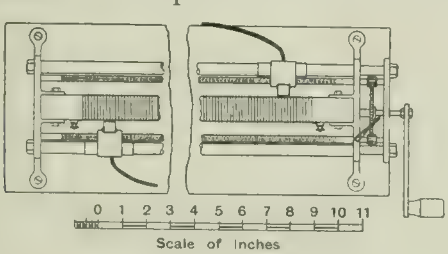


Fig. 6.

continuous for the authors' purpose, the rheostat was undeniably non-continuous in principle.

For these reasons the authors made several attempts to design a resistance which, instead of being a recognised approximation, should be continuously adjustable both in practice and principle. For the reasons previously given these attempts were wholly restricted to rheostats based on wire or strip resistances. The first matter to be determined was the amount of waste current permissible in the apparatus. This was finally settled at 1 ampere when the resistance is placed across 10 volts. The larger this current is permitted to become, the greater must be the energy available, the higher is the working temperature and the smaller are the dimensions of the instrument and the lower is its cost.

The simplest continuously adjustable resistance that can be devised is a single stretched wire many yards in length, and the problem under consideration was the adaptation of this wire to a compact and convenient form. With a single wire there is the difficulty of passing contacts, which can only be satisfactorily avoided by the use of two wires, thereby increasing the wasteful energy and the initial cost of the instrument.

Mr. C. G. Lamb, of Cambridge, adopts, we understand, no very elaborate modification of this device, and uses a large circle of wire mounted upon a table, the contacts being fixed at

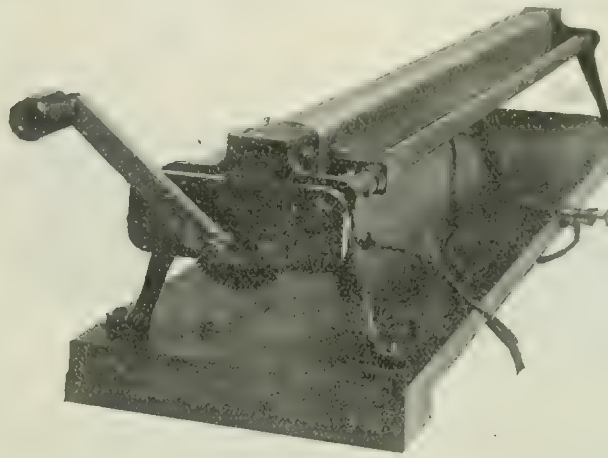


Fig. 7.

the two ends of a diameter and capable of rotation about the centre. The pressure is applied to the circular wire at the extremities of a fixed diameter. This arrangement is obviously neither compact nor easily portable.

The authors now attempted to substitute a flat spiral for the simple stretched wire. With this device two spirals would be necessary to permit of two contacts, it being hardly possible to arrange continuous contact simultaneously on both sides of the spiral. Mechanical difficulties finally disposed of this arrangement.

Cylindrical spirals of screw-thread form were then experimented with, but again the difficulty of two contacts moving in

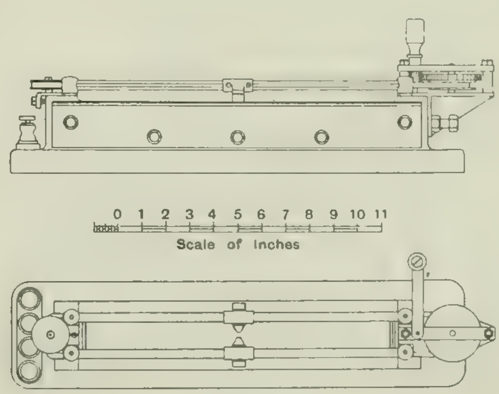


Fig. 8.

opposite directions on the spiral was not easily surmountable. The only practical device of this form evolved was a long spiral used with the connections shown in Fig. 3, contact being made by a split nut moving along the spiral when the latter was rotated.

Reverting to the case of the simple wire, another means of reducing its length is to use it in zigzag form. In this way an enormous reduction in dimensions can be effected. This device would remain quite continuous in principle if contact across the whole width of the zigzag wire were made on either side. A more compact and much more mechanical arrangement can, however, be obtained by using strip in place of wire as the resistance material. This was the type of resistance ultimately adopted.

The section of strip employed was 1·25 in. by 0·005 in., mica insulation of the same thickness as the strip being used. The resistance was enclosed in a cast-iron frame of the form shown in Figs. 8 and 9. Stud bolts were inserted at one end of the frame to form a tightening device for the strip. The number of zigzags in the resistance being about 2,000, it was decided to utilise only one face of the resistance for contact purposes, the sliders being shortened to permit of their passing, as the simplification of the mechanical arrangement more than compensated for the sacrifice of absolute continuity of adjustment. The contacts took the form of sliders bridging across from the planed surface of the resistance to a Eureka strip on either

Fig. 9.

side. These contacts were narrowed down as much as was permissible to reduce the time occupied by their passing, as during this period the voltage between them remains at zero. The sliders were moved by a steel tape passing round aluminium pulleys. The driving was accomplished by means of toothed gearing, about 20 turns of the handle being necessary for a complete reversal. This driving mechanism can be seen on the right of Fig. 9, while to the left is shown the belt-tightening device. The guides for the contacts consist of slotted steel tubes, inside of which the belt passes, the contacts being attached thereto by means of pins. These guides serve to maintain constant contact pressure.

As already explained, the resistance was made equal to 10 ohms, and the final temperature rise was about 150°C., with 5 amperes flowing.

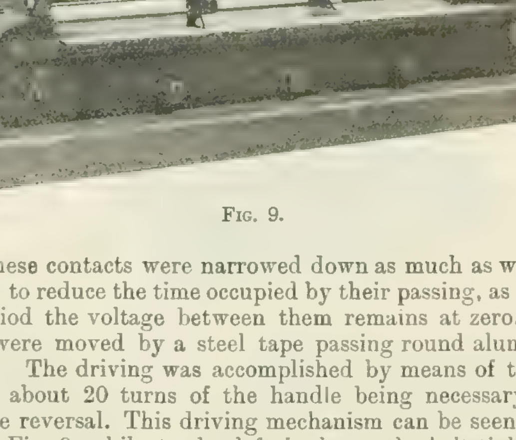


Fig. 10.

In practice this rheostat was found to answer the author's purpose admirably, the only defect being the definite time required for the reversal of the current due to the width of slider contact. This effect is graphically illustrated in Fig. 10, where the curve shows actual observations of the voltage between the sliders in relation to their position, the straight line being obtained when no current is taken from the sliders, and the curved line when a current of 1 ampere was reversed in the shunt circuit. The insets show the centre portions of these curves magnified, the upper one for the resistance of Fig. 7 and the lower for that of Fig. 9.

In order to obtain an entirely unbiased record of the comparative merits of the two instruments, oscillographic curves were taken of the voltage between the contacts, and are reproduced in Figs. 11, 12, 13 and 14. In Figs. 11 and 13 the oscillograms show the definite time required for the reversal of the current. In the case of the wire resistance, the effect of the shunt circuit in reducing the magnitude of the steps can be clearly seen.

There can be no doubt, from an inspection of these figures, that the finally adopted type of resistance is immensely superior as far as continuity of adjustment is concerned to that illustrated in Fig. 7. In addition, this instrument is far more mechanical, compact and convenient.

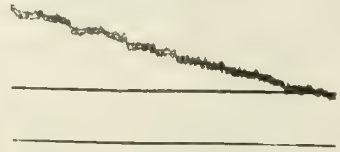


Fig. 11.—Wire Resistance with No-Shunt Current. Taken across centre portion.

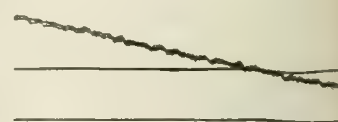


Fig. 12.—Wire Resistance 10 Ampere Max. Shunt Current. Taken with slider embracing one-half of resistance.

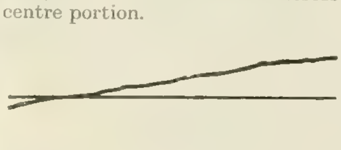


Fig. 13.—Strip Resistance No-Shunt Current. Taken over centre.

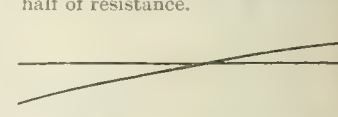


Fig. 14.—Strip Resistance No-Shunt Current. Sliders embracing one-half resistance.

In conclusion, it gives the authors much pleasure to acknowledge the active part taken by Mr. E. T. Cook, of this college, in the development of this apparatus, and to express their thanks to him for the excellent way in which he has overcome the mechanical difficulties incidental to its construction.

REPORT TO THE BOARD OF TRADE ON THE TRAMWAY ACCIDENT AT GLASGOW.

The report of the Board of Trade Inspector (Col. H. A. Yorke) has been issued in connection with the tramway accident which occurred on January 3rd to a tramcar belonging to the Glasgow Corporation, whereby two persons, one of whom was the motorman of the car in question, were killed and about 10 injured. Owing to the death of the motorman the Inspector remarks that it has been difficult to ascertain the cause of the disaster. We referred briefly to the question in our issue of January 17th. It will be remembered that owing to a difficulty in removing the reversing handle at the terminus the motorman left it on No. 1 controller and drove the car from No. 2 end without a reversing handle, thus depriving himself of certain methods of braking the car. In order to operate the controller the reversing barrel at the No. 2 end was turned into its proper position by a pair of pliers, and a telephone message was sent to the depot for a fitter to meet the car in order to rectify the trouble.

Col. Yorke, in his report, gives the particulars of the accident, which are, of course, well known. It will be remembered that the car attained a high speed on the Bell of the Brae hill, eight collisions with lorries occurring, in one of which the motorman appeared to be injured and fell from the car, the conductor eventually bringing the car, which fortunately never left the rails, to a standstill on the level by means of the hand brake on the rear platform.

The Inspector's report then proceeds as follows :—

Owing to the death of Motorman Dolan and the absence of any direct evidence as to what happened at the front end of the car, it is impossible to say with certainty how it was that Dolan lost control of it or why he failed to stop at the two important places, viz., Rottenrow and Duke-street. It was a foggy night, but not so foggy that Dolan would have had any difficulty in seeing the usual landmarks, such as lamp posts, &c., which would guide him as to his position. The fog may have made the rails slightly greasy, but according to the evidence of Conductor Child and Constable Donald the rails were not in a bad condition, and as Dolan had sand available he should have been able to counteract the effect of the fog on one of the rails. An examination of the gear of both the magnetic track brake and the

hand brake after the accident indicated, so far as their damaged condition would permit, that no defect had existed in either of them prior to the accident.

Four methods of braking were under normal circumstances available on the car, as explained in the book of Rules and Regulations issued to their men by the Glasgow Corporation viz.: (1) By means of the hand brake: (2) by means of the magnetic track brake: (3) by reversing the motors: the reversing handle being placed in the backward position; (4) by short-circuiting the motors while acting as generators: the reversing handle being placed in the backward position, and the controller handle placed on the highest power notch. This method to be used only as a last resort. Of these, (3) and (4) were not available to Dolan owing to the fact that he had no reversing handle at his end of the car.

The rule in Glasgow is that on gradients such as those on the Bell of the Brae hill cars should coast down with the magnetic brake applied sufficiently to maintain the speed at 8 miles an hour, but, assuming for a moment that something was wrong with the magnetic brake, there would have been no difficulty whatever in coasting down that hill by the use of the hand brake had it been applied at the top of the hill at Rotten-row, and the speed never allowed to exceed the 8 mile limit. In either case the brake should be applied while the car is at rest at the top of the hill. Judging from Constable Donald's evidence, Dolan was using both the magnetic brake and the hand brake at the time of the first collision. If the speed was then anything like 25 to 30 miles an hour the hand brake would be practically useless, and the only result of applying it would be to interfere with the action of the magnetic track brake by causing the wheels to skid. And although the track brake, if properly used, would be able to stop a car travelling at that speed, given sufficient time or distance, it seems that the first collision occurred before any reduction of speed could have been effected. Had the reversing handle been available at the front end of the car, it is probable that Dolan, following the usual custom, would, if time had permitted, have made use of No. (4) method of braking which, as already stated, is to be used only as a last resort. This method is in reality nothing more than another form of wheel brake, the power of which is limited by the co-efficient of friction between the wheels and the rails, and it is not nearly so effective as No. (2). Under these circumstances I do not think that the fact that Dolan was unable to use No. (4) method of braking had any bearing upon the accident, inasmuch as this method would not have had time to take effect before the collisions occurred and Dolan received his fatal injuries.

When the car came to rest, the hand brake was found to be off and the controller handle in the full braking position, the effect of which would be to apply the magnetic track brake with full force. But as the front end of the car was very much damaged, and the hand brake spindle bent and the controller case broken and forced backwards out of its position, it is impossible to say definitely whether the handles were in these positions when Dolan fell off the car, though it is not improbable that they were. Even if Dolan was using either the hand brake or the track brake up to the last moment, I have no doubt that both brakes became released, either by the shock of the collision, or, in the case of the track brake by the interruption or dislocation of the electrical connections owing to the damage done to the controller, and that thereafter the car continued its course entirely unbraked. One of the passengers is said to have pulled the trolley pole off the wire, with a view to cutting off the current from the car. If, as is probable, the current had been already cut off from the car by the driver, the only effect of removing the trolley pole from the wire would be to put the lights out.

It is difficult to explain why Dolan failed to stop his car in the usual manner at the top of the Bell of the Brae hill, and allowed it to descend the incline at an excessive rate of speed, so that by the time it reached the bottom of the hill it was entirely out of control. There seem to be only two ways of accounting for the occurrence. Either Dolan was driving carelessly, or even recklessly, and allowed the speed of the car to increase too rapidly before he took any steps to check it, or else some portion of the magnetic track brake gear which he should have been using must have failed him. Dolan was an experienced motorman, and bore a good character for steadiness and sobriety. The Corporation for some years past have given bonuses to their men every six months if their records showed a freedom from accident (for which they could be held responsible), and Dolan had earned these bonuses regularly since they were first introduced. It therefore seemed improbable that he would have negligently or recklessly allowed his car to get out of hand. The question therefore arises: "Did the magnetic track brake fail him"?

I have gone very thoroughly into the effect of leaving the reversing handle in the forward position at No. 1 end of the car, upon the driving and braking of the car by means of the controller at No. 2 end. I have paid a special visit to the works at Manchester, of the British Westinghouse Company, who supplied the controllers, and by the courtesy of their officers I have had all the details of the controller exhibited and explained. As a result of the investigations, I found that No. 90 pattern of controller differs from other tramway controllers in that the movement of the reversing handle does not directly move the reverse drum itself, this not being actually rotated until the main handle is moved from the "off" position towards either the power or the brake notches. The ratio of the gear by means of which the reverse drum is rotated by the movement of the main drum, is such that a very slight movement of the main (controller) handle causes the contacts of the reverse drum to make connection with their corresponding fingers.

The wiring of an electric car is very complicated and difficult to follow, even with the aid of a diagram, without which it is impossible. But it may be briefly stated that the placing of the reversing key of the controller in the forward position at one end of the car has, so long as the handle of the controller at that end is accurately in the "off" position, absolutely no effect upon the driving or braking of the car by means of the controller at the other end. But if by any chance the controller handle at the first end is displaced, even to a small extent towards the brake notches, contact is made between the reversing drum and its correspoding fingers, with the result that when the controller handle at the other end is moved to the braking position the armatures of the motors are short-circuited, and the magnetic track brake cannot be applied. Similarly, if the main handle at one end of the car is slightly displaced towards the driving notches, the reversing key being as before, it would prevent the car from being started by means of the controller at the other end.

In addition to what I saw and learnt at the Westinghouse Company's works, I also, by the courtesy of the managers of the Salford Corporation tramways and the London County Council tramways, have been able to make experiments in running with cars fitted with No. 90 controllers, and have found that the above statements are correct.

If, when Inspector Muirhead told Dolan to remove the controller handle from No. 1 end of his car to the other end, the pointer was exactly in the "off" position, he was right in saying that the reversing handle at No. 1 end of the car being left in the forward position would make no difference whatever to the driving or braking of the car by means of the controller at No. 2 end. But if in removing the controller handle from No. 1 end it was displaced even to a very slight degree (say, from $\frac{1}{4}$ in. to $\frac{3}{8}$ in.) in the direction of the braking notches, it would render it impossible to operate the magnetic brake from the controller at No. 2 end.

When the reversing key is in any but the neutral position, the controller handle is free to move in either direction, and I proved by personal experiment that a slight displacement of the controller handle might easily take place unobserved during the process of removing that handle. Should anything of this sort have happened when the men were hurriedly removing the handle from one end of the car to the other at Springburn, it is possible that when Dolan came to apply his magnetic track brake on the Bell of the Brae hill it did not operate, not on account of any defect in it, but simply because the electrical connections were wrongly made. This would take him by surprise, and not knowing the reason for the failure of the brake he might have made more than one attempt to apply it. By the time he realised that for some reason, which he did not understand, the magnetic track brake was out of use, the speed would have got beyond the power of the hand brake, and the car would then be out of control.

I am of course unable to say that the accident actually occurred in this manner, but it is undoubtedly a possible and not improbable explanation of the disaster. It may be argued that Dolan should have found out before reaching the Bell of the Brae hill that his magnetic track brake was not available. But the custom at Glasgow is for the hand brake to be relied upon under ordinary circumstances, and for the magnetic track brake to be chiefly used for coasting down steep hills. That being so, there is no assurance that Dolan had attempted to use his magnetic track brake after leaving Springburn before reaching the hill, and, as I have said, he may have been entirely unprepared at the Bell of the Brae hill for such an emergency as I have suggested.

Whether this is the correct explanation or not, I consider that Inspector Muirhead committed a grave error of judgment in allowing the car to leave Springburn with the reversing handle in the forward position at the rear end of the car, and without any reversing handle at the driving end. For, disregarding altogether the suggestion made above, it is not to be disputed that Dolan was deprived of the third and fourth methods of braking the car which are specified in the Glasgow tramway rule book, and although, for reasons already given, I do not think that if these methods of braking had been available the disaster would have been altogether averted, as the collisions would have occurred before either of those methods had time to take effect, Muirhead had no right to cause or permit Dolan to run any risks. A heavy double-decked tramcar is at all times an awkward thing to manage on an incline, and not a single precaution can be safely dispensed with. Muirhead's duty, and Dolan's duty if Muirhead had not happened to be present, was to cause the car to be taken to the nearest depot as soon as the difficulty with the reversing handle occurred. It happened in this case that there was a depot at Possil Park not very far from Springburn, and if the car had been sent there there would have been no occasion for it to descend the hill until the defect had been put right.

It is quite easy to guard against the possibility of removing the controller handle when it is not absolutely in the "off" position by casting on the lid of the controller case an overhanging lip round the spindle of the main drum, with only one gap in it—viz., immediately opposite the "off" position—attaching at the same time to the handle a lug which would engage in the lip in such a way that the handle could only be put on or taken from the controller in the correct position. Such a lip is provided on controllers of other types, and the manufacturers (the British Westinghouse Company) agreed to act upon this recommendation in future when manufacturing controllers of No. 90 pattern.

I have not yet referred to the cause of the jamming of the reversing handle at No. 1 end of the car. When the case of the controller was opened after the accident the whole difficulty was found to be due to the screw pivot stud at the top of the reverse interlocking pawl having become unscrewed, thus allowing the pawl to get out of position, and preventing it from passing through the slot in the sprocket wheel, the result being that the interlocking gear became jammed and the reverse handle could not be moved in either direction. I believe that this is

not the first occasion on which the pivot studs, either at the top or bottom of the pawl, have worked loose. The defect is easily remedied, either by inserting a small plug of wood or metal in the pivot hole on the top of the pivot stud, or, better still, by lengthening the pivot stud itself, and the manufacturers promised to attend to it.

Two other points call for notice. As I have already stated, it is the custom on the Glasgow Corporation tramways to use the hand brake for ordinary stops, and to reserve the magnetic track brake for emergency stops and when coasting down hills. As I have said on a previous occasion, I do not regard this as the proper manner in which to employ the magnetic or any other form of "power" brake. I am disposed to think that it is a mistake in tramway practice to regard any brake as an "emergency" brake, and as one which is only to be used on rare occasions. When this custom is followed there is a risk that the brake will either be wrongly applied, or for some reason or other will fail when the occasion for its use arises. In tramcar driving the "emergency" is ever present, and the motormen should be instructed to use at all times the most powerful braking device at their disposal.

The tramcar to which this accident occurred, and most of the tramcars belonging to the Glasgow Corporation, are fitted with only two sand-boxes—viz., one at each end of the car. This means that sand can be applied to only one rail at a time, so that when the rails are greasy, and the efficiency of the braking appliances is of the utmost importance, it happens that the brakes, of whatever description, only do good work on one side of the car, which in other words means that when the rail conditions are at their worst only half the brake power is available. This seems to be a very unsatisfactory arrangement, and I strongly recommend that the Glasgow Corporation should take early steps to fit all their cars with four sanders—viz., two at each end.

SINGLE-PHASE ELECTRIC TRACTION ON THE HEYSHAM, MORECAMBE AND LANCASTER SECTION OF THE MIDLAND RAILWAY.

(*Concluded from page 371.*)

ROLLING STOCK (*continued.*)

Diagrams of the connections of the Siemens and Westinghouse cars are given in Figs. 29 and 30, whilst Figs. 24 and 25 show views of the Siemens and British Westinghouse equipments, respectively. In Fig. 24 the apparatus—from left to right—consists of the H.T. chamber, auxiliary transformer, main transformer and part of the switch group, and Fig. 25 shows the main transformer, switch group and auxiliary transformer.

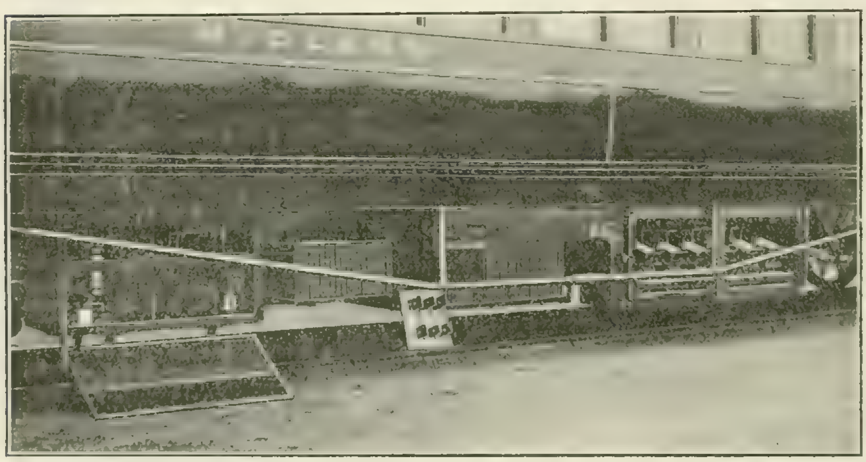


FIG. 24.—VIEW SHOWING (FROM LEFT TO RIGHT) H T. CHAMBER, AUXILIARY TRANSFORMER, MAIN TRANSFORMER, AND PART OF SWITCH GROUP ON ONE OF THE SIEMENS TRAINS

The forced ventilation for the motors of both sets of cars has been fairly simple to arrange. For the Siemens car, the suction duct has been carried inside the car under one of the seats, the whole of the air coming in this case from the inside of the car. The Westinghouse car has a similar duct inside, but, as more air is required for these motors, they have also a suction duct with a filter taking air from the outside of the car.

In both cases this duct comes direct into the suction eye of the fan, and the delivery duct, after leaving the fan, splits into two pipes, one of which crosses to the other side of the coach and comes up under the longitudinal seat on that side, thus getting across the cross member of the underframe, and coming down again above the motor, to which the air then proceeds through a rubber concertina pipe. The other half of the duct proceeds direct up under the longitudinal seat on its own side, coming down in a similar way to the other motor. A section of the Siemens motor is given in Fig. 26.

The auxiliary transformer was adopted chiefly at the instance of Messrs. Siemens, with a view partly to better suiting their control gear, and partly to obviating any possibility of the lights in the coaches being put out by the coming out of the overload circuit-breaker in the high-tension circuit, or by any other accident which would cut off supply from the main transformer. Also, during a great portion of the year the cars will be standing in the stations for long intervals between running, and an appreciable saving of energy will be effected by doing away during such stoppages with the magnetisation losses of the large transformer. On the Westinghouse car, however, at the instance of that company, the main transformer is kept continuously energised except when the main circuit-breaker comes out on overload. The auxiliary transformer might be dispensed with in cases where the cars are in continuous service, and this would also save some amount of high-tension apparatus.

On the Westinghouse car there is no interlocking of the high-tension chamber with the bow, the high-tension circuit breaker and fuse being put in lock-fast cases the keys of which are kept at headquarters so that the train staff are not permitted access to these chambers at all.

The performance of the motors of these three cars, both on the test bed and on the line, suffices to disprove the assertion made against single-phase motors of excessive and injurious sparking. It may also be mentioned that in a test with a two-car train weighing approximately 58 tons, made incidentally,

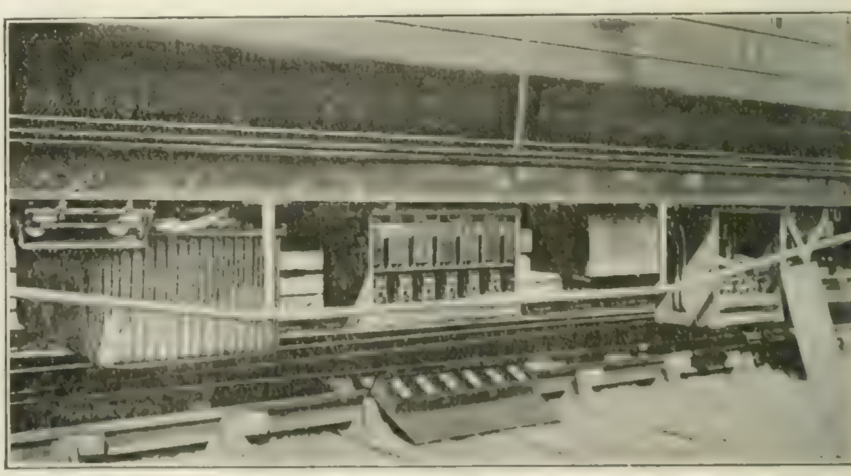


FIG. 25.—VIEW SHOWING MAIN TRANSFORMER, SWITCH GROUP AND AUXILIARY TRANSFORMER ON BRITISH WESTINGHOUSE TRAIN.

in the course of ordinary running, one of the Siemens cars attained speeds of 30 miles per hour in 41 seconds, and 48 miles per hour in 80 seconds and the free running speed of 60 miles per hour in 160 seconds, starting, and running for 440 yds. after starting, on an up grade of 1 in 200, there being, however, thereafter about 100 yds. of level, and then a down grade of 1 in 500 for 1½ miles; this portion of the line is also very considerably curved, with curves of 30 and 40 chains radius.

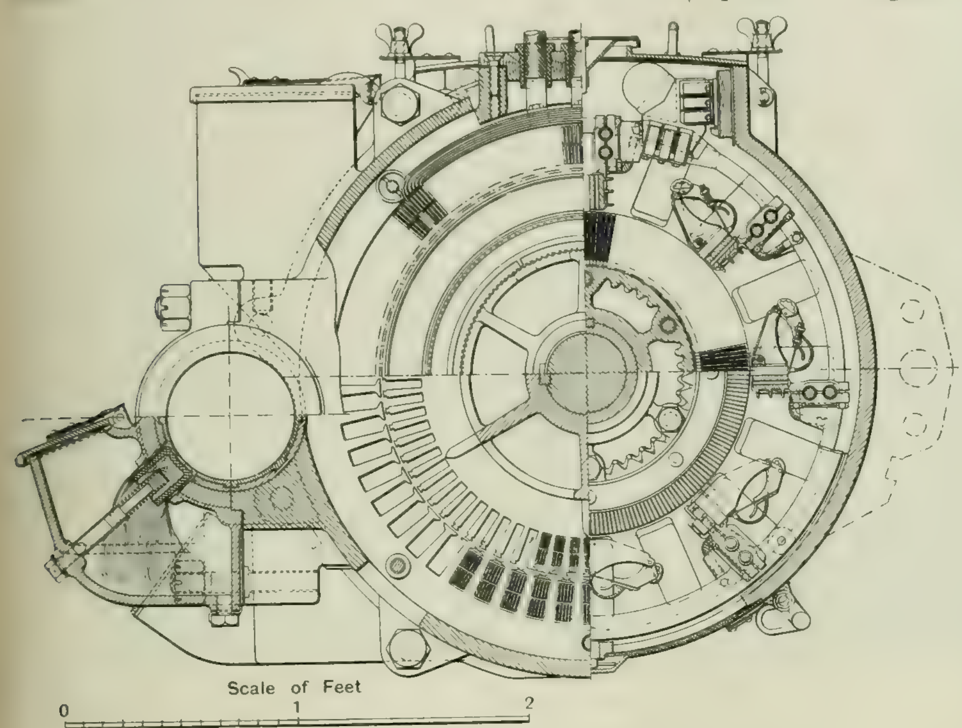


FIG. 26.—VIEW SHOWING CROSS SECTION OF SIEMENS MOTOR. Scale 1:10.

These tests are not the most favourable that could be obtained, as the motors were not being worked to their utmost capacity. If analysed, bearing in mind that the machines are geared for "free running" at 60 miles per hour, and remembering the high train resistance at this speed, this test shows the accelerating power of the equipments to be very satisfactory. The characteristic curves of a Westinghouse single-phase motor are given in Fig. 27.

POWER STATION.

The line is supplied from the existing power station, situated at the Heysham end of the line. The necessary additional machinery to increase its capacity and to enable it to supply single-phase current from the direct current plant has been installed to the requirements of Mr. R. M. Deeley, locomotive superintendent of the company, and his assistant Mr. J. Dalziel. There are no feeders other than the two contact wires.

The existing power station is that provided for working the cranes, capstans, lifts and other machinery, together with lighting, of the harbour at Heysham. This station is a gas-driven one working from "Mond" producers by the Power Gas Corpn., a description of its equipment appearing in *The Electrician* of June 24, 1904, and of the application of the electrical power to the machinery at the harbour in the following issue.

There are two producers of about 750 H.P. to 1,000 H.P. capacity each, with the accessory blowing, steam producing, cooling and cleaning apparatus. A view of the Mond gas plant is given in Fig. 31. The engine room originally contained three 250 H.P., three cylinder British Westinghouse Company's engines, driving 150 kw. (continuous current, 460 volts) generators, and Fig. 28 shows the engine room with the additional equipment detailed below. There was also installed a battery having a capacity of 100 kw. for five hours, with the usual corresponding rates for shorter and longer periods. The existing load on the station, consisting chiefly of fast speed, heavy motored cranes, is very variable and the battery has been used, in conjunction with a British Westinghouse Company's automatic reversible booster, for taking up the "peak" loads.

In connection with the traction scheme an additional 350 H.P. 235 kw. Westinghouse Company's engine and generator, also generating continuous current at 460 volts, has been added. The single-phase alternating current is obtained through two motor-generators by the Electric Construction Co., which effect the necessary conversion from continuous current.

From the nature of the traffic the demand on the station will be one of a very "peaky" character and with very heavy "peaks." During these "peaks" the whole possible output of the machinery at work in the station must be utilised, and the intention is for the engines, whatever the actual load they may be working on previous to heavy loads coming on, to work up to their full overload capacity, which is about 20 to 25 per cent. in the case of the old and 10 to 15 per cent. in the case of the new sets, before the battery is called upon to discharge heavily. The latter will, however, be called on to work up to its full one-hour rate of 750 to 1,000 amperes. The old battery booster not being large enough for these discharges a new one has been installed, built by the Lancashire Dynamo & Motor Co., whose machine is particularly suited for this method of working. A difficulty was, however, found in that the generators were working on a rapidly falling portion of their characteristics, and their pressure dropped badly as their loads increased, this having been compensated for by hand regulation of their excitation, or else during "peaks" they continued to work at their previous loads, and the battery supplied the excess, both courses being inadmissible under the new conditions.

Compound winding in the usual way was an extremely expensive remedy since, as the copper necessary for full excitation was already on the fields, new series coils would be excessively large and heavy, added to which was the trouble of entirely dismantling the machines. A very simple solution was found in fitting exciters, each mounted on the engine bedplate, and belt-driven from a pulley fitted on the generator shaft, com-

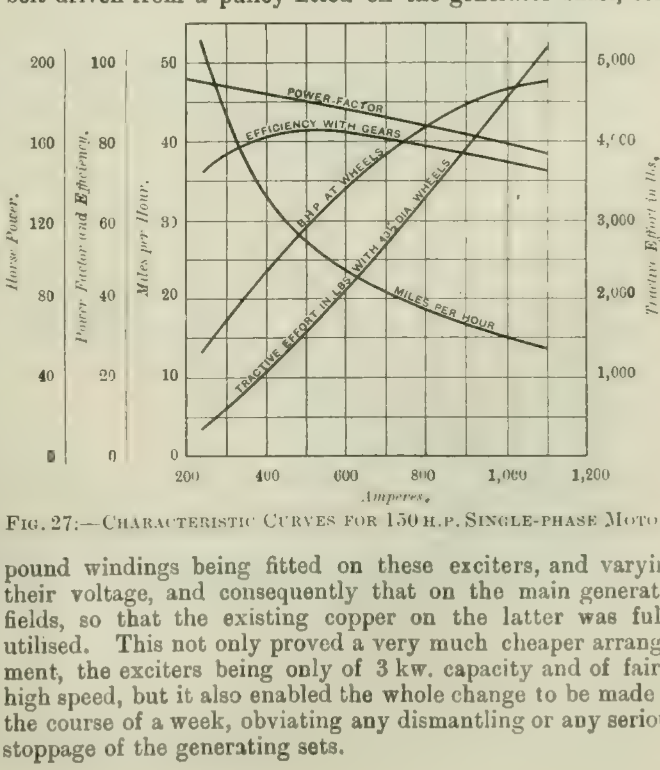


FIG. 27.—CHARACTERISTIC CURVES FOR 150 H.P. SINGLE-PHASE MOTOR.

pound windings being fitted on these exciters, and varying their voltage, and consequently that on the main generator fields, so that the existing copper on the latter was fully utilised. This not only proved a very much cheaper arrangement, the exciters being only of 3 kw. capacity and of fairly high speed, but it also enabled the whole change to be made in the course of a week, obviating any dismantling or any serious stoppage of the generating sets.

As regards the new machines, the Lancashire Dynamo & Motor Co.'s booster is of that firm's standard three-wire type. With a comparatively low continuous rating it satisfactorily other conditions, without any serious drop in the 'bus-bar voltage.

The new Westinghouse Company's generating set is of the

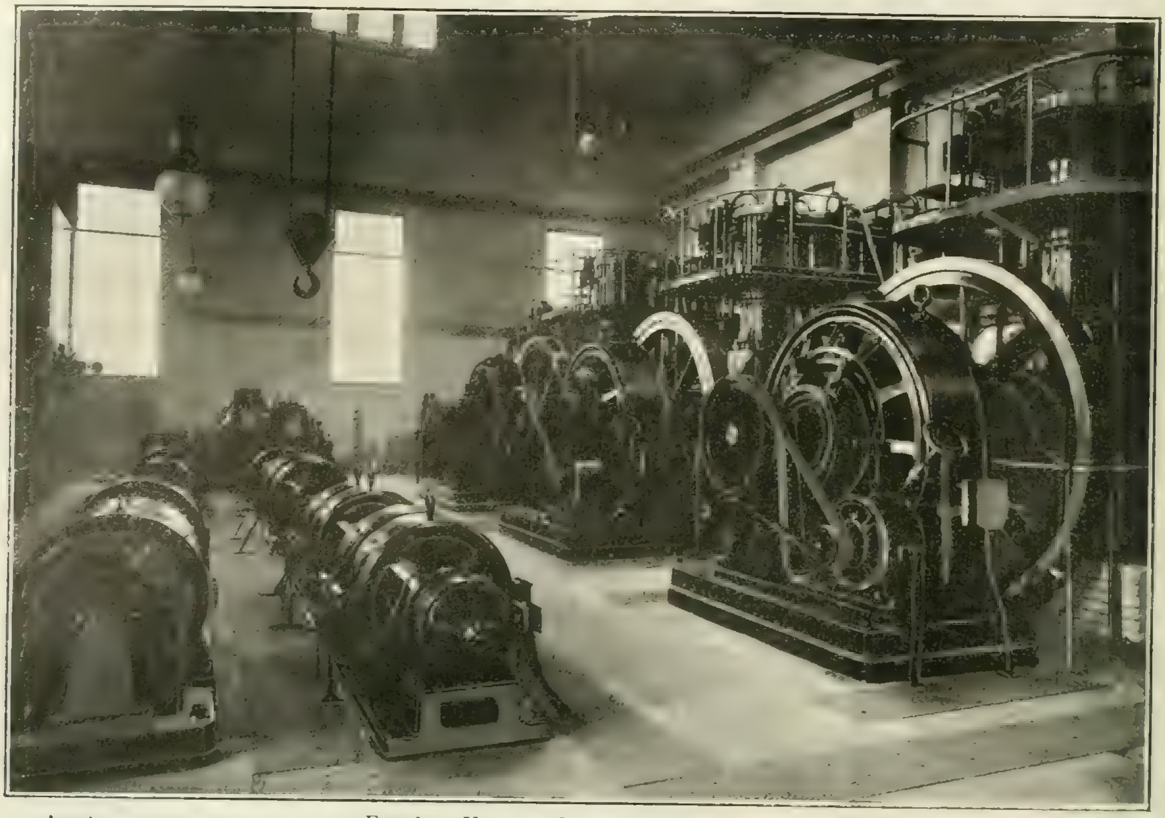


Fig. 28.—View of Power Station Plant.

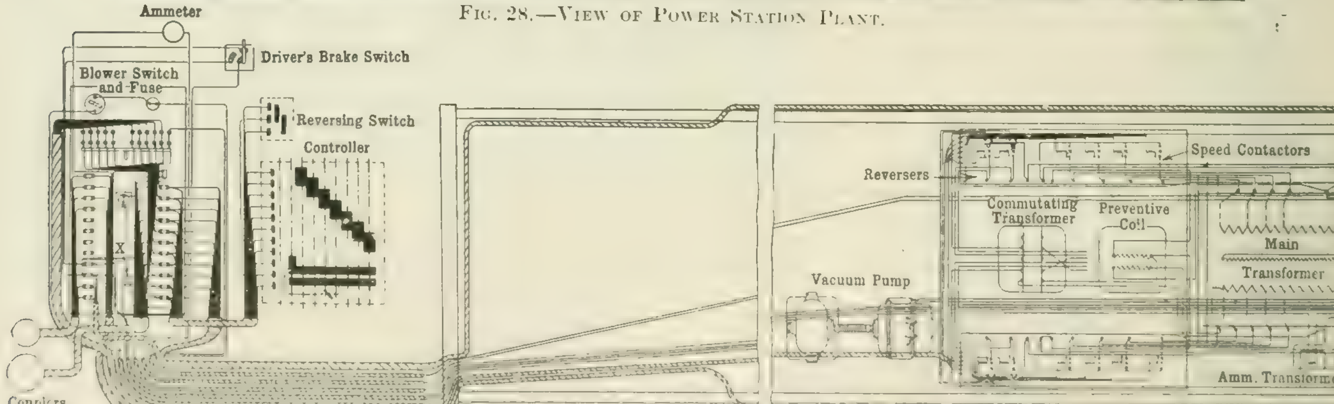


Fig. 29.—Diagram of Car
E Earth. I Trans Plug

Fig. 30.—Diagram of Car
E=Earth. T=B.F. Terminal for 600 volts. O=Compressor Governor. I=Trans Plug

commutates the "peak" discharges up to 750 to 1,000 amperes, and it can be set to make the engines work up to their overload as mentioned above, or to work under practically any firm's latest type of gas engine, being a three-crank engine, with three sets of cylinders, two in tandem in each case. Its speed is 300 revs. per min., and its lubrication "forced." It

need only be said here that its design and construction are sound and thoroughly mechanical, and its performance so far proves it to be an excellent engine, and one as reliable as any steam engine.

The motor generators, which are illustrated in Fig. 32, deserve special mention, not only because they form that part of the generating station most directly connected with the traction installation, but because there are many noteworthy points about them. They are in many ways exceptional machines, and work under exceptional conditions, bearing the heavy "peaky" nature of the load in mind.

This load indeed varies from nothing to upwards of 1,000 kw. in very short periods. The specification called for the machines to be each capable of a continuous output of 150 kw.—200 kw., with a temperature rise of 80°F., but they were also called upon to be capable of safely carrying instantaneous output overloads of 900 kw., 600 kw. for $\frac{1}{2}$ minute, 500 kw. for $\frac{3}{4}$ minute, and 300 kw. for $2\frac{1}{2}$ minutes, and were required to be also tested under a regular cycle of these overloads, with underloads in between, for eight hours. The internal driving losses were also required to be kept down, while on the alternating current side they were required to regulate within 6 per cent. on throwing off a non-inductive load equal to the full continuous load, and within 20 per cent. on throwing off a similar but inductive load of 0 8 power factor. Further,

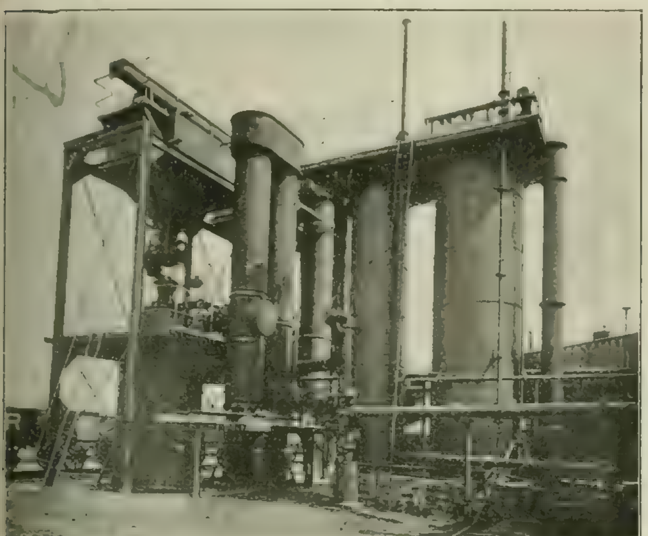


FIG. 31.—VIEW OF "MOND" PRODUCERS.

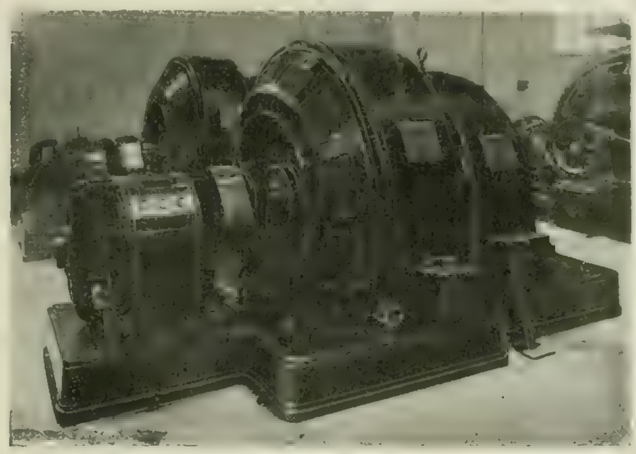
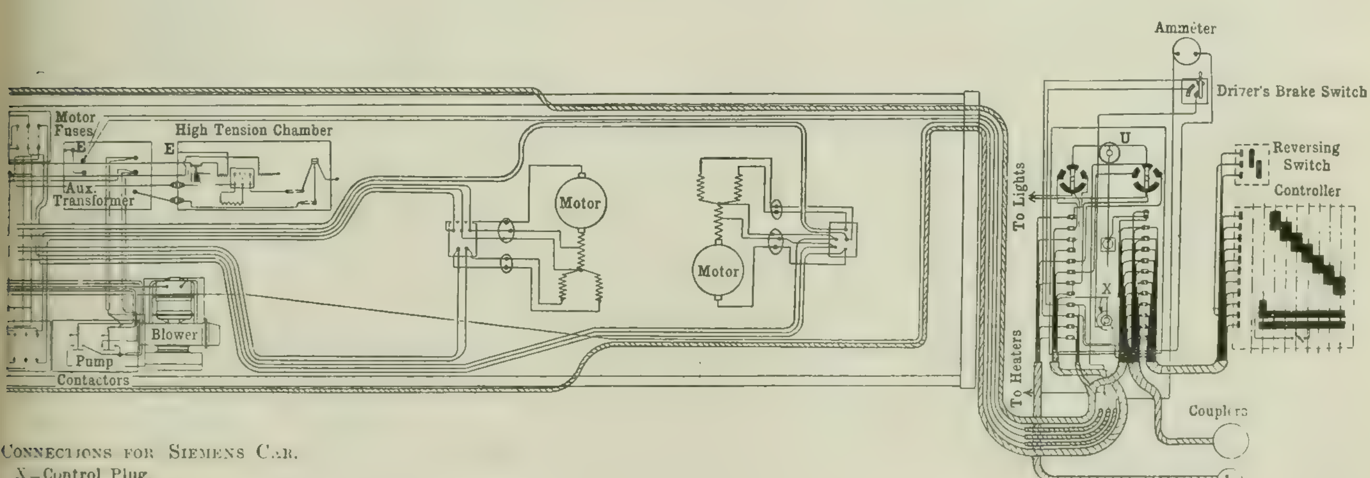
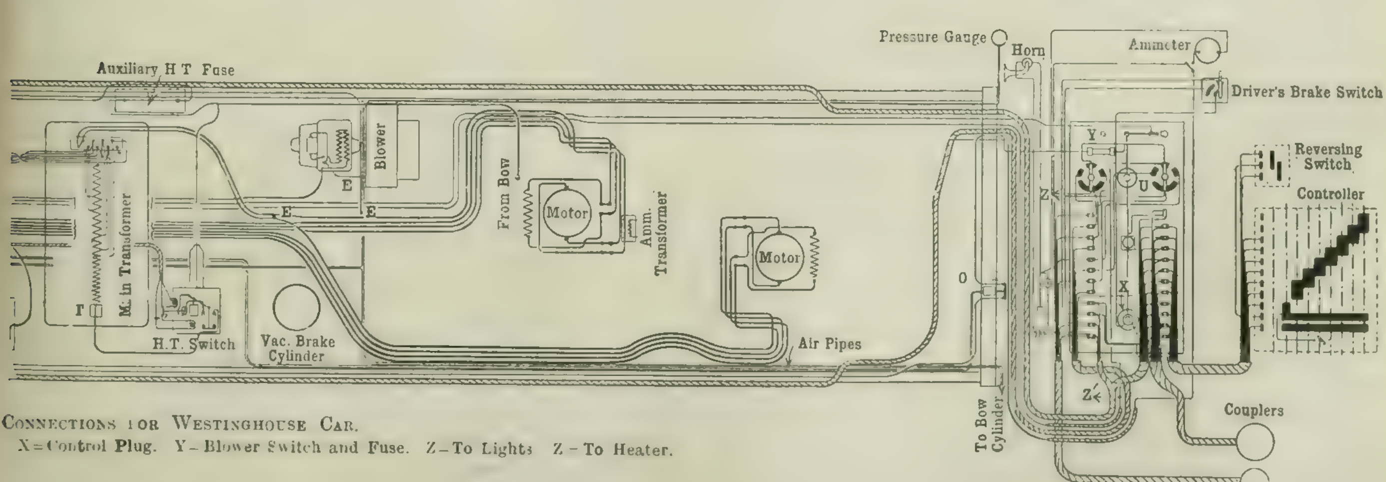


FIG. 32.—VIEW OF E.C.C. MOTOR-GENERATORS.



CONNECTIONS FOR SIEMENS CAR.
X—Control Plug.



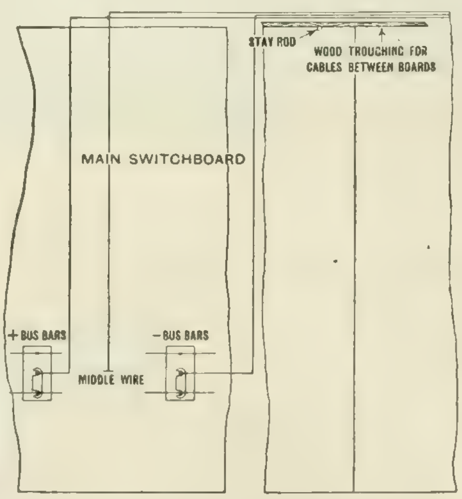
CONNECTIONS FOR WESTINGHOUSE CAR.
X=Control Plug. Y—Blower Switch and Fuse. Z—To Lights Z—To Heater.

they were required, with the assistance of external means, if necessary, to restore the pressure to its normal value within seven seconds of the coming on, or throwing off, of loads up to 600 kw. at 0·8 power factor, or 300 kw. at power factors down to 0·3.

Widely varying proposals were received in connection with these machines, the Electric Construction Co.'s machines, however, being finally selected, their machines being very compact and requiring a small amount of driving current, as well as having a high efficiency.

The makers' specifiation was 175 kw. on continuous rating, the machines on test being well within the specified temperature rise, but not excessively so. During the experimental running of the trains at Heysham, each of the sets have several times been subjected to loads up to 900 kw. input without the slightest commutator trouble, and smaller overloads of 600 kw., 500 kw., &c., have been very frequent, and have been carried with equally satisfactory results. The alternating current regulation is also fully up to the specified requirements, and generally after the switching on or throwing off of a heavy load the voltage is restored to its normal of 6,600 volts within three seconds, while the voltage even then only varies about 300 volts each way; nothing could, indeed, be more satisfactory than the performance of these machines.

The direct current motor is compound wound with commutating poles, the series winding being a very small one, and put in principally to assist the two sets to run in parallel satisfactorily, which they do. The alternator has a three-phase star winding, so that if one winding breaks down the other two may be used for the single-phase supply, otherwise no use is made of the three-phase connections. The machine is of the standard internal revolving field type, and is excited from an exciter which is carried on the end of the bedplate and spur geared up to about 1,100 revolutions per minute. This exciter has laminated fields and is compound wound, its series winding carrying a portion of the main motor current, so that (so far at least as varying loads of equal power factor are concerned) the tendency of the alternator to drop in volts is thus compensated for.



Compensation for varying power factors is effected by means of a regulator, designed and constructed by the Electric Construction Co., and the first of its kind, which inserts or extracts resistance from the circuit of the shunt field of the exciters by the action of solenoids, which are respectively excited as the voltage exceeds, or is less than, the normal.

The direct current motor armature and the revolving field alternator are carried on the same shaft without any intermediate bearing. There are only two main bearings on the machines and these are ball bearings. These bearings have so far given every satisfaction, and have proved very advantageous in reducing the starting current, which at 460 volts is only about 75 amperes, and the no load loss, which is about 23 kw., with the exciter and alternator fully excited.

The switchboard has been designed and constructed by the Railway Company, the instruments being of the Westinghouse Company's make. From the diagram, Fig 33, it will be seen that each of the motor generators is supplied from the low tension 'bus bars through a no-voltage and overload circuit-breaker. The shunt circuit is excited through a separate double pole knife switch, with kicking contacts and resistances. Starting resistance is cut out by means of a set of knife switches. By means of a throw-over switch these can be used to start either of the two sets, a heavy triple-bladed knife switch being thrown in finally when the machines are fully started up, connecting them direct to the 'bus bars.

On the alternating current side each alternator is connected up to the 'bus bars by a hand-operated oil switch, and the current passes from the 'bus bar through duplicate automatic circuit-breakers to duplicate feeders passing out to the overhead

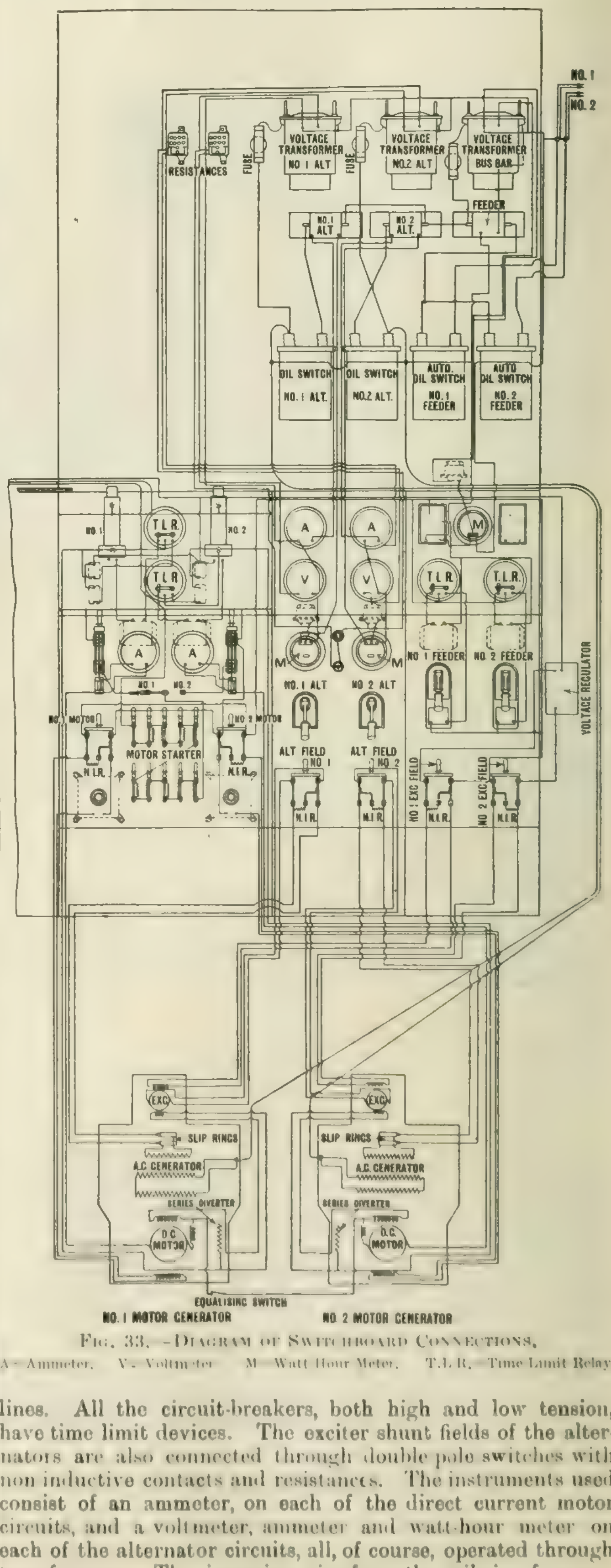


Fig. 33.—Diagram of Switchboard Connections.

A = Ammeter. V = Voltmeter. M = Watt Hour Meter. T.L.R. = Time Limit Relay.

lines. All the circuit-breakers, both high and low tension, have time limit devices. The exciter shunt fields of the alternators are also connected through double pole switches with non inductive contacts and resistances. The instruments used consist of an ammeter, on each of the direct current motor circuits, and a voltmeter, ammeter and watt-hour meter on each of the alternator circuits, all, of course, operated through transformers. The incoming wire from the rails is, of course,

at "earth" potential. There is also an indicating wattmeter between the 'bus bars and the out going feeders, and the regulator is connected to the same transformer.

The high-tension apparatus is contained in a lock-fast expanded metal chamber placed over and at the back of the actual switchboard, the switches being operated from the handles of the latter through rods. The door of this high-tension chamber is interlocked with the holding-up coil of the motor circuit-breakers, so that unless the door is closed neither motor generator set can be started, while if it is opened during running everything stops.

In conclusion, we desire to express our indebtedness to Mr. R. M. Deeley, locomotive superintendent of the Midland Railway Company, for most of the information and many of the illustrations contained in this description, to Mr. Dalziel for his courtesy in allowing us to inspect the plant, and also to the various contractors for kindly supplying drawings showing details of the equipment.

THE INSTITUTION OF ELECTRICAL ENGINEERS.

It is practically essential that every learned society should have, for the benefit of its members, no less than for the carrying out of the routine work connected with its affairs, a suitable and well-arranged building. The reasons for this are many. There can be no doubt that a building such as that owned by the Institution of Civil Engineers stands as a monument to the greatness of the engineering profession, while, looking at the question from another point of view, such a building, in providing many comforts for members, helps to give them a greater interest in the well-being of their Institution.

The Building which the Council propose to acquire as the future Home of the Institution of Electrical Engineers.

It is, therefore, with great pleasure we are able to announce that active steps are being taken by the Institution of Electrical Engineers towards obtaining a building of their own. To this end a special general meeting is to be held at 5:30 p.m. on Tuesday, June 30th, in the lecture theatre of the Medical Examination Hall on the Victoria Embankment, when a resolution will be considered regarding the purchase of this Hall, which we are enabled to illustrate, and the site occupied by it. It is at present owned by the Royal Colleges of Physicians and Surgeons and its purchase will involve the disposal of the site already owned by the Institution in Tothill-street.

The purchase of such a building offers many advantages. First among these is that it already exists and no time need be wasted in waiting while a new building is erected. It is said that practically no alterations will be required and further the position of the Hall is very central and for most members living in the suburbs quite as convenient as Westminster.

Visitors to London in the near future who enquire the object of that fine building near Waterloo Bridge will then be told it belongs to the Institution of Electrical Engineers, and will doubtless go away with a higher opinion of the electrical profession than they before possessed. The rooms in Victoria-street have served as a convenient *pied à terre*, but doubtless many people will be glad to see the last of them.

PARLIAMENTARY INTELLIGENCE.

LONDON ELECTRIC SUPPLY BILLS.

THE LONDON ELECTRIC SUPPLY (JOINT COMMITTEE) BILL.

On Thursday last week Mr. J. B. Braithwaite (chairman of the City of London and County of London companies), examined by Mr. Hutchinson on June 18, said he had had considerable experience in the raising of capital for electric supply companies and a wide experience of the commercial aspects of electricity supply. He and those associated with him in the present bill had long considered the best solution for the electrical problem of London, which had been under their anxious consideration during the past 10 years, and the bill was the outcome of their long consideration. Due regard had been given to the past expenditure on the part of the existing companies and local authorities, and also to the purchasing rights of the local authorities. Mr. Hammond had said the companies had done splendidly in the past in the discharge of their duties, and witness thought the companies had kept themselves thoroughly up to date as to the best methods of supply. This scheme would solve the question for the next 25 years. The present bill would enable them to meet the demands for the next five years, and they would then have to come to Parliament to obtain powers for raising more money. Various local authorities had the right to purchase in 1932. It would be impossible to raise new capital now for a new bulk supply scheme if it were to be terminated in 26 years. They had considered how they could meet the desire of the L.C.C. and the local authorities, and he thought the terms for purchase were absolutely fair and reasonable. There was extreme importance attached to the security of supply, and it was a common thing for a supply to be given by alternative routes. He had come to the conclusion that the supply should ultimately be given from six or eight stations. In the event of one station being entirely wrecked this would not materially affect the supply. The gradual increase in the load would be met by the resources of the existing companies, supplemented by the present scheme. In his judgment the security which the six guaranteeing companies offered was a powerful and material factor in the raising of the capital. If the powers under the bill were granted, they would immediately proceed to put these powers into force. It would be a hardship to the pioneer companies, who had successfully performed their duties in the past,

and had steadily reduced their prices; if parliamentary sanction were given to any other company to come in and compete. It would be unfair if, because of existing conditions they had been burdened with a great number of stations, these circumstances should be made the foundation for letting a new supply company in. Having been the pioneers of electric supply in the metropolis, and having brought the industry to its present point of development, it was but right and fair that they should be allowed the extended powers they now sought. Their record in the past showed that if any one could do the work effectually it was the present companies.

Cross-examined by Mr. FITZGERALD: He did not suggest that the mere linking up of the present stations would provide all power required for London. Generation in bulk would be provided as required. As to sec. 42, setting out the price for current for power, he had no precedent for seeking powers that would fix the price to be charged by local authorities within the area. He did not agree that the powers sought under the bill would compel local authorities to sell current at a considerably lower maximum than they were at present charging.

By Mr. RIGG: In 1899 the City of London Co. were the only company supplying current in the city. Subsequently the Charing Cross Co. were given powers to supply in the city. He could not agree that they were given those powers because the City of London Co.'s charges were too high. The value of the stocks of the companies were going down, or had gone down, due possibly in some measure to the fact that their period of lease was getting shorter every year, and any increase in the lease of life of the companies would increase the value of the shares. The companies still had a quantity of unissued capital.

By Mr. TALBOT, K.C. (on behalf of Camberwell Council): He knew that consent was given by Camberwell to the County of London Co.'s order on condition that certain terms with regard to purchase by the Council were inserted. The Corporation could take over the company's undertaking in Camberwell at any time before the expiry of the term by payment of the paid-up capital and making up the dividends to 5 per cent. The company were also under an obligation if required to set up a generating station in the borough to supply Camberwell. The bill now proposed might interfere to some extent with the Council's privileges with regard to the company's undertaking in Camberwell.

Re-examined by Mr. BALFOUR BROWNE: The Committee who had been considering the matter for the companies for the past 12 months or more came to the conclusion to introduce this bill before they knew of the London and District Bill being introduced, so that it was obvious the company's bill was not merely introduced to oppose that measure. With regard to Camberwell, if the company's bill went through that Council would have a period in which to decide whether they would exercise their option to take over the company's undertaking in the borough on the terms set out in the order. If they did not take that option they would be swept into the scheme.

Mr. W. F. FLADGATE (chairman of the Charing Cross, West End & City Electric Lighting Corpn.), examined by Mr. Balfour Browne, said the company's bill was decided upon quite independently of the London and District Bill. In fact, the question had been before them ever since the introduction of Mr. Merz's first bill. He was satisfied that it was the intention of the Joint Committee to carry out the scheme comprised in the bill.

Cross examined by Mr. ASKWITH, for the London & District Co.: Any advantage to the consumer under the bill would be derived through the authorised distributors.

This concluded the case for the promoters.

THE OPPOSITION TO THE BILL.

Mr. MORTEN, representing West Ham Corporation, said he wished to state their position. West Ham had a well-designed and carefully carried out system of electricity supply, costing about £400,000, expended in a manner calculated to bring about the best results, and whereas they strongly opposed the London & District Bill on the ground of competition, they had only one slight objection to the Companies' Bill. The Victoria Dock was in West Ham, but was one of the London and India group. In these docks were railways which were or were likely to be in the near future users of current for traction purposes. If power was supplied to these railways by the Joint Committee direct, the local authorities in whose districts the docks were situate would be deprived of that custom, and, so far as West Ham was concerned, they considered that whatever power was used in the Victoria Dock should be taken from the corporation who had taken into consideration the likely requirements of the dock when designing their system. If the promoters of the bill would give an undertaking not to supply to the dock companies that would remove all objections so far as West Ham was concerned.

On Friday Mr. CRIPPS, for the promoters, said, in reply to questions by the chairman, that he did not think clause 29 was intended to enable the Joint Committee to purchase the whole of the undertakings of the companies. It was intended to exclude the distribution business. The word "transferred" in clause 29 meant "acquired by the Joint Committee under the powers of the act."

Mr. TALBOT dissented from this interpretation.

Mr. CRIPPS further explained that the generating station and works would remain the property of the companies, and would be purchasable under the 1888 Act on the "then value" terms, provided the company concerned was subject to that act; some of them were not. The promoters had agreed to the condition in clause 43, sub-sec. 2, that if a public authority proposed to purchase in 1932 they must give notice of their intention. If the purchasing authority, say the L.C.C., purchased in 1932 the Joint Committee, not having purchased the undertaking of any particular company, the L.C.C. would have to pay the sum required to redeem any portion of the million pounds of stock which the Joint Committee had issued, plus the loss of profit which might have been earned between 1932 and 1952, and they would also have to pay the "then value" of the company; but, if the Joint Committee had bought the company's undertaking, the works would have ceased to be the company's property, and they would not sell at their then value, and the County Council would have to pay off the Joint Committee stock plus compensation for loss of dividend for 20 years. It might be, as the chairman suggested, an enormous advantage for the companies to sell to the Joint Committee, but any transaction would have to be carried out with the consent of the Board of Trade, and the Joint Committee would not have the capital to deal with matters of that kind. However, since the question was raised, perhaps their lordships would allow the promoters to further consider the clause.

In reply to Lord SANDERSON: If the purchasing authority decided not to purchase until 1952 a local authority could not purchase the works of a company in 1932. They would have to wait until the whole thing was bought over.

Sir RALPH LITTLER, K.C., on behalf of the City of London, said the City had stronger objection to this bill than to the other, from which they were to be excluded. The City was supplied by two companies in competition. These were purchasable in 1914, and they had no inconsiderable power over the companies in the meantime. The Bankside station was the largest in London, and the Corporation had the right of acquiring as much as was necessary of that and the Bow station. He had challenged the promoters of the other bill to find any consumers in the City with demand over 250 kw., and he thought they had found three, which he did not think justified a new power supply. Clause 36 enabled the Joint Committee to break up roads. But that power was only required in the City for the purpose of going beyond, and that would be a serious trouble. The capital cost of taking the mains round the City would probably not exceed £3,000. In taking power to purchase stations the promoters had forgotten the right of the City to purchase such portions as they required of the stations he had mentioned. The Joint Committee might buy the stations and then sell them which would utterly defeat the intention of previous legislation, giving certain rights to the City Corporation. He wished to preserve the Corporation's right to purchase in 1914. He asked the Committee not to pass the bill if it contained terms so unfair to his clients. The bill provided that a local authority must give, prior to the time of purchase by the L.C.C., three years' notice to purchase a portion of an undertaking, whereas at present they could give six months' notice, even after 1914. It was proposed that the companies should cease to own their undertakings if the latter were acquired by the Committee, and as the City could only purchase the property as the property of the companies that would deprive them of ever acquiring them.

In reply to Lord Lytton, Mr. RIGG said he did not think the Corporation would have much to say if the Joint Committee kept their mains out of the City.

Sir RALPH LITTLER said linking up was one thing, but clause 43 was different.

Mr. BLENNERHASSETT (for Willesden) said excluding Willesden from the bill seemed to be a most extraordinary proceeding.

The CHAIRMAN and Lord SANDERSON expressed the opinion that the North Metropolitan Co. would not have power to prevent the Council from taking current from the Joint Committee after their present agreement expired.

Mr. BLENNERHASSETT said he would be satisfied if it were provided that clause 37 would not apply to Willesden.

Mr. SEYMOUR BUSHE, K.C. (for the Kensington, Notting Hill, St. James', Westminster and Central Companies, the promoters of the Westminster and Kensington Bill), said his clients were not active opponents of this bill, and so far as it was based on co operation by the companies it commanded their support. Clause 45 of this bill embodied the main principle of the Westminster and Kensington Bill, and it appeared to provide satisfactorily for a cheap supply. But they objected to the business being carried out on the Joint Committee basis and also to the purchase clause, and on those grounds, apart from which their sympathy would be entirely with the promoters, they remained in opposition.

Mr. E. R. DEBENHAM (chairman of Marylebone Electric Lighting committee), examined by Mr. Cane, said he considered the bill, in many respects, a good one, but it did not provide sufficiently for public control. He would like the bulk supply guaranteed by all the local authorities and not controlled by a Joint Committee which did not represent the whole of London. The local authorities on the Joint Committee would be outvoted if the guarantors had one vote for every £10,000 capital. So long as the companies were the only guarantors it would be impossible to counteract their preponderating influence. Every authority ought to have the opportunity of guaranteeing to the extent of their interest. Clause 42 fixed the price for power supply for the whole of London. He thought this was a wrong principle, and there would be no way of getting out of it for seven years.

Cross-examined by Mr. CRIPPS: The right principle was to utilise the existing installations, which must be done by a joint committee or a joint commission. There must be some joint control in a general scheme. He thought the local authorities should all be compelled to come into the scheme, to guarantee, and to be represented on the committee. If the local authorities were put on the same footing as the guaranteeing companies that would meet their objection to some extent. The arbitration clause was not sufficiently wide, as it only permitted a distributing authority to go to arbitration on matters

where their particular interests were affected. They wished to be able to bring objections of a general kind before an arbitrator. For instance, if a bulk supply station were put up in a position suitable to the companies, but unsuitable to the interests of London as a whole, the Council's interests might not be directly affected, but he thought they should have the right to go to arbitration on matters of that kind. Clause 42 fixed the price of energy for power, and he thought that was rather a matter for a public body like the Board of Trade.

By Mr. CANE: There was a difficulty about the local authorities guaranteeing under present circumstances. He did not think they could do so without power from the Board of Trade.

Mr. COWARD, K.C. (for the L.C.C.), said, although the L.C C. had not cross examined the witnesses, he wished it to be understood that they did not desire to be on the Joint Committee.

Mr. CANE said Marylebone Council opposed the bill with great reluctance because they thought it was based on the right principles. His clients sympathised with the contention that the interests of the companies and other undertakers who had done pioneer work should be taken into consideration, and that the development should proceed by utilising the foundations they had laid rather than by demolishing them, and it would have the advantage of getting over the difficulty of the occupied field. In spite of the enormous interests of the local authorities they had no opportunity of effective control under this bill. The only satisfactory scheme was that suggested by Mr. Debenham, which would put the whole of the financial responsibility upon the whole of London and give the whole of London the control.

On Monday Mr. CRIPPS said, in reference to the question asked by the Chairman on Friday with regard to the possibility of companies tranferring their works to the Joint Committee with a view to obtaining an enhanced value from the purchasing authority if the Joint Committee's undertaking were purchased 1932, it was not the intention of the promoters that any enhanced value should attach to the undertakings in that case, and they would have the same value as under the 1888 Act.

Mr. BLENNERHASSETT, in his address for Westminster Council, said if they were safeguarded as regards their terms of purchase they would welcome the London and District Bill, but they offered unqualified opposition to the present bill because it was a gross attempt to deprive them of rights granted to them by Parliament. The bill stated that the undertakings of the London electric supply companies would, if transferred to the Joint Committee, cease to be the property of the companies, and the bill referred to purchase by the L C.C. or some other body to be appointed by Parliament in future. The Westminster Council would be deprived of their right to acquire the Central Company's Marylebone station in 1908 and there was no advantage offered to the Council to counterbalance that. The application of the provisions for purchase by the local authorities was rendered perfectly nugatory because the undertakings would be inextricably mixed up. Sec. 43 was in every respect fatal to the Council's rights. The aim of the bill was to reduce the local authorities to mere distributors. Mr. Balfour Browne had spoken of the difficulty of dividing a generating station unto nine parts. There was no such difficulty in the case of the Westminster Council, who would only require to buy up four of the seven companies supplying in Westminster. Under the bill they could only buy if the purchasing authority decided to purchase. Suppose the latter did not buy, Westminster Council's right would be completely gone, and they could not even acquire distributing plant. If the purchasing authority did not purchase until 1952 the local authorities' right was deferred until the same year. He asked the Committee not to put Westminster in the bill.

In reply to the CHAIRMAN: He did object to the general plan of the bill contained in clause 45, because it would complicate the Council's action under clause 2 of the 1888 Act, which provided for compensation for severance if the Council purchased part of an undertaking.

Mr. JOHN HUNT (town clerk of Westminster), examined by Mr. Rowland Berkeley, said the London and District Bill was not destructive of their rights. They were opposed to clause 43 of the Joint Committee Bill. His Council laid stress particularly upon the effect which this bill would have upon their rights of purchase. Unless the purchasing authority purchased in 1932 or 1952, Westminster Council would have no right of purchase under the bill.

Mr. TALBOT, in an address on behalf of Camberwell Council, said the Council were partly supplied by the County of London Co., and under their 1896 order they could buy the undertaking of that company in their area at any time up to 1931 on payment of capital expenditure plus 33 per cent. and a sum to make up the dividends to 5 per cent. They had alternative rights to purchase the same undertaking after 1931 at "then value," plus the value of goodwill, to be determined by arbitration. They could also buy the undertaking of the London Co. in their area on the latter terms. What was the justification for the present bill destroying those rights? The bill did not unify electrical supply, as it left outside its scope, so far as purchase was concerned, the undertakings of the local authorities. His clients were not clear as to the effect of clause 45 or whether under that clause the promoters could not get rid of the competitive powers to which Camberwell attached value. He hoped the clause if passed would be amended so as to retain the advantages of the Council afforded by the competitive supply, and he also asked that their purchase rights should be preserved. The promoters of the London and District Bill had accepted a clause with that object.

Mr. READER HARRIS (for Barnes) asked that Barnes should be taken out of the bill. They objected to the proposals with regard to supply for haulage and traction, and there was no need for the Joint Committee's mains to go through Barnes. They also objected to the companies breaking up their streets.

Mr. WILLIAMS (Stepney) said his Council had been hostile to the other bill, and although they desired to be as favourable as possible to the present one, as there were matters, such as the appointment of the Joint Committee, which were immaterial to the Council, and the linking up, to which they were extremely favourable, and the raising of capital and the powers of purchase did not affect them. The sinking fund and the life might affect them, but he would pass those by for the moment. But there were clauses which were detrimental to them, and therefore he asked that the bill should not be allowed to proceed. They could not expect to get a cheap supply from the Joint Committee so long as the latter got their supply from the companies. It was unreasonable to put upon the Council a maximum of £5 per kilowatt and ⅝d. per unit for the energy supplied. If Mr. Highfield's figures as to the cost of generation by the new plant were correct, they were asking the Council to pay £5 per kilowatt above what it cost to generate.

In reply to Mr. CRIPPS: A clause to prevent the Joint Committee supplying to London Dock would not altogether remove their objection. The Council had done their duty to the consumers and to the ratepayers, and he did not see why the promoters should seek to give any few ratepayers the power to bring them before the Board of Trade. It was unfair that persons who might become competitors should get the right to make them liable to arbitration proceedings. He asked that clause 42 should be eliminated.

Mr. ERSKINE POLLOCK (for Middlesex Council) said it was not desirable to put any part of their county under the control of another County Council, either at present or in the future. The difference in the area of this and of the other bill showed how persons might differ as to the fringe of London that should be included in such a scheme. So far as the principle of the bill went his Council felt that these were the people who have borne the burden of the pioneer work; they thought the promoters of the first bill had a more selfish motive. The demands of the present bill were less exacting. It was clear, however, that the promoters felt unable to apportion to Middlesex Council any position on the Joint Committee. Probably no portion of Middlesex would have been included had it not been for the report of Mr. Luke White's Committee in 1906, which was in favour of extending the area. Mr. Highfield had said he would prefer to carry out a scheme for London, leaving out the Middlesex Council area, and he did not think any Committee would include Middlesex after hearing Mr. Highfield's evidence. Mr. Conacher had also said he thought Middlesex was already sufficiently provided for.

In reply to the Chairman, Mr. Pollock said his Council did not object to this bill so much as the other, because it did not take in so much of Middlesex nor powers to supply to individual ratepayers.

Mr. CRIPPS said it was now proposed to add to the purchase clause (after line 34, p. 25) a provision that the Joint Committee should not be entitled to any additional payment to represent the loss of revenue which might have been earned by the use of plant, works, &c., transferred to the Committee by any of the companies, and which, but for such transfer, could have been purchased by the local authority under the provisions of sec. 2 of the 1888 Act or under special provisions of provisional orders granted to any of the companies. This was to be introduced because there were at present some words differing from clause 2 of the 1888 Act. It was also proposed to alter the portion of cluse 30, beginning with line 15 on p. 13, so as to provide that no agreement for transfer of stations or works should be effective or binding unless it should receive the approval of the Board of Trade, and that under any agreement for such transfer of any such works which the local authority could require a company to sell, the price to be paid by the Joint Committee should be approved by the Board of Trade, with due regard to the fact that if such transfer had not taken place such station and works would have been purchasable on the terms of and in accordance with the provisions set forth in sec. 2 of the Electric Lighting Act, 1886, or, as the case may be, in accordance with the terms set out in any provisional order granted to the company by whom the same may be transferred.

Mr. W. F. DEWEY (town clerk and parliamentary agent for Islington Council) said the Council were strongly opposed to the powers in clause 42 of this bill and also to clause 35, which enabled an outside authority to come in and break up the roads.

The CHAIRMAN remarked that an arbitrator who had to take the arbitration clause as it stood would deserve pity, and he hoped counsel would do something to make it clearer.

Mr. FREEMAN (for L.C.C.) said London County Council were in favour of a large central scheme which would solve the question permanently, and they did not think it could be solved by any linkings up or mere combinations between the companies. The Council were mainly in favour of the London and District Bill for the whole area proposed. It seemed to the London County Council that the companies could, under their existing powers, make sufficient arrangements for assisting each other. The Joint Committee Bill would, he thought, have effects disastrous to the public interests, particularly with regard to the period in which purchase had to take place. The Council did not wish to take any part on the Joint Committee, and they did not think the latter would be a satisfactory body to manage the undertaking. Clause 29 stated that the Committee could purchase, take over, &c., generating works of any supply authorities and enlarge them. Clause 30 authorised agreements between the Joint Committee and supply companies and distributing authorities. The main object was to enable the companies to transfer their undertakings, which would then cease to be under their control and would come under the legislation affecting the Joint Committee.

PARLIAMENTARY INTELLIGENCE *continued on p. 418*

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APPLICATIONS OF ELECTRICITY TO FARMING.

ELSEWHERE in this issue we publish a short article on the Applications of Electricity to Farming, in which it is pointed out that there are many farming operations lending themselves admirably to electric working. These may be classed either as operations on the land or those within the homestead. Among the former, ploughing at once suggests itself as a familiar operation which has been carried out for many years by means of steam, but so far the electric motor does not seem to have been brought into requisition. There is also a great deal of machinery now used in which horses are employed as the motive power; as, for example, in reapers and binders. Although the horse affords one of the simplest means of obtaining power, this ancient method is not altogether desirable as a certain amount of damage to the land is almost inseparable from it, and in such operations as potato drilling this may be a disadvantage. Assuming that an overhead supply of electric power is available, an electric motor anchored at one end of a field, with a steel rope running over an anchored pulley at the other end, gives a very simple means of obtaining easily controlled and easily directed power.

In the homestead there is ample scope for the electric motor in such operations as chaff cutting, cake breaking, root cutting and thrashing. In the case of dairy farming there are, in addition, the operations inseparable from such work, and the up-to-date farmer in America is even milking his cows by electricity instead of by manual labour. An instance is given of a farmer at Gunton who had a cable laid from the Corporation electricity mains and put in a

30 H.P. electric motor which was coupled up to the thrashing machine. The result effected was an increase of 25 per cent. in the output.

Unfortunately, a supply of power is not easily available at all farms (indeed it is the exception), though very possibly some of the electric power companies may have mains of a suitable kind running through rural districts, in which case the possibility of obtaining a load from the farmer should certainly be borne in mind. In America this difficulty has been overcome to some extent by the railways, where electrified, but we imagine that electric railways in this country would get into legal difficulties if they supplied electrical energy for farming. There is, however, much to be said in favour of such methods, for undoubtedly any assistance which can be given to farmers in the neighbourhood of a railway must react beneficially upon the railway itself.

Undoubtedly the average farmer has no wish to spend a great deal of capital upon experiments, or even upon plant by no means experimental, and, therefore, if he can obtain a supply of electrical energy without putting down plant for the purpose he is more likely to try electrical driving than when it is necessary for him to obtain generating plant as well. On the other hand, we think that something might be done in the way of portable generating sets for farming purposes, suitable for the farmer who has no chance of obtaining energy from a public supply, and who very possibly may find difficulty in hiring steam plant except from a long distance. Petrol ploughing machines have been on the market for some time, but we do not know that they have met with any great success. A high-speed oil engine using a heavier grade of petroleum could be placed upon the market comparatively cheaply, and would be suitable for a variety of work. There would be no difficulty in running such a set, and it would be suitable for working in the field, or, when occasion required, for working in or near a farm building with equal ease. In these days when there is a general desire for expansion, so as to place the electrical industry upon a more certain basis, the farmer should not be forgotten, and he should be educated accordingly, for education is a necessary forerunner in a movement of this kind.

REVIEWS.

(Copies of the undermentioned works can be had from *The Electrician* Office, post free on receipt of published price. Add 5 per cent. for abroad or for foreign books.)

Practical Mathematics. By Prof. JOHN PERRY, D.Sc., F.R.S. (London: Wyman & Sons). 9d.

It is always refreshing to read Prof. John Perry's views on scientific matters, and the publication of a new edition of his well-known lectures to working men on the subject of practical mathematics affords him the opportunity of re-stating, in characteristic style, his ideas on the way in which mathematics should be taught to all those who require to use them in the affairs of everyday life.

Practical Mathematics, as outlined by the lecturer, is a fascinating subject, very different from the dull but rigorous study of the orthodox mathematician.

How very much more interesting it is to plot on squared paper the tabulated values of data, and deduce from the curves the law connecting the variables than to spend a vast amount of time in studying co-ordinate geometry by means of the complicated properties of the conic sections. Again, how very simple are the explanations given by the lecturer compared with the usual methods of the text-books. Who can fail for example to understand the meaning and use of logarithms as explained here?

Much of the strength of the lecturer's method lies in his constant appeal to the common sense of his hearers. This is well shown by the way in which the notion of a differential coefficient is introduced. Using successively the notion of the slope of a road, the rate of growth of population and the speed of a railway train, the lecturer is able to explain the meaning of the symbol dy/dx and to show how it can be used in calculation. It is quite possible on these lines to explain to a class of intelligent apprentices or first year students in a technical college, the meaning and use of the fundamental processes of the calculus, such as are in common use in text-books of electrical and mechanical engineering.

The possibility of this has been demonstrated again and again, and, despite the warnings of many mathematicians who honestly believe that such teaching is a sham and a sin against the spirit of mathematical progress, the writer has never found anything but good result from the process. E. G. C.

Die Englischen Elektrochemischen Patente. By Dr. P. FERCHLAND. Vol. I. "Elektrolyse." Vol. XXIX. of "Monographien Über angewandte Elektrochemie." (Halle-a. S.: Wilhelm Knapp.) Pp. vii.—163. M. 9.

The book before us shows great pains upon the part of the author. To collect together all the patents taken out in a given number of years in any one country, is by no means a light task; and it is also hardly an enviable one, because the author may be quite sure if he has not done the work satisfactorily, and if those who know about the subject take up the book and find a few important patents missing, they are quite certain to condemn the whole book in consequence.

The present book, which is another of the excellent series of Monographs upon Applied Electrochemistry, commences with the Patent 9,374, of 1842, taken out by Mr. H. B. Leeson, which is concerned with the deposition of metals—particularly platinum. We do not suppose the patent was ever worked, but at the same time it is of historical interest. The last patent dealt with in the book was taken out December 12, 1906, and treats of the winning of tin by treating tin residues and so on with hot caustic soda.

The chief advantage of this book to electrochemists in this country will be to prevent them from repeating the pioneer work which has already been done by others. Of course, it hardly gives an exact idea of the electrochemistry which has been done in this country, because many of the patents have actually been taken out by our competitors, in order to prevent their processes, which they are working abroad, being worked here. If the new Patent Law which has just been passed serves to prevent this exploitation of British hospitality, then not only electrochemists, but all manufacturers, will have much to be thankful for.

The patents are described in short abstract, some of them being very short; and we find sometimes that simply the heading of the patent is given, and then one is referred to the previously published monograph describing German Patents. For example, on page 113, there are three such references. We do not think this really matters; it simply means that one ought to buy the other monograph, and as we have already had experience of this book, we can say it is quite worth getting.

The diagrams throughout the book considerably add to its value. It should be noted, in conclusion, that this is only the first volume of the work. F. M. P.

The Proell Steam Calculator. (London: J. J. Griffin & Sons, Ltd.) Pp. 183.

The object of the Calculator is to reduce the labour connected with the detailed calculations of the many problems arising in practical thermodynamics, and in general to replace the usual arithmetical methods by a graphical process. The method of achieving this object is to draw out a series of curves or scales so arranged and related to one another that the greater proportion of problems may be solved by merely laying a straight

edge across the appropriate scales and reading off the answer. The curves are published in three sets, one set being divided according to the metric system, the second set according to the metric system with a slight variation to suit the convenience of electrical engineers, and the third set according to the British units. In the pamphlet accompanying the curves full instructions are given for their use. Many numerical examples are worked by means of the curves to illustrate the method. Problems of the following kind are exemplified :—

Given the temperature, find the total heat of unit mass of steam.

Given the dryness, find the total heat.

Given the heat content, find the entropy.

Given the temperature, pressure and final pressure after expansion, find the specific section of a nozzle.

Given any two functions of the state of the steam, find the values of the other functions.

Information regarding the construction of the scales and the thermodynamic equations on which they are based is not given in the pamphlet, but the reader is referred to a publication in the *Journal* of the Society of German Engineers, Sept. 17, 1904. To a draughtsman or designer who has to make repeated calculations of the same kind, but using different data, the curves would be of assistance.

ON CERTAIN ASPECTS OF THE WORK OF LORD KELVIN.*

BY SIR OLIVER LODGE, F.R.S.

When a man of the first magnitude works continually at a single group of subjects from an age preceding 20 to an age exceeding 80 the circumstance is so exceptional and the output so enormous that no ordinary summary or criticism can do it justice. It is only therefore with some aspects of that work that I propose to deal, and, unconsciously I suppose, I select those aspects which have from one or another point of view specially impressed myself. I shall, however, except from even these all that portion which relates to practical applications, partly because this portion has been dealt with elsewhere, but chiefly because on this occasion it is appropriate to review those portions of the work which are on the border land of chemistry and physics, or else are where physics runs into philosophy.

Energy.—I expect that posterity will say that his most immortal work is the development and application of the doctrine of the conservation of energy, together with the comprehension and elaboration of the laws of thermodynamics. Later he became more immersed in the work of the world ; but although his later work is the best known to the general public—if indeed any scientific work can be said to be really known to that body—yet in pure genius nothing to my mind since Newton comes up to his achievement in the fifth and sixth decades of the last century, especially from 1848 to 1856.

Absolute Measurement.—To Lord Kelvin, more than to anyone else, we owe the realisation of the system of absolute measurement applied to such intractable quantities as are found in electricity and magnetism. Counting, or the enumeration of discrete quantities, is a very easy and natural operation ; but measurement, in the sense of expressing the warmth of a day, or the brightness of a light, or the strength of a current, or the field of a magnet, or the resistance of a wire, or the transparency of a window, or the conductivity of a metal, or the conducting power of a gas, in numerical fashion, is not by any means a simple thing ; it usually needs great ingenuity, and sometimes can hardly be done.

The invention of suitable units, and the mode of measuring currents and E.M.F.'s and resistances in such units, is very far from being an obvious notion, and even now the full meaning of the idea of absolute measurement is not in all quarters quite clear. In the first instance it was not always quite clear, I venture to say, even in the mind of Lord Kelvin himself ; and a certain partial incompleteness was almost necessary in order to reduce electric and magnetic quantities to simple mechanics. For, as a matter of fact, they cannot be reduced to simple mechanics, or at least have not yet been so reduced, and it was partially by blinding ourselves to that fact that the idea of the ohm, the ampere and the volt were attained We used to be told that resistance was a velocity and that electrostatic capacity was a length, also that self induction was a length, and so on. But, of course, resistance is not a velocity, nor is self-induction or capacity a length. Nevertheless, had it not been for this partially erroneous simplification, the introduction of any system of electric measurement would probably have been seriously delayed. Incidentally it may be noted that the magnetic method of measuring resistance, or determining the ohm, was devised by Weber. Kelvin's first method was based upon Joule's law (*see* p. 502, Vol. I.).

Then, again, many people seem to think that absolute measurement has something to do with the metric system, and with the expression of quantities in C.G.S. units. And again, others have urged that nothing expressed in arbitrary and perishable units, like centimetres, grammes and the like, could be really absolute, but that a unit independent of convention and humanity and terrestrial considerations, one really eternal and the same throughout the universe, ought to be employed—such, for instance, as the wave length of a specified kind of light as the unit of length, the mass of a certain kind of atom as the unit of mass, and the period of some fundamental movement as the unit of time.

Undoubtedly the determination of any conventional unit in terms of these natural units has a distinct value ; inasmuch as it enables the conventional unit to be reproduced or understood at any epoch in the world's history or on any other planet. But it has nothing to do with the principle of absolute measure, nor is it necessary to employ these universal units for practical purposes. The connection between them and the conventional unit is a matter of careful determination, to be performed from time to time ; and it is usually expressed in such a phrase as "measurement of the wave-length of light in metres," or "determination of the mass of an atom in grammes," rather than by the converse mode of expression, which to some would seem more appropriate. The fact is, however, that anything will do for a unit of absolute measure, so long as it is definite and constant—a foot or a yard is as good as anything else —and it is a great pity that the inventors of the metric system did not employ one of these old historical units instead of a brand new one supposed to be connected with the size of the earth—a comparatively unimportant and irrelevant magnitude. They could hardly have realised that the relation between any two units arbitrarily chosen must necessarily be incommensurable, and that historical continuity was far more valuable than approximate round numbers for relations not frequently wanted.

The real essence of absolute measure is that every quantity shall be thoroughly and completely specified, so as to be of the right dimensions without any factor being omitted or understood. Thus, for instance, a foot-pound is not an absolute unit of work, unless the intensity of gravity be included as a factor ; nor can a self-induction be expressed as so many earth-quadrants without the introduction of the factor μ. More than this. Any equation which is only true when the quantities are interpreted in a certain way—as, for instance, if lengths are expressed in feet, weights in tons, and the like, as is the case with so many engineering equations—avoids all the advantages of absolute measure : these expressions are not really equations at all, but arithmetical dodges or shorthand statements for immediately practical convenience. For such purposes they are often useful, though their constant employment tends to stunt the theoretical faculties, and seems to hinder perception of the advantages of the more important kind of equation, which, being in absolute measure, is true in every system of units whatever —an equation in which the symbols represent the quantities themselves, and not some mere numerical relation in terms of a conventional unit.

Absolute Temperature.—One of the remarkable achievements of Lord Kelvin has been the conception and determination of absolute temperature. The idea of an absolute temperature—that is to say, of a temperature reckoned from a real and actual zero, not a conventional one, and specified so as to be independent of the properties of any particular substance—follows rather naturally from the second law of thermodynamics, and from the fact that the efficiency of a perfect or reversible heat engine is independent of the properties of the working substance, being dependent only on the temperatures at which heat is supplied and withdrawn. Absolute temperature is, in fact, the reciprocal of Carnot's function, as Kelvin showed in 1848 (p. 100, Vol. I.). And the absolute zero is the temperature at wh ch the working substance has exhausted all its heat in doing work, so that there is none to yield up as waste—the temperature, in fact, at which a condenser or "cold body" becomes unnecessary.

The actual determination, as hitherto experimentally made, of the zero of absolute temperature, below which it will be for ever impossible to cool bodies—since at that temperature they possess no heat, and, therefore, cannot have any more removed—may be said to depend, not necessarily or theoretically but actually as in practice the simplest method, in the first place on the conception of a perfect gas—that is, one whose molecules act upon each other and upon the surrounding walls solely by bombardment, their being no cohesion whatever between the molecules. The temperature at which the pressure of such a gas becomes zero must be simply the temperature of absolute molecular rest, and, therefore, will be the absolute zero. From the properties of such a gas its absolue temperature could at once be experimentally determined if only such a

* Extracts from the presidential address to the Faraday Society, delivered on May 26th.

gas were actually available for experiment, for it would come out as the reciprocal of its coefficient of expansion. But as a perfect gas is not available an imperfect gas has to be employed and a correction made for the amount of its imperfection, the amount of this correction being deduced by reasoning based on its behaviour when subjected to an irreversible operation—as irreversible as possible. For instance, it might be allowed suddenly to expand in such a way as to do no external work, and, therefore, not to cool itself if it were perfect and if time is allowed for all the eddies and streaming motions to subside, and then observing the actual consumption of heat or fall of temperature ready produced—which would be proportioned to the cohesion times the change of volume. The change of temperature so observed is the chief term in a correction to be applied to the observed coefficient of expansion under constant pressure of the imperfect gas.

The experiment as first made by Joule, of allowing a gas to double its volume inside a closed vessel by opening a connection between a full and an empty portion of a vessel, was manifestly an interesting and suggestive experiment, and a check or verification of Meyer's hypothesis that the mechanical equivalent of heat could be obtained by equating the heat supplied and the work extracted from expanding air; but the full meaning and bearing of such an experiment is by no means obvious, and it is remarkable that it should lead to a determination of the zero of absolute temperature. For this purpose it has to be repeated in a more refined form, the oozing of gas as a steady stream from high pressure to low through a porous plug, and a determination made of the change of temperature resulting, when all the eddies and organised kinds of motion have subsided, and when everything has become heat again except what was lost in internal work. It is well known now that the practical liquefaction of gases depends on this very effect, for, of course, without some cohesion between the molecules, liquefaction would be quite impossible. The essence of liquefaction is the subdivision of the contents of a vessel into two sharply bounded regions of different density, and kept in this condition for a time by internal molecular forces.

Instruments.—Of Lord Kelvin's many instrumental inventions I shall say nothing beyond calling attention to the strongly mathematical basis on which they are founded. This fact was conspicuous to me long ago in connection with the infancy of the quadrant-electrometer—an instrument now older than most physicists, and so familiar that its unobviousness at first can hardly be appreciated; but the treatment of an electrometer as a variable condenser, which naturally led to the design of one flat surface moving over two other flat surfaces in the same plane, was, I judge, a distinctly mathematical, not an experimental, idea. It furnished at once a first approximation to the moment acting upon the upper flat surface grotesquely called a "needle," showing that the expression contained two factors—the difference of potential between the two quadrants and the difference between their average potential and the potential of the needle above them, the needle being thereby urged to move so that the potential energy of the system should become a minimum.

Electrical Theory of Matter.—On the great modern region of physics centring round an electrical theory of matter Lord Kelvin's mind was somewhat conservative, as perhaps it was in electricity generally wherever results could not be obtained by straightforward dynamics or by energy calculations. In other directions he only advanced under protest, as it were, towards the goal at which others were enthusiastically working. Nevertheless, we owe to him some pioneering work even in this branch. Comparatively early speculation and calculation on the structure of an atom are contained in a remarkable Paper by Lord Kelvin, published in the *Phil. Mag* in 1901 under the curious title "Æpinus Atomised." It is reproduced in the volume of Baltimore Lectures as Appendix E. It was probably the first attempt to work out the statics of an atom, according to a simple conception whose major consequences can be traced with comparative ease—viz., that of a spherical portion of uniform positive electricity in which minute negative charges are sown like specks, being attracted towards the centre of the sphere according to the law of direct distance, and repelling each other according to the inverse square law. Various interesting groupings can be easily calculated as stable patterns, and they tend to become more stable if they revolve regularly round the centre, or if sustained by a central group or particle. But although the calculable distribution and properties of such groups are profoundly suggestive and interesting, the behaviour of an atom of positive electricity with even a single electron inside it became instructive in the hands of Lord Kelvin.

His conception of the simplest possible electrical atom is that of a comparatively large positive uniform globe neutralised by an equal charge of negative as a speck at the centre. Two such atoms, of course, exert no force on each other from a distance, but if they are of unequal size, and if the smaller one penetrates the bigger, until the centre of the smaller is included in the circumference of the bigger, then each electron begins to be displaced, and, oddly enough, both are displaced in the same direction. If the penetration continues, both electrons enter the smaller sphere, and there adjust themselves and remain, the smaller one having robbed the bigger one of its charge, so that when they separate again the smaller one has become negative and the larger one positive. This is the idea supposed to correspond to some features in frictional electricity or electrification by contact between substances of different kinds.

Lord Kelvin further goes on to calculate what would happen when one neutral atom with an electron at centre is approached by a small positive sphere without any neutralising electron charge. Displacement of the electron now begins long before contact, and when they approach within a certain distance—namely, 1·89 times the larger radius distance between their centres—the electron in the bigger one is displaced a distance of 0·63 times its radius from the centre, and there its equilibrium becomes unstable, so that it jumps across the intervening space "like a cork jumping out of a bottle" and enters the smaller sphere. It will then shoot through the smaller sphere and oscillate "perhaps 10 or 20 times (or perhaps a million)," and ultimately settle down to rest at some place—not the centre—depending on the ultimate distance of the larger atom, which, however, has no power under any circumstances of regaining its charge from the smaller one. It is always the smaller that robs the bigger. This, indeed, is only a particular case of the general importance of "concentration" in the electrical theory. The mass of an electron depends upon its smallness—that is, upon its potential as well as upon its charge—and could be made enormous if it were assumed small enough; though, as we well know, to account for its actual mass a definite smallness is appropriate.

Cosmic Calculations.—The fact that after a lifetime of immersion in all the intricacies of natural philosophy Lord Kelvin still postulated an origin or beginning for the material universe—a beginning when it was essentially different, not only locally but universally, from its present condition—and that he endeavoured to conceive what it might then have been like in those early times, is a notable circumstance and one of general interest. To us there appears no reason for calling those times early rather than late, nor would I suppose a beginning or ending at all either for space or for what is in space other than such beginnings or endings as we might detect or may hope to detect somewhere even now. But Lord Kelvin clearly thought otherwise, so with this notable aspect of his life-work I conclude my address.

In the other parts of his address, Sir Oliver Lodge referred at considerable length to Lord Kelvin's work on energy, electric oscillations, absolute temperature and cosmic research.

ELECTRICITY APPLIED TO FARMING.

(Communicated.)

There is no doubt that with the increased spread of electric distributing systems in the rural districts there will be a considerable increase in the application of electricity to purposes in and about farm buildings, and it may be, therefore, worth while briefly reviewing the purposes to which electricity may be applied.

Tillage implements appear to offer a field which has not yet been adequately considered. There is still a prejudice in favour of cultivating by means of horses, inasmuch as steam cultivators have sometimes been introduced which till the ground up to too great a depth, and although the land was rendered of a friable nature it was disturbed to too great a depth for efficient cultivation. At the same time, bearing in mind the few days available in the year for proper tilling it would seem that a quick and rapid means for this purpose would be desirable, and it is surely worth suggesting that the electric motor with its rapid and easy means of starting and stopping, its instantaneous variation of speed when required, and its comparative portability, should prove a very valuable factor in this problem.

For harrowing, manure distributing, hay-spreading, machines and potato drilling, practically the same arrangement could be used of a reversible haulage operated by means of a motor anchored at one side of the field, the haulage rope running over a pulley placed at the other end and also anchored. Such a method would do away with the heavy trampling of horses feet upon prepared ground, which in the case of two or four-horse drills is absolutely ruinous to efficient cultivation. This argument gains greater and greater weight every year with the advance of automatic machinery for agriculture, such as the improvements in mechanical diggers and planters for potato fields and economical methods of collecting the potatoes when dug.

In the case of corn cultivation electrical power can be admirably applied to reapers and binders, and the use of the traction engine for threshing purposes is now quite a common practice. It is, however, rather an expensive matter to bring a steam engine, straw elevator or chaff cutter from any considerable distance, and the application of electric power, which involves such a light weight of moving machinery, is of great advantage to a farmer who studies the cost of power in distribution.

A case in point is that of a farmer at Gunton, near Lowestoft, who had a cable laid from the Corporation electricity main to his stack

yard, where a 30 H.P. electric motor was coupled up to the threshing machine. This arrangement worked admirably, 25 coombs per hour being threshed, as compared with 20 coombs by a previous steam engine. For cleaning or winnowing, the use of electric power for producing the blast is, of course, obvious. Coming now to the home stead, there are a large number of purposes for which electricity can be employed with a considerable saving to the farmer. For example, manual labour is often employed to excess in such simple operations as loading carts. It is a heavy job for one man to get, say, a sack of corn into a cart unassisted, whereas by means of a small motor operated windlass all the lifting and hauling required in and about a farmyard could be executed with a minimum amount of hand labour. For pumping water from well or river for house purposes, electrically operated pumps give high efficiencies especially if operated automatically in connection with float-controlled starters.

Most farmers now-a-days, especially where a large amount of pasture land is maintained, have very full and complete dairy equipments, and a great deal of this plant, from milk separators to butter churns, can be operated electrically. In some instances, of course, a supply of hot steam is necessary for the purpose of heating the cream for the separators and for scalding the dairy utensils, but it is hardly worth while keeping a steam engine going especially for this purpose. Moreover, the fast working of overheated cream is most injurious, and with the decreased cost of electric power available now-a-days a little more time might profitably be spent in securing the very best quality of product. Cheese making demands a steam plant of sorts, but the power required could be produced electrically.

Every farm requires chaff cutting, cake breaking and root cutting, and in the majority of cases these operations have to be performed frequently and upon small quantities, inasmuch as broken cake is subject to rapid fermentation or moulding, which would have injurious effects upon the animals. For intermittent work of this nature the electric drive is by far the most suitable means, inasmuch as it can be instantaneously applied or discontinued, and it could also be available for mixing the chaff and roots should a mixed diet be required for the farm stock.

In recent times the operation of milking cows has been successfully accomplished electrically, at any rate in America, perfectly authentic cases of this nature have been reported, with a considerable saving in the amount of farm labour required in the operation. It is a case in support of the argument that the installation of electric power in a farm house tends towards a considerable diminution in the number of hands required, thus substituting a charge on the farm which is in almost direct proportion to the work done for the cost of upkeep, which is practically independent of the operations, consisting of the hire of the labourers and not infrequently the provision of food and house accommodation for them.

It may be argued that the future of electric power in this connection will be seriously menaced by the rapid progress made in oil-engine construction and the introduction of such forms of motive power as the suction gas plant, but it should be pointed out that in the first place power supply from central station service is becoming more and more a matter of differential rates relying on a diversity factor which is absent in isolated plants. In the second place, it can be shown that farmers are of similar likes and dislikes to other power consumers, in the fact that they prefer to put down a comparatively small capital outlay for the supply of their energy involved in the installation of an electric service, as compared with the prime cost of an isolated equipment. In the third place, there is nothing more adaptable to portability, which is one of the first requisites of a farm equipment, than the overhead system of transmission on pole lines, which can run to the farm and through the fields at a very small cost and from which may be tapped at convenient points an electric supply to a motor, which can be anchored in any suitable position. There is an element of beautiful simplicity in the idea of fixing a motor to a strong cart, taking it out to any desired point, connecting it by means of flexible cable to the nearest pole line, tapping, anchoring the cart firmly, and then simply applying the power. Such an arrangement cannot be paralleled for simplicity in any other means of obtaining motive power on farm lands.

SWITCHGEAR CONTROL APPARATUS AND RELAYS FOR ALTERNATING CURRENT CIRCUITS.

In connection with the Paper read by Dr. C. C. Garrard before the Institution of Electrical Engineers, and abstracted in our issues of May 29th and June 5th, we have received from the author some additional particulars concerning the protection of interconnector cables where continuous current is not available in the sub-station.

The adjoining diagram shows Dr. Garrard's arrangements for the protection of interconnectors by means of electrically interlocked reverse relays, using alternating current tripping coils. A and B are contacts on the main switch, A being closed when the switch is open and B being opened with the switch. They consist of simple metal tongues on the mechanism of the switch. The other end of the interconnector is fitted up in exactly the same manner. Both A and B may be shunted, if desired, by press button keys for testing purposes.

It will be noticed from the diagram that when power is flowing into the three-phase interconnector at both ends at the same time the reverse relays RR operate and close the circuit through an auxiliary relay AR. This auxiliary relay AR can be energised from a few primary or secondary cells. If the pilot wire consists of 7/22 cable this only has a resistance of about 9½ ohms per mile, so that it will be seen that quite a small voltage given, say, by some Leclanché cells, is quite powerful enough to operate the auxiliary relay.

Both series and shunt tripping are shown. This is in order that the interconnector shall be disconnected no matter what the voltage or current may be which are available to operate the trip coils. Thus, if the voltage drops, this will be due to a large current passing, and the series coils will be effective. If, on the other hand,

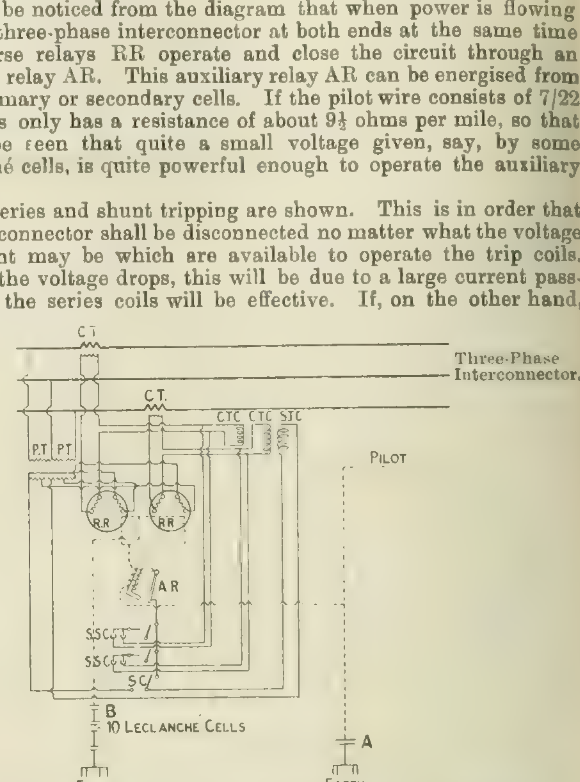


DIAGRAM SHOWING PROTECTION OF INTERCONNECTORS WITH A.C. TRIPPING (SERIES AND SHUNT).

but little current passes, the voltage will keep up and the shunt trip coil will be the one that operates. It will be noticed that under normal conditions the current trip coils CTC are short-circuited by means of the contacts SSC. Only when the auxiliary relay AR operates is this short circuit removed and the current from the current transformers diverted through the trip coils.

CORRESPONDENCE.

MARCONI'S SYSTEM OF WIRELESS TELEGRAPHY.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: It may be through my own fault that Mr. Charles Bright has misunderstood my meaning. If so, I am sorry. His quotation of my words falls short of giving the sense of what I wrote. A full stop and no context replace my comma and what follows.

Mr. Bright's former statement that duplex-automatic is "for long distances only applicable to wire telegraphy at present" led me to point to a known instance of practical LONG distance radio-duplex, by the Poulsen system, across 1,250 miles. Surely this is genuine long distance work, especially when considered in the light of Mr. Marconi's words, as reported in the *Morning Post* of May 20th, relating to his satisfactory duplex results up to 4 or 5 miles.

As to success or non success of radio auto-transmission —for which, by the way, aspirants to radio-telegraph appointments were trained as punchers in telegraph schools as long ago as 1906, if not before—I cannot see how this can be a subject for discussion, as this system has always been feasible.

The question whether radio transmission be manual or automatic is purely one of convenience, and is in no way affected by radio technical considerations, excepting as regards—in spark telegraphy—the necessary high insulation of all parts in the electro magnetic make and break worked, on local circuit, from an auto.

In arc telegraphy, or in any methods for signalling by undamped oscillations, auto work is still further facilitated by the remarkable simplicity of the "sending" devices, such, *e.g.*,

as signalling merely by the short-circuiting of a non-inductive resistance; a practically noiseless process.

Just as my knowledge of cable work drew from me the letter of May 21st to the *Morning Post* (see *The Electrician*, May 29th), so was it owing to a keen interest in wireless, engendered by vivid personal experiences with Marconi and other radio installations, from time to time, afloat and ashore, that I ventured to supplement by a few little annotations the letter in which Mr. Bright first took friendly exception to certain conclusions of my own.—I am, &c.,

Wimbledon, June 20. E. RAYMOND-BARKER.

POLYPHASE INDUCTION MOTORS: THE CHOICE OF TYPE.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: With reference to the abstract of my recent Inst.E.E. Paper in the current issue of *The Electrician*, and to the subsequent discussion thereon, I would ask you to note that the remarks attributed to me in the reply thereto are scarcely correct.

I certainly do not hold the view that the use of slip-ring motors is out of the question for mining work. It is a matter of common knowledge that such machines are very largely used to meet the conditions in respect of starting torque and speed control in driving, for example, the various classes of haulage gears.

The point I desire to emphasise is simply that a squirrel-cage motor is a much more satisfactory machine to put down a coal mine, more especially if General Rule No. 8 applies. I believe that a more careful study of the conditions to be met in mining work, together with a consideration of existing mechanical devices, would lead to the installation of a larger proportion of this class of motor.

I shall therefore esteem it a favour if you will be so good as to insert this correction.

With thanks in anticipation.—I am, &c.,

GEORGE STEVENSON.

KEARNEY HIGH-SPEED RAILWAY.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: I beg to thank you for kindly sending me a copy of your publication containing a notice in reference to my high-speed railway.

In respect to your criticism, I notice that your paper is the only one which realises the difficulty to be overcome owing to stress on the top rail caused by a side gale of wind. This is a more important factor than any other single point in regard to the safety of the system, but I have no doubt whatever that the difficulty can be overcome by my semi-circular standard construction, which is extraordinarily rigid for its weight. So long as the gauge between the rails does not vary more than 2 in. (and there is no reason why it should) my special form of guide wheel provides for absolute safety.

In reference to your last remark I can assure you that no single point in connection with the involved subject of rapid transit has escaped my notice.

You will, no doubt, be interested to hear that Col. Yorke and Col. von Donop, both of the Board of Trade, accompanied by Mr. Foxlee, M.I.C.E., have inspected my working model and put it through some very severe tests, including running the car over the rails at an actual speed of 22 miles an hour after they had been deliberately distorted to a considerable extent. These were all passed without a hitch, and Col. Yorke and the other two gentlemen present expressed their opinions "that every claim made for the Kearney system had been amply substantiated, and that they were very pleased with the demonstration."

The model has now been removed and fitted up at the Battersea Power Station, Lombard-road, Battersea.

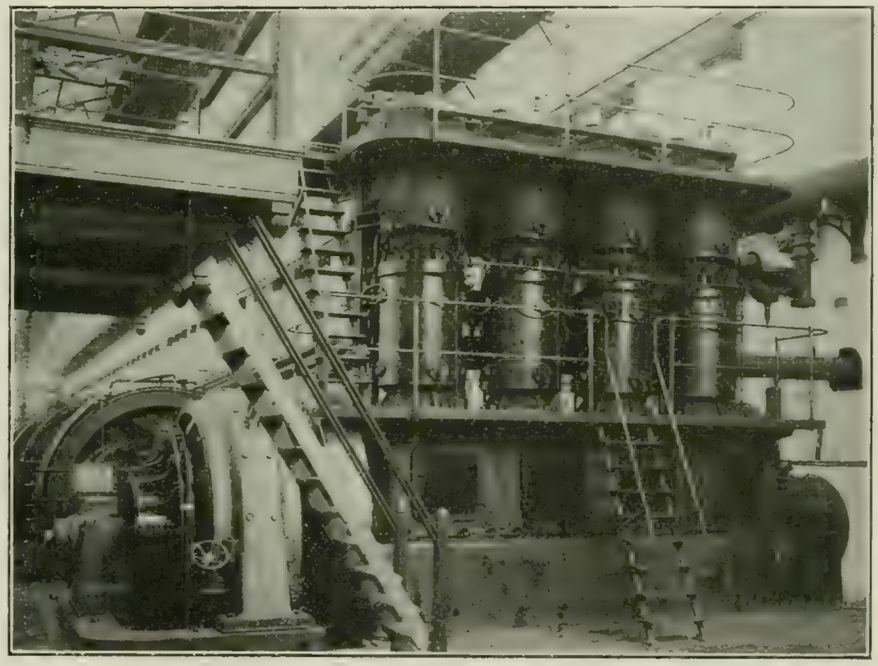
Again thanking you,—I am, &c,

E. W. C. KEARNEY.

LARGEST VERTICAL GAS ENGINE IN THE WORLD.

An event of more than usual interest took place on the 6th inst. at the works of the Castner-Kellner Alkali Co., Runcorn, when a 1,000 B.H.P. gas engine was started by Mr. P. Allen, engineer to the company. The engine, which is of the latest standard vertical type, was supplied by the British Westinghouse Co., and is connected to a direct current generator supplied by the same makers. It forms an extension to the existing installation at Runcorn, where four 750 B.H.P. engines of the same type have been in operation for some considerable time in connection with the electrolytic process of the above firm.

Some idea of this 1,000 B.H.P. engine may be gathered from the accompanying illustration. It will be noticed that the cylinders, in pairs, are placed over four cranks, by which arrangement the makers claim that they can give the most even turning moment of any gas engine on the market. No water-cooling is used for the pistons, valves or other moving parts, thus avoiding any danger of breakage of pistons, which is often a source of trouble in connection with large horizontal engines. Forced lubrication is used throughout, the oil pumps being in duplicate, and these can be examined and the oil sieves changed whilst the engine is in operation. All valves are positively operated by means of straight push rods actuated directly from the cam-shaft. These are also arranged with adjustable screws, so that any play or wear can be taken up on these valves, whilst the engine is in operation.



1,000 B.H.P. BRITISH WESTINGHOUSE GAS ENGINE.

The installation of this engine may be said to mark an epoch in the gas-engine industry, as we understand that it is the largest vertical gas engine yet manufactured and put into successful operation.

In addition to the five Westinghouse engines of this type now installed at the Castner-Kellner works, three of 750 B.H.P. capacity have been supplied to Messrs. Pilkington Bros., St. Helens, for their glass works, and one of 750 B.H.P. to the Hollins Mill Co., Marple, which has been for some considerable time operating their cotton mill; also visitors to the Franco-British Exhibition will have noticed one of these large engines in the right-hand corner of the Machinery Hall. This engine runs in conjunction with a Parsons turbine, and supplies electric current to the Machinery Hall, so that those who are interested in gas-engine work will have the opportunity of inspecting this example of a type entirely British, both in design and manufacture, which is taking a premier position in the gas-engine world of to-day.

PARLIAMENTARY INTELLIGENCE.

(*Continued from page 411.*)

Continuing, Mr. Freeman (for London County Council) said: The modification that had been proposed, and which he had referred to, did not entirely remove the Council's objection. The Board of Trade had stated that they did not wish to have the power of approving the price to be paid by the Joint Committee for companies' works, and therefore the clause ought to be struck out. With regard to clause 31, which enabled the Joint Committee to enter into agreements to supply energy to authorised distributors and lay lines or works for the purchase of such supply, he suggested that the powers might be modified so as to enable the companies to do this themselves. That would remove the reason which Mr. Braithwaite had mentioned as justifying the formation of a Joint Committee—viz., that the Joint Committee could do that business and the companies could not. The promoters asked in clause 42 for extraordinary powers, which were unprecedented in the case of commercial companies, to regulate the charges of all distributors in the area. When one turned to clauses 38 and 43 it was perfectly obvious what the main object of the Joint Committee was. The first clause mentioned referred to the power to issue £1,000,000 of stock, to be redeemed at a price not exceeding £110. The effect might be that they might issue at £75 or £85 and the stock might be subject to be redeemed at par or higher. The purchasing authority would have to pay the amount to redeem the stock, and a sum to compensate for loss of profit if the purchase took place in 1932, and the value of the undertakings which might have been acquired by the Joint Committee. Under the bill, before the amendment had been made that day, such companies' undertakings would have been subject to the same terms as the Joint Committee's own original undertaking. He understood the effect of the alteration was that it still left this distinction: Instead of the companies' property being purchasable, as under the 1888 Act, at the "then value," it came under the same principle as that proposed for the purchase of the Joint Committee's property—viz., of making good the amount of the stock issued and not the value of the property itself. Although it took away the additional 20 years' life, it still made it so much to the interest of the companies to be purchased by the Joint Committee that it was almost impossible to conceive a condition in which it would not have taken place. The Council were in favour of the equalisation of periods of purchase, but they were strongly in favour of purchase at "then value."

In reply to the CHAIRMAN: He did not think any general committee was necessary. The companies could raise their money separately and use it jointly by linking up their mains. He proposed that all the provisions about raising stock should disappear. The Council still adhered to their opinion, expressed some time ago, that the most satisfactory solution of the question would be found in a principal generating station in a favourable situation. He suggested that this second bill (promoted by the existing companies) should be practically confined to clauses 45 and 46, which provide for mutual assistance and co-operation between the companies, with the addition of the consolidation of the purchase of the companies' undertakings. All the Council wanted in that respect was the consolidation of the purchase as provided for in clause 43 on the basis of the Electric Lighting Acts—namely, at the "then value"—that was on the basis of the 1838 Act unchanged. They did not propose to oppose the first bill on the ground that the financial prospects were not sufficiently favourable. That was a matter they proposed to leave to the Committee.

In reply to Lord SANDERSON: The County Council were strongly of opinion that the second paragraph of clause 45 (which authorised the present companies to provide new, enlarged or extended stations) should be omitted.

Mr FITZGERALD, in his address (which comprised his reply on the London and District Bill and remarks on behalf of the promoters of that bill against the Joint Committee Bill) said the former bill was opposed by local authorities, companies and the two County Councils. Ten of the 34 local authorities who were authorised distributors had appeared in opposition, and the City of London and City of Westminster Corporations had also appeared. Mr. Blennerhassett had said Westminster were in favour of the principle of the bill. What they objected to were clauses 52 and 73. He had suggested a modification of clause 52 which he believed would meet the views of London County Council, and which, he hoped, would meet Westminster Council also. Clause 73 enabled the promoters to acquire by consent and with the approbation of the Board of Trade, the undertaking of any authorised distributor. Mr. Blennerhassett required a modification, but he (Mr. FitzGerald) thought he would be able to put forward, when the clause stage was reached, reasons why the modification should not be granted. He did not know whether the City of London were against the principle of the bill, but they did not want any electric main laid through the City. That, again, was a clause question. The opposition of the distributors was, firstly, that they did not want a supply in bulk, because they could do better themselves, and, secondly, they objected to competition. There was no obligation under the bill to take the bulk supply unless they wished, and they had the option, under the London and District Bill, of taking it at lower prices than any yet actually offered in a bill of that sort. He would have thought that was an option of the greatest value, and one of which the distributors would avail themselves to a very large extent. A comparison of the [illegible] tables 5, 9 and 10, setting out the works costs of the authorised distributors and the maximum and estimated prices under the bill would show how extremely valuable that option was. It must be for the distributors' interest when the period came for further expenditure of capital to take the additional supply they required from a large central station instead of extending their works. The second point, which he thought was really at the bottom of all the opposition, was the fear of competition. It became essential to consider whether the competition that could be set up under his bill was of a character that ought to be prevented or obstructed by Parliament. Local authorities who owned tramways could take current for the tramways from the company or continue to supply it from their own works. The local authorities' power supply income did not exceed one-tenth of their total income, so that nine-tenths would not be subject to any competition. It had been suggested, he thought by Mr. Conacher, that the promoters would lay down the ordinary distributing mains of a lighting company, get into a house by supplying a radiator, and then supply the house for lighting. The capital powers would not enable the promoters to do anything of the kind, and the idea that they could supply for ordinary lighting purposes, even at the prices mentioned in the bill as their maximum prices, was absolutely absurd. If they did so they would be in the hands of a liquidator in a short period. With regard to the objection to a manufacturer being allowed to use 20 per cent. of his power supply for lighting, it would be useless to offer a manufacturer supply for power, and tell him he must go on taking his supply for lighting from some other company or local authority, and this had been recognised in every power bill. Up to the present he had not heard any real facts put before their lordships showing that 20 per cent. was an unreasonable percentage. The real competition was for power for consumers of 250 kw. and over, and that was reasonable competition. Why were not large manufacturers to get a supply at the cheapest rate? Mr. Conradi, manager for Vickers, Sons & Maxim, said his company's own station at Erith had a capacity of 800 kw., and they proposed to increase to 1,360 kw. They were also taking 150 kw. from Erith Council. He said "there would be a very considerable saving if they took their power from the company at the prices set out in the bill rather than generate it for themselves. It would pay manufacturers to scrap their plant and buy from the company." In objecting to competition the objectors lost sight altogether of the interests of the manufacturers. The London manufacturer was at a disadvantage in regard to cheap power compared with others in the provinces and abroad. He thought it desirable that power should be given to enable his clients to supply the manufacturer with cheap electricity without any question of getting the local authorities' consent. Opponents had said, in effect: "We shall be ruined by competition," and then they said: "We can generate as cheaply or more cheaply than you can." Mr. Highfield had put in figures to show that his company could generate more cheaply than the Power Co., and if that was so what fear was there of competition? With regard to competition under 250 kw., an alteration, with which he would deal next day, had been proposed at the instance of the L.C.C. Stepney Council whose works costs were low and whose station was well situated, as far as a small station of that sort could be, was one of the distributors who agreed in 1905 to take all their additional supply from the Administrative Co. if the company's bill had passed, and Mr. Williams had wanted to know whether the London & District Co. would agree to the same terms. Before this bill got to the other House he had no doubt Mr. Williams would have presented a clause showing the terms on which Stepney would take a future supply from the company. The case in regard to competition with the existing companies was very similar. Mr. Balfour Browne had said that when the provisional orders of his companies had been granted there was a Parliamentary bargain which prevented Parliament passing a power bill for London, but there was no foundation for that suggestion. Parliament gave notice to every company and local authority taking a provisional order under the 1882 Act that they would or might be subject to competition hereafter.

The CHAIRMAN here announced that the Committee did not wish to hear anything further about the London and District Bill, except with regard to the purchase clause and the Kitson clause, on which the promoters were conferring with the L.C.C., and Mr. FitzGerald promised to report the result of the negotiations on the following day.

On Tuesday Mr FITZGERALD gave particulars of the clauses which it was proposed to add and the alterations proposed to be made in the bill. By agreement with the L.C.C. it was proposed to strike out subclause 3 of clause 51 and insert a subclause providing that electrical energy shall not be supplied by the company except to authorised undertakers or proprietors or trustees of any railway, tramway, tramroad, canal or navigation, without the consent of the authorised distributor, that such consent shall not be unreasonably refused or withheld, and that if any question arise as to whether such refusal is unreasonable it shall be determined by the Board of Trade, and the consent shall be deemed to be unreasonably refused or withheld if the distributor is not willing and in a position to give the requisite supply on reasonable terms and in a reasonable time, due regard being paid to the financial circumstances and capital expenditure of the distributor.

Lord LYTTON: You leave out the 250 kw. power users?—Yes, we have given way on that point at the instance of the L.C.C. In this case there is now no reference to users of power above 250 kw.

The CHAIRMAN: There is no distinction between users over 250 kw. and those under?—None whatever. The clause is similar to that in the L.C.C. Bill of last year.

Mr FITZGERALD continued: Clause 61 provides a sliding scale which the L.C.C. wish to have introduced, and to which they agree. Clause 61 is in place of clause 64 and provides that the dividend shall not in any year exceed the standard rate of 5 per cent. on the capital paid up, but if in any year the average price charged per unit is less than the maximum price for the respective kinds of electrical energy set out in the second schedule by 1 per cent. or more, the dividend the company are authorised to pay may be in-

creased in the ratio of ¼ per cent. in respect of every 1 per cent. by which the average price has been below the maximum prices, and the company may in any year make good any deficiency in any previous dividends which may have fallen below the rate which the company are authorised to pay, but any difference between the rate of interest payable out of capital moneys and the rate of dividend authorised shall not be deemed a deficiency which the company are entitled to make up.

Any minimum annual sum received by the company shall not, so far as it exceeds the price payable for electrical energy, be taken into account in determining the amount per unit received for current and the amount of dividend payable under the sliding scale. (The last-mentioned provision refers to clause 57, which is known as the stand-by clause, and which remains in the bill.) The average price shall be ascertained by dividing the total receipts from sale of current during any financial year by the total number of units sold.

Lord WELBY: The sinking fund will go out altogether? —Yes.

Mr. FITZGERALD: A new clause, 61A, is added, stating that the company may, before ascertaining the profits available for dividend, set apart sums reasonably necessary to maintain buildings, plant, mains and apparatus and to renew the same when necessary, and such sums may be invested in any trustee securities, and any dividends or interest arising from such securities may be invested in the same or like securities. The fund shall be called "the maintenance and renewal fund," and the sums so set aside shall not exceed 1½ per cent. per annum on the capital expenditure of the company.

In reply to the CHAIRMAN: The reserve fund still goes on and is for dividend. The original purchase clause goes out altogether with the proposed amendments on it. The new purchase clause is to be substituted and it, therefore, becomes necessary to have a maintenance and renewal fund, having regard to the sliding scale. A new clause 62 (which is the ordinary insurance clause in bills containing a sliding scale) is the same as the old clause 62 except that it is limited to insurance against extraordinary claims and demands, the cost of maintenance and renewal of plant (included in the original clause 62) having been provided for in the maintenance and renewal clause already read. A new clause, 62A, gives power to create a reserve fund, and is in substitution for clause 63, and specifies that the money for the reserve fund can only be taken out of the divisible profits which the shareholders otherwise may be entitled to divide. It enables the company, instead of dividing the full profits, to carry a portion of them to reserve, and to use such reserve afterwards in making up the profits to the standard rate in any year. A new clause, 62B, provides that any sum applicable for dividend in any year, and not applying to any other purpose authorised by the act, may be carried to the benefit of revenue for the needs of the following year.

The purchase clause would now read: "The undertaking of the "company shall be liable to purchase by any County Council or joint "committee of County Councils, body of trustees, or other public "authority or body who may be authorised by Parliament to purchase "the undertaking, hereinafter called the purchasing body, on and sub- "ject to the following terms and conditions—that is to say, the pur- "chasing body may, on giving not less than 12 months' previous "notice in writing to the company of their intention to acquire "the undertaking, purchase the same at the expiration of the year "1931, or at the expiration of each subsequent period of 10 years upon "the terms of the purchasing body paying to the company the then "value of all lands, buildings, works, material and plant of the com- "pany, and in the event of the purchase being made at the expiration "of the year 1931, or the year 1941, or the year 1951, also paying to "the company, in addition to such sums as aforesaid, compensation "in respect of the loss sustained by the company by reason of such "purchase taking place at the expiration of the year 1931, or "the year 1941, or the year 1951, as the case may be, instead of at the "expiration of the year 1961." 1931 is the year under which nearly all the London companies are purchasable under the general acts.

Mr. FREEMAN: The question whether the L.C.C. should be specifically mentioned as the purchasing authority is the only outstanding point. The promoters have not inserted it, and I am going to ask the Committee to insert it.

Mr. FITZGERALD: The purchase clause goes to provide that "the "value of the lands, buildings, works, mater ial and plant shall in "case of difference be determined by arbitration, and shall be deemed "to be the fair market value at the time of the purchase, with due "regard to their condition and their suitability for the purposes of the "undertaking, and that any additional payment in respect of goodwill "or loss of future profits or any similar consideration shall also be "determined by arbitration in the manner provided in the Lands "Clauses Act. From and after the date of such purchase all "lands, buildings, works, material and plant shall vest in the "purchasing body, free of mortgages or obligations, but any "debts, &c., due to the company or investments or moneys repre- "senting the insurance, maintenance and renewal and reserve "funds shall remain the property of the company." There is no question of 10 per cent. premium, as in the original purchase clause. The promoters feel that inserting the name of the L.C.C. as the purchasing authority would create great difficulties in the political sense. The other County Councils would object. The outside County Councils were not willing to allow the L.C.C to become the water supply authority within their areas, and therefore when the purchase of the water companies took place the Government Bill, as eventually carried, set up, not the L.C.C., but a special body—the Metropolitan Water Board—as the authority. We submit that it is better to allow that matter (the purchasing authority) in the present case to be dealt with by Parliament when the question arises, although it makes no difference to the District Co. who pays the money. There is one other clause (viz., clause 66, relating to the revision of prices) which is modified so as to provide that the Board of Trade, after five years from the passing of the act, may, on the application of the company or the L.C.C. or any authorised undertaker in the area or of 20 or more persons to whom electricity is supplied by the company, revise the maximum prices, and at the expiration of 10 years, on like application, revise the relation of prices and dividends, and they shall, so far as practicable, provide that the surplus profits shall be divided amongst the shareholders and the distributors and consumers. This has been agreed to by the L.C.C.

Mr. FitzGerald went on to say the promoters had no objection to the L.C.C. per se as the purchasing authority, but naming them in the bill as the purchasing authority might cause difficulty. There was a fresh clause in substitution for clause 75, providing that if the company had not substantially commenced their works in two years from the passing of the act, or if they had not £600,000 of capital subscribed within 12 months, their powers should cease. There might be a few other words to add, but that was the skeleton clause.

In regard to the Joint Committee Bill, he could not regard it as a serious attempt to deal with the problem of electric supply for London. It was not a businesslike or workable proposal, but an attempt to occupy the ground which would leave matters much as they were at present. It was proposed that the Joint Committee should be composed, in the first instance, of the chairmen of the eight companies promoting the bill, but besides one vote which each member of the Committee had a hundred votes were to be divided between the six companies guaranteeing the capital, and those companies would have control of the voting power. It was proposed to add two members from the L.C.C., but the L.C.C. had no desire to be members. Other companies or local authorities being authorised distributors might come in, and that might add 20 or 30 members, but the voting power would remain in the hands of the six companies. The only way the authorised distributors could exercise any influence would be by constantly appealing to the standing arbitrator. Was that really a businesslike or serious proceeding? There was no probability of local authorities coming in and being members under such circumstances. The companies themselves would not be a very happy family, as they were engaged in the most active competition and had the most divergent interests in the supply of electricity throughout London. What were they going to do? They were going to make use of the existing stations and plant. Of the six stations they indicated that they might use, Bow and Bankside stations were purchasable by the City of London in 1914. Therefore, in 1914 Bow and Bankside would disappear. Deptford and Blackwall stations had been vouched as suitable for power supply, but neither of those sites was authorised by Act of Parliament as a site for a generating station, and if the works were increased so as to create a nuisance they could be stopped by injunction. Further, if the clause asked for by the Commissioners of Works were inserted neither of those stations could be enlarged except by an Act of Parliament. The report of the Commissioners of Works had been sent to the Committee six weeks ago, but the promoters had not given any definite answer as to whether they were going to insert the clause asked for.

The CHAIRMAN: The promoters agreed with four points out of five.

Mr. BALFOUR BROWNE: And the fifth is under discussion at the present time.

Mr. FITZGERALD: That left Wandsworth and Willesden. Wandsworth station was a small site of 1¾ acres, and was not capable of extension. Coal had to be got to it by barges, and it was useless for power supply for London. Willesden had to get their coal by rail, and it could never become a station from which cheap power could be supplied for any large district in London. The Charing Cross Co. gave only one bulk supply, being unable to get more because of the prices they charged. The Joint Committee were going to begin by using their 10,000 kw. of spare plant, which was in four stations, but the systems of generation at all those stations were different either in voltage or periodicity. If they got to the position of being able to put in new plant it was to be put in existing stations, was to be the property of the Joint Committee, and was to be worked by the companies. This did not seem a very workable method of setting about power supply. It was with such small units as 750 kw. gas-driven sets that Mr. Highfield proposed to supply bulk demand and power demand in London, but there was the gravest doubt whether supply from gas plant would be a commercial success. At the only place where it had been tried on a large scale—Johannesburg—it had been a complete failure. Mr. Fladgate had told his shareholders that no further generation of electricity was required at the present time, and that there was no intention of raising a million, or anything like a million, at once, and the shareholders on that basis gave their consent to the guarantee for their share of the capital of the Joint Committee. The scheme was by no meas a new one; it was brought forward in 1906, and the answer of Mr. Luke White's Committee was that they were of opinion that the best means of providing supply of electrical energy in bulk, and for power and motive purposes, was by one large inclusive scheme extending, not only over the entire County of London, but also to adjoining boroughs and districts. In 1908, again, the same patchwork scheme was seriously put forward as a solution of the problem. What possible right had the companies to fix prices (as they proposed in clause 42) for other distributors, and what right had they to ask the Committee to alter the provisions for the purchase of undertakings and the terms and conditions under which they had been authorised, without the consent of the local authorities who had the right to purchase in 1931? If the Committee gave the companies power to supply each other (to which the Board of Trade suggested

clause 45 should be limited they would be doing everything for which the promoters had any case.

Mr. FREEMAN was asked by the Chairman to explain the reference he had made to the consolidation of the purchase of the various companies, and said the L.C.C. wanted consolidation as provided in clause 43 of the Joint Committee Bill, and as provided by the Electric Lighting Acts—viz., at the "then value." At present the local authority had only the right to purchase so much of an undertaking as lay within its own domain. The L.C.C. wished to keep alive that portion of the bill which enabled generating stations to be purchased by the central purchasing authority, taking for example the L.C.C., and they considered that an extremely valuable part of the bill in the public interest, because otherwise the purchasing powers of the separate authorities to purchase separate parts of undertakings in their own domain would be of little value. They wanted the purchasing authority to be able to purchase the whole thing en bloc, but without any joint committee, at the "then value." The advantage would be that the whole of the generating machinery of the company which was going to be purchased would be in one hand, whereas at present local authorities could not purchase stations because they were in the domain of other authorities, and the distributing plant was of no use without the generating nor the generating without the distributing. Purchase under existing conditions was illusory.

Mr. Freeman handed in a table showing where one company supplies in several boroughs and where one borough is supplied by several companies.

Mr. BALFOUR BROWNE (in his reply on behalf of the promoters of the Joint Committee Bill) said nothing could have suited his purpose better than Mr. Freeman's table and remarks. What turned an illusory purchase into a real and practical purchase was not a clause of the County Council. It was clause 43 of the Joint Committee Bill. The table showed the impossibility of solving the problem of unification without some such bill. It meant that the L.C.C. desired to have his clause 43, which made essential the existence of a joint committee. Mr. FitzGerald had started by saying that the Joint Committee Bill did not solve the problem, but he would try and prove that it did and that the other bill did not. The principle of the bill was first to develop the existing properties to the full. Mr. Luke White's Committee had said that due consideration should be given to the fact that local authorities and other distributors had expended a great amount of capital and that any bill ought to uphold, in a reasonable manner, the interests of authorised distributors. He asked their Lordships to say that was right not only for the companies but also for the local authorities. It was monstrous that local authorities, who had spent the ratepayers' money, should be subjected to competition like that of the District Company. His friends had not read the words of the 1888 Act properly. It stated that undertakers should not hinder or restrict the granting of licences or provisional orders to the local authorities or other companies in the same areas, but that referred to competition under similar conditions. There was not one word to apply to a scheme like that, which was to deal with every area in London. Where permission had been given to two companies to supply in one area they were both under the same disabilities, they were competing on fair terms, and were subject to purchase at the same period—in 1932, but the District Bill dealt with a competitor who was to compete in every part of London, who tried to take away the companies' customers and would be working under entirely different conditions. With regard to the supply to authorised distributors the bills were on all fours, but he had called his engineers and shown that up to the demand of 25,000 kw. they could supply more cheaply than the District Company, who, although they had all their engineers present, dared not put in one man to deny that. His clients wanted the authoised distributors to go on as they were, but to give them a cheap supply so that they might retail it. They were not seeking to take away the customers of any company or local authority. Mr. Debenham (Marylebone) said he approved the principles of the Joint Committee Bill, but did not think it could be effected without compulsion, yet his friends had sneered at them because they were putting in a provision that every distributor should supply cheap electricity. The Westminster Council's attitude was answered by Mr. Freeman's last remarks and by the County Council's table, because Westminster was not in a position to-day to exercise its purchase powers, and Westminster's position was founded on an entire mistake as to its rights. If they tried to exercise their powers of purchase under their present Act they would be in a worse position than Marylebone—they would have to pay compensation for severance, not to one company but to three, the Metropolitan, the London Electric, and the Charing Cross, and if they only bought one they would be in competition with the other two, and it would very likely turn out a bad speculation. The Joint Committee would give Westminster a practical purchasing clause. If the purchasing body appointed by Parliament purchased the whole undertaking of the Joint Committee and the companies, Westminster would have a right to buy back all the distributing mains and apparatus in its own area without any severance clause. The purchase was not in his interests; it would be better to be like any other power company without any purchase clause, but Parliament had indicated that it wanted a purchasing clause and the offer they had made had met with the County Council's approval. The period of the District Bill had been that day extended to 1961, and that meant they would make more out of the public. He was prepared to sell the Joint Committee's undertaking in 1931 and the undertakings that existed to-day would be sold without any goodwill, but with regard to the £1,000,000 they were going to raise he asked their Lordships to say if they had to part with that at the same time they should be paid the goodwill they were losing between 1931 and 1961? With regard to Mr. Freeman's suggestions, sec. 45, in various ways, did not do what they wanted, it arranged for coupling up companies, but they desired to couple up not only companies but local authorities, and they also wanted to supply the urban districts in London, which sec. 45 would not allow them to do, nor would it allow them to use spare lands for extension of stations, nor to lay circular mains for supplying energy to one another. He asked their Lordships to come to the conclusion that the essential part of their scheme was the Joint Committee. If there was not a Joint Committee there would not be compulsory supply, as the companies were not bound to give it. The compulsion would be upon the committee to give a supply, but there was no compulsion of the customer to take it. The comment on clause 45 in the Board of Trade report had been read, but the second paragraph, which said that the criticism was not intended to be used in the way it had been used, had not been read. The second paragraph said: "The present report does not deal with the general question of policy raised by these proposals, but only with the details of the clauses." There was another paragraph in which the Board of Trade said they did not want the burden put upon them of deciding upon the transfer of undertakings, but there was to-day a provision that an Order should not be transferred without the consent of the Board of Trade, and they were exercising that function every day, and he asked the Committee to say it was in the interest of the public that the Board of Trade should do as they had proposed. If the companies would be all struggling and quarrelling amongst themselves on the Joint Committee, as Mr. FitzGerald predicted, the local authorities would have the more weight on the Joint Committee. Clause 45 would not give power to lay mains through intervening authorities' areas, but in the bill as proposed they had power for the Joint Committee to lay mains anywhere. Mr. FitzGerald had said there would be constant appeals to the standing arbitrator, but in the case of railways, harbour and dock boards, and conservancies, the same principle was followed, and there was no friction. With regard to the Joint Committee's stations, Deptford had been carrying on its business for 19 years, and had never yet been stopped for nuisance, and Mr. Parshall had said that Bankside possessed every facility that could be given to a power station. The statement that the Charing Cross Company only offered current at 2d. was entirely wrong. Mr. Seale said they supplied at West Ham at £4 per kw. and ½d. per unit, at Poplar £4 and 0·33d., and at Stepney they offered £3 and 0·4d.; therefore it was not the price that prevented the supply being taken, but the difficulty of getting the local authorities to give up those jealousies which had been spoken of. They wanted to be masters in their own houses, and the Joint Committee scheme, giving equal votes, would settle that. A criticism had been raised with regard to gas plant. Mr. Highfield had stated that it was working successfully at Essen, and that there was no doubt it would come into use for electricity supply. There was no doubt that, for the solid part of the load, the gas engine would be used in the early future. Gas engine costs were higher originally, but it was more economical in working. They were spending £30,000 at one of the Charing Cross Company's stations for that kind of plant. His friend had placed great weight upon what Mr. Fladgate said to his shareholders—that there was enough electricity produced. It was a fact. Mr. Hammond's tables showed that there were 84,000 kw. surplus produced, and the promoters of the Joint Committee Bill had put in a table showing the enormous amount of spares at the present time which it was desirable to couple up. Mr. FitzGerald had asked what business the companies had to force the local authorities to supply at a certain price, but what right had he even to come and criticise it. He was not even a company. Mr. Freeman had asked that the provision in the bill that the Board of Trade should approve transfers of undertakings should be struck out, as the Board did not want the duty, but Parliament had a right to put duties upon the Board of Trade. Clause 37 of this bill said they could only supply in an area where there was a bulk supply company with the company's consent, but the London & District Company wanted to supply in such an area without consent. Mr. FitzGerald had said the real object of the committee was financial, which was, in a sense, true. They wanted to raise money as cheaply as possible, so that the consumer would pay less. No one company could raise the capital necessary, but by the combination of the companies there would be no difficulty in raising the capital, probably at 4 per cent. With regard to the suggestion that they might issue at 75 and get the capital back at par, he would agree that they should not issue at less than 95, and they might be able to issue 4 per cent. stock at a little over par. The only power of transfer they took was to transfer generating stations and works connected therewith, and not "undertakings," as Mr. Freeman put it. If the London & District Bill were passed and also the Joint Committee Bill he would still have no difficulty in raising the £1,000,000 by the guarantee of the companies, but the companies would not guarantee unless they formed a Joint Committee and had control of the undertaking. If the financial clauses were deleted it would neither be fair nor in conformity with the Parliamentary bargain which gave the companies 42 years, at their own instigation, in 1888, in order that they might recoup their capital, and only subjected them to one kind of competition, viz., by persons under the same disabilities as themselves. If the Committee authorised a new company and left the present companies under those disabilities the companies would be handed over bound hand and foot. It was no use his taking the purchase clause without the other conditions as to the existence of the Joint Committee and the power of the Joint Committee to raise the capital, and for those conditions he was willing to give the purchase clause Mr. Freeman approved. The real solution of the problem was to use, as far as they could, the existing plant, supplement it where necessary on sites already acquired, and at the same time secure to the public that local authorities might join the Joint Committee and, with the consent of Parliament, subscribe and become guarantors. The combination would be of a semi-public character, and would be in the interests of the public.

In regard to the District Bill Mr. Balfour Browne said the £400,000 to be paid as interest during construction of works (under the District Bill), and which they asked to be allowed to spend in order to get on their legs, would be a burden hung round their necks for all time. Security of supply was everything, and in the Joint Committee Bill that was one of the most important features. The District Bill promoters wanted to take from the existing distributors street lighting and lighting obtained by customers from the 20 per cent. (which was equal to 80 per cent. if metallic filament lamps were used) of their power demand. He would ask their Lordships not to allow that. It was an extraordinay thing that at the end of the case a totally new bill should be submitted. The so-called sliding scale was not a sliding scale. The 8 per cent. dividend was not (according to the present wording of the clause) a standard dividend but a maximum dividend. The sliding scale was one that only worked one way and there was no decrease of dividend provided for. There was not even a maximum dividend if, as provided by the new clauses, the company may in any year make good any deficiency in previous dividends. In no sliding scale ever passed by Parilament had the making up of back dividends been allowed. The company may set apart sums for maintenance and renewals, insurance and reserve funds, but there was nothing obligatory. If the Committee gave the District Company the extension of time to 1961 he presumed they would give it to the Joint Committee also. There was no doubt the promotion of the Administrative Bill of 1905 did good. It wakened up the companies and local authorities to meet the power demand, and they had met it, and therefore when the companies came forward and said they would go further, raise the money and supply electricity at a cheaper rate than the new company he asked their Lordships to say Parliament would trust them, and he ventured to say their scheme was, certainly for the next six or seven years, the best solution of the question of cheap supply for London.

THE COMMITTEE'S DECISION.

The London & District Electricity Supply Bill, 1908.

On Wednesday, the Chairman announced that the Committee had decided that the London & District Bill could proceed, on the assumption that the cessor clause in substitution for clause 75, the full text of which the Committee had not seen, was satisfactory. The Committee were of opinion that it should be provided in the bill that a larger proportion than one-fifth of the £600,000 mentioned in clauses 9 and 10 to be subscribed in the first instance should be actually paid up within 12 months. In regard to clause 52, sub-sec. 2, the Committee would wish to consider, when this came under consideration, whether any modification of the 20 per cent. limit allowed for lighting should be made. As regarded the new clause, 61a, the Committee would wish to consider whether some contribution to the renewals fund should not, in certain circumstances, be made obligatory. In regard to new clause 61, sub-sec. 5, the Committee desired to point out that in the second schedule of the bill three different kinds of electrical energy were specified with three maximum prices. There would seem to be considerable difficulty in making a comparison with a single average price. The Committee wished this point to be considered in the discussion of this clause. Lord Welby had received a letter from the Smoke Abatement Society, which would be read and put on the notes. The Committee wished to consider the points raised by the society when clause 3 came under examination.

Lord Welby read the letter from the Smoke Abatement Society, in which it was pointed out that under sec. 3 of the bill the company would not be subject to sec. 81 of the Electric Lighting Act, and that if the bill passed in its present form no proceedings were possible to protect public interest under Public Health Acts or otherwise in the event of emission of black smoke from shafts of any works constructed under the bill. In the opinion of the society, the company should be liable at common and statute law.

The Chairman asked if the promoters of the bill understood the points raised by the Committee, and Mr. FitzGerald said the only point he had not quite followed was in regard to the renewals fund.

The Chairman: The new clause as it stands provides that the renewals fund shall not accumulate beyond a certain extent. In that we entirely concur. On the other hand, as it is purely permissive, it does not make any provision for an obligatory renewals fund. We think it ought to be considered whether something of that nature should not be done. There are a variety of ways in which it may be done. For instance, when a certain rate of interest (I do not wish to name a figure) below the maximum of 8 per cent. has accrued, whether some proportion should not go to reserve fund. But I do not wish to name a figure.

Sir R. Littler: Has the position of the City of London Corporation been taken into consideration?—Yes.

The London Electric Supply (Joint Committee) Bill, 1908.

In regard to the London Electric Supply (Joint Committee) Bill, the Chairman said the Committee had come to the conclusion that this bill could also proceed, but only in respect to the following clauses:—Clause 35, with the omission of the Joint Committee; clauses 45 and 46, with the omission of lines 5 to 11 on page 28, and with the addition of a clause giving power to the companies to lay connecting mains through intervening areas. The Committee considered, also, with reference to this latter point, that what was generally known as a "route" clause should be inserted. Finally, the Committee did not wish to consider the clauses of this bill until the case of the Westminster & Kensington Bill had been heard.

The Committee decided to hear the evidence for the Westminster & Kensington Bill yesterday (Thursday) and to take the clauses of the London & District Bill on Monday next. Amendments or objections to the London & District Bill were to be sent in to the agents for the promoters by last night (Thursday) and to the London Electric Supply (Joint Committee) Bill by to-night (Friday).

Mr. Bushe, K.C., said that there was no opposition so far as he knew on the preamble of his (the Westminster & Kensington) bill.

The London (Westminster and Kensington) Electric Supply Companies' Bill, 1908.

The Preamble of the Third Bill also Proved.

Yesterday (Thursday) the Committee considered the third of the three bills submitted to Parliament this session, the London (Westminster and Kensington) Electric Supply Companies' Bill, 1908, which proposes to confer further powers upon the Kensington & Knightsbridge, Notting Hill, St. James' & Pall Mall, Westminster and Central Companies to associate for the purpose of providing for the supply of electric energy in bulk by any one or more of the companies to all the other companies, or any of them, at such a point or points as may be fixed by the receiving company; and powers to lay mains for the purposes of such bulk supply in intervening districts not belonging to the companies. Provision is made that such mains and works as are laid or constructed under the provisions of the act by a company outside its area of supply shall be marked in a distinctive manner so as to distinguish them from other mains or works, and shall not be liable to be purchased by the local authority in whose district they shall be situate, but shall be deemed to be part of the undertaking of such company and shall be purchased along with such undertaking as if such mains or works had been within the district of the local authority entitled to purchase the undertaking of such company. The prices to be charged by the companies for electrical energy supplied within their respective areas of supply for power shall not, as from the passing of the act, exceed a fixed sum at the rate of £6. 15s. per annum per kilowatt of the maximum power required to be supplied and, in addition, 0·33d. per unit for all units supplied. Provision is made as to the supply of energy to any railway, tramway, tramroad, canal, navigation, docks or waterworks situate partly within and partly without the companies' areas, but energy so supplied may be used outside the supply company's area only for haulage or traction and for lighting vehicles or boats. The bill also contains the usual standby clause and provisions for testing, inspection, &c., of meters.

The Chairman said it was not necessary to go into the general details of the bill, as they had already considered the somewhat analogous London Electric Supply Bill.

Mr. Seymour Bushe, K.C., counsel for the promoters, said their bill might seem very small relatively to the other two bills, but the promoters attached much importance to it, and if sanctioned it would prove a valuable instrument in their hands for the purpose of discharging their duties. The areas occupied by the four companies were all within the borough of Kensington and the City of Westminster. The St. James' and Westminster Companies were entirely in the City of Westminster, but the Notting Hill Company's area was partly in the borough of Kensington and partly in the City of Westminster. The powers exercised were composed of two series of enactments; provisional orders, of which the earliest was dated 1889, and acts, the earliest of which was dated 1893. Under these powers local generating stations for the steam generation of electricity were installed according to the ideas of those days, necessarily within the area of each company. Low-tension feeders supplied a series of low-tension mains, and formed a perfect network in each area. Up till 1899 each company under its own act carried on its own operations strictly within its own area. This was, of course, owing to the principle of non-association which had grown up and become a practice in all provisional orders at that time issued in London, and which perhaps in the judgment of later times led to some inconvenient results. He asked the same relief from these restrictions as the Committee had found it possible to grant to the other companies under sec. 45 of the London Electric Supply Bill. In 1899 Parliament had to some degree relaxed the stringency of these restrictions so as to allow the four companies, which up till that time had been operating in what he might term watertight compartments, to resolve themselves into two groups of two each, and each of these groups to connect itself with a generating station outside its area. The St. James' and Westminster Companies connected themselves to a generating station at Grove-road, St. John's Wood, and the Central Company was a subsidiary company promoted by these two companies for the purpose of working that station. Similarly, the other two companies had a generating station at Wood-lane, Hammersmith. The City of Westminster, lying partly in the area of the Kensington Company and partly in the area of the Westminster Company, drew its supply from each, and formed a sort of connecting link between the two systems, although at present this was the only connection between them. The result of the combination sanctioned in 1899 had been entirely satisfactory. Mr. Balfour Browne had borne tribute to the excellent results which had followed on that degree of combination. The object of the present bill was simply to develop a little further that association. Instead of two groups of two companies they wished to have one group of four, and if the linking up asked for in the bill was sanctioned that object would be obtained. The promoters were satisfied that the efficiency and reliability of both the systems would be increased if worked in combination.

The Chairman: I do not quite see the use of this bill. In the schedule of the London Electric Supply Bill the whole of these companies are mentioned

Mr. Bushe: The names of the companies were put in without our consent or wish. We desire to have our own act to secure our own purpose. If we rely upon the London Electric Supply Bill our whole future would depend upon whether that would go on or not and we would be entirely at their mercy. We would earnestly press upon your Lordships

that you should give us our own bill and that we should not be dependent upon what might happen to others.

The CHAIRMAN: The two bills must be identical to some extent.

Mr BUSHE: That is so in their general conception, so far as I can see, but we do not wish our names to be retained in the schedule of their bill; we want our own act.

Mr. L. H. HORDERN, manager of the Westminster Electric Supply Corpn. and joint manager of the Central Electric Supply Co., gave evidence in support of the bill. The 1899 act enabled them to enter into combination forming two groups of two, and as a result economy and efficiency had been increased. They wished to carry the principles of association a little further, and to join the supply of both bulk stations. They would speedily obtain some advantage under the bill, which would result in a reduction in the charge for supply. They wanted their own title deed, and had never given their consent to their names being put in the London Electric Supply Bill. They did not want to be involved if the other bill did not go on.

The CHAIRMAN: You want your bill as a standby in the event of anything happening which would prevent the passage of the other bill, or your companies being cut out. If it went through and your companies were not cut out you would not require a separate bill?—I think not.

Mr. BUSHE said they had prepared a bill for a definite object which they knew they could accomplish. It was unfair to expose them to a bill which they had not themselves inaugurated, and it would be disastrous to them if they were now put aside on a chance of another bill going on.

Mr. FREEMAN said it was contrary to the practice of Parliament and the Committees of Parliament to pass a bill merely as a standby. There was already a bill which admittedly covered the whole of the ground which would be covered by this bill if it became law, and there was nothing to prevent the companies associating themselves with the promotors of the other bill. He submitted that this third bill was unnecessary, and that the four companies were seeking a second string to their bow.

The Committee then retired for consultation, and on their return the CHAIRMAN said: The Committee are of opinion that the bill may proceed, but it must be understood that in dealing with all the clauses they will have to be practically identical with the clauses of the London Electric Supply Bill. Therefore I hope that between now and the time the clauses of the London Electric Supply Bill come on counsel on both sides will arrange so that the whole of the argument on the clauses in the Westminster and Kensington Bill may practically be considered and determined in dealing with the London Electric Supply Bill as regards the important points, so that we may practically consider the two together. When we get to the clauses of the Westminster and Kensington Bill it will be a purely formal matter, because we shall already have considered them.

The Committee then adjourned till Monday.

AUDIT OF ELECTRIC SUPPLY COMPANIES' ACCOUNTS.

In the House of Commons on Thursday last week, Mr. CLELAND asked the President of the Board of Trade whether the professional auditors employed by the South London Electric Supply Corpn. had been appointed official auditors of the same accounts for the purposes of the Board of Trade audit; whether these auditors had failed to question the charging to capital account of certain proportions of the salaries of the company's permanent officials, a practice which the Local Government Board declined to allow local authorities to pursue; whether the company had also charged directors' fees to capital account, and had made an inadequate depreciation provision; and whether, in view of the fact that capital expenditure was always an important factor in determining the price a local authority had to pay for a company's undertaking, the Board of Trade would in future appoint independent official auditors other than those employed by the companies, and would make regulations under its statutory powers with the object of ensuring that the audit should be efficient and effective.

Mr. WINSTON CHURCHILL said: The answer to the first part of the question is in the affirmative. The auditors have reported that they see no reason to question the principle upon which a proportion of salaries of officials has been charged to capital account in respect of the time occupied by them on capital works. The Board of Trade are in communication with the Local Government Board as to the practice adopted in that department. The auditors have called attention to the fact that a sum in respect of directors' fees charged to capital account in and before the year 1903 still remains in the account. They do not consider that the provision made for depreciation is inadequate. The Board of Trade have at various times endeavoured to induce the company to remove from capital account the charge for directors' fees, but they have no power to enforce an auditor's recommendation. The arrangement made for the audit of the accounts to 1907 is being carefully watched, in case it should be necessary to make any change. The Board of Trade have issued instructions to the auditors appointed by them with the object of ensuring that the audit shall be efficient and effective.

Mr. S[illegible] asked whether it was not possible and not necessary in the public interest that the firm of accountants employed by the Board of Trade should be [illegible] by the terms of their appointment from acting as auditors to private companies.

Mr. CHURCHILL replied that that appointment had been made for the present year, and until the appointment was reviewed in the ordinary way he considered it was not possible to take any further step. As to whether another firm should be employed, there were special reasons which had to be considered.

Surface Contact System of Tramways.—In the House of Commons on Monday, the President of the Board of Trade (Mr. W. Churchill) stated, in reply to Mr. B. S. Straus, that the Board of Trade approved of the adoption of the "stud" system on the London County Council electric tramways from Aldgate to Bow in October. That approval was, of course, subject to inspection of the line when completed, and should the report of the inspector recommend that sanction be given to the opening of the line the necessary certificate would be issued forthwith. (This line was opened for traffic yesterday, Thursday.)

Railway Electrification.—In the House of Commons on Tuesday, Mr. Winston Churchill replied to the question asked by Mr. Chiozza Money, set out in our last issue (p. 387), that he had no reason to doubt that railway companies in this country were aware of the progress of electric traction on foreign railways, and already several English railways had equipped their lines, or portions of them, for electric traction, or were in process of doing so.

Patents and Designs Bill.—This bill was read a second time in the House of Commons on Friday. Mr. Kearley said its object was to make clear the Patent and Designs Act of last year. Doubt had arisen as to whether the appeal to the House of Lords in case of the revocation of a patent by a lower Court was safeguarded and conserved, and the bill was introduced to clear up that matter.

Royal Assent.—On Thursday last Royal Assent was given to the Loch Leven Water Power Order Confirmation and the Tramway Order Confirmation (No. 1) and the Rochdale Corporation Acts.

LEGAL INTELLIGENCE.

Ernest Scott & Mountain v. Kent Collieries (Ltd).

Mr. MUIR MACKENZIE, K.C., official referee, delivered judgment in this case on Tuesday. The action has been fully reported in *The Electrician* for April 10 and 17, and May 1, 8, and 15.

The official referee said the action was to recover £3,249, alleged balance due for (1) two sets of pumping machinery, each set consisting of an engine, generator motor and pump; (2) the price of an additional pump and motor; (3) certain wages and allowances. Defendants resisted payment on the grounds that the two sets of pumping machinery were not to specification, and that they were not liable to reimburse the wages referred to. Defendants counterclaimed for £17,000 damages for breach of contract. The description of the machinery ordered was contained in a specification submitted by plaintiffs dated Dec. 14, 1905, the construction of which was one of the chief issues in the case. Plaintiffs alleged that they had complied with its terms, while defendants denied this. It provided (*inter alia*) that each generator should have an output of 300 k.v.a., and as regards each engine 400 effective B.H.P.; 450 indicated H.P.; steam consumption per k.w. hour 28 lb. Each pump was to be driven by a three-phase motor developing up to 300 H.P at 1,440 revs. per min., and was to be capable of raising 1,000 gals. of water per minute against a head of 640 ft. including friction. Plaintiffs contended that as regarded the output of the generators the conditions were satisfied with an output of 255 k.w., and that the specification would be complied with if the steam consumption was 28 lb. or 29 lb. per k.v.a., treating the kilowatt as equal to the k.v.a. multiplied by a power factor of 0·85, and as regarded the output of the motor that 272 H.P. with capacity to develop up to 300 as a maximum was sufficient. Defendants contended, on the other hand, for an output of 300 k.w., a steam consumption of 28 lb. per k.w. hour, and an output from the motor of 300 B.H.P. under ordinary working conditions. Applying the principles of "Bank of New Zealand *v.* Simpson," he was bound to look at all the facts so as to ascertain the meaning of the words and phrases used. After giving weight to all the evidence he could not adopt plaintiffs' contention that the specified kilowatts were the equivalent of 300 k.v.a. multiplied by a power factor of 0·85—that was to say 255 k.w., or that the steam consumption was to be 28 lb. per k.v.a. hour. If plaintiffs had so intended they should have made it clear in their last tender. He, therefore, held that the generators to be supplied should have had an output of 300 k.w., and the steam consumption was not to exceed 28 lb. per k.w. hour. As to the motor the development of power up to a maximum of 300 B.H.P. was guaranteed, but if the required work could be done on a smaller rating the terms of the contract would have been satisfied. That was sufficient to dispose of the main part of defendants' claim to be recouped the loss occasioned by the failure of the pumping machinery. The next question was whether the pumping machinery was according to the specification. It was delivered in June, 1906. The output of each generator was 255 k.w. while the steam consumption exceeded 28 lb. The normal development of each motor was 272 H.P., but it could be developed up to a maximum of 300 H.P. The next issue was whether property in the two sets had passed to defendants. The contract provided that a complete running test was to be taken after delivery and erection, before defendants' representatives. A portion of the purchase price was reserved until after the test. He held that the property in the two sets had passed to defendants. The case was thus one to which the following provisions of the Sale of Goods Act applied:—

"Sec. 11 (1) (c): where the contract of sale is not severable and the buyer has accepted the goods or part thereof, or where the contract is for specified goods, the property in which has passed to the buyer, the breach of any condition to be fulfilled by the seller can only be treated as a breach of warranty and not as a ground for rejecting the goods and treating the contract as repudiated.

Sec. 53 (1), where there is a breach of warranty by the seller, or where the buyer elects, or is compelled to treat any breach of condition on the part of the seller as a breach of warranty, the buyer may (a) set up against the seller the breach of warranty in diminution or extinction of the price, or (b) maintain an action against the seller for damages for the breach of warranty. (2) the amount of diminution for breach of warranty is the estimated loss directly and naturally resulting in the ordinary course of events from breach of warranty

Sec. 54. nothing in this Act shall affect the right of the buyer to recover special damages in any case where by law such damages may be recoverable.

Defendants were clearly entitled to set up, as against the claim of plaintiffs for the balance of the contract price of the machinery, that they were entitled to a diminution of the price equal to the difference between the value of the thing supplied and the value of the thing which they would have had if the conditions which were not fulfilled had been fulfilled. Defendants' first claim was for damages for delay in delivery of the machinery. Having regard to the correspondence between the parties, and to all the circumstances of the case, he found that, though there was delay in delivery, defendants suffered no damage thereby, since their appliances were not in a fit condition and were not ready to set the plant at work before it did actually arrive. The next claim was for the loss sustained in consequence of the failure of the pumps during the latter part of 1906. The early negotiations and correspondence showed that plaintiffs contemplated and advised defendants that the two pumps should be put into the shaft together, and worked alternately. In his opinion defendants' gear and appliances were not fit, however, to adopt this method, and only one pump at the time could be lowered into the shaft, so that if that broke down or stopped, the water at once rose and there was no means of keeping it down. Defendants' claim was that these stoppages and breakdowns had occurred because the machinery of each pump was not capable of pumping 1,000 gals. per minute against a head of 640 ft., and this contention was supported by the test which was made in 1908. This test it was contended, showed that the pump could not do its work owing to overheating, due to insufficient ventilation. On this part of the case, although the output of the generators was 255 k.w. instead of 300 k.w., their output was sufficient for the work they had to do. He found this on the evidence, but it seemed to follow from the fact that the generators supplied sufficient power to work No. 3 pump satisfactorily. Each of the pumps, No. 1 and 2, as driven by the motors was capable of raising 1,000 gals. of water against a head of 640 ft. with 1,440 revs. per minute, but neither of the pumps, if worked night and day continuously, in the manner which they were worked by defendants, could by itself get down as far as 640 ft., and from that depth raise 1,000 gals. of water per minute. Plaintiffs argued that the motors were not designed so that each of them should be capable of running by itself continuously for a long period at a maximum load, without overheating. This was supported by the passage in the specification which, in effect, as far as the generators were concerned, guaranteed a full output for a continuous run of six hours without overheating. In his opinion defendants were not under any obligation to put both the pumps into the pit simultaneously and work them in the manner suggested by plaintiffs. Having, however, decided not to do so, and to try and unwater the pit with one pump only, they could not recover damages for the loss occasioned by each pump breaking down except in so far as the breakdown was due to plaintiffs' default, and the losses which defendants were seeking to make plaintiffs liable for were not, as he found, except to a certain extent, due to plaintiffs' failure to make the electrical pumping machinery conform in all respects to the conditions of the contract. He ought, however, to add, that if the right conclusion ought to be that the failure of the pumps to get below about 640 ft. without overheating owing to want of adequate ventilation was due to plaintiffs' default, defendants would have the right to claim, besides an abatement of the price, some reasonable compensation for the losses they incurred, but the compensation would have to be assessed at a very much smaller sum than that which defendants had claimed. The delays and outlay consequent on them were largely augmented by reason of the defective character of defendants' headgear and appliances. Claims 9 to 13 could not, therefore, be maintained. With regard to the claim for coal consumption, he found that the steam consumption per k.w. hour was 38 lb. against 28 lb. guaranteed. The engine was therefore less valuable to defendants than an engine conforming to the contract would have been. In respect of this failure of plaintiffs to comply with the contract, defendants were entitled to damages. They claimed the estimated excess of coal consumption when the plant was at work over the coal consumption guaranteed, and for the quantity used by the plant when at work without producing useful results. That, in his opinion was not the right measure of compensation, and he decided that the right measure was to award such sum as one could estimate to be the difference in the value of the engine as delivered and an engine with the guaranteed steam consumption. He therefore took the basis of plaintiffs' claim and he awarded them the balance of £2,943. 6s. On defendants' counterclaim he disallowed £30 because he was unable to find that those expenses had been incurred by any breach of contract, express or implied. Defendants had a claim for £375 in respect of No. 3 pump, but this he held had failed. Plaintiffs had delivered the plant which was less valuable to defendants than if it had conformed to the contract, and he allowed them on that item £417. He also assessed them £700 on the contract. Defendants were, therefore, entitled to reduce the claim of plaintiffs by £1,117 and deducting that sum from the £2,943. 6s. he gave judgment for plaintiffs for £1,826. 6s. Defendants had succeeded in some of the issues, but it was very difficult to separate them, and if it was convenient for the parties on both sides he would hear an application with regard to costs at a future date.

Counsel agreed to this, and the matter will come before the official Referee again on Monday.

Consolidated Supply Company (Ltd.)—The case of the Consolidated Electric Co. v. Consolidated Supply Co. (Ltd.), a debenture holder's action, came before Mr. Justice Swinfen Eady on Saturday. Mr. Whitmore Richards asked for judgment in default of defence. Appearance had been entered, but defendant did not now appear. A breach of condition took place by reason of the non-payment of interest for two months. His lordship gave judgment as asked.

MANCHESTER ELECTRICAL EXHIBITION.

A meeting of the general committee was held in Manchester on Tuesday, 16th inst, when it was announced that good progress had been made in the erection of the huge building, the skeleton of which is now complete. The management reported that satisfactory support was being received from all branches of the industry. Already over 100 spaces were let, representing between 140 and 150 individual exhibitors. Dr. Edward Hopkinson (Mather & Platt), Mr. Rushton (Dobson & Barlow) and Mr. W. T. Stubbs (Joseph Stubbs & Sons) had accepted seats on the general committee, representing the allied engineering trades.

Schemes for decorating and lighting the building inside and out were discussed. It was announced that special arrangements are being made with the railway companies all over the country for cheap fares and excursions to Manchester during the progress of the Exhibition.

A further meeting was fixed for July 7, by which time it was hoped the buildings will be sufficiently advanced for Press inspection.

The management propose arranging for a demonstration of wireless telegraphy between the Exhibition buildings and an important town within, say, a radius of 50 miles of Manchester.

Members of the Gas and Oil Engine Manufacturers' Association have decided to arrange for a number of complete working exhibits of special plants as applied to the generation of electricity.

We may add a few notes to the above. The exhibition building has now assumed shape; the front is up, the roof nearly completed, and the general contour of the structure can now be seen. It may be mentioned that the building was originally to have been 500 ft. by 150 ft. by 40 ft. in area, and this has since been extended to 500 ft. by 286 ft. by 40 ft. There is still room for extension at the rear, and should the demand for space warrant it the general committee will have no difficulty in considerably enlarging the area of the building. At present only one entrance is provided for, although the means of exit are ample. Should the committee decide later to provide an additional entrance at the rear of the exhibition building, facilities exist for this to be done. The exhibition grounds adjoin, at the rear, a large open space which has recently been dedicated by Manchester Corporation to the Manchester public as an open space. We understand that arrangements are being made for the electric tramway service (which already passes the front entrance to the exhibition) to run direct into the exhibition grounds.

Manchester Corporation Electricity Department is busily engaged in the work of construction of a main distribution centre for electric energy in the exhibition building, and considerable progress has already been made with this work.

MUNICIPAL, FOREIGN & GENERAL NOTES.

APPOINTMENTS VACANT AND FILLED.

A draughtsman is required for wireless telegraph and telephone apparatus. Salary $112 per month. Applications to the National Electric Signalling Co., Brant Rock, Massachusetts, U.S.A. See advertisement.

An experienced armature winder is wanted, accustomed to traction work with the British Westinghouse and B.T.-H. equipments; also a man experienced in building up commutators for same companies' motors and motor-generators. See an advertisement.

A second assistant is required in the engineering department of Woolwich Polytechnic to take up duties in September next. A knowledge of electrical engineering is essential. Commencing salary £180. Applications to the Principal (from whom further particulars can be obtained) by July 15. See an advertisement.

Teachers in magnetism and electricity, electrical engineering, practical mathematics, applied and theoretical mechanics, &c., are wanted for next session at Erith (Kent) Technical Institute. Particulars from Mr. A. T. Flux.

Mr. J. R. Groves, manager of Peterborough tramways, has been appointed manager of Worcester electric tramways.

NOTICE.

The Electrician for July 3 will contain a full report of the Papers and general proceedings at the Convention of the Incorporated Municipal Electrical Association at Nottingham up to Thursday, July 2. This report will be concluded in The Electrician for July 10.

The Electrician for July 10 will include a Supplement dealing very fully with the subject of Electricity as Applied to Mining Operations. The following are amongst the principal contributors to this Mining Issue :—

Mr. J. H. C. Brooking	"Mining Cables."
Mr. H. W. Clothier	"Switchgear for Mines."
Mr. J. C. Futers ...	"Electric Winding."
Mr. J. W. Gibson ...	"Electric Ventilation of Mines."
Dr. R. Herzfeld ...	"Electric Pumping."
Mr. F. Hird	"Electric Signalling in Mines."
Mr. E. Holt	"Electric Generation in Mines."
Mr. F. W. Hurd......	"Electric Coal Cutting."
Mr. R. Livingstone .	"Energy in Coal Winding."
Mr. W. Maurice ...	"Employment of Storage Batteries in Colliery Power Stations" and "Electric Blasting."
Mr. W. C. Mountain	"Electric Haulage."
Mr. W. S. Toplis ...	"General Survey of Electric Power in Mining."

The Electrician for July 10 will, therefore, be extremely valuable as a record of the applications of Electricity to Mining Work up to the present time.

Particulars as to advertising space in the Mining Issue on application.

Orders for additional copies of the above-mentioned issues should be placed with the agents at once, or should be sent direct to the Publisher, 1, 2 & 3, Salisbury-court, Fleet-street, London.

EDUCATIONAL NOTICES.

Heriot Watt College, Edinburgh.—At this college there is theoretical and practical training for mechanical, electrical and mining engineers, technical chemists, &c. The training for engineers consists of three years in the college and a three years' apprenticeship on the "sandwich" system in a local engineering works. The total cost, including apprenticeship premium and fees at college, is from £120 to £200. There are complete courses of instruction, extending over four years, for students studying for the fellowship of the Institute of Chemistry The classes are recognised by the University of Edinburgh as qualifying for science degrees. Full information may be obtained from the Principal, Mr. A. P. Laurie, M.A., D,Sc.

Technological Scholarships.—The West Riding of Yorks County Council offer four technological scholarships (each of the value of £60 per annum), open to residents within the administrative area of the West Riding of Yorkshire, and available for courses of instruction in connection with textiles, dyeing, engineering (mechanical or electrical), metallurgy or other approved industry. These scholarships are intended for young artisans who already have a suitable amount of mill or workshop experience. The awards will be mainly based on the results obtained at examinations of the Board of Education, and of the City and Guilds of London Institute. Application forms and full particulars may be obtained from the Education Department (technical branch), County Hall, Wakefield.

Accrington.—An unopposed inquiry was held here last week into the application of the Council for permission to borrow £7,500 for extensions of the electricity undertaking.

Battersea (London).—The Electricity committee has prepared a scheme for public and private lighting of the Battersea Rise House estate, at an estimated cost of £5,362.

It is proposed to erect 10 additional arc lamps and 37 lamp columns fitted with brackets similar to those on the Northfield estate, but with 100 c.p. osram lamps for the side streets. One builder has already arranged to wire 60 new houses on the estate.

Bexhill.—The Council have received sanction to a loan of £3,000 for mains, services and meters.

Canadian Telegraphs.—The telegraphs and telephones of the Dominion have been placed under the jurisdiction of the Railway Commission.

"Cheaper Cables."—Much clap-trap is being written in the popular papers on the subject of cheaper cable rates, the remarkable feature being that the nonsense which appears is apparently inspired by men who should be acquainted with the circumstances which, in the main, govern this question. Whether these gentlemen are acquainted with the facts or not, St Martin's-le-Grand has made the position perfectly clear through the medium of one of its high officials, who definitely exposes the stupidity of the suggestion of a universal penny-a-word cable service.

Customs Amendment.—Telegraph and telephone materials have been added to the list of goods which may be imported into Northern Nigeria duty free.

Dunfermline.—The Council have decided to adopt Sir Alex. Kennedy's recommendation to lease the Dunfermline electric lighting order to the Fife Electric Power Co.

Edinburgh.—At the meeting of the Corporation last week Treasurer Harrison moved a resolution recommending that the equated period for redemption of debt for capital expended on electricity supply be reduced from 30 to 25 years. He also moved that minor miscellaneous items in connection with extension work, which would, on strict accounting, be charged to capital, should be debited to revenue.

Treasurer Harrison said he was assured that the "minor miscellaneous items" did not amount to more than £200 or £300 a year, and, therefore, he did not press the point. But he found these "miscellaneous items" swollen to £4,238. 14s. 4d., not one item of which should legitimately have been charged to revenue, but should have been charged to capital. These items were connected with extension work which, if they had been contracted for, would have been charged to capital. But because the department did the work themselves, they were charged to revenue. It was said that it was doing no harm. Well, it was for one thing concealing from the Council the amount of the capital charge for the year, and it was not good finance. He would far rather that the decision of what was to be charged to capital and what to revenue should be left to their officials, who would look at it from a purely accounting point of view. As to the proposal to reduce the equated period of the redemption of the debt from 30 to 25 years, the Council could not help doing that after the report they had had from Sir Alex. Kennedy, who had said that in all the circumstances of the case it was desirable that the period of repayment should be shortened from 30 to 25 years. He, therefore, proposed that from May 15 last they should pay $\frac{1}{25}$th of the capital instead of $\frac{1}{30}$th.

Mr. Brown said 30 years was the period generally adopted throughout the country for the redemption of the debt, but recently London County Council, acting under skilled advice, gave notice that they meant to reduce the time to 25 years, and as they were the largest borrowing authority other Corporations would have to follow suit.

Bailie Stevenson moved that contributions for the future should be such that past as well as future capital expenditure will be paid off in 25 years from the date of its incurrence. He thought that was the only logical outcome of the proposal that the redemption period should be shortened. He proposed to take full advantage of the present years of plenty, so that if in a few years they might not be so favourably placed, their contributions would be correspondingly lessened. They expected a surplus this year on the electric light fund of £13,000, and that, despite the advance in the coal bill, which would be at least £14,000.

Mr. A. Murray, convener of the Electric Light committee, moved a negative to the motion dealing with miscellaneous items, and on the other part of the subject that the proposal to reduce the period for redemption of debt to 25 years only apply to new capital. He was strongly at variance with the Treasurer's proposition that it was bad finance to try to pay off as many little things as they could out of revenue instead of borrowing money and putting it to capital. They had the money, and believed in the cash down principle. It was a spendthrift way to spend the surplus on something outside of the undertaking and increase the charges on capital. By having tha miscellaneous items fund they saved expenses on loans. Of course the Committee had to exercise the discretion given to it by the Council in a reasonable way; and he would rather have the view of the committee, subject to the ruling of the Council, than the dictum of officials as to how they were to deal with their capital and revenue account. They put such items as inspection of new boilers, advertising for contracts, repairs of new mains, cost of season tickets to their men, and such items to revenue. Why should they be charged to capital? The present system was a good one, and it was in the interest of all concerned that it should be continued. There was nothing in the state of the undertaking which made Mr. Bailie Stevenson's proposal necessary. Of their capital expenditure of £942,000, £305,000 was in land and buildings. They had paid to the sinking fund £234,000 so that beyond these sums they had only got £403,000 outstanding unpaid on things which might be called of an ephemeral character. In addition, they had £92,000 in their reserve fund, so that he did not see any need for the proposal being made retrospective. In regard to the future, he thought that probably they might agree to pay off debt in 20 years instead of 25—that, he indicated, being an expert suggestion also, and he altered his motion accordingly.

After discussion the proposal to rescind the miscellaneous items resolution was carried by 28 votes to 15. By 35 to 9 Mr. Arbuthnot Murray's proposal was rejected; and as between the other two proposals, Treasurer Harrison's was carried by 33 votes to 11.

Electricity in Mining.—On Thursday last week the new electrical winding engine at the Maritime Pit of the Great Western Colliery, Pontypridd, was tested on load under the supervision of the consulting engineer, Mr. G. H. J. Hooghwinkel, M.I.E.E., of Westminster. The results were entirely satisfactory, and as this is practically the first large electric winding engine erected in this country, the results obtained under regular working conditions will be awaited with much interest by mining engineers.

The substitution of electricity for steam and compressed air is making rapid progress among the South Wales Collieries.

At the three pits of Locket's Merthyr Collieries (1894), at Mardy, Rhondda Valley, the whole of the surface plant, including tippling, screening, coal washing and pumping, is driven by electricity, and at the Ferndale pits of Messrs. D. Davies & Sons an extensive electrical installation is nearing completion. In connection with the scheme for the electrical operation of the surface and underground haulages at the Mardy pits of Locket's Merthyr Co. the whole of the plant at No. 3 pit will be operated electrically. The extensions now in progress will include the conversion of an Uskside steam haulage engine of 200 H.P. and three new electrical hauling engines of 200, 500 and 100 H.P. respectively. The 200 H.P, and 150 H.P. motors will be of the protected type with enclosed slip rings, and will be capable of an overload of 100 per cent. applied during 20 minutes when running at 350 revs. per min. at 2,200 volts, 25 cycles, three-phase. All motors of 100 H.P. and under are running at 440 volts, 25 cycles, three-phase. The whole of the motors and switchboards have been made by the British Westinghouse Co. When the complete plant is in operation, upwards of 1,500 H.P. will be installed, the current being obtained from the Treforest Electrical Consumers Co. A new Schiele ventilating fan, driven by a Robey compound engine, has been laid down, with Thompson high-pressure dish-ended boilers, equipped with Green's economisers and Sugden's superheaters and furnaces. Crossthwaite's patent furnaces are also replacing the forced draught blowers on the other boilers. The tippling and screening arrangements have been entirely remodelled, and three tipplers and picking bands have been erected by Heenan & Froude.

Electrobuses.—In connection with the present outcry against the petrol 'buses, the chairman of the Electrobus Co. (Sir Hy. Dering) points out that the panacea for the troubles complained of is to be found in the use of electricity as the propelling power. There are now, it is stated, 16 electrobuses running in London; these are without smell, vibration is reduced to a minimum, and it is impossible for the driver to exceed 12 miles per hour. The company's percentage of accidents is, therefore, lower than that of any other similar service of vehicles.

Erith.—The sub-committee appointed to consider how the annual loss on the tramways undertaking could be lessened has reported that

These losses had rapidly increased year by year, and that Erith was the third from the lowest of 72 municipally-operated undertakings in regard to traffic earnings per car-mile. Working expenses and administration of the department could not be reduced materially, having regard to the safety and efficiency of the system. Bent rails at several curves on the system would shortly require to be renewed, parts of track would require underpinning and part re-paving, and extensive rail corrugations would have to be remedied, necessitating special plant for dealing with the work. Under these circumstances, it was impossible to continue carrying on the system without a large increase in working expenses. The net loss on last year's working (notwithstanding the low working expenses of 6·2d. per mile) was £4,449, and this sum would be exceeded during the current year owing to decreased revenue. The total loss for the current year, it was estimated, would be something over £7,000 to be provided for out of the rates.

The Council agreed to the committee's recommendations to abolish ½d. fares, and to issue exchange or transfer tickets at a uniform 1d. fare, entitling the holder to travel over any two given stages approximately ½ mile long, either consecutively or at any time during the day of issue; to make certain changes in respect of workmen's tickets, and to abolish free riding by members of the Council, staff and employés, except in the case of the uniformed staff (the last named to be allowed to travel free to and from duty only).

Exhibition.—What is claimed to be the first International Rubber Exhibition in Europe will be held at Olympia (London) during the last fortnight in September. There will be a conference held, during which Papers will be read on the rubber industry.

Greenock.—The Corporation have received £1,000 from Sir Donald Currie to be invested, and the proceeds to go in providing bursaries for young officers or engineers studying in the James Watt Memorial School.

Hastings.—The Electricity committee reported to the Council last week that the borough electrical engineer (Mr. R. F. Ferguson) had prepared a report showing that there were 480 gas lamps (469 ordinary 50 c.p. incandescent gas lamps and 11 fitted with more than one burner) which were within 60 ft. of the electric mains and could be lighted by electricity.

The committee were prepared to supply current to the whole of these lamps and to undertake similar services with regard thereto as are undertaken by the gas company (*i.e.*, lighting, cleaning and extinguishing of lamps and renewal of lamps when requisite) at the same annual cost for each class of lamp as is at present charged by the company, and they recommended that a standing instruction be given to the committee to in future supply electric current to all public lamps in the streets in which electric mains are now laid or in which such mains may hereafter be laid (said lamps being within 60 ft. from the main) on terms above mentioned.

After a lengthy discussion the report was adopted by 17 votes to 13.

Hospital Lighting.—The Metropolitan Asylums Board (London) have approved an electric lighting scheme for the North Eastern Hospital. The cost of the installation, including the wiring, fittings, &c., is put at £4,500, and electric current will be supplied by the North Metropolitan Electric Power Supply Co. (at less than 2d. per unit).

The engineer-in-chief (Mr. W. T. Hatch), who prepared the scheme, submitted a statement of the actual cost of gas lighting for the last two years, from which he estimated that the total cost of electric light and gas (a small quantity being required for cooking, heating, &c.) would be £700 per annum, compared with the present expenditure of £1,200, or a saving of £500.

The Hospitals committee pointed out that electric light had an advantage over gas in that it could be more favourably arranged in the wards, and was also more convenient, more hygienic, was attended with less risk from fire, and was generally accepted as the most suitable light for institutions.

An inquiry was held at Sheffield last week into the application of the Corporation for permission to borrow £1,900 for an electric lighting installation at the Lodge Moor Hospital.

The town clerk (Mr. R. M. PRESCOTT) gave evidence in support of the application, and the medical superintendent of the hospital (Dr. WILLIAMS) described in detail the proposed new lighting arrangements. He strongly urged the advisability of having electric light in the hospital.

The inspector (Major J. STEWART, R.E.): You have given us excellent reasons for adopting electricity. I don't know why you did not have it before.

King Edward's New Yacht.—The Royal rooms on board the King's new yacht "Alexandra," which is to take the place of the "Osborne," consist of a dining room, reception room and two tea rooms on the upper deck, and on the main deck the King's writing room, the bedrooms for the use of the King, the Queen, Princess Victoria and a Royal guest, together with a connecting corridor and secretary's bedroom. The contract for decorating and furnishing these apartments was entrusted to Waring & Gillow. Pretty electric fittings are employed, and in the ceiling light the glass is ingeniously covered with a soft rose-coloured silk shade of unique design and giving a delightful effect.

London County Council.—On Tuesday it was agreed to loan Battersea £1,847 for electric lighting.

Commercial Audit of the Tramways.—Lengthy reports were submitted by the Finance and Highways committees dealing with the policy to be pursued in order to carry out the recommendations of the auditors who recently enquired into the tramway accounts. One of the principal findings was that there had been a loss on capital account of £1,500,000, owing to the displacement of the horse traction system, and they considered that this should be met in a more rapid manner than by the annual instalments for repayment of debt. The controller, after conference with the other officers concerned, computes that the obsolete capital expenditure in respect of horse traction at March 31, 1914, after deducting debt repaid in respect thereof, will amount to £961,951. The Finance committee think that annual payments should commence in that year to extinguish the debt by March 31, 1929. The committee recommended: (*a*) That the mount of capital expenditure rendered obsolete from time to time owing to the conversion of the horse-traction system to electric traction, and the provision made per contra for the liquidation of the debt thereon, be in future shown in the balance-sheet of the tramways undertaking. (*b*) That, subject to the approval of the Treasury, provision be made within 15 years from March 31, 1914, for repayment of the debt in respect of obsolete capital expenditure outstanding on that date on the horse tramways. (*c*) That £5 547 be charged to revenue account of the tramways as on March 31, 1908, for additional central office establishment charges for the period prior to April 1, 1907. (*d*) That it be referred to the Finance, Improvements and Highways committees to consider the resolutions of Nov. 20, 1906, as to allocation of cost of street improvements connected with tramways, together with the report of Messrs. Peat & Pixley on the same subject, and to report jointly to the Council as to the action which should be taken thereon.

After long discussion the recommendations were adopted.

Tramways Renewal Fund.—Further reports were submitted with regard to the renewals fund of the tramways account and the Finance committee recommended:—

(*a*) That the "Renewals Reserve Fund" be called the "Renewals Fund."

(*b*) That a "General Reserve Fund" to provide for general contingencies be established in connection with the Council's tramways; and that for five years from April 1, 1908, any surplus which may be available, after a sufficient sum has been credited to renewals fund to bring it up to the full amount necessary on the basis of ⅜d. per car-mile run by electric traction, be paid into general reserve.

(*c*) That £34,634, being amount of £30,772 transferred to renewals reserve on April 1, 1904, in respect of the horse system, with interest to March 31, 1908, be transferred to general reserve.—Carried.

Sand Transport Vehicles.—It was decided to fit the sand transport vehicles of the tramway department with magnetic brakes at an estimated cost of £81.

Telephones at Colney Hatch Asylum.—It was agreed to re-arrange the telephones at the above asylum at an estimated cost of £500.

G. B. Surface Contact System.—In reply to questions, Mr. Whittaker Thompson, chairman of the Highways committee, stated that the Board of Trade inspected the lines in the Mile End-road where

the G. B. surface contact system had been laid, on Monday, and had granted them a certificate for six months. He hoped to have a few cars running in the course of the present week and an increased number as rapidly as possible. He was not prepared to admit that the system as [illegible] was defective. He was not yet in a position to say what action the committee would take in reference to the further electrification of the northern lines. Although the Board of Trade certificate was only for six months he personally anticipated a renewal of the certificate in due course.

The surface contact tramway between Bow Bridge and Whitechapel Church, referred to in the above report, was opened for public traffic yesterday (Thursday).

Lough Erne (Ireland) Electric Power Proposal.—Lough Erne Drainage Board at their meeting at Enniskillen last week discussed a letter from Mr. W. A. Lindsay (Belfast) asking whether the board would encourage a scheme for generating electrical energy at Belleek by water power obtained from the falls. It was decided to favour the suggestion, but the board required a more definite proposal as to terms. The Secretary stated that the board had been approached from other quarters on the subject.

Manchester Telephone Service.—The central group of exchanges has been extended to include Heaton Moor and Eccles, and on July 1 a further extension will be made to include Sale and Urmston.

Marylebone (London) Electricity Undertaking.—We have received from the electricity supply department of Marylebone Council a nicely printed and well-bound book giving a description of the municipal electricity works, &c. After a brief sketch of the early history of electricity supply in Marylebone, and of the proceedings connection with the transfer of the Marylebone portion of the in Metropolitan Electric Supply Co.'s undertaking to the Council, a description is given of the plant and equipment of the Richmond-street generating station; particulars are next given of the distribution network and the sub-stations, the head offices and the commercial department of the electricity undertaking, &c. Information is furnished as to the progress and development of electricity supply, the charges for electrical energy, &c. There are a number of excellent illustrations and curves, which make the book of more than usual interest to the consumer of electrical energy.

Mexico.—The present month should see the inauguration of the new electric lighting and power plant at Vera Cruz, and also the commencement of the electrical working of the tramways of this city. This undertaking is a British one, of which Messrs. S. Pearson & Son (Ltd.), the famous firm of contractors, are closely connected.

£600,000 is to be expended in plant, buildings, &c., in connection with a company which was organised in London last November, called the Vera Cruz Terminal Co., which will take over the handling of all traffic, rail and otherwise, at Vera Cruz, maintain and operate warehouses, piers, &c., and the loading and unloading of ships and all other terminal duties. In connection with this undertaking custom house warehouses are to be constructed which will be equipped with industrial tracks and turntables, overhead travelling hoists and cranes, capstans, &c., all of which are to be operated electrically. Four of the cranes will be of 3 ton capacity, and there will be 16 electric capstans. For these extensive works it is probable that a large part of the plant, machinery and material will be ordered from Great Britain.

At Puerto Mexico (this is the new name for Coatzacoalcos) there have been great improvements effected in the harbour and port works, which are nearing completion. A modern system of steel wharves and warehouses have been constructed, each equipped with a broad guage track to suit overhead electric travelling cranes. There are 18 of these cranes, each of 3 ton capacity, for loading and unloading direct from the ship's holds, and there are also 30 electric capstans in operation. At the terminal railway yard at Puerto Mexico there is a very complete and up-to-date electric generating station.

Newcastle (Staffs.).—An unopposed inquiry was held here last week into the Council's application for sanction to a loan of £700 for meters, &c.

Presentation.—Torquay electricity works staff have made a presentation to Mr. C. D. H. Jackson on his marriage.

Ramsgate.—The East Cliff and Park bandstands and certain portions of the park are to be wired for the electric light.

Roumania.—The work of establishing electricity service at Constantza [illegible] The public service will include a supply of [illegible] at the new casino now being erected.

St. Pancras (London).—The recommendation of the Electricity committee to [illegible] the wiring of consumers' premises (through contractors) was referred back by the Council last week.

Sicily.—[illegible] Rome, Palermo, Messina, Catania, &c., are undergoing considerable improvement and extension. The [illegible] system of operating is to be adopted on several of the lines under construction or reconstruction, the [illegible] simplex on [illegible] lines, and the [illegible] duplex system on the remainder.

At the end of 1907 the public telephone system of Sicily passed into the possession of the Italian Government, and it is announced that besides a cheaper service considerable extensions are in contemplation.

In November last an agreement was entered into between a Belgian company and Messina Town Council for the establishment and operation of electric tramways in the city.

In August last year a company was formed with a capital of £120,000 (to be doubled if necessary) for the establishment of electric power undertakings in Sicily, and for carrying out works of a general character connected with the supply of electric energy. The first project undertaken by the company is one for utilising the waters of the river Alcantara, which, by means of an artificial fall, are estimated to be capable of providing 4,000 H.P. The construction of these works was commenced in April.

Southampton.—The Corporation have resolved to apply for a provisional order for South Stoneham.

Southend.—Sanction has been received to a loan of £18,344 for extensions of the electricity undertaking.

Spain.—The "Madrid Gazette" announces that a concession for the construction of an electric tramway in Bilbao has been granted to the Cia del Tranvia Urbano de Bilbao.

Into the port of Malaga in 1907 72½ tons of electrical machinery and accessories were imported, but no portion of the imports came from the United Kingdom, Germany (25 tons), Holland (22½ tons) and Belgium (19 tons) being the chief sources of supply.

Stepney (London).—The Thames Conservancy have given permission to the Council to construct an embankment and place two 36 in. suction and discharge pipes in the river at Blyth's Wharf generating station.

Supply of Electricity Bill.—Stepney (London) Council are circularising the other London Councils, and also the local authorities of Greater London, asking that representatives be appointed to a deputation to wait upon the President of the Board of Trade to urge upon him the desirability of reintroducing the Supply of Electricity Bill of 1906.

Training Ship Lighting.—The Metropolitan Asylums Board have decided to provide, at a cost of £275, a battery of accumulators and a small additional dynamo for the training ship "Exmouth."

West Ham.—Application has been made to the Board of Trade for an extension for two years for the construction of the Prince Regent's lane tramway.

Electricity Supply Cricket League.—The following particulars are issued of the points scored in this league up to and including Saturday, 13th inst.:—

Club.	Played.	Won.	Lost.	Drawn.	Pts.
Kensington & Knightsbridge	7	6	0	1	13
St. James'	7	4	2	1	9
Central	4	2	2	0	4
St. Pancras Power	2	1	1	0	2
City of London	4	0	4	0	0
Marylebone	4	0	4	0	0

Faraday House Dinner.—The fourth annual dinner of the Faraday House O.S. Association was held at the Queen's Hotel, Leicester-square, London, on the 18th inst., with the president of the Association (Mr. Gerald W. Partridge, engineer-in-chief of the London Electric Supply Corpn.) in the chair. The company included Mr. W. M. Mordey, Mr. Robert Hammond, Major O'Meara, Mr. Hugo Hirst and Mr. Philip Dawson, who proposed the toast of the evening—"Faraday House and its Old Students." As is usual at these gatherings, beyond this toast there were no other speeches, the dinner being followed by an excellent smoking concert. The members are to be congratulated upon a most successful evening.

Operatives' Annual Holiday.—The works of Ed. Bennis & Co., at Little Hulton, Bolton, Lancs., will close on Friday, June 26, and reopen on Monday, July 6.

ELECTRICITY SUPPLY AND TRAMWAY ACCOUNTS.

Acton.—The gross profit for the year ended March was £1 082 2s. 2d., but, after paying interest, sinking fund, &c., there was a net deficiency to date of £2,934 18s. 3d.

Brighton.—The total income of the electricity department for the year ended March 31 was £88,082. 10s. 11d. against £85,684. 9s. 7d. in 1906-7, including £61,3[illegible] 9s. 9d. from sale of current by meter, £195 from bulk supply to Hove, £11,811. 13s. 11d. from the tramway department, £10,211. 3s. 6d. from public lighting, &c.

Gross profit was £41,52[illegible] 4s. 1d., of which interest absorbed £[illegible] 1s. 10d., and sinking fund £[illegible] 5s. 11d., leaving a [illegible] of £5,6[illegible] 1s. 3d. for the year, against £10,355 in 1906-7. [illegible] has been met out of the reserve fund, which now stands at £[illegible]. The total capital outlay is £7[illegible] 2s. 1d., an increase of £[illegible] 11s. 10d. on the year. 8,002,376 units were sold against 7,840,196. There are 4,525 consumers against 4,099 with the equiva-

[illegible] of 319,628 8 c.p. connected against 307,604 8 c.p.). The total works-costs were 0·89 per unit (coal being 0·55d. against 0·61d.) compared with 1·11d. in 1906-7, and the total costs were 1·26d., against 1·[illegible]d.

Colchester.—The traffic revenue of the tramways department for the year ended March 31 was £10,475. 16s. 11d., and the total revenue £10,982. 12s. 11d.

Expenses were £9,313. 9s. 6d. or 6·564d. per car mile, leaving a gross profit of £1,669. 3s. 5d. Interest absorbed £2,701. 2s. 4., and £1,[illegible]. 17s. 6d. was set aside for repayment of loans, so that there was a deficit of £2,923. 16s. 5d. for the year. The gross capital expenditure is £69,300. 15s. 7d. 2,308,721 passengers (against 2,514,599) were carried, and 340,539 car-miles (against 353,331) run; 486,973 units of electrical energy were consumed. The percentage of working expenses to receipts was 84·8, the average traffic revenue per car-mile being 7·383d.

Exeter.—The total receipts of the electricity department for the year ended March 31 were £19,267. 6s. 11d.

Expenses were £9,742. 7s. 6d. and the gross profit was £9,524. 19s. 5d. Interest and sinking fund required £6,920. 5s. 7d., leaving a net profit of £2,604. 13s. 10d., or about £1,000 more than in any previous year. 1,357,412 units were sold, an increase of about 10 per cent., the principal increase being in street lighting.

The report of the city electrical engineer (Mr. H. D. Munro) states that the rate of increase of the general lighting supply has been retarded by the use of metallic filament lamps, but the rate of increase in the number of consumers has been well maintained, the applications in hand being more numerous than ever previously. Although the price of coal during the year has averaged 20 per cent. more than in the previous year, the cost of generation per unit had been kept down to the same figure as before. A portion of the year's surplus has been applied to the repayment of £637. 10s. 3d. owing on the street lighting installation suspense account. Increases in the salaries of certain members of the staff have been made.

Dover.—For the year ended March 31 the income of the electricity department was £19,375. 14s. 6d.

Expenses were £10,159. 3s. 10d. Gross profit was £9,216. 10s. 8d.; interest absorbed £7,555. 1s. 2d. and sinking fund £4,107, leaving a deficit of £2,446. 10s. 6d. The total capital expended is £164,805. 19s. 9d., an increase of £4,982. 6s. 1d. on the year. The total connections now amount to 47,200 30 watt lamps, 1,448,132 units were generated, 136,905 were supplied to public lamps, 420,351 to the tramways department and 617,906 to private consumers (a decrease of 95,304 compared with 1906-7). The maximum supply demanded was 483 kw. a.c. and 285 k.w. d.c. Total costs were 2·08d. per unit sold (against 1·72d. in 1906-7).

Gravesend.—The gross profit of the electricity department for the year ended March was given in our last issue as £4,261, against £4,209 in the previous year. These figures should be £4,621, against £4,029.

Kirkcaldy.—There is a net profit of about £100 on the past year's working of the electricity supply and tramway undertaking, against a deficit of £1,200 in 1906-7.

Luton.—The income of the electricity department for the year ended March 31 was £9,082. 17s. 5d.

Expenses were £4,064. 14s. 10d. Gross profit was £5,018. 2s. 7d. (against £3,502 in 1906-7), of which interest absorbed £1,800. 18s. 1d. and instalments of principal and sinking fund £2,012. 11s. 7d., leaving a net profit of £1,263. 4s. 9d. (against £862). The total capital expended is £53,364. 10s. 10d., an increase of £9,511. 0s. 5d. on the year. 1,226,933 units were generated and 1,125,235 units were sold. The total maximum supply demanded was 705 kw. There are 476 consumers (against 382), with the equivalent of 26,150 8 c.p. lamps is connected (against 22,293 8 c.p.), and there are motors of 1,373 H.P. (against 960 H.P.) connected.

Newport (Mon.)—There was a profit of £2,000 on the past year's working of the municipal electric tramways.

Watford.—There was a profit of £915 on the past year's working of the electricity department, and this has been applied in relief of rates. There are 640 consumers connected.

TRADE NOTES AND NOTICES.

TENDERS INVITED.

Dublin Lighting committee invite tenders for supply and erection of sub-station switchboards, transformers and accessories. Specifications, &c., from the city electrical engineer (Mr. Mark Ruddle), Fleet-street. Tenders to the Chairman of the Lighting committee, 3, Cork-hill, Dublin, by noon July 13. See also an advertisement.

The Lighting committee of *Dublin* Corporation are also prepared to receive tenders for supply and erection of boiler plant, &c., at Pigeon House generating station. Specification, general conditions and forms of tender from the city electrical engineer (Mr. Mark Ruddle), Fleet-street, Dublin. Tenders, addressed to the Chairman of the Lighting committee, 3, Cork-hill, Dublin, by noon July 13. See also an advertisement.

Dublin Corporation also invite tenders for 12 months' supply of machinery oils for the Corporation electricity works. Copies of specification, with conditions of contract, can be obtained from the town clerk, Mr. Hy. Campbell, and tenders must reach his office by 29th inst.

St. Pancras (London) Council invite tenders for additions to their low-tension switchboard at King's-road generating station. Copies of specification, &c., at the Electricity Department Offices, 57, Pratt-street, Camden Town, N.W. Tenders to the town clerk (Mr. C. H. F. Barrett), Town Hall, Pancras-road, N.W., by noon Monday, July 13. See also an advertisement.

London County Council invite tenders for the manufacture and delivery of high-tension main switchgear and low-tension auxiliary switchgear, to be erected at the Council's generating station at East Greenwich. Tenders, on official forms to be obtained from the clerk of the Council (Mr. G. L. Gomme), County Hall, Spring-gardens, S.W., by 11 a.m. on July 7.

The Electricity Supply committee of *Stepney* (London) Council invite tenders for supply, during the year ending June 30, 1909, of (1) ampere-hour meters, demand indicators and time switches; and (2) arc lamp carbons. Specifications, &c., from the borough electrical engineer and manager, Mr. W. C. P. Tapper, A.M.I.E.E., 27, Osborn-street, Whitechapel, where tenders must be delivered by noon of June 29.

Salford Electricity committee invite tenders for re-wiring the Royal Technical Institute. Specifications and forms of tender may be obtained from the borough electrical engineer, Mr. V. A. H. M'Cowen, electricity wo ks, Frederick-road, Pendleton. Tenders by noon of July 1.

The Guardians of the parish of *Fulham* (London) invite tenders for a vertical high-speed engine and 20 kw. steam dynamo, both British made. Form of tender of specification from the clerk, Mr. E. J. Mott, 129, Fulham Palace-road, Hammersmith, W., to whom tenders by July 2.

Tenders are wanted for an electric light and power installation for the new engineering laboratory, Heriot-Watt College, *Edinburgh*. Specifications from the Superintendent of Works. Tenders to the Clerk to the Heriot Trust, 20, York-place, Edinburgh, by 10 a.m. July 3.

Woolwich Council want tenders by noon July 23 for supply and erection of coal handling plant at Globe-lane electricity works. Specification from the Borough Electrical Engineer.

Bradford Corporation want tenders by noon July 7 for an electric light installation at the nurses' home and isolation block of the city hospital. Forms. &c., from the City Architect.

Pontypridd Council invite tenders for supply and delivery of six double-deck tramcars. Tenders to the Clerk by noon June 30.

Odessa (Russia) Council want tenders by noon Sept. 1 (O.S. Sept. 14) for erecting and working under a concession an electricity generating station, with a capacity not less than 4,500 kw., for lighting, heating, power and traction. Particulars from the Building Department of the Town Uprava, Odessa. A deposit of 50,000 roubles (about £3,335) is required.

The Communal Council of *Gouda* (Holland) have decided to erect an electric power station, and communications on the subject are to be addressed to Mr. Alderman Nederhorst, Gouda.

Copenhagen Lighting Department want tenders by noon July 8 for supply of electric cables required during 12 months ending August, 1909. Tenders to the Direktoren for Belysningsvaesenet, Raadhuset, Copenhagen.

TENDERS RECEIVED AND ACCEPTED.

For the manufacture and supply of two electrically-driven centrifugal pumps, to be erected at their Greenwich generating station, the London County Council received the following tenders:—

		£	s.
Dick, Kerr & Co. (*accepted*)	£3,415 and	£3 320	0
Entwistle & Gass		4,342	0
Greenwood & Batley	£4,074. 10s. and	4,004	10
Gwynnes Limited		3,866	0
John Cochrane		3,757	10
Thomas Parker (Ltd.)		3,706	0
Electric Construction Co.		3,501	0
British Westinghouse Co.		3,379	17
Worthington Pump Co.	£3,530. 10s., £3,406 and	3,375	0
Drysdale & Co.		3,358	0
British Electric Plant Co.		3,335	10
General Electric Co.	£3,375. 7s. and	3,333	6

For wiring the Hackney car shed the L.C.C. received the following tenders:

	£	s.	d.		£	s.	d.
Perry & Co. (*accepted*)	£911	0	0	Comyn Ching & Co.	£1,099	8	1
Tilley Bros.	1,397	16	10	Pinching & Walton	1,014	19	10
H. J. Cash & Co.	1,245	0	0	Cannon & Sons	1,010	16	2
Cross & Cross	1,209	0	0	Suter & Wood	961	0	0
G. E. Taylor & Co.	1,189	13	6	A. C. Smith	775	2	0
G. Weston & Sons	1,158	8	9	Jenkins & Cawte	702	4	4

The contract with Geo. Wimpey & Co. has been extended by London County Council to include alterations to the bridge carrying Shepherd's Bush-road over the L. & S.W. Rly.

In April London County Council accepted the tender (amounting to £500. 3s. 2d.) of the Forced Lubrication Co. for supply, delivery and erection of shafting, brackets and pulleys required for the first

portion of the central car-repair depot. Vickers, Sons & Maxim have now purchased all British rights in Tilston's patent forced lubrication system, which is to be used in the execution of the work, and the Council have authorised arrangements being made for Vickers, Sons & Maxim to undertake the work in the place of the Forced Lubrication Co.

For the supply of motors, transformers, &c., for the central car-repair depot it was reported to the L.C.C. on Tuesday that tenders had been obtained from selected firms for the supply of (i.) four single phase static transformers and (ii.) eight three-phase motors and four auto-transformer starters. Only one firm (the British Electric Transformer Co.) was in a position at present to supply the static transformers, and, as those were urgently required, the tender of that firm was accepted. Three other firms were asked to submit tenders. The tenders for the supply of the three phase motors and auto-transformer starters were as follows :—

Electric Construction Co. (*accepted*)	£427 10
General Electric Co.	595 18
British Westinghouse Co.	468 0
Dick, Kerr & Co.	Tender incomplete

The tender of Watlington & Co. (at £84) has been accepted by London County Council for seven switches and that of Pfeil & Co. (at £82. 2s. 3d.) for forge shop tools for the central car-repair depot.

London County Council have extended the present contracts with W. Manders for road work and plate laying, and with Hadfield's Steel Foundry Co. for special track work for the reconstruction of the tramways in Lea Bridge-road.

Dick, Kerr & Co.'s contract for overhead equipment for the tramways from Beresford-square, Woolwich, has been extended by London County Council to include the equipment of the tramway from Brixton to Camberwell Green at an estimated cost of £3,160.

In connection with the equipment of the Bow and Hammersmith car sheds, London County Council have accepted the following tenders: Lighting transformer, British Electric Transformer Co., £91. 10s.; distribution switchboard, Spagnoletti Limited, £53; main switch boxes and wiring materials, Edison & Swan Co., £212. 12s. 10d.

For 50 jacks for electric cars, London County Council has accepted the tender of W. A. Green at £88. 15s., and for the supply of 400 anchor plates the tender of Mountain & Gibson at 1s. per lb.

West Ham Electric Lighting and Tramways committee have received the following tenders for supply of a 3,000 kw. turbo-generator :—

British Westinghouse Co. (*provisionally accepted*)	£6,100
Electrical Co.	11,400
Richardsons, Westgarth & Co. (Brown-Boveri turbine)	9,675
Do. (Parsons turbine)	9,400
Do. (Electric Construction generator)	9,300
Do. (Dick-Kerr generator)	8,520
Do. (Siemens generator)	8,175
Elec. Construction Co. (Richardsons, Westgarth turbine)	9,400
Do. (Parsons turbine)	7,704
Willans & Robinson (Dick, Kerr generator)	9,182
Jas. Howden & Co. (Dick, Kerr generator)	8,865
Do. (Westinghouse generator)	8,750
Do. (Siemens generator)	8,500
General Electric Co. (Richardsons, Westgarth turbine)	8,745
Do. (Parsons turbine)	7,349
C. A. Parsons & Co. (Parsons turbine)	8,184
Do. (Dick, Kerr generator)	7,494

The British Westinghouse Co. is to make delivery in five months, and the contract provides for two years' maintenance, and the Council are to have the option of purchasing a similar turbo generator within two years for £6,300.

The Electrical Engineer's estimate for the first of the two turbo generators was £10.000.

The Metropolitan Asylums Board have accepted the following tenders for annual electrical supplies :—

General Electric Co., Pyke & Palmer, G. Binswanger, Stirling Telephone & Electric Co., Siemens Bros. & Co., British Insulated & Helsby Cables, W. T. Henley's Co., Edison & Swan Co., Davies Kent & Stewart, Callender's Co., Connolly Bros., India Rubber, Gutta Percha & Telegraph Works Co., Goessens, Pope & Co., Sunbeam Lamp Co., Crypto Limited, H. G. Mayer & Co., A. P. Lundberg & Sons, Cadsworthy Limited, J. H. Tucker & Co., London Electric Wire Co., Hope & Johnson, G. McLellan & Co., A. Macintosh & Co.

Southend Council have accepted the following tenders :—

Ferranti Limited, meters; Stone & Co., condenser pipes, £8 per ton; Edgar Allen & Co., bends, £[illegible], and bends and crossings for tramway extension, £1[illegible]; E. W. Blackwell & Co., permanent way of tramway extension, £1,730; rail bonds, £42 4s.; poles, £165. 15s.; brackets, £55. 13s. 6d.; booms, £66. 13s. 6d.; trolley wire, £155; overhead fittings £13 10s. 6d.; H. Garland (Société anon des Aciéries Angleur), 160 tons of tram rail at £6. 2s. 6d. per ton, fish plates, £8 2s. 6d. per ton.

Worksop Council have received the following tenders: Vernon & Co., Hookham meters; E. Green & Son, fuel economiser, £250; Tinkers Limited, repairs to boiler, £30; Flamwell & Sons, rubber valves.

The Metropolitan Asylums Board have accepted the tender of Edmundson's Electricity Corpn. at £194 (less 5 per cent.) for wiring the Belmont Laboratory, Sutton.

Heckmondwike Council have placed an order with the General Electric Co. for motors and starters for letting on hire.

The tender of J. Wright & Sons has been accepted for the electrical work at the forthcoming pageant at Dover.

Portsmouth Electric Lighting committee have accepted the tender of the British Thomson-Houston Co. for 200 meters.

Electric Signs.—O. C. Hawkes (Ltd.), Birmingham and London, have received an order for between 700 and 800 electric signs and maps for the Underground Electric Railways of London—viz., the Metropolitan District and Metropolitan Railways, the Bakerloo, Piccadilly & Brompton and Hampstead Tubes, the Central London, City & South London and Great Northern and City lines. These railways are henceforward to be jointly known as "underground," and their present titles and abbreviations, including the word "tube," are to be discarded. Through bookings are being arranged. The Waterloo & City "tube" has also come into the arrangement. In order to keep the advantages of the combined system before the public, the companies propose to make extensive use of illuminated signs and maps. Maps of the underground system are to be provided which will also show the parks and the principal business and show places of the Metropolis. The maps are to be engraved on glass and are to be 7 ft. by 4 ft. Their utility will be enhanced by the fact that they also are to be electrically lighted from behind at night. The contract placed with Messrs. O. C. Hawkes involves the use of about 70,000 sq. ft. of plate glass and considerable ironwork and electrical equipment.

BUSINESS NOTICES.

Messrs Crompton & Co. (Ltd.) are moving their offices to a larger and more convenient suite on the first floor of their present building at Salisbury House, London Wall, E.C. The entrance will be in the main corridor, which is accessible from either London Wall or Finsbury-circus. The company's telephone numbers (488 and 14,802 Central, 1,959 London Wall; trunk calls T.S. 86 London) will not be altered

Arc Lamps (Ltd.) have now removed their works from Camden Town to their specially-built factory at St. Albans. Clients can secure spares from Messrs. Frampton & Paine, 29, Old Queen-street, Westminster (sole selling agents of the company for London and the South of England), where a stock of carbons, globes and other spare parts is kept.

Messrs. Pooley & Austin, 25, Victoria-street, London, S.W., have been appointed sole agents in London and the Home Counties for Engineering Instruments (Ltd.), manufacturers of totally enclosed motor control gear for d.c. and a.c.

The Leeds offices of Messrs. C. A. Parsons & Co. have been removed to 65, Prudential-buildings, Park-row, Leeds. The telegraphic address (Turbo Leeds) and the telephone number (1194) remain as before.

Correction—In the note given in our last issue (p. 390) in regard to the change of address of Messrs. L. E. Wilson & Co., we stated that their telephone number was 67 Central Liverpool. This should have been 87 Central.

Sales by Auction.—Messrs. Fuller, Horsey, Sons & Cassell have been instructed to offer for sale by auction at the Copper Wire Works, Queenborough, Kent, on Tuesday, July 7, the remaining plant and machinery, including low-tension generating set (Parker dynamo direct-coupled to Willans 350 I.H.P. triple-expansion engine), a 22 kw. 220 volt dynamo, five c.c. motors (from 5 H.P. to 12 H.P.), a Belliss 60 H.P.-90 H.P. compound steam engine, two Robey vertical engines, two Davey-Paxman Economical steam boilers, two Weir steam pumps, forced draught fan and engine, pair-rod rolls, five pair copper wire draw benches, two electric welding machines, two two screw-cutting lathes, drilling machine, switchboards, 15 arc lamps, &c.; also the extensive corrugated iron and steel buildings forming the main factory, a corrugated iron bungalow, steel chimney shaft and various outbuildings, &c. May be viewed by orders to be obtained of the auctioneers, 11, Billiter-square, E.C. Catalogues can be obtained of Messrs. Bennett & Ferris, solicitors, 68, Coleman-street, E.C., Mr. L. W. Chance (receiver), 1, Old Broad street, E.C., and of the auctioneers. Further particulars are given in an advertisement.

By order of the Lords Commissioners of the Admiralty, Messrs. Fuller, Horsey, Sons & Cassell will include in their sale at H.M. Dockyard, Portsmouth, on July 14 and following day, 100 tons old brass tubes and scrap metal, 40 tons scrap white metal, 17 tons foundry ashes, 22 tons old lead and zinc ashes and bottoms, 1,200 tons mild steel and iron scrap, 70 tons old wire rod, 60 tons electric cable, electrical gear and stores, eight lathes, five cranes, 16 steam engines (various), 19 air compressors, pumps, lamps and lanterns, vices, loose tools, &c. On view three working days prior to and on mornings of sale. Catalogues (6d. each) may be had at the Dock-

yard and of the auctioneers, 11, Billiter-square, E.C. See also an advertisement

For Sale.—An 8 H.P. gas engine, with accessories, also ½ ton tees, bends and reducing sockets, two lathes, &c., are advertised for sale.

Patent Exploitation.—The patentee (Mr. H. G. Osburn) under British Letters Patent No. 11,597 of 1900 and No. 20,129 of 1901, for flexible conduits for conductors, &c., desires to license British manufacturers to work the patents, or propositions for the sale of the patent rights would be considered. Applications to Messrs. Boult, Wade & Tennant, chartered patent agents, 111 and 112, Hatton-garden, London, E.C. See also advertisements.

Partner Wanted.—A partner is wanted in a small electrical manufacturing business, to bring in at least £2,000 for developing several patents. See an advertisement.

The "Journal." Part 189 of the "Journal" of the Institution of Electrical Engineers is now ready, price 5s. Particulars of contents are given in an advertisement.

CATALOGUES, &c.

Simplex Lighting, Heating and Cooking Specialties.—We have received a new catalogue of electric lighting, heating and cooking material, &c., from Simplex Conduits (Ltd.), and it is an artistic production. One almost wishes it were cold again, so that we could have one of these beautiful stoves in our office. At first sight it would not appear that an egg boiler would lend itself easily to æsthetic development, but a glance at the Simplex catalogue will disabuse scoffers of this notion. In this connection it is particularly requested that the trade will not take the fittings and cooking and heating appliances shown in the catalogue as the limit of the Simplex Co.'s capacity in regard to these goods.

"Pick Quick" Calculators.—The majority of colliery managers are familiar with the monthly data cards, the feature of the publicity campaign of Messrs. Mavor & Coulson for some time past. These relate to the performance of the Pick Quick electric coal-cutting machines under varying operating conditions, and have been prepared with an eye to furnishing the data in as compact a manner as possible. These data cards are now collected in pamphlet form, and we have received copies of the first three pamphlets which have been furnished with striking covers. The matter has been tastefully arranged from the printers' point of view, and the three yellow books will certainly be retained for reference.

Publicity Pamphlets.—Marylebone electricity supply department send us a selection of the literature which they use from time to time with the view of encouraging users of electrical energy for light, heat and power. So far 12 publications have been issued, and these vary from a single leaflet to an artistic booklet of a number of illustrated pages. The main object appears to be the creation of general interest which may be followed up by the blandishments of personal solicitation. The publications are in every way creditable products, while from a literary point of view they leave nothing to be desired. We must compliment Mr. F. A. Wilkinson, the electrical engineer and manager, and Mr. F. A. Davis, commercial engineer, on their enterprise in the preparation and distribution of these pamphlets.

Carbon Brushes.—Messrs. Wm. Geipel & Co., Vulcan Works, St. Thomas'-street, London, S.E., are issuing a circular dealing with Henrion graphitic carbon brushes, arc lamp carbons and incandescent lamps.

Aluminium.—We have received from the British Aluminium Co., 109, Queen Victoria-street, London, E.C., two pamphlets dealing with their manufactures. One is entitled "Aluminium: Its Present and Future Uses," and, after a sketch of the rise of the aluminium industry, some particulars are given of the company's factories and works, and chapters are devoted to an advocacy of the use of aluminium for electrical and general purposes. The second pamphlet, on "Aluminium v. Copper for Electrical Conductors," contains a number of tables and statistics relating to the use of aluminium, including a table of comparisons between copper and aluminium as used for electrical purposes, a table of comparative costs, a report by the National Physical Laboratory upon samples of hard and soft aluminium wire, methods of jointing aluminium conductors, &c.

Electro-Medical Apparatus.—From the Sanitas Electrical Co., 61, New Cavendish street, London, W., we have to acknowledge a very complete catalogue and price list of electro-medical and allied apparatus. The book contains some 350 pages with numerous illustrations. The first 100 pages are devoted to X-ray and high-frequency apparatus. Illustrations and descriptions are given of different types of interrupters, a new range of spark coils, the latest developments in focus tubes and approved appliances for protecting operator and patient from the rays. A motor mercury interrupter (the "Sanax" interrupter), which has just been placed on the market, is described for the first time. The following 50 pages are devoted to various patterns of electric light baths, static machines, nebulisers, hydro-electric baths, electro-magnets and lamps for the Finsen treatment of lupus and all skin diseases, including the popular Finsen Reyn lamp and the new quartz mercury vapour lamp. The next section (also about 50 pages) is devoted to the Schnee four-cell bath. Not only is the apparatus itself described, but some interesting reading matter relating to the application of the different currents by Schnee's method is provided. Then a section is devoted to a description of apparatus utilising current from ordinary electric light mains for a variety of purposes. One machine particularly worthy of notice is the "Multostat" universal apparatus providing galvanic, sinusoidal and galvano-sinusoidal currents, cautery and light in the one compact machine, the motor transformer of which may be used for working vibrators, surgical drills, pumps, centrifuges, &c. A number of miscellaneous appliances are also included in the catalogue, which is nicely got up and should be in the hands of every practitioner.

BANKRUPTCIES, LIQUIDATIONS, &c.

Fras. Benj. Egginton, electrical engineer and contractor, 11, Tempest-street, Wolverhampton, has been adjudicated bankrupt. First meeting of creditors July 2 at the O.R.'s, Wolverhampton, and the public examination on July 22 at the County Court, Wolverhampton.

A meeting will be held on July 23 at 27, Brazennose-street, Manchester, to receive an account of the winding up of the Electro-Medical Institute (Ltd.)

A meeting will be held at 120, Bishopsgate-street-within, London, E.C., on July 21, to receive an account of the winding up of the Rand Electric Works (Ltd.)

COMPANIES' MEETINGS AND REPORTS.

BRITISH ELECTRIC TRACTION CO. (LTD.)—The Chairman (Sir C. Rivers Wilson) stated at the meeting yesterday (Thursday) that, in the directors' opinion, the fall in the market value of their debentures and shares, was much greater than the circumstances called for, for they had a surplus in assets of £3[illegible],000. The net profit was £203,194, and after adding the balance forward there remained £118,824. The directors were able to add £35,000 to general reserve, and after applying £48,438 to payment of preference dividend, equal to 3 per cent. for the year, there remained £35 393 to be carried forward. The company stood upon a sound foundation and its liabilities were small. The company's undertakings had been well established. They were not over capitalised and were well managed, yet they had not been so successful as anticipated. The reason was in their environment. They had a large interest in British electrical engineering companies, but English electrical manufacturers, unlike those on the Continent, were not prosperous. Personally he was sanguine of the future of the industry and of the company.

BUENOS AYRES ELECTRIC TRAMWAYS CO. (1901) (LTD.)—The report for the 15 months ended March 31 states that after allowing for debenture interest and transferring £2,530 to sinking funds for redemption of debenture stock, and deducting credit balance brought forward (£2,639), there is a debit balance of £1,931 to be carried forward, and when this balance has been wiped out depreciation of rolling stock, plant, &c., will be duly provided for.

ELECTRICITY SUPPLY CO. FOR SPAIN (LTD.)—The report for 1907 states that after deducting £11,138 for debenture interest and expenses, and £2,148 for administration expenses and income-tax in England, the profit was £26,656, which, in addition to the debenture sinking fund of £46,520 and the credit balance of profit and loss account at Dec. 31, 1906, £12,034, have been applied in writing down the company's assets in Madrid.

GLOBE TELEGRAPH & TRUST CO. (LTD.)—The net revenue for the year ended May 31, after deduction of expenses amounts to £210,294. 15s. 9d., or with £26,565. 12s. 6d. brought forward, £236,860. 8s. 3d. From this there has been distributed £131,769. 10s. 7d. in interim dividends, leaving available £105,090. 17s. 8d. The directors now recommend the following final dividends: 3s. per share (less tax) on the preference shares, making 6 per cent. for the year (less tax), and 5s. 9d. per share net on the ordinary shares, making 5¾ per cent. net for the year. These dividends will absorb £77,884. 12s. 3d. and leave £27,206. 5s. 5d. to be carried forward.

GREENWOOD & BATLEY (LTD.)—The directors' report for the 12 months ended March 31 states that, after providing for debenture interest and expenses of management and making provision for doubtful debts, the profit was £23,695. 9s. 1d., which, with £654. 3s. brought forward, makes £24,349. 12s. 1d. £5,000 has been written off for depreciation, and the directors recommend that dividends for the year ended March 31 last be declared of 7 per cent. on the paid-up cumulative preference shares and of 4 per cent. on the paid-up ordinary shares, absorbing £13,896. 2s., leaving £5,451. 10s. 1d. to be carried forward.

LEAMINGTON & WARWICK ELECTRICAL CO. (LTD.)—The report for 1907 states that the capital expenditure during the year amounted to £2,293, of which £426 was incurred in the reconstruction and equipment of the electric tramways and £1,886 in connection with the electricity supply station. The amount owing to the British Electric Traction Co. for advances in connection with the reconstruction and equipment of the tramways and power station, &c., is £28,233, which it is proposed to repay as soon as arrangements have been made for issuing a portion of the authorised debenture stock. In the meantime interest at the rate of 4½ per cent. is being paid on the loan. The

accounts show a net credit balance of £4,731 from tramways and electricity supply, and sundry receipts amount to £68. Deducting administration and general expenses (£1,421), interest on loans (£662) and provision for renewals (£350), there remains a balance of £2,356, which, with £1,257 brought forward, is available for distribution. The directors recommend £300 being placed to depreciation and reserve and £350 to sinking fund and to pay a dividend of 4 per cent on the ordinary shares for the year, leaving £139 to be carried forward.

MONTREAL LIGHT, HEAT & POWER CO.—The report for the year ended April 30 shows gross earnings $3,792,218, operating expenses, renewals, &c., $1,651,656, leaving net earnings $2,140,562. Fixed charges absorbed $493,095, leaving net profits $1,647,466. Deducting dividends (1,120,000) there remains $627,467, which with surplus earnings from previous years brings the total to $1,732,314. Appropriations aggregating $318,422 have been made (depreciation $268,422, insurance $50,000).

WESTERN UNION TELEGRAPH CO.—The report for the quarter ended June 30 shows that the surplus at Jan 1 was $14,077,080.88, the net revenue during the quarter ended March 31 was $1,330,886.11. Dividend of 1¼ per cent. (paid April 15) required $1,230,100.00 and interest on bonded debt $433,062.50, leaving surplus on March 31 of $13,744,804.49. The net revenue of quarter ended June 30, based upon nearly completed returns for April, partial returns for May and estimating the business for June, will be about $1,400,000.00, and after deducting interest on bonded debt ($433,062.50) and amount required for dividend of ½ per cent. ($437,550.00) there will be a surplus of $14,214,191.99, and the committee recommend that a dividend of ½ per cent. be paid on and after July 15.

J. G. WHITE & CO. (LTD.)—The annual report of the directors to Feb. 29 last states that the business has continued to be satisfactory, and the year's trading shows a net profit of £36,162. 2s. 2d. Profit has only been taken into the accounts on work actually completed at date of balance-sheet. Included in the completed works was the Luton tramway system now being operated successfully by the company under a leasing agreement. The company is actively carrying out work in Buenos Ayres, Montevideo, Para (Brazil), Dumbarton and at other places. Since the date of the balance sheet contracts have been secured for an electricity supply installation at Arbroath, for the supervision of tramway works in Santos (Brazil) and for other tramway construction. Various negotiations are in progress which, it is hoped, will lead to additional business of considerable magnitude, both at home and abroad, and the directors look upon the company's position, in view of the severe competition and financial stringency which has existed in businesses of this nature, as being satisfactory. The Building Company, in which the company has an interest, has also shown satisfactory progress. Investments are shown in the balance-sheet at the usual conservative valuation, which should provide for a profit on realisation. Since the date of the balance-sheet securities valued at £24,752 have been sold at a profit, which will come into the current year's accounts, leaving £119,495. 18s. 5d. as the valuation of the remaining securities. The average yield in interest and dividends during the year was equal to a percentage of 6¼ per cent. on the amount of the valuation. The balance to credit of profit and loss account, after bringing in £18,311. 12s. 5d. from previous account, deducting interim preference dividend paid, and making provision for percentages due to directors and staff, is £47,749. 2s. 10d. The directors recommend the payment of the 6 per cent. cumulative preference dividend (tax free) for the half-year to Feb. 29 (£4,500), a dividend (tax free) of 6 per cent. on the ordinary shares for the year to Feb. 29 (£3 000), and a bonus of 2 per cent. on the preferred and ordinary shares, making 8 per cent. for the year (£4,000), placing £20,000 to reserve and leaving £16,249. 2s. 10d. to be carried forward.

NEW COMPANIES, MORTGAGES AND CHARGES.

NEW COMPANIES.

BOURNE END ELECTRIC INSTALLATION CO. (LTD.) (98,428.)—Reg. June 1[illegible], capital [illegible] £1 shares [illegible] Bourne End, Bucks. [illegible]

PAIGNTON ELECTRIC LIGHT & POWER CO. (LTD.) (98,437.)—Reg. June [illegible] £1 shares [illegible] J. A. [illegible], D.Sc., and W. T. [illegible] the Western Electricity Corporation [illegible] 1907 in respect of the Urban District of Paignton [illegible] supply of electricity. First directors: [illegible] Paignton.

REVY, PHILLIPS & CO. (LTD.) (98,421.)—Reg. June 18, capital [illegible] Revy, Phillips & Co. [illegible] Victoria-street, London, E.C.

MORTGAGES AND CHARGES.

MARCONI INTERNATIONAL MARINE COMMUNICATION CO. (LTD.)—[illegible] June 11, 1908 [illegible]

CITY NOTES.

MEMORANDA (June 25).—Bank rate 2½ per cent. (May 28, 1908). Price of silver, 25¼d. per oz. Consols 87$\frac{11}{16}$—87$\frac{13}{16}$ for money and 87$\frac{13}{16}$—87$\frac{15}{16}$ account. Consols Pay Day, July 1; Stock and Shares Continuation Days, July 13 and 28; Ticket Day, July 14; Pay Days, June 26 and July 15; Mining Share carry-over Day, July 10.

PRICES OF METALS (London).—*Copper*, cash, 57⅛—57⅜; three months, 57⅞—58⅛. *Lead*, English, 13—13¼; foreign, 12⅝—13. *Spelter*, foreign, 18⅞—19⅛. *Tin*, English, 126—127; foreign, cash, 125⅛—125⅝, three months, 126⅛—126⅝. *Iron*, Cleveland, cash, 50/9—51/0; three months, 49/7½—49/10½.

BRUCE PEEBLES & CO. (LTD.) (IN LIQUIDATION).—Notice is given that the Court of Session, Edinburgh, has directed separate meetings of (1) debenture-holders, (2) creditors other than debenture-holders, (3) holders of preference shares, and (4) holders of ordinary shares in this company to be convened for the purpose of considering and approving a scheme of arrangement of which all parties interested have received a copy. The meetings will be held at Dowell's Rooms, 18, George-street, Edinburgh, on Friday, July 10, at 10:30, 11, 11:30, and 12 o'clock respectively. We have already referred to this scheme (*The Electrician*, June 5, p. 314), and briefly outlined the scheme to be submitted to the meetings which provides that a new company shall be formed with a capital of £250,000 in £1 shares. This new company will take over all assets and liabilities of the old company. The directors are to be Messrs. C. H. M'Euen (Callender's Co.), M. B. Mountain (Mountain & Gibson), A. Mackenzie (Mackenzie & Moneur) and F. E. Andrews (Brush Co.), one director to be nominated by the liquidators, and one director to be nominated by the debenture-holders of the old company. Under the scheme referred to (1) Present debenture-holders are to receive first debentures in the new company for the present amount of their holding (£75,000). These first debentures are repayable in 10 years (July 1, 1918), and are secured, by Scots Law, on the heritable property and fixed machinery, but form no charge on the movable plant, book debts, and other loose assets. The debentures carry interest at 5 per cent., as at present, and a sinking fund of 2 per cent. has to be set aside for their redemption, and one-third of the surplus profits, after payment of a dividend of 6 per cent. per annum on the issued capital, is also to be set aside for this purpose. (2) Creditors are to receive in respect of their admitted claims 7s. 6d. in the £ in the form of a second debenture, carrying interest at 6 per cent., and 12s. 6d. in the £ in ordinary shares of the new company credited as fully paid. The second debentures are repayable, either wholly or in part, at any time at 14 days' notice, and, in any event, in 10 years from date of issue. Creditors for under £10 may, if they choose, receive a composition of 5s. in the £, payable in cash in three months from date of allotment of capital of the new company, instead of debentures and shares as above set out. (3) Preference shareholders are to be allotted three ordinary shares of £1 each in the new company, credited as 13s. 4d. paid up, for each £5 preference share held, and the balance of 6s. 8d. per share (equal to £1 per share of the old company) will be called up in cash. (4) Ordinary shareholders are to be allotted one new ordinary share of £1 (credited as 10s. paid up) for each £5 ordinary share held, and the balance of 10s. per share will be called up in cash. It may be added that unless the scheme, after its approval at the meetings to be held on July 10, is adopted by the new company within six weeks after it is sanctioned by the Court of Session, the liquidators may, with the sanction of the Court, declare the scheme to have fallen through.

It is stated that considerable economies have been effected by the joint liquidators during their period of office, and there is every reason to believe that the business should, in a comparatively short time, regain its place in the electrical industry and become a prosperous concern.

DURHAM COLLIERIES ELECTRIC POWER CO. (LTD.)—At an extraordinary meeting on Wednesday the amendment of the articles of association agreed upon at a previous meeting was confirmed.

HOBART ELECTRIC TRAMWAY CO. (LTD.) The directors have declared a divided of 1s. per share, tax free.

PROVINCIAL TRAMWAYS CO.—An interim dividend of 3s. per share upon the ordinary shares in respect of the year ending Sept. 30 next has been declared.

STOCK EXCHANGE NOTICES.—The Stock Exchange committee have appointed July 1 a special settling day in provisional certificates for a further issue of 50 000 £5 ordinary shares issued at £6, fully and partly [illegible] Quotations have also been granted to [illegible]

VICTORIA FALLS POWER CO. Mr. Arthur E. Hadley has joined the board of the company. Mr. Hadley is a director of the [illegible] and joint general manager of the Electrical Co.

ELECTRIC TRAMWAY AND RAILWAY TRAFFIC RECEIPTS.

Line	Week ended.	Amount.	Inc. or Dec. (a)	Aggregate No. of weeks.	Amount.	Inc. or Dec. (a)
		£	£		£	£
Aberdeen Corporation	June 17	1,417	− 96	3	3,742	− 195
Airdrie	,, 12	225	− 8	23	5,175	+ 51
Anglo-Argentine	,, 17	17,760	+ 1,558	24	414,747	+ 48,218
Ayr Corporation	,, 20	355	+ 24	5	1,556	− 67
Baker St. & Waterloo Ry.	,, 20	3,010	+ 180	25	76,395	+ 16,859
Barnsley	,, 12	226	+ 53	23	4,023	+ 293
Barrow	,, 12	319	+ 46	23	5,292	− 65
Bath Electric Trams, Ltd.	,, 17	748	− 62	24	16,144	− 1,366
Birkenhead Corporation	,, 21	1,074	+ 40	...	...	...
Birmingham Corporation	,, 20	6,138	+ 112	12	75,151	+ 4,031
Birmingham & Mid	,, 5	813	+ 74	22	17,788	+ 553
Blackburn Corporation	...	...	...	...	...	...
Blackpool Corporation	,, 18	1,597	+ 763	§11	10,291	+ 417
Blackpool and Fleetwood	,, 20	831	+ 243	...	...	...
Bolton Corporation	,, 21	2,478	+ 192	12	28,286	+ 1,247
Bombay	May 28	R34,525	+ R7,736	21	R[illegible]	+ R[illegible]
Bournemouth Corporation	June 17	1,539	+ 6	11	18,318	− 195
Bradford Corporation	,, 20	4,537	− 107	12	55,650	+ 190
Brighton Corporation	,, 21	900	+ 9	12	10,201	+ 110
Bristol Trams & Carriage	,, 13	4,787	− 220	30	115,286	− 2,217
Buenos Ayres & Belgrano	,, 17	3,495	− 151	24	91,207	+ 475
Burnley Corporation	,, 20	1,150	− 68	12	15,410	+ 171
Burton Corporation	,, 21	257	− 19	12	3,174	− 241
Bury Corporation	,, 14	1,375	+ 311	¶11	13,079	+ 1,356
Calcutta Tramways Co.	,, 20	R34,546	− R10,786	...	...	...
Camborne Redruth	,, 20	143	+ 26	25	3,072	+ 208
Cardiff Corporation	...	...	...	...	...	...
Cavehill	,, 12	108	+ 26	23	1,887	+ 182
Central London Railway	,, 20	7,091	+ 1,625	25	154,758	+ 3,140
Charing Cross, Euston & H'stead	,, 20	3,240	...	25	81,010	...
Chatham & Dist. Lt. Rys.	,, 16	819	+ 14	§24	17,109	+ 429
City & South London Rly.	,, 21	3,101	− 124	25	80,547	+ 6,036
City of Birmingham	,, 12	3,283	+ 352	23	64,125	+ 413
Colchester Corporation	,, 16	302	+ 96	...	...	...
Cork Electric Trams Co.	,, 18	489	− 32	§24	10,378	− 416
Croydon Corporation	,, 19	1,463	− 13	12	16,996	+ 86
Devonport & Dist. Trams	,, 12	552	+ 121	23	10,230	+ 28
Dover Corporation	,, 13	252	+ 34	11	2,232	− 168
Dublin & Lucan Railway	,, 19	136	− 2	25	2,769	+ 130
Dublin United	,, 19	5,420	− 1,087	25	122,740	− 2,745
Dudley Stourbridge	,, 12	1,479	+ 622	23	18,314	− 1,094
Dundee Corporation	,, 17	1,197	+ 57	15	5,842	+ 518
East Ham Council	,, 20	876	− 83	12	10,093	− 578
Gateshead & Dist. Trams	,, 12	1,100	+ 97	23	22,986	+ 211
Glasgow Corporation	,, 20	18,082	− 406	3	51,609	− 5,016
Glossop	,, 20	123	− 2	24	3,051	− 179
Gravesend – Northfleet	,, 12	297	+ 47	23	4,611	− 679
Great Northern & City Rly.	,, 20	1,486	− 250	25	42,314	− 3,123
Gt. Northern, Piccadilly, &c	,, 20	5,440	+ 1,230	25	135,380	+ 37,141
Greenock & Port Glasgow	,, 12	548	− 150	23	11,581	− 3,165
Hartlepool Tramways	,, 12	335	+ 21	23	5,107	− 970
Hastings Elec. Trams Co.	,, 18	1,014	+ 4	25	21,626	− 324
Hong Kong	,, 20	$6,647	− $692	...	...	...
Huddersfield Corpn.	,, 20	1,580	− 26	12	19,567	+ 650
Hull Corporation	,, 20	2,382	− 1	12	28,505	− 67
Ilkeston District Council	,, 17	124	− 19	11	1,591	+ 41
Ipswich Corporation	,, 20	396	− 23	12	4,491	− 31
Isle of Thanet Co.	,, 20	697	− 64	35	12,023	− 370
Jarrow	,, 12	130	+ 5	23	2,328	− 344
Keighley Corporation	,, 18	148	− 21	51	8,083	+ 359
Kidderminster & District	,, 12	260	+ 143	23	2,269	− 129
Kilmarnock Corporation	,, 20	151	+ 2	5	803	− 91
Lanarkshire Trams Co.	,, 18	1,282	+ 97	24	30,797	+ 3,650
Lancashire United	,, 17	1,518	+ 277	24	30,653	+ 1,188
Leamington	,, 12	319	+ 161	23	3,487	+ 133
Leeds Corporation	,, 20	6,392	...	12	76,761	+ 2,134
Leicester Corporation	,, 20	2,301	− 132	...	...	...
Leith Corporation	,, 13	522	− 26	§4	2,255	− 121
Lincoln Corporation	,, 20	110	− 2	12	1,422	+ 62
Liverpool Corporation	,, 13	11,672	+ 511	24	250,288	− 1,713
Liverpool Overhead Rly.	,, 21	1,424	− 102	25	25,131	− 808
London County Council	,, 13	39,378	+ 1,219	¶11	361,883	+ 37,526
London United	,, 20	7,413	− 115	24	151,014	+ 2,690
Lowestoft	,, 20	207	+ 6	38	6,163	+ 204
Maidstone Corporation	,, 13	280	...	11	2,078	...
Manchester Corporation	,, 20	15,191	+ 421	12	177,339	+ 8,238
Mersey Railway	,, 20	1,998	− 69	25	48,041	+ 1,674
Merthyr	,, 12	203	+ 93	23	4,830	+ 85
Metropolitan Dist. Railway	,, 20	9,379	+ 1,386	25	223,240	+ 23,894
Metropolitan Elec. Trams	,, 12	8,177	+ 3,043	23	123,161	+ 24,989
Middleton	,, 12	532	+ 144	23	7,932	+ 52
Nelson Corporation	,, 20	136	− 10	¶11	1,688	− 126
Newcastle-on-Tyne Corp.	,, 20	3,701	− 347	12	44,015	− 4,422
Newport (Mon.)	,, 20	634	+ 5	12	8,989	− 889
Northampton Corporation	,, 19	449	+ 24	¶11	5,405	+ 307
Oldham, Ashton & Hyde	,, 12	701	+ 76	23	13,662	− 33
Oldham Corporation	,, 21	2,118	+ 216	13	25,430	+ 517
Perth (N.B.) Corporation	,, 17	147	− 5	5	726	− 29
Perth (W.A.) Elec. Trams	,, 19	1,258	− 95	¶25	34,967	− 917
Peterborough	,, 12	193	+ 71	23	2,677	+ 37
Portsmouth Corporation	,, 20	1,996	+ 3	12	22,639	− 87
Potteries	,, 12	2,021	+ 110	23	42,340	+ 18
Preston Corporation	,, 17	722	− 38	25	17,551	− 130
Rotherham Corporation	,, 18	589	− 28	§11	7,049	+ 166
Rothesay	,, 12	246	+ 26	23	2,303	− 121
Salford Corpn.	,, 22	4,696	+ 116	12	56,907	+ 138
Sheerness	,, 10	75	+ 15	23	1,197	− 4
Sheffield Corporation	,, 21	5,558	− 266	†13	71,364	− 242
Singapore Trams	,, 20	$8,754	− $401	...	...	...
South Metropolitan	,, 12	1,258	+ 426	23	17,290	+ 429
South Staffs	,, 12	1,294	+ 413	23	20,374	− 108
Southend Corporation	,, 17	432	+ 48	12	4,283	+ 205
Southport Tramways	,, 12	520	+ 206	23	5,701	− 371
Stalybridge, Hyde, &c., Jt. Bd.	,, 20	791	+ 6	†12	9,239	− 86
Sunderland Corporation	,, 21	1,159	− 314	12	13,641	− 2,910
Sunderland and District	,, 17	142	− 3	33	15,217	+ 1,397
Swansea Trams	,, 12	1,289	+ 389	23	20,063	+ 1,578
Swindon Corporation	,, 17	138	− 21	...	...	...
Taunton	,, 12	53	+ 10	23	903	− 31
Tynemouth and District	,, 12	420	+ 154	23	3,939	− 362
Tyneside Trams Co.	,, 17	382	− 48	25	9,036	− 1,198
Wallasey District Council	,, 20	949	+ 63	†12	10,350	+ 516
Walsall Corpn.	,, 20	492	− 6	25	13,085	+ 1,325
Warrington Corpn.	,, 18	360	− 33	11	4,283	+ 36
West Ham Corporation	,, 18	2,146	− 183	12	26,719	+ 4,129
Weston-super-Mare	,, 10	386	+ 269	23	1,478	− 160
Wolverhampton Co.	,, 12	798	+ 333	23	10,558	− 135
Wolverhampton Corpn.	,, 17	783	− 50	2	2,117	...
* Worcester	,, 12	432	+ 134	23	5,383	+ 9
Wrexham	,, 12	141	+ 44	23	2,281	+ 21
Yorkshire W.R. Trams	,, 21	1,205	+ 36	25	29,388	...
Yorkshire Woollen District	,, 12	1,170	+ 134	23	20,936	− 769

(a) The comparisons are with the corresponding period last year. § Plus 2 days.
¶ Plus 3 days. * Partly electrical. † Minus 3 days. ‡ Minus 2 days.

ELECTRICAL COMPANIES' SHARE LIST.

Share	Last Dividend	Name	Price Wed June 24	Rate Yield	Dividend Due	Business Week to June 24 Highest	Lowest
		ELECTRICITY SUPPLY.		£ s. d.			
10	9 0	Bournemouth & Poole Elec. Sup. Ord.	10½ −11	6 7 0	Mar, Sept	10½	..
10	4 6	Do. 4½ per Cent. Cum. Pref.	9½ −10½	4 7 0	Feb, Aug	10¼	..
10	6 0	Do. 6 per Cent. Cum. Second Pref.	10½ −11½	5 11 6	Feb, Aug		
St.	4½	Do. 4½ per Cent. Deb. Stock (red.)	102 −105	4 5 6	Jan, July	..	..
5	3 6	Bromley (Kent) El. Lt. & Power Shares	4½ −5	5 10 0	April, Oct	..	..
St.	4½	Do. Do. 1st Debs.	94 −97	4 12 9	May, Nov	..	..
5	5 6	Brompton & Kensington Elec. Sup. Ord.	[illegible]	[illegible]	March....	..	..
5	3 6	Do. 7 per Cent. Pref.	6⅞ −7⅞	4 10 0	Mar, Sept	7	7
St.	4%	Central Elec. Sup. Co. 4% Guar. Db. Stock	98 −101	4 0 0	June, Dec	..	..
5	2 6	Charing Cross (W. End & City) E. Sup. Co.	[illegible]	5 1 0	Feb, Aug	4	..
5	2 3	Do. 4½ per Cent. Pref.	4¼ −4¾	4 17 0	Feb, Aug	4½	..
St.	4%	† Do. 4 per Cent. Deb. Stock (red.)	95 −98	4 2 0	Jan, July	..	..
5	2 3	Do. City Undertaking 4½ Cum. Pref.	3⅞ −4⅜	5 3 0	Jan, July	..	..
5	2/8	Chelsea Electric Supply Ord.	3 −3½	6 8 9	March ..	..	..
St.	4½	* Do. 4½ per Cent. Deb. Stock (red.)	101 −104	[illegible]	June, Dec	..	..
10	7 0	City of London Electric Lighting Ord.	[illegible]	5 16 6	Feb, Aug	..	..
10	6 0	Do. 6 per Cent. Cum. Pref.	12 −13	4 12 0	Jan, July	..	..
St.	5	Do. 5 per Cent. Deb. Stock (red.)	124 −127	3 18 0	June, Dec	..	..
St.	4½	Do. 4½ per Cent. 2nd Deb. Stock (red.)	102 −105	[illegible]	Jan, July	..	..
5	[illegible]	County of Durham Elec. P.D. Ord.	[illegible]	[illegible]	April, Oct	..	..
5	[illegible]	Do. 5 per Cent. Non-Cum. Pref.	3⅝ −3⅞	6 13 4	April, Oct	..	..
10	[illegible]	County of London Elec. Supply Ord.	7½ −8½	[illegible]	Feb, Aug	..	..
10	6 0	Do. 6 per Cent. Cum. Pref.	11½ −12½	5 10 0	Mar, Sept	..	..
St.	4½	Do. 4½% Deb. Stock (all paid) (red.)	107 −110	4 2 6	Jan, July	108	..
St.	4½	Do. Second Deb. Stock	98 −101	4 9 9	May, Nov	[illegible]	[illegible]
5	3 6	Folkestone Electricity Supply Co. Ord.	[illegible]	5 7 0	April, Oct	..	—
5	2 6	Do. 5 per Cent. Cum. Pref.	[illegible]	4 11 0	Mar, Sept	..	..
St.	4½	Do. 4½ 1st Deb. Stock (red)	94 −97	4 13 0	Feb, Aug	..	..
5	4 8	Hove Electric Lighting Ord.	6 −6½	6 11 0	April, Oct	..	..
5	5 0	Kensington & Knightsbridge Ord.	7 −8	6 5 0	Feb, Aug	..	..
5	6	Do. 6 per Cent. 1st Pref.	6 −6½	4 12 0	Jan, July	..	—
St.	4	Do. 4 per Cent. Deb. Stock (red.)	96 −99	4 1 0	..	..	..
St.	4	Kensingtn. & Kngtlsg. Co. & Notting Hill Co. (Joint Station) 4% Deb. Stock (red.)	97 −101	3 19 0	April, Oct	..	..
St.	4½	Kent Elec. Power Co.	88 −92	4 18 3	Jan, July	..	..
3	1 6	London Electric Supply Ord.	2 −2½	5 8 0	Mar, Sept	1	..
5	3 0	Do. 6 per Cent. Pref.	4½ −4¾	6 6 9	Mar, Sept	..	..
St.	4%	† Do. 4 per Cent. 1st Mort. Deb.	89 −92	4 7 0	Jan, July	..	..
5	3 6	Metropolitan Electric Sup. Ord.	4½ −5	6 10 0	April, Oct	4¾	4½
5	2 3	Do. 4½ per Cent. Cum. Pref.	4½ −5	4 10 0	Jan, July	..	..
St.	4½	Do. 4½ per Cent. Deb. Stock 1st Mort.	107 −111	4 1 0	June, Dec	..	..
St.	3½	Do. 3½ per Cent. Mrt. Deb. Stock (red.)	85 −90	3 18 0	Jan, July	..	..
100	4½	Midland Elec. Corp. for P.D. 1st Mort. Db.	96 −99	4 11 0	June, Dec	..	..
10	4	Newcastle & Dist. Elec. Ltg. Ord.	7½ −8½	5 0 0	Feb, Aug	..	—
100	4½	Do. 4½ per Cent. Deb.	95 −98	4 12 9	Jan, July	..	..
5	8%	Newcastle Elec. Supply Ord.	[illegible]	6 19 2	Feb, Aug	..	..
5	5	Do. 5 per Cent. non Cum. Pref.	[illegible]	4 13 0	Feb, Aug	..	..
100	4%	Do. 4 per Cent. Mort. Deb. red. 1907.	97 −99	4 1 8	Jan, July	..	..
1	3	Northern Counties Elec. Sup.	..	..	Mar, Aug	..	..
100	4½	Do. 4½ per Cent. Deb.	95 −97	4 13 9	Jan, July	..	..
10	8 0	Notting Hill Electric Ord.	11½ −12½	5 11 6	March ..	12	..
5	4 6	Oxford Electric Ord.	[illegible]	5 12 0	March ..	..	..
St.	4	Do. 4 per Cent. Deb. Stock	94 −98	4 1 6	Jan, July	..	..
5	5 0	St. James' & Pall Mall Elec. Ord.	7½ −8½	6 1 3	Feb, Aug	[illegible]	7¾
5	3 6	Do. 7 per Cent. Pref.	[illegible]	4 16 3	Feb, Aug	..	..
St.	3½	Do. 3½ per Cent. Deb. Stock (red.)	85 −90	3 17 9	Jan, July	..	..
5	..	Smithfield Markets Electric Sup. Ord.	½ −¾	..	Feb	..	..
St.	4%	Do. 4 per Cent. Deb. Stock	70 −74	5 8 0	Feb, Aug	..	..
5	4 0	South London Electric Supply Ord.	[illegible]	7 6 0	April	..	..
1	0/6	South Metrop'n Elec. Lt. & Power Ord.	[illegible]	4 0 0	..	..	..
1	[illegible]	Do. 7 per Cent. Cum. Pref.	[illegible]	[illegible]	Feb, Aug	..	..
St.	4½	Do. 4½ 1st Db. Stk. Red.	99 −102	4 8 0	April, Oct	..	..
5	2/6	Urban Electric Supply Ord.	1 −2	12 10 0	April, Oct	..	..
5	2 6	Do. 5 per Cent. Cum. Pref.	[illegible]	10 12 0	April, Oct	..	..
St.	4½	Do. 4½ per Cent. 1st Mort. Deb.	87 −90	5 0 0	April, Oct	..	..
5	5 0	Westminster Elec. Sup. Ord.	7½ −8	6 5 0	Mar, Sept	7½	7
5	2/3	Do. 4½ per Cent. Cum. Pref.	[illegible]	4 4 0	Jan, July	[illegible]	..
		ELECTRIC RAILWAYS, TRAMWAYS, &c.					
St.	4%	Baker St. & Waterloo 4% Perp. Db. St.	90 −92	4 7 0	Jan, July	[illegible]	..
1	..	Bath Elec. Trams Pref. Ord.	¼ −½	8 0 0	April	..	—
1	0/6	Do. 5 per Cent. Cum. Pref.	[illegible]	5 14 0	Jan, July	..	..
St.	4½%	Do. 4½ 1st Mort. Deb. Stock (red.)	85 −90	5 0 0	April, Oct	..	..
St.	4½	B'ham. & Midland Trams 4½ 1st Db. Stk.	93 −96	4 15 0	Jan, July	..	..
10	9%	Bristol Tramways & Carriage Ord.	10 −10½	8 11 9	Feb, Aug	..	..
10	4%	Do. Cum. Pref. (fully paid)	[illegible]	4 14 0	..	..	..
St.	4%	Do. 4 per Cent. Debs.	[illegible]	4 0 0	Feb, Aug	..	..
10	..	British Electric Traction Ord.	[illegible]	..	June, Dec	1½	1
10	6/0	Do. 6 per Cent. Cum. Pref.	[illegible]	..	Feb, Aug	4	[illegible]
St.	5%	Do. 5 per Cent. Perpetual Debs.	92 −97	5 3 0	April, Oct	[illegible]	93
St.	4½%	Do. 4½ per Cent. 2nd Deb. Stock	75 −77	5 15 0	May, Nov	[illegible]	74½
St.	3%	Central London Ordinary Stock	77 −78	3 17 0	Feb, Aug	75	75
St.	4%	Do. 4 per Cent. Pref. Stock	90 −92	4 7 0	Feb, Aug	[illegible]	..
St.	2%	Do. Deferred Stock	56 −59	3 8 0	Feb	[illegible]	55
100	4%	Do. 4 per Cent. Debs.	103 −106	3 15 6	Jan, July	105	104
St.	4%	Charing X, Euston & Hmpstd Per Db. Stk.	82 −85	[illegible]	Jan, July	[illegible]	[illegible]
5	2/6	City of Birmingham Trams, 5% Cm. Pref.	[illegible]	5 5 0	April, Oct	..	..
100	4%	Do. 4 per Cent. 1st Mort. Debs.	97 −100	4 0 0	April, Oct	..	..
St.	1½%	City & South London Rly. Con. Ord.	[illegible]	[illegible]	Feb, Aug	..	..
St.	5%	Do. 5 per Cent. Perp. Pref. (1891)	113 −116	4 6 0	Feb, Aug	115	113½
St.	5%	Do. (1896)	112 −115	4 7 0	Feb, Aug	..	..
St.	5%	Do. (1901)	110 −113	4 8 6	Feb, Aug	..	..
St.	5%	Do. (1903)	[illegible] −108	4 12 6	Feb, Aug	..	..
St.	4%	Do. 4 per Cent. Perpetual Debs.	100 −103	3 17 6	May, Nov	101½	101½
10	7/0	Dublin United Trams. Ord.	[illegible]	4 10 6	Feb, Aug	..	..
10	6/0	Do. 6 per Cent. Pref.	[illegible]	4 9 0	Feb, Aug	..	—
10	..	Gt. Northern & City Rly. Pref. Ord.	[illegible]	..	Feb, Aug	..	..
10	4/0	G. Northern, Piccadilly & Brompton Ord.	[illegible]	6 3 0	Feb, Aug	..	..
St.	4%	Do. 4 per Cent. Deb. Stock	[illegible]	4 7 0	Jan, July	[illegible]	[illegible]
5	4/0	Hastings & Dist. Elec. Trams. Cum. Pf.	[illegible]	7 1 0	Mar, Sept	..	..
St.	4½%	Do. 4½ Deb. St.	[illegible]	5 15 9	April, Oct	..	..
10	9%	‡ Imperial Tramways Ord.	[illegible]	7 17 0	Mar, Sept	..	..
10	6%	‡ Do. 6 per Cent. Pref.	[illegible]	5 17 0	Mar, Sept	..	..
St.	4½%	‡ Do. 4½ per Cent. Debs.	[illegible]	4 15 9	Jan, July	..	..
5	..	Isle of Thanet E. T. & Lt. 5 per Cent. Pref.	[illegible]	..	Mar, Sept	..	..
St.	4%	Do. 4 per Cent. Deb. Stock	[illegible]	6 7 0	Jan, July	..	—
10	6/0	Lanarkshire Tramways	[illegible]	[illegible]	Feb, Aug	..	..
St.	5%	Lancs. Utd. Trams. & Power Co. Deb. St.	91 −94	5 6 0	Jan, July	..	..
10	..	Liverpool Overhead Railway Ord.	[illegible]	..	Feb, Aug	..	..
10	5	Do. 5 per Cent. Pref.	[illegible]	8 0 0	Feb, Aug	..	—
St.	4%	Do. 4 per Cent. Deb.	85 −87	4 11 0	Jan, July	..	—
10	5 0	London United Trams. 5% Cum. Pref.	[illegible]	6 2 0	Jan, July	8	7⅞
St.	4%	Do. 4 per Cent. 1st Mort. Deb. Stock	81 −86	4 13 0	Jan, July	..	..
St.	..	Mersey Con. Ord. Stock	[illegible]	..	Feb, Aug.	..	..
St.	..	Do. 3 per Cent. Perp. Pref.	8 −6	..	..	..	..
1	..	Metropolitan Elec. Tramways Def.	[illegible]	..	April..	..	..
1	0/6	Do. 5 per Cent. Cum. Pref.	[illegible]	6 3 6	Feb, Aug	..	..
St.	4½	Do. 4½ per Cent. Deb. Stock	95 −98	4 12 0	Jan, July	96½	96
St.	2	Metropolitan Railway Cons. Ord. Stock	33½ −34½	[illegible]	Feb, Aug	[illegible]	[illegible]
St.	2½	Do. Surplus Lands Stock	68 −70	3 10 0	Feb, Aug	..	..
St.	3	Do. 3½ per Cent. Preference	86 −89	3 19 9	Feb, Aug	[illegible]	[illegible]
St.	3½	Do. 3½ per Cent. "A" Preference	75 −78	4 9 6	Feb, Aug	79	75½
St.	3½	Do. 3 per Cent. Consolidated Pref.	73 −76	4 12 0	Feb, Aug	75	..
St.	3½	Do. 3 per Cent. Debenture Stock	91 −94	3 14 6	Jan, July	93	..
St.	3½	Do. 3 per Cent. "A" Debenture	89 −92	3 16 0	Jan, July	91	90

* In calculating the yield allowance has been made for accrued interest but *not* for redemption.
† Ex Dividend

ELECTRICAL COMPANIES' SHARE LIST.—*Continued.*

ELECTRIC RAILWAYS & TRAMWAYS—*Continued.*

Share.	Last Dividend	Name.	Price Wed., June 24.	Rate % Yielded. £ s. d.	Dividend Due.	Business Week to June 24. Highest.	Lowest.
..	..	Metropolitan District Railway Ord.	12 —13	..	Feb, Aug	12½	12 5/16
..	..	Do. Extension Pref. (5 per Cent.)	23 —28	..	Feb, Aug	..	..
..	3½	Do. Assented Ext. Pref. (Int. Guar. by Und. Elec. Rlys. Co. of London, Ltd.)	44 —48	7 6 0	Feb, Aug	..	..
St	3%	Do. 3 per Cent. Consolid. Rent charge	72 —77	3 18 0	Jan, July	75	72½
St	4%	Do. 4 per Cent. Midland Rent charge	100 —104	3 17 0	Jan, July	..	..
St	1½	Do. Guar. Stock 4 per Cent.	41 —44	3 11 0	Mar, Sept	..	..
St.	6	Do. 6 per Cent. Perp. Deb. Stock	120 —125	4 16 0	Jan, July	..	..
St	4	Do. 4 per Cent. Ditto	73 —78	5 3 0	Jan, July	78	77
5	..	New Gen. Tract. 6 per Cent. Cum. Pref.	½—¾	..	May	..	—
1	/9½	Potteries Electric Traction Ord.	½ ½	8 0 0	April, Oct	..	..
1	0 6	Do. 5 per Cent. Cum. Pref.	¾ ¾	6 13 0	Feb, Aug	..	..
St.	4½	Do. 4½ per Cent. Deb. Stock	93 —96	4 14 6	May, Nov	..	..
1	0 7½	S. Met. Elec. Trams. & Ltg. 6% Cm. Pref.	¾—1	6 0 0	Feb, Aug	..	..
St.	4%	Do. 4 per Cent. Deb. Stock	77 —81	4 19 0	Jan, July	..	..
100	5%	Sunderland Dist. Elec Trms. 5% 1st Mt. Db.	76 —81	6 9 0	Jan, July	76½	..
..	5%	Underground Elec. Rys. Co. of London...	39 —43	11 12 0	June, Dec	42	41½
5	..	Yorkshire (W.R.) Elec. Trams. Ord.	⅞ —1⅛	—	March ..	..	..
5	..	Do. 6 per Cent. Cum. Pref.	3½ —3¾	..	..	3½	..
St.	4½	Do. 4½ per Cent. 1st Debs.	84 —87	5 3 6	Jan, July	85¼	85

ELECTRIC MANUFACTURING, &c.

Share.	Last Dividend	Name.	Price Wed., June 24.	Rate % Yielded. £ s. d.	Dividend Due.	Highest.	Lowest.
1		Aron Electricity Meter Ord.	[illegible]	..	..	..	..
1	1/2	Do. 6% Cum. Pf.	[illegible]	7 2 0	April, Oct	[illegible]	..
1	2/4½	Babcock & Wilcox Ord.	3 [illegible] —4 [illegible]	4 17 6	April, Oct	4 [illegible]	3⅞
1	0 7½	Do. Pref.	1 [illegible] —1 [illegible]	3 16 9	..	..	..
5	6 0	British Insulated & Helsby Cables Ord.	6¼—6¾	8 0 0	July, Feb	..	..
5	3 0	Do. 6 per Cent. Pref	5¾ 6¼	4 16 0	Jan, July	5⅞	..
St.	4½	Do. 4½ per Cent. 1st Mort. Deb. (red	102 —105	4 5 6	Jan, July	..	..
St.	4½	British Thoms'n-Houst'n 4½% 1st Mt. Db.	93 —98	4 12 0	Mar, Sept	..	..
5	..	British Westinghouse 6 per Cent. Pref...	[illegible]	..	Feb, Aug	—	..
St.	4%	Do. 4 per Cent. Mort. Deb. Stock	[illegible]	8 0 0	Jan, July	..	..
2	..	Brush Electrical Engineering	½	—	March ..	..	..
2	..	Do. 6 per Cent. Pref. non-Cum.	[illegible]	..	Mar, Sept	..	..
St.	4½%	Do. 4½ per Cent. Perp. 1st Deb. Stock	71 —75	6 0 0	Mar, Sept	..	..
St.	4½%	Do. Perpetual 2nd Deb. Stock	55 —60	7 0 0	Jan, July	..	..
5	16 0	Callender's Cable Con. Ord.	9½ 10½	7 1 0	Jan, July	10 [illegible]	..
5	2 6	Do. 5 per Cent. Cum. Pref.	5¼ —5¾	4 7 0	Jan, July	..	..
St.	4½%	Do. 4½ per Cent. 1st Mort. Debs. (red.	107 —109	4 2 0	Nov, May	..	..
1	1/0	Castner-Kellner Alkali Co.	1¼—1⅜	9 18 0	May, Nov	1 [illegible]	1 [illegible]
St.	4½%	Do. 4½ per Cent. 1st Mort. Deb. (red.)	101 —104	4 6 6	Feb, Aug	..	..
1	0 9½	Chadburn's (Ship) Telegraph Ord.	1 [illegible] —1 3/16	8 8 0	March ..	1 [illegible]	..
1	0 7½	Do. 6 per Cent. Cum. Pref.	1 —1⅛	5 6 6	April, Oct	..	..
1	[illegible]	Consolidated Electrical Co.	[illegible]	7 0 0	August ...	..	..
1	1/0	Consolidated Signal Co.	1½ 1¾	4 5 6	April, Oct	..	..
1	0 7½	Do. 6 per Cent. Cum. Pref.	[illegible] —1	6 0 0	April, Oct	..	..
3	3/0	* Crompton & Co. (Nos. 1 to 85,000)	1⅝ —1⅞	8 1 6	Jan, July	..	..
100	5%	Do. 5 per Cent. 1st Mort. Debs. (red.).	92 95	5 5 0	Jan, July	..	..
1	0 7½	Davis & Timmins	⅞—1⅛	..	Mar, Sept	..	..
5	2/0	Dick, Kerr & Co. Ord.	1⅜—1⅝	7 11 0	Sept	..	..
5	0/7½	Do. 6 per Cent. Cum. Pref.	1 —1¼	4 16 0	Sept	..	..
St.	4½%	Do. 4½ per Cent. Deb. Stock	101 —104	4 0 0	Jan, July	..	—
5	2/6	Edison & Swan United ("A" sh.) (£3 pd.)	½—¾	..	Feb, Aug	..	..
5	1/2	Do. £5 paid)	1½—2½	5 0 0	Feb, Aug	[illegible]	—
St	4%	Do. 4 per Cent. Mort. Deb. Stock (rd.	78 —81	4 19 3	June, Dec	..	..
St.	5%	Do. 5 per Cent. 2nd Deb. Stock	85 —87	5 15 0	Mar, Sept	..	..
5	..	Edmundson's Elec Corp. Ord.	⅜—⅝	..	Jan, July	..	..
5	..	Do. 6 per Cent. Cum Pref.	½—1	..	May, Nov	..	..
St.	4½%	Do. 4½ per cent. 1st Mort. Deb. (red.)	63 —73	5 2 9	Jan, July	..	..
2	..	Electric Construction Co.	¼ —½	..	Jan, July	..	..
2	..	Do. 7 per Cent. Cum. Pref.	1¼ —1¾	..	July	..	..
St.		Do. 4 per Cent. Perp. 1st Mort. Debs.	61 —65	6 2 0	Jan, July	..	..
10	5 0	General Electric (1900) 5% Cum. Pref.	7¾—8¼	6 1 8	June, Dec	..	..
St	4%	Do. 4 per Cent. 1st Mort. Debs.	87 90	4 9 0	Mar, Sept	..	..
5	10/0	Henley's Telegraph Works Ord.	10½ —11½	6 10 0	Feb, Aug	11 [illegible]	11
5	2 3	Do. 4½ per Cent. Pref.	5 —5½	4 2 0	Feb, Aug	[illegible]	..
St.	4½%	Do. 4½ per Cent. 1st Mort. Deb. Stock	104 —106	4 5 0	Mar, Sept	[illegible]	..
10	15/0	India Rubber, Gutta Percha, &c., Wrks.	15½—16½	6 2 0	Feb, Aug	16 [illegible]	..
100	4%	Do. 4 per Cent. Debs. (red.)	98 —100	4 0 0	April, Oct	98 [illegible]	98
1	[illegible]	National Elec. Construction Co.	⅜ [illegible]	..	April	..	..
1	[illegible]	Richardsons, Westgarth & Co., Ltd. Ord.	[illegible]	7 2 0	Nov	[illegible]	..
1	0/5	Do. 6 per Cent. Cum. Pref.	¾—[illegible]	6 17 0	May, Nov	..	..
St	4½	Do. 4½ per Cent. Perp. Deb. Stock	87 —91	4 19 0	Jan, July	..	..
1	..	Simplex Conduits Ord.	1½	..	..	..	—
5	..	Do. 6 per Cent. Cum. Pref.	5½	..	..	..	..
12	3/0	Telegraph Construction & Maintenance	30½ 31½	6 7 6	Mar, July	31½	30¾
100	4%	Do. 4 per Cent. Deb. Bonds (1909)	102 —104	3 10 0	Jan, July	..	..
1	2 0	Vickers, Sons & Maxim, Ltd. Ord.	1¾ —1 [illegible]	8 1 6	..	1 [illegible]	1¾
1	1/6	Do. 5 per Cent. non-Cum. Preference	1 —1½	4 9 0	..	1 [illegible]	..
St	5%	Do. 5 per Cent. non-Cum. Preferred	102 —106	4 14 6	..	..	..
St	4%	Do. 4 per Cent. 1st Mort. Db. Sk. red	102 —104	3 16 6	June, Dec	102½	..
100	4½	Do. 4½ per Cent. 2nd Mort. Deb. red.	102 —105	4 6 0	June, Dec	104	103¾
100	15 6	Do. 5 per Cent. 3rd Mort. Debs. Perp.	101 —103	..	..	102	101½
1	[illegible]	J. G. White & Co. 6 per Cent. Cm. Pref.	7½ —8½	7 1 0	..	..	..
5	1	Willans & Robinson Ord.	[illegible] 1½	4 0 0	Apr, Oct	..	..
5	5/0	Do. 6 per Cent. Cum. Pref.	3⅛ —3½	8 5 0	Apr, Oct	—	..
100	4%	Do. 4 per Cent. 1st Mort. Debs.	70 —74	5 7 0	May, Nov	..	..

TELEGRAPHS.

Share.	Last Dividend	Name.	Price Wed., June 24.	Rate % Yielded. £ s. d.	Dividend Due.	Highest.	Lowest.
10		Amazon Telegraph	2 —3		June, Dec	..	
100	5%	Do. 5 per Cent. Debs. (red.)	85 —88	5 14 0	June, Dec	86½	86¼
St	15/0	Anglo American	58 —62	5 11 0	F,My,Ag,N		.
St	30 0	Do. Preferred	104 —105	5 14 0	F,My,Ag,N	104⅜	104
St	1%	Do. Deferred	16¼ —16¾	6 1 0	F,My,Ag,N	16	16 [illegible]
St	4%	Commercial Cable 4 per Cent. Deb. Stk.	84 —87	4 12 0	Jn,Ap,Jy,O	..	..
10	[illegible]	Cuba Submarine Ord.	7½ —8½	7 0 0	Feb, Aug	..	..
10	10/0	Do. Preference 10 per Cent.	15½ —16½	6 10 0	Feb, Aug	..	..
5	[illegible]	Direct Spanish Ord.	[illegible] —3½	6 4 0	April, Oct	..	..
5	5 0	Do. 10 per Cent. Cum. Pref.	8 —9	5 11 0	April, Oct		..
St	[illegible]	Do. 4½ per Cent. Deb.	100 103	4 7 6	Jan, July	.	
20	1 0	Direct United States Cable	13 [illegible] 14 [illegible]	6 9 0	Ja,Ap,Jy,O	13½	13¾
100	4½%	Direct West India Cable 4½% Rg. Db. (rd.	10[illegible] —10[illegible]	4 8 0	June, Dec	.	..
St	[illegible]	Eastern Ordinary	133 —136	5 3 0	Ja,Ap,Jy,O	1[illegible]	133½
St.	17 [illegible]	Do. 3½ per Cent. Pref. Stock	84½ —[illegible]	4 1 0	Ja,Ap,Jy,O	[illegible]	[illegible]
St	4	Do. 4 per Cent. Mort. Deb. Stk. (red.)	10[illegible] —102½	3 18 0	May, Nov	1[illegible]	102
10	6/6	Eastern Extension	12½ 13½	5 6 0	Ja,Ap,Jy,O	1[illegible]	1[illegible]
St.	4	Do. 4 per Cent. Deb. Stock	10[illegible] —10[illegible]	3 18 0	Feb, Aug	1[illegible]	1[illegible]
100	4%	Eastern & S. African 4% Mort. Deb. 1900	101 —103	3 17 6	Feb, Aug	..	..
25	4	Do. 4% Mauritius Sub. Deb. red	100 —102	3 18 6	May, Nov	..	..
10	30/0	G. N. of Copenhagen ... (Cou. 73	[illegible]	6 13 0	Jan, July	28 [illegible]	..
100	4½	Halifax & Bermudas 4½% 1st Mt. Db. (red.	10[illegible] —104½	4 8 0	June, Dec	..	..
	[illegible]	Do. European	64 —67	5 19 0	May, Nov	..	..
100	$1	† Mackay Companies Common	60 —70	5 11 0	Ja,Ap,Jy,O		
100	$1	† Do. Preferred	60 —70	5 11 0	Ja,Ap,Jy,O		..
1		Marconi's Wireless Telegraph Co.	—	..	April		
100		Pacific & European Tel. 4% Guar. Dbs. red.	10[illegible] —10[illegible]	3 1[illegible] 6	June, Dec	.	..
	1	West Coast of America	1 —1	3 18 0	May	.	..
100	1/3	Do. 4 per Cent. Debs.	100 —104	3 18 0	Jan, July	.	..
10	4½	West India & Panama	¾	..	May, Nov		[illegible]
10	[illegible]	Do. 6 per Cent. 1st Pref.	[illegible] —8½	6 17 0	May, Nov	[illegible]	8 [illegible]
10	[illegible]	Do. 6 per Cent. 2nd Pref. [illegible]	[illegible]	.	May, Nov	.	
100		Do. 5 per Cent. Debs.	101 —104	4 16 0	Jan, July		..
10	2 0	Western Telegraph	13[illegible] —1[illegible]	6 1 0	Mr,Jn,O,D	13¾	13[illegible]
St		Do. 4 per Cent. Deb. Stock (red.	101 —10[illegible]	3 17 6	June, Dec	10[illegible]	
..	4	Western Union Tel. $1,000 4% Bonds	[illegible] —[illegible]1	4 19 0	..	.	..

TELEPHONES.

Share.	Last Dividend	Name.	Price Wed., June 24	Rate % Yielded. £ s. d.	Dividend Due.	Business Week to June 24. Highest.	Lowest.
100	28	Amer. Telephn. & Telegh. Cap. St.	120 —124	6 12 6	..	..	..
..	4%	Do. Coll. Trust $1,000 4 per Cent. Bds	85 —88	4 11 0	Jan, July	..	..
St.	5%	Anglo-Portug'se Tel. 5% 1st Mt. Db. Stk.	99 —102	4 18 0	Mar, Sept	..	—
5	3 0	Chili Telephone	7¼—7¾	5 2 0	August ..	..	..
1	0/7½	Monte Video Telephone Ord.	[illegible]—1 [illegible]	6 16 0	Nov	1	..
1	0/6	Do. 5 per Cent. Pref.	[illegible]—[illegible]	5 7 0	May, Nov	⅞	..
St.	6%	National Co. Pref. Stock	109½—110½	5 8 0	Feb, Aug	109¾	109¾
St.	6%	Do. Def. Stock	113 —115	5 4 0	Feb, Aug	114½	113½
10	6 0	Do. 6 per Cent. Cum. 1st Pref.	10½—12½	4 16 0	Feb, Aug	11½	11
10	6/0	Do. 6 per Cent. Cum. 2nd Pref.	10½—12½	4 16 0	Feb, Aug	..	..
5	2/6	Do. 5 per Cent. non-Cum. 3rd Pref.	5⅜ —5⅝	4 9 0	Feb, Aug	..	..
St.	3½%	* Do. Deb. Stock 3½ per Cent. (red.)	99½ —101½	3 9 0	June, Dec	..	..
St.	4%	Do 4 per Cent. Deb. Stock (red.)	102½ —104½	3 17 0	Jan, July	103¾	..
1	1/0	Oriental	1¼—1¾	5 9 0	April, Oct	..	..
1	0 7½	Do. 6 per Cent. Cum. Pref.	1⅛—1¼	4 16 0	April, Oct	1 7/32	..
St.	4%	Do. 4 per Cent. Red. Deb. Stock	90 —93	4 6 0	Jan, July	..	..
St.	4½%	Telephone Co. of Egypt 4½% Db. Stk. (red.)	99 —102	4 8 0	Jan, July	..	
5	3/0	United River Plate	6⅜—6⅞	5 16 6	July	6⅝	6 [illegible]
5	2/6	Do. 5 per Cent. Cum. Pref.	5 —5½	4 11 0	June, Dec	5⅜	..
St.	4½%	Do. 4½ Deb. St. Red.	100½ —102½	3 18 0	Jan, July	101¾	101⅛

FINANCIAL, INVESTMENT, &c.

Share.	Last Dividend	Name.	Price Wed., June 24	Rate % Yielded. £ s. d.	Dividend Due.	Highest.	Lowest.
5	8/0	Elec. & Gen. Investment 6% Cum. Pref.	3¾—4¼	7 1 0	Jan, July	..	..
10	2 0	Globe Telegraph & Trust	10⅜—10⅞	5 1 6	Sp Dc Mr Ju	10¾	10 7/16
10	3/0	Do. 6 per Cent. Pref.	13⅝—14⅛	4 5 0	Sp Dc Mr Ju	13⅝	..
10	6%	Submarine Cables Trust (Cert.)	127 —130	4 12 0	April, Oct	..	..

COLONIAL AND FOREIGN ELECTRIC RAILWAYS, TRAMWAYS, &c.

Share.	Last Dividend	Name.	Price Wed., June 24	Rate % Yielded. £ s. d.	Dividend Due.	Highest.	Lowest.
5	3/0	Anglo-Argentine 6% Cum. 1st Pref.	6¼—6½	4 12 0	April, Oct	6 7/16	..
5	5 0	Do. 10% Non-cum. 2nd Pref.	8 7/16 —[illegible]	5 15 6	Jan, July	8⅝	8 7/16
St.	6%	Do. Permanent 6% Deb. Stock	141 —146	4 2 0	June, Dec	..	..
St.	5%	Auckland Elec. Trams. 5% Deb. (red.)	104 —107	4 13 6	Jan, July	..	..
5	4 0	Brisbane Electric Trams. Invest. Ord.	4 3/16—4 7/16	4 10 6	May	..	..
5	2 6	Do. 5 per Cent. Cum. Pref.	4⅝—5⅛	4 17 6	May, Nov	5	4 [illegible]
St.	4½%	Do. 4½ per Cent. Db. Prov. Certs.	99 —103	4 7 6	Jan, July	100½	..
St.	8%	British Columbia El. Ry. Df. Ord.	125 —130	6 3 0	Mar, Sept	.	..
St.	65 0	Do. Pref. Ord. Stock	108 —112	5 6 6	May, Nov	110¾	110½
St.	5%	Do. 5% Cum. Perp. Pref. Stock	107 —111	4 10 0	Jan, July	..	..
40	4½%	Do. 4½ per Cent. 1st Mort. Debs.	99 —102	4 8 0	April, Oct	..	..
100	4½%	Do. Vancouver Power Debs.	101 —104	4 6 6	Jan, July	..	.
St.	4½%	Do. 4½% Perp Con. Deb. St.	99 - 102	4 3 0	.		..
5	3/0	Buenos Ayres & Belgrano Ord.	4¾ —4⅞	8 1 6	April, Oct	..	..
5	3/0	Do. 6 per Cent. "A" Cum. Pref.	4⅝—5⅛	5 17 6	April, Oct	..	
5	3/0	Do. "B"	4⅝—5⅛	5 17 6	April	..	..
St.	5%	Do. 5 per Cent. Debs.	110 —116	4 6 0	Jan, July	..	..
St.	5%	Do. 5 per Cent. 2nd Debs. (red.)	102 —105	4 15 3	Jan, July	..	..
St.	5%	Buenos Ayres Elec. Trams (1901) Ltd. Deb. St.	95 —99	5 1 0	Ja, Jul ..	..	..
5	..	Buenos Ayres Grand National Ord.	2¼—2¾	..	..	..	..
5	2/6	Do. 5 per Cent. Cum. Pref.	3⅝ —4⅛	5 14 0	Feb, Aug	4 [illegible]	4
100	5½%	Do. 5½ per Cent. Pref. Debs	101 —105	5 4 9	Jan, July	..	..
100	6%	Do. 6 per Cent. 1st Deb. Bonds.	100 —101	5 14 6	April, Oct	..	..
St.	5%	Buenos Ayres Lacroze Trams 1st Mt. Db.	91 —9[illegible]	5 6 6	Mar, Sept	—	..
St.	6%	Buenos Ayres Port & City Tram. 1st Mt. Deb. Stock £75 Paid	64 —68	6 12 0	Feb, Aug	..	..
5	2 6	Calcutta Tramways (1 to 137,010)	5⅝—6⅜	4 15 0	Mar, Sept	6	5¾
100	2/6	Do. 6 per Cent. Cum. Pref.	5 —5⅜	4 13 0	Jan, July	..	.
1	4½%	Do. 4½% 1st Deb. Stock (red.)	103 —106	4 5 0	Jan, July	..	..
St.		Cape Electric Tram Shares	[illegible]—7/16	.	..	[illegible]	
5	1/3	City of Buenos Ayres Trams Co. (1904 Sh.	5 [illegible] —5 [illegible]	4 6 6	F,My,A,N	5 [illegible]	5⅝
St.	4%	Do. 4 per Cent. Deb. Stock	99 —103	3 17 6	June, Dec	..	..
	5%	Colombo Tr. & Ltg. 5% 1st Mt. Db.	85 —91	5 10 0	May, Nov	..	—
100	5%	Electric Traction Co. of Hong Kong 5 per Cent. 1st Mort. Debs.	85 —90	5 10 0	June, Dec	..	..
1	5%	Havana Elec. Ry. Con. Mt. 5% $1,000 50 year Coup. Bds.	82 —87	5 14 6	Feb, Aug	..	..
1	..	Kalgoorlie Elec. Trams Sh.	[illegible]	..	..	[illegible]	..
100	5%	† Do. 5 per Cent. "A" Deb. Stock	85 —87	5 12 0	Jan, July	..	
5	6%	† Do. 6 per Cent. "B" Ditto	69 —73	8 4 0	Jan, July	..	..
5	1/0	Lisbon Elec. Trams. Ord.	1 —1¼	4 0 0	July	..	.
100	0 7½	Do. 6 per Cent. Cum. Pref.	1 —1¼	4 16 0	Jan, July	..	.
St.	5%	Do. 5 per Cent. Reg. Mort. Debs	90 —95	5 6 0	Jan, July	94½	.
St.	5%	Madras Elec. Trams. 5% Deb. Stk.	95 —98	5 2 0	Jan, July	..	
.	5%	Manila Elec. Ry. $1,000 Gold Bonds	86 —90	5 11 3	Feb, Aug	..	..
100	$1	Mexico Trams Co. Com. St.	101 103	3 17 6	..	102¼	101½
500	5%	Do. Gen. Con. 1st Mort. 5% Gold Bds.	101 —103	4 17 6	..	91½	9[illegible]
St.	4½%	Montreal St. Ry. Sterling 4½ per Cent. Debs. (1922)	101 —103	4 7 6	Feb, Aug	..	.
1	1/0	Perth Elec. Trams Ord	½—⅝	8 0 0	May	[illegible]	..
St	5	Do. 1st Mt. Db. Stock	103 —106	4 14 3	Jan, July	..	..
5	3/0	Rangoon Elec. Trams & Supply Co. 6 Cum Pf.	5¼—5¾	5 4 0	..	..	..
St.	4½	Do. 4½% 1st Mort. Deb. Stk.	95 —100	4 10 0	..	..	..
..	$2½	Sao Paulo Tramway, Light & Power Co. $100 Stock	132 137	6 11 6	..	134	..
	5%	Do. 5 per Cent. 1st Mt. $500 Db.	95 —98	5 2 0	June, Dec	96⅝	9[illegible]
100	4½%	Toronto Ry. Co. 1st Mt. 4½% Ster Bonds	98 —100	4 10 0	Feb, Aug	..	..

COLONIAL AND FOREIGN ELECTRICITY SUPPLY, &c.

Share.	Last Dividend	Name.	Price Wed., June 24	Rate % Yielded. £ s. d.	Dividend Due.	Highest.	Lowest.
5	3 0	Adelaide Elec. S'ply Co. 6% Cu. Pr.	4¾—5¼	5 14 0	Mar, Sept	..	..
10	5/2	Bombay E. S. & T. 6% Cm. Pf.	10¼—10¾	5 11 6	..	10½	..
St.	4½	Do. 4½ per Cent. Deb. Stk. (red.)	94 —96	4 14 6	Jan, July	95	..
5	4/9	Calcutta Elec. Supply Ord.	5½ —6½	6 2 0	April, Oct	..	..
100	7/2	Canadian Gen. Elec. Co. Com. St.	88 —90	7 18 0	..	91½	..
100	5%	Castner Electrolytic Alkali Co. (of U.S.A.) 1st Mort Stl. Debs.	94 —99	5 1 0	Jan, July	..	..
500	5	Elect. Development Co. of Ontario	84 85	5 15 0	..	84	84[illegible]
5		Elec. Ltg. & Trac. Co. of Aust. 6 per Cent. Cum. Pref.	2¼—2¾	..	Feb, Aug	..	.
St.	5%	Do. 5 per Cent. Deb Stock	84 —88	5 11 0	Jan, July	..	..
St.	5%	Elec. Supply Co. of Victoria 5 per Cent. 1st Mort. Deb. St.	90 93	5 7 6	Jan, July		..
St.	6	Indian Elec. Sup. & Trac. Co. Deb. St. Rd. Prov. Certs.	90 —93	6 7 0	Jan, July	..	.
100	0/3	Kalgoorlie Elec. Power & Ltg. Ord.	—	.	.		
1	[illegible]	Do. 6 per Cent. Cum. Pref.	[illegible]	7 16 0	April, Oct		.
St.	5%	Madras E. S. Corp. 5 per Cent. Constn Deb. St.	85 —90	5 11 0	April, Oct	..	..
500	5%	Mexican Elec. Light Co. 5% 1st Mort. Gold Bonds	[illegible] —83½	6 0 0	..	83½	82[illegible]
St.	..	Mexican Lt. & Power Co. Cap. St.	5[illegible] —5[illegible]	..	..	6[illegible]	57½
500	5%	Do. 5% 1st Mort. Gold Bnds.	87 88	5 11 0	..	87½	8[illegible]
100	6 2	Montreal Lt. Ht. & Power Co. Cap. St.	96 —99	6 1 0	F,My,A,N		..
1	1/	River Plate Electricity Co. Ord.	[illegible] 1	6 4 0	April ..	..	..
1	1 [illegible]	Do. 6 per Cent. non-Cum. Pref.	[illegible]	6 0 0	May	..	..
St	5%	Do. 5 per Cent. Deb. Stock	96 —99	5 1 0	Jan, July	..	.
5	5/0	Rosario Elec. Co. 6% Pref. (1 20,000)	[illegible] 5½	5 17 6	April, Oct	..	.
100	8	Shawinigan Water & Power Co. Cap. St.	71 73	5 10 0	..	71½	..
..	5%	Do. 5 per Cent. Bds.	102 —104½	4 17 0	Jan, July	103	102¼
..	7 [illegible]	Victoria Falls Power Co. Pref.	[illegible]	—	Jan, July	..	..

* In calculating the yields allowance has been made for accrued interest but not for redemption. † Ex dividend. ‡ The London Stock Exchange Committee have declined to quote these

CONTENTS.

THE
ELECTRICIAN INDUSTRIAL SUPPLEMENT.

Electrician No. 1571
Indust. Suppt. No. 24
Gratis to Subscribers.

JUNE 26, 1908.

The Sale of Power.

THE doctrine of organisation is so often preached nowadays and the attempts at practising it are so numerous and give such promise, that it may well be considered in its relation to the sale of electrical energy for power purposes. Briefly, the problem of electricity sales is a narrow one. In a general sense the business methods followed in one district will answer in another—that is, if broadly regarded as illustrating a principle. The appeal, for instance, to a woodworking establishment for the electric service, if couched in similar terms in Dundee and Plymouth might apply equally well in both cases, making allowance, of course, for local peculiarities. Considered in another way, a pamphlet on electricity in woodworking shops, if prepared by a local authority in the South of England, would be equally valuable in the hands of a solicitor for business on the banks of the Clyde. At first glance, therefore, the sale of electrical energy in different towns presents a problem which is applicable to each industrial centre; in a word, it affords a basis for co-operation between the suppliers of electricity in these centres. This similarity of appeal to power users in various parts of any country has provided an opportunity for organisation which, up to the present, has passed almost unnoticed by British electrical engineers. In America there already exist flourishing or apparently flourishing societies whose sole object is the furtherance of the business of electricity supply. We are only able to judge by reports, but these give all the appearance of vigorous policy and concentrated effort on the part of these bodies. They also furnish a rather interesting aspect of the vexed question of co-operation between the suppliers of electrical apparatus and the sellers of electricity proper. Not only do friendly relations exist between these two—and in a general way they also are noticeable in this country—but also a basis for regular negotiation seems to have been fixed upon which a firm business understanding between both parties has been built up. While we always look askance at American methods we yet feel that, for us, they contain some good lessons, some useful reminder of what may be done with the same means over here. At present there is little or nothing tangible being done. No move towards a co-operative scheme for the sale of electricity has been put forward. Each supplier is watching his neighbour and imitating him in one of two ways. He either slavishly copies his example of *laisser faire*, or he endeavours to do the same thing as his confrère, in the way of publicity work, canvassing, &c., so that it shall look as little like the imitation as possible. In all conscience we have enough diversification in electricity supply already. Let us at least hit a note of uniformity in the methods adopted of securing business. In justice to the future of the industry this should be done, more so because all the factors of the case assist in this desirable consummation. If electricity must be manufactured by dynamos of different make but similar principle, if it must be distributed through cables laid on the solid, semi-solid and steel-clad systems, and utilised in motors which come from all corners of the globe, let some spirit of uniformity pervade the work of bringing the merits of this important service to the notice of power users. The thing cannot be done at once. But now is the time to settle the preliminaries of its treatment in the future. During dull times future possibilities should receive consideration. A slavish copying of the work done in other countries in this important branch of electrical work is to be deprecated, but even more so must a policy of lassitude and indifference be decried. We are fairly well settled to the business of electricity production and distribution. Now is the time to formulate a scheme of co-operation between manufacturer, contractor and station engineer which would work out profitably to all concerned.

[T]his SUPPLEMENT is issued Gratis to Subscribers to "The Electrician."
EXTRA COPIES can be obtained, price 4d. per copy post free.

Vickers Electrical Machinery.

At their River Don Works, Sheffield, Messrs. Vickers, Sons & Maxim (Ltd.) have an extensive electrical department, in which they undertake the manufacture of dynamo-electric machinery. In the development of the various types of alternating current and direct current machines which constitutes its standards the company has had a practically unique experience, particularly in the driving of large machine tools and the provision of power plant for large engineering works. In a recently issued publication typical examples of Vickers electrical products are illustrated and briefly described, and several of these merit comment on our part. We may say at the outset that the machine tool equipment of the electrical shops includes many fine examples of motor-driven tools, comprising large lathes, boring mills and planers. The majority of these tools are equipped with variable-speed motors, regulated by shunt control only. The planer drive is the subject of a special patent, and provides for an accelerated return of the table during the idle stroke by the speeding up of the motor. We understand that this drive has proved exceptionally efficient in practice.

The varied character of the industrial operations which come within the scope and purview of the business of Messrs. Vickers gives them excellent facilities for meeting, in the design of their electrical machinery, the requirements of large industrial establishments.

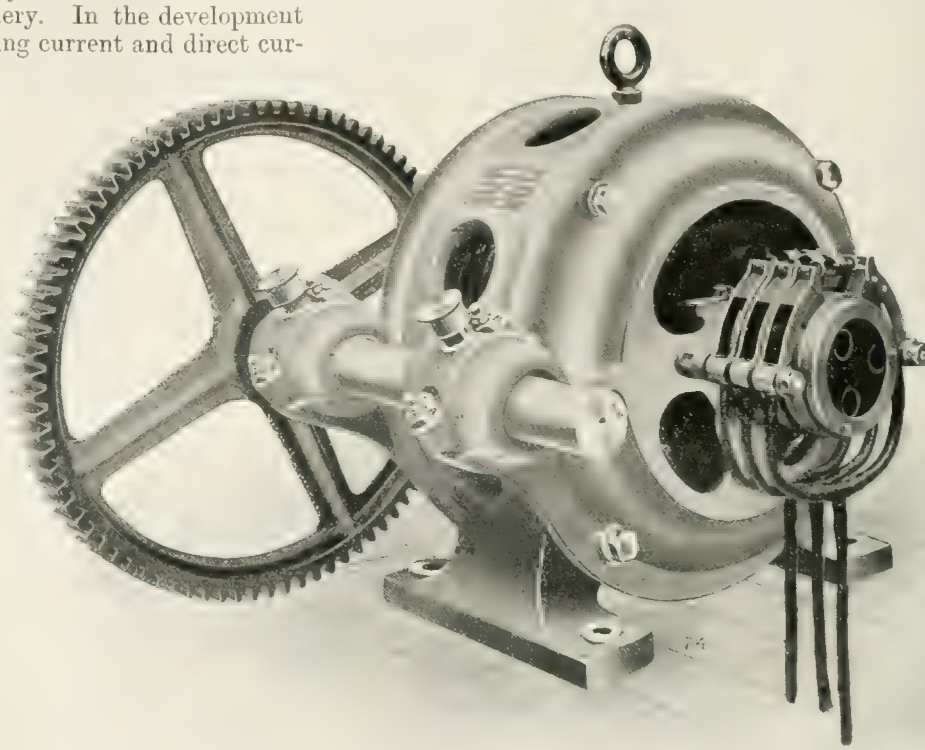


Fig. 2.—Standard Vickers Slip-Ring Polyphase Motor.

The generators built at River Don works are both alternating current and direct current machines. Fig. 3 illustrates a pair of 350 kw. 500/550 volt direct current generators mounted on test plate in the shops. These machines are of the open multipolar compound wound type, and are intended for a three-wire circuit on an installation in South Africa. Each unit is furnished with a self-contained balancing arrangement, which will deal with an out-of-balance current of 25 per cent. on each side of the neutral.

In Fig. 2 we show a Vickers standard semi-enclosed induction motor with slip rings designed for a three-phase circuit of 220 volts 40 cycles. The machine illustrated is provided with a 4 to 1 reduction gear. These motors are built in standard sizes, and a large number has been

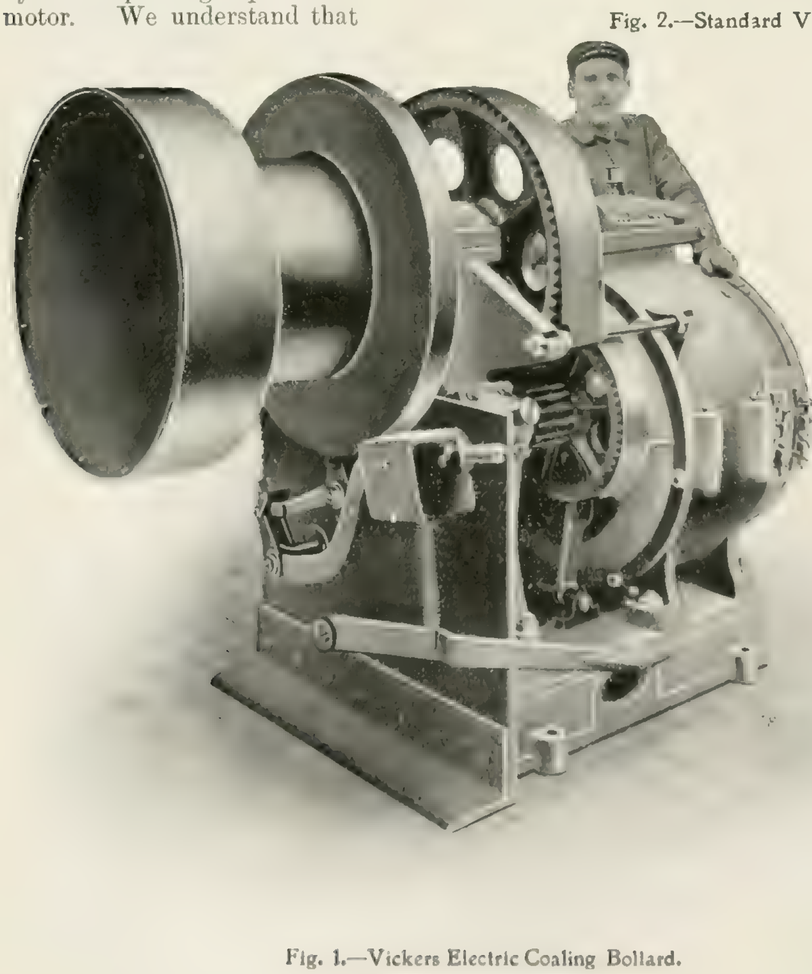


Fig. 1.—Vickers Electric Coaling Bollard.

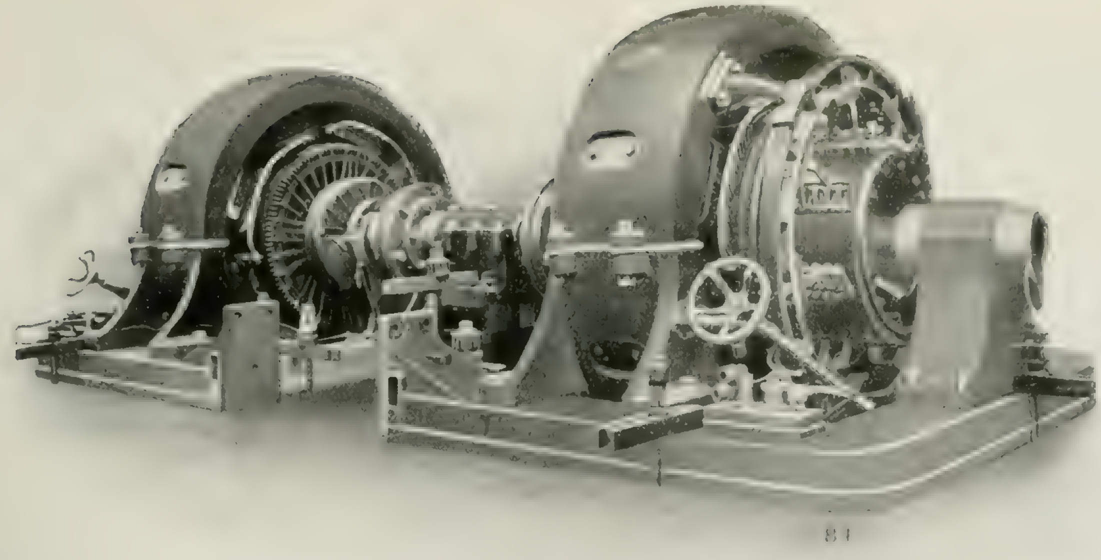
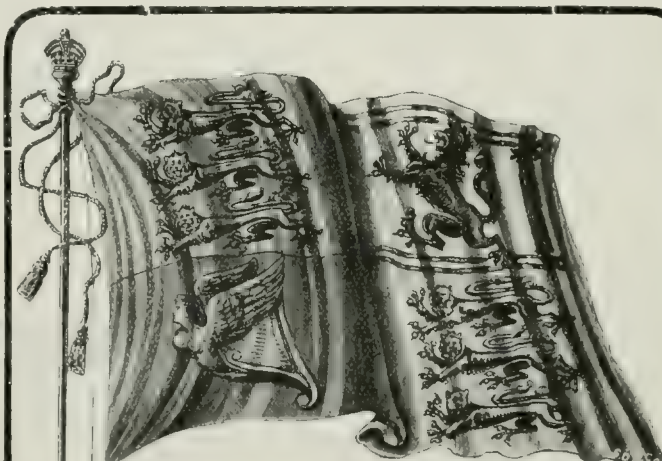


Fig. 3.—Two Vickers 350 kw. Three-Wire Generators on Test Bed.

installed for the driving of various classes of industrial machinery.

An interesting type of capstan, such as is used for the hauling of battleships, is illustrated in Fig. 4. To show the gearing more readily the water-tight cover has been removed. A standard Vickers totally enclosed crane-type motor is fitted for driving, and this motor is controlled by a "Stellite" reversing drum type controller having the contacts each way and a magnetic blow out. The spindle of the controller is operated from the outside of the containing case as the illustration shows, and the resistance used has a special five minute rating. The motor operates on a 440-volt circuit, and develops 50 B.H.P. at 500 revs per min. The rated capacity of the capstan is 12 tons at 40 ft. per minute, or 6 tons at 80 ft. per minute.

An electric coaling bollard, as employed on British battleships is shown in Fig. 1. In this case the drive is furnished by a Vickers constant speed motor of the iron-clad pattern, developing 25 B.H.P. Each bollard is capable of lifting a load of 1 ton at an average working speed of



Refrigerating Machinery.

THE following extracts from the *Electrical World*, on the subject of Electrical Refrigeration, will doubtless be read with interest in these warm days.

To the wide-awake central station manager there is a comparatively new power market opening up, that of the motor-driven refrigerating outfit. The size of this market may be imagined when one stops to consider the number of commercial enterprises using ice; for in nearly every case the ice may be displaced by the more convenient and less bulky artificial refrigeration. Markets, hotels, restaurants, dairies, chocolate factories, fish dealers and packing houses all need cooling facilities of some kind. The majority of them use fron 1 to 6 tons of ice per day.

If this business can be obtained for the electrically-operated refrigerating machine, a motor of from 3 H.P. to 15 H.P. may be installed, according to the amount of cooling needed.

This load will be of great assistance in straightening out the station load curve, as it will be at a maximum in the hottest weather and in the warmest part of the day, when the lighting load is off and the power load is apt to be below normal.

Tons per 24 hours	0·45	0·9	1·3	2·5	4	5	8
Horse-power required ..	1·0	2·0	3·0	5·0	7½	10	15

For the average requirements it will be unnecessary to operate the machine all the time, and as the minimum capacity will be required at night and in cool weather, it may be kept off the peak entirely, if desired. These conditions are favourable to a low price per kilowatt-hour. At the present time a rate of 3 c. makes it possible for the outfit to compete very successfully with ice.

The refrigerating manufacturers are of course pushing the sale of their systems, but they do not cover the field closely enough. Each central station man ought to get out and canvass his own town and get every possible customer connected. The central station company doesn't care about the refrigeration end, but it most assuredly ought to be concerned about the motor load.

200 ft. per minute. The motor speed is reduced to that of the winding drum by spur-gearing, as shown. The drum is fitted with a clutch, and this clutch is put in by foot lever when the load is to be raised. The drum then revolves and the pawls slip round on the ratchet wheel which is held by the brake. When stopping the clutch is thrown out of gear, and the pawls retain the load and keep it from running back. The lowering process is equally simple; the clutch is left out of gear and the brake lever is raised, an operation which allows the brake wheel driven by the load to rotate within the band.

The foregoing descriptions and illustrations will give some idea of the utility of Vickers' electrical plant for industrial service. We need hardly say that they represent but a small portion of the standards which have been reached in the electrical department in the matter of heavy dynamo and motor machinery. A general survey of these will be found in the publication to which we referred briefly at the opening of this article. We are indebted to the company for the supply of the above data and illustrations.

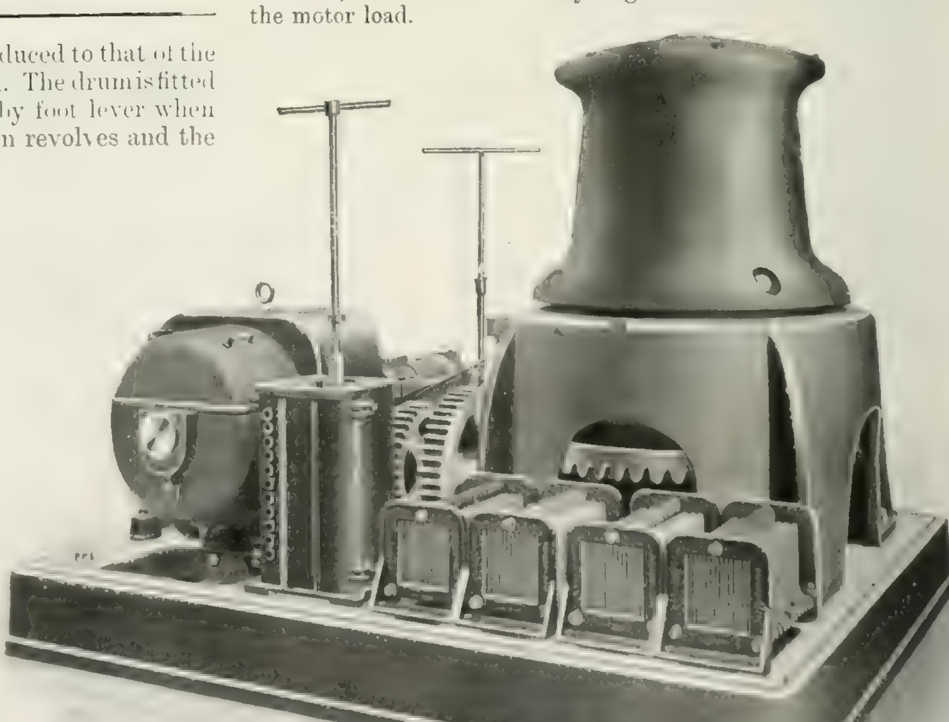


Fig. 4. Vickers Standard Capstan, Battleship Pattern.

The Olivetti Electrical Instrument Company.

Some Notes on its Works and Products.

IN these days of the *entente cordiale* it would appear to be a matter of fashion to direct attention to the products of our Continental neighbours. On one or two occasions we have described the electrical departments of Continental firms who have built up a reputation for soundness of design and product, which they have made the true basis of their business. In the present instance, both from a political point of view and also in the matter of its electrical aspect, we may turn with some feelings of pleasure to the work of Italian electricians. It has been the good fortune of this country to co-operate with Italian electrical engineers on more than one occasion, and in turning over the pages of some future electrical history the agreeable association of both these parties should be frequently noticeable. Italy is essentially a country for which the future has laid up an abundant store. It possesses geographical advantages which may, if present developments in hydro-electric power proceed as rapidly as they bid fair to do, raise its industries to a level of national importance, which has not hitherto been realised under any other engineering regime. This fact is in itself important enough to justify the forging of friendly links between this country and one which has such a brilliant industrial prospect before it. We refer in these terms to Italian electrical developments, as we trust they will form a fitting introduction to the descriptive matter which follows on the works and products of the Olivetti Electrical Instrument Co., of Milan.

Through the courtesy of this company we are enabled to present our readers with views showing the different departments of their Milan shops. These have been made out for the specialised production of electrical instruments of all classes, ranging from costly electrical standards

View in the Controlling Department.

to inexpensive patterns of instruments for rough-and-ready service on industrial circuits. Olivetti instruments are so well known that we need make no reference to the historical developments of the company responsible for their manufacture. Many years' experience has placed the company in possession of information and data, the immense value of which is practically expressed in the equipment and organisation of the present works.

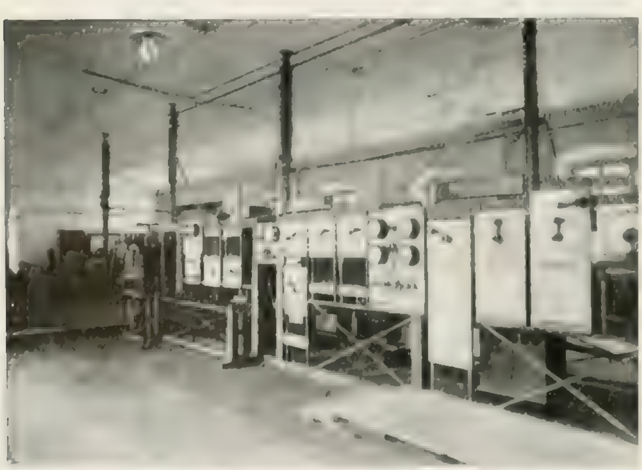
The works are divided into three main departments, each of which is presided over by a chief engineer; under these engineers are several foremen. In the first of these departments the casting and general machining of instrument parts is carried on. The principal object in view is inter-

Corner of Transformer Assembling Department.

changeability of all parts of instruments in the same class, and for the attainment of this object special tools, jigs, templates and gauges are employed.

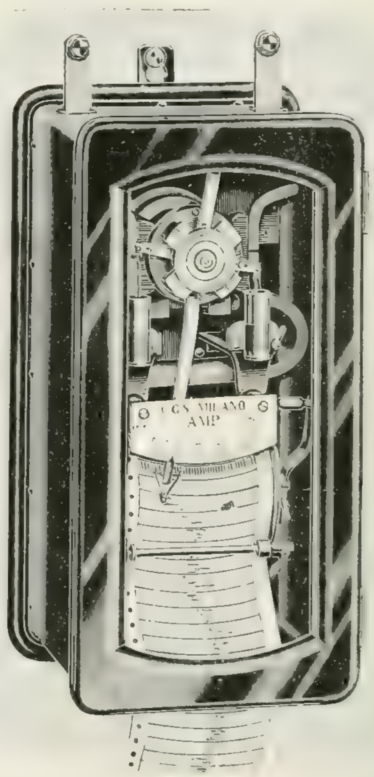
In the same department is a shop devoted to electroplating and enamelling. These processes are both useful and ornamental, and are recognised as essential in all modern instruments. Another large department is given over to wood working, the products being mainly instrument cases and the special cabinet work usually met with in instrument manufacture.

The general configuration of the shops is such that the manufacture of all instrument parts is carried forward towards the stores, in which each single item is classified and conveniently arranged on shelves, &c. The assembly of these parts into complete instrumens is undertaken by the aid of special tools, designed for the work with the object of saving labour. The stores constantly feed this department with material, so that the work of assembly proceeds smoothly and efficiently.



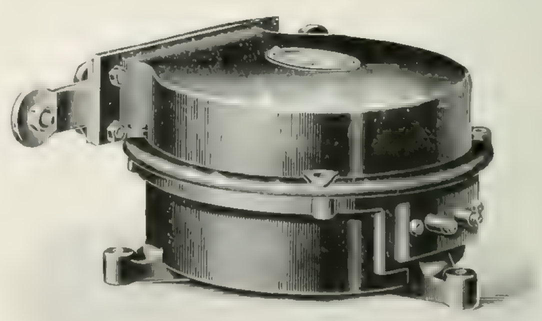
General View of Laboratory Storage Battery Mains.

Probably the most interesting section of the works is that devoted to research and the testing of all classes of instruments manufactured in the various shops. The main laboratory is probably one of the most complete of its kind, and merits special description. One of the rooms in this



C.G.S. Indicating and Recording Moving Coil Instrument.

department measures 40 ft. by 80 ft., and here the work of calibrating and testing of all kinds of industrial instruments is carried on. In the centre of the room six large switchboards are erected, and the instruments and switches on these are connected to secondary standards, against which the readings of instruments are checked. Different sizes of rheostats are also coupled up to these boards, and these enable the strength of the current to be varied in accordance with the tests undertaken. Both continuous and alternating current is supplied to these boards. The first-mentioned is furnished by four storage batteries, two of which, if worked in parallel, give a current of 6,000 amperes.

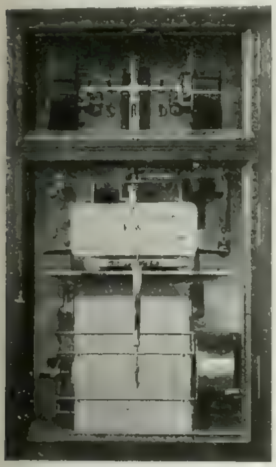


C.G.S. Current Transformer: Solid Cast-iron Core.

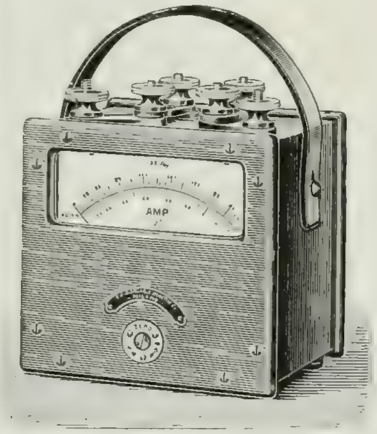
Three phase alternating current is supplied from the local circuits of the Milan Edison Company at a pressure of 160 volts 42 cycles. Two alternators are also installed and driven by a variable speed motor, so as to obtain a range of frequency from 8 to 100 cycles. By the use of suitable transformers alternate currents up to 25,000 amperes can

be obtained. Should it be necessary to conduct tests with real power a 400 kw. transformer coupled to the Edison Company's mains can be made use of. An interesting item of the equipment of this laboratory is a phase regulator which supplies currents having a definite and known difference of phase from 0 to 90 deg. This regulator has proved exceptionally useful in the testing of the wattmeters, of which Messrs. Olivetti make a speciality. In another room provision is made for much finer measurements, and also for dealing with high potentials up to 10,000 volts. The majority of the secondary standards employed in the works and referred to above are calibrated and checked in this room. A phase regulator is also included in the equipment.

For extra high-tension experiments and tests a special room divided off from the rest of the testing department is made use of. The transformers in this room will furnish pressures from 12,000 to 120,000 volts. For the measurement of these voltages a precision relay electro-dynamometer is made use of, and by the use of standard resistances readings can be taken up to 60,000 volts. For potentials between 30,000 and 120,000 volts a Jona electrostatic voltmeter is used. Extreme precautions are taken to ensure the safety of the test room staff, and these include a number of special devices, which have been found adequate for the purpose. In another portion of the laboratory extremely sensitive measurements, such as are usual with standard resistances and primary standards of every description are made. All instrument scales are printed in another room by girls, who trace these off by a special process. This has been found very exact in practice.

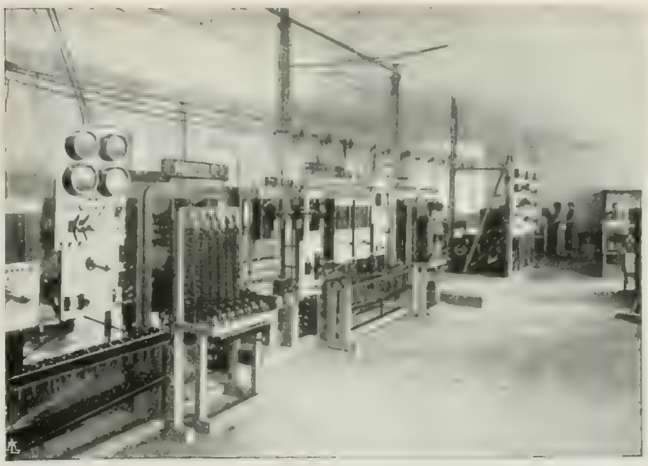


C.G.S. Relay Indicating and Recording Three-phase Wattmeter.



C.G.S. Portable Electro-magnetic Instrument.

A Corner of the High Tension Room. Testing a High Potential Transformer.



General View of Laboratory: Wattmeter Testing Department.

The instruments manufactured include ammeters and voltmeters for alternating current and direct current circuits, wattmeters, portable instruments, current and potential transformers, recording ammeters and voltmeters, &c. Various types of movement are employed, instruments being of the hot-wire, electromagnetic, moving-coil, electrostatic and relay patterns in this respect. In the least expensive models the same attention to constructional details and accurate reading is paid as to instruments which rank in a more costly class. In the illustrations accompanying this article we show several types of these instruments, and in most cases the general constructional details will be readily noticeable.

We may conclude by expressing our thanks to the company for placing these details at our disposal.

Heywood's Electrical Transporters. . . .

IN another part of this issue we refer to the industrial importance and value of the electrical transporter. The manufacture of these useful devices has been taken up on specialised lines by several firms, and the general efficiency of their products appears to have been abundantly proved in practice. Messrs. S. H. Heywood & Co., Reddish, near Stockport, are among the firms who have specialised in this class of work. They construct a standard line of transporters suitable for travelling on the lower flange of a single rolled steel joist, and any section, including and greater than 8 in. by 4 in. Generally considered, the transporters consist of two travelling trolleys and a steel framework, to which is fixed a hoisting gear and cage. One of the trolleys carries the motor for operating the travelling motion, and the four running wheels of this carriage are driven from one motor, so as to obtain a maximum tractive effort and to reduce slipping to a minimum. Suspended from the trolleys by stout steel pins is a framework carrying the hoisting gear and the cage. The suspension is so arranged that both trolleys and framework can swivel in a horizontal and vertical direction respectively. This construction admits of the transporters running smoothly round curves of small radius at high speeds.

The load on the transporter is raised by a steel wire rope wound on a spirally grooved barrel driven from the motor by spur gearing with machine-cut teeth. The bearings throughout the transporters are gunmetal bushed. The motor is a series-wound machine liberally rated and totally enclosed. An electric brake and an additional foot brake are fitted to enable the load to be lowered by gravity. Over-winding and over-lowering gear is fitted to all sizes of transporters. The controllers are of the tramway drum type, and are used in conjunction with resistances of a special crane type. The general construction of the transporters may be gathered from the illustration in Fig. 1, which shows two machines complete with their electrical equipment. It will be noticed that the operator has ample room from which to view the raising and lowering operations, there being a special cage provided for his accommodation. In this cage main and branch switches and fuses in cast-iron cases are fixed up. The hoisting gear framework and cage of these transporters are entirely of steel, and cast-iron is only used for bearings, spur wheels, winding barrel, &c.

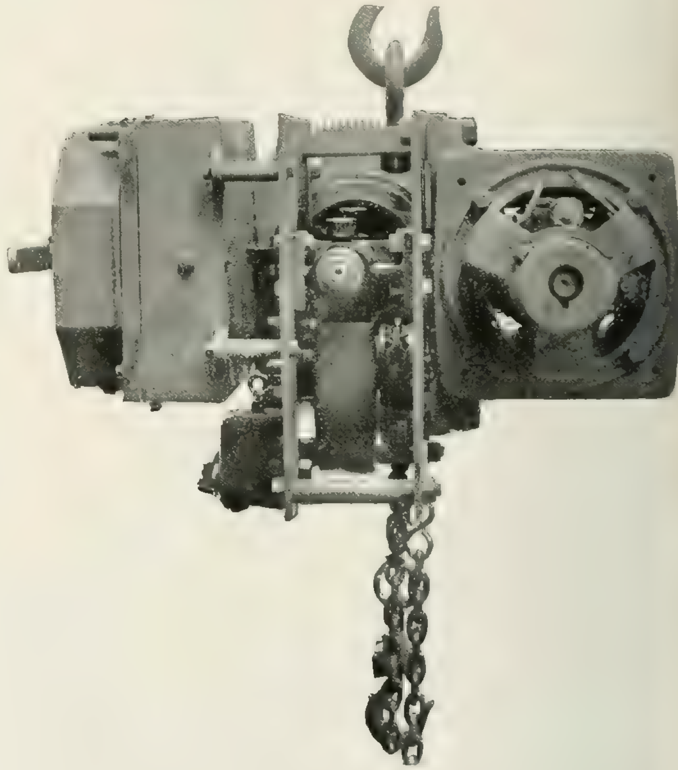


Fig. 2.—Heywood Electric Pulley Block attached to Crane Hook.

Where the transporters are required to run in the open the motors are specially protected, and the operator's carriage and resistances are covered in. Fig. 2 illustrates an electric hoisting tackle suitable for attachment to a crane hook. It is built up complete with motor, spur and worm-gearing and controller, the latter being operated from the ground level. We understand that a large number of these transporters and hoisting devices have been installed in glass works, steel works, coal stores, bakeries, iron and chemical works and in large shipbuilding and engineering works. The makers claim that where large quantities of material have to be transported from one place to another a high efficiency and low cost of upkeep and great reliability are secured. The transporters are manufactured in four standard sizes, having capacities of ½, 1, 2 and 4 tons, with hoisting speeds of 40, 20, 15 and 10 ft. per minute. Travelling speeds can be arranged to suit the special arrangements of customers. High speeds are in every way desirable where electrical transporters are employed. The bogie construction of the Heywood transporter would appear to facilitate high-speed travelling, particularly round curves. The success of the bogie in locomotive practice is in itself an earnest of satisfactory running.

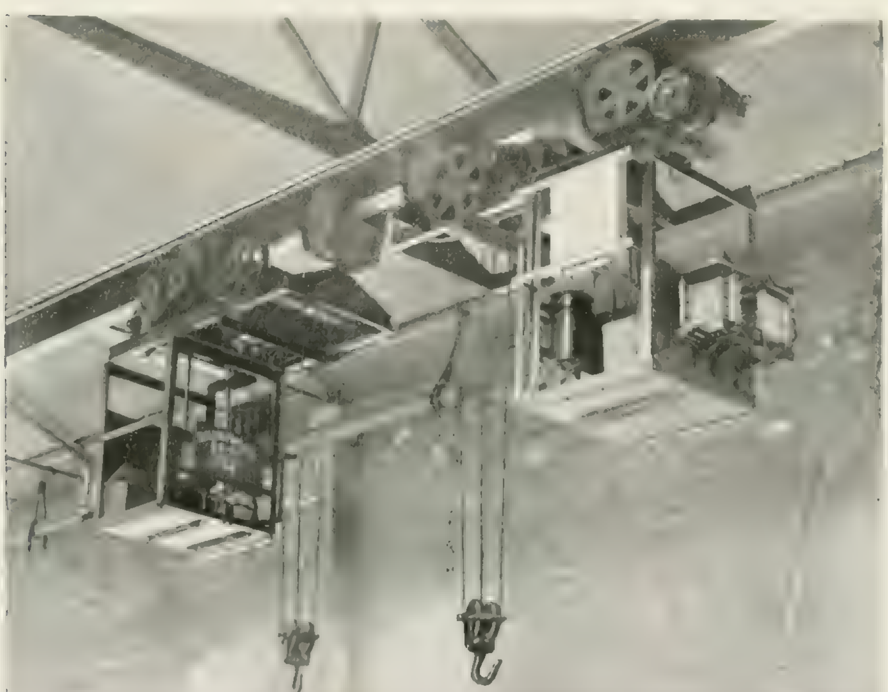
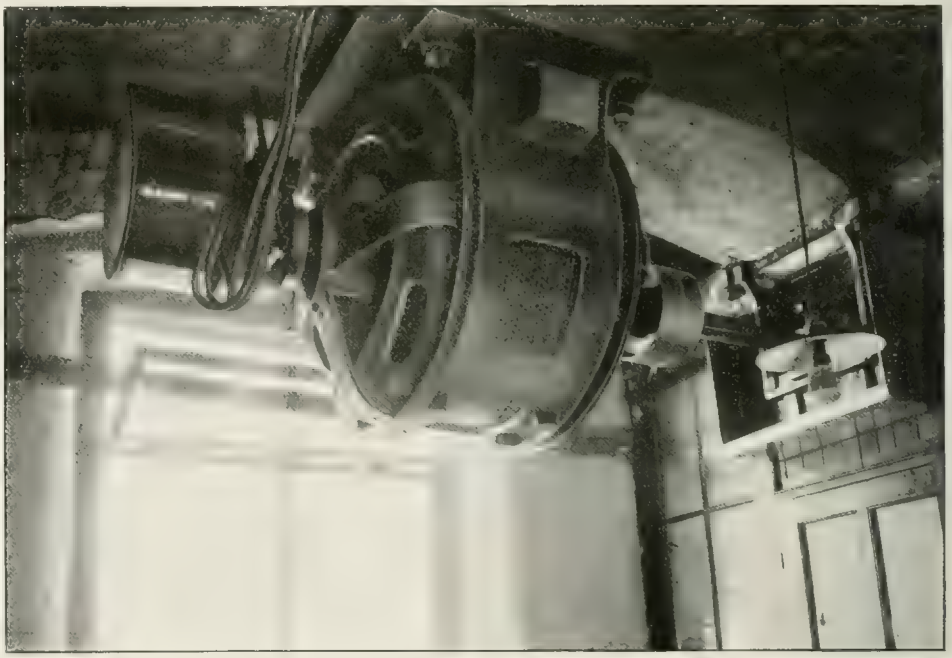


Fig. 1.—Heywood Transporters on Single Rail.

Electric Power and Textiles.

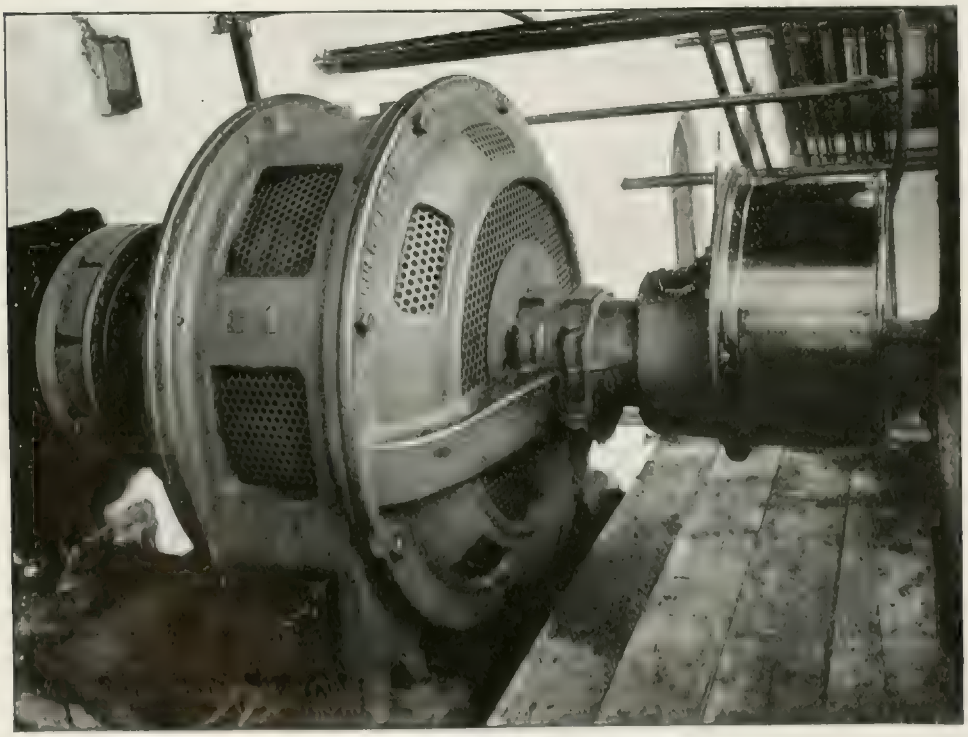
"THERE is no better advertisement than a satisfied customer." It may equally well be postulated that there is no better advertisement than an electric power installation. For years power users have dilly-dallied with electricity, and even electrical engineers themselves have appeared apathetic to developments of industrial electrical energy—that is, they have seemed indifferent to outsiders. The initial trouble was an installation, a complete equipment, of a workshop or factory, which might be pointed out as typical of the practice and representative of the economics of electric driving. A motor maker or supplier of electricity able to point to actual work done with motors was streets ahead of others deficient in this respect. Small wonder. The man to be convinced naturally wanted tangible evidence. Once started, the subsequent effort to persuade the next prospective customer is ridiculously small by comparison with the first problem. What is the general result? Electric power is now accepted as the first axiom of works driving in industries which for some years now have identified their productive machinery with the electric motor.



Brush Induction Motor driving Shafting in Textile Mill.

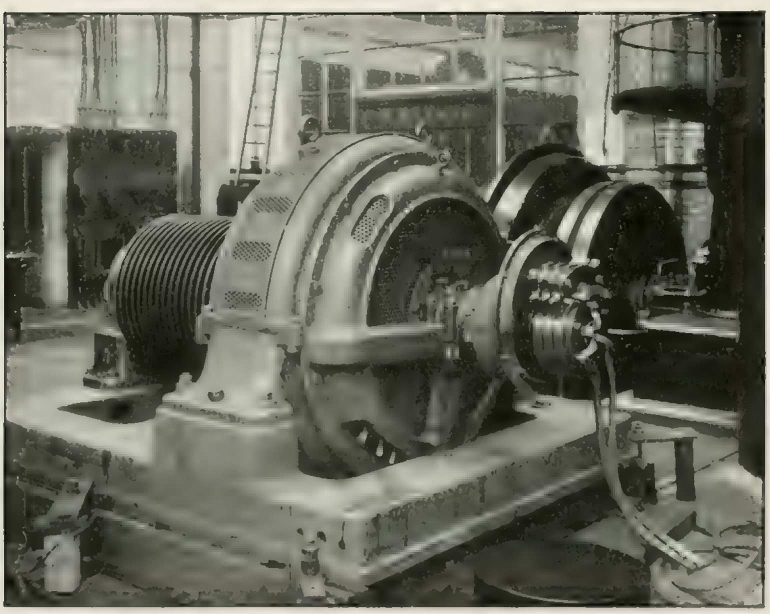
And this is happening with textiles. Here the conditions are peculiar; the districts in which the mule and loom have been developed are notorious for their prejudice against innovations, the annals of the industry dip so deeply into the past—an engineering past bristling with mechanical as distinguished from electrical achievement—that process has become hidebound and methods stereotyped; in fact, it would probably be difficult to find another branch of industrial effort, excepting, perhaps, coal mining, in which the past so markedly guides and controls the present. We refer, of course, to the power aspect of the question, with which we are dealing, rather than to the development of textile machinery proper; progress in the latter has been admittedly phenomenal.

After several years of hard missionary work, the electric motor has found its place in the textile mill. Our own textile centres of activity—assuredly the largest and most enterprising in the world—have lacked, and still do lack, we think, the number of electrically driven mills which the amount of effort already expended in giving electric power prominence would justify. The returns at the moment do not bear comparison with the initial exploitation expenditure. But the results achieved really represent the bulk of the labour required. Several mills are running, equipped throughout with the electric drive, either operating their own plant or purchasing power from outside. Questions of shafting, speeds, positions of motors, duty of controllers, &c., have been settled for the particular installations at work, and these in themselves constitute a decided step forward. They display evidences of the most tangible character of a confidence—a certain confidence—on the part of the textile



Brush Slip-Ring Motor driving Shafting through Wall.

manufacturer in the electric driving of his machinery. Clearly outlined against the background of general discussion of the subject of electric power in textiles were the criticisms and comments upon methods of driving, purchase and cost of power, &c. Side by side with these wranglings, which are useful if only as advertisements for electric power, has proceeded the surer, steadier policy of installation under existing conditions. This is already exercising a strong influence upon the prejudices and opinions of the engineers and directors of textile factories. It is also serving the electric power engineer. Constant extension of his experience enables him to suggest improvements or better conditions for the installation of motors in other mills. Comparison between plant and plant can also



Brush Textile Motor with Three Bearings adapted for Rope Driving.

be made with unquestionable advantage to the new purchaser of motors and the most recent example of their installation.

In this way slow, steady and sure progress is being made by electrical engineers among textile industries. The ideal conditions which electric driving may ultimately usher in are for the time being set aside. They can wait. A motor to each machine must come when the group drive with a motor on each floor has seen its day. Meantime it can serve the textile industry well and incidentally be instrumental in bringing nearer the day when the design of textile machinery will be based on some essentially electrical device, without which it will not be considered in every way complete. The illustrations adjoining show typical applications of modern polyphase motors to the driving conditions met with in textile mills. They have been installed by the Brush Co. and are doing yeoman service in the good cause of electric power expansion.

Electrical Irrigation.

THE attention which we recently directed to centrifugal pumps driven directly by electric motors, adds interest to the fact that in many districts, abroad and in the United States, traversed by transmission lines, irrigation by means of electric centrifugals can be successfully and profitably carried on. Some data regarding the actual cost of plants of this kind were recently published in the *Electrical World*. The average cost of a pumping outfit suitable for 150 acres is between £3 and £100 per acre. What may be termed an "acre inch" is equal to 27,150 gallons, and taking the case of a 140 acre farm two acre inches are supplied at each watering over 14 acres. This is equal to 760,000 gallons, or $3\frac{1}{2}$ acres per hour. An 8 in. pump discharges 1,600 gallons per minute, or 96,000 per hour; in eight hours 768,000 gallons would be supplied, or 8,000 in excess of the required amount. A pump of this capacity requires 0·82 H.P. per foot lift, so that for a 14 ft. lift, which may be taken as a fair average, during an eight hour day 92 H.P. hours would be required. A season of 100 days is taken as a basis for comparison, and during this period 6,863·2 kw.-hours would need to be supplied. Taken at the rate of $1\frac{1}{2}$d. per kilowatt-hour the cost for the whole season would be £41, or about $1\frac{1}{4}$d. per acre. These pumping plants are becoming quite common on transmission lines for use in connection with irrigation systems.

The merits of the centrifugal pump, as applied to central station service, are also dealt with in the same issue of our contemporary by Mr. E. N. Percy. Referring to the matter of irrigation the writer states that 760 acres of crops were raised on desert land irrigated by a 4 in. pump lifting water 15 ft. In another instance a 12 in. pump, lifting water 15 ft., irrigated 1,500 acres from which four crops of alfalfa were raised in 12 months. These plants were driven by steam engines, but it was pointed out that they might equally well have been operated by electrical energy from a transmission line.

THE ELECTRICIAN INDUSTRIAL SUPPLEMENT.

ISSUED MONTHLY

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Manufacturers, Contractors, Central Station Engineers, and those interested in Electrical Industrial Developments are cordially invited to contribute original matter to the SUPPLEMENT, and when suitable this will be inserted as space permits.

Filing Case for "The Electrician" Industrial Supplement.

The INDUSTRIAL SUPPLEMENT is holed for filing, and we are distributing cases which will hold twelve issues. On request a case will be sent to Consulting, Manufacturing, or Contracting firms; to Chief or Resident Engineers of Electricity Supply, Traction or Power Stations; to any firm of Merchants or Agents; to Railway, Tramway, Dock, Harbour, or other companies interested in the applications of Electric Power, &c., to their undertakings; and to other large consumers of electrical energy, either at home, in the Colonies, or abroad.

A portion of each issue of the SUPPLEMENT is reserved for special circulation oversea.

Editorial.

Small Transporters. We give considerable space in this issue to the subject of electrical transporters of the small travelling mono-rail type. The industrial value of these useful devices will be enhanced in direct proportion to their employment. The more they are used the more will their utilities force themselves upon the manufacturer and the power user. They have now been standardised to an extent which admits of a comparison being made between them and other methods of transport. They have very clearly demonstrated practically and effectively their ability to handle small loads at high speeds with an economy which is unapproached. It may be remarked here that the small travelling transporter is essentially an electrical device. No other power agent could be applied and controlled in just the same way as the motors of mechanisms of this class. The electric motor may claim the mono-rail transporter as peculiarly its own. It is singularly interesting to recall the earliest, and probably the first, of these devices ever put into practice. It was erected many years ago in Victoria Station, Manchester, by Mather & Platt, and has been run constantly since its installation. It differs from modern machines in that there are two insulator-supported rails which serve as current conductors and running track. This design appeared to be the best solution of a somewhat troublesome problem in those days—that of current supply to the travelling motors. The later pattern transporters run on the ubiquitous steel girder and bare conductors run by the side of this, current being collected by a miniature tramcar trolley. This is found to answer admirably, proving as reliable as the last mentioned well-tried device. The manufacturer and the merchant will find the small electrical transporter solve many problems for them, while it will also suggest methods of dealing with material which are quite impossible without it. For some industries it is a device which has long been wanted, and only needs a trial to be generally used. First cost is perhaps against its wholesale installation, but beside this must be placed the operating economies made up of time and labour saved. The same may be said for the electric pulley block, and we may look to both this and the electric traveller to revolutionise the industrial transport of small goods.

Italian Electrics. The matter which we publish on another page describing the Milan Works of the Olivetti Electrical Instrument Co. brings to mind the future prospects of electrical development in a country like Italy. Without the statistics of Italian electrical industries before us we cannot consider the facts as they stand, in the light of futurity. Still, we are safe in prophesying for Italy a future which will be indissolubly associated with hydro-electric power. In these days of engineering activity a high international status is achieved by development of the industrial arts. Natural resources, such as mineral wealth, rich arable lands and an industrious people; given these, with an abundance of cheap power, and one has a potential industrial system, whose limits of development it would be difficult to impose with certainty. Our insular position among European nations has in no small measure contributed to our prowess in the realm of engineering. In like measure the extensive maritime boundaries of Italy and its snow-capped northern borders give it in some measure the advantages of isolation with certain other facilities only afforded a Continental nation. We may look to Italy to maintain the position of Europe in hydro-electric transmission schemes in competition with the engineering achievements of America. In the matter of power utilisation also we may anticipate the introduction of methods which will establish valuable precedents and be of service to other countries engaged in similar work. We may remark upon the preponderance of alternate current plants among Italian installations. Much pioneering has been done in this province, even to the extent of polyphase railway traction, installed some years ago on the Valtellina line. Similarly, the hydro-electric transmissions are alternate current plants, and in their development Italian engineers have established standards in insulator practice which meet with recognition in all parts of the world. This attachment to alternate current working recalls the fact that the Olivetti Instrument Company, whose works we have referred to above, make a speciality of wattmeters of an extremely reliable and sensitive class, for the measurement of electrical energy. This class of instrument has always proved somewhat of a problem to manufacturers owing to the numerous varying factors which must be allowed for. We shall, therefore, watch the progress of the Olivetti instrument with considerable interest. Incidentally we may remark here that the works of the company are the largest in Italy devoted solely to the making of electrical instruments, which range from delicate standards to ordinary commercial types of instrument. Its methods of manufacture are based on many years' experience and we have been able to indicate elsewhere that its products are both wide in range and give every appearance of quality and durability.

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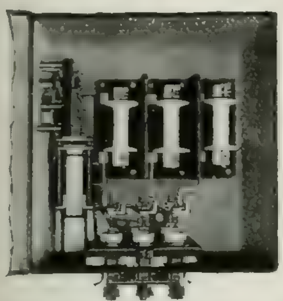

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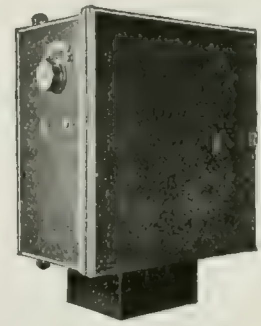

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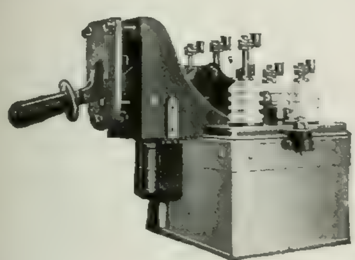

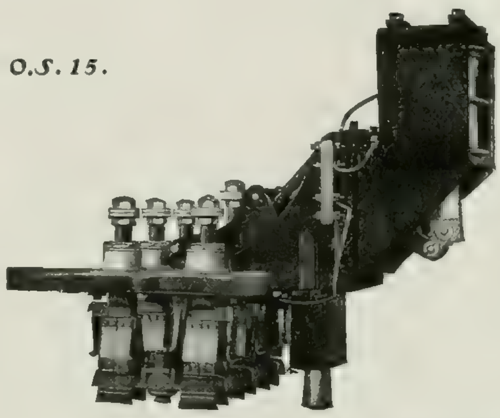

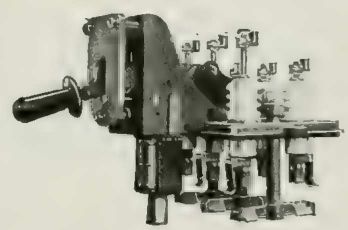

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Davidson & Co., Ltd.,

Sirocco Engineering Works,

Belfast.

The Electrical Equipment of the Clement-Talbot Works.

It is not so many years ago that the advance of a mechanically-propelled vehicle along the road was made the occasion of a sort of procession, in which a man with a red flag bore a prominent part. But that is all changed now, perhaps for the better, and perhaps, as some would have us suppose, for the worse. At any rate, the advent of the motor car has practically created a new industry, in the evolution of which there are many points of interest.

It is but right that this new movement should identify itself with the electric drive. Being essentially modern, it is only natural it should cling to new methods, and, as a result, a motor-car works is generally a good example of up-to-date workshop practice.

Among the foremost of these may be placed the works of Messrs. Clement-Talbot (Ltd.), makers of the well-known Talbot car, at North Kensington. Having been built only in 1905, the management were enabled to make use of the most modern electrical appliances in the equipment of the various shops.

As far as power is concerned, the works are self-contained. This applies especially to the engine room. It contains two 150 H.P. gas engines, which are direct coupled to Siemens dynamos, the voltage throughout being 110 volts. The necessary gas is generated in a separate building at the far end of the works, and is transmitted through underground pipes to the engine room. Recent extensions have made necessary the addition of a 100 H.P. horizontal gas engine, direct coupled to a Siemens generator, and the engine room also contains a small set for lighting the offices, &c., when main engines are shut down.

The switchboard possesses some points of interest. There are two sets of 'bus bars, to one of which one large unit is connected, the second set being connected to the others. The new set can be connected through a change-over switch to either set of bars. This is a special advantage in a gas-driven station, for it allows the load to be equalised with the greatest ease. The machine panels are further equipped with main ammeters and the usual field regulators. The feeder switches are also capable of connection to either set of 'bus bars, thus making subdivision of the load a simple matter. The distribution from this point is of two kinds. In the older shops the motors are fed by separate circuits straight from the switchboard, though in the more modern portion the usual practice of fitting distribution boxes is followed. The small panel shown at the end of the switchboard is for the control of the battery, which can be placed on either 'bus bars for charging or discharging. In the former case it can be subdivided into two halves. It is used for lighting offices and shops after hours, and thus allows the main engines to be shut down.

The motors installed aggregate 200 H.P., while the equivalent lighting comes to about 100 H.P. This includes 100 enclosed arcs.

In the machine shop group driving has been, in general, adopted. The motors are fixed upside down to roof girders in the older shops. This arrangement, however, possesses some disadvantages, and in the newer part they are fitted the right way up. In all cases cages have been provided so that the motors are easily get-at-able. This arrangement is doubtless appreciated by all concerned, as it avoids scrambling about with ladders and thus removes at least one element of danger.

The motors, over 30 in number, the largest of which is 40 H.P., are controlled by a single-pole switch and starter, fixed on a special board near the motor. An ammeter is also fitted, thus permitting a close watch to be kept on overloading. When works are being rapidly extended, and new machine tools are added almost daily, this is of extreme importance, and for this reason these special precautions have been taken.

A place of interest is the engine testing shop, where all engines are "run in" and tested before being fitted on the cars. The load on the engine is measured by quasi-electrical means in the following manner: It is coupled to a shunt dynamo whose field frame is revolvable about the shaft axis. When the machine is excited a certain drag is exerted between armature and field windings which can be measured on a dynamometer. Calibration curves have been got out, and to measure the horse-power exerted is then very easy. The switchboard on the left is fitted with switches, allowing a wide field regulation to be obtained, and further enables the dynamo to be put on to a bank of resistances for absorbing the load. These arrangements enable the output of the car engine to be tested with great ease, while the fact that the electrical equipment is a fixture does away with the "stray" wiring usually met with in a test room.

In general arc lamps have been used for shop lighting, but an incandescent lamp is fitted on each machine tool, and there are also a number of pilot circuits which allow the shops to be partially illuminated after hours. There is not much scope for outside lighting, but the track on which every Talbot car is run before being sent out is lighted by arc lamps.

From the above description it will be seen that Messrs. Clement-Talbot have spared no pains in laying out their works so as to produce the necessary finished material for the modern motor car in the most efficient manner. We are indebted to Mr. C. R. Garrard, the works manager, and to Mr. R. C. Milliken, works engineer, under whose supervision the recent extensions were carried out, for the electrical details given above.

Index to Advertisers.

Transportable Motors.

IN the average engineering workshop in which electric driving of machine tools is in vogue there would appear to be numerous opportunities for the employment of transportable motors. The use of motors in this way is facilitated by the existence at various parts of the works of supply circuits which can be tapped by the insertion of a suitable socket and wall plug. Fittings of this class are now standardised for workshop use, and are constructed to withstand the rough usage which the average workman generally gives to everything coming under his hands. As far as the portable motors are concerned, these also have been recently standardised in the matter of their application to drills and hoists. It is not a particularly difficult matter to attach the motor to a suitable gearing and to mount these with starting and regulating gear, instruments and flexible connections on a pair of wheels attached to a suitable truck. Motor equipments of this class will be better known amongst engineers, builders, shipwrights, &c., and, in fact, in every situation in which power is required temporarily. Not unfrequently, where extensive motor drives of a semi-permanent character are installed, either the value of a transportable out-

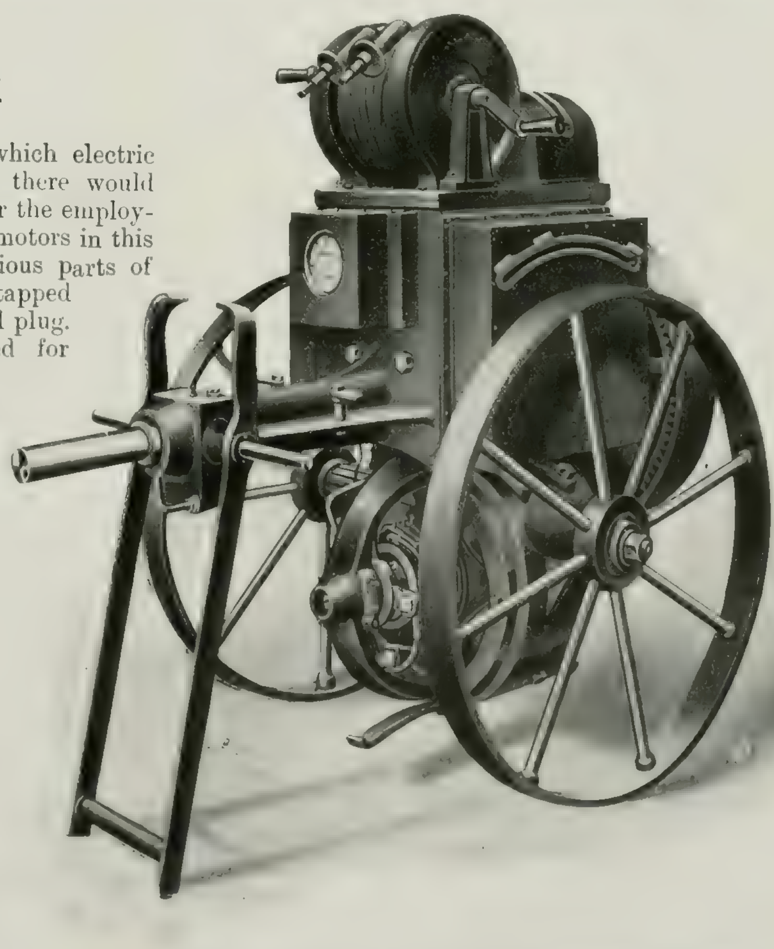


Fig. 1.—General View of Schorch Transportable Motor.

fit is not appreciated or the existence of standard apparatus of this class is not known.

We depict in Fig. 1 a typical transportable motor complete with starting gear, which is supplied by the Schorch Electrical Co., 35, Basinghall-street, E.C. It will be noticed that the motor practically forms a part of the carriage, there being bosses cast on the field frame for the reception of the shafts for the wheels. The speed of the motor is reduced to that of the drill shaft by a single pinion and spur wheel. The latter is carried in a substantial casting, which also forms a support for the main switch, flexible cable drum, starting rheostat and main ammeter. The main switch and starting switch are interlocked so that the latter cannot be moved ahead. The flexible cable is wound round a drum fitted with sliding contacts below the level of the top of the resistance box. Substantial plugs are fitted to the free ends of the flexible cables. When the motors are in use the shafts of the carriage are turned downwards and locked in position to form legs for the support of the entire gear. The same design of motor is suitable for the operation of hoisting jacks in locomotive shops and also for use as an independent hoisting unit. Motors of this class are illustrated in Fig. 2 diagrammatically.

The locomotive rests upon the supports, which in their turn are resting on four lifting jacks, c and d. The spindles of the lifting jacks c must move simultaneously, as both are connected automatically to the motor shaft h by means of the coupling g. In order to ensure the simultaneous driving of the spindle of the jacks d and c, chain wheels, i, are attached to the shaft f, and these wheels drive the gear wheels of the lifting jacks d by means of a chain with joined links.

As an alternative to the chain wheels i and chain, as shown above, two pairs of conical wheels, which are connected by means of a loose shaft, may be employed.

The Schorch Electrical Co. has supplied a large number of this type of motor to the Administration of the Royal Prussian Government Railways for the driving of locomotive lifting jacks in the locomotive shops.

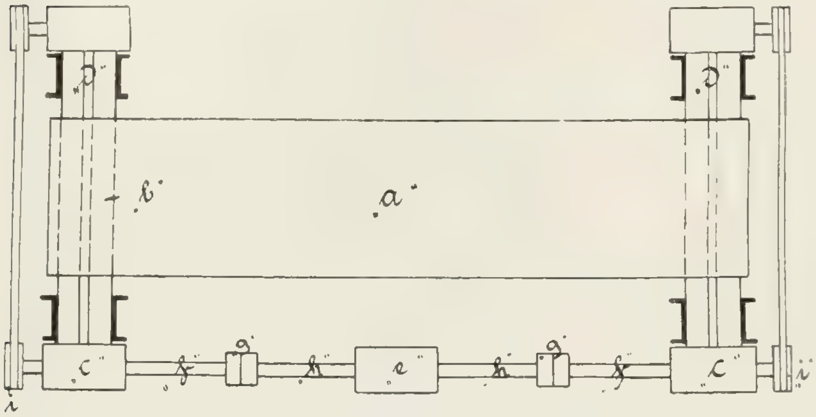
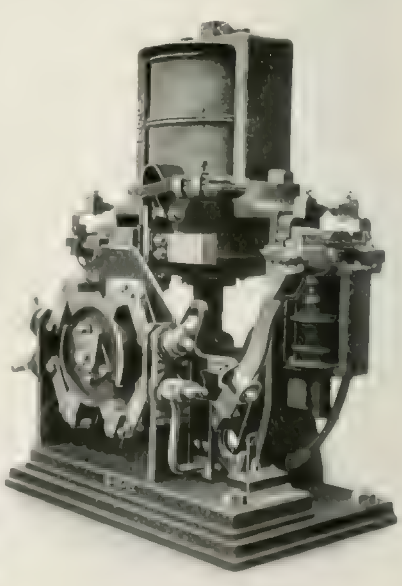


Fig. 2.—Portable Motors driving Hoisting Jacks.

E.C.C. Electrical Lifts.

THE superiority of the electric lifts over the hydraulic has been so constantly proved by experience that it is quite unnecessary to advance arguments in favour of the former. The world's best hotels, residential flats and palatial commercial establishments, each and all boast of an electric lift of one kind or another. Large manufacturing works, mills, factories, warehouses and numerous other industrial establishments are considered incomplete without an electric lifting equipment. These facts add considerable interest to the design and construction of the lift gear which the Electric Construction Co. has recently put on the market.

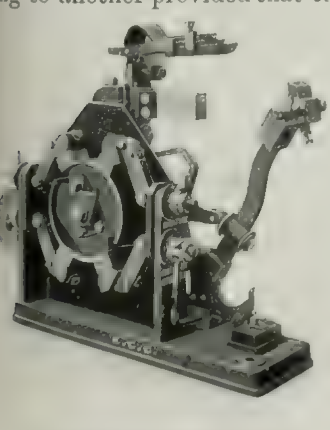
Standard designs have been prepared for both passenger and goods lifts, and we understand that the company is prepared to manufacture, erect and set to work lifts of this class, wherever they may be required. In connection with this description it is interesting to recall that the Electric Construction Co. were the first if not among the first to employ solenoid switch apparatus for the control of circuits from a distance. In pioneering the high-tension continuous current system in this country they were instrumental in bringing forward a class of controlling gear which has since been accepted as standard by the industry at large. No surprise need, therefore, be expressed at the fact that in the E.C.C. lift gear the solenoid switchgear occupies a prominent position.



Solenoid-operated Main and Reversing Switch.

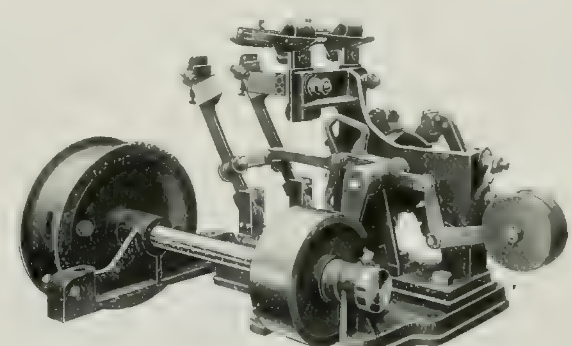
The E.C.C. lift is designed for three distinct methods of control — hand rope, car switch and the press button. The

hand rope method is usually employed for goods lifts which do not exceed the speed of 100 ft. per minute. In the E.C.C. equipment ample travel of the rope has been allowed for between the on and off positions of the switch to prevent the lift being set in motion in the opposite direction when it is desired to stop. The car switch control consists of a simple pilot switch in the car fitted with a handle, which is pushed for the descent and raised for the ascent of the cage. The safeguards against accidents are important. The reversal of the cage is provided for by the design of the operating handle, this must be taken out, turned round and replaced before the car can be reversed. The switch is also fitted with two positions for high and low speeds to facilitate accurate stopping of the car opposite the landings. The press button control is naturally somewhat elaborate, but is one of the most simple to operate. No attendant is required, and the user of the lift has complete control over its movements. The cage can also be brought from one landing to another provided that the doors and gates are closed.



Main and Reversing Switch.

In the lift gear itself there is a single reduction between the motor and the winding drum, worm gearing being employed. As the general view shows, the worm is mounted on top of the wheel, and this shaft runs in special bearings provided with a ball thrust block. The whole of the gear runs in oil, and as the speed is low, ample lubrication is assured. Two types of winding drums can be provided, the wound or the non-wound types. In the first of these, the cage ropes are anchored to the drum at one side and the balance weight ropes to the other, and as the drum is turning round, one set of ropes is wound and the other set unwound. In the non-wound type the



Rope-operated Main and Reversing Switch for Three-phase Motor.

set of four ropes is fitted to one end and each touches the balance weight from these, the ropes passing through the overhead pulleys down shaft, and under the winding drum, then up again through a further set of overhead pulleys, and down to the car. The drive in this instance is entirely by the friction of the ropes in the grooves of the drum. With this arrangement it is impossible to overwind, as, when the balance weight reaches the bottom of the shaft the rope becomes slack and looses its grip on the drum.

Special precautions have been taken to ensure absolute safety for the lift, should the ropes break, or the controlling gear get out of order. There is a powerful brake fitted to the motor shaft, this being held off by a solenoid in cir-

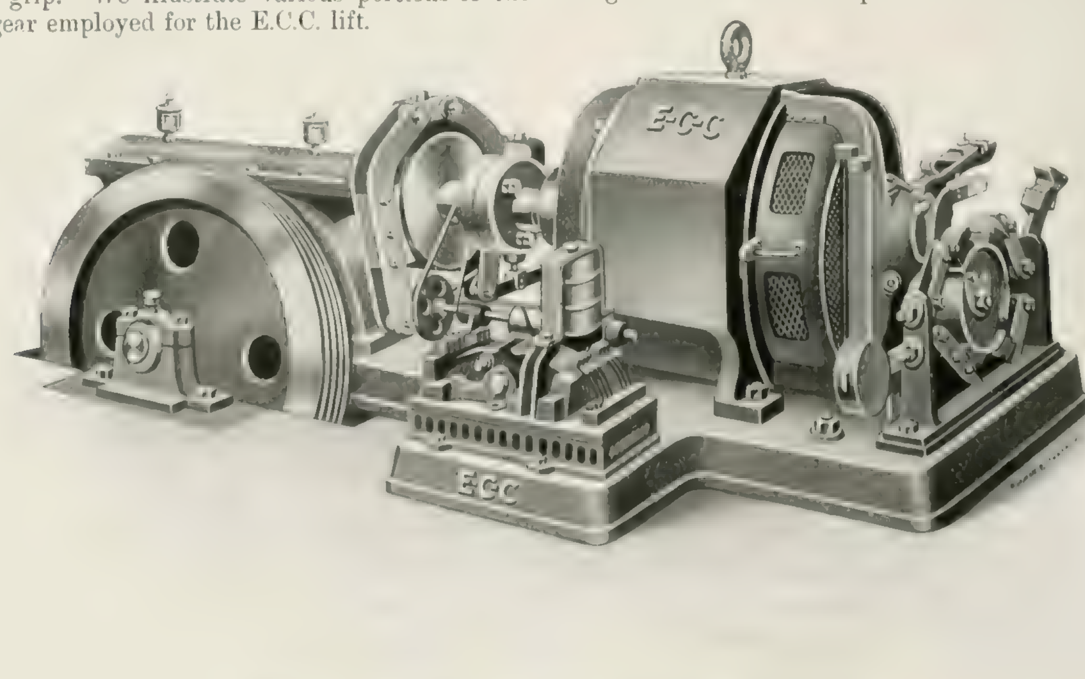
cuit with the motor itself. Should the supply current fail at any time the solenoid becomes deenergised and the brake is put on by means of a powerful spring. With rope-controlled lifts collars are fitted to the rope so that as the car approaches the top or bottom floors the rope is moved either up or down by the car itself, and the main switch is opened. Should these, however, fail switches are provided at the bottom of the lift shaft and re-opened either by the car or the balance-weight, and entirely disconnect the main circuit with the car-switch and press-button lifts. These trip switches have auxiliary contacts, which open the inductive circuit of the brake. For high-speed lifts controlled from the car, cam-gear is fixed in the lift, and will automatically move the car-switch to the off position as soon as the top or bottom floors are approached. The E.C.C. lift cars are fitted with special safety grips. The rope passes from the car over the top pulleys to the balance-weight, and is so arranged that if the distance between the car and balance weight, measured over the pulleys, were increased by a few inches, the safety grips would be brought into action. These grips are sufficiently powerful to hold the car when fully loaded. We understand that the company is prepared to demonstrate this by hanging the car, when fully loaded, to a hempen rope, cutting this, and allowing the car to drop on to the safety grip. We illustrate various portions of the controlling gear employed for the E.C.C. lift.

Automatic Control Switches.

A NOTEWORTHY feature of the application of electric motors to industry is the employment of the automatic switch. The "knock on and off" switch has been common enough for some time, its sphere of utility being mostly confined to pump motors, air compressors, certain machine tools, &c. Its function is usually that of governing the starting and stopping of the motor or controlling its direction and speed. Pull rods and cords are mostly used for the operation of these switches, the switch being mounted in the most suitable position for direct alignment with the pull rod. Not infrequently this arrangement leads to the fixing of the switch in inaccessible positions —*i.e.*, inconvenient from the point of view of inspection. Carrying as they do the full current of the motor, switches of this class need to be fixed where it is possible to get at them easily. This cannot always be readily arranged, so that an alternative must be sought to overcome the difficulty. The solenoid distance control switch is the alternative, and an excellent one it makes, because it may be placed in a position always under observation and always accessible. The solenoid control switch has been "tried out" and proved reliable. Although it increases the number of control units by one, it improves the starting conditions of the motor, as, by the introduction of what we have termed above the "discriminating" element, the motor can be got away under conditions which are always regularly reproduced.

Fig. 1.—Pressure Gauge for Control of Solenoid Switch.

The foregoing comments may serve fittingly to introduce to our readers a line of starters being put on the market by the Union Electric Co. These have been specially designed to meet the requirements of automatic control



Complete E.C.C. Electric Lift driven by Continuous Current Motor.

usually presented by air and water pumps, lifts, machine tools, &c. The series includes rope operated starters actuated from floats in the water tank, or pressure receiver supplied from the motor-driven pump or air compressor. This type, known as "System A," is fitted with knock over weights which throw the starting switch on or off as the case may be, the switch movement being further controlled by a damping fan during the switching on period. Pull ropes and weights are used with this system, and it should be noted that if the travel of the float between its high and low limits is not great enough to actuate the switch, a pulley may be attached to the float to increase the travel, but the float must be twice as large and twice as heavy as before.

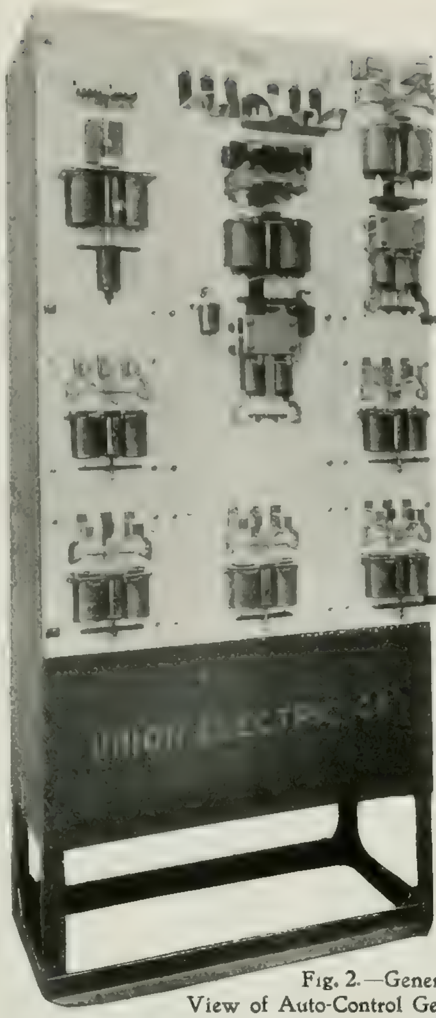


Fig. 2.—General View of Auto-Control Gear.

System "B" includes what are termed contact starters, or the type to which we have referred above, intended for use with solenoid switches. The usual arrangement is a single-pole switch, to open and close the circuit of the solenoid starter, the switch being actuated by a float and cord in the usual way. A pressure gauge, such as is shown in Fig. 1, is also made for the purpose of motor control, and may be coupled to water, air or gas receivers. A gauge of this type can be placed in any desired position, even to the extent of several hundred yards from the actual controlling gear. In the case of long distances, relays are used in the line circuit to ensure full voltage at the solenoid of the starting switch. The starting gear employed with the pressure gauge in Fig. 1 is illustrated in Fig. 2. This shows the solenoid switches for a 70 H.P. 500 volt three-phase motor. The larger solenoid at the right top of the panel controls the stator circuit and is switched in first. The small switches cut out the rotor resistance, and their circuits are controlled by the centre solenoid which brings them up one by one much in the same manner as direct current starters of the similar type. This last-mentioned controller is fitted with a mechanical time element. The direct current starters are built after the same pattern, but the rate of cutting out the resistance is governed by the armature speed, as the solenoids controlling the resistance switches are wound for different pressure values. It is claimed that uniform acceleration is obtained without disturbance of the line voltage. Starters of this pattern are made for the control of motors from 15 H.P. to 100 H.P. and for pressures between 110 and 500 volts. A recently issued catalogue, No. 6,020, Section VII., gives the fullest details of these starters.

Mono-Rail Transporting Appliances.

THE many advantages to be obtained by the use of mono-rail hoisting and transporting appliances in preference to hand-operated machines are rapidly being realised. The saving in time and labour is so great that their adoption is well worth the consideration of any manufacturers who are constantly handling loads up to about 5 tons in shops or warehouses. They combine the advantages of the electric overhead travelling crane with the compactness of a hand-pulley block. High lifting and travelling speeds can be obtained, and the current consumption is exceedingly small, 1d. worth of electricity being sufficient for 50 lifts of 1 ton, inclusive of lowering.

The following is a specification of an electric mono-rail hoist designed and constructed by Messrs. Kramos (Ltd.), of Bath, which is particularly compact. It consists of a motor driving a machined drum through several sets of machine-cut spur-gearing. The motor is series-wound, so that light loads can be raised at considerably higher speeds than the full-load. In some cases a Renold high-speed chain-drive is used for the first reduction instead of spur-gearing. The drum runs loose on a fixed shaft, and is so arranged that almost any lifting height can be obtained by winding several layers of rope over the first, the flanges preventing the rope slipping in the case of side pulleys. On the motor shaft an electric brake of the double solenoid type, with leather-lined brake shoes, is fitted. This brake opens immediately current is sent through the motor, and closes when the supply ceases. It is extremely powerful, and can hold the load in any position. Best plough steel wire rope is employed for raising the load, and the lifting hook is mounted between solid steel plates and arranged to swivel. All these parts and the necessary bearings and brackets are bolted to a solid steel top plate.

The hoists are made in four types as follows :—

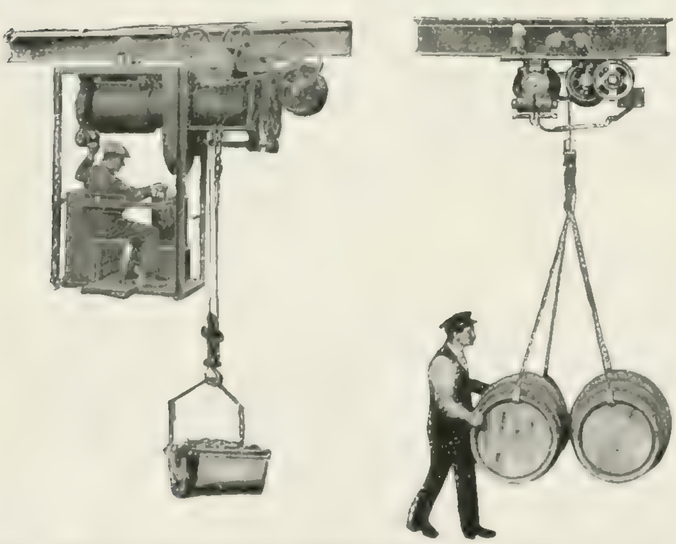
1. For suspension from existing crane hooks or chains, &c. For this purpose it is fitted with a suspension link attached to top of steel plate.

Mono-Rail Tansporter with Lifting Magnet controlled from Floor Level.

2. For travelling on an I beam by pushing the load. Four ball-bearing rollers are then fitted in steel brackets bolted to the top plate, and as the load is suspended in centre line of hoist and girder easy travel is assured.

3. By travelling on an I beam by means of chain wheel and chain, the sprocket wheel and chain driving a set of spur gearing which gears on to two of the travelling rollers.

4. For travelling on an I beam electrically. A separate electric motor drives the travelling rollers through machine cut spur gearing, a separate controller being provided for this motion.



Two Views of Transporters in which the Motors are Controlled from a Cage and from the Ground respectively.

The control in every case is obtained by means of a Kramos controller fitted with Kramos patent resistance units, and this has been designed specially for hoist work of this description. A large deadway is allowed between reverse positions to prevent accidental reversal when switching off quickly.

Hoists can be arranged for three systems of control:—

1. The controller can be fixed to the hoist and operated by means of pendant cords with labelled handles.

2. The controllers can be fixed separately against a wall and operated by a lever handle.

3. A cab can be fixed to the hoist frame in which the operator sits and travels with the hoist. The controllers are all placed in this cab and arranged for convenient operation.

The current supply is brought to travelling hoists by means of bare copper wires stretched alongside girder from which current is brushed off by collectors fitted on the hoist. The suspension types are supplied with terminals to which the supply cables are brought. Overwinding and overtravelling switches to prevent the hoists overrunning should the operator fail to switch off can be fitted when necessary.

The above description applies particularly to direct current hoists, but alternating current machines for two or three-phase current are supplied, the only variations being that the motors have constant speeds, and the brake is mechanically operated by a cam action from the controller shaft. The types illustrated are Messrs. Kramos' standard designs, but in addition to these they design and construct all types of hauling and winding gears for special requirements, and also the necessary accessories for transporting plants, such as grabs, electro-lifting magnets, &c.

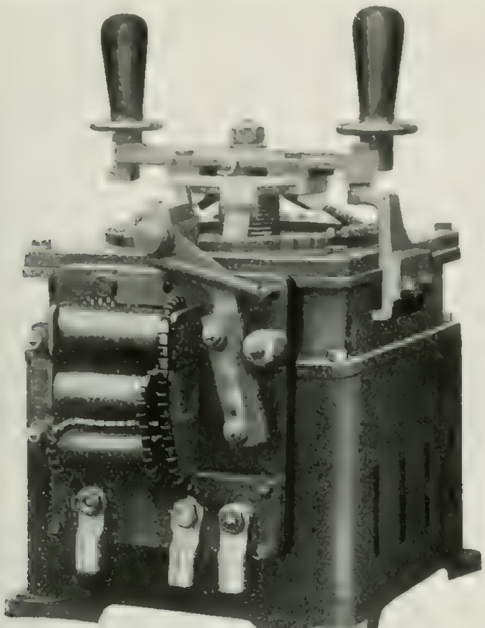
New Starters for Induction Motors.

AMONG the specialities manufactured by Siemens Bros. Dynamo Works (Ltd.) are starters for induction motors. They are supplied in many standard sizes for operating induction motors up to 175 B.H.P. and larger sizes are made to order. Most of the sizes are made in two variations—namely, for starting the motor every 10 minutes or every half-hour. The starting of the induction motor is effected in the usual manner by means of a three-legged non-inductive resistance induced in series with the rotor windings, and gradually cut out by the switch as the motor comes up to speed. The resistance has the effect of reducing the initial rotor current and at the same time increasing the starting torque. The starters can be used with any induction motor having a three-phase rotor.

Protected Type Starter.

The starter is supplied in the open type or protected type as shown in the illustrations. The starters can be fitted with no-load release, stator switch or magnetic blow-out and slow-motion device, and the smaller sizes can also be provided with a reversing stator switch, which is interlocked with the stator in such a manner that it can only be operated when the starter is in the "off" position. The stator switch is mounted on the side of the resistance box, and has a positive movement, so that it cannot remain in an intermediate position. The slow-motion and magnetic blow out device, which can be fitted to the larger sizes of starter, is of special value when the starter is required to withstand heavy duty and unskilled use. It is free from sparking between contacts, a disadvantage possessed by many slow-motion starters of other makes. In this device the contact is both made and broken by two renewable auxiliary contacts fitted with blow-out and snap action. All sizes are provided with contacts easily renewable from the front, with the exception of the smallest size, which has button contacts.

The firm also supplies starters with specially large running contacts to enable a comparatively small starter to be used with motors which are not called upon to start against



Open type Starter.

full load torque. It is worthy of note that no soldered connections are used in the starters. The resistances are of the firm's well-known "brick" type, which is specially suitable for motor-starting work. They are enclosed in strong cast-iron boxes which protect them from mechanical injury.

Acme Rotary Pumps.

THE Acme rotary pump, manufactured by Samuelson & Co., Banbury, has been designed for dealing with hot and cold water, and for liquids of every description. The pumps are of the rotary positive pattern, and the makers claim that, as there is practically no slip, the pumps operate at a high efficiency. The pumps consist of two revolvers or rotary pistons, accurately machined, so as to come together without actual contact, and these deal with the fluid to be pumped without the use of valves. Rotary pistons are mounted on steel spindles of large diameter, which are forced into the pistons by hydraulic pressure. The casings are substantially built and accurately bored to receive the rotary pistons, and the end plates are fitted with long stuffing boxes and machined on the face. The bearings are of the self-oiling ring pattern, and the bearing plates are of phosphor-bronze make, being specially long, so as to reduce wear to a minimum. The pistons rotate one upon the other, and are geared together by gearwheels at each end of the spindles. These gearwheels are machine-cut, and are enclosed in oil-tight cases. The pump is suitable for driving by hand, by belt or by electric motor. It can also be coupled direct to steam, gas and oil engines. The pumps are made in three patterns for dealing with heads of 50, 120 and 250 ft. A pump specially designed for dealing with 42,000 gallons of water per hour against a head of 430 ft. is being installed in a coal mine, and driven directly by an electric motor.

The Electrical Transporter.

In the majority of warehouses and store yards methods of transport are woefully deficient. The prevailing tendency appears to be towards rather than away from the methods of our forefathers in the handling of material. While there is a valuable quotum of enterprising manufacturers who leaven the present heavy lump which characterises the great majority, there remains a great mass of industrial and engineering establishments into which the products of transport development find their way but slowly.

The electrically-driven transporter, however, may reasonably be expected to place a different complexion on this state of affairs. Now that motors, light and powerful enough to be placed on overhead transporters, are available there is little or no excuse for ignoring their value or assisting in the efficient transport of material and light manufactured goods. From the user's standpoint, a likely difficulty—the supply of electrical energy—is overcome by the fact that in most workshops current is available at almost any point in the building. Even if this is not the case there is usually an electricity supply in the large cities and towns in which transporting devices are required.

We may consider for a moment a few of the special cases in which there is a constant loading and unloading of heavy and light goods and deal in some detail with their relation to the electrical transporter.

Newspaper and Printing Offices.—Daily newspapers are generally so placed that they cannot store the huge rolls of paper required for each day's editions. Even if store space were available there would be the difficulty of keeping it filled by the paper maker; further, it is questionable if storage space is desirable. The paper is used so quickly and in such quantity that the rehandling of it would become altogether too costly a matter. The most cogent reason against storage is that by the use of electrically operated transporting devices, both in the shape of lifts, hoists and travelling tackle the need for storage in any form is entirely done away. The paper can be run in from the dray and actually dropped into or near the machine, for which it is required. There is generally sufficient head room to allow of the fixing of the runway girders to the ceiling, especially as the vertical space occupied by the transporter is very small in comparison with its capacity and general utility. The duty imposed on electrical transporters in newspaper offices is naturally heavy, but the construction is substantial enough to merit their constant employment even under the most regularly arduous duty.

Warehouses, Stores, &c.—The lifting tackle and transporting appliances in these places are usually either operated by hand or they play no part in the work of the establishment. Where labour-saving devices are not used goods are carried in and out by hand, and there is no attempt made to introduce mechanical transport. There must, of course, always remain a considerable section of the community in which hand labour will always receive preference over machinery. Still, in the vast majority of cases, mechanical appliances can be introduced with expedition and profit. The electrical transport meets the requirements of the average warehouse and store so admirably that it merits the attention of merchants and manufacturers alike. In certain cases a small transporter will take the place of a large hoist and do the work more quickly. With a lighter lifting unit the goods to be handled can be placed in the desired position inside the store or warehouse and no further moving is required. The principal point to keep in mind in considering the merits of the electrical transporter is this; up to the present appliances of this kind have only been spasmodically used and their employment means the breaking down of an old regime and the setting up in its place of an entirely new method of operation.

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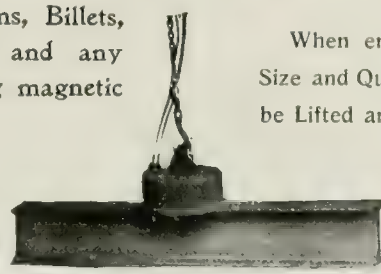

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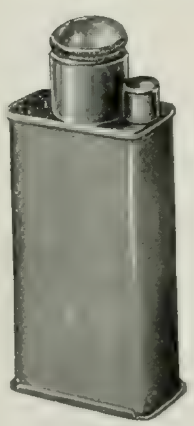

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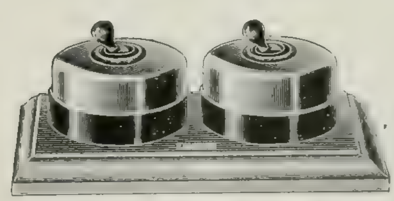

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CONTENTS OF THE CURRENT NUMBER.

NOTES.

The I.M.E.A. Convention Papers.

THE gathering of the municipal clans at Nottingham this year has been favoured with exceptional weather, a circumstance which has made the proceedings pleasurable from every point of view. Apart from its importance as the centre of the lace industry, represented by many large and progressive factories and mills, Nottingham is within easy reach of the Derbyshire dales, Sherwood Forest and other beautiful resorts, which serve to relieve the heavier items of a Convention programme. The Papers presented this year are noteworthy for the preponderance of the engineering as distinct from the "committeeman" element, a circumstance which need give little occasion for surprise. The Paper of Bailie WIGHTMAN, while interesting as a record of the trials and troubles of a convener during the getting to work of an undertaking, must not be taken too seriously. While the Bailie stated that the experience of Govan, from his own observation, resembled that of other towns of similar size, the particular conditions dealt with in his Paper were not typical altogether of present-day practice. A glance at the Paper itself, which is abstracted on another page, will, however, point the all too regrettable moral that the majority of committeemen are painfully ignorant of how an electricity works should be set up in a municipality and afterwards run on strictly commercial lines.

THE other Papers dealt with in this issue are of some engineering interest, particularly that of Mr. RICHARDSON, of Dundee. This covers so much ground in its treatment of modern power house design, that it might well have formed the subject of an afternoon's discussion by itself. It has the advantage, from a station engineer's point of view, of dealing with the lay-out and construction of a modern power house equipped with turbine plant and up-to-date condensing accessories. Mr. RICHARDSON'S comments on the use of reinforced concrete are worthy of careful note. We have often felt that the later methods of utilising concrete might be taken advantage of by station engineers in erecting new buildings. With Mr. RICHARDSON'S station on made-up ground, many opportunities of utilising concrete in different ways have presented themselves. Although he considers reinforced concrete unsuitable as a whole for station buildings, his investigations point favourably to the building of a concrete stack. Mr. SHAW'S Paper on the Worcester plant will, no doubt, earn for him the fullest sympathy of his brother engineers blessed (or otherwise) with only one type of prime mover. Similarly he may accept their congratulations on the manner in which he has tackled an extremely complex problem and achieved some measure of success. We fear that the record of his reconstruction difficulties, while it may prove useful to engineers in a similar position, and in this way might be read with profit by American engineers, clearly indicates that small combined water and steam plants cannot be made general in these islands owing to the uncertainty of the water power. Worcester is, of course, an old station, and this fact must be taken into account, but it is doubtful, if the undertaking were started now, whether the consulting engineer would be bold enough to carry through the combined water and steam power scheme.

The Institution of Electrical Engineers.

AT the special general meeting held on Tuesday last, the members of the Institution of Electrical Engineers had practically two questions to consider, one being the suitability of the building it was proposed to purchase, and the other the financial conditions involved. The building itself

is large, and indeed some members felt it was too large, though this in itself can scarcely be considered an ultimate disadvantage. Buildings are rarely what is just required by an incoming tenant, but we think it will be generally allowed that in this case the main buildings could be well adapted to the requirements of the Institution, more particularly if the social needs of the members are to be considered increasingly, as indeed we feel they should be. When, however, we pass to the lecture theatre, which is a building practically separate from the rest, we think the general opinion formed by those who saw it will be that the theatre as it stands is quite insufficient. The approach is bad, the size is small, and the acoustic properties, as demonstrated last Tuesday, are not good. We think, in fact, that the theatre as it stands will make a very poor substitute for the theatre of the Institution of Civil Engineers, and we are therefore of opinion that its reconstruction should not be delayed if money for this end is forthcoming.

WITH regard to the financial position, this is not very satisfactory, as will be found by referring to the figures which we publish on page 451 of our present issue, and we are not altogether surprised that there was some opposition to their acceptance. It is a somewhat bold step to start off with the possibility of a deficit on the first year's working. It is always difficult for the ordinary member, who is ignorant of all the pros and cons that must be taken into account, to come to a sound conclusion on a question of this kind; but perhaps the strongest evidence in favour of the project is that the Council were unanimous in supporting the scheme. Undoubtedly in such matters, which must necessarily be brought as far as possible to a conclusion without being made public, the Council should receive the complete support of the members, unless it is quite clear that there is good ground for opposition. Nevertheless, we think it will be admitted that the proposition cannot be described as a "business proposition," for the simple reason that it depends for a satisfactory financial outcome on certain estimated possibilities which have yet to be realised. We have every hope that these possibilities will not fail, and we trust that those members of the Institution who are in a position to do so will contribute generously to the building fund, which will still exist, and in that way support the Council so adequately in providing a home for the Institution that there will be no possibility of financial difficulties when the building is taken over in June next year.

The British Electric Traction Company.

THERE will be found on another page of this issue a report of the proceedings at the meeting of share and debenture holders of the British Electric Traction Co., practically the pioneer enterprise of this method of tramway and light railway working in this country. The report is full of interest to those who study the important public questions with which the B.E.T. Co. and its undertakings are chiefly concerned. Whatever differences of opinion may exist as to the advantages, or otherwise, of municipally-owned tramway enterprises we think it will be generally agreed that the efforts of the British Electric Traction Co. to establish a network of electric tramways and light railways in this country have been persistent and in the public interest. It will be further agreed that this vast undertaking has been ably managed and its numerous ramifications well engineered and officered. If these points are granted, and we think they will be, it is to be regretted both in the interests of the company and of the public, that a greater measure of financial success has not been attained by the company. Even in bad times a 6 per cent. dividend is not an unreasonable goal for such an investment, and if, as is contended by the responsible officials of the company, it is due in the main to the dog-in-the-manger policy of local authorities that this reasonable return on the investment is unattainable, it is in the general interest that such a state of affairs should be the subject of investigation. There is, from our reading of the company's report and balance-sheet, and a casual study of the general situation, nothing seriously amiss with the company's finances, but it is, all the same, urgently necessary that the shareholders, who are an influential body, should bring such influence to bear upon the local authorities as is in their power. A company such as the B.E.T. is dependent upon public sympathy and support, and if it is conducted on sound financial lines and with every due regard to the public interest, this sympathy and support should be given as a right in return for the public services which the company has rendered.

The International Radio-telegraphic Convention.

AN important stage in the development of radio-telegraphy was reached on Wednesday, when the International Radio-telegraphic Convention of Berlin, 1906, came into orce. Our readers will remember that this Convention enables the adhering Powers to prevent the indiscriminate employment of wireless telegraphy, and to compel interchange of messages between different systems. The Convention was discussed with great vigour in and out of Parliament, and strenuous opposition to its ratification by Great Britain was forthcoming from certain quarters. This opposition, however, did not avail, and the working of the new arrangements will be watched with great interest by all concerned with wireless telegraphy.

Civil List Pensions.—Among the Civil List pensions granted during the year ended March 31, 1908, is one to Dr. J. Hall Edwards, in recognition of his devotion to the furtherance of radiography in its application to medical and surgical science, and one to Mrs. J. W. Blyth, in consideration of the eminent attainments of her husband, the late Prof. James Blyth, in physical science. It will be remembered that Dr. Edwards has recently had both hands amputated owing to the effect of dermatitis brought on by his experiments with the Röntgen rays.

Institution of Electrical Engineers.—The annual Conversazione of this Institution was held at the Natural History Museum, South Kensington, on Thursday, June 25th. The President (Col. R. E. Crompton, C.B.) and Mrs. Crompton received the guests, who were not quite so numerous as usual. Among those present were: Prof. W. E. Ayrton, F.R.S., and Mrs. Ayrton, Sir J. Wolfe Barry, K.C.B., Prof. H. L. Callendar, F.R.S., Mr. E. Cunliffe Owen, Dr. R. T. Glazebrook, F.R.S., Mr. R. Kaye Gray, Sir Henry Mance, Sir Hiram Maxim, Mr. W. M. Mordey, Major W. A. J. O'Meara, Sir Clifton and Lady Robinson, Sir Joseph Swan, F.R.S., Prof. S. P. Thompson, F.R.S., and Prof. W. A. Tilden, F.R.S.

Cable Interruptions.	Date of Interruption.
Cayenne–Salinas	May 12, 1908
Las Palmas–Arrecife	May 18, 1908

Académie des Sciences.—M. Henri Becquerel has been elected permanent secretary of this society for the physical sciences.

Proposed University of Bristol.—It is announced that a petition for a charter to be granted for a University of Bristol has been sent to the Privy Council.

Students' Section of the Institution of Electrical Engineers.—As previously announced, members of this section will pay a week's visit to the Newcastle district, beginning on Monday next, July 6th. The party will leave St. Pancras on Monday morning and will break their journey at Derby to inspect the works of the Midland Railway Co., proceeding to Newcastle in the late afternoon. Among the works to be visited in and around Newcastle are those of Messrs. Ernest Scott & Mountain, Messrs. Armstrong, Whitworth & Co., Messrs. J. H. Holmes, Messrs. Clarke, Chapman, the Consett Iron Works, the shipyards of Messrs. Swan, Hunter & Richardson, and the Horden Collieries. On Saturday morning a visit will be paid to the Carville power station of the Newcastle-upon-Tyne Electric Supply Co. Mr. E. Moss, chairman of the Section, will be in charge of the party.

International Radio-Telegraphic Convention, Berlin, 1906.—It is announced publicly by the Post Office authorities that the International Radio-Telegraphic Convention came into force on July 1st for all adhering countries, which include the United Kingdom and almost all divisions of the British Empire.

It is further stated that notice will shortly be given of the stations on the coasts of the British Isles which will be open for communication with ships equipped with any type of wireless telegraph apparatus, and lists will be published from time to time giving particulars of the ships and the shore stations, in the United Kingdom and elsewhere, which are open to public correspondence, and of the rates which will be charged. The land telegraphs of all countries, with very few exceptions, will also be available in connection with radio-telegraphic shore stations, so that it will be possible to send radio-telegrams to ships from telegraph offices in the United Kingdom through the medium of foreign radio-telegraph stations, and foreign telegraph offices will accept radio-telegrams for transmission to ships through the medium of British stations. British ships will, moreover, be able to exchange messages with stations open for public correspondence in all countries which adhere to the Convention, irrespective of the system of radio-telegraphy employed, and will be able to secure the transmission of such messages to any part of the world.

Wireless Telegraph Notes.—The *London Gazette* contains an announcement that the Postmaster-General has made regulations (dated June 20th), which came into operation July 1st, regarding the working of apparatus for wireless telegraphy installed on foreign ships whilst such ships are in British territorial waters. Copies of the above-mentioned regulations were, however, not obtainable from the official printers in London nor from the Post Office up to the time of going to press, but we are informed that the regulations are simple and provide that disturbance must not be caused by the apparatus referred to, and that its operators must conform to the regulations governing the coast stations.

Royal Society's Conversazione.—The exhibits at the second of the two annual conversaziones of this society, which was held on Monday evening last, ladies being admitted on this occasion, did not differ to any considerable extent from those at the conversazione a short time ago, to which we referred in our issue of May 15th.

Among the exhibits attracting attention was the apparatus of Dr. J. A. Fleming, F.R.S., showing on a small scale high-frequency induction wireless telegraphy. A transmitting circuit had been set up at one end of the main library, whilst a receiving circuit containing an oscillation valve was fixed at the most distant end of the suite of rooms, 100 ft. away. The oscillations were cut up into Morse signals by a punched tape and relay in the primary circuit, and a telephone in connection with the oscillation valve served to indicate audibly the received oscillations. Dr. Alex. Muirhead, F.R.S., showed the latest form of Kelvin syphon recorder which had been converted into a cable relay by substituting fine gold wire for the silk fibre connecting the syphon to the vibrator. The local contacts are made between the vibrating gold wire and two silver stops, which are connected to the two terminals of the local or retransmitting line battery. Mr. J. T. Irwin showed, by means of his hot-wire oscillograph, the low frequency of the current in the rotor of an induction motor; the supply current was obtained from a rotary, and the very high frequency fluctuations were plainly indicated on the voltage waves. An interesting series of stereoscopic radiographs of molluscal shells was exhibited by Dr. H. Rodman, the radiographs providing the equivalent of vertical and horizontal sections. Previous to the application of Röntgen rays to this research, it was necessary to sacrifice valuable specimens in order to disclose their internal anatomy. Prof. A. Gamgee, F.R.S., described thermo-electric apparatus for recording fluctuations in the diurnal curve of temperature of animal bodies, continuous graphic records being shown.

Birthday Honours.—The list of King's birthday honours issued on Friday last contains no name which can be considered directly connected with the electrical profession or industry. Among those who were honoured, however, the following are not unremotely interested in electrical affairs, either from a scientific, legislative or financial point of view. They are as follows:—

New Baronet.—Mr. R. W. Perks, M.P., who was for a long time connected with the Metropolitan District Railway as chairman of the board of directors, and took a prominent part in the scheme for the electrification of the line.

New K.C.B.s.—Mr. Babington Smith, C.B., C.S.I., who is well known to readers of *The Electrician* as secretary to the Post Office. In that position he has had much to do with telegraphic work. He was the chief representative of Great Britain at the Radio-Telegraphic Conventions at Berlin in 1903 and 1906, and at the International Telegraph Conference at Lisbon, 1908.

Mr. H. H. S. Cunynghame, C.B., M.I.E.E., one of the assistant under-secretaries (legal) of the Home Office, well known as an expert in patent law, as an authority on electric clocks and synchronisation, &c.

New K.C.M.G.—Mr. C. N. Dalton, C.B., Comptroller-General of Patents, Designs and Trade Marks.

New Knights.—Prof. A. G. Greenhill, F.R.S., who was professor of mathematics at the Royal Indian Engineering College, Cooper's Hill, until it was closed.

Mr. R. A. Hadfield, an electro-metallurgist of note, and one of the most prominent members of the iron and steel trades. He has been Master Cutler of Sheffield and president of the Iron and Steel Institute.

Prevention of Rust.—A Paper on this subject, important to all and sundry, was recently read by Mr. Thornton-Murray before the Birmingham University Metallurgical Society. The author first dealt with the theories of rust. It was once considered to be due to chemical action, carbon dioxide and water being necessary for its occurrence, and the compound formed having the formula $2Fe_2O_3 . 3H_2O$. This supposition has to some extent been modified by an electrolytic theory due to Cushman, who considers that the action is mainly promoted by irregularities in the metallic surface, though the presence of carbon dioxide and water greatly facilitates matters. Turning to the prevention of rust, Mr. Thornton-Murray briefly described the various methods employed for this purpose, including tinning and galvanising, and showed that, of the different varieties of iron, some resist rusting action to a greater extent than others. In conclusion, he mentioned a method, due to Mr. T. Corlett, of Birmingham, which consists in immersing the article in a hot solution of some phosphate and an iron compound. This covers the metal surface with a mixture of ferrous and ferric phosphates, and presents a pleasing dull black appearance. The process, it is said, makes the iron highly resistant to corrosion, and is adapted for light engineering work, such as cycle frames, gun barrels, stampings and press work.

ARRANGEMENTS FOR THE WEEK.

INCORPORATED MUNICIPAL ELECTRICAL ASSOCIATION.

FRIDAY, July 3rd (to-day).

10 a.m. Meeting at University College, Nottingham. Papers on "A.C. Accumulator Sub-Stations," by Mr. A. M. Taylor, and on "The Work and Equipment of a Testing and Standardising Department," by Mr. H. A. Ratcliff.

THE TRAMWAYS AND LIGHT RAILWAYS ASSOCIATION.

THURSDAY, July 9th.

10:30 a.m. Reception by the President and Reception Committee, at the Congress Hall, Franco-British Exhibition.

11 a.m. Lecture on "The Tramways of the World," by Sir Clifton Robinson.

12 noon. Paper on "Tramway Rail Joints," by Mr. A. H. Gibbings.

FRIDAY, July 10th.

11 a.m. Short Address by Mr. A. L. C. Fell.

11:30 a.m. Lecture on "Rail Corrugation," by Prof. C. A. Carus-Wilson.

7:30 p.m. Dinner in the Banqueting Hall, Garden Club, Franco-British Exhibition.

ELECTRIC TRACTION ON RAILWAYS.*

VI.—GENERAL COMPARISON OF CONTINUOUS AND ALTERNATING-CURRENT TRACTION.

BY PHILIP DAWSON.

(*Continued from page 362.*)

Summary.—The author, having described the chief points in connection with continuous current, three-phase and single-phase systems of railway electrification, now makes a comparison between them, giving in the form of tables particulars of various typical equipments.

Having thus examined the various systems of electric traction applicable to railway conditions, it may be of interest to attempt a comparison between them, and for this purpose the following tables have been prepared. In Table I will be found some data regarding the weight and speed under normal conditions of a certain number of recognised and proved continuous current railway motors. Let it here be said that several authorities have considered it advisable to work out some basis, into which the dimension as well as the speed enter, in order to make a comparison between the motors of the three types so far considered, *i.e.*, continuous current, three-phase and single-phase. It is quite true, that from the manufacturers' and the designers' point of view some such basis is desirable, but solely considered from the user's standpoint such a basis does not appear necessary. Manufacturers and designers of electrical apparatus have designed a series of types of motor, either driving through gearing or direct connected, and it is on this basis that the railway engineer must decide, as it would appear to his advantage to use existing apparatus rather than himself attempt to design new types; and when all is said and done, it is the actual weight of the machines as constructed which has to be hauled. Furthermore, although

Table I.—*Data Regarding Weights of Continuous-current Traction Equipments.*

Type.	Armature weight lbs.	Motor Weight without Gear.	Motor Weight with Gear.	Speed, revs. p.m.	Weight per H.P.
Dick. Kerr 4 A railway motor, 150 H.P.	1,920	6,050	6,550	470	4·36*
General Electric Co. B.T.H. 200 H.P. motor, G.E. 69	...	...	6,100	...	3·05
G.E. 76 British Thomson-Houston 150 H.P.	...	5,200	...	...	3·46
Siemens Schuckert 1,000 volts, 130 H.P.	...	5,500	...	700	4·23
Siemens Schuckert gearless, 210 H.P.	...	9,560	...	101	4·55
Oerlikon, 200 H.P.........	...	...	6,800	400	3·40
G.E. 65, 243 H.P.........	...	...	8,140	...	3·36

* With gear.

Table II.—*Data Regarding Three-Phase Traction Motors.*

——	One hour ratio H.P.	Normal speed r.p.m.	Weight in lbs.	Weight per H.P. in lbs.
Simplon loco. (gearless) Brown-Boveri.	575	224	23,650	4·1
Bergdorf train loco. Brown-Boveri.	150	300	8,800	5·86
Bergdorf train Motor Car. Brown-Boveri	60	600	3,300	5·5
Siemens & Halske Zossen (gearless)	250	900	8,970	3·59
A.E.G. Zossen gearless	250	960	7,040	2·82
Ganz Valtellina first loco. (gearless.)	225	128	9,780	4·35
Ganz Valtellina new loco. (gearless.)	600	225	14,740	2·46
Ganz Valtellina motor car (gearless.)	250	300	8,360	3·34
Ganz Valtellina newest loco. with cascade motor (gearless.)	450	112·5	27,280	6·07

Table III.—*Various Data of some Single-phase Motors.*

—	Rated Capacity. H.P.	Weight of Armature. lbs.	Weight of Motor without gear and case. lbs.	Weight of Motor with gear and case. lbs.	Maximum Efficiency including gears. %	Weight per H.P.	Normal Speed in revs. per min.
General Electric Co., type G.E.A. 605A	50	1,200	4,200	4,500	79	8·4	...
General Electric Co., type G.E.A. 603A	100	2,016	6,496	...	77½	6·5	840
Westinghouse	150	1,501	5,400	...	79	3·6	700
A.E.G. experimental Spindleless field motor	100	...	...	4,700	78	4·7*	...
A.E.G. Hamburg motors..................	120	1,850	5,700	6,160	84	4·7	600
Siemens-Schuckert...........................	100	2,724	...	5,734	77½	5·7*	550
A.E.G. experimental locomotive.........	350	4,345	11,550	12,980	90	3·30	400
Siemens-Schuckert Swedish loco.........	120	...	5,600	...	...	4·67	650
Felten-Guilleaume-Lahmeyer	27	...	...	3,360	...	12·44	...
A.E.G. Bovinage motor, 40 cycles	40	...	3,050	...	...	7·62	800
A.E.G.	200	2,790	6,468	7,251	...	32·3	500
Siemens-Schuckert...........................	175	...	...	6,076	...	3.36*	700

* With gears.

Table IV. *Weights of some Single phase Motor and Accessories (Siemens Schuckert.)*

Items.	125 H.P. per Motor, one hour rating. Kilogs.	60 H.P. per Motor, one hour rating. Kilogs.	225 H.P. per Motor, one hour rating. Kilogs.	370 H.P. per Motor, one hour rating.* Kilogs.	210 H.P. per Motor, one hour rating.† Kilogs.
Two motors, gear casing and gear transformer	6,950	5,150	10,750	16,575	8,750
One compressor and pump governor.........	450	450	450	450	450
Current collector bars............................	540	540	540	540	540
Controller and contactors wiring...............	1,920	1,770	2,170	2,405	2,070
Additional fittings.................................	2,140	2,090	2,090	2,530	2,190
Total electrical equipment consisting of two motors per Coach	12,000	10,000	16,000	22,500	14,000
Gear ratio	1 : 4·6	1 : 4·6	1 : 3·7	1 : 2·8	1 : 3·7
Number of poles	6	—	—	—	8

* With forced cooling † Speed 700 revs. per min.

Table V.—*Weights of D.C. and A.C. Motors.*

Type of motor.	Weight in lbs.	Speed of motor at normal rating.	Difference in weight per motor.	Difference against a.c. motor in lbs. per H.P.
Weight of two 150 H.P. Westinghouse d.c. motors	11,000	560 revs.	—	—
Weight of two 150 a.c. Westinghouse motors	12,000	560 ,,	500 lbs.	3¼
Weight of d.c. double 200 H.P. Westinghouse motors	13,200	675 ,,	—	—
Weight of double (gearless) 250 Westinghouse a.c. motor	29,000	240 ,,	—	—
Double 100 H.P. d.c Westinghouse equipment	9,650	535 ,,	—	—
Double 100 H.P. a.c. Westinghouse equipment	10,400	575 ,,	375 lbs.	3·75

Table VI.—*Comparison of Weights of D.C. and A.C. Equipments according to Westinghouse Co.*

Item.	*D.C.* Weight in lbs.	*A.C.* Weight in lbs.
Weight of double equipment consisting of two 150 H.P. motors, including control wiring and collecting shoes for third rail in *d.c.* case and auto-transformers controls and trolley in *a.c.* case.	13,850	18,700
Weight of double 100 H.P. equipment, same items as above.	12,500	15,700

Table VII.—*Giving Specific Data of Single-phase Motors of various makes.*

	Make of motor.				
	A	B	C	D	E
Rating for one hour of motor in H.P.	100	120	100	120	150
Flashing test in volts..	12,000 and 2,000	12,000 and 1,000	2,500	12,000 and 2,500	2,000
Number of brushes per motor.	6 sets*	5 pairs	3 pairs	3 pairs	6 pairs
Thickness of brushes...	⅜″	0·35″	0·375″	⅜″	½″
Normal current density in brushes in amperes per square inch	38·5	45	40	25	65
Air gap in millimetres	1·75	4	2	3	4
Average volts per commutator segment	12	..	4·8	3·38	..
Reactance volts per commutator segment	2·2	2·5	1	4	..
Normal speed in revs. per minute	550	500	840	600	700
Weight of rotor in cwt.	22·7	26	18	20	13·4
Weight of stator in cwt	26·6	33	40	28·5	34·8
Combined weight of stator and rotor	49·3	59	58	48·5	48·2
Temperature rise after one hour run rated load with open cover in °F.	135 Com. 160	140	Com. 180	135	135
Efficiency of motor and gear at rated load	77¼%	77%	77%	79½%	79%
No. of poles of motor	6	8	6	4	6

* Five brushes per set.

Table IX.—*Weights of Railway Continuous-current Motors of the British Thomson-Houston Co. (General Electric Co., of America).*

Type of motor.	Capacity one hour rating in H.P.	Current one hour rating in amperes.	Weight of Armature in lbs.	Weight of Motor without Gear.	Weight of Motor with Gear.
G.E. 73. ...	85·8	150	1,183	3,665	4,020
G.E. 66. ...	115	188	1,327	3,966	4,375
G.E. 55. ...	164	280	1,550	4,925	5,415
G.E. 69. ...	200	300	1,798	5,540	6,178
G.E. 65. ...	243	420	2,840	8,095	8,855
G.E. 76. ...	160	...	1,526	4,577	5,166

Table X.—*Giving Data of Standard Single-phase Motors manufactured by the General Electric Co., U.S.A. (British Thomson-Houston Co.), for 25 cycles.*

Type.	G.E.A.603	G.E.A.605	G.E.A.609	G.E.A.610	G.E.A.611
Rated H.P. for 1 hour.	125	75	150	250	125
Volts.	225	225	225	500	500
Amperes at rated load	550	320	650	600	275
Speed, revs. per min.	600	750	475	225	750
Wt of motor only in lbs.	5,300	4,400	7,500	14,000	5,000

Summary of Figures Given in Preceding Tables Regarding Comparative Data of Continuous Three-Phase and Single-Phase Traction Equipments.

Continuous-current motor, weight in lbs. per rated H.P.	3·05 lb.	to	4·55 lb.
Three-phase motor, weight in lbs. per rated H.P.	2·46 lb.	to	6·07 lb.
Single-phase motor, weight in lbs. per rated H.P.	3·26 lb.	to	6·5 lb.*
Transformer weights necessary to be added per rated H.P. of motor equipment in lbs. in case of alternating current traction	5·0 lb.	to	12·5 lb.
Weight of controlling gear, contactors, choke coils, &c., to be added in case of single-phase traction, in lbs., per rated H.P. of motor equipment	4·2 lb.	to	5·17 lb.
Weight of control apparatus, including resistances to be added in case of continuous-current motors, per rated H.P. of motor equipment	9·33 lb.		

* This weight is taken because all large weights per H.P. refer to small motors under 100 H.P., which cannot be included in heavy traction motors.

from an electrical point of view one type of motor may be designed to be much lighter than another, practical and mechanical reasons often intervene to make the lighter construction impracticable.

Table II. gives data regarding weight and speed of some of the oldest as well as the most recent examples of three-phase traction motors constructed and in successful operation.

Table III. has been prepared to give similar data regarding single-phase railway motors, and Table IV. give some interesting figures regarding the total weights of single-phase equipments, as manufactured by the Siemens-Schuckert Company, of Berlin.

Table V. gives further comparative data of a similar nature for continuous and single-phase equipments and Table VI. gives further data of a similar character. Table VII. comprises many interesting comparative figures of recent single-phase equipments and mechanical and electrical data of various

Table VIII.—*Data Regarding Weights of Transformers Required for Single-phase Traction Motors.*

Size of Motor-car equipment.	Rated Transformer Capacity per Motor car kw.	Full load Transformer Efficiency. %	Weight in lbs. of Transformer Equipment per Motor car.	Kilowatts of Transformer installed* in rated H.P. of mtr.	Weight in lbs. of Transformer installed* in H.P. of motor.	Weight of Control Equipment.*	Weight in lbs. of Entire Equipment per H.P. of Motor.
Four 100 H.P. motors...	300	97·2	2,464	0·75	6·16	1,680	4·2
Four 100 H.P. motors...	220	98·0	5,006	0·55	12·5	3,136	7·85
Four 120 H.P. motors...	300	96·5	4,760	0·59	9·9	2,100	4·38
Four 150 H.P. motors...	600	95·6	3,000	1·00	5·0	3,100	5·17
Two 125 H.P. motors...	150	96·5	3,520	0·60	14·0	1,100	4·4

* This includes cables, contactors, choke coils—in fact, everything except compressor and train lighting.

makes, and fairly recent types of construction, and shows what difference exists between them, while Table VIII. gives data as regards the weights and efficiencies of the auxiliary apparatus necessary with single-phase motors. Table IX. gives data regarding continuous-current apparatus, and Table X. data of the standard single-phase motor of the General Electric Co., of America. From these tables many interesting facts can be gathered, and for convenience sake they have been summarised below Table X.

The comparison as regards weight per H.P. of rated motor equipment capacity therefore can be put as follows :—

Continuous-Current System.—Total weight per rated H.P. of motor equipment.—3·05+9·33=12·38 lbs. to 4·55+9 33 =13·8.

Three-Phase System.—In this case the control gear may be very ponderous, and figures are not available to make satisfactory comparisons.

Single-Phase System.—Two cases must be considered here, one when plain series motors are used, which necessitate the employment of static transformers of a capacity equal to the average load on the motors ; the other the case when compensated repulsion motors are used, in which case only very small exciting transformers, having a capacity equal to only about one-fifth the capacity of those necessary when series motors have to be employed. At the same time in most cases even with compensated repulsion motors it would appear desirable to transform all the current, in which case the transformers for both cases have to be of the same capacity. On this basis the figures for single-phase work out as follows :—

Total weight per rated H.P. of motor equipment

=3·26+5+4·2=12·46 lb. to 6·5+12·5+5·17=24·17 lb.

These figures show that, given certain types of apparatus and certain makers, the very large difference which is claimed to exist between the weight of continuou-scurrent, three-phase and single-phase apparatus very largely disappears.

It is not contended for one moment that single-phase motors and complete single-phase motor equipments must not for theoretical reasons be much heavier than the corresponding continuous plant ; but it *is* contended that where there is so large a difference already in existence between different continuous-current machinery as manufactured by different makers and operated by different lines, it is not necessary to conclude that all single-phase equipments must greatly exceed in weight all equivalent continuousc-urrent plant. What it really amounts to is that continuous current and single-phase motors, considered by themselves, differ so little in weight, that any difference which may exist is unimportant from the user's point of view. Single-phase equipments usually necessitate transformers, which are not necessary in the case of continuous current machines ; but on the other hand, owing to the practical absence of resistances and the simplicity of speed regulation with single-phase motors, the weight of the speed controlling and reversing apparatus is much smaller than with continuous-current equipments.

If, however, for any reason it should be found necessary to make a comparison under the most unfavourable conditions, *i.e.*, if the lightest continuous current is to be compared with the heaviest single-phase traction equipment of the same size for one complete motor car, it will then become necessary to ascertain how such a difference in weight will affect the total train weight to be hauled. For this purpose it will be necessary to devote a few lines to consider what are those weights, such as trucks and car bodies, which will enter into the consideration in connection with ascertaining the train weights and which are entirely independent of the system of electric traction finally adopted :—

Trucks for motor coaches........................	5 to 6½ tons each.
Trucks for trailer coaches	4½ to 5½ tons each.
Air brake reservoirs and piping for one coach	1 to 1¼ tons.
Electrically operated air compressor and governor	11 cwt. to 18 cwt.
Brake rigging and brake cylinders per coach	15 to 18 cwt.
Collector gear for third rail per motor coach	780 lb. to 1,500 lb.
Collector gear for overhead conductors per motor coach	1,100 to 2,000 lb.
Carriages and under-frame according to type and size	15 tons to 24 tons.

From the above it will be seen that the weight of a motor coach exclusive of electrical equipment, except so far as the current collector and electrically-operated air compressor are concerned, will be approximately between the limits of 28 tons and 40 tons, and it is to this figure that the electrical equipment will have to be added in order to obtain the complete weight of the motor car.

On the basis of a quadruple equipment consisting of four 150 H.P. motors we should get the following comparative results as far as the motor cars are concerned.

The weight for a continuous-current 500 volts 150 H.P. motor equipment would be between 9·3 tons and 11·7 tons, to which would have to be added the controlling gear or 2·5 tons, making the weights 11·8 tons and 14·2 tons respectively. Hence the minimum and maximum weight of a motor car complete, but without passengers, would work out somewhat as follows :—28+11·8=39·8 tons and 40+14·2=54·2 tons.

If, on the other hand, we were to adopt single-phase equipments the weights for the electrical motor equipment consisting of four 150 H.P. motors and necessary transformers and controlling devices would work out somewhat as follows :—13·5 tons and 14·5 tons, and therefore the weight of a motor-car equipped with single-phase motor would be —

28+13·5=41·5 tons and
40+14·5=54·5 tons respectively

or the ratio between the motor coaches equipped with continuous and single-phase motors of similar capacity would work out as follows :—

Continuous current.		Single phase.		Difference in favour of continuous.
39·8	......	41·5	......	1·7 tons.
54·2	......	54·5	......	0·3 ..

A trail coach will weigh complete according to length, type and design, anything from—

25 tons to 34 tons

and on this basis a train composed of two motor and two trail cars, respectively, equipped on the continuous and single-phase systems would work out as follows : The four car train consisting of two motor and two trailer coaches equipped with continuous-current motors would weigh, exclusive of passengers—

129·6 tons to 176·4 tons

and the same train equipped with single-phase motors would weigh—

133 tons to 177 tons.

Another comparison may perhaps be suggested, *i.e.*, between two motor coaches each equipped with say two hundred H.P. continuous current and single phase equipments, and this comparison would work out as follows :—Taking as the bases of the continuous current the G.E.69 motor of the British Thomson Houston Company on one hand, and on the other, the most recent example of a 200 H.P. direct-current motor as manufactured by the Oerlikon Company, and adding the weight of the controlling appa-

ratus, resistances, &c., the total weight of a double motor equipment will work out at—

8 tons to 8·6 tons.

Now, if we compare with this the various single-phase equipments we should get on the basis of naturally cooled single-phase motor a corresponding weight of—

11·36 tons,

or a difference in favour of the continuous equipment of 3·35 tons, equal to 42 per cent. on the weight of the equipment alone, but on the basis of the complete motor-car one would find a very much smaller percentage.

Weight of d.c. Motor car.	Weight of a.c. Motor car.	Difference of weight.	Percentage increase over cont.-current equipment.
Tons.	Tons.	Tons.	Tons.
36	39·36	3·36	9·3
48	57·36	3·36	7

or if we take it on the broader and the real basis of the total train weight including passengers, based on a four-car train the comparison works out as follows :—

Cont.-current Train passengers included.	Single-phase Train passengers included.	Difference in Weights.	Percentage inc. of Weight in s.-p. over cont.
Tons.			
138	144·72	6·72	4·9
180	186·72	6·72	3·73

It will thus be seen that on the basis of the only comparison which interests the user of electrical apparatus, the increase in weight is exceedingly small and hardly worth discussing. Table XI. is interesting as giving the weights of the auxiliary apparatus.

Table XI.—*Data giving Weights of Auxiliary Apparatus Required with Continuous Current Operation.*

For four motor equipment consisting of four 150 H.P. motors, weight of control equipment	5,600 lbs.
Or weight per rated H.P. of motor-car equipment for controlling apparatus..	9·33 lbs.

(*To be continued*)

THE RECONSTRUCTION OF AN ELECTRIC LIGHTING SCHEME WITH OBSERVATIONS ON THE WORKING OF A COMBINED STEAM AND WATER POWER PLANT.*

BY C. M. SHAW.
(Chief Electrical Engineer, Worcester.)

Most engineers in charge of electricity supply undertakings have had at one time or another to consider the question of the reconstruction or rearrangement of generating plant and mains. The Worcester electricity supply scheme embodies features of a highly interesting engineering and commercial nature not obtaining elsewhere in this country.

There are two sources of power—viz., steam and water prime movers; two systems of distribution irrespective of traction supply; two methods of supply, alternating and direct, each having two standard pressures; and finally, two tariff systems with 19 separate prices for current. The capital expenditure on December 31, 1905, amounted to £127,385, being £73 per kilowatt when all water plant was available, or £78 when such plant was useless through flood or drought. The deficits on 1904 and 1905 working after payment of all charges amounted to £1,290 and £298 respectively.

The plant in use in 1905 consisted of

POWICK STATION (WATER AND STEAM).

420 kw. capacity driven by steam engines.
120 kw. ,, ,, water turbines.
240 kw. ,, ,, water or steam power by means of clutches.
Six water tube boilers : 10,460 sq. ft. heating surface.

HYLTON-ROAD STATION (STEAM).

250 kw. capacity for direct current supply.
500 kw. ,, ,, ,, ,, or traction.
70 kw. motor generator coupled to engine by a clutch used for alternating current or direct current supply.
Three water tube boilers : 9,420 sq. ft. heating surface.

* Abstract of a Paper read, on Thursday, July 2nd, at the Convention of the Incorporated Municipal Electrical Association.

As the systems at each works are different it was not possible to interwork the supplies, beyond the capacity of the small motor generator at the new works. Various combinations of working this small machine were tried, and when possible the Powick station was shut down entirely during daytime, when the water flow failed.

In due course, the author arrived at a decided opinion that no great improvements could be effected in the cost of generation with the old conditions of working the two stations. The 1904 works costs of 1·56d. per unit sold, on the combined output of the two works, were unduly high, having regard to the fact that there was a water-driven plant by which current is generated cheaply, and further, that the traction output should have assisted in lowering the costs. This high cost was in a great measure brought about owing to the heavy expenditure entailed in maintaining a steam plant and staff at Powick, when such plant was, during a great portion of the year, inoperative.

In 1905 the Powick output was 721,000 units, of which 380,000 were generated by water-driven plant. The salaries and wages item for current generated by water turbines should be very low, as few attendants are required. Sufficient men had, however, to always be in attendance to work the whole of the output by steam, owing to the uncertainty of the water supply. Although a full complement of men sufficient to work the steam plant were in attendance daily, it was found to be more economical to entirely shut down the Powick plant during daytime for 1,181 hours, over a period of 180 days during 1905, and 1,332 hours on 150 days during 1906, owing to floods or lack of water, during which time the whole of the alternating current output was dealt with by a small motor generator at the Hylton-road works.

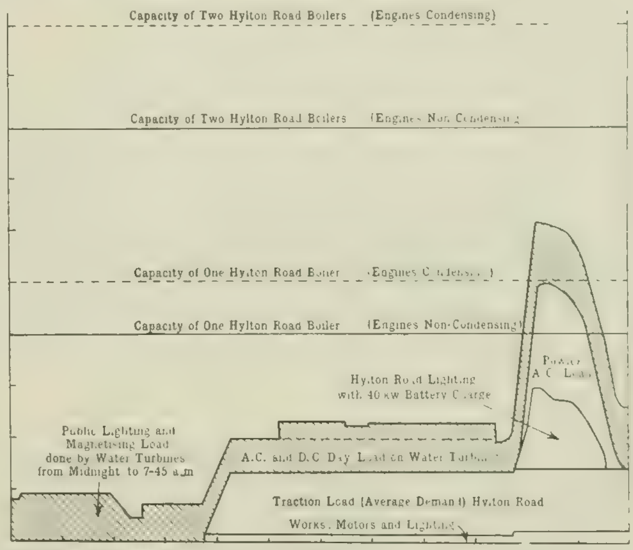


FIG. 1.—DIAGRAM SHOWING ADDITION OF OUTPUT FROM POWICK, DURING EVENING WHEN WATER SUPPLY IS GOOD, NIGHT AND DAY LOAD TAKEN UP BY WATER TURBINES, TO THE OUTPUT AT THE D. C. STATION.

From these remarks it will be apparent that the steam plant was worked under very disadvantageous conditions, especially when consideration is given to the fact that no economiser was in use, that the lay out of the works necessitated very long double steam ranges, also that the extra cost of carting coal 1½ miles beyond the new station was expensive, and finally, the original steam plant was of old design and very unsuitable for modern requirements. The author had, therefore, little hesitation in recommending the scrapping of four small boilers, and all the engines, &c., at the old works. It was accordingly decided to dismantle the steam plant at Powick, and concentrate all steam generation at the Hylton-road works. Previous to the change two to four boilers had to be worked or kept under banked fires at Powick in case the water power, &c., failed. At Hylton-road one boiler was steamed and one kept under banked fires, making five to six boilers in commission, whereas under the new conditions of working only three boilers are in use—viz., two steaming and a third under banked fires.

The rearrangement of staff and workmen for working water plant at Powick and steam plant at Hylton-road has effected economies. The uncertainty of the water supply in times of flood or drought often releases the attendants at the water power station. During winter, if floods occur, the staff are transferred to the steam station to assist in meeting the heavier call on steam plant. Should a shortage of water occur during summer these men are particularly useful for assisting with the necessary overhauling of plant, which methods of working we have found very beneficial and economical.

In preparing the scheme for rearrangement of works, due regard had to be given to the following conditions which obtained at Wor-

cester: (*a*) The heavy capital expenditure already incurred, (*b*) the area of supply being very large necessitates a high-tension system, (*c*) the complete system of alternating mains and transformers already supplying outskirts and a portion of the centre of the city, (*d*) the high periodicity of supply (100 periods single phase) is unsuitable for power purposes, (*e*) the system of direct current feeders and distributors in the centre of the city and power area.

In order to avoid unnecessary capital expenditure, a complete change of periodicity was not advisable. Also a very extensive single-phase alternating current, 100 ∼, network had already been laid down at heavy cost in residential districts for lighting demand. The area of supply was very extended, and the demand for power negligible, consequently a change over to direct current with the sacrifice of capital expended on high-tension mains, &c., would not have been justified. It was, however, imperative that the old 100 periods supply should be not extended more than possible, as such system might ultimately have to be changed.

New generators, switchboard, mains, &c., of a design easily convertible to 50 periods two-phase were accordingly installed. 50 period transformers of standardised capacity are also gradually displacing the original small 100 period type. A slight percentage in efficiency is so sacrificed by using these transformers, which loss,

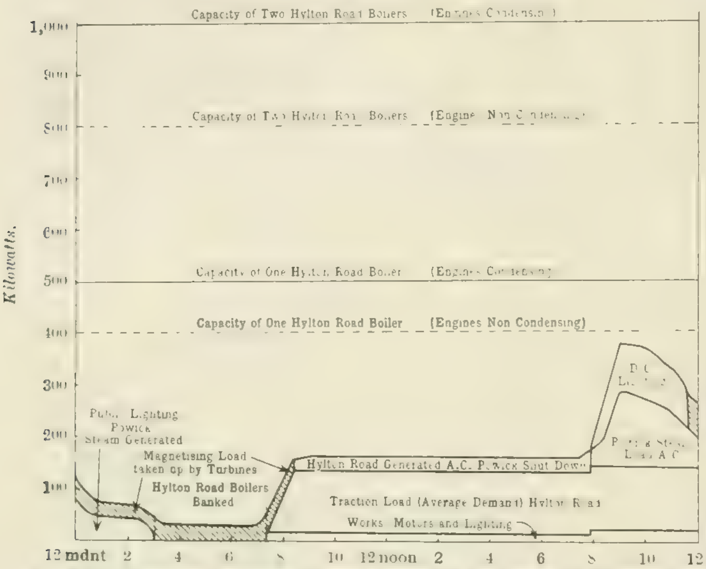


FIG. 2.—DIAGRAM SHOWING TOTAL STEAM LOAD DURING TIME WHEN WATER SUPPLY IS ONLY SUFFICIENT FOR SUPPLYING A PORTION OF NIGHT LOAD AT POWICK.

however, is neutralised by the reduction of open circuit losses. The adoption of this course minimises the ultimate cost of a change in periodicity.

The following limited scheme was eventually decided upon:—

Extension of engine room for three generators	£1,150
Two alternating current steam generators, 350 400 kw.	4,550
Switchgear	200
Mains	260
Contingencies	340
	6,500
Less receipts from sale of old plant	1,650
Net cost	£4,850

Then the question as to how the cost of the change should be met arose. As it was not possible to meet such a heavy charge out of revenue in one year, steps were taken to obtain sanction to spread the cost over three years. The Local Government Board were communicated with, and they held an unofficial inquiry. The inspector informed us that the Board would probably grant a loan for the full amount of £6,500 if the Council guaranteed the repayment of the outstanding debt of £4,072 on old plant within three years. An official inquiry was held at a later date, and sanction given to borrow £4,072 and £2,428 for three and 18 years respectively. This procedure is not quite consistent with the usual practice of the Local Government Board, in that the Department have still to meet interest and loan charges on outstanding debt on discarded plant for a further term of 12 years, even though same be non-existent.

The author gives tables of works costs, &c., which show the value of 1·174d. per unit for 1904 and 1·193d. for 1905 have been reduced to 0·824d. for the 15 months ended March, 1908. This reduction is not altogether attributable to the more economical working of the rearranged plant, during the last six months, but to a combination of the economies effected by the new scheme.

The author gives particulars of the water turbine installation. (This was described in *The Electrician*, Vol. XXXIII., pp. 669-672, whilst a description of the Hylton-road station appeared in *The Electrician*, Vol. LI., pp. 197-200.)

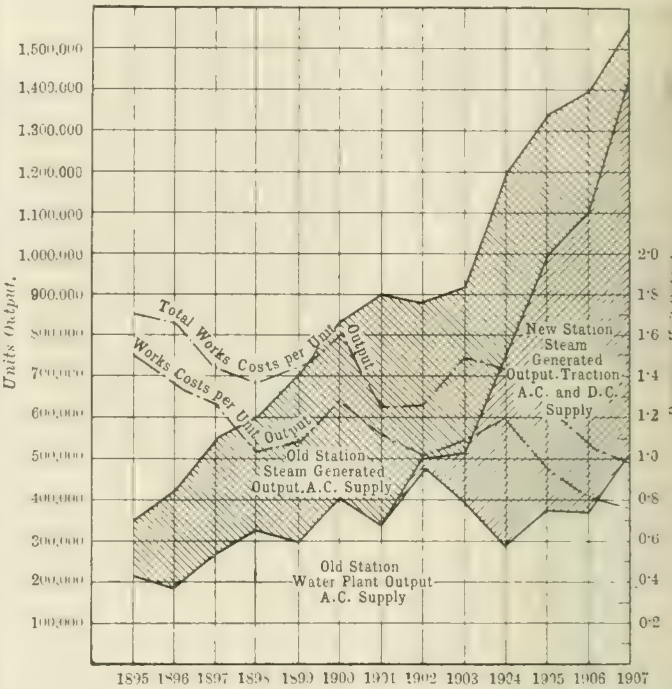


FIG. 3.—CURVES SHOWING RELATION BETWEEN TOTAL WORKS COSTS, WORKS COSTS AND OUTPUT BY WATER AND STEAM PLANTS.

The author gives six record charts showing the conditions of working of Powick. Fig. 1 shows the Powick output curve for May 6, 1905 (when the water supply is good and the water plant is working under ideal conditions), superimposed on to the output at the direct current station, which indicates the more economical con-

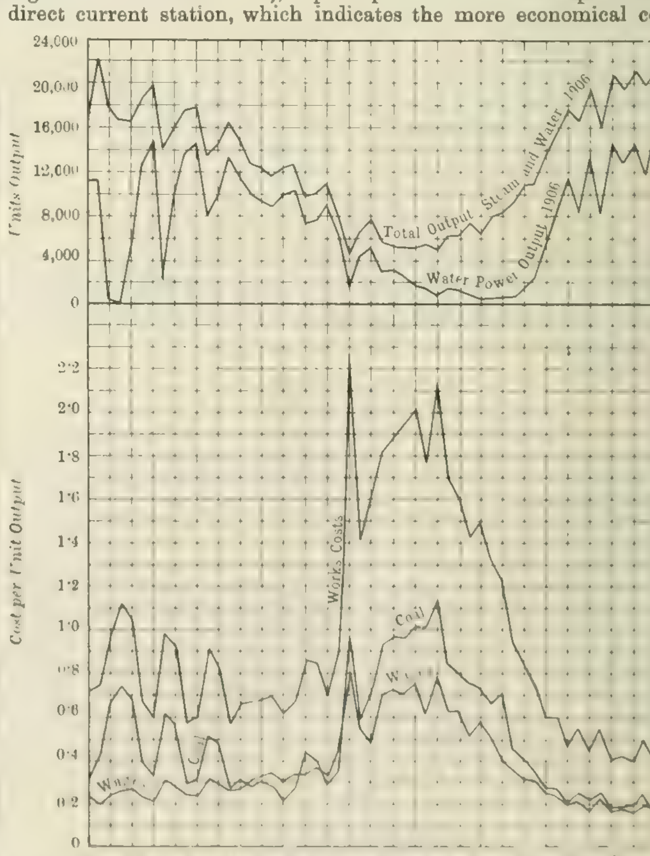


FIG. 1.—CURVES SHOWING RELATION BETWEEN WATER OUTPUT AND WORKS COSTS, &c.

ditions of working when the water supply is good, and the benefits that would have been derived had all the steam plant been concentrated at one station. Fig. 2 similarly shows the Powick output curve for July 26, 1905 (an example of the worst conditions for

water turbines), superimposed on the direct current load at the new station for that day, and indicates that it is better to then store up water for use on peak load and to deal with all output from the steam plant.

The yearly outputs of current generated by steam and water power at the two stations have been plotted in Fig. 3. From this it will be seen that the water-generated output is liable to great fluctuations. During the early years of the undertaking, full use could not be made of the water supply, as the demand during certain hours was limited. The greatly increased output for power and the altered conditions of working since the steam plant has been concentrated at one works, together with a good supply of water during 1907, enabled us to make good use of the water power during the last year, with the result that 500,771 units were generated, which figure, it is hoped, will be exceeded in the future now that we have control of the full flow of water.

Attention is also called in Fig. 3 to the rise and fall of works costs from year to year, generally following inversely the water output. This effect is more clearly shown in Fig. 4, where the weekly costs and outputs are plotted. The author also gives curves showing the monthly water plant output during the poorest (1904) and the best (1907) years. In the former year a series of floods experienced during January and February greatly reduced the utility of the water by flooding out the turbines, the water-plant output for February only totalling about 6,000 units, whilst it reached a maximum of 50,000 units in April of that year. In 1907, however, the monthly output during the first eight months never fell below 45,000 units. The usual decline commenced during April; the effect of this was, however, prevented by obtaining full control of the water, as explained previously, and avoiding the usual fall during the summer.

In conclusion, the author has no hesitation in saying that a water-power plant similar to that at Worcester is of great value, if there be a direct market for the power, without the intervention of wasteful storage entailing heavy capital expenditure. He does not consider any system of storage entailing accumulators of sufficient capacity to take the maximum output is justifiable, as the maximum only endures for short periods. The proper combination is to build up a sufficient mean load throughout the day that such mean shall be greater than the maximum of the water output, surplus demands being taken up by steam sets of suitable size.

PORTABLE TYPE OF HIGH-FREQUENCY ALTERNATOR.

BY R. A. FESSENDEN.

Summary.—The author describe sa high-frequency alternator driven by a small steam turbine for use in wireless telegraphy. A frequency of 250,000 was originally intended, but 90,000 was finally adopted as being more suitable for work during daylight. The output of the machine is about $2\frac{1}{2}$ kw. at 75,000 cycles. The speed regulation, which is of importance, is effected electrically.

In a previous note (*The Electrician*, October 4, 1907) I referred to a small high-frequency dynamo under construction, designed for an output of 1 kw. Fig. 1 shows this machine. The high-frequency alternator forms the left portion of the machine. The governor, with its gear, is in the centre, and the steam turbine is on the right-hand side. The machine is approximately 12 in. high and nearly 3 ft. long.

These dimensions are considerably larger than is necessary, owing to the fact that a great many experimental adjustments were placed on the machine, which will not be necessary in actual work. Also the governor will be omitted in futnre types, the governing being done by an electrically-governed throttle valve, described below. The diameter of the rotating field disc is 6 in., and the diameter of the steam turbine disc is $3\frac{1}{2}$ in.

It was originally intended to construct this machine for a frequency of 250,000 cycles per second, as the experimental work on the other machines showed that this frequency could be reached without any trouble and with an output of more than one kilowatt. In view, however, of the writer's discovery (*The Electrician*, p. 604, July 26, 1907) that a machine operating at this frequency would have, with the same output, only a small fraction of the range during daylight that a machine with a frequency below 90,000 would have, it was decided to construct it so as to be capable of operating at a frequency of 100,000 and to run normally in the neighbourhood of 75,000. It is intended however, as a matter of curiosity to construct a rotor to give the original frequency as soon as time can be spared to do the work.

With a steam pressure of 100 lb. per square inch the machine gives 75,000 periods per second, and 100,000 frequency with a steam pressure of about 135 lb. As regards the mechanical operation of the machine, the design called for operation for a period of 24 hours without attention, and this test has been passed successfully. The oiling arrangements are automatic, and are similar to those used on automobiles.

It is possible that the gear may be retained, on account of the advantage of being able to drive a small exciter, though possibly it may be decided to rely entirely on storage or dry

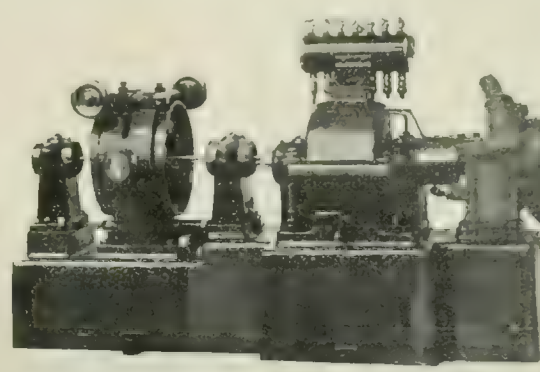


Fig. 1.—High-Frequency Turbo-Alternator.

cells, especially where the telephoning is accomplished by using a transmitter in series with the field, which has very low inductance.

At present the machine gives about 225 volts on open circuit at 75,000 cycles, with an armature resistance of 5 ohms. The available output of the machine is therefore about $2\frac{1}{2}$ kw. at 75,000 cycles. This is somewhat larger than the machine was originally designed for, but certain losses were found to be smaller than had been anticipated, and the original estimate was, in accordance with the writer's practice, intentionally

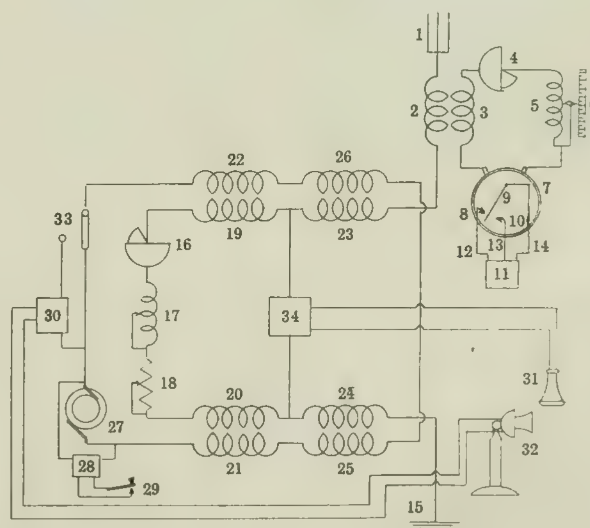


Fig. 2.—Diagram of Connections.

conservative. The friction losses due to windage, &c., are approximately 3 kw. While this is very satisfactory, it is expected to reduce this to less than one-half by some further alterations.

An output of about 4 kw. is theoretically obtainable at 100,000 cycles, but so far it has not been attempted to increase the load above $2\frac{1}{2}$ kw. for the reason that the shaft is so small that it would probably be injured if it were attempted to operate it at the higher load.

This machine is of the double armature type, there being 300 coils on each armature, and the field having 150 teeth.

The two field gaps are approximately $\frac{1}{16}$ in. in length. There is, of course, absolutely no vibration while running, the 24 hour test above referred to being made with the machine standing on a couple of blocks.

For speed regulation it has been found impossible to depend upon speed regulators of the usual type, and the writer's resonance speed indicator is used ("Frequency Meters," *Electrical World*, November 11, 1899). The method employed is to attach a circuit to the antenna, as shown in Fig. 2, containing a dynamometer with two contacts. This circuit is tuned about $\frac{1}{20}$th of 1 per cent. higher than the desired frequency. These contacts govern an electrically-controlled throttle valve in series with a sensitive reducing valve in such a way that if the frequency increases $\frac{1}{20}$th of 1 per cent. the needle touches the upper contact and cuts down the speed. If the frequency falls $\frac{1}{20}$th of 1 per cent. the needle falls and increases the steam admission.

By using a large amount of inductance in the circuit, and air condensers, and using a low resistance dynamometer, the speed can be kept constant to approximately $\frac{1}{50}$th of 1 per cent. if desired, which result is much better than can be

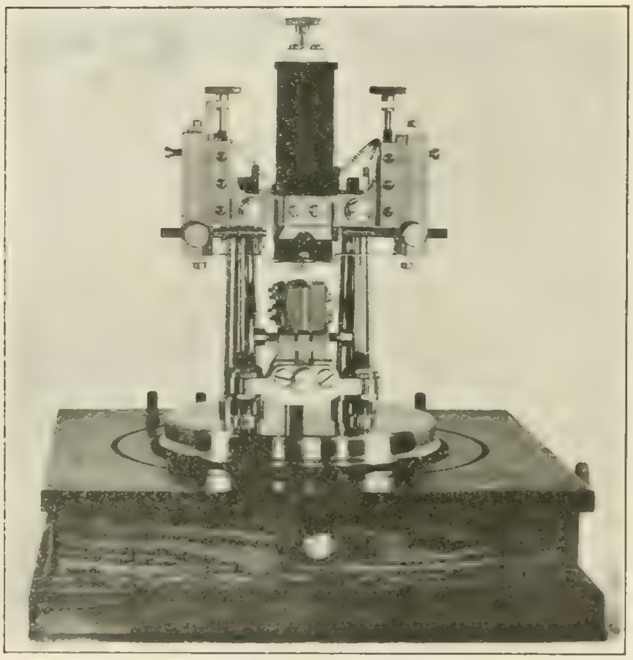


FIG. 3.—"TROUGH" RELAY, SHOWN WITHOUT WATER JACKET.

obtained with any mechanical speed indicator with the writer's knowledge. While this latter result has only been accomplished in an experimental way so far, [illegible]th of 1 per cent. being the best regulation so far obtained in practical working, the experiments indicate that no particular difficulty will be met with in obtaining a speed regulation of [illegible]th of 1 per cent. in commercial work. The greatest difficulty met with so far has been the variation in the dimensions of the air condenser and inductances due to change of temperature, but it is believed that this can be overcome by constructing these parts of the apparatus in such a way as to compensate for the temperature. At first considerable difficulty was met with from leakage, even a very minute leak being sufficient to appreciably cut down the amount of resonance and alter the sensitiveness of the governing, but this difficulty has been overcome.

This method also has the advantage that by the addition of a couple of hinged springs all that is necessary to set the speed to any desired frequency is to turn off the inductance until the pointer shows the desired frequency, when the circuits will automatically alter the speed of the dynamo and maintain it at the desired frequency.

In special cases a safety device is used consisting of an additional tuned circuit arranged so as to be in resonance at a frequency of about 5 per cent. higher than that of the governing circuits. This is arranged so that should for any reason the rotor speed up, as soon as it reaches a frequency 5 per cent. higher than that for which the governor is set a bell is rung, or a small fuse is blown which automatically shuts off the steam. In practice, however, this is not found necessary.

Fig. 2 shows the general arrangement of circuits used: 27 is the high-frequency alternator, 28 is an apparatus for altering the frequency of the alternator approximately $\frac{1}{20}$th of 1 per cent. without altering the speed of the rotor, 29 is the key used for telegraphing. When this key is depressed the normal frequency is sent out and produces beats in the receiver at the receiving station. When the key is released the apparatus 28 immediately (*i.e.*, in less than $\frac{1}{1000}$th of 1 second) alters the frequency of the dynamo about $\frac{1}{20}$th of 1 per cent., so that the beats produced at the receiving station are of a different frequency and do not affect the receiver. It is necessary to accomplish this change of frequency electrically without changing the speed of the rotor and without changing the intensity, for the speed of the rotor could not be made to vary quickly enough for high speed telegraphy, and if the intensity were varied it would slightly disturb neighbouring stations which were not using the heterodyne or interference preventer.

As it is, however, it will be seen that even nearby stations are not affected, for the reason that the change of frequency being only approximately $\frac{1}{20}$th of 1 per cent., and the waves being generated continuously under the same intensity, no audible indication is produced on the nearby station either when the key is depressed or when it is released.

Referring again to Fig. 2, 31 is a telephone receiver and 32 a telephone transmitter, which may be placed in an entirely different building from that containing the high-frequency apparatus. On board ship they may be placed in the captain's cabin.

A receiver and transmitter may also be placed in the room containing the electrical apparatus, with the usual arrangements for cutting in, so that the operator may first get into communication with the other operator on board the ship to which it is desired to talk, and after doing so notify the captain of the vessel that everything is ready for him to talk, and then to plug him in, in the same way as the ordinary local wire telephone exchange.

A transmitting relay (marked 30 in Fig. 2) is shown in Fig. 3. This will stand 15 amperes for several hours without decreasing in sensitiveness, and has an internal resistance of approximately 6 ohms. It is therefore capable of modulating more than 1 kw. of energy. While 200 miles is the longest distance to which the writer has yet succeeded in telephoning wirelessly, as this was done with an expenditure of less than 200 watts and a receiving mast only 175 ft. high, calculations show that the present apparatus, with a 400 ft. tower at the receiving end, should be capable of transmitting speech a distance of approximately 1,000 miles during daylight.

The switch 33 is thrown to one side or to the other as it is desired to telephone or to telegraph.

The apparatus for regulating the speed is shown to the right of the figure; 2 is the primary of a transformer which excites the secondary 3; in circuit with the secondary 3 is the variable air condenser 4 and the variable inductance 5, and the dynamometer 7. The needle of the dynamometer 9 is placed between two contacts 8 and 10, and actuates through a relay the electric throttling mechanism, 11; 12, 13 and 14 are three binding posts which go to this mechanism, and 6 is a scale for showing the required frequency. One turn on the inductance corresponds to a change in frequency of about $\frac{1}{4}$th of 1 per cent.

The antenna is marked 1, and 15 is the ground or wave chute. The transformers 22 19, 26 23, 20 21 and 24 25, together with the circuit 16, 17 and 18 form the means by which the talking and listening are carried on simultaneously without the necessity of throwing a switch; or, when telegraphing, the means whereby one operator can send a message to one station while another operator is simultaneously receiving, over the same antenna, a message from another station, or from another operator at the same station as that to which the first

operator is sending. Telephone engineers will recognise this as somewhat analogous to an old Edison circuit.

The variable capacity 16, variable inductance 17 and variable resistance 18 form what I call a "phantom antenna," and balance the real antenna. While the balancing in the case of an ordinary wire line would be practically impossible on account of variable weather conditions, leaks, &c., no difficulty has been experienced in balancing these wireless circuits, for the reason that the insulation of the antenna is always practically perfect, even in foggy weather, especially if a low voltage is used, and a wave chute. The balancing can be made so perfect that, even when using the liquid barretter as a receiver, not only is the minute Wollaston wire uninjured, but the spoken words or transmitted signals are absolutely inaudible in the receiver.

In actual practice, however, it has been found advisable to slightly upset the balancing, for two reasons: First, because when talking it is advisable for the speaker to hear his own voice, so that he can be sure that his transmitter is working correctly; secondly, because when working as a heterodyne unbalancing affords a very convenient way of obtaining the local potential. The strength of the signals is, of course, cut down to half by this method of connection, but this is a matter of comparatively little importance, and is more than compensated by other advantages.

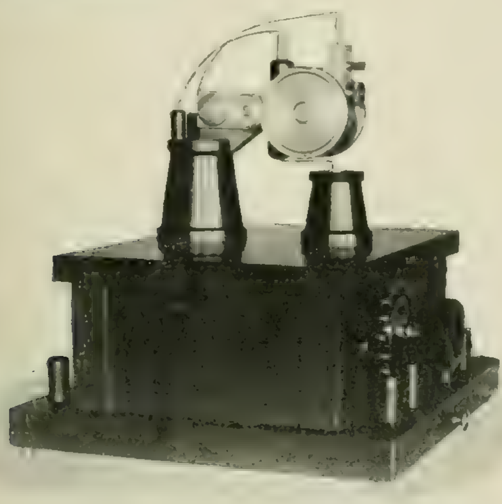


Fig. 4.—Liquid Barretter.

It will be seen that there have thus been four distinct types of wireless telegraph systems, as follows:—

1. The Lodge-Popoff-Jackson-Marconi system, using damped waves and coherers.

2. The writer's intermittently produced sustained oscillation-current operated receiver method type "A," using a local tuned circuit for sustaining the oscillations and using a current-operated receiver. 1898-1899.*

3. The writer's continuously produced sustained oscillation method, type B, using the Elihu-Thomson-Fessenden arc or high-frequency dynamo. 1899-1900.†

4. The writer's sustained oscillation heterodyne method, type C. 1902-1908.

It is believed that the heterodyne method, using either the high-frequency dynamo or one of the writer's arc methods, which has not heretofore been described, will be found to possess important advantages in practical and commercial wireless work, on account of the fact that they are not affected by interference or atmospheric disturbances, do not disturb other stations, are able to work duplex and multiplex, and operate in a simple and mechanical manner.

Fig. 4 shows a liquid barretter and Fig. 5 a heterodyne head telephone.

The output of these high-frequency machines increases almost as the cube of the dimensions. If all dimensions are multiplied by the same amount and the same peripheral speed is used the output increases as the square of the linear dimensions. For the reason that it is possible, however, to run machines of large diameter at a higher peripheral speed than those of small diameter and also for the reason that large machines will be used for working over longer distances, and hence will have antennæ of greater capacity and use a lower frequency, the output is found to work out approximately as the cube of the linear dimensions.

The machine herein described gives as stated an output of $2\frac{1}{2}$ kw. With some further changes which experiment has shown to be advisable it is believed that the possible output can be raised to approximately 5 kw., though this will probably not be attempted on account of the small diameter of the shaft. Assuming, however, only the present actually obtained output of $2\frac{1}{2}$ kw., it will be seen that since the diameter of the disc is 6 in. the large power machine previously referred to, which has a 3 ft. disc, should theoretically give an output of $2\frac{1}{2} \times 6^3 = 500$ kw. It will be seen from these figures that there is no reason why this machine should not give the output for which it was designed—*i.e.*, 50 kw., with a considerable margin.

There is, of course, no practical object in designing high-frequency alternators of larger capacity than this, as, through

Fig. 5.—Heterodyne Head Telephone.

the discovery of the fact that atmospheric absorption can be overcome by using low frequencies and through the use of the heterodyne, which is many times more sensitive than the liquid barretter, this amount of power is more than sufficient for obtaining any desired range of transmission.

The degree of selectivity attained is only limited by the extent to which it is possible to maintain the speed constant. Assume that the transmitting dynamo has a frequency of 80,000 cycles per second, and the dynamo at the receiving station a frequency of 80,300. There will then be 300 beats per second. Assume that the receiver is mechanically tuned to respond to a note of 300 per second, but not to one of 290 or to one of 310. It will be evident then that if the frequency of either dynamo changes as much as 10 cycles per second the receiver will not respond. A frequency of 10 cycles per second is, however, $\frac{1}{80}$th of 1 per cent., and no practical and commercial means, suitable for general use, is known whereby such constancy of speed can be maintained. The best that has been done so far in practice has been $\frac{1}{20}$th of 1 per cent., and the best results obtained in the laboratory $\frac{1}{50}$th of 1 per cent.

For this reason it is inadvisable to make the mechanical tuning of the receiver too sharp. It is hoped, however, by other means which are now being experimented with, to be able to maintain still greater constancy of speed. Even as it is, however, the degree of selectivity is more than ample for present working conditions, allowing, as it does, for more than 50,000 separate non-interfering tunes.

* U.S. patents, 706,735, 706,736, December 15, 1899.

† U.S. patents 706,737, May 29, 1901; specification and claims 19, 20, 21; 706,742, June 6, 1902; 727,330, March 21, 1903; 730,753, April 9, 1903. U.S. patent 706,737, is of interest as being the first publication of the method of telegraphing by using continuously sustained oscillations. U.S. patents 706,742, 727,330 and 730,753 are of interest as being the first publications showing a practically operative method of generating sustained oscillations for wireless work by arcs, the use of metallic electrodes, regulating resistances, synchronising circuits, the use of direct-current circuits of 1,000 volts, &c.

Since the previous note was written, the mechanically-tuned amplifier has been still further improved, so that it now amplifies more than 100 times instead of the 30 times previously given.

For the successful carrying out of this work I am very much indebted to Mr. Alexanderson of the General Electric Co., Mr. Guy of the De Laval Steam Turbine Co.; my electrician Mr. Stein and his assistant, Mr. Hill; my draughtsman Mr. Mansbendel, and to my shop superintendent, Mr. Williams.

SOME INTERESTING MACHINES FOR THE WAR DEPARTMENT.

By the courtesy of Messrs. Siemens Bros. Dynamo Works we are enabled to give particulars of some interesting machines which they have recently supplied to the War Department.

Fig. 1 shows one of two large generators which are of special interest as being amongst the largest machines yet built with com-

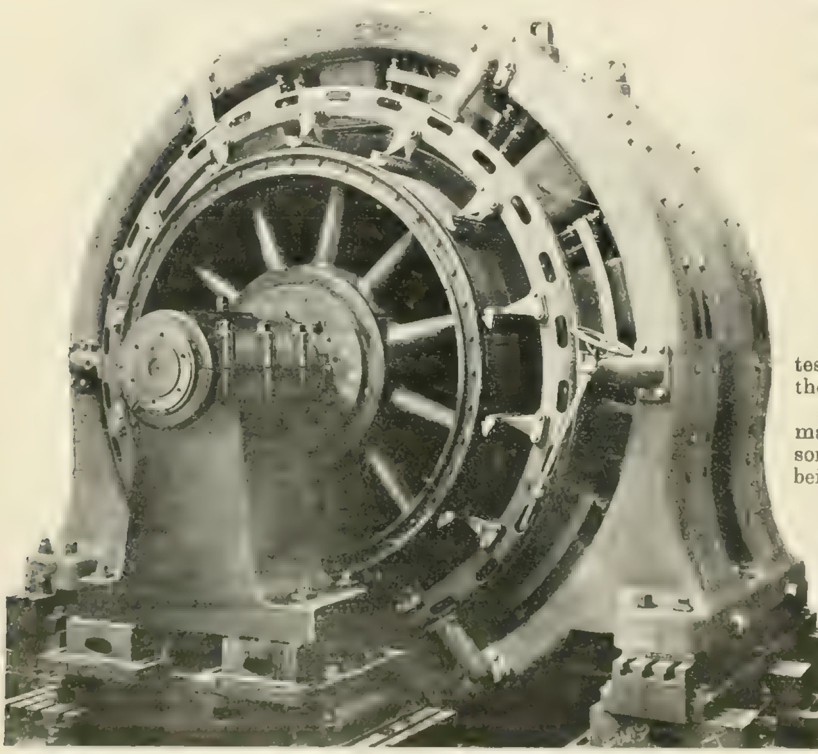


Fig. 1. 1,500-kw. Siemens Continuous Current Generator.

mutation poles. They will be driven by triple expansion vertical type steam engines by Messrs. Yates & Thom. The armatures are directly bolted to the engine flywheel. There are 14 shunt-wound main poles and an equal number of commutation poles, through each of which the whole current of the machine passes in turn. Each machine is designed to give 2,900 amperes continuously at from 500 to 530 volts as a shunt generator, when driven at 85 revs. per min., the specified temperature rise of the hottest part after 12 hours run on full load being not more than 70°F., and the efficiency not less than 93 per cent. by the Hopkinson test. The specified overload capacity is 25 per cent. for two hours. These specified figures were more than fulfilled on test, the temperatures coming out very low and the efficiency 94 per cent.—that is, 1 per cent. above guarantee.

The yoke is of cast steel and the main poles are laminated throughout; both the latter and the commutation poles can be removed without dismantling the machine. The armature is of the slotted drum type, and is built up of soft iron laminations with specially small hysteresis losses. It is mounted on a cast-iron spider, and is well provided with ventilating ducts. Former-wound and interchangeable armature coils are employed, and are kept in place in the slots by wooden wedges throughout the whole of their length, the end connections being secured against displacement by centrifugal force by a special steel binding ring, easily removable.

The insulation of the coils consists of layers of mica and presspahn, which are held together with shellac and moulded while hot over the group of conductors, previously taped. An extra thickness of insulation is provided between the top and bottom members of two coils in a slot. A suitable number of equalising rings of large section are provided. The commutator is of hard-drawn high-conductivity copper, and is insulated with mica. Each segment was carefully milled to the correct taper before being built in, and the whole subjected to a heavy pressure before being machined. The brushes are of carbon, the current-density at full load being about 30 amperes per square inch.

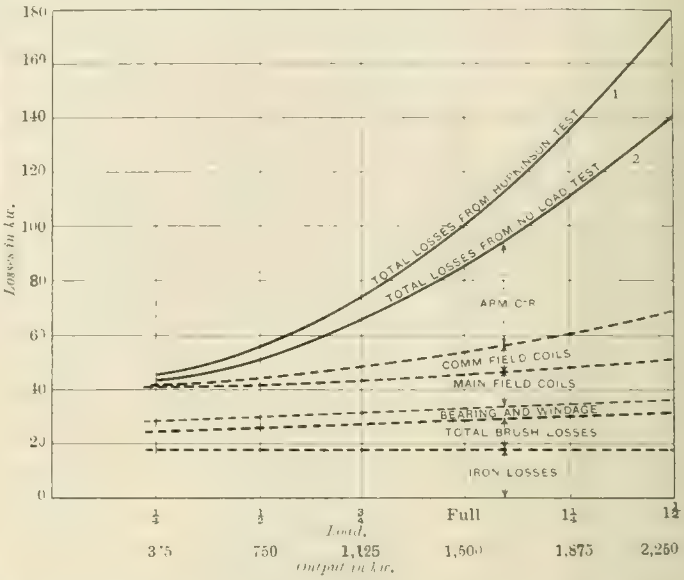


Fig. 2.

Before leaving the works, the machines were subjected to severe tests, and the excellence of their performance may be gathered from the following:—

For the 12 hours' full-load run at 530 volts 2,900 amperes, the machines were coupled up in the usual way for the parallel Hopkinson method, the losses being supplied electrically and both fields being excited from an external source. The run was made with the generator giving the full rated output of 1,500 kw., corresponding to about 14 per cent. overload on the motor. At the end of 12 hours' continuous run at this output, the following temperature rises were observed (by thermometer):—

	Rise in temperature above surrounding air.	
	Generator.	Motor.
Armature core	29°C.	29·0°C.
Armature end connections	23°C. ...	24·0°C.
Commutator	21°C.	18·0°C.
Shunt coils	31°C.	24·5°C.
Commutation coils	28°C.	32·5°C.

The commutation was sparkless throughout.

In the efficiency test the machines were coupled up as before, and the following results were obtained:—

Speed.	Generator. Gen. Amps.	Generator. Field. Amps.	Motor. Motor. Amps.	Motor. Field. Amps.	Volts common to both.	Amps. supplied externally.	Mean load. Kw.	Efficiency of each machine on mean load.
85·2	740	23·9	842	21·9	532	127	420	90·2
85·0	1,450	24·8	1,595	20·8	528	172	805	93·4
85·0	2,250	27·3	2,560	21·9	530	266	1,272	94·0 %
85·0	2,970	29·1	3,360	22·8	530	380	1,675	93·8
85·0	3,700	31·1	4,220	24·0	529	536	2,095	93·3 %
85·3	4,500	33·4	5,320	24·9	529	767	2,570	92·2

It will be noticed that besides being well above the guaranteed figures at full load, the efficiency remained high also at light loads. The maximum motor current of 5,820 amperes corresponds to an overload of 84 per cent., and there was only a trace of sparking. In all the other cases the commutation was sparkless.

A third test of 10 hours' duration was also carried out to determine the temperature rises on overload, the following results being obtained:

Generator current 3,500 amperes. Motor current 4,000 amperes.

	Temperature rise	
	Generator.	Motor
Armature core	36·5°C.	32·5°C.
Commutator	21·5°C. ...	32·0°C.
Shunt coils	37·0°C. ..	29·5°C.
Commutation coils	41·5°C. .	57·0°C.

Thus, on an overload of 39 per cent. on the motor for 10 hours, the only parts with a temperature rise higher than specified for the normal load of 2,900 amperes were the commutation poles. The reason for the lower temperature rises on the motor is due to the fact that the cool air was delivered to the motor side of the combination, and the generator had the disadvantage of receiving air which had already passed the motor. In calculating the temperature rise, the mean air temperature was taken, and this, of course, handicapped the generator. The commutation was perfect throughout the test.

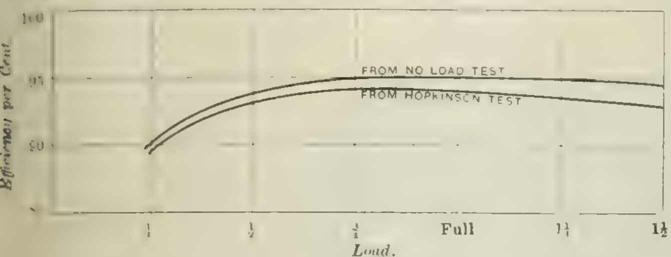


Fig. 3.

It is well known that the sum of the no-load losses, plus the additional C^2R losses due to the load, do not make up the total power lost at full load, but the extent of this discrepancy is not generally recognised, and has led to much doubtful practice in specifying efficiencies. The serious nature of this error is well illustrated in Fig. 2, in which the upper curve represents the total losses as given by the Hopkinson test, and the lower curve the total losses as obtained from a no load test. In Curve 1, Fig. 2, half the losses supplied from external sources are plotted against the mean load of the coupled machine as found from the Hopkinson test. The discrepancy in the efficiency as obtained by these two methods is very considerable, as may be gathered from Fig. 3, and the following table:—

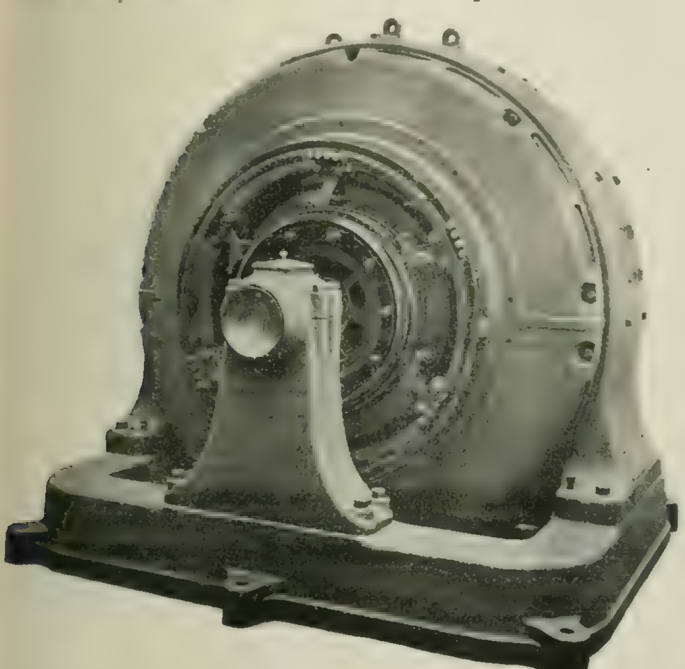


Fig. 4.—View of Commutator End of Siemens Variable Speed Motor.

Load.	Efficiency by Hopkinson test.	Efficiency by no-load test.	Guaranteed efficiency.
50% overload	93·0 per cent.	94·5 per cent.	...
Full load	94·0 ,,	95·0 ,,	93·0 per cent.
¾ ,,	94·0 ,,	94·8 ,,	...
½ ,,	93·0 ,,	93·8 ,,	...
¼ ,,	89·5 ,,	90·2 ,,	...

In view of the fact that machines are sometimes required to give their full-load current with a very weak field (for instance, for Siemens-Ilgner flywheel converters for colliery winding, where a current considerably in excess of full-load current may be required at practically zero volts), it was decided to test these machines also in this direction. The test was a short-circuit test, and it was observed that about 2 per cent. of the normal shunt current was required to produce full-load armature current, and about 3 per cent. for 50 per cent. overload. With the very weak fields thus produced, a current of 4,500 amperes was taken from each machine in turn, and the commutation was quite sparkless with fixed position of brushes. This current corresponds to an overload of 55 per cent.

Another machine supplied to the War Department, interesting on account of the fact that it is one of the largest, if not the largest, motor yet made with as wide a speed variation as 1 : 6, is shown in Fig. 4. It is designed to give 100 B.H.P. when supplied with current at a pressure of 500 volts, the speed ranging between 100 and 600 revs. per min. There are six main poles and an equal number of commutation poles. As will be gathered from the illustration, the motor is of the ventilated type, the openings being covered with gauze. The speed variation is obtained by shunt control, and on test the motor was perfectly stable and ran absolutely sparklessly under all working conditions—from no-load to 100 per cent. overload at all speeds. Sparking could not be detected even when the brushes were tilted on to their sparking edge, and a test more severe than this can scarcely be devised. After a 5 hours' run at full load and 350 revs. per min.—the mean speed of the motor—the temperature rise nowhere exceeded 37°F., and after six hours' full-load run at the highest and lowest speeds the temperature rises were quite within normal limits.

The efficiency of the machine at full load is some 88 per cent. from 200 to 400 revs. per min., being slightly lower at the extreme speeds. In view of the unusual nature and very special design of the motor, this efficiency must be regarded as very satisfactory.

ELECTRICAL EXHIBITS AT THE FRANCO-BRITISH EXHIBITION.—I.

Although somewhat late in completion, the collective exhibit organised by the London electric supply companies now serves very well to draw attention to the many uses of electricity for domestic purposes. The companies have secured an excellent position for their display in the Machinery Hall, the more so as it is adjacent to the stand where the gas industry is demonstrating the corresponding benefits arising from the adoption of gas for illuminating, heating and cooking purposes. In this connection the public are informed by a placard, prominently displayed on the latter stand, that the relative costs of lighting by gas, by osram lamps and by carbon glow lamps are £7, £21 and £55 respectively, although those responsible for the placard do not display the basis of the calculation by which these results have been arrived at.

Turning to the exhibit of the electric supply companies, this consists of a reception room, at one side of the central passage traversed by the visitor to the Machinery Hall, faced by a model house, furnished by Messrs. Waring & Gillow, consisting of a hall, dining room, drawing room, bedroom, nursery and kitchen. A small card on one of the walls informs the public that the annual cost of lighting such a house by the methods displayed amounts to only £6, with current at 5d. per unit. Metallic filament lamps are, of course, largely in evidence, and will be referred to later. A view of the entrance to the model house is given in Fig. 1.

Electric fans are very prominent, whilst electric radiators and an electrically-driven sewing machine are also noticeable. It is, however, in the kitchen that the greatest interest is centered. Here demonstrations of electrical cooking are given from 4 p.m. to 6 p.m. daily, and its many advantages, as regards convenience and cleanliness, explained, whilst Messrs. Electromotors show a boot polisher, a knife cleaner (capacity 1,000 knives per hour) and a silver polishing machine, all electrically driven.

The cooking table, which is exhibited by Messrs. Rashleigh Phipps & Co., of 147, Oxford-street, W., and which we illustrate in Fig. 2, replaces the usual kitchen range, and does away with all coal or gas stoves. It consists of a number of circuits, each controlled by two switches, giving three degrees of heat—one-third, two-thirds and full—pilot lamps being arranged to show which circuits are in use, and in order to do away with all loose flexible cords these latter, when out of use, automatically fly back into the frame of the apparatus, leaving only the plugs visible, so that it is impossible to damage the flexibles. Fuses for the various circuits, together with main switch and cut-outs, are mounted in two recesses above the switchboard, and an ammeter, showing the total amount of current in use at any time, is provided.

In addition to the above-mentioned circuits, which are intended for use with frying-pans, saucepans, kettles, &c., there is provided an electrical oven ("Prometheus" type) on an entirely new principle and the

first of its kind ever constructed, in which, on account of the high temperature obtainable in the new form of electrical element used. roasting and baking are said to be performed with very much less expenditure of current than has hitherto been required. The resistances employed in the oven are run at bright red heat, and are said to be unaffected if covered with water when in that condition. Also it is able to stand over-running to the extent of 100 per cent. The various regulating switches and pilot lamps in this instance form a part of the oven, rendering it entirely self-contained and suitable for fixing in a kitchen quite apart from the other portion of the cooking table.

On the top of the oven is fitted a cooking hot plate, a grill and a toaster (said to be the first efficient and practical electrical toaster

Fig. 1. View of Entrance to the Model House erected for the London Supply Companies.

ever exhibited), all fitted with the new high-temperature elements as used in the oven. A small boiler, fitted with tap, enabling a supply of hot water to be obtained at any moment, completes the outfit. A canopy is fitted over the cooking table which, by means of a small Blackman fan, provides for the efficient ventilation of the kitchen and prevents any smell of cooking penetrating to other portions of the house. The space under the cooking table, as will be seen in the illustration, is provided with a rack for holding saucepans, &c., when not in use.

The utensils shown in the kitchen suitable for use with the above store comprise stewpans, saucepans, frying-pans, omelette-pans, kettles porringers, potato steamers, coffee-makers, hot-plates, steam cookers, brazing-pans and fish-kettles. A spacious hot cupboard for warming plates and dishes and keeping food hot is also fitted, and electric irons of various shapes and sizes are shown in actual operation. Should the necessary space be available, it is intended also to show an electrical plate and dish washer.

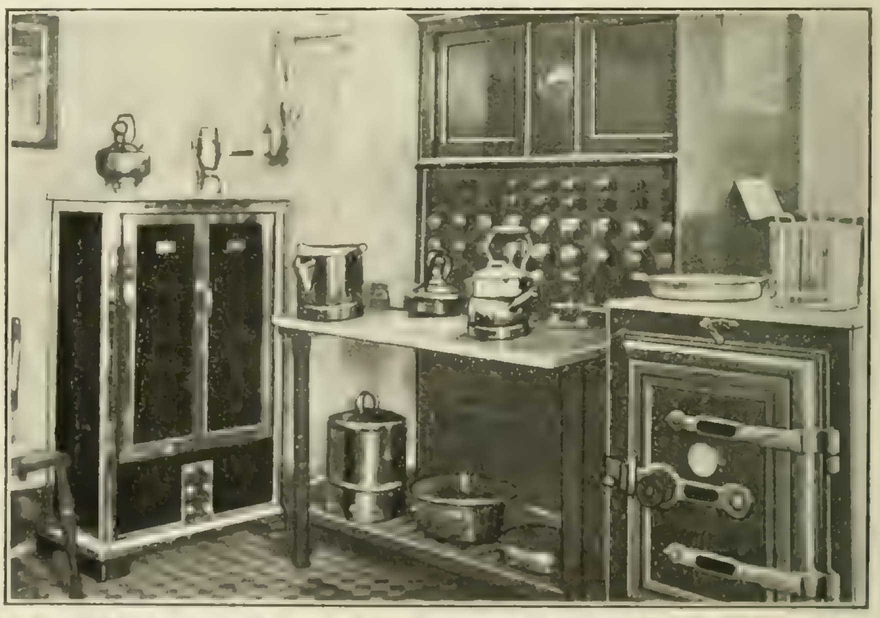


Fig. 2. View of Cooking Table and Oven supplied by Messrs. Rashleigh Phipps & Co. in connection with the Combined Exhibit of the London Electricity Supply Companies.

In connection with the demonstrations of electrical cooking, which will be given throughout the run of the Exhibition, the chief points to which attention will be drawn are the ease of operation, absolute cleanliness, perfect control of heat giving certainty of results, the entire absence of any noxious fumes which are found so great a drawback to the use of gas stoves for cooking, and the complete freedom from the unhealthy and unpleasant heat attending cooking by means of a coal range.

In addition to the above apparatus in the kitchen, various other domestic utensils are shown in the various rooms, as follows: Hall, a small hat-iron and a cigar-lighter; dining room, a hot plate and a kettle; drawing room, an afternoon tea kettle and a foot warmer; bedroom, a bed warmer, a bed foot warmer, a curling tongs heater, a particularly small and convenient form of hair dryer, a shaving pot, kettle, hot-water jug, and a form of immersion heater used for heating water directly in the wash-hand basin or jug; nursery, a milk bottle steriliser, a flatiron and a kettle. Electric radiators of various designs for warming rooms are also shown, besides electric glue pots and medical sterilisers.

It should be noted that the kitchen arrangements, having been installed with a special view to giving a thoroughly complete demonstration of electrical cooking in all its branches, are far more extensive and elaborate than would be in any way necessary for a house of the size shown, the accommodation provided being ample for cooking for 30 persons.

As demonstrating the moderate cost of the current used by the various utensils, we may mention that, with a supply of energy at 1d per unit, an electric iron can be used for ¼d. per hour, or 6 pints of water can be boiled for about ½d., whilst five dozen breakfast omelettes, each requiring two minutes, can be cooked for 1d.

In the reception room to which we have previously referred, a representative of the supply companies furnishes any information desired by visitors, and pamphlets and price lists are conspicuously displayed. Displays by individual exhibitors are situated in this reception room. Thus, an electric punkah, to reproduce exactly the effect of the hand-operated one, is suspended near the entrance and is shown by Messrs. Bergtheil & Young. An electric piano plays in one corner of the room, and fans are situated on several tables and attached to the ceiling. The electrical installation has been carried out by Messrs. Leonard & Co., of 4, Soho-street.

The artificial lighting of the room is provided by an arc lamp in the centre and metallic filament lamps of Edison & Swan manufacture, these being 50 volt lamps run in series of two. This firm are supplying 25 c.p. metal lamps for 100 volts and 16 c.p. lamps for burning on 50 volt circuits.

Among the show cases which attract attention are those of A. P. Lundberg & Co., containing switches, fittings, &c.; Reason Mfg. Co., meters and testing instruments; London Decorative Metal Works, ornamental switchplates, &c.; Sunbeam Lamp Co., various types of incandescent lamps; Birmingham Guild of Handicraft, electric fittings; and Messrs. Verity, fittings and "Astonlite."

Not the least interesting of these exhibits are the "Sunbeam" metal lamps, which that company are to shortly place upon the market. These are exhibited by them for high and low-voltage circuits, the former being seen hanging from brackets in the reception room. The high-voltage lamps of about 55 c.p. are burning on a 220 volt circuit at an efficiency of 1·35 watts per candle-power, whilst the low-voltage lamps are running at an efficiency of about 1·2 watts per candle-power with a candle-power of 30. The filaments are strong and likely to bear fair usage in transit, which claim is fully borne out by the lamps themselves, which arrived at the Exhibition without any special packing.

We understand that the company are at present erecting a special factory for the production of these metal lamps, and will be able to meet the demands of the coming season. They are also prepared to guarantee the lamps against infringement, as they are working under licence of the Westinghouse patents.

Round the exterior of the model house and reception room a number of electrical manufacturers occupy stands. Among these that of the Edison & Swan United Electric Light Co. occupies a corner position at the right of the entrance of the Information Bureau. Prominent in this display is, of course, the exhibit of the royal Ediswan carbon and metal filament lamps, which are shown not only in every conceivable form and shape and for every possible purpose, but also in the various stages of manufacture. These possessing, as they do, such great interest, owing to the firm having been the original patentees and inventors of the incandescent electric lamp, are the

chief attraction on the stand. It is interesting to learn that the whole of the lamps used by the Exhibition authorities, totalling several hundred thousand, have been supplied by this firm.

It is doubtful, however, whether more interest is not taken by visitors in the Ediswan arc lamp, burning with pure carbons and giving a light the spectrum of which is said to be identical with that of pure daylight. This lamp is used for illuminating the Information Bureau. Fittings are, of course, exhibited in great profusion, from pendants and brackets to artistic standards.

The engineer will be more attracted by the exhibit of switchgear, especially by that portion which deals with the firm's new patents for quick make-and-break action. The Ediswan circuit-breaker, a notice of which has already appeared in our columns, is also shown, together with the new type of branch switch—the "Phlatta"—which is in use in the Exhibition itself, particularly in the reception room and the electric bungalow, where it is fitted throughout. A large show case prominently displayed contains a complete range of Ediswan instruments, from the large central station type down to the small pocket cell testing voltmeter. A large amount of business should be done in the installation of horse-power meters, which, calibrated for direct reading, show the output of a machine at a glance; the economy resulting in the use of these will be obvious, and will certainly repay the small initial outlay in a very small time.

At the present moment station engineers will be most interested in the new Ediswan auto-transformers, which are prominently shown on this stand, it being claimed for them that, not only are the no-load losses very small, but the power factor is extremely high, being 0·99 at three-quarters and full load.

THE STEARN ELECTRIC LAMP CO., of 47, Victoria-street, S.W., have an interesting exhibits of their English-made "Leuconium" metallic filament lamps, specially illustrating the use of these high efficiency lamps, consuming as they do only about 1¼ watts per English c.p. on a 220 volt circuit. The particular lamps shown are what they term their "Nevaout" series lamps, these being all fitted with a special automatic fuse in the cap of the lamp, and a substitutional carbon resistance in the bulb, so that used in series the failure of one lamp does not entail the extinguishing of the whole group as in ordinary series lighting, but with this device the circuit is automatically maintained through the carbon resistance until a new lamp is put in place of the broken one. Their exhibit consists of a 5 light electrolier fitted with 4 lamps of 44 volts—the fifth point being occupied by a double tubular fitting, each tube being for 22 volts, the total making the 220 volts used on the circuit. They also show a 3 light bracket, each point being 74 volts, and in this case the two outer lamps are of bulb form whilst the centre point is a 3 tube cluster. Below this are two 3 light brackets with all six points wired in series and consequently smaller c.p. at each point. There are two small standards illustrating the use of 55 volt lamps 4 in series on 220 volts, one being fitted with ordinary bulb form lamps, the other with their special tubular form in clusters of three. The Stearn Electric Lamp Co. make a great point of the utility of this device for street lighting, for which purpose, where it is desired to have a yet larger spread of light, they are prepared to supply a 10 tube fitting and to demonstrate this they have fitted up an ordinary street gas lantern adapted for use with electric light on this system.

SOME CONSIDERATIONS ON THE DESIGN OF A GENERATING STATION.*

BY H. RICHARDSON.
(Chief Electrical Engineer, Dundee.)

The author is bound by the limits of a short Paper to mainly consider a special type of plant, while only touching lightly on others. Therefore, the plant to be discussed will be a steam turbo-alternator system with extra-high-pressure alternating supply, this giving greater choice of sites. In most large towns near rivers or estuaries the railways run very near the water, therefore, sites near the water possess a double advantage. Unfortunately, when such land is to be had at a reasonable price it is usually found to be filled-in or made-up land, reclaimed within a comparatively recent period. Therefore, viewed from a foundation standpoint, it is always very bad, unreliable, and in many cases contains the potentialities of chemical actions which will cause the authorities grave distress ere long with regard to all pipes, cables, &c., which have been laid in the ground, if they are not specially and expensively protected. The problem of securing foundations giving a maximum of stability with a minimum of cost is, however, an interesting point in connection with such sites, and much could be said thereon.

First of all the cheapest system is the construction of a large floating or raft foundation. The commonest method was to use a plain concrete raft of considerable thickness, but there are very few cases where this has not developed cracks, and unequal settlement of superstructures has occurred. Many such rafts have been reinforced with old tramway rails, but with little improvement.

Next, as wood piles, particularly in such grounds as the above, are liable to rapid deterioration, the tendency in view of the experience obtained latterly is to make use of reinforced concrete in the construction of piles. If carefully and properly excuted no better foundations can be made, taking into consideration maximum stability with minimum weight and cost. There are, of course, many different systems of reinforcement and sketches showing typical construction are given in the Paper. This subject, however, can be but lightly touched upon, though the following notes may be of interest. In very bad made-up ground containing much silt, with distances of 25 ft. to 35 ft. to rock, a safe load of 60 tons may be allowed on any well-constructed pile. In connection with the driving of these piles it is often specified that a weight equal to 2 tons, falling 3 ft., is to be used, giving a specified maximum amount of set, such as ¼ in. for 10 blows, before driving is stopped. The author is of opinion that this results in a needlessly severe blow in ordinary practice, the change of velocity on impact being too great, resulting in damage to the heads of the piles, and causing much extra work and inconvenience. Piles should not be driven until from 50 to 60 days old at least. Even longer than this should beallowed for the concrete to set if possible.

Buildings.—The advantages of reinforced concrete construction may be carried beyond the actual piling, as it can be used to make a strong and light raft or floor over the heads of the piles and monolithic with them, forming a very complete and stable foundation for the superstructure. It lends itself to easily and cheaply conforming to the exigencies of the plant as regards differences in level of floors and foundations. As regards superstructures they may be subdivided into the following classes of buildings: (1) Brick or stone entirely, (2) reinforced concrete, (3) steel skeleton with light brickwork filling, (4) steel skeleton and corrugated iron walls and roofs.

With regard to (1), such a building is unnecessarily heavy and expensive, and is the form generally used when an architect is allowed carte blanche. The heavy burden of capital expenditure unnecessarily carried by many stations has undoubtedly been largely contributed to by such useless extravagance further aggravated in many cases by equally useless and more sinful ornamentation. The author strongly recommends engineers to check with a firm hand this tendency of their architects, unfortunately often receiving public approbation at the time owing to the usual municipal cry of providing "something worthy of the town."

With reference to reinforced concrete superstructures, the author is strongly of opinion that they are not eminently suitable for the requirements of electrical generating stations. They are not cheaper than the style of building above referred to, the stability is in no way superior, and while certainly lighter, considerable inconvenience is met with in the fact that, once up, the design cannot be interfered with in the way of alterations without prohibitive cost. Also, so much depends, apart from the value of the system itself, on highly skilled and expensive supervision, and one weak part involves such heavy consequential damage. In the complication necessary for superstructures as distinct from foundations, small but important weaknesses are apt to creep in almost beyond detection, however vigilant the inspection, or however good the work of designers or contractors may have been.

Coming now to the composite building, consisting of a steel skeleton filled in with light brickwork, this appears at the present time to be the most perfect system of building, giving as it does a minimum of cost and weight when considered in connection with its probable life, reliability, strength, adaptability, neatness and appearance. If the insides of the buildings are to be lined for the sake of cleanliness, the author is of opinion that opalite or crystopal tiles are very much superior in appearance, cleanliness and expense to the ordinary glazed brick. The author also makes a plea for a clean and brighter boiler house.

A very great deal can be said in support of corrugated iron buildings throughout. It is merely a question of putting their shorter life and more expensive upkeep against the considerable difference in price. In most cases the steel skeleton building with corrugated iron walls is the right form to use if the locality of the generating station does not require æsthetic consideration.

Chimneys.—The engineer has the choice of three main types—viz., brick, reinforced concrete and steel. All the peculiarities of brick chimneys are well enough known, and providing that great care is taken to spend some weeks after the work is finished in gradually heating up the chimney, there is, perhaps, nothing to beat it. The unsightly and apparently dangerous cracks are more often due to bad treatment than to faulty design or settlement.

An interesting modern development is the reinforced concrete chimney. The author had occasion to go very carefully into the merits of this form of construction and came to the conclusion that there is a good deal to be said for it, because, owing to the simplicity of form, the before-mentioned disadvantages of reinforced concrete should not have an opportunity of attaining importance. Two of the firms which have built most of the reinforced concrete chimneys in existence were of opinion that such chimneys would stand a temperature at the base of 1,500°F. without harm or deterioration, and claim that the usual fire-brick lining is unnecessary as they are mostly built up with a separate internal concrete shell extending part of the way up.

The author was surprised to find that in comparing steel chimneys with brickwork the result is so very doubtfully in favour of the

* Paper (slightly abbreviated) read, on Thursday, July 2nd, at the Convention of the Incorporated Municipal Electrical Association.

steel chimney. Dealing with chimneys from 120 ft. to 200 ft. high, the steel chimney equals, and in some cases exceeds, in cost the brick one, if the foundations are excluded, but as so many modern generating stations are built on very bad ground, the foundations have to be particularly good in both cases, so that the lower cost of foundations for the steel chimney is not in any proportion to its comparative lightness. On inquiry from several users of steel chimneys, it was found that their cost of upkeep is quite a considerable item, if they are maintained in a reliable condition. The following are examples of comparative costs:—

Height and diameter	220 ft. by 11 ft.	80 ft. by 9 ft.
Brick chimney	£1,550	£400
Concrete chimney	1,300	470
Steel chimney	1,460	450

In reference to chimneys generally, the great importance of a smooth interior is often lost sight of.

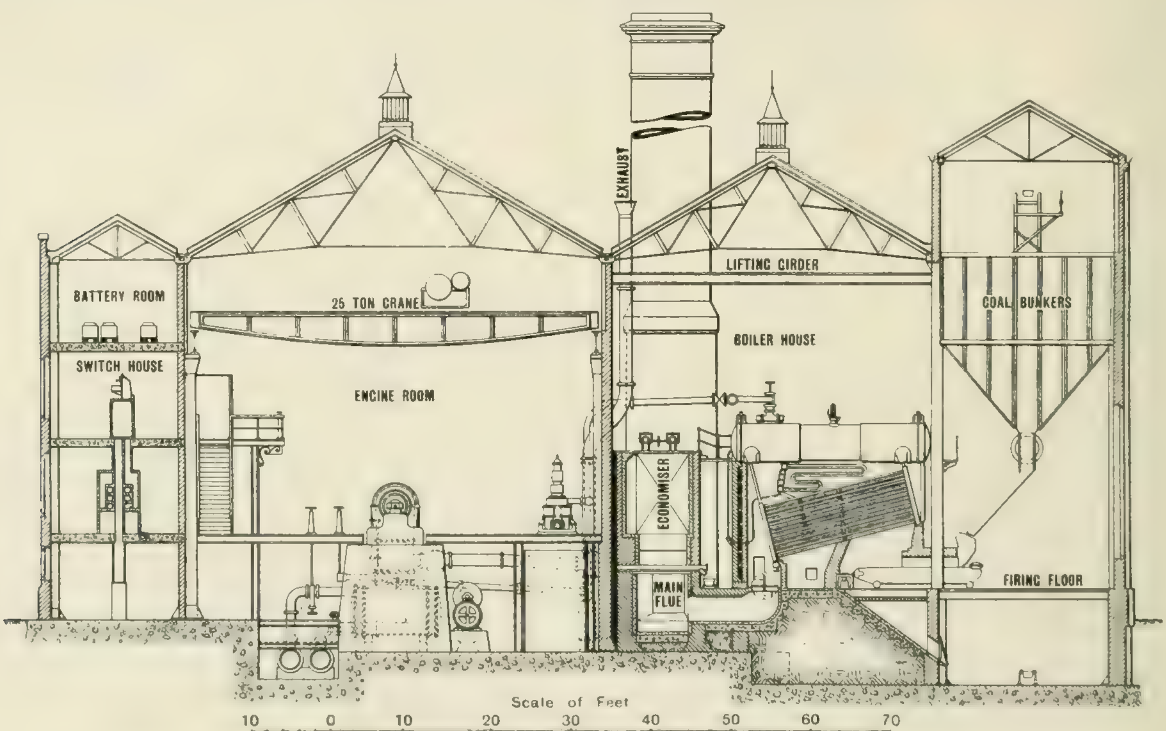
Types of Plant.—There is very little choice left us under the present conditions in this country, and as water power in any quantity is very rare, the case is limited to the consideration of gas or steam-driven prime movers. Being anxious to put in most up-to-date plant, and attain the best possible results in the supply of cheap power, the author was very desirous of using gas engines in connection with a new power station, and made most detailed and careful inquiries from owners and engineers who were using such engines of modern types. The inquiries were limited to the larger and in comparing it with the water tube boiler it appears, in the author's opinion, to fall behind the latter for the following reasons:—

First cost (taking into consideration the ample economiser plant necessary for equal economy). Space occupied and cost of such space. The extreme difficulty of making a good boiler house arrangement of Lancashire boilers to fit in with a good engine room lay-out of steam turbines. Inferior combustion chamber giving less control over the smoke problem and limitations in the choice of mechanical stoker. More inefficient, complicated and expensive arrangement of piping, partly owing to the larger number of units required.

There are several well-known types of water-tube boilers, all of which are practically equal in first cost and efficiency under test conditions, so that, as far as economical coal bills have to be considered, it matters little which of the best types be chosen; but it behoves the engineer to look further than the merely efficient design of the boiler and first cost. The type of boiler should be chosen after careful consideration of the following points:—

Size of boiler and space occupied. Arrangement and size of grate and size of combustion chamber in relation to the quality of coal dictated by local conditions. Adaptability to a practical and efficient arrangement of superheater. Simplicity in arrangement of tubes. Ease of inspection. Accessibility and cost of cleaning. Liability to priming. Cost of repairs and maintenance.

In view of the above, the conditions of manufacture under which



Cross section of Power Station.

units and latest installations. The results were extremely disappointing, in that by a large majority opinions were unfavourable, principally on the grounds of unreliability, cost of upkeep, space occupied, first cost, and the inability to meet sudden overloads o short duration. This being so, the question was reduced to the consideration of the reciprocating steam engine versus the steam turbine.

On inquiry there seemed to be no doubt as to the superior efficiency of the steam turbine, but in view of the common accusations of high cost of upkeep and liability to breakdown, visits were made to several turbine plants in the country, and the result was distinctly in favour of the turbine on all points, and as regards reliability, the vertical impulse type was equal, if not superior, to the horizontal reaction type. One noticeable thing in all stations where both reciprocating and turbine plants were installed was the fact that the turbines were running and doing the brunt of the work and the reciprocating plant, where possible, was standing idle. This was by no means due to any difficulty in stopping and starting the turbines, but entirely to their superior efficiency and lower repairs cost.

Generation of Steam.—Under this head fall to be considered for the larger electric stations only two classes of boilers—viz., the shell type (with ample economiser plant) and the water tube type. Of course, both of these classes can again be considerably subdivided, but without doing so most engineers present will agree that a well-designed Lancashire boiler is about the best of its type, the boiler is made, the standing responsibility and reputation of the firm who make the boiler, the ease and speed with which standard parts can be got for repairs and maintenance are very serious considerations which, in the author's opinion, should go a very long way in settling the particular plant to be used, as such matters have a very important bearing indeed upon the total commercial efficiency of the plant, even though the mere test efficiencies may point to another deduction.

As regards working pressure for reaction turbines a commercially high and quite successful efficiency is obtained with working pressure of from 160 lb. to 200 lb. per square inch, with a minimum of practical difficulties. As regards superheat, however, the author is of opinion that in order to avoid any working difficulties and secure at the same time a maximum reliable efficiency the amount of superheat should be that necessary to attain a working temperature of 550°F. While the efficiency of the separately fired superheater is undoubtedly lower than that of a combined superheater, yet it has a great advantage in the possibility it holds out of maintaining a regular superheat at all loads. This is neutralised by the extra space, attention required, and multiplication of pipes and valves.

Economisers.—The development of the water-tube boiler has undoubtedly rendered the installation of these valuable adjuncts of less importance, and in particular where cheap coal is being used they have a difficulty in justifying their extra cost. At the same time the author recognises that in connection with turbine plants, where the condensed water is at such a low temperature, they have their

uses in protecting the boilers from the well-known bad effects of a cold feed. Under ordinary circumstances economisers should be put in and careful attention given to their position and size to give the best results from the commercial rather than the strictly technical point of view.

Brickwork Settings.—The settings, both in detail and arrangement, do not always receive that strict attention which is their due. So far as their arrangement is concerned, the principal rule to follow is to design the settings as compact, stable and accessible as possible, and to shorten the lengths of all flues and passages to an irreducible minimum, giving good, sweeping smooth curves at every change in area or direction. To reduce the loss of heat by radiation is an additional reason for compact design. Although the loss by radiation appears comparatively small in ordinary boiler tests, it must be borne in mind that such tests are usually made at or near full load, and that, therefore, a constant loss like that of radiation assumes a much greater importance in the practical case of an ordinary generating station. Two practical devices suggest themselves in this connection; one is to build the settings with hollow walls, packing the cavities with a suitable non-conducting substance, and another to face the outside with glazed bricks. As an example of loss of temperature that may take place due to the above causes, the author may mention a case with which he is well acquainted. The economiser is separated from the boilers by a flue about 50 ft. long, and although the brickwork of the latter is in good condition there is a difference in temperature of the gases in this flue, measured at two points 43 ft. apart, of 100° F.

Built-in fittings, particularly dampers, must be carefully designed with a view to freedom from sticking in working, due either to their position, settling of brickwork, expansion or contraction. Instead of being as rough, as they often are, they should be most carefully fitted. Arrangements should be made to stop the leakage usually considered inseparable from dampers. The best cure for this is the use of butterfly dampers. Expansion being a considerable factor in such fittings, sufficient clearance must be left to ensure easy working when the boilers are being forced, as the inability to open or close a damper may have very serious effect.

During construction the following points should be borne in mind. The bricklaying should be done by men experienced in the construction of furnaces because the requirements are not the same as for ordinary building. In all cases the joints should be as close as possible, and the cutting of bricks should be avoided. Where it is absolutely necessary, as, for example, the closing of an arch, the cut surface of the brick should be rubbed smooth to ensure a close joint. Great care should be taken to render all surfaces smooth, as the effect of rough surfaces on the draught are often under-estimated, and as far as the furnace is concerned, careless laying militates against durability under the effect of the fires. Certain schemes of reinforcing the brickwork by means of steel network in the joints, &c., are in the market, and there is much to be said for their consideration.

Draught.—The question of mechanical *versus* natural draught is likely to remain an unsettled one. If mechanical draught is decided upon by any designer, he has to choose between an induced draught system, and what is called forced draught, meaning a system of moderate pressure supply designed to control the air for combustion to a boiler within the limits of efficiency, and without deteriorating effects. In considering such a pressure draught it is assumed that the air is supplied to a closed ashpit, and that the pressure above the fire is equal to or very slightly below that of the surrounding air. The difference of pressure necessary to overcome the resistance of the boiler flues and economiser would then be provided by a comparatively short chimney. It is submitted that the pressure draught is superior for the following reasons: In case of any leaks in the settings, the efficiency of the draught will be preserved, and as the difference in gas pressure between the interior of the flues, &c., and the surrounding air is much less, harmful air leakages will be avoided. If the quality of the coal is such as to require frequent opening of the fire doors to break up clinkers, &c., the inrush of cold air with consequent loss of efficiency and damage to brickwork and boiler will be avoided. The size and consequent price of the plant is smaller. This, of course, may be a disadvantage from the fan-maker's point of view. And, finally, although all the makers of mechanical draught consulted strongly deprecated the use of a pressure draught system, none of them advanced any solid reasons in support of their contention, but only drew imaginary pictures of excessive local actions in the furnace, &c.

Speaking generally of draught, the installation of a chimney of a capacity sufficient to deal with the normal full load of the plant is recommended because this method is, after all, the most efficient, simple and reliable, and appears to be cheaper in first cost. During the erection of extensions nearly all power stations are pressed; therefore, it is recommended that everything should be constructionally ready for the installation of a pressure or induced draught, not in recognition of the superior economy of such apparatus, but in appreciation of their temporary utility in producing a desirable margin of power.

Coal Handling Plant.—It is only after a power station has attained considerable size that any superiority in the mechanical or automatic handling of coal is made manifest. The question is entirely one of putting the standing charges and maintenance cost of such plant against the saving in labour and probably increased efficiency of the mechanical stoker. As this Paper refers to larger stations they will be considered as necessary, and it will be taken for granted that a railway siding runs into the station premises, with facilities for feeding the said sidings with waggons from the wharves if not near enough for transporters.

As to the means of emptying the waggons there are four methods available—viz., by hand, bottom door emptying, end tipping and side tipping. The choice between the last three necessarily depends upon the type of waggons available and the speed of service

The conveyor is undoubtedly the most interesting and important part of the equipment, and much depends on the type chosen. Leaving the worm and belt conveyors out of the question for this work practically limits consideration to the well-known bucket type, and the equally familiar scraper type. The author's opinion favours the bucket type in spite of its considerably higher cost for the following reasons: Longer life, neater and cleaner work, less wear and tear, less power used, less noise, increased reliability, less breakage of coal; in short, less total cost in working.

As to the bunkers, although steel bunkers are convenient, light and in more general use, yet a case is clearly made out for the serious consideration of reinforced concrete. An estimate of the probable saving in cost obtained from four known cases approximates 25 per cent. for equal capacities. In designing the bunkers, special attention should be given to the arrangement of the compartments with a view to storing different classes of coal to be easily drawn from by the engineers at their discretion. Such facilities offer great convenience and have a considerable effect on the total economy of the station.

As regards the measuring of coals, the conflicting results obtained where the weighing system is in vogue, and the impossibility of tallying, however accurate the machines, decide in favour of the volumetric measuring as against weight measurement. The results thus obtained will compare more consistently. This only refers to boiler house measurement, and not to the measurement of coal supplied to the station, which, of course, must be weighed.

Mechanical Stokers.—The different requirements which must be fulfilled by any satisfactory mechanical stoker are as follows: Low first cost; reliability and simplicity; cost of upkeep; cost of power for working; accessibility and ease in replacing damaged parts; extent of control over rate of combustion; suitability to the type of boiler to be adopted; smokelessness.

After consideration it will be found that the number of stokers that will answer the above requirements satisfactorily is very limited, and so far as use with water tube boilers is concerned the author favours chain grate close-linked stokers in spite of the following disadvantages. Clinkers are very apt to adhere to the brickwork at the sides of the grate, and these scrape off the fire at the edges, leaving the bars exposed. The act of breaking away these clinkers does considerable damage to the brickwork. The wear on the worms and worm wheels is sometimes very severe, due to distortion of the whole grate, which takes place after a time, and causes the gear to work very stiffly. This trouble is aggravated by the difficulty of keeping the working parts lubricated when working the stoker slowly with the dampers nearly shut, owing to the rise in temperature of these parts. The split cotters in the pins of the grates come out, the pins then work their way out, and jamb, generally somewhere at the back. If an attempt is made to deal with a very light load by reducing the air supply it is found that the fire will ignite right back to the furnace doors and front. This results in considerable damage by overheating, and is liable to set the coal in the hoppers on fire. Sticking and breakage of dumping bars and rods in some types, due to overheating from ash accumulation, is extremely awkward at times, and not unusual. The cost of renewing the brick arches may become excessive unless they are constructed with unusual care. In some types clinkers will not ride over the dumping bars, but accumulate on the grate, reducing the effective area of the latter, and causing a drop in the steam pressure. In such types also the dumping bars give trouble by getting displaced and burning away. Even in view of these defects the author is of opinion that a well-made chain grate stoker is by far the most economical in all-round working, and there are several good makes.

Ash and Soot-Handling Arrangements.—These should be designed so as to keep ash and soot out of and away from the boiler house proper. The ash basement under the boilers or firing floor is the proper place for dealing with such refuse, and it is quite simple to load it into the conveyor, with a minimum amount of scattering or dust. The cleaning of the economisers ought to be arranged for in the same way, giving easy connection with the conveyor. An economiser arrangement, specially intended for use with very small cheap coal, consists of screw conveyors fitted in sloping sided compartments, forming the floor of the economiser chamber. This will prevent the annoyance of shutting and cooling down of the econo-

misers for the necessary frequent cleaning, and will result in a considerable saving of labour.

Feed Pumps.—It would seem that where a pump is to work at full load for long periods the superior efficiency of the electrically-driven pump would point to its adoption. Such pumps, however, do not lend themselves easily and economically to regulation over wide ranges, and this, combined with their appreciably higher first cost, militates against their use under conditions of variable loads. It is necessary in any case to instal one steam-driven feed pump at least in a generating station for use in emergencies when electrical power is not available. Probably the best policy to follow is to start the first instalment of plant in a station with steam pumps, and use electrically-driven pumps for the extensions. Although feed pumps are more frequently located in the boiler house, there is a great deal to be said for situating them in the engine room. The arrangement of feed piping can often be simplified and made more direct, and the pumps are likely to receive more attention than they would get at the hands of the firemen. It is important in such cases to arrange for convenient regulation from the boiler house.

Engine-room Lay-out.—In dealing with the lay-out of the engine room with turbine plant of the horizontal type, the first thing is to decide whether the axis of the turbines shall be parallel to the length of the engine room or across it. With the larger sizes of turbines of 1,500 kw. and above, and a single row of boilers parallel to the engine room, considerable space can be saved by the first arrangement. Before taking the utmost advantage of this, however, it is well to forecast future possibilities in the way of other types of plant, such as vertical turbines, gas engines, &c., as the span and height of the crane may otherwise greatly handicap the choice of plant required for extensions. With regard to the position of the condensing plant, this is now almost universally situated immediately below the turbines, on account of the importance of reducing the frictional resistance to the flow of the exhaust steam, and it also minimises chances of leakage by diminishing the number of joints. The condensers can either be placed lengthwise with or across the turbines. The former gives a very compact arrangement with the turbines along the length of the engine room. In condensers of the contra-flo type, however, the steam inlets are situated eccentrically and such condensers must, therefore, be placed across the turbine.

With regard to the air pumps there are two or three modifications to choose from—viz., the simple air pump or two separate pumps, one for dealing with air and vapour, the other for the water, or, thirdly, a vacuum augmentor in combination with the air pump. The absolute pressures attainable respectively in the condenser decrease in the above order, the extra complications being intended to increase the density of the air and vapour before it is dealt with by the air pump, which is done by cooling in the one case and by a preliminary compression with a steam jet pump in the other. The practical advantage of the possible increase in vacuum by the use of such methods is rather doubtful, except, perhaps, in the case where the available amount of cooling water is limited and its temperature is high. It will also be found that this apparatus requires to be below the level of the condenser, and that the necessary depth cannot always be given owing to complications of sewers and liability of flooding. Facilities for the cleaning and replacement of tubes should not be lost sight of in the design.

Circulating Water Pipe System.—To reduce the power required for pumping the circulating water to a minimum, the outlet end of the discharge pipe should be below the level of the source of supply, so that the arrangement forms a species of syphon. Precautions are necessary to deal with air liberated from the water or leaking in at joints, if the top of the syphon is far above water level, otherwise the syphonic action will soon cease. The advantage of the syphonic effect is, of course, limited to about 30 ft. (practically it may be found to be much less), and in cases where the water has to be raised to a considerable height, the recovery of power rendered possible by the use of turbines situated near the lower end of the discharge pipe, and driven by the water on its return merits consideration. As the integrity of the circulating water system is of such vital importance in a steam turdine installation, every care should be taken in the laying and jointing of the pipes, and the latter should be specially protected from corrosion if the ground is bad. Trouble has been experienced in cases where cast-iron pipes have been embedded in solid concrete with breakage, due, probably, to expansion and contraction with the varying temperatures of the discharge water. A form of pipe which possesses considerable advantages for this work is one constructed of reinforced concrete. Such pipes are cheap and durable, and can be moulded practically in any desired shape. In any case substantial foundation must be provided for the pipes to obviate subsidence, and if the ground is soft, piling becomes necessary.

Main Steam and Feed Piping.—The author desires to advance a plea for reducing duplication of pipe work to an absolute minimum and securing reliability by simplification, thoughtful design, careful erection, and the use of the very best materials. The simplification and reduction of the amount of steam piping has its effect on the coal bill, while the reduction in the number of valves and joints is correspondingly beneficial in economy of maintenance. Although steam traps may possibly work correctly for a few hours or days, yet experience shows that they cannot be relied upon (without constant adjustment and overhaul) to prevent waste of steam on the one hand, and accumulation of water on the other. The diameter of the main steam pipes can advantageously be reduced when used for super-heated steam. When turbines are used there are additional reasons, as the flow of steam is more uniform and the retention of temperature of super-heat is of greater importance than a slight reduction in steam pressure.

Generators.—The modern standard designs of the best makers are very similar and their differences do not entail any special features in the design of a station. The question of efficient ventilation has risen into great prominence since the advent of the turbo-generator, and ducts are generally formed in the concrete foundations for this purpose. If possible it should be arranged that these ducts lead from a cool space in which the air is still, dry, free from oily matter, and has had time to deposit some of its dust. If air is drawn specially from outside the building, the position of its entrance should be carefully considered in connection with this question of dust, and filters may be used.

Auxiliaries.—The use throughout a generating plant of continuous current motors for driving auxiliaries is recommended in cases where direct current is to be distributed in the locality of the generating station, as it is very convenient to have a storage battery reserve for this class of work, and economical adjustment of speed has advantages.

Switchgear.—In moderate and large-sized stations the best system is to isolate the whole of the high-tension gear in special chambers, the operation being effected from a gallery overlooking the engine room through the medium of electrical control. The cellular type of board is to be preferred, and as much space as can be afforded should be allowed for the gear. This is a strong reason for arranging the switch chambers along the side of the engine room, rather than across the end; besides, this method allows of some simplification in the connecting cables. The 'bus bars should be divided by means of section switches, so that any part may be made dead for inspection or repair without interference with the supply. Too much thought cannot be bestowed in obtaining a safe working arrangement. In a system which is being carried out by the author the doors of the compartments containing the feeder isolating switches are provided with double locks. One key will be kept by the station department and one by the mains department. Whenever any cable is required to be disconnected for testing or repair, the isolating switch will be opened and the compartment locked by both parties. The cable then cannot be made alive again except in the presence of both the departments concerned. Facilities for earthing parts of the gear should be provided as a safeguard against their becoming charged by leakage or otherwise, while persons are working on them. It is almost universally acknowledged that oil-break switches are the only type that should be used for breaking high-tension circuits, and their breaking capacity should be chosen with reference to the total kilovolt-ampere capacity of the station on a momentary short-circuit.

A number of diagrams showing such a power station are attached to the Paper; we give herewith one showing a cross-section of the station.

THE LAMP TESTING ROOM AT MESSRS. SIEMENS BROS. DYNAMO WORKS' LONDON STORES.

Even if the Daylight Saving Bill is allowed to pass into law supply engineers and those manufacturers who deal in such wares as lamps will still have some crumb of comfort, for at any rate there will always be a certain time when artificial light is necessary.

A study of the history of artificial light from the earliest days reveals some interesting points. First among these is the increasing desire for greater illumination as time went on. The development in this respect is especially marked during the last 150 years. What was a brilliant spectacle to our great grandfathers would seem intensely dull to us, and the same will doubtless also apply to our great grandchildren if they are not in the meantime blinded by the close proximity of high power lighting units. Our present tendency in this respect is, therefore, to make the night as much like day as possible, and the manufacturers, whose only object is to oblige—in fact, their collective motto might be "Wir Dienen"—have provided us with what we desire—high illumination by night as well as by day. In the fulfilment of this desire the supply engineer plays a by no means unimportant part.

So much for the man in the street's point of view. Electrical engineers, however, have in this development an altogether different interest. Looking at it from an engineering and scientific point of view, they can, with complacency, regard the progress that has been made during the last few years, years which have seen the introduction both of the flame arc and the metallic filament lamp, not only as experiments, but as fully fledged members of the commercial market. A like development during the same period from the present date will do away with any necessity for the Daylight Saving Bill.

These reflections, which in these long evenings are perhaps a wee bit unseasonable, are called forth by a visit lately paid by us to the London stores of Messrs. Siemens Bros. Dynamo Works in Bath Street, City road. These stores are essentially for small articles—motors of all types up to 5 H.P., motor starters, arc lamp carbons, and last but not least carbon filament and Tantalum lamps. In connection with these last, and especially the Tantalum lamp, which holds the proud position of being the earliest of the many metallic lamps now on the market, a very interesting test room has been fitted up.

The lamps on receipt at the stores are deposited on the first floor; they then pass to the second floor where they are submitted to various testing operations, and are finally deposited in stores on the top floor.

The necessary testing current is derived from an auto-transformer in the basement, fed from the County of London Electric Supply Co.'s mains. By a suitable adjustment voltages ranging from 30 to 300 can be obtained, and in this way a large variety of lamps may be tested without trouble. The normal capacity of this transformer is 50 kw., but this has constantly been exceeded without any excessive damage accruing. Direct current at 530 volts is also available, and, besides lamps, these facilities are also used for testing motors.

All the testing equipment is on the second floor. The lamps on receipt are first arranged in trays whose bottom is covered with iron filings and which is earthed, and are then submitted to a vacuum test. The testing voltage is 10,000 volts, which is obtained from a transformer one pole of which is also earthed, while the other is connected through a flexible lead to a contact which can be applied to the lamp. An imperfect vacuum is indicated by the well known violet glow. Lamps which pass this test are then arranged on a number of movable racks, appropriately equipped as regards type of holder, voltage, &c. These racks can be drawn from the testing chamber into the main test room, and it is only when so drawn out that the lamps are mounted. The act of drawing out makes the holders "dead," as connection is made to the mains through theatre plugs, which are pulled from the sockets when the carriage is drawn out. A single-pole switch is, as a further protection, fitted on the carriage under the control of the mounter.

While on this carriage the lamps are tested for mechanical defects, and if satisfactory are stamped to that effect. In this connection it may be interesting to mention that a special substance possessing particularly advantageous properties is used for this purpose.

In addition to this equipment a complete photometer room is also provided. It has dead black walls and the photometer bench is 10 ft. 6 in. long; but this can be extended, when required for arc lamps, to a total length of 25 ft. The photometer is of the Simmance-Abady type, the secondary light standard being of the Fleming pattern. This latter is calibrated against the standard lamp before the commencement of each test. As regards measurements of power precision instruments of Messrs. Siemens & Halske are employed for this purpose. Their construction deserves a special article to itself, for they are beautifully made, and by means of a number of convenient sized shunts a large range can be obtained. In this room a certain percentage of lamps are tested for candle-power, the procedure being to obtain a number of values for both horizontal and vertical candle-power, and thus to deduce the mean hemispherical candle-power. In the case of the Tantalum lamp the former set approximates fairly closely to the hemispherical candle-power.

We cannot leave this subject without congratulating Messrs. Siemens on the general lay out of these stores. Everything is light and airy and in excellent order. We were surprised to learn the total number of lamps stored on one floor, our own guess being about one-quarter of the actual number. This optical delusion was doubtless assisted by the compact arrangement of the lamps.

It is unnecessary here to draw attention to the wide sphere of usefulness over which the Tantalum lamp holds sway. It is, nevertheless, still advancing and one of its latest conquests is ship lighting. Unlike some of its less hardy comrades it is a good sailor, being little affected by vibration, and of ample mechanical strength. Its adaptability as regards shape and size is also an advantage in this kind of work. We are informed that on one large Atlantic liner the use of two generators out of a total of three has been discontinued since the introduction of the Tantalum lamp for lighting purposes.

In conclusion, we have to thank Mr. E. P. Barfield, of the Supplies Department of Messrs. Siemens Bros. Dynamo Works, and Mr. F. H. Callow, of the same department, for the information set out above.

Aluminium Consumption in the United States.—More than 17,000,000 pounds of metallic aluminium were consumed in the U.S.A. during last year, according to Mr. W. C. Phalen, of the United States Geological Survey, whose statistical report on the production of aluminium and bauxite has just been published by the Survey as an advance chapter of "Mineral Resources of the United States, 1907." This is an increase of 2,301,000 lb. over the consumption in 1906, which amounted to 14,910,000 lb. The great increase in domestic use predicted in the early part of 1907 was not realised, and the failure of the predictions is attributed by Mr. Phalen, in large part at least, to the falling off in demand toward the close of the year as a result of general business depression.

THE INSTITUTION OF ELECTRICAL ENGINEERS.

On Tuesday last a special general meeting of the Institution of Electrical Engineers was held to consider the proposal referred to in our last issue—namely, that the Institution should purchase the lease of the Medical Examination Hall on the Victoria Embankment, London. After some opposition, the resolution was finally carried unanimously. In order to enable the members to judge of the financial possibilities the following figures were given, these being based as far as possible on the 1907 accounts:—

1.—CAPITAL REQUIREMENTS.

For purchase of building	£50.000
Estimated cost of enlargement of theatre, six months' rent of old premises, removal, painting, new furniture, new bookshelves	6,000
	£56,000

2.—CAPITAL RESOURCES.

Trustee Investments.		
Life composition fund	£5,555	
Entrance fees fund	3,719	
Building fund	1,940	
General fund	12,042	
	£23,256	
Less Life compositions fund, possibly not deemed to be available for investment in building	5,555	
	£17,701	
Less transferred to Kelvin lecture fund	862	
		£16,839
Estimated realisable value thereof		£15,000
Value of investments made in current year		4,000
Estimated additional amount available by June 1, 1909, out of the usual annual increment		4,000
		£23,000
Book value of Tothill-street site (estimated to realise a larger sum)		19,260
		£42,260
Amount to be raised on loan		16,000
		£58,260

3.—INCOME FOR 1909.

Subscriptions	£10,441	
(a) „ estimated increase	600	
		£11,041
Dividends on Investments.		
Life Compositions Fund		173
Journal.		
Sales	£201	
Advertisements	357	
		558
Entrance fees	587	
(a) „ „ estimated increase	100	
		687
(b) Rental from portion of Victoria Embankment building already let		650
		£13,109

(a) It is anticipated that the possession of a spacious building will lead to an accession of members and, therefore, an increase in these items.

(b) It is fully expected that it will be possible to let a further considerable portion of the upper floors and thereby substantially increase this item.

4.—ANNUAL EXPENDITURE IN NEW BUILDING.

Expenditure last year	£8,032
Library (current)	150
Estimated increase in expenditure in new building	700
Rates, taxes (say)	1,670
Ground rent	2,201
Amortisation fund	200
	£12,953
Until the loan is paid off there will be an additional annual liability for interest of (say)	640
Until the Tothill-street site is sold there will be a still further additional liability for interest of (say)	150
	£13,743

SUMMARY.

Annual expenditure in new building	£13,743
Estimated income for 1909	13,109
Deficit for the year	£634

It is confidently anticipated that the financial position will be much improved by the further sub-letting of the upper floors of the building; in fact, the figure mentioned at the meeting as an estimate of further income that might be expected from this source was about £5,000.

We comment further upon these figures in our Editorial Notes.

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THE LONDON POWER BILLS.

As mentioned in our last issue, a Select Committee of the House of Lords has come to the conclusion that the preambles of the three Power Bills under consideration at the present time have been proved. This result may be considered as something of an achievement, though what the ultimate result may be it is quite impossible to say. Power Bills for London have become an annual event, and we have almost become weary of the subject, which, although coming forward every year, makes no progress. As on previous occasions, the Bill for a bulk supply to the whole of London—which Bill during the present session has been promoted by the London & District Electricity Supply Co.—is urged in a spirit of philanthropy. The promoters have sought to show that the present suppliers of electrical energy would gain enormously by the establishment of such a bulk supply. Curiously enough, however, the very suppliers whom it is desired to assist fail to see the advantages put forward, and so much is this the case that they oppose the scheme as strongly as possible. In other words, the philanthropy is entirely undesired by those whom it seeks to benefit. We think that this is due to a somewhat mistaken idea of the promoters of bulk supply that the position of electrical power in London is exceedingly bad. Moreover, the tacit assumption is made that those who have been in the business for many years past, and who have done all the work of pioneers, know very little of how things should be done; in fact, that they know less of their business than do the promoters of bulk supply. Of course, there is the old idea that the manufacturer is crying out for cheaper power. If that is so, we do not understand

why existing suppliers find it necessary to engage most actively in canvassing, even when power is offered at very low rates. The fact is that there is great difficulty in getting manufacturers to make any drastic change in their arrangements for power, however cheap the new source may be.

In dealing with this subject the promoters of the Bill do not seem to realise the very great progress that has been made during the last few years. The prices at which electrical energy is supplied have dropped continuously. Only since 1904 the costs per unit of the Metropolitan Company have fallen 31½ per cent., of the County of London Company 30 per cent., and of the Charing Cross Company 19 per cent. Similarly, the price obtained per unit has dropped materially, so that, whatever reason there was to propose a bulk supply in 1904, there is much less reason for doing so at the present time. So much is this the case that Mr. FALCONER, who was one of the promoters of the original company associated with Mr. MERZ, stated in evidence that he and his colleagues had decided that the prices at which electrical energy is now being supplied in London are too low to admit of successful competition by a bulk supply. Of course, supply in bulk will always have its advocates, and if London were not already provided with a number of stations there would be much to be said in favour of such a scheme, though we think that to give a supply from a single point to so large an area is not necessarily the ideal method. We have rather to consider London as it is, and that being so, we think that there would be great difficulty in supplying energy in bulk to any of the larger stations at a cheaper rate than they can generate it themselves. Many of the large stations are equipped with most economical plant, and although the larger sets proposed for the station at Barking might show some further economy, the capital cost of mains and distributing costs involved in transmission to any of the stations in London must not be left out of account. These costs would not be negligible. Even though it may seem that there is a margin of profit at the present time, it does not follow that there will be any such margin after the next two or three years at the end of which the large station at Barking might get to work.

Among the many misconceptions that have arisen in this fight over supplying London with power is the idea that a very large amount is required. When Mr. MERZ's scheme came forward it was stated that the average horse-power per factory in London was 50. In the present scheme the figure has dropped down to 30, and as the result of a canvass made by the supply companies the actual figure is found to be about 15. In obtaining a figure for the horse-power used in factories those who are not already in the supply business stand at a disadvantage. Estimates so obtained are apt to be made at random, whereas supply companies are in the best possible position to obtain information on this point. The only new feature that seems to have developed in the present instance is that a certain number of railways appear prepared to take electrical energy from a bulk supply. There is, however, no technical reason why they should not obtain energy from existing undertakings. The London, Brighton & South Coast Railway have adopted this course. Negotiations have taken place with other railways, but in certain cases the companies are hampered by legal restrictions.

Instead of forcing the companies, which have been established with full Parliamentary sanction, to fight for their existence every year, we think that it would be more beneficial to the cause of power supply if such legal restrictions were removed and if the companies were allowed to work out their own salvation in that way which they consider the most suitable. Electricity supply is essentially a business that must develop according to requirements. The effect of mis-statements and of promises of a very cheap supply of electrical energy, or the announcement of tariffs which the public only partly understand, has only a very unsettling effect upon prospective consumers. The existing companies, who have borne the heat and burden of the day in pioneering work of a most costly description, should be rather assisted to handle the problem in the way which appears to them best, than hampered by unnecessary competition.

REVIEWS.

(Copies of the undermentioned work can be had from *The Electrician* Office, post free on receipt of published price. Add 5 per cent. for abroad or for foreign books.)

Public Ownership and the Telephone in Great Britain. By HUGO RICHARD MEYER. (London: Macmillan & Co. Pp. xxvii.-364. $1.50.

"The conduct of the Post Office, although not legally dishonest, is, at least, morally indefensible. There can be no just ground for a claim to possess the telephone, by virtue of words introduced into an Act of Parliament before the telephone was thought of; and the effects of this claim are nearly as disastrous to the country as to the inventors and owners of the instrument. . . . The action of the Post Office has been so directed as to throw every possible difficulty in the way of the development of the telephone, and of its constant employment by the public."

These sentences are quoted from an article in *The Times* for June 13, 1884, and they are virtually the text on which Prof. Meyer has based his political history of the telephone in Great Britain. In 20 chapters, which are written with the utmost clearness and accuracy, and contain references to the original authority for every important statement of fact, Prof. Meyer sets out the melancholy story of the struggle of the telephone industry against a quarter of a century of constant political interference. The reader who goes carefully through this book will get a vivid impression of the evil results of State monopoly of a trading industry, and can hardly fail to lose a portion of what respect he may have had for the intelligence, foresight and commercial acumen of British politicians.

Prof. Meyer, who, though not a technical man, shows a sympathetic appreciation of the technical difficulties of the telephone business, considers that four factors have shaped the telephone policy of Great Britain: The desire of the State to protect the telegraph from competition; the promotion by the late Duke of Marlborough of a telephone company (in 1892) to supply service in London at a low flat rate (the author says £10, but my recollection is that the rate proposed by the stillborn New Telephone Company was £12. 12s.); the desire of the municipalities to regulate the charges of the telephone company; and the political ambition of the late Mr. Hanbury, who dominated the Telephone Inquiry of 1898 and was responsible for the Telegraph Act of 1899, which authorised competition in telephony to be conducted by the Post Office and the municipalities.

A fifth factor might have been added—the failure of the telephone companies in the early years to realise that the essential requisites for popularising the telephone are a highly efficient service and systematic education of the public in its proper use. But I am reviewing Mr. Meyer's book and not airing my own ideas on telephone policy; moreover, the failure to realise their mission was universal with all telephone com-

panies for many years, and is still conspicuous in Government administration of the telephone business on the Continent. There is also this to be said for the English telephone companies, as the book under review shows; the time and efforts of their management have been so constantly occupied in fighting for mere existence, and their whole situation has been so continuously overshadowed by the uncertainty as to the future created by constant political interference and obstruction, that it has been impossible for them to concentrate their energies on a broad policy of expansion and high efficiency—which is the cardinal policy of commercial telephony under normal conditions, and naturally involves capital expenditure on a bold scale.

Prof. Meyer has shown great industry in mastering the mass of blue books, Parliamentary debates, agreements and other documents in which the political, and much of the practical history of British telephony is written. He traces the main episodes in the campaign of repression, from the crude restrictions imposed by the early licences, and the crippling of sound telephone development through the refusal of way-leave powers, up to the Agreement of 1905, by which the State has conferred on itself power to buy a great and prosperous business, which has gone through all its experimental stages and has reached a pitch of high organisation, with capacity for unlimited expansion, to buy all this on terms so harsh as to amount virtually to confiscation. He gives perhaps undue weight to the late Duke of Marlborough's meteoric incursion into the telephone field, an episode almost forgotten, which had little practical result, but he describes most ably and clearly the other principal landmarks—the practically compulsory transfer of the trunk lines to the Post Office, the sullen obstruction of the great municipalities, the London County Council and the City Corporation, and the efforts of Mr. Hanbury (dictated, according to the author, chiefly by political ambition), to destroy the capital which had been invested in the development of the telephone service.

One ends a reading of Prof. Meyer's most valuable book with a feeling of amazement on two points. One is the absence of any serious attempt on the part of the political authorities to master the real merits of "the telephone question," or to study the technical characeristics of the telephone industry. The superficial and narrow treatment of the whole subject throughout all the various telephone inquiries and debates is disheartening in the extreme. The other point is the extraordinary ignorance of politicians, press and public of the real status of the business which has been the cause of the repressive policy of the British Government towards the telephone industry. The political authorities have, from the start, crippled and hampered the telephone business in order to protect the revenue of the State telegraph monopoly; in doing so not only have they committed the industrially criminal act of conspiring to prevent the survival of the fittest, but they have been protecting that which does not exist—for there is no revenue from the State telegraph monopoly and there has been none since it became such. Thirty-eight years of Government management of the telegraph business have rolled up a total *deficit* of over £15,000,000, and to-day, in spite of all the improvements made in telegraphy in 38 years, the working cost per message appreciably exceeds the receipts per message, and is steadily rising. The British telegraph service is, I believe, more efficient than some other Government telegraph services, but it does not approach the standard of efficiency maintained by the cable companies. These results are by no means the fault of the very able officials of the Post Office—they are the fault of politics, of the totally unpractical conditions under which a Government owned business has to be run. And it is to a Government department responsible for the greatest commercial failure the electrical industry can show, which loses more money in the telegraph business every day that passes, which has a staff that is virtually a political organisation in a chronic state of insubordination, that Parliament, press and public are willing to transfer another great electrical industry, whose very life breath is enterprising and enlightened commercial management. If this were to be in Ruritania one would smile a tolerant smile. But that public opinion in commercial Britain should be so ignorant or so apathetic makes one rub one's eyes; and one rubs them still harder after reading Prof. Meyer's book, where the damning evidence of the political ineptitude and prejudice which have stunted the growth of one of the most valuable aids to commerce and society which invention and industry have produced is set forth in convincing fashion.

HERBERT LAWS WEBB.

THIRTEENTH ANNUAL CONVENTION OF THE INCORPORATED MUNICIPAL ELECTRICAL ASSOCIATION.

Affairs municipal in electricity supply have been marked for the past 12 years by the annual Convention of central station engineers, and the thirteenth of these interesting gatherings is being brought to a close in Nottingham to-day, after being in progress since Tuesday. The election of Mr. H. Talbot, electrical engineer to the Nottingham Corporation, as President of the Association for 1907-8 centred the Convention meetings this year in the lace city, and from both the engineering and social aspects of the Convention the location could not have been better placed.

As in previous years, a large number of engineers attended the meetings and followed the programme from start to finish. The hotel accommodation has been taxed somewhat severely, and the experience of former meetings has monotonously repeated itself—the visitors have found room in hotels in different parts of the city. The following are among those who attended the meetings: R. L. Acland, A. Blackman, Ald. Brodie, T. D. Clothier, A. Clough, A. A. Day, J. E. Edgcome, S. E. Fedden, W. W. Lackie, V. A. H. McCowen, A. B. Mountain, Councillor A. Murray, F. A. Newington, S. L. Pearce, Ald. G. Pearson, P. J. Pringle, H. Faraday Proctor, C. E. C. Shawfield, Ald. Smith, H. Talbot (president), Sir John Turney, W. Vignoles, Bailie R. A. Wightman, G. Wilkinson and T. P. Wilmshurst.

Through the courtesy of the authorities, the meetings have been held at the University College in the lecture theatre, where it was possible to both hear and see the speaker. At Sheffield last year, and in other places in years gone by, the large rooms at the headquarters hotel used for the meetings have not been at all suitable, the placing of the chairs and the acoustic properties of the room being all against genuine comfort, both during the reading and discussion of the Papers. The arrangements of the lecture theatre, therefore, came as a pleasant variant.

Tuesday, June 30th.

Most of the members, some with their wives, who travelled from afar reached Nottingham on Monday evening, but the serious work of the Convention did not begin until this morning. At 10.30 a hearty welcome was extended to the engineers and chairmen attending the Convention, together with their friends, by the Mayor of Nottingham (Mr. Councillor Spalding) and the Sheriff (Mr. Councillor Carey). The former, who was well received, referred in pleasing terms to the duty imposed upon him of officially expressing the gratification of the citizens of Nottingham in having the Convention proceedings conducted in their midst. During his present year of office no less than 10 conventions had been held in the city. He appropriately referred to the successful electricity undertaking of the Corporation, so ably presided over by the President of the Association, Mr. H. Talbot, and remarked that upwards of £11,500 had been allocated from its funds for the relief of the rates. Although a feeling existed among certain inhabitants that the lighting charges were somewhat high, the department was a great success. The Sheriff, in supporting the

words of welcome of the Mayor, expressed his belief in the practical value of conventions, and hoped that the proceedings would prove profitable to both the engineers and committeemen concerned.

Mr. H. Talbot, after proposing a vote of thanks to the Mayor and Sheriff for their cordiality, then read his presidential address, of which the following is an abstract:—

The common ground on which we meet is that of giving an efficient and cheap supply of electricity to all consumers and for all purposes, consistent with the principle that the long-hour consumer shall not be called upon to pay part of the cost incurred in supplying the short hour, or, in other words, the non-profitable consumer, and I assume that one of the main ideas at these conventions is to strengthen and encourage one another in our efforts for this attainment.

Two years ago your president, Mr. Edgcome, in his address, mentioned the fact that out of a possible 800 assistant engineers eligible for election as associates only 61 had joined the Association. Although your council, with the view of encouraging assistant engineers to take an interest in the Association by writing Papers, offered travelling studentships for competition, only one such studentship was gained last year by Mr. McCourt of Harrogate, for his very complete and interesting Paper on "The Value of Photometry in Central Station Work." This year no Paper has been received from any associate, and the number of associates has slightly decreased.

Now there must be some cogent reason why such apparent apathy is shown by assistant engineers, and I do not think we have far to seek for a solution of the difficulty. With my own assistants I have asked them on several occasions why they do not join the Association, and the answer invariably is: "Why should we? We cannot attend the Convention, and we can read the Papers and discussions when the proceedings are published." Everyone will admit that many of the assistant engineers of to-day will eventually become chief engineers somewhere or other in the course of time, and I would strongly advise the chairmen of committees and chief engineers to see if something cannot be arranged so that assistant engineers can be induced to join the Association, and thereby become interested in the valuable Papers that are read at our Conventions and in the more valuable discussions which take place. As the Conventions always takes place in the summer, when stations are working at their minimum output, it ought to be quite feasible to allow one more assistants to attend the Convention, and should a difficulty be found in the matter of expense to the assistant, I do not see why his expenses should not be paid by his committee, for most certainly the assistant would become more useful in his work, and the advantage would be with his committee, and at a very trifling cost

The past year has been comparatively uneventful with the exception of one feature. I refer to the continually increasing use of metallic filament lamps. It is certainly interesting to note that after over 30 years' careful work in improving the carbon filament lamp, a return should be made to the use of metals and their alloys for the substance of the filament, and it would be interesting to know whether the advent of these lamps will not result in the carbon filament lamps becoming obsolete. What ultimate effect these new lamps will have upon our undertakings it is, of course, impossible to predict, but there can be no doubt that any improvement in the present extravagant methods of producing light must eventually prove beneficial to every one. Of course, the use of these new lamps necessarily involves a considerable reduction in the revenue of an undertaking, but at the same time it is to the immediate advantage of the consumer who keeps his installation up-to-date. This reduction of revenue can only be temporary, as the cheapening of the light will have the effect of enormously increasing the number of our consumers, and so necessitate a larger output in the near future, although for the time being it may go hard with contractors for electrical plant, as extensions will not be required so soon.

This brings us to the point as to the best means of increasing the number of our consumers, and I think the fairest way is to offer special inducements to the more profitable ones. This naturally raises the much-vexed question of "Flat rate *v.* Other methods of charging." There can be no doubt that the flat rate method of charging is unjust, and that its only recommendation is its extreme simplicity. The use of a scale of discounts increasing with the number of units consumed only tends to aggravate the injustice. The "maximum demand" system is after all the fairest and most equitable method of charging which has been devised up to the present. It falls short of absolute equity, inasmuch as we are unable to differentiate between those who do and those who do not make use of their maximum demand at the time of maximum load on the supply station, but this, I think, is of very slight importance.

The Corporation of Birmingham has lately issued an announcement stating that it is their intention to register wiring contractors who are authorised to carry out installations in the city. This is a matter which requires much careful consideration. At the outset, it must be admitted that a municipality does not appear to be endowed with power to authorise or prevent the carrying out of an electrical installation by any contractor or other person. Nor would it seem that they can refuse to supply such an installation unless the work be done in such a manner as not to comply with one or other of the various Regulations of the Board of Trade. Nevertheless, I cannot but think, and I am sure you will all agree with me, that some scheme whereby workmen should be certified as competent would prove advantageous alike to the consumer, the supply authorities and the contractors themselves. Of course, registration would only be a means of minimising, and would not prevent, bad and scamped work, but it would at least tend to guard against the deplorable ignorance of some of the electrical workmen of to-day. It would hardly appear desirable for the municipalities individually to take this work in hand, as a purely local registration would be far too narrow a basis on which to carry out such a scheme. Neither do I think it would be competent for this Association to undertake the work, as it should be of an entirely national character, and would be better carried out by the Electrical Contractors' or similar Association. The registration should be conditional on the gaining of a certificate for the passing of a fairly elementary examination on somewhat similar lines to that instituted by the Worshipful Company of Plumbers.

At one time it was thought that great results would be obtained by the combination of a generating station with a refuse destructor. There are even now people who refuse to believe that a refuse destructor is not a great financial acquisition to an electricity supply undertaking. Undoubtedly, looked at from the broadest standpoint of the ratepayer, the combination is, perhaps, desirable, as the refuse must be destroyed, and that as effectually and as cheaply as possible. It is a certain fact, notwithstanding, that the handling and burning of the refuse alone costs more than the same output could be obtained for at the coal-fired generating station.

In the case of the Eastcroft destructor at Nottingham, 28,302 tons of refuse were destroyed during the last year, producing 1,069,885 units. Wages amounting to £2,146 were paid for stoking this refuse and providing additional engine drivers—otherwise unnecessary, as this output, averaging about 240 kw, could easily have been generated at the main generating station without extra help—brings the cost up to 0·48d. per unit, which would more than pay for the extra steam power required, and to this must be added the increased maintenance and capital charges for plant, &c, at the destructor. Although of such small capacity, the destructor station runs 14 to 18 hours per day with a load factor of 28 per cent., and generates 9 per cent. of the total electricity supply for the city.

For the moment this sounds extraordinary, and certainly appears to justify the enthusiasm of destructor advocates. They very naturally say: "You have turned out 9 per cent. of your total supply for £2,146, and you say this has cost more than you could have generated it for at your main station. Your total revenue for 11,116,835 units is £90,921. Clearly, therefore, you should pay something for the refuse." A very little consideration, however, will show the higher up the peak of our load curve we get so does the cost of supplying each unit generated increase out of all proportion. The destructor station, of necessity, supplies cheap units at the bottom of the curve, and leaves to the main station the task of supplying the expensive ones at the top, with a consequent reduction of the load factor. It must not be thought that I am disparaging the utility of destructors. Towns' refuse must be disposed of, and burning is the most effectual method. This being the case, the cost of burning must inevitably be borne whether the heat be utilised or not. Under these circumstances it would be a pity not to utilise the heat, even if in so doing the electricity undertaking be asked to contribute indirectly towards the expense of destroying the refuse.

The amount of the reserve fund allowed under the Electric Lighting Acts, of one-tenth of the aggregate capital may, or may not, be sufficient for this purpose, but I am of opinion that it is a wise policy to reach this amount before the plant is worn out, or more likely becomes antiquated. I suggest that, further than this, and as soon as convenient, a depreciation fund should also be started. With these two funds in existence an undertaking would be placed on a sound financial basis. In Nottingham our reserve fund stands to-day at £43,926, and this sum is invested outside the Corporation.

In several of the recent sanctions for loans under the Electric Lighting Acts, the Local Government Board have advised that meters, and so-called short-lived assets, should be purchased out of revenue. This may also be a sound policy, but it must of necessity reduce the profits of the undertaking by the amount so spent. I think it is found in practice that when a trading concern has once given an amount to the relief of the rates, the Finance committee, or those responsible for making the rate, expect at least the same amount each year, and this will be impossible so long as plant which certainly should be charged to capital account has to be paid for out of revenue.

It is surprising when visiting generating stations how many of them look more like museums than modern stations, and why is it? It cannot be that the plant has cost less, or that it is more efficient, for in some stations you will find the same type of engine coupled to various types of generators, and vice versa. To have good sound efficient plant should be the first care of every committee. That this can be obtained with uniformity at the same time is a fact that many of us are agreed upon and appreciate. After having decided upon the type of plant to be installed, why change every time an extension of the plant becomes necessary? There are some who will probably say that it is purely a question of cost; but is it? I am glad to say that my committee has provided as good a plant as it is possible to obtain, and as far as practicable have kept to uniformity, and this at no extra cost. During the 14 years our stations have been in operation we have only had to repair four armatures and one field coil, and with the exception of one short stoppage during the daytime, the supply has not been interrupted.

Mr. Talbot also referred to the advantage of the continuity in office of the chairman and members of committees.

A hearty vote of thanks, proposed by Councillor A. Murray (Edinburgh), to the President for his address was carried unanimously. Bailie Wightman, J.P., then read his Paper on

THE EXPERIENCES OF A CONVENER IN THE ESTABLISHMENT OF AN ELECTRICITY UNDERTAKING.*

BY BAILIE WIGHTMAN, J.P.
(Convener of the Govan Electricity Works.)

The author describes his experiences as Convener at Govan in the hope that it will be interesting by bringing out the experiences of others who have held a similar position in other towns.

It is about 15 years since the Govan order was acquired. It was not obtained with the immediate intention of putting it into operation, but merely as a precautionary measure, and some years later, when the writer was Convener of the Watching and Lighting Committee, the first step was taken to enforce it. A committee was appointed who contented themselves by marking time until a new interest was awakened by an application from two separate companies and an inquiry from the Board of Trade as to our position in relation to our order. We declined to entertain the proposals of the London companies, and we intimated to the Board of Trade that we were at present considering the matter.

At this time we were merely coquetting with the question. There were three courses open to us: Hand over our order to a private company; hand over our order to Glasgow, our near neighbour; or carry it out ourselves. The municipal spirit was too strong for the first, the anti-annexation feeling too keen for the second. The alternative left was to do it ourselves. We determined to take the advice of an expert. The first name suggested was that of an eminent London engineer. Although we had gone so far on our way we still wanted to leave ourselves free to go back on our tracks if necessary. We, therefore, in asking for a report, requested him to state his fee in the event of our failing to go on with the scheme. His answer was that he would make no report unless we were prepared to go ahead. Such an answer was unfair; we were in the position that we knew nothing; we wanted information; we wanted a scheme presented to us upon which we could give an intelligent decision. We then turned to a local engineer who was more amenable to our views. He got out a scheme, and after consideration we agreed to carry it out. Viewed in the light of to day it was not a bad scheme.

In the staffing of the station the committee did not always follow the advice of the consulting engineer, nor did they allow the resident engineer after his appointment, to guide them altogether in the subordinate appointments. In spite of these eccentricities it is surprising to be able to say that the venture met with much success. The writer considers it due to the simplicity of the system, the three wire continuous current, and the perfection of the plant.

As regards breakdowns, none have come to the author's knowledge during the last five years, but he describes one or two of the early stoppages.

There is one experience the convener of an electricity committee has which is unknown, or, if known, it is only to a limited extent by other committees. It is usual for the department upon the first year or two of its existence to consistently show a deficiency which, of course, has to be met out of the rates. That, together with the continual capital expenditure, causes the committee to become a byword for swallowing up the money. The result of this is that the convener becomes a cock-shy for the discontented.

The writer thinks if he had the facilities for recording the fortunes of the chairmen since he has had the honour of being a member of this association, he would find that not a few went down in the November storms, and that because of their electrical experiences.

That an influential syndicate should seek Parliamentary power to compete with a local authority in its own district is not a prospect which can be looked forward to with equanimity. The money which we had already expended appeared to us as good as lost, and the best part of our business the production of power which was the real hope of our undertaking was in danger. We resolved to resist the invader to the utmost of our power. It was in that spirit that we opposed the proposals of the two power companies who were rivals upon the Parliamentary field, but to us both enemies. Notwithstanding their eminent counsel and engineers, their work came to nought so far as we were concerned, as Govan was excluded from the area of the bill that was passed. This was attributable to the earnestness and intrepidity of our opposition, and also to the fact that the chairman of the Parliamentary Committee had a thorough grasp of the situation and a mind in sympathy with municipal institutions.

Our earlier energies all appear to have been directed towards lighting. The writer thinks it would be the promotion of the power companies, and their attempts to get a footing in our town, which helped to give us a proper view of our position and opportunities. It undoubtedly had the effect that when we considered another extension it caused us to take a much larger and broader view of the situation. It also influenced us in making up our mind that we had come to the point when we might with advantage appoint an engineer with skill to advise us upon this extension, but one also with tact and experience to make the undertaking a commercial success.

The relation of the convener and the engineer is a very interesting point in the development of an undertaking. To determine clearly the line of demarcation, how far and to what extent, the committee, as represented by the convener, should take part in carrying on the work.

In the writer's opinion we will best discriminate the relation between the committee and the engineer by determining first the duties and what we expect from the official. His duties as engineer require that he should report upon all proposals which involve capital expenditure, whether they have been initiated by himself or by any member of the committee, with a view to their consideration, and when passed it is his duty to carry out the proposals into execution. As manager they involve his superintendence and supervision of the undertaking in all its departments. The appointment of his staff, or by delegation, all salaries and wages of the staff appointments to be approved by the committee.

The duty of the convener on the other hand, at least, so far the executive part is concerned, is purely honorary, and he will be a wise man indeed if he keeps it strictly so. There is nothing the writer can imagine more vexatious to an official than to find his committee meddling and interfering with the work of his staff. There are occasions when opportunity is given him of showing his interest and sympathy with them in their work.

The circumstances of municipal management combine to make it absolutely necessary that a good understanding should prevail between the committee and the chief executive officer. This can only be attained if there be mutual sympathy on the part of the Convener and the official, and in order to secure this it should be a necessary part of the engineer's duties to keep the convener constantly informed of the doings of his department. He should acquaint him with its progress and developments, and also with all disappointments or "regrettable incidents" which may have occurred. Complete confidence on the part of the chairman in the official, and reliance and trust on the part of the official in the chairman are essential to success.

At meetings of his committees the convener is the spokesman of the official and he should be in a position to afford explanations to his committee upon all the details of the work of the undertaking. He would be able to appreciate special difficulties and cases, and confer with and advise the official. Not only would the work of the committee be facilitated, but there is no doubt their joint work would result to the ultimate advantage of the enterprise under their care. When any matter is likely to be the subject of debate it is most desirable that the engineer and convener should know each other's minds with regard to it. The may not hold the same opinions, but it is most conducive to harmonius working if the head of the committee and the head official understand one another's position beforehand.

DISCUSSION.

Alderman G. Pearson (Bristol) welcomed the opportunity of a debate which voiced the opinions of chairmen and committeemen on matters of importance to the electricity department. He deprecated the idea, expressed in the paper, of a local authority obtaining a provisional order mainly with the idea of keeping out some other possible supplier. Govan might with advantage have leaned upon its larger neighbour Glasgow instead of erecting a small local station. Chairmen of electricity committees were, he thought, best away from the station in cases of breakdown, [illegible] the engineer [illegible] the light on [illegible] possible, and at that time a chairman could only be in the way. [illegible] in the Bristol [illegible] years back served to illustrate his point admirably. He upheld the opinions of the writer with regard to the relation of the engineer and his committee and continuity of office of the chairman contributed greatly towards the

* Abstract.

maintenance of this good feeling. Bristol had derived great benefit from a pursuit of this policy, and other towns might reasonably be expected to do the same. On the subject of power supply, they could appreciate in Bristol the importance of making the relation of the municipality absolutely definite with any local power-in-bulk company. It was possible for such a company to come into Bristol, but he did not see how it could hope to live on what it would get there. His undertaking had not the least fear of competition from this quarter, though progressive steps were not the less being taken with the power load. In seven years some 7,000 H.P. of motors had been connected. Their initial mistake was the installation of too small a plant. In the extension of the supply to the Avonmouth Docks instead of erecting a local station with small units and inefficient plant they were transmitting 8 miles from the large stations in Bristol, securing thereby the advantages of generation on a large scale at a central point. On the subject of the consulting engineer and the local "expert," he felt that the advice of a competent man should of necessity be taken on the installation of so important an undertaking as an electricity station.

Bailie FINLAY (Glasgow) remarked that in Glasgow they were guilty of the initial blunder of starting with too small a station. They had remedied this now by the concentration of their plant into two large stations, north and south of the river, but the experience with small plants had taught them a lesson. For this reason Govan might reasonably have taken its supply from Glasgow instead of building a small station in its own area. The policy of the engineer and chairman having the committee in complete agreement with them had his hearty approval, and during the development of the Glasgow electricity department he knew of instances in which, if this policy had found practical expression, many blunders would have never been committed. A technical man should head the department, and on emergency occasions the chairman was only in the way. The latter might, on the contrary, co-operate with the engineer, on the business side particularly, in the giving out of contracts. He felt that every effort should be made to avoid unfairness in this latter particular.

Councillor SINCLAIR (Swansea) appreciated the previous speaker's remarks as to starting in too small a station, and he also emphasised the necessity for a good power load. As chairman of a comparatively small undertaking, his experience confirmed the view that expert advice was necessary to the building of a good station and Govan might have avoided trouble if they had not followed the counsel of a local engineer. It was also very necessary that the chairman and committee should have the fullest confidence in the engineer and should shape their policy on his advice. In dealing with the problems of securing a power load, he, personally, always urged the necessity of securing power consumers at low rates. There was a tendency to charge too much for power supply. He thought that chairmen should read two Papers at the convention, so that they might have an oppotunity of discussing the commercial as distinguished from the engineering aspect of their undertakings

Alderman SMITH (Liverpool) thought that the local engineer, by reason of his better acquaintance with local affairs, was to be preferred to an outside expert. In Liverpool they had been able to avoid starting in a small way, as the Corporation had bought out a company supplying 1,500,000 units per annum, and by a progressive policy had increased the output in 10 years to $31\frac{1}{4}$ million units per annum.

Alderman BRODIE (Blackpool) agreed with continuity of service for the chairman and approved of having a practical man in charges of the station. He qualified for the post of chairman, because he knew nothing about electricity. A previous chairman had been an amateur electrician and some of the committee knew something of electricity, and between them they managed to run the undertaking to a standstill. He felt somewhat aggrieved that the Paper in dealing with the conditions of a decade back was liable to be misleading in giving a bad impression of an electricity supply undertaking, and he should have preferred a treatment of the subject on modern lines.

Councillor A. MURRAY (Edinburgh) caused some amusement by giving a few examples of committeemen seeking to know something of electrical technicalities and endeavouring to advise the engineer on the basis of their "knowledge." Chairmen and members of committees should confine their labours strictly to the commercial side, and leave electrical engineering severely alone.

Alderman COOTES (Hanley) said the discussion could not fail to be helpful to chairmen in similar circumstances. Chairmen should always try to carry their committees with them. The engineer should be given credit for honesty of purpose and soundness of judgment, and he would not lead them far wrong. Good results could only be obtained from large stations which could be worked more economically. Had the pottery towns agreed upon some combined scheme for the supply of power to the tramways now run by a company, Hanley would now have a good day load. But at that time his committee had failed to appreciate the commercial importance of co-operation in the matter. An attempt was now being made to federate the towns, and a large station would probably then be erected for the supply of power over a very wide area.

Bailie JACKSON (Partick) said that although Partick had an expert to guide them, he did not altogether agree that it was unwise to take the advice of a local man. There were local conditions of which the local man would have best knowledge. Their undertaking had grown at a rapid rate, and while they showed a balance on the right side of the account, the district was a growing one and they were confronted with conditions of supply that complicated the accounts in such a way that one did not get a fair idea of the cost. The output was now something like 2,000,000 units per annum.

Bailie A. FISHER (Paisley) said there was one point he would like to mention. When the Clyde Valley Bill was passed by Sir James Woodhouse's Committee, Paisley was excluded as well as Govan and Partick. They had spent close on £200,000 on their undertaking, and had now an output of about 3,800,000 units. They could not boast of having relieved the rates, and he hoped they never would.

Bailie WIGHTMAN, in replying, said some of the speakers had found fault with him for interfering with the engineer, but this was more apparent than real. Then, as regards the employment of an expert, some seemed to think that all the experts were in London. That was not the case. They had them in Scotland too. The engineer they consulted was not only a local man, but he was an expert electrical engineer, and was no doubt quite in line with experience at that particular time. Their experience was pretty much the experience of other undertakings founded at about the same time.

A hearty vote of thanks was accorded to Bailie Wightman for his Paper, and the meeting closed.

On the invitation of the chairman of the Nottingham Electricity committee, Ald. Sir J. Turney, Kt., J.P., the members and their friends were entertained to luncheon in the Mechanics' Hall. The mayor presided over a large company which included a number of ladies. After the loyal toasts had been duly honoured, Mr. S. L. Pearce (Manchester) proposed the health of the chairman and members of the Nottingham Electricity committee, a toast which was received with musical honours. Sir John Turney expressed pleasure at the presence of the Convention members in Nottingham, and the high compliment paid the city by the election of Mr. Talbot, then electrical engineer, as president of the Association. Bailie Stevenson (Edinburgh) called for the toast of the mayor and sheriff, and after this had been duly acknowledged, the party repaired to the special cars which had been arranged to take them to the Trent Bridge car sheds and the St. Ann's power house. A visit to both these places made up a pleasant afternoon's programme. At the power station tea and light refreshments were served.

Wednesday, July 1st.

To-day was given up entirely to an excursion to Dovedale, one of the most charming spots in Derbyshire. A special train conveyed the party to Matlock Bath, and then followed a $2\frac{1}{2}$ hours' drive through Cromford, the Via Gellia Valley, Bradbourne and Tissington. Luncheon was served at the Peveril Hotel, and the afternoon was spent in seeing the Dale. The return journey was by Matlock Bath, which was reached in time to give members of the party time to look round the village and see the sights. Brilliant weather favoured the outing, which was very much enjoyed by all.

Thursday, July 2nd.

The annual general meeting was held this morning at University College, Nottingham.

It was proposed by Ald. Smith (Swansea) and seconded by Bailie Fisher (Paisley) that Mr. S. L. Pearce be elected President for 1908-9. No other nominations were made, and the motion was carried unanimously.

Mr. Pearce thanked the members for the honour conferred upon him, which he said was all the greater honour as it was a comparatively short time since he was elected on the Council.

Manchester was decided upon as the place of meeting next year.

Mr. W. W. Lackie (Glasgow) was elected senior vice-president.

Mr. J. Christie (Brighton) and Mr. G. Wilkinson (Harrogate) were nominated for the office of junior vice-president, and as a result of the voting Mr. Christie was elected.

The following five chairmen of committees and 14 engineers were proposed for the vacancies on the Council. Those marked with an asterisk were elected :—

Chairmen.

*Councillor G. Howarth (Manchester).	Ald. A. Wilkinson (Luton)
*Ald. Chas. West (Coventry).	Councillor J. Heald (Lancaster).
	Councillor A. Sinclair (Swansea).

Engineers.

*A. C. Cramb (Croydon).	J. D. Knight (Ealing).
J. H. Bowden (Poplar).	*H. Richardson (Dundee).
A. S. Barnard (Walsall).	C. Furness (Blackpool).
*F. M. Long (Norwich).	A. S. Blackman (Sunderland).
W. M. Rogerson (Halifax).	*V. A. H. McCowen (Salford).
S. J. Watson (Bury).	J. K. Brydges (Eastbourne).
H. C. Bishop (Newport).	*A. A. Day (Bolton).

Councillor Howarth (Manchester), on behalf of his committee, gave the members a cordial welcome to Manchester next year,

when everything possible should be done to make the meeting a success.

The hon. solicitor, hon. treasurer and hon. secretary were then reelected and the constitution of the new Council for 1908-9 is as under :—

EXECUTIVE (1908-9) COUNCIL.

President—S. L. Pearce (Manchester).

Vice-Presidents.

W. W. Lackie (Glasgow). J. Christie (Brighton).

Past-Presidents.

H. Talbot (Nottingham). | J. E. Edgcome Kingston-upon Thames).
F. A. Newington (Edinburgh). | S. E. Fedden (Sheffield).

Council.

Ald. Bruce (Sunderland).	C. E. C. Shawfield (Wolverhampton).
A. A. Day (Bolton).	Councillor Sinclair (Swansea).
Councillor Howarth (Manchester).	Ald. J. P. Smith (Barrow-in-Furness).
Ald. West (Coventry).	Ald. Wilkinson (Luton).
A. C. Cramb (Croydon).	G. Wilkinson (Harrogate).
F. M. Long (Norwich).	T. P. Wilmshurst (Derby).
V. A. H. McCowen (Salford).	
H. Richardson (Dundee).	

Hon. Solicitor—Ald. G. Pearson (Bristol).
Hon. Treasurer—J. E. Edgcome (*Past Pres.*) (Kingston-on-Thames).
Hon. Secretary—H. Faraday Proctor (*Past Pres.*) (Bristol).
Secretary—C. McArthur Butler (London).

The annual report of the Council was then considered.

In their report the Council mention that the membership of the Association now stands at 385, made up as follows: Committees (members) 165, chief electrical engineers (members) 168, honorary members 2, chief assistants (associate members) 10, assistants (associates) 40, the total showing a decrease of seven on last year's total, principally in the class of associates.

Accounts of Local Authorities.—A sub-committee of the Council is co-operating with the Municipal Tramways Associations in considering the report of the Departmental Committee appointed to inquire into the accounts of local authorities.

Local Authorities Liability under the Employers' Liability Act, &c.—The attention of the Council has been drawn to the liability of a local authority in connection with damages to persons or property occurring in connection with works carried out for the local authority by contractors. This liability divides into two sections: first, the liability caused by an accident to the contractor's workmen under the Employers' Liability Act; and, secondly, the third party risks—*i.e.*, accidents or damages caused to persons or property not under the control of the contractor. Several Corporations have been communicated with to ascertain the clauses in use in contracts for safeguarding the Corporations in question against such liability. Whilst it appears to be the invariable practice to insert a clause in contracts making the contractor responsible for all accidents and damages, it appears to be almost exceptional that the precaution is taken of requiring the contractor to take out an insurance policy under the Workmen's Compensation Act in the name of the Corporation, or, in the event of such already existing, of adding an endorsement to such policy showing that the insurance company relieves the Corporation from all liability in connection with the works. This appears to be necessary owing to the fact that a person sustaining an injury will often prefer taking action against a Corporation rather than against his employer, very probably on account of the general impression that it is more easy to get judgment against a Corporation than any other body or person in the case of accidents or damages. Such a course seems to protect a Corporation as far as is possible regarding the first-named difficulty, but it is understood that insurance companies generally will not accept third-party risks, and thus enabling Corporations to be insured against liability for accidents to third parties, and this matter has yet to be looked into more fully. The Council will welcome any suggestions with a view to overcoming this difficulty.

[illegible] The Board of Trade have been approached again relative to this matter, and whilst they regret that they consider [illegible] supply fittings, &c., on hire.

[illegible] Mr. R. McCourt [illegible] has submitted his report of his tour of inspection [illegible] works in London and the provinces [illegible] approved by your Council and will be published [illegible]

[illegible] Representatives of the Association [illegible] The

matter is still under consideration, and negotiations are proceeding with the Board of Inland Revenue.

Home Office Regulations.—Most valuable amendments were secured by the Council; the cost of doing so being distributed amongst upwards of 120 municipalities will not be a serious item to any one contributor.

Franco-British and Manchester Exhibitions.—The Association is represented in the electrical engineering section of the Franco-British Exhibition, and also on the Executive committee of the Manchester Exhibition to be held in October next, by the president, Mr. H. Talbot.

Great Eastern Railway General Powers Bill.—The attention of the Council was called to a clause of this bill which it was felt might seriously endanger the interest of municipal electrical undertakings if it passed into law. After the Council had decided to oppose the bill, the clause was withdrawn.

Allocation of Wages of Workmen on Permanent Staff.—This matter has not been pushed so vigorously as last year, owing partly to the general political unrest throughout the country, and partly to time having been taken up so fully in connection with the Home Office Regulations. It is, however, being kept well in view, and further steps will be taken to obtain an equitable ruling as to the allocation of all wages incurred in connection with capital works.

Honorary Treasurer's Report.—The balance-sheet shows a surplus of £39. 4s. 10d. for the year, and a total surplus of £349. 4s. 1d., of which £266. 4s. 3d. is on deposit. There is a small deficit in the Convention account, the receipts being some £8 less than the outgoings.

DISCUSSION.

Mr. H. TALBOT (Nottingham) said that, notwithstanding the subscription for associates having been reduced by 50 per cent., it was very difficult to get them to join the Association.

Mr. A. C. CRAMB (Croydon) asked in regard to local authorities' liability under the Employer's Liability Act., &c., whether any actual case of trouble had arisen.

Mr. S. L. PEARCE (Manchester) replied that it had come under the consideration of the Council owing to an accident which occurred in Manchester to an employé of one of the contractors at work at the sub-station. The workman did not bring an action against his employer, but against the Corporation, and succeeded in getting pretty substantial damages. They were advised that it would be almost impossible to draft a clause which would meet the circumstances. Contributory negligence was pleaded against the corporation in the case in question.

Ald. PEARSON said the Council had a great number of suggested clauses in their hands, and were endeavouring to get a clause which would comprehend the good points in these. The one received from Bristol was, he thought, as good as any he had yet seen. Mr. Pearce had mentioned the point of contributory negligence, which was, of course, very important indeed. They should get from their contractors an indemnity for risks of this kind.

By Telegraph.

(FROM OUR OWN CORRESPONDENTS.)

NOTTINGHAM, *July* 2 (Evening).

Mr. A. C. CRAMB (Croydon) said more should be done with the Supply of Electricity Bill as promoted by the Board of Trade. The same facilities for wiring as obtained in London should be given to outside authorities.

Ald. PEARSON (Bristol) deprecated the tardiness of the Government on so important a Bill. Certain towns utilised their own powers without troubling about others. The Bill was unopposed by the municipalities, to his knowledge. Answering a question as to the number of municipalities opposing the Home Office regulations, Ald. Pearson said that the number was about [illegible], and the cost of opposing the Bill had been about £650.

Mr. CRAMB asked if the Local Government Board might authorise the payment of expenses of engineers attending the Convention.

Ald. PEARSON replied that although the proposal was backed by [illegible] Members of Parliament, Mr. John Burns disapproved the idea.

Mr. J. E. EDGCOME (Kingston), replying to a question re the ability of the Association to oppose the Great Eastern General Powers Bill, said, that under the method adopted in opposing the Home Office [illegible] He presented the balance-sheet and said that bad debts, in the way of unpaid subscriptions, should be written off. Answering a question, he said the secretary's salary had not been reduced, but last year's accounts [illegible]

[illegible] customers along the line by means of wayleaves from the railway company. [illegible]

municipalities. Such companies were usually exploited by promoters and were merely the dumping ground for electrical machinery. The municipalities were not afraid of fair competition, but they must protect themselves from unfair competition.

Ald. Pearson was inclined to think that the erection of generating works beside railways and working with the railway company would enable private individuals on the railway route to obtain a supply without going to public suppliers. Illegitimate competition was certainly to be feared, and municipalities would have to take serious steps in future.

The following resolution was then submitted :—

"That it be remitted to the Council to consider the question of the proposed supply and sale of electricity by private companies by means of wayleaves obtained from railway and canal companies, and to draw the attention of municipalities to the proposal and the dangers of same, with power to consult and co-operate with the Convention of Burghs of Scotland and similar associations in England if so advised."

Mr. G. Wilkinson (Harrogate) proposed a hearty vote of thanks to the retiring chairman, and said the present year was a heavy one on account of the inquiry into the desirability of the Home Office draft regulations and the Manchester Exhibition.

Mr. H. Talbot suitably returned thanks for the vote, and the meeting closed with a vote of thanks to the honorary officers.

In the afternoon two Papers were read and discussed. The first was by Mr. H. Richardson, on

"Some Considerations on the Design of a Generating Station."

An abstract of this Paper will be found on p. 447.

The second Paper, by Mr. C. M. Shaw, was on

"The Reconstruction of an Electric Lighting Scheme."

The latter Paper is abstracted in our present issue and will be found on p. 439.

A résumé of the discussion which followed the reading of the Papers is given (as far as possible) below :—

By Telegraph.

(FROM OUR OWN CORRESPONDENTS.)

Nottingham, *July* 2 (Evening).

The discussion on Mr. Richardson's Paper was begun by

Mr. S. L. Pearce (Manchester), who asked whether Mr. Richardson had taken for his load 60 tons with reinforced concrete. On the question of pile driving, he thought 5 tons with 5 ft. drop not excessive if the weight to be supported was to be reckoned at 60 tons. A heavy monkey with short fall was better than a light monkey with long drop. He thought 1,500°F. too great to use with concrete chimneys. The British Fire Prevention Committee issued a report on the effect of heat on reinforced concrete. At certain temperatures this material crumbled and the structure was unsafe. The chimney should, therefore, be lined. On the subject of gas engines Mr. Pearce referred to the visit to the Continent with Mr. Andrews' party. Although he went biased by the Johannesburg, experience he returned with the opinion that gas engine had a future in this country. Undoubtedly great progress had been made in Germany. Producer gas was a most important question. To-day 2,500 H.P. was about the limit with gas engines using two cylinders. The capital cost of the engine and producer was probably 20 to 30 per cent. greater than reciprocating steam engines and greater proportionately than steam turbine units. He did not agree with the author of the Paper regarding their reliability, and there was not much to choose between the cost of upkeep and maintenance of gas engine plant and reciprocating steam plant. At Cockerill's works last year 24,000,000 units were generated at $\frac{f}{8}$d. per unit. Good use might be made of gas engines combined with steam plants, the gas engine taking the load during hours of steady demand and steam turbines coming on at the peaks. The night load at Manchester was never below 3,500 kw., therefore it was obvious they could instal one or two gas engines to run 24 hours per day, turbines taking the peak load. There was no advantage gained by using 200 lb. steam pressure, as against 160 lb., with so-called reaction type of turbines. Tests made on a 5,000 kw. Parsons-Brown Boveri unit showed a full-load saving of only 5 per cent. steam consumption for 40 per cent. increase of steam pressure. There was no saving on half-load. Regarding superheat, he thought that 550°F. was too high for reaction turbines. As to condensing plant, he referred interested engineers to a Paper by Mr. Morrison, read before the Institution of Naval Engineers, on "The Influence of Air on Surface Condensing Plant." They used totally-enclosed generators at Manchester with external cooling fans, resulting in a noiseless, clean machine, with more control on output and less cost, despite the cost of the blower and air filter. Polyphase motors were better for auxiliaries and small storage batteries for excitation. The greatest possible simplicity should be aimed at in the large schemes so as to reduce risk of breakdown.

Mr. Leonard Andrews agreed that the cost of gas engines was always greater than steam, particulary of turbine plant; he thought 25 per cent. 1·75 lb. of coal per unit was on the high side for gas engines. The overload capacity of gas engine would probably never favourably compare with that of the steam turbine. Gas engines were not altogether reliable, and details in this respect were difficult to obtain. But makers were getting repeat orders and many large prodncers plants had been running in this country with little trouble.

Mr. C. E. C. Shawfield (Wolverhampton) said that steel chimneys were safe and reliable, and the cheapest in the end, owing to low cost of foundations, this cost being about one-fifth that for brick. The varying character of concrete depended on the time between mixing and using. Fractures in concrete invariably occurred at the same height. Despite the economy of gas engines in coal, steam plant would produce energy cheaper. He thought forced draught less economical than induced draught. Using bituminous coal it was necessary to admit air over fire, or gases were unconsumed. As to feed pumps, he approved the rotary type as best for the purpose.

Mr. A. T. Yates said induced draught gave the greatest evaporation for a given fuel consumption owing to higher furnace temperature, and cheaper coal could be used. The plant paid for itself in the first year of installation and was simple.

Mr. Seaton (British Westinghouse Company) referred to gas engines and steam turbines, and quoted a French steel works in which steam engines were used entirely, the reason given being that no competitor of theirs had done any good with gas engines as they could not be always relied upon. Any economy in coal consumption with gas plant was wiped out by increased oil consumption.

Mr. C. Turnbull (Tynemouth) thought there was great danger in the use of gas engines on account of the fumes attacking the copper in both commutators and 'bus bars, also the insulation of generators. He had heard of trouble of this kind experienced at Johannesburg.

Mr. A. C. Cramb (Croydon) asked if Mr. Pearce intended installing gas engine plant up to, say, of 4,000 H.P. capacity. In the London power schemes gas engines were not dealt with.

Mr. H. R. Burnett (Barrow) complained of trouble with firebrick arches, and asked for information re mechanical stokers without damping bars.

Mr. C. Atchison (Rochdale) said he found the best plan to remove soot was to make the economiser door large enough to admit of a man with a barrow. He avoided back firing by an arrangement which closed the dampers before the fire doors opened.

Messrs. E. E. Hoadley, J. K. Brydges, W. A. Vignoles and H. Talbot also contributed briefly to the discussion.

The authors reserved their replies for the *Proceedings*.

We must defer our account of subsequent events, including the annual dinner which was held, at 7:30 p.m., in the Exchange Hall, Nottingham, until our next issue, when we shall also give an account of Friday's proceedings.

BOOKS RECEIVED.

(Copies of the undermentioned works can be had from *The Electrician* office, post fee, on receipt of published price. Add 10 per cent. for abroad or for foreign books.)

"Switchboard Measuring Instruments for Continuous & Polyphase Systems." By John C. Connan. (London: E. & F. N. Spon.) 5s. net.

"Aldum's Pocket Folding Mathematical Tables." (London: E. & F. N. Spon.) 4d. net.

"Matriculation Directory" (London University). No. 49, June, 1908. With Articles on Text Books. (Cambridge: University Correspondence College.) 1s. net.

"Inventions." By Frederic B. Wright. (London: E. & F. N. Spon.) 1s. 6d. net.

"Agenda de L'Electro, 1908." (Brussels: "L'Electro.") 5 fr.

"Elektrotechnische Meskunde." By Alex. Königswerther. Vol. II. of "Grundriss der Elektrotechnik." (Hanover: Dr. Max Jänecke.) M. 4.20.

"Le Nuove Lampade Elettriche ad Incandescenza." By G. Mantica. Vol. I. (Milan: Tipografia Antonio Cordani.) L. 4.

"Proceedings of the Royal Society." Vol. LXXX. No. A542 Series A.—Mathematical and Physical Sciences. No B540. Series B.—Biological Sciences. Vol. LXXXI. No. A543. Series A. (Obituary Notices of Fellows Deceased—Lord Kelvin.) (London: Harrison & Sons.) 2s. 6d., 4s., 4s respectively.

"Science Abstracts." June, 1908. Vol. XI. Part 6. Section A—Physics. Section B—Electrical Engineering. (London: E. & F. N. Spon.) 1s. 6d. each.

Telegraph College in China.—The *Electrical World* gives the following further information with reference to the establishment of a Postal and Telegraph College in China. It states that the Board of Posts and Communications has sent a memorial to the Throne, asking for an appropriation of about £9,320 for the maintenance of the college. Instruction will be given by experienced foreign and Chinese teachers, who will instruct and train young men for service in all postal and telegraph departments.

CORRESPONDENCE.

MARCONI'S SYSTEM OF WIRELESS TELEGRAPHY.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: Mr. Raymond-Barker and myself are clearly writing at cross purposes, and it is for this reason probably that we have misunderstood each other. I did not trouble to quote the rest of the passage in Mr. Raymond-Barker's letter, to which he alludes, because it appeared to be only based on a report in another journal.

As Mr. Raymond-Barker implies, there is no technical difficulty attached to automatic transmission in wireless telegraphy, and I regret to note that in my last letter I wrote the words "automatic transmission" where I should have written "the duplex-automatic system." (Whether or no the traffic experienced in wireless telegraphy sufficiently warrants automatic working is another matter. So far, manual transmission appears to be almost exclusively in vogue.) On the other hand, I am inclined to adhere to my original statement that "the duplex-automatic system is, for long distances, only applicable to wire telegraphy at present," until Mr. Raymond-Barker is able to give us full particulars, from his own personal experience, of continuous practical working by the system on a basis comparative with the continuous everyday duplex-automatic working through cables. Certainly, so far but little, if anything, has been done in this way with wireless telegraphy—under the conditions involved for long-distance working—other than experimentally.

DIPLEX radio-telegraphy can, of course, be more readily managed; but I feel sure that, with his wide knowledge of the subject, Mr. Raymond-Barker will readily admit that there are serious difficulties in the application of the duplex system to long-distance radio-telegraphy on a continuous practical basis.—I am, &c.,

Westminster, July 28. CHARLES BRIGHT.

OVERSHOOTING OF METALLIC FILAMENT LAMPS.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: In your issue of the 12th inst. (p. 318) you make some remarks on the overshooting of metallic filaments. May I offer the following possible explanation of this phenomenon?

If the lamp be examined at the moment of switching on, it may easily be seen that the parts of the filament near the supports remain black during the overshooting. This seems due to the high heat capacity of the support.

The resistance of the filament while black is, of course, lower, consequently increased watts per unit length are dissipated in the rest of the filament which assumes momentarily an abnormal brilliancy.—I am, &c.,

East London College, June 29. E. TINDALL COOK.

PHYSICAL SOCIETY.

A special general meeting was held at the Royal College of Science on June 12th, Dr. C. Chree, F.R.S., president, in the chair, at which the resolution passed at the special general meeting on May 22nd was confirmed. An ordinary meeting of the society was then held, and a Paper by Messrs. E. Bellini and A. Tosi on

"Experiments on a Directive System of Wireless Telegraphy"

was read by Mr. Tosi. The authors describe the results obtained in the course of their work upon a further development of their original directive system. In the earlier method previously described it was not possible to say from which side of the receiving station the transmit;ed waves arrived, for though the radiation was practically confined to the plane of the aerial system, it was emitted equally in the opposite direction to that desired.

In the new unilateral system the waves are sent in a single direction only, and the problem of getting rid of the backwardly extending radiation has thus been solved. The method adopted consists in superposing a bilateral directive system, as previously described, upon an ordinary or vertical antenna system. Since the two half-diagrams of the directive aerial are opposed in phase, it follows that when the two systems (directive and vertical antenna) are simultaneously excited and in phase, the one half of the directed radiation will add itself to, and the other half subtract itself from, the radiation due to the vertical antenna system. The diagram of the vertical antenna system being a circle, the resultant diagram of the superposed systems will, for the case where these are in phase as regards excitation, be a cardioid whose maximum radius vector is double that of the diagram of the directive system alone. Since, then, the directive system is able to vary the direction of its maximum emission by means of the radiogoniometer, it follows that by moving the position of this latter it is possible to shift the direction of the resultant emission represented by the cardioid in a corresponding manner. Several energy diagrams obtained by means of the thermo-galvanometer are reproduced in the Paper, and these show that, even where the excitations are not exactly in phase, the only result is a slightly less good diagram Diagrams of the scheme of connections employed during the taking of the energy diagrams are also given.

The same principle of the superposition of the two systems has been applied to the case of the reception. In this case a phase displacement of 90 deg. in the excitations is produced in a suitable manner and in this way, when the pointer of the radiogoniometer is directed, say, towards the transmitting station, the reception is a maximum, whilst when turned at 180 deg. from this it is a minimum, or zero. Diagrams of received energy and of the connections employed are also given in this case.

The system of unilateral directive wireless telegraphy described in the present Paper is of special interest owing to the facility with which it is possible to change over from one system to the other, thus, from the ordinary vertical antenna system to the bilateral directive or the unilateral directive, or vice versa. The aerial arrangements, moreover, remain exceedingly simple. When a message from a station of unknown position is expected, the vertical antenna or ordinary system would be employed; on once effecting reception, one can pass to the bilateral or unilateral directive system and thus determine the direction and on which side the transmitting station lies, at the same time making oneself independent of other transmissions. In the same way, with the transmission, the vertical antenna would be employed for calling up an unknown station or for simultaneously sending to several stations: on once getting a reply the operator can then readily determine the position of the receiving station, with the aid of the unilateral system, and thenceforth will transmit solely in that direction. Attention is called to the advantages which such a directive system offers in the case of the commercial services as well as for military and naval purposes.

Dr. FLEMING said that he had long been acquainted with the interesting experiments of the authors of this Paper, and desired to express his congratulations on the skill and inventiveness with which these investigations had been prosecuted. He was glad to see that the experiments of the authors confirmed in many ways the theory which he (Dr. Fleming) had given of the operation of a bent antenna as employed by Mr. Marconi. When Mr. Marconi read his Paper at the Royal Society in March, 1906, describing his experiments on directive telegraphy, he gave no theory in the matter, but Dr. Larmor pointed out in the discussion that an antenna partly vertical and partly horizontal was equivalent to the sum of a magnetic oscillator and an electric oscillator, and shortly afterwards he (Dr. Fleming) had gone more carefully into the matter mathematically, and showed that the observed effects could be accounted for on this theory. Both Mr. Marconi and he himself had obtained by the same methods as those employed by Messrs. Bellini and Tosi the same type of pear shaped radiation curves obtained by the authors of the Paper by combining together the effect of closed and open oscillators. Although this theory had been criticised by Dr. Mandelstam lately, yet nevertheless there did not seem sufficient grounds for objecting to it. Mr. Marconi had, as everyone knew, employed directive antennæ for a long time past in his power stations at Poldhu and Clifden, and had also given demonstrations showing that the position of ships out of sight could be located by means of such receiving directive antennæ. Nevertheless, Messrs. Bellini and Tosi had worked out extremely ingenious arrangements for determining the direction of the radiant point without moving the antennæ themselves. He (Dr. Fleming) had also shown that, having the power to locate the radiant point, two stations equipped with such antennæ at a known distance apart could by simultaneous observations determine also the distance of the radiant point, and this might become important in connection with marine work. It ought also to be noticed that Dr. F. Braun, of Strasburg, had, by the employment of three open antennæ having oscillations in them of definite phase difference, been able to obtain radiation curves having the form of a cardioid similar to some of those given by the authors of the Paper.

Dr. W. H. ECCLES warmly congratulated the authors upon their beautiful and original method. On this method by merely rotating a small coil of wire on the table, a fixed aerial directive system of any size was made to do what could otherwise only be done by turning the whole system of aerial wires in azimuth. The essence of the system was the piece of apparatus styled the radiogoniometer, which, by causing appropriate component radiation from two fixed wire triangles set at right angles, brought about a resultant radiation in any direction desired—just as if a virtual aerial of the full size of the fixed aerials were being rotated in the air. Someone had compared the result so achieved with that obtained by Marconi's well known arrangement of a number of fixed bent antennæ with their horizontal portions directed from a

centre to various points of the compass. Apart from the fact that it was rarely feasible to fix up a large number of antennæ, the radiogoniometer method had the advantage that the direction of transmission or reception could be altered perfectly smoothly: so that if it could be used, as stated by the authors, accurately to about 1 deg. of arc the radiogoniometer was the practical equivalent of 360 bent antennæ. The looped aerials used by the authors did not seem to the speaker to be the best kind of radiator for utilising the principle they had developed. The radiogoniometer would prove to be capable of giving excellent results with two fixed antennæ of the bent type set at right angles, one, for example, in the meridian plane and the other in the east-west plane. The two looped aerials of the authors might each of them be assimilated to a pair of vertical antennæ emitting waves of 180 deg. phase difference and with the assumption that for a single vertical aerial the inverse square law held for the propagation of electrical effects from a single aerial, the speaker showed by aid of the ordinary equation of wave-motion that a looped antenna obeying the condition stated emitted two waves of equal period, of phases differing 90 and 180 deg. respectively from the phase of the radiation from either side of the loop, and of amplitudes having a ratio proportional to λ/x. This meant that one portion of the resulant radiation obeyed an inverse square law and the other portion an inverse cube law; the latter portion was the more important of the two when the distance x was small, the former was the more important when the distance x was much greater than the wave-length λ. This explained why Dr. Fleming's measurements of the radiation from closed oscillators, which were carried out at short distances, gave small promise of powerful propagation to a distance, and why Messrs. Bellini and Tosi had found as a fact that good propagation occurred to great distances. As regards the phases of the two portions of the radiation, the important portion for wireless telegraphy—namely, that obeying the inverse square law—was 90 deg. out of phase with the near side of the loop; and thus it was clear that the vertical aerial the authors had used to cancel the radiation to one side of the sending station, must for that purpose emit radiation 90 deg. out of phase with the near side of the loop. Messrs. Bellini and Tosi had reached this conclusion in the course of their experiments. After eliciting that the power supply to the primary of the induction coil for the Dieppe-Havre experiments was 500 watts, Dr. Eccles concluded by remarking that the authors were worthy of special congratulation because in their method of unilateral transmission by phase and intensity adjustment of several radiators they had eluded the difficulties of managing the phases that had apparently baffled F. Braun when he was using the same principle.

Mr. W. DUDDELL complimented the authors upon their Paper, and asked for the wave-length of the waves given out by the transmitter. He also asked what would be the effect of opening the closed antennæ at the top.

Mr. TOSI, in reply to Dr. Fleming, stated that Braun's cardioid diagram was a theoretical diagram only; the method had not succeeded, and no actual diagram obtained experimentally had ever been shown. Referring to the similarity which Dr. Fleming said the pear-shaped diagram of Marconi bore to the authors' diagrams, Mr. Tosi could only say that they had purposely shown some bad diagrams as well as some good ones. The good diagram of Marconi's corresponded to the author's bad diagram. With the Marconi horizontal aerial it would, moreover, be necessary, as Dr. Eccles had pointed out, to employ 360 such wires to obtain an accuracy in locating the bearing of the radiant point equal to that secured with the system now described. Further, if the emitted energy was actually represented by Marconi's pear-shaped diagram, it was difficult to understand why the trans-Atlantic messages from Clifden to Glace Bay were readily picked up off the Algerian coast, at right angles to the line of transmission. In reply to Mr. Duddell he said that the wave length of the waves employed was from 350 to 400 metres.

A Paper

"On the Lateral Vibration and Deflection of Clamped-Directed Bars"

was read by Dr. J. MORROW. This is an investigation of the problems which arise in connection with the lateral vibrations of clamped-directed bars. The term "directed" is used to describe the extremity of a bar which is constrained to maintain its original direction but is free to take up any position of lateral deflection. These terminal conditions are mentioned in Rayleigh's "Sound," but are dismissed on the ground that the directed end cannot be realised experimentally. In the present Paper, however, it is shown that the "directed" end is of great importance and of frequent occurrence in engineering practice; and, further, that by the aid of a simple device it can easily be investigated in the laboratory. The first problem is the ordinary one of a bar vibrating under the effect of its mass alone. The frequencies of the fundamental and harmonics are determined. The equation of the curve assumed at any instant by the elastic central line is obtained, and the positions of the nodes found. When the bar vibrates under the influence of a longitudinal force in addition to its own mass, the problem is more difficult. The solution is exact up to a certain point after which it is assumed that the longitudinal force is confined within certain limits. An approximate solution is then obtained which should be satisfactory for nearly all purposes.

Other portions of the Paper deal with further cases of loaded and unloaded bars, both with and without longitudinal force. In each problem means are supplied by which the necessary magnitude of the constraining couple at the directed end can be found. When the mass of a bar, in addition to that of a concentrated load, is taken into account, the method used is that of continuous approximation previously developed by the author. The method is found to be as readily applicable to this as to other cases. In the last section an account is given of a few experiments on clamped-directed bars, and the results are seen to be in complete agreement with the theory. The Paper also contains the solutions of some cases of deflection under static loads.

A Paper entitled

"On the Resistance of a Conductor of Uniform Thickness whose Breadth Suddenly Changes and on the Shape of the Stream-lines"

was read by Prof. C. H. LEES. A knowledge of the resistance of a conductor whose section suddenly changes is of considerable practical importance, but mathematical difficulties have prevented an exact solution of the problem. Lord Rayleigh had given an approximate solution of the case in which a cylinder of circular section is joined at one end to the plane surface of a large conducting solid; and Prof. Hicks has solved the case of a wire of small diameter ending in the surface of a conducting sphere. The mathematical difficulties of the problem disappear if the conductors are of rectangular section and one dimension, *e.g.* the thickness remains constant while the breadth suddenly changes and the two are joined together either with their axes or with two sides collinear. The paper shows that the resistance between two transverse sections through points situated at considerable distance from the change of section on opposite sides of it is equal to the sum of the resistances of the portions of conductor between each of the two sections and the change of section, each considered as part of an infinite length, plus the resistance of a length of either conductor equal to its breadth multiplied by an expression given.

Dr. RUSSELL congratulated the author on having obtained the exact solution of an important problem and thanked him for giving it in a form in which it could be utilised readily by electricians. Somewhat similar problems were of frequent occurence in practice, in particular he instanced the measurement of the resistance of the bonds connecting the rails in electric tramway systems. The difficulty in this case was in knowing where the rail ended and the bond began. A small variation in the position of the potential contacts made a large variation in the reading of the galvanometer. In many cases the only way of attacking the problem was to calculate the resistance from the known resistivity of the metals by the approximate method indicated by Maxwell. An exact solution, therefore, like the one obtained by the author, would be of great value in checking the accuracy of the approximate method.

A Paper on

"The Inductance of Two Parallel Wires"

was read by Dr. J. W. NICHOLSON. When direct and return currents flow in two wires of great length, and the alternation is not rapid, the effective self-induction per unit length of the system may be calculated readily by simple integration. If the wires have radii a, b and permeabilities μ, ν, and if C be the distance between their axes,

$$L = 2 \log c^2/ab + \tfrac{1}{2}(\mu + \nu).$$

This formula is often of little practical use when the frequency of alternation is several thousands per second. Such frequencies are of constant use in practical work. For example, in the measurement of small inductances by Mr. Campbell's method it is necessary to employ long leads in order to keep them at some considerable distance from the bridge and other circuits. The self-induction of these leads must be small, and a calculation of its value is very desirable. The general case presents very great mathematical difficulty, but the solutions given in the Paper appear to include most cases of practical utility. The mode of proof depends upon a transformation of a harmonic series containing the Bessel functions of type k_n finite at infinity to a similar series with respect to a new origin.

Mr. A. CAMPBELL congratulated the author and said it was often desirable when measuring self-inductances to check the results by calculation. The author's formulæ would be useful in finding the inductance of parallel leadi, although this was best obtained experimentally as a separate experiment.

Dr. RUSSELL said that it required considerable mathematical skill and great patience to attack this problem, and so he thanked the author for having obtained a solution sufficiently accurate for practical purposes. He pointed out that the formula would have to be used with caution at very high frequencies as the capacity current was then appreciable. He suggested to the author that he should compute the kinetic energy of the ions or electrified particles by the motion of which modern theory explained the phenomena of the electric current. It had hitherto been the custom to assume that the self-inductance of a current flowing in a circuit could be calculated by finding the magnetic energy only, and this was what Dr. Nicholson had done. If they accepted modern theory, however, they must admit that part of the total energy of a current was due to the kinetic energy

of the ions. To take this into account it was necessary to add the term $\Sigma mv/i$ to Dr. Nicholson's solutions, where m was the mass of an ion, v the mean velocity given to it by the electromotive force, and i the current. In the case of metallic conduction this term was in general negligible compared with those found by the author. In cases, however, where the current took place through gases—as in vacuum tube lighting—the value of the correcting term was appreciable owing to the high velocity of the electrified particles. In a Paper to the Röntgen Society on the measurement of a current through an X ray tube, Mr. Duddell recently described some very interesting phenomena which he had noticed during his difficult but very successful experiments. The speaker thought that probably some of these effects might be explained by taking in account the kinetic energy of the moving ions.

A Paper by Dr. Barkla and Mr. Sadler on "**Homogeneous Secondary Radiation**" was read in abstract by the Secretary. Two Papers by Prof. Morton, entitled "**Note on the Amount of Water in a Cloud formed by Expansion of Moist Air,**" and "**An Elementary Treatment of the Motion of a Charged Particle in a Combined Electric and Magnetic Field**" were taken as read.

THE NEW WORKS OF MESSRS. GEORGE KENT (LTD.) AT LUTON.

No one whose daily wanderings takes him through the residential parts of London can have failed to be struck by the large and increasing number of empty houses. This is due, no doubt, in part to the excellent facilities offered by the railway companies to suburban dwellers, and in part to the introduction of the motor car. As regards the industrial side of the question, however, other factors operate to a considerable extent. The high rents and rates in London, together with the small space available for extension, and the stringent provisions of the London Building Act, make it impossible for an industry to expand proportionately with its needs, and these causes operate disastrously as regards profit-earning capacity.

Among the firms who have found it necessary, both on account of their increasing business and for the reasons outlined above, to move from the London area are Messrs. George Kent (Ltd.), of High Holborn, who for many years have been justly celebrated as makers of the Venturi water meter and other similar apparatus. If personal feelings may be allowed to draw aside for once the editorial veil, may we take this opportunity of expressing to Messrs. Kent our gratification that they have shifted their quarters. On a beautiful summer's day it gave to a London worker rather too familiar with wood pavements and motor 'buses a breath of country air and a glance at the blue sky.

On Tuesday last Messrs. Kent inaugurated their new works at Luton by a luncheon, presided over by Mr. Walter Kent, at which about 50 or 60 persons were present. Before luncheon the new works were inspected, and general admiration was expressed at the lay-out and arrangement of the shops.

When in full working order these works will be specially devoted to the manufacture of water meters, and it is expected that, as at present constructed, their output capacity will be 400 water meters per week. The works themselves were erected under the superintendence of Mr. Alfred King, and the design, erection and construction of the whole of the steel work in the roofs, gantries, stanchions, &c., were carried out by Messrs. F. Morton, jun., & Co. The builder was Mr. W. G. Dunham, of Luton.

The dominant idea in planning the works has been to minimise labour and facilitate production. To this end, all work is conducted on one level, while the raw material is, as far as practicable, received at one end of the works; it undergoes various stages of manufacture on its way through, and the finished article is completed, packed and dispatched at the other. The iron and brass foundries form a separate department, and include a laboratory for the testing of iron and bronze alloys. As in all modern works, ample provision has been made for the work people's comfort, a club and mess being provided at one end of the works.

In conclusion we must thank Messrs. Kent for the facilities provided for inspecting their works, and must wish them success in their new venture.

BRASS-CASTING REGULATIONS.

In June, 1907, the Home Office issued draft regulations for works and factories in which brass casting is carried on. Mr. W. Wills was appointed to inquire into the objections lodged against these proposed regulations. Inquiries were held in Birmingham, Glasgow, and London by the Commissioner.

In his report to the Home Office, Mr. Wills states that he has no doubt the process of brass casting, as carried on at present in the majority of [illegible], is [illegible] a dangerous trade, but there is considerable divergence of opinion among those engaged in the trade as to the character and extent of the evil. In regard to ventilation, strong opposition was made on the part of the employers to being compelled to install the exhaust draught as near as possible to the point of origin of the fumes. It was urged that the only known apparatus which fulfilled this condition was [illegible] invention, and evidence was given that that invention, which has been found to work successfully in the case of "sand-casting" (though not in all cases), is unsuitable for "strip-casting" and "solid-drawn tube-casting." Mr. Wills has no hesitation in suggesting that regulations should be modified so as to specifically refer to other forms of apparatus for securing an exhaust draught. Another objection urged on behalf of the strip and solid drawn tube casters was that if the exhaust draught is to be required during the actual pouring, it will result in the metal being chilled and developing "spills," a sort of luminous cracks or blisters in the castings. Having in some instances seen this form of casting carried on in breezy weather with open doors and windows, he entertains great doubts whether the fears expressed are well founded; but he does not feel justified in rejecting the large body of expert opinion on which the objection is based. At the same time, he thinks employers should be induced to apply the exhaust draught as near to the point of origin of the fumes as they consider reasonably possible, having regard to their requirements, and also where the exhaust draught apparatus is not placed near the point of origin, to place it, so far as is reasonably possible, where it can be put in operation while the metal is being poured without risk of damage to it.

Another objection was that there were many casting shops where the air space was so large, having regard to the work done, and where the natural ventilation through the openings in walls and roof was so good, that there was no practical danger to the health of the men; and it was pressed upon him that this regulation should not apply in such cases. He carefully considered on what lines such an exemption should be framed, and has come to the conclusion that the most convenient basis is the cubic air space per man engaged in the shop. Therefore he recommends the exemption of sand casting shops having an air space equivalent to 2,500 c. ft. for each person employed, and the exemption of other shops having an air space equivalent to 3,500 c. ft. for each person employed. In addition he considers it will be necessary to provide for individual exemption in exceptional circumstances, to be granted at the discretion of the chief inspector. It was strongly urged that there should be an exemption in favour of shipbuilding, engine building, electrical engineering, machine tool making, motor car and cycle manufacturing, machine making, and auxiliary machinery making works, and there seems no alternative but to introduce in the regulations a provision for discretionary exemption.

As to lavatory requirements, having regard to the conclusions of the Committee of 1896 as to the contamination of the men's food, the inefficiency of the present special rule, and the substantial amount of assent which the proposal has received, he is disposed to recommend the enactment of the regulation wherever exhaust draught is also required.

Having regard to the fact that compliance with the regulations so as to combine as far as possible both efficiency and economy will involve the making of some experiments and the solution of some difficult problems, and that it must involve a considerable burden upon employers in a small way of business, Mr. Wills considers the period of 18 months from the date of the enactment of the regulations will not be an excessive time allowance.

PARLIAMENTARY INTELLIGENCE.

LONDON ELECTRIC SUPPLY BILLS.

Lord Cromer's Committee commenced consideration of the clauses of the London and District Electricity Supply Bill on Monday.

Mr. Balfour Browne, on behalf of the promoters of the London Electric Supply Bill, said they did not intend to take any part in the discussion on the London and District Bill.

Mr. Seymour Bushe, for the promoters of the Westminster and Kensington Bill, said they took the same view. He however suggested that his companies should be struck out of the London Electric Supply Bill.

Consideration of the clauses followed. Numerous suggested amendments, additions and excisions were rejected.

Mr. Talbot: The promoters had agreed to the L.C.C.'s amendment to Clause 50 to substitute for the last three lines. "In respect of all electric lines laid down by the Company in any street in the Administrative County of London, the L.C.C. shall, for the purposes of this section, have the same rights, powers and privileges as if they were the local authority for the district in which such street is situated."

On the invitation of the chairman, Mr. Talbot stated the Company did not propose to alter the 20 per cent. limit for lighting; but the Committee decided to reduce the limit to 15 per cent.

Mr. Talbot said he agreed with Mr. Morten's (for West Ham) proposal to insert in clause 52 the word "or" before "trustees," and to strike out the words "or power user." It was also agreed to delete the words "or power user" in the same clause.

The Chairman did not think the term *force majeure* was a good term to use in an English Act, and Mr. Talbot said the promoters would consider a modification.

Mr. Morten moved to delete Clause 61, referring to the sliding scale, and to insert an amended clause.

Mr. Talbot said the promoters proposed, to meet the difficulty which the chairman had said might be found in arriving at the average price obtained for three different kinds of energy, to alter the clause to provide that "if in any year the revenue obtained by the Company from the sale of electrical energy is less by 1 per cent. or more than the revenue the Company would have obtained if they had charged for such energy

the respective maximum prices set out in the second schedule of this Act, the dividend which the Company may pay in respect of that year may be increased above the standard rate to the extent of $\frac{1}{4}$ per centum on the paid up capital of the Company in respect of every one per centum by which the revenue obtained by the Company has been less than the company would have obtained by charging such maximum prices for such supply." It took the total revenue for all classes of energy, which appeared to be the only way.

Mr. TALBOT went on to say the promoters proposed, in regard to clause 61A, to omit "per annum" in the last line, and add at the end of the clause "provided also that in any year in which the Company pay a dividend at the rate of not less than £6 per cent on the capital of the Company for the time being paid up the Company shall set aside and pay into the maintenance and renewals fund an amount being not less than $\frac{3}{4}$ per centum upon the capital expenditure of the Company."

The CHAIRMAN said the Committee would prefer to begin at 5 per cent. dividend, instead of 6 per cent. and $\frac{1}{2}$ per cent. for the maintenance and renewals, making $5\frac{1}{2}$ in all, instead of $6\frac{3}{4}$.

Mr. TALBOT said it had been agreed to delete clause 64.

Sub-clause 5 of clause 67, proposed by L.C.C. was agreed, and related to testing and inspection of meters, &c., and payments therefor.

Mr. ROWLAND BERKELEY (Westminster City Council), moved a new sub-clause (A1) to clause 73 to the effect that when an undertaking to be acquired by the Company is not the undertaking of a local authority the undertaker shall before applying to the Board of Trade for approval to the transfer, obtain the consent of any local authority in whose district such undertaking is situate to such transfer, and in the event of refusal the matter shall be referred to the Board of Trade.

Mr. TALBOT said he would agree to some such sub-clause but not in those words. A further proposal with regard to it would be submitted. The following was the new clause 75 which the promoters had adopted:

Unless the Company shall within 12 months from the passing of this Act obtain a certificate from the Board of Trade that not less than 600,000 of the share capital of the Company by this Act authorised has been *bona fide* subscribed, and that not less than £240,000 of such share capital has been paid up, and unless within two years from the passing of this Act the Company shall have substantially commenced their works for the purpose of carrying out their powers under the Act, the Board of Trade shall after considering any representations which the L.C.C. may desire (and are hereby authorised) to make, may order that the powers of the Company under this Act shall cease as to the whole or any part of the area of supply, and on any such order being made those powers shall cease accordingly."

Mr. MORTEN did not think the L.C.C. should be the only body to make representations. He proposed an amendment to bring in local authorities outside the administrative County of London.

This amendment was rejected.

A clause for the protection of Kent sewers was agreed.

Mr. BERKELEY proposed a clause providing that (1) nothing in the Act shall be deemed to alter or supersede the rights of Westminster Council under the Electric Lighting Acts, and (2) that in fixing the value of any undertaking to be acquired by the Council no regard shall be had to loss occasioned by severance; and that (3) the transfer of an undertaking to the Company shall not be deemed to alter the area for the purpose of purchase by the Council. They feared that the new Company might buy up one of the Companies in their area, and then when the time came for purchase by the Council they might claim for severance of the business from the London and District Co.'s undertaking.

Mr. TALBOT said his friend could not have considered clause 73 of the bill, which enabled the London and District Co. to acquire undertakings, and which provided that the Company would be considered the undertakers for all purposes under the provisional order. The Board of Trade must hear the local authority, and would give them the fullest protection.

Mr. BALFOUR BROWNE (asked by the Chairman to give his views on the subject), said under his bill (the London Electric Supply Bill), the only value he got for severance was for severance of an existing company's undertaking, and not for severance of two undertakings which might be joined henceforth.

Mr. TALBOT said his bill did not affect Westminster Councils' purchase rights, and it was impossible to foresee what effect Mr. Berkeley's proposed provisions would have in time to come.

Sub-clause 1 and 2 were then accepted, and sub-clause 3 rejected by the Committee.

Several clauses had been agreed with the L.C.C., providing for easement through Blackwall and Rotherhithe Tunnels; prohibiting interference with parks, open spaces, embankments, subways, main sewers, &c., without the Council's consent; providing that the Council shall have all the rights powers and privileges of a Metropolitan Borough Council, being an authority under the Act, and all the rights of the Postmaster-General in regard to lines, works and apparatus; and for compensation for obstruction of tramway traffic, &c.

On Tuesday Dr. MACASSEY asked for a clause giving the same protection to the South Esses Water Co., as had been given to the Metropolitan Water Board, and this was granted by the Committee.

Mr. MORTEN asked for a clause giving West Ham Council protection in their capacity of Commissioners of Sewers, and this was agreed.

Mr. MORTEN said all other amendments he had prepared referred entirely to West Ham, and, in consequence of their Lordships' ruling, he did not intend to move them.

With regard to the provision which the Smoke Abatement Society required, Mr. TALBOT, for the promoters, said he thought that was met by the Office of Works requirement which was now in the bill, as follows:—

"Provided nevertheless that nothing in this Act shall exonerate the Company from any indictment, action or other proceeding for nuisance caused or permitted by the Company on any lands used by them for generating electrical energy, whether such nuisance is caused by non-consumption of smoke, by the reasonably preventible evolution of oxides of sulphur, the use of refuse distructors or the emission of oil or other matter in conjunction with steam." The Committee decided to adhere to the clause as it stood.

Mr. TALBOT asked that the promoters might insert in the schedule to the bill referring to prices of current in (B) (for transformed alternating-current), the words: "at the periodicity of the main supply," and in (C) after the word "current" "or of transformed alternating-current at a periodicity other than that of the main supply."

The CHAIRMAN said the Committee had decided that the dividend and contribution to maintenance and renewals fund mentioned in the addition to Clause 61A, proposed by Mr. Talbot on Monday, should be altered to 5 per cent., and $\frac{1}{2}$ per cent., respectively.

LONDON ELECTRIC SUPPLY BILL.

The Committee then took the clauses of the London Electric Supply Bill.

Mr. TYLDESLEY JONES (for the promoters), said a paragraph had been added to Clause 3 (the old clause 45), providing that "Notwithstanding that any of the Companies enter into agreements such as those authorise by this clause, they are, in respect of their separate undertakings, to remain liable to all the obligations and liabilities to which they are now subject." That had been submitted to the Lord Chairman of Committees' counsel (Mr. Gray): but his approval had not yet been received.

Mr. BUSHE suggested adding "except for the purposes of this agreement."

The additions and the clause were accepted.

In reference to the provision in the Bill allowing the Company to supply to docks and West Ham Corporation's opposition, the Chairman suggested the addition of a condition that the supply should not be given without the consent of the Corporation.

Mr. MORTEN agreed to accept the clause with an addition, which would prevent the Company from supplying Victoria Dock.

Mr. JONES said he did not think a case had been made out for exclusion of Victoria Dock.

The Committee passed the clause in the following form: "Provided that energy shall not be supplied under the powers of this section for use in any dock undertaking which is wholly within the area of supply of the Metropolitan Borough of Stepney or in the Victoria Dock situated within the area of supply of the Corporation of West Ham, without the consent of the said Corporation or Metropolitan Borough respectively."

Mr. JONES said Clause 5 (old clause 36) of his Bill remained to be settled. It provided means for the Companies to get their mains through intervening areas. The clause had been amended to meet points raised by opponents. He suggested that the agents for his Bill and for the Westminster and Kensington Bill should endeavour to bring into agreement their respective clauses, and appeal to the Lord Chairman of Committees in case of difference.

Mr. BUSHE preferred that the promoters of the two Bills should put the clause in their own words.

The CHAIRMAN said the Committee accepted the clause in the London Electric Bill, subject to the settlement of details with the Board of Trade, and the Lord Chairman, and at Mr. Jones' request the words "for the purpose of carrying into effect any agreement or exercising any of their powers under this Act, or crossing any district intervening between any areas of supply or generating stations," were added.

Mr. MORTEN proposed an amendment to the route clause, which would make the Company concerned responsible for all costs of a reference to an arbitrator or to the Board of Trade.

Mr. JONES said the arbitrator would have power over the costs, and could order them to be paid by either the companies or the local authorities.

The Committee accepted the clause as it stood, without Mr. Morten's amendment, and said the same principle would be applied in the Westminster Bill.

Mr. SEYMOUR BUSHE said he did not see why his companies' names should be in a schedule of the London Electric Supply Bill. Their names were not put in at their request.

Mr. JONES said that when Mr. Bushe spoke against the Bill he said that, so far as the Bill was based on the principle of association between companies for mutual assistance, it commanded their sympathy. He looked upon clause 45 as the most important part of the bill, and that clause embraced Mr. Bushe's clients. The promoters of the present bill did not object to the Westminster and Kensington Bill, but they objected to the exclusion of the companies from the schedule, because they thought the future problem of supply in London would ultimately be dealt with by a coupling up of all the companies. There was nothing in the bill which would put any compulsion on Mr. Bushe's companies to take current from any of the others.

Mr. BUSHE said it was unusual to confer powers upon persons against their will.

The Committee decided to strike out the names of the Central Kensington and Knightsbridge, Notting Hill, St. James', and Westminster Companies from the schedule.

In reference to the clauses required by the Commissioners of Works (as in the London and District Bill) Mr. JONES said with regard to the clause providing that nothing in the Bill should exonerate the promoters from liability to indictment, &c., for nuisance, his companies were in a different position from the London and District Co. All except two had been authorised by Acts of Parliament, and were exempt from such indictment or other proceedings, unless it could be proved that any nuisance

that arose had been caused by negligence, and the companies, on the faith of such exemption, had spent large sums of money upon extensions.

Mr. BUSHE supported Mr. Jones. The proposed clause was an attempt to put upon the companies a liability which was never intended by the legislation under which they were established.

The Committee deferred their decision.

Mr. JONES said the next clause was for the protection of Royal Palaces and Parks, and the object was to give the Commissioners of Works and their engineer power to inspect generating stations, and if it appeared to them that proper precautions were not being adopted for consumption of smoke, or for preventing as far as reasonably practicable the evolution of oxides of sulphur and generally for protection of the palaces, &c., to require the company or companies having control of the stations to carry out such works, and do such things as in their opinion might be necessary. The Board of Trade had full power of regulation, and the companies ought not to be dictated to by somebody appointed by the Commissioners of Works, and who might know nothing about the running of a generating station.

The CHAIRMAN said the Committee were not disposed to insist on the clauses of the Commissioners of Works, because of their retrospective effect, which affected the companies concerned in this bill in a different way to the London and District scheme, but he suggested that the promoters should confer with the Commissioners of Works, and try to come to some agreement.

LONDON (WESTMINSTER AND KENSINGTON) ELECTRIC SUPPLY COMPANIES BILL.

There being no contentious matter to be dealt with in the Clauses stage of the London (Westminster and Kensington) Electric Supply Companies Bill, at a brief meeting, at which the agents and counsel of the promoters were present, on Wednesday afternoon, the Committee made such slight final adjustments as were necessary to bring the clauses as far as possible into conformity with those of the London Electric Supply Bill, and this concluded the House of Lords' Committee stage of the three bills.

LEGAL INTELLIGENCE.

Ernest Scott & Mountain v. Kent Collieries (Ltd).

The Official Referee (Mr. Muir Mackenzie, K.C.) had this case before him on a question of costs. The judgment was given in our last issue, p. 422.

Mr. RUSSELL, K.C., submitted that plaintiffs had been perfectly justified in bringing their action and, therefore, were entitled to costs. Defendants had put forward an enormous counterclaim, and the only figure they had recovered on which they could get costs was £417. Therefore plaintiffs should have all the costs of the action excepting as regarding that sum. Mr. Russell read a letter written by plaintiffs to defendants during the progress of litigation stating that they were prepared to give £2,000 as an allowance to be accepted by defendants, each party to pay their own costs. Defendants' solicitors, however, stated that the offer was wholly inadequate, and the only basis upon which their clients could consider the matter would be that defendants should keep No. 3 pump and set off the amount of the generating plant against an amount to be discussed and arranged. Plaintiffs had no option but to fight the counterclaim.

Mr. [illegible], K.C., said that the Official Referee had found in substance that not only was the machinery not according to contract, but, having regard to the amount he had allowed off the price, he had found in defendants' favour that there was very considerable lack of conformity with the contract.

The Official Referee said the costs must follow the event. In that case plaintiffs would get the costs of the action just as if there had been no counterclaim at all. He directed the costs of the counterclaim, half of which would be awarded to defendants, to be taxed, and the amount deducted from plaintiffs' costs. The Official Referee refused to grant a stay of execution as it was not, he said, for him to do so.

Eccles Corporation v. South Lancashire Tramways Co.

On Thursday last week Mr. HUGHES, K.C., for plaintiffs, moved before Mr. Justice Swinfen Eady for an injunction restraining the South Lancashire Tramways Co. from running tramcars over lines belonging to the Corporation and otherwise trespassing on their lines. He said that there was an arrangement between Eccles and Salford Corporations under which the latter worked the tramway service in Eccles. The present dispute arose over a claim by the South Lancashire Company, under a licence from Salford Corporation, to run their trams over a portion of the lines without the consent of Eccles Corporation, whose case was that Salford Corporation were not entitled to sublet the lines. Eccles objected to this being done without their consent. If defendants had obtained permission on terms there would have been no difficulty.

Mr. Justice EADY said he did not see how he could determine the construction of the agreement on a motion and in the absence of Salford Corporation he ordered the motion to stand over until the trial of the action, but granted leave to appeal.

Bache v Jones.

At Gloucestershire Assizes last week Mr. Walter Jas. Bache, Cheltenham borough electrical engineer, sued Mr. T. R. Jones, draper, a member of Cheltenham Town Council, for alleged slander.

For the plaintiff, Mr. STURGES said the action was brought to recover damages for a slander alleged to have been uttered by defendant against plaintiff by way of his profession. At a public meeting on March 5 last, defendant made a speech criticising the action of those members of the Council who had voted for an increase of the salary of Mr. Bache who, said Mr. Jones, "had been cutting down the working men at the electrical works to the very bone." Plaintiff considered defendant meant by those words that he (plaintiff) had been improperly using his position as electrical engineer to Cheltenham Corporation and had been sweating the workmen employed at the electrical works and cutting down their wages below what was necessary for their reasonable maintenance; and further that he had been cutting down the wages and sweating the workmen in order that he might effect economy at the works, and thereby induce the Council to give him an increase of salary. Mr. STURGES said if defendant had apologised and stated publicly he did not mean to reflect on plaintiff, the case would not have been brought.

Plaintiff said that since his appointment as borough electrical engineer no man at the electricity works had been reduced in wages, except in one case, which was for misconduct.

Mr. CRANSTOUN (for defendant) pointed out that plaintiff had obtained an increase of salary and he had not suffered by anything that might have been said about him to the slightest extent. Defendant desired to cast no reflection on plaintiff, and he referred to the action of certain members of the Cheltenham Council.

The jury held that plaintiff had no ground of action, and found for defendant, for whom judgment was entered with costs.

D. Santoni & Co. (1906) (Ltd.) v. Farringdon Engineering Co.

At Clerkenwell County Court on Monday plaintiffs sought to recover £45. 16s. 10d., the price of 314 armature coils for tramway motors which were made to defendants' order and to sample. Defendants alleged that the coils were defective and returned them.

Mr. TASKER, chief consulting engineer to plaintiffs, said he saw a number of the coils tested before being sent out; they were tested to ten times the working pressure, and in no case was there a fault. In September they had a complaint that the coils were inferior to what defendants had previously supplied to Birkenhead Corporation, and in January defendants returned the whole lot as rejected.

In cross-examination, WITNESS admitted that wire taken from an old machine had been used in winding the coils; the wire was, however, good.

The FOREMAN of plaintiffs' armature winding department said all the coils were properly tested before being sent out.

An ENGINEER said that he had made thorough tests of a number of the coils and he found them quite satisfactory.

Mr. LEVER (for defendants) said the real issue was whether there was proper insulation between the turns of the coils. The defence contended that such insulation was insufficient. Thirty-three of the coils were used on the Birkenhead tramways, but they short-circuited at once and would not bring the car out of the yard.

JAMES McLONNEN, chief engineer and manager to defendants, said they had supplied coils for Birkenhead tramways some six or nine months previous to sending out the coils now in dispute. The first coils were made by another firm and were quite satisfactory. After the coils supplied by plaintiffs were dispatched to Birkenhead he received a complaint. He saw Mr. Tasker and told him the coils had broken down. Mr. Tasker asked if it was due to rough treatment in being placed in the slots and witness replied that he had not received particulars from Birkenhead. The Corporation complained that the coils supplied were not the same as the original sample.

His HONOUR thought it necessary the original sample should be produced. It would also be helpful if someone from Birkenhead Corporation attended to speak as to what happened when the coils were tried.

WITNESS said he had made an examination of the coils complained of, and found the wire brittle and very much discoloured. It looked like old wire, and in his opinion it was not proper wire to use for winding coils. Never in his experience had he heard of wire, in use for 15 years on a dynamo, being used again for new coils.

The hearing was adjourned.

Light Railway Rating Appeal.

At the West Riding of Yorks. Quarter Sessions, Bradford, on Tuesday, it was announced that in the appeal of the Wakefield & District Light Rly. Co. against the assessment of their property within the parish of Wakefield by Wakefield Assessment committee it had been agreed that the gross estimated rental for the land, tramways, electric power stations, and car sheds should be reduced from £[illegible],151 to £5,225, this sum consisting of £2,050 in respect of land and tramways, and £3,175 in respect of power stations and car sheds. The rateable value of the land and tramways would remain at £150, while the rateable value of the power stations and sheds would be reduced from £1,800 to £1,175.

NOTICE.

The Electrician for July 10 will include a Supplement dealing very fully with the subject of Electricity as Applied to Mining Operations. **The following are amongst the principal contributors to this Mining Issue :**

Mr. J. H. C. Brooking	"Mining Cables."
Mr. H. W. Clothier	"Switchgear for Mines."
Mr. J. C. Futers ..	"Electric Winding."
Mr. J. W. Gibson ...	"Electric Ventilation of Mines."
Dr. R. Herzfeld ...	"Electric Pumping."
Mr. F. Hird	"Electric Signalling in Mines."
Mr. F. W. Hurd......	"Electric Coal Cutting."
Mr. R. Livingstone .	"Energy in Coal Winding."
Mr. W. Maurice ...	"Employment of Storage Batteries in Colliery Power Stations" and "Electric Blasting."
Mr. W. C. Mountain	"Electric Haulage."
Mr. W. S. Toplis ..	"General Survey of Electric Power in Mining."

Particulars as to advertising space in this Mining Issue on application. **Orders for additional copies should be placed with the agents at once, or be sent direct to the Publisher, 1, 2 & 3, Salisbury-court, Fleet-street, London.**

MUNICIPAL, FOREIGN & GENERAL NOTES.

APPOINTMENTS VACANT AND FILLED.

The Pacific Cable Board is prepared to consider applications from candidates for the post of general manager. The candidate elected will be required to have experience in ocean and other telegraphy and in the business conduct of an undertaking similar to that of the Board. Applications, accompanied with statement of age and qualifications and salary expected, to be addressed to the Chairman of the Pacific Cable Board, Queen Anne's-chambers, Westminster, S.W., not later than July 20. See also an advertisem ent.

A second assistant is required in the engineering department of Woolwich Polytechnic to take up duties in September next. A knowledge of electrical engineering is essential. Commencing salary £180. Applications to the Principal (from whom further particulars can be obtained) by July 15. See an advertisement.

A foreman wireman is required at the Borough Polytechnic Institute, qualified to give instruction in electric wiring (elementary and advanced) to City and Guilds of London Institute technological classes. Particulars from the principal, Mr. C. T. Millis, 103, Borough-road, S.E., to whom applications by July 11. See an advertisement.

Mr. J. H. Thompson, A.M.I.E.E., of Burton-on-Trent, has been appointed station superintendent at Carlisle.

Mr. C. F. Moorhouse has been appointed Sussex district manager of the National Telephone Co. in succession to Mr. F. W. Taylor, who has been promoted to the Manchester district.

Derby Council have appointed Mr. J. Hebb canvassing engineer in connection with the electricity department.

Mr. Jas. G. Petrie, of Edinburgh, has been appointed engineer and manager of the Todmorden municipal motor 'bus department at £3 per week.

Mr. W. T. Maccall, of the Woolwich Polytechnic, has been appointed head of the electrical engineering department at Halifax Municipal Technical School at £200 per annum.

The Postmaster-General has appointed Lieut. F. G. Loring, R.N., as inspector of wireless telegraphy at the General Post Office.

EDUCATIONAL NOTICES.

Heriot Watt College, Edinburgh.—At this college there is theoretical and practical training for mechanical, electrical and mining engineers, technical chemists, &c. The training for engineers consists of three years in the college and a three years' apprenticeship on the "sandwich" system in a local engineering works. The total cost, including apprenticeship premium and fees at college, is from £120 to £200. There are complete courses of instruction, extending over four years, for students studying for the fellowship of the Institute of Chemistry. The classes are recognised by the University of Edinburgh as qualifying for science degrees. Full information may be obtained from the Principal, Mr. A. P. Laurie, M.A., D.Sc.

University College of North Wales.—A systematic course of instruction in electrical measurement and practical electricity is given at this college for students proposing to enter the electrical engineering profession. The physical laboratory is well equipped, and the course commences in October next. Prospectuses, &c., from the secretary, Mr. J. E. Lloyd, M.A.

Electrical Standardising Testing and Training Institution.—An examination for a "Maxwell" entrance scholarship, value £105, will be held at Faraday House, 62 70, Southampton-row, W.C., on the 22nd and 23rd inst., and notices of intention to compete should reach the Secretary (Mr. Howard Foulds) by July 12.

Argentina.—The "Review of the River Plate" says Buenos Ayres City Council have approved the ad referendum contract which permits the Buenos Ayres and Belgrano, the Buenos Ayres Electric and the Belga-Argentina Cos. to be incorporated with the Anglo-Argentine Tramways Co.

The Buenos Ayres Port & City Tramways Co. have opened the first two sections of their electric system, which is to consist of 7 miles of double track, from Retiro Station to Barracas Bridge, via the Port Lands.

Burnley.—The Tramways committee have decided to purchase five additional tramcars.

Coventry.—An inquiry was held on Friday into the Council's application for sanction to borrow £25,000 for the electricity undertaking.

Of the proposed loan £10,000 was in respect of the original area of supply (mains £5,000, transformers £1,500, motors £500, services £1,000, motors for hire £2,000), and the remaining £15,000 was for a new area recently added. It is not intended to carry out all the work this year, but it is hoped to complete it by July, 1909.

The city electrical engineer and manager (Mr. J. A. Jeckell) gave evidence and said the demand for power and light had considerably increased of late years, and was still increasing.

Croydon.—The salaries of the station superintendent (Mr. D. Cowan) and the mains superintendent (Mr. E. A. Fellaw) have been increased.

Dorking.—The L.G. Board have sanctioned a loan of £10,120 (out of £11,494. 14s. 7d. applied for) for extensions of the electricity undertaking. The period allowed for repayment is only 16 years, and the Council have asked the Board to extend this to 25 years to fit in with the existing arrangement with Edmundsons' Electricity Corpn. for working the undertaking.

Eccles.—The Council have decided to put down water purifying plant at the electricity works.

Electric Taxicabs.—A company is being formed to place electric taxicabs on the London streets. The cabs will seat four passengers, and provision will also be made for carrying luggage

Electrical Contractors' Association.—The annual meeting of this association was recently held, and Mr. E. C. Wallis, of Leeds, was elected president for the ensuing year.

The outgoing president (Mr. A. Rashleigh Phipps) reported that during the past year considerable interest had been shown throughout the country in the affairs of the association. Nearly 100 new firms had been elected members; new branches had been formed in Dundee, Aberdeen, Leicester, Birmingham and Cheltenham. The financial position had considerably improved and the Law and Parliamentary committee had been successful in getting clauses amended in nearly a dozen Corporation bills. Negotiations had been entered into with the kindred association for a more intimate connection. He hoped the ensuing year would be equally fruitful of results, and stated that the Central Board would be shortly considering the question of registration and examination of workmen and the formation of other branches throughout the kingdom.

Electricity in Breweries.—At the meeting of Ohlsson's Cape Breweries (Ltd.) on Tuesday the chairman (Mr. A. L. Elwes) said the company had installed electrical plant to supplant steam at Johannesburg in order to economise in fuel.

Electricity in Mining.—At the first ordinary meeting of Gt. Cobar (Ltd.) last week the chairman (Mr. A. Haes) said the capital of the company was provided to buy the mine and the properties attached thereto, and to erect a new plant which would be capable not only of treating a very much larger quantity of ore, but which would treat it much more cheaply wherever possible. Everything in the new plant was electrically driven. The whole of the plant was automatic. The ore brought up from the shaft was placed in vessels which run down of their own weight, and are pulled up again by electricity and tipped into the furnaces, and everything was done with the greatest possible economy. But many things were against them in Australia. Australia had put huge duties on foreign goods. They had favoured England slightly, and he believed that they had said that everything could be made in Australia. They had found, however, that was not quite the fact, to their great annoyance and loss. The bonds for the electric railway could not be made in Australia. They had had to set to work to make them themselves. The latest news was that the furnaces had been finished, the boilers were under steam and all engines in the power house had been tested, but they had not finished bonding the railways.

French Post and Telegraph Rates.—The Post and Telegraph committee of the Chamber of Deputies has adopted the proposition

for the reduction of the letter tariff between France and England from 25 c. to 10 c., and of the telegraph rate from 20 c. to 10 c. per word.

Holidays. There is a general desire at this period of the year for information of a readily accessible kind concerning holiday travel, and for this purpose the railway companies have this year paid the closest attention to the preparation of literary matter which shall afford the completest information concerning their holiday travel arrangements with the utmost facility of reference. We have seen a number of these travel books, and all of them have been prepared with an almost parental regard for the convenience of travellers. In this connection the Great Central Co. have issued what is described as an A.B.C. programme, giving particulars of a multiplicity of cheap and comfortable pleasure journeys; the London & South-Western Co. have several publications to serve a similar purpose; the Great Northern, the Great Western, the South-Eastern & Chatham, the Midland, the Great Eastern, the London & North-Western, and, in fact, all the principal lines, have excelled themselves this year in regard to their literary efforts for the guidance of the travelling public. Copies of the various booklets can be obtained post free from the publicity departments of the companies at the principal stations, and Messrs. Cook & Sons and other travel caterers have the means of giving the fullest information on the important subject of holiday travel.

Hospital Lighting.—Twickenham Council have decided to adopt electric lighting at the new isolation hospital. Electric current will be supplied from the sewage works, and £1,000 is to be spent on wiring the buildings and in providing additional generating plant.

Hove.—At the Surveyor's Institution (London) on Tuesday the Board of Trade inquiry into the application of Hove Council for a reduction in the price of electricity supplied by the Hove Electric Lighting Co. was resumed before Mr. Sims Williams.

The first portion of the inquiry was commenced on Dec. 1, 1906, when it was contended for the Council that one of the conditions on which the Council transferred to the company in 1892 their electric lighting order was, that if at any time after the expiration of seven years from the date of the transfer they made representation to the Board of Trade, "that the company during the seven years last preceding had distributed or earned profits sufficient to have enabled them to distribute dividends equal to an average of 10 per cent per annum," the Board could, if they thought fit, after inquiry, make an order varying the price or methods of charge, or substitute other methods of charge. For the company it was argued that before any case arose for the interference of the Board of Trade, the company was entitled to charge 10 per cent. interest, not only on the share capital as ordinarily understood, but also upon the share capital plus the amount from year to year standing to credit of reserve. It was also part of the company's case that before it could be said to have earned dividends sufficient to enable them to distribute 10 per cent., it was necessary that provision should be made for an adequate reserve fund, and that the amount of the provision had to be deducted from the earnings of the company. The Inspector's finding, which was presented to the Board of Trade in Jan., 1907, was that the company had earned 10 per cent., and the present inquiry is directed to fixing what reduction in charges (if any) should be made.

For the Corporation Mr. Earle said the agreement was a curious one to construe, but he thought that under it everything was open to the Board of Trade, both as to the prices and the methods of charging. It might be contended that at the expiration of 42 years from the date of the agreement the Corporation had the right to take over the whole undertaking without compensation, but he did not think that formed an element in the present undertaking, or that it could actually happen in practice.

Mr. Miller (for the company) said his clients had written the Corporation asking whether they would pledge themselves to exercise at any time their powers under clause 12 of the agreement and buy the company out. The answer was a direct negative.

Mr. Earle replied that the Corporation could not bind their successors. Their representation to the Board was a reduction on the present price of an average of 1½d. per unit.

Mr. Robert Hammond put in a number of tables applicable to the Hove company's business. Taking a 7 per cent. dividend as a fair basis on which to fix the price per unit, he said he estimated that that dividend would have been earned in 1904 by a charge of 4·41d. per unit, and in 1905 by a charge of 4·15d.

The Inspector: According to your calculation that would give the company a 7 per cent. dividend? Yes. He thought the company's figure for working costs (2·46d.) was very fair. Assuming the corporation did not buy them out, it would be a reasonable thing for the company to provide a sinking fund to replace what would be lost capital.

Mr. A. H. Dykes (Messrs. Hancock & Dykes) said that, assuming they were right in taking a 7 per cent. dividend as the basis, witness had worked out prices which would have provided for the company's ordinary running expenses, repairs and upkeep, a 7 per cent. dividend, and the return of the share capital and debentures at the end of the specified period if the company were not bought out by the corporation. On this principle witness's view was that the price per unit for the seven years commencing 1906 should be 4·5d. compared with 5·34d. the company were charging in 1905.

On Wednesday Mr. A. H. Dykes, recalled, said it was certain that a substantial sum would be needed for further plant and machinery if the company continued the undertaking until 1934, but he had provided for that in the figures he had given. The company's present output would not be affected to any appreciable extent by the adoption of metallic filament lamps.

Mr. Miller, for the company, said that it was almost impossible to say that there was any particular basis upon which they were to proceed in that branch of the inquiry, which was what reduction, if any, should be made in price. The case presented for the Corporation was based upon a reduction in price of roughly 1½d. per unit; and because there was a reference in the indenture to a 7 per cent. dividend the Corporation asked that that should be taken as a guide and that anything over 7 per cent. should go solely in reduction of the price to the consumer. The position of the company at the end of 42 years, if the Corporation did not exercise their right to buy out the company, had been shirked. It would be in the interest of both parties that that uncertainty should be put an end to, and the company were willing to enter into a supplementary arrangement, but the Corporation replied that they did not see their way to consider the proposal. The company had, therefore, to face the possibility of their being turned out without compensation when their lease came to an end in 1934. They must therefore provide a sinking fund sufficient for the loss they would sustain. At Hove many residents remained for only a small part of the year; and a special feature was the influence of new metal filament lamps. For the first time there had been, during the second quarter of this year, an actual decrease in the total output compared with the corresponding period last year. He asked the Inspector to find that, having regard to the peculiar position they were in with reference to the agreement, the effect of the new lamps, &c., no case had been made out for any alteration in price.

Sir Alex. Kennedy gave the results of an inspection he had made of the company's works and said that he found that although there had been an average annual increase in the supply this average had diminished of late years. He had based certain calculations on a yearly average of 1,000,000 units for the next seven years, and on the assumption that the Corporation did not exercise their option of purchase, so that in 1934 the company would cease to have any powers of supply. Making provision for a sinking fund, increase of plant and renewals, maintenance, &c., he worked out the total cost of production to the company at 4d. per unit. Adding 1·25d. for a 7 per cent. dividend on share capital, he brought the cost of current up to 5·25d., which was the average price the company had obtained for the past two years. The company had made reductions in price from time to time, and these reductions were as much as the company could afford. In 1905 the average price obtained was 5·34d. per unit, in 1906 it was 5·29d. and in 1907 5·19d.

Col. R. E. Crompton, C.B., the engineer responsible for the Hove system, and consulting engineer to the company, agreed with Sir Alex. Kennedy's figures, and regarded them as fair on the whole. As to the future, the whole situation of electrical undertakings had been greatly affected by the introduction of the new metal filament lamps, and he thought Hove would be certain to have the latest improvements at a more rapid rate than poorer districts. At Hove the company were face to face with the possibility of a drop from an average output of 1,000,000 units to 800,000. If that came about the dividend would practically disappear at present prices. Compared with Brighton, he thought the Hove undertaking was much more economically worked, and that if the company had Brighton's load factor their works cost would be 1.61 instead of 2.4d. per unit. It would not be reasonable to require the company to make any reduction in their prices during the next seven years.

The inquiry was adjourned.

Japan.—The imports into Japan of electrical machinery in 1907 included dynamos and motors to the value of £180,900, and other electric machines and apparatus £78,600, the total imports of machinery of all kinds into Japan reaching £2,827,600, of which the United Kingdom supplied over 52 per cent., exactly the same proportion as for the year 1906. Japanese exports and machinery are increasing rapidly, the value for 1907 being £242,000, compared with £92,000 in 1906. Insulated electric wire imports into Japan in 1907 were valued at £251,400, compared with £116,600 in 1906, and electric car imports at £57,000, compared with £31,200.

In the province of Hakodate an important industrial undertaking is approaching completion—the Oshima Hydro-Electric Power Co. When this company's works are completed electric power will be available at a cheap rate. The works are situate about 20 miles from Hakodate, near the outlet of Lake Onuma from which the water is led in a flume some 6 ft. square and 3 miles long to a point where a fall of 220 ft. is obtained. The average flow of water is 140 sq. ft. per min. The total horse-power available is 3,500 H.P. At first only 1,500 H.P. is to be utilised. The cost per horse power supplied will range from 5 yen to 15 yen (10s. to £1.10s.) "per 24 hours," which will, it is stated, represent a saving to the power user of over 35 per cent. compared with power from steam boilers. The capital of the company is £100,000. The company has already taken over the electric lighting of Hakodate, and it is hoped will electrify the horse tramway system of the district.

Leicester.—In order to encourage new industries the Tramways committee have decided to supply electricity to power consumers on the following terms: 15s. a quarter per horse power in respect

of the maximum horse-power demanded, plus ¼d. per unit of electricity supplied.

Littleborough (Lancs.)—Rochdale Corporation offer to supply electricity in bulk in this district (three-phase current at 3,000 volts) at 3d. per unit for the first 100 hours per quarter and 1d. per unit after.

London County Council.—On Tuesday the annual estimates of the Highways committee were discussed. The amount estimated was £1,290,000 for the purchase of tramway undertakings, reconstruction for electrical traction of authorised tramways, &c

Sir J. W. Benn, M.P., proposed "That, in view of the profitable results referred to in the memorandum of the chairman of the Highways committee, and the pressing demand for more electric tramways in London, it be referred to the committee to bring up a supplemental estimate providing for a capital expenditure equal to the average of the past two years." He argued that the L.C.C. tramways had paid well, that London wanted more and that the Highways committee was retarding their development.

Mr. W. W. Thompson, chairman of the Highways committee, denied that his committee were antagonistic to the development of the tramways on proper lines. Last year their estimate was £2,000,000, and they spent £1,500,000. At the next meeting of the Council he hoped to bring up a report to the effect that, rather than wait for electric traction on the G.B. surface contact system, they should proceed to electrify two of the important North London lines on the conduit system.

The amendment was negatived by 70 to 41.

Mr. Gordon moved "That in view of the unsatisfactory results obtained by the electrification of the tramways on the Bow route, and in view of the consequent danger to users of the highways, it be referred to the Highways and the Finance committees to prepare and to submit to the Council at an early date a revised or supplemental estimate with a view to the prompt electrification, on systems already permanently approved by the Council, of the various tramway routes specified in the detailed estimates." He contended that the G.B. surface system was altogether unsuitable for the London streets.

Sir M. Beachcroft asked the Council not to agree to the amendment until they had received a report from the Highways committee on the result of the experiment.

Mr. W. W. Thompson declared that he still had faith in the surface-contact system. He admitted that it had difficulties of working, but those difficulties would, he believed, diminish until the line was in thorough working order.

The amendment was negatived and the estimate approved.

Nine Elms-lane to East Hill Tramways.—The Highways committee recommended a capital expenditure of £32,110 in respect of the reconstruction, on the conduit system, of the existing horse tramways from East Hill, Wandsworth, to Nine Elms-lane.—Carried.

Manchester.—An inquiry was held here on Thursday last week into the application of the Corporation for sanction to borrow £130,500 for extensions of the electricity undertaking.

The deputy town clerk (Mr. Hudson) said the main object was to increase the generating plant at Stuart-street station. Since 1904 the number of consumers had increased from 5,171 to 7,519, and the total lamp and motor connections had increased from 607,000 to 1,238,000 8 c.p., the number of units sold from 29,000,000 to 63,000,000, the gross revenue from £267,000 to £384,000. The gross profit from the beginning had been £1,077,567. Interest on loans had amounted to £464,853 and £445,939 had been transferred to sinking fund, leaving net profit £166,275, of which £4,351 had been used in extension of works, £62,480 had been paid in aid of rates and £99,444 carried to reserve. In addition to the reserve there was a renewals and suspensions account of £130,5€8. The present plant was capable of producing very little more power than was actually required to meet the present demand, which was rapidly increasing. The scheme in respect of which the application was now made would provide additional plant of 12,000 kw. capacity. It was, however, proposed to carry out half the scheme in the winter of 1908-9 and the other half in the winter of 1909-10. The cost of the new plant for 1908-9 was £53,750 and for 1909-10 £54,750. The application included £1,000 for feed-water heaters for 19 boilers at Dickinson-street station and £13,500 for sinking a well at Stuart-street. A large quantity of water, approaching half a million gallons a day, was used at these works. Water was conveyed to it at present by means of one main alone, and if anything happened to that main the works would be entirely stopped. It was estimated that the construction of the well would effect a saving to the department of £2,000 a year.

Councillor Howarth, chairman of the Electricity committee, said it was of the utmost importance that the committee should not be delayed when they wished to proceed with the second part of the scheme.

The application was also supported by Mr. Councillor Kay and Mr. S. L. Pearce, chief electrical engineer to the Corporation.

Marylebone (London).—Tenders are to be invited for the rearrangement of Aybrook-street sub-station buildings so as to concentrate the electrical distributing staff under healthier conditions, and the L.C.C. is to be asked for a loan of £5,000 for the work.

Monmouth.—On 25th ult. a bill to confirm a provisional order of the L.G. Board, relating to Monmouth, was before the House of Commons Committee on Unopposed Bills.

The bill proposed to repeal certain local acts and to confer borrowing powers on the Corporation for the purposes of electric lighting.

Mr. Boyce, of the L.G. Board, called attention to the report of a deputation on the subject in 1907. He stated that in respect to contracts the Corporation had expended £45,000, in respect of which they had not a shred of documentary evidence except a bundle of engineer's certificates. These were merely orders to pay, and some of them were even written on ordinary notepaper. The department consequently refused to sanction further loans, and insisted on a change in the system of audit. He did not suggest fraud of any kind, but he had a great distrust of the system of municipal audit in both small towns and large.

The bill was reported for third reading.

Municipal Telephony.—Hull Telephone committee have decided to extend the telephone to Cherry Burton and Wawne.

Mutual Insurance for Tramways.—A conference of municipal and other tramway authorities was held at Westminster Palace Hotel (London) on Friday last under the presidency of Mr. W. C. Fenton (Sheffield) to consider various proposals put forward by Halifax Corporation for establishing a mutual scheme of insurance against "third party" tramway risks.

Mr. C. F. Spencer (chairman) and Mr. D. Hanson (vice-chairman) of Halifax Tramways committee represented the conveners of the conference and Mr. Spencer explained in detail the methods by which a mutual insurance scheme might be created. After discussion it was agreed, on the motion of Councillor C. E. Perry (Exeter) seconded by Ald. Winter (Birmingham), to appoint a committee to formulate a scheme and submit the same to the authorities represented at the conference at a subsequent meeting.

The committee was constituted as follows: Councillors C. F. Spencer and D. Hanson (Halifax), Mr. G. Proudman (Birkenhead), the Hon. A. Stanley (Lancashire United Tramways), Councillor C. E. Perry (Exeter), Mr. E. Hatton (Newcastle), Ald. Winter (Rotherham), Mr. F. Schofield (Leyton), Mr. H. E. Blain (West Ham), Mr. R. Hilton (Swindon), Mr. C. Barber (Bournemouth) and Ald. Lindsey (Salford). Mr. H. Ashling, deputy town clerk of Halifax, was appointed secretary.

"Patents, Designs and Trade Marks."—We have received from Messrs. Mewburn, Ellis & Pryor, chartered patent agents and consulting engineers, 70-72, Chancery-lane, London, W.C., a pamphlet which gives in a handy form much useful information in regard to the patent law and procedure as amended by the Patents and Designs Act, 1907. A useful digest is given of the terms and conditions upon which patents are granted, the average cost of obtaining patent rights, &c., in the principal British Colonies and foreign countries.

We have also received from the same firm a copy of an interesting Paper on "Book Artistic and Design Copyright," which was read by Mr. G. B. Ellis (the senior partner of the firm) at the Chartered Institute of Patent Agents on March 25 last. Both pamphlets contain much valuable information on the subjects of which they treat.

Portuguese East Africa.—At Lourenço Marques greatly improved wharfage facilities have been completed, and these include the installation of four Temperley transporters and three 3 ton, one 5 ton, one 10 ton and one 20 ton cranes, while additional cranes are shortly to be put up, including one for 50 ton lifts. In addition to the above there are seven new capstans. The whole of the cranes and capstans are worked by electricity. The wharves, which extend for a distance of over 1,000 yds., will accommodate eight large steam vessels; there is storage area of nearly 48,000 sq. yds., and the whole of the wharves, sheds, &c., are lighted by electricity.

Presentations.—At the offices of the City of Birmingham electric supply department on June 25 Mr. W. Y. Anderson, a member of the staff, was presented with a marble clock, two bronzes and a dessert dish on the occasion of his marriage. The presentation was made by the city electrical engineer and manager (Mr. R. A. Chattock). Every member of the staff subscribed towards the cost of the presents.

The Sussex District Staff of the National Telephone Co. have presented a tea and coffee service to the manager, Mr. F. W. Taylor, who has been appointed to Manchester.

Mr. R. R. Fairbairn, the retiring general manager of the Worcester Electric Traction Co. has been the recipient of a presentation from the staff of the company.

Provisional Orders Revocation.—The Board of Trade have revoked the Hemworth and District (1905), the Sandwich, Deal. Walmer and District (1903), the Sittingbourne and Milton (1903), and the Stroud, Nailworth and Dursley (1904) electric lighting orders.

St. Anne's-on-the-Sea.—An inquiry was held last week into the application of the Council for permission to borrow £3,500 for extensions of the electric lighting cables, &c.

Stepney (London).—The Electricity Supply committee has resolved to commence proceedings against the City of London Electric Lighting Co. to restrain the company from continuing the supply of electrical energy within the precincts of the Tower of London, which, it is contended, is outside the company's statutory area of supply and within that of the Borough Council. The officials of H.M. Office of Works, it is stated, gave the company permission to lay and maintain cables within the Tower precincts, but no formal licence was granted by them, as it was not considered to be necessary.

Telegraphists in Persia.—Persia is or has been seething with unrest, and the staff of the Indo-European Telegraph Co. were recently in a position of grave danger in Teheran. According to an advice from the manager the station was under fire during the fighting, and a member of the native staff in the compound was wounded. The staff, needless to say, are reported to have "behaved splendidly."

Tube Make s' Association.—It is reported that the International Tube Makers' Association, which was formed in December last to control the prices and output in England, the United States and Germany, has come to an end.

Walthamstow.—The electrical engineer (Mr. G. R. Spurr) ha been instructed to substitute osram lamps for 32 c.p. lamps on lamp columns in such parts of the district as he considers suitable.

Wimbledon.—Sanction has been received to a further loan of £15,131 for additional generating plant, extensions of mains, &c.

Works Electrification.—We are informed that Basted Paper Mills, Sevenoaks, are being electrified to the specifications of Mr. Frank Broadbent, M.I.E.E. The motors are designed for wide-speed ranges by means of shunt control, and in the case of the large machines (such as calenders) a speed-control system is arranged, so that creeping speeds down to about 10 per cent of the full speed can be obtained for leading in the paper on the lines of rotary printing press control.

Wrexham.—On the recommendation of the Electricity Supply Committee the Council have decided to adopt the following method of charging for current supplied to dwelling houses: An annual charge equivalent to 12½ per cent. of the ratable value of the dwelling house supplied, plus 1¼d. for each unit of electricity used, subject to a discount of ¼d. per unit upon payment of the account within one calendar month after end of quarter to which account relates, the charges including meter rentals.

Sports.—Manchester Corporation tramway employés athletic society held their fifth annual sports on Wednesday and yesterday (Thursday). The various events (including open races) were well filled and well contested. The society numbers now over 2,000 members.

ELECTRICITY SUPPLY AND TRAMWAY ACCOUNTS.

Batley.—The total income of the electricity department for the year ended March 31 was £5,916. 3s. 5d.

Expenses were £3,340. 15s. 5d., gross profit £2,575. 8s. 0½d. Interest absorbed £1,351. 6s. 4d. and sinking fund £1,102 5s 0d., leaving a net profit of £121. 18s. 2d. The total capital expended is £42,871. 2s. 6d., an increase of £793. 15s. 3d. 936,878 units were generated. 499,243 units were sold by contract, 236,239 to private consumers and 44,500 to the public lamps. The total maximum supply demanded was 350 kw. for traction and 19,916 8 c.p. lamps for lighting and power.

Brighton.—In his report on the past year's accounts of the electricity undertaking (abstracted in our last issue, p. 426) the engineer and manager (Mr. John Christie), after referring to the main causes for the deficit of £3,658, deals with the economies effected in the total cost of production by going to Southwick compared with old conditions prevailing at North-road works.

In 1904-5, the last year when the whole output was generated at North road, the works costs were 1·17d., against 0·89d. in 1907-8, and the total costs 1·49d., against 1·26d. per unit, which represented a saving of 0·23d. per unit., or, on the basis of last year's output, £7,670, but as Welsh coal in 1904 was abnormally low (22s. 11d. per ton) and small coal in 1907 was abnormally high (16s. 8¾d.), and as the conditions of operating as regards output and load factor were somewhat different, it was not possible to make an absolutely fair comparison. During the year the net increase in the number of consumers has been 23 only, equivalent to 12,024 8 c.p lamps. That small advance was undoubtedly due to depression of trade. Things, however, now seemed to be improving, and since April 1 they had a net gain of no less than 52 services. At the end of the financial year they had 764 motors, equivalent to 1,423 H.P., connected, an increase of 52 motors and 132 H.P. Of the above, 130 motors, representing 705 H.P., were hired from the Corporation. That portion of their business was most satisfactory, and its benefits were much appreciated by the smaller power users.

Chester. For the year ended March 25 there was a net profit of £1,548. 9s. 9d. on the electricity supply undertaking. £852 19s. 3d. is placed to reserve, £550 applied in payment for renewals and new works, and the balance carried forward.

Coventry.—At the meeting of the City Council on Tuesday it was reported that for the year ended March 31 the total income of the electricity department was £32,281. 3s. 9d.

Expenses were £15,[illegible] 5s. 6d., gross profit £16,385 13s. 5d., and after paying interest (£[illegible] 1s. 3d.), sinking fund (£4,3[illegible] 0s. 10d.) and other items, £4,114 11s. 1d. was placed to reserve, £1,000 voted in relief of rates, £1,1[illegible] 16s. 1d. to meet bank charges, leaving £1,647 4s. 6d. to be carried forward. 5,651,[illegible] units were generated and [illegible] 310 units sold to private consumers and 241,[illegible] supplied to public lamps. The total maximum supply demanded was 2,835 kw. The capital expended is £218,907. 15s. 4d., an increase of £38,947. 9s. 6d. on the year. Total costs per unit were 1·31d., against 1·26d. in 1905-7.

In moving the adoption of the report and accounts the chairman of the Electricity committee (Ald. West) stated that the past year had been the best in the 12 years' history of theunder taking, and that the auditors had given a clean certificate. On account of increase in the price of coal works cost had risen by £2,233, but the selling price was only 1½d. per unit, while the average for Birmingham, Bristol, Leicester, Leeds and Nottingham was 2½d.

Fulham (London).—For the year ended March 31 there was a net profit on the electricity undertaking of £1,408, of which £1,000 is to be transferred to machinery and maintenance reserve account and the balance carried forward.

Glasgow.—The traffic revenue of the tramways department for the year ended May 31 was £907,494 7s. 11d. (10·488d. per car-mile), and the total income was £910,318. 8s. 5d. (10·521d. per car-mile).

Traffic expenses were £256,605. 5s. 11d. (2·956d. per car-mile), general expenses £91,322. 16s. 11d. (1·055d.), general repairs and maintenance £122,650. 0s. 10d. (1·418d.), and power expenses £39,316. 13s. 3d. (0·454d.), making total working expenses £509,894. 16s. 11d. (5·893d.) Including interest on surplus revenue the gross balance is £405,670. 13s. 11d. Interest absorbed £53,152. 0s. 3d. (compared with £63,769. 8s. 5d.), sinking fund £68,804. 5s. 11d. (£49,775. 16s. 6d.), income tax £9,435. 11s. 2d. (£9,931. 19s. 5d.), rental of Govan and Ibrox tramways £5,077. 4s. 7d. (£5,073. 15s. 7d.), proportion of traffic receipts due Paisley District Tramway Co. £4,783. 15s. 5d. (£4,874. 5s.), depreciation £100,415. 15s. 5d. (£35,031. 13s. 7d.), permanent way renewals £88,187. 10s. (£83,376. 14s. 1d.), Parliamentary expenses £2,884. 12s. 1d. (£6,977. 9s. 5d.), and payment to common good £35,000 (£35,000), leaving a net balance of £38,929. 19s. 1d., out of which £4,061. 0s. 10d. has been appropriated to special depreciation (single-deck cars) and £34,868. 18s. 3d. has been placed to general reserve. Last year, under special depreciation, £25,000 was appropriated to buildings and £20,000 to power station plant, and £25,279. 0s. 5d. was carried to general reserve. Working expenses show an increase per car mile of 0·172d., chiefly due to increase in wages to motormen, conductors, car cleaners, &c., price of fuel, &c. The Scotch Office having expressed the view that it is necessary to charge revenue with sinking fund upon the amount expended on capital out of depreciation and renewal fund, the amount of sinking fund chargeable against revenue has been increased by £17,534. 3s. 3d.

The amount expended on capital account during the year was £41,515. 2s. 11d., bringing the total to £3,145,575. 18s. 8d. The balance at credit of depreciation and permanent way renewals is £1,224,051. 8s. 2d. The rate of depreciation on the electrical equipment of the lines has been increased from an average of 3·06 per cent. to 4·28 per cent., and the rate chargeable on the plant in Pinkston power station has been increased from 5 per cent. to 7½ per cent. The amount at credit of general reserve was £70,832. 15s. 9d. The total number of electric cars in stock was 759. The number of passengers carried was 226,948,290.

Sheffield.—The general manager and engineer of the electric supply department (Mr. S. E. Fedden) reports that for the year ended March 25 there was a large increase in the demand for electrical energy for power, which was greater in proportion than the increase in the number of customers. This was due to the introduction of electric driving in large works. Many new connections are traceable to the recommendations of consumers, and canvassing and advertising were producing eminently satisfactory results. Capital expenditure was £893,537, increase £33,295 on the year. Revenue was £78,543. 19s. 10d., and the total cost of generation, distribution, rates, taxes and management was £25,344. 9s. 3d., leaving gross profit £53,190. 10s. 7d. Interest absorbed £27,138. 16s. 10d., and sinking fund £21,255. 8s. 6d, leaving a net surplus of £4,796. 5s. 3d. The accumulated suplus is £21,328. 18s. 4d., from which £5,000 has been transferred to renewals fund, leaving total available surplus £16,328. 18s. 4d. With the report are charts showing the progress of the department for the last four years. As regards light and heat, the increase during the past year was less rapid than in the preceding year, and the small difference is attributed to the introduction of metallic filament lamps, but there has been a continuous and rapid advance in the energy sold for power. There are 3,383 consumers (against 3,207 in the previous year), and the increase in the total connections is due to a combination of moderate advance in lighting, heating and cooking connections, with a rapid advance in the number and size of electric motors taking supply. This year, for the first time, the energy sold for power and the capacity of motors connected exceeds the consumption and connections for light and heat.

Worcester.—The accounts of the electricity undertaking for the past 15 months show a net profit of £1,694. 12s. 11d.

After wiping out the deficit from 1906 (£192. 1s. 7d.), £1,149. 11s. 11d. was applied to meet certain items of capital expenditure, leaving a surplus of £352 19s. 5d. The total receipts were £20,[illegible] 10s. 11d., works costs £8,626 9s. 2d., leaving gross profit £12,144 1s. 9d. The demand for power has been most gratifying, and the city electrical engineer (Mr. Shaw) is of opinion that the financial position will shortly be much improved as soon as the £4,072 loan is paid off in 1910.

TRADE NOTES AND NOTICES.

TENDERS INVITED.

Tenders are invited by *Melbourne* City Council for supply of 600 arc lamp globes. Copies of specification, conditions of contract, and form of tender on application to the agents for the city council, Messrs. McIlwraith, McEacharn & Co., Proprietary, Ltd., Billiter-square-buildings, London, E.C., to whom tenders by noon Monday July 20. See also an advertisement.

London County Council invite tenders for the manufacture and delivery of high-tension main switchgear and low-tension auxiliary switchgear, to be erected at the Council's generating station at East Greenwich. Tenders, on official forms to be obtained from the clerk of the Council (Mr. G. L. Gomme), County Hall, Spring-gardens, S.W., by 11 a.m. on July 7.

London County Council also want tenders by 11 a.m. July 7 for 12 months' supply of coal (about 100,000 tons washed singles) to East Greenwich generating station. Particulars from County Hall, Spring-gardens, S.W.

Dublin Lighting committee invite tenders for supply and erection of sub-station switchboards, transformers and accessories. Tenders to the Chairman of the Lighting committee, 3, Cork-hill, Dublin, by noon July 13.

The Lighting committee of *Dublin* Corporation are also prepared to receive tenders for supply and erection of boiler plant, &c., at Pigeon House generating station. Tenders to the Chairman of the Lighting committee, by noon July 13.

St. Pancras (London) Council invite tenders for additions to their low-tension switchboard at King's-road generating station. Tenders to the town clerk (Mr. C. H. F. Barrett), Town Hall, Pancras-road, N.W., by noon Monday, July 13.

Islington (London) Lighting committee want tenders by noon July 16, for supply and erection of natural draught cooling tower at the electricity works. Specification, &c., from the borough electrical engineer.

Birmingham Tramways committee invite tenders for the erection of a tramway depot. Tenders to the Chairman by noon of July 20.

Halifax Tramways and Electricity committee want tenders by July 7 for supply of pea slack coal for 12 months. Particulars from the General Manager of the Tramways and Electricity Department.

Erith Council want tenders by noon July 6 for 12 months' coal for the electricity works. Forms of tender from the Electrical Engineer.

Gillingham Education committee want tenders by July 17 for wiring three schools.

The Department of Marine, *Ottawa*, Canada, want tenders by Aug. 1 for supply of lighthouse apparatus during one year. Specifications at the office of the High Commissioner, 17, Victoria-street, London, S.W.

TENDERS RECEIVED AND ACCEPTED.

Middlesex County Council received the following tenders for construction of tramway along Friern Barnet-road to New Southgate station and along Woodhouse-road to Great North-road, Finchley, N.:—

Dick, Kerr & Co. (*accepted*)	£31,431	7	10	Holloway & Co. ...	£35,063	15	11
A. Fasey & Son ...	37,161	14	0	Wimpey & Co.......	34,048	17	0
C. Wall	36,364	17	1	J. Mowlem & Co....	33,704	12	6
Law & Co............	35,855	13	10	Thos. Adams	32,668	1	8
				Ford Clift	31,431	7	10

The county engineer's estimate was £33,524. 15s. 9d.

Dartford Council have accepted the following tenders:—

Johnson & Phillips, house service cable, jointing materials and accessories; S. W. Gibson & Co., general stores (£67. 10s. 11d., and repair and maintenance of fire alarms and bells for a year (£16. 10s.).

Wimbledon Council have accepted the tender of E. J. Shaw & Co. for 12 months' supply of arc lamp globes, and that of Charrington, Sells, Dale & Co. for a year's supply of Mapperley small nuts (at 15s. 9d. per ton).

Bolton Electricity committee have accepted the tender of the British Insulated & Helsby Cables for a year's supply of wire for the fittings department, and that of the British Westinghouse Co. for a combination booster.

High Wycombe Education committee have accepted the tender of the local electric light company for wiring the Spring Gardens schools (99 tantalum lamps and 57 switches) at £79. 19s.

Twickenham Council have accepted the tender of the Twickenham & Teddington Electric Light Co. for wiring the town hall.

Stoke-on-Trent Guardians have accepted the tender of Blackburn, Starling & Co. for electric fans for the board room at £14. 10s.

The Postmaster-General of Australia has accepted the tender of the Western Electric Co. (Sydney) for supply and delivery of 20 miles of telephone cable (at £490 per mile), and 150,000 paper sleeves.

The tender of Messrs. Siemens Bros. & Co. for the manufacture and laying of two new cables between Victoria and Tasmania has been accepted by the Federal Government at £47,955.

Oerlikon Turbo-Generators.—We are informed that the two 1,600 kw. three-phase turbo-generators supplied by the Maschinenfabrik Oerlikon to the *Stockholm* Electricity Works have given so great satisfaction, both as regards economy, silent and mechanical running, &c., that a repeat order has been placed with the company for two turbo-generators, each for 6,000 kw. output. The turbines will be built for a steam pressure of 13 k.g. per cm^2 abs., and a vacuum equal to 0·05 kg. abs. The steam will be superheated to from 280-300° C. The electrical figures for the generators are: pressure, 6,000-6,500 volts, periodicity, 25 per second, power factor, 0·85. The speed of the machine will be 750 r.p.m. The Kensington and Notting Hill Electric Lighting Cos. recently ordered from the Oerlikon Co. two 1,600-2,000 kw. three-phase turbo-generators. All the inductor-type generating plant at Wood-lane was built at the Oerlikon works.

BUSINESS NOTICES.

Messrs. Sleigh & Wood have removed to 3, Royal Arcade, Pilgrim-street, Newcastle-on-Tyne.

F. W. Dingwall and G. E. Lewis, who have been associated for 20 and 12 years respectively with the business of Everett & Co., iron, metal and general merchants, 40, Chapel-street, Liverpool, have been admitted into partnership. Mr. W. W. Davies will sign per pro as heretofore, and the style of the firm will remain unaltered.

We learn that Mr. Miles Brown, F.C.I.S., has resigned the secretaryship of the Electric & Ordnance Accessories Co. (Ltd.), of Birmingham, and has returned to his London offices at 1, Lancaster-place, Strand, W.C.

Sale by Tender.—The official liquidators of Harris, Lee & Co. (Ltd.) invite tenders for the purchase, as a going concern, of the con-

cession for the supply of electric current in the town of Bethlehem, Orange River Colony, with the engines, buildings, poles, wires, tools, &c. Tenders to the liquidators, Johannesburg, by noon July 15. Copies of the agreement and all further particulars may be obtained from the agents for the official liquidators, Messrs. Josolyne, Miles & Blow, chartered accountants, 28, King-street, Cheapside, London, E.C.

Plant for Sale.—The South London Electric Supply Corpn. advertise for sale the contents of a private direct current generating station, comprising three 80 kw. and one 50 kw. d c. sets (130 lb. steam, 110 volts.), two B. & W. boilers, with Bennis stokers and motors, two feed pumps, exhaust heater, piping, valves, &c. Can be seen in operation on written application to the manager of the company, 54, Bengeworth-road, Loughborough Junction, S.E.

Agents Wanted.—The Brockie-Pell Arc Lamp Co., Wimbledon, advertises for pushing agents employing travellers to sell arc lamps, transformers, &c.

Patent Development.—The owners of patent No. 15,801 of 1901, relating to holders for electric incandescent lamps, are desirous of arranging either for the granting of licences to work upon royalty or to dispose of their rights. Particulars from Messrs. Allison Bros., 52, Chancery-lane, London, W.C.

Patent Restoration.—Prof. A. Blondel has applied for the restoration of the patent granted to him for "Improvements in or relating to wireless telephony" numbered 15,527, of July 11, 1902, which expired July 11, 1906. Notice of opposition (on Patents Form No. 16) to the Patent Office, London, W.C., by Aug. 24.

CATALOGUES, &c.

Simplex Heating and Cooking.—A complete catalogue of the specialities of Simplex Conduits (Ltd.) in heating and cooking apparatus, electric fans, lamps, fittings, &c., has come to hand. Its contents cover a very wide field, and electrical contractors will find the list a very useful addition to their stock of trade literature. As a printer's production and the work of an energetic publicity manager the catalogue is above praise.

Wooden Poles.—We have received from Richard Wade, Sons & Co., of Hull, a copy of their revised catalogue of wooden poles, containing the results of severe tests tabulated for all purposes. The catalogue has been considerably enlarged and should be in the hands of all engineers interested in electric power transmission, telegraph and telephone work and overhead construction generally. Messrs. Wade are sending copies free of charge to regular consumers only, the price per copy to others being 10s. 6d.

Storage Batteries.—The Hart Accumulator Co. have ready a list giving prices and particulars of their special batteries for 25-volt high-efficiency metallic filament lamps. The standard sizes that can be supplied from stock are listed, but the company, who are making a specialty of these batteries will quote for other sizes.

Fans and Motors.—Messrs. Hogan & Wardrop, Charing Cross road, London, W.C., send us their latest list, which deals with every class of electric fan, and also a special range of small motors. The latter are listed for direct currents, and range from $\frac{1}{30}$ H.P. to $\frac{1}{2}$ H.P. series wound, and from $\frac{1}{30}$ H.P. to $\frac{1}{2}$ H.P. shunt wound. The line of electric fans includes a number of a.c. designs, both for disc and porthole use.

Tramcar Trucks.—The Warner Engineering Co. are sending out a brochure on the subject of their non-parallel axle truck for railways, tramcars and mining work. The main particulars of this truck were given in our issue of Jan. 17, 1907, but the leaflet will be found to generally epitomise the chief details of this interesting device.

Cooling Towers.—The Worthington Pump Co.'s name has long been celebrated in connection with pumping work. We have just received a catalogue of their patent rectangular and circular cooling towers. The catalogue is illustrated with some interesting photographs, showing in detail the various plants installed by the company. There is no doubt the methods employed in the erection of these towers has proved successful and the company are justified in claiming the advantages they do for them. Anyone interested in the subject should write for a catalogue.

Renewable Valves.—The problem of renewable valve setting has often been tackled by engineers. Messrs. James Baldwin & Co., Keighley, have sent us a copy of their latest catalogue, in which reference is made to "The Betall" renewable stop valve specially made for superheated and steam pressures up to 800 lb. per square inch. The test pressure applied is 1,000 lb. per square inch, and the valve is made in a variety of sizes. Particulars are also given of Baldwin's tube floats for use with high steam and low water valves or alarms. The list is full of interesting information which engineers should find valuable for reference.

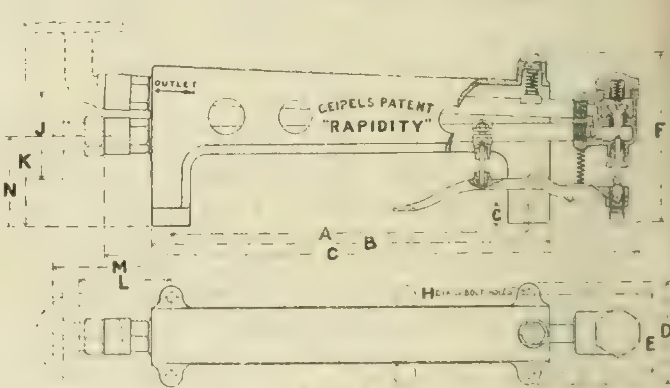
A.E.G. Pamphlets.—The foreign department of the A.E.G., Berlin, is issuing pamphlets on c.c. meters, switch panels, lightning arresters, h.t. oil switches and fuses and accessories. These are thumb indexed and holed for filing in the company's standard file.

Motors.—We have received from the Union Electric Co., Park-street, Southwark, S.E., a copy of list No. 1,012, which gives illustrated particulars and prices of Union motors, "Fortiter" motor starters, &c. The list is interesting as giving for the range and horse powers that it covers a very large number of alternative speeds, while it is so arranged as to show in a perfectly clear manner all points of technical detail, and dimensional drawings are given, so that there should be no delay in the preparation of foundations for the machines which are stocked, completely finished and tested in all current sizes. At the end of the list particulars are included of air cooled as well as oil-cooled motor starters with no voltage and overload release devices.

Tubes and Poles.—We have received from John Spencer (Ltd.), Wednesbury and London, a copy of the 24th edition of their catalogue and price list of iron and steel tubes and poles. A great variety of tubes, pipes, bends, valves and fittings for steam and hydraulic purposes, wire and cable tubes, boiler tubes and accessories, high-pressure steam mains, stocks and dies, screwing machines, tools, &c., is listed, as well as overhead electric light and tramway, telegraph and telephone poles, &c.

Transformers.—The Brockie-Pell Arc Lamp Co., Wimbledon, S.W., are issuing a price list of transformers for ordinary purposes, arc-lamp work and for use with metallic filament lamps. A very high efficiency is claimed for these transformers, and an extra high efficiency can be obtained at slightly extra cost. For the convenience of customers, diagrams of connections are given at the end of the list. The transformer branch is an additional department of the Brockie-Pell arc lamp business.

Steam Traps.—A new type of patent rapidity type is described in a circular just issued by Wm. Geipel & Co. The accompanying illustration shows details of the construction of this trap.



DETAILS OF CONSTRUCTION OF GEIPEL'S PATENT "RAPIDITY" TRAP.

It will be seen that the brass tube, which constitutes the inlet and should be connected to the vessel to be drained, is at the bottom of the trap. The iron tube, which constitutes the outlet for the discharge, is at the top as in the ordinary Geipel trap. The valve is held normally on its seat by the steam pressure combined with the pressure of a light spring. When the trap is cold or full of water, the valve is depressed from its seat by the valve spindle, which abuts against the end of the lever. When steam enters the brass tube, the latter expands and moves the valve casing upwards. The steam pressure and light spring then close and hold the valve tight until water has again entered the brass tube and cooled it, upon which the brass tube contracts and moves the valve casing downwards until the valve spindle impinges on the valve and forces it open. As soon as the valve is open the rush of water, so to speak, forces or wedges the valve upwards, thus making the large opening which gives the rapid discharge. The valve is separate from the valve spindle and is, therefore, not held fast by the friction of the stuffing box; further, being provided with veins, it is caused to rotate whilst discharging, and consequently to grind itself in at each discharge so that the seat is kept in good order. There is no dribbling, but as soon as the trap commences to discharge the valve is forced well open; a sharp blow-through then occurs until all water is discharged, when the trap is as suddenly shut. The trap can be blown off by depressing the lever by hand or by foot. The ordinary rapidity type of trap, adjusted, say, to close at 60 lb., will work up to 150 lb., or a trap adjusted at 90 lb. will work up to 180 lb.

BANKRUPTCIES, LIQUIDATIONS, &c.

In the bankruptcy of Thos. Arthur Evans (trading as T. Arthur Evans & Co.), electrical and mechanical engineer, 14, Heathfield-street, Swansea, the first meeting of creditors will take place on July 9 at 31, Alexandra road, and the public examination on July 31, at the Town Hall, Swansea

Meetings will be held on July 30 at Salisbury House, London Wall, E.C., to receive accounts of the winding up of the Totnes Elec-

tricity Supply Co. (Ltd.) and the Chelmsford Electric Lighting Co. (Ltd.).

A meeting will be held on July 28 at Orient House, New Broad-street, London, E.C., to receive an account of the winding up of the "Z" Electric Lamp Synd. (Ltd.).

Sanfil Limited is being wound up voluntarily. Mr. F. S. Tomkins, Watergate House, Adelphi, London, W.C., is liquidator.

COMPANIES' MEETINGS AND REPORTS.

British Electric Traction Co. (Ltd.)

We referred briefly last week to the meeting of the share and debenture holders of this company on Thursday last week. We now give a somewhat extended notice of the proceedings.

Sir Charles Rivers Wilson, G.C.M.G., C.B., occupied the chair, and the secretary (Mr. C. H. Dade) having read the notice convening the meeting and the report of the auditors,

The CHAIRMAN said: In the directors' opinion the fall in the market value of the company's shares and debentures during the past year is much greater than the circumstances call for, and the best way to remove the unwarranted impression which appears to prevail to a certain extent that the general position is not satisfactory, is to give every possible information concerning not only the affairs of this company, but also of its associated companies. The amount of information given in the report which you have all received is quite unusual, and while we appreciate that, in laying bare the whole situation to the shareholders, there is a danger of giving information to those who may use it to the detriment of the company, the directors consider this risk is far outweighed by the advantage of being able to show that the company is in a strong and sound financial position. Although the business done in the past has yielded a moderate reward for the inception and creation of the various undertakings, owing to various causes these undertakings are working at less profit than we had every reason to think would be the case. The subscribed share and debenture capital of our company is £4,949,969, the amount due to creditors is only £12,570, and the debenture interest accrued at the date of the balance-sheet was £46,623, so that, apart from reserve for depreciation and the balance to net revenue account, the total on the debit side is £5,009,165. To meet this there are assets appearing on the credit side amounting to £5,658,653. Of this large amount, intangible items like expenditure on Acts of Parliament and other rights and powers, which may or may not be realised, and goodwill, represent only £18,528, so that there is a surplus of assets of about £631,000. The important question for the shareholders is, therefore, whether the depreciation of the securities held by the company is greater or less than the surplus. The difficulties of making an accurate valuation of the numerous investments and undertakings controlled by this company are so great that the directors are unable to attempt it. The fundamental difficulty is to decide on any general principle on which such a valuation could be made. Several of the undertakings are not yet fully developed, and the circumstances surrounding others are not sufficiently defined to admit of accurate estimates of their values. There can, however, be no doubt that the estimated depreciation of the company's debentures and shares has been exaggerated.

As to the past year's business, the net profit amounts to £203,194, and after deducting interest on first and second debenture stocks and adding balance forward (£13,115) there remains £118,824. The directors have discussed how this balance of profit should be applied, and as a result of earnest consideration they make a unanimous recommendation that £35,000 be added to general reserve (raising this to £604,420), that £35,393 be carried forward, and that £48,431 be applied to payment of a dividend on the preference shares equal to 3 per cent. for the year. The directors regret the dividend they recommend is not larger, but they have come to the conclusion that the important thing at the present juncture is to reassure the shareholders that the directors are not paying dividends at the expense of the future stability of the company. The dividend on the preference shares is cumulative, and if, as a result of the policy of the board, the profits can be increased, the sacrifice which the shareholders are asked to make may be regarded as only temporary. We have very small liabilities or commitments. At 31st March we had £200,000 Consols, and since we have purchased a further £50,000. We had at the same date about £50,000 in cash at the bankers, and close on £400,000 in debenture stocks of electrical companies, besides several millions of other securities, and, as I have just said, but practically no indebtedness. There are very few companies in England that can show an equally strong position. We have now been working for about thirteen years, and during that time we have established a large number of undertakings which have proved of great advantage to the community. In the earlier years of its career the company was able to make profits on the promotion of these enterprises, and as the officers of the company were never wanting in energy, a large business was done in proportion to the capital employed, and satisfactory, though moderate, dividends were paid upon the capital in the full expectation that when the promotion of undertakings diminished the profits made on the working of them would replace the promotion profits; it is in this respect that we have been to some extent disappointed. The undertakings have been well established, they have not been over-capitalised, but so far they do not yield the anticipated profits. Our undertakings are not different in this respect from other electrical enterprises in this country, as is conclusively shown by the Board of Trade returns. The reason we do not make on the working of these undertakings the profits which we anticipated, and which we consider we are entitled to make, is not to be found from examination of the internal affairs of the companies, but from a consideration of their environment, which is to a large extent determined by legislative and municipal conditions. Electrical enterprises in this country have been very greatly influenced by political considerations. Electric traction was not generally adopted in this country for nearly 10 years after electric tramways had been demonstrated as sound commercial undertakings in America and on the Continent, the reason being that it was impossible to embark capital under the terms of the original Tramways Act. But at the time this company was started the Light Railways Act had just been passed, which gave every promise that tramway undertakers would, in the future, be treated with less hardship than under the old Tramways Act. The Light Railways Act did not give the local authorities any right of veto, and contained no purchase clause. This and the expressions of opinions by representative legislators, added to the generally favourable feeling of the public, encouraged capitalists to enter upon electric traction enterprises. Thereupon this company acquired control of a number of more or less derelict horse and steam tramways with a view to extending them and converting them to electric traction. The immediate result of the company's efforts was to arouse the jealousy of the local authorities, who were urged, by an agitation in favour of municipal socialism, to enter upon the business themselves. Where, by reason of limitation of boundaries and other circumstances, the said local authorities were unable to do the business themselves, they considered the next best thing was to thwart and harass private enterprise, with the result that many of the undertakings we had in hand were broken up into sections, and these mutilated undertakings were unnecessarily bled and injured. Owing to the great political power possessed by local authorities, Parliament yielded to the clamour for municipal trading, and we have suffered. Nor can it fairly be said that the industry has received the protection and encouragement it might reasonably have expected in official quarters. Add to this the constant demands by the public, supported in large measure by the local authorities, for increased facilities and reduced fares, and it is not difficult to see why industrial undertakings such as ours, established on the basis of making a reasonable commercial profit, do not yield an adequate return. Capital expenditure has in some cases been unnecessarily increased, working expenses are in many cases higher than they would be under ordinary industrial conditions, and the fares are much too low, having due regard to the facilities and services given and the capital embarked. All these factors tell on profits, and instead of our investments making an average return of the estimated 6 per cent. per annum, we find that out of about £5,000,000 of investments $3\frac{1}{4}$ millions earn only $4\frac{3}{4}$ per cent., while $1\frac{1}{2}$ millions do not yield any return at all—or an all-round average of rather over 3 per cent. In speaking of our investments in this way, I would point out that I allude, not to separate undertakings, but to the separate classes of investments of the various companies. It is not to be assumed that any improvement in our net profits is entirely dependent upon the amelioration of the legislative and municipal conditions under which we are working. We have the financial and other resources for initiating new electrical enterprises, and there is plenty of scope in this country for further development of the electrical industries, but we are deterred from embarking upon them from fear that we may not receive better treatment from Parliament and local authorities than we have received in the past. We are, consequently, giving our consideration to various foreign and colonial proposals which have been submitted to us. But foreign business requires much closer study, negotiations are carried on under greater difficulties and the responsibility is greater, even though the prospective profits may be larger.

As to the manufacturing branch of the electrical business. We have received no dividend on our shares in the Brush Electrical Engineering Co. during the past two years, and our investment is over £200,000 in that company. There is scarcely an electrical manufacturing company in this country earning an adequate profit. It is difficult to explain all the reasons which have brought about this lamentable state of things. One reason, no doubt, is that the economic conditions of this country are and have been for some years dominated by a general desire or necessity for undue cheapness of all commodities and services, and the condition of the electrical industry in this country affords a very good example of what this economic policy is costing the country. Still, in spite of the fact that prices are depressed and unremunerative, owing to the competition of foreign countries which close their own markets against us, but which are able to compete successfully in other markets by reason of their own large and profitable home trade, our manufacturers, with a courage and tenacity most creditable to them, do not abandon the struggle, but work on with the smallest margin of profit—and even at a loss—in the hope of better times. This is the case with the Brush Company. I believe, however, public opinion is beginning to take an interest in the problems with which we have to deal, and that a certain sympathy for our sorely tried industry is growing up alongside a feeling that it has not had a fair play.

The chairman then proposed the adoption of the report and accounts, and

Mr. H. O. ARNOLD-FORSTER, in seconding the resolution, said: We have in the British Electric Traction Co. a genuine business concern, operating on a vast scale, and dealing in the most direct fashion with one of the vital industries of this country. The business is real; taken as a whole, the business is growing, and is undoubtedly destined to grow (applause). This great business is conducted with the highest profes-

sional skill, and with the aid of the most skilful experienced technical advisers. During the past year much has been done by the creation of the British Electric Traction Federation to make the working of the various subsidiary companies economical and efficient, to prevent overlapping, and to enable the companies to make their purchases on the best terms and under the most advantageous conditions. But, while the business is sound and genuine, it is being conducted under great and growing difficulties. In the first place, there is the lamentable and disastrous legislation which Parliament imposed upon all electrical enterprises when the industry was, so to speak, in its infancy. It is difficult to overrate the mischief which has been done by these crude and ill-considered Acts of Parliament, which seem to have been designed for the sole purpose of crippling industry. Then, from year to year, we have had to meet in growing measure the competition of rate-supported enterprises (hear, hear). Competition of this kind, in which one of the competitors in the long run is supported by unlimited contributions from the public purse, is not to the advantage of private enterprise, and the forcing down of fares to an unremunerative figure—a practice which can be adopted at will by a public body—cannot be followed without very serious consequences by a public company (hear, hear). I am glad to think, however, that on this question of fares we seem to be approaching a more rational period, and that there is a tendency on the part of sensible men to realise and give effect to the rather obvious principle that to conduct business at a loss is an absurdity, and that where fares have been cut down to a point to which every journey involves a loss, the time has come for readjusting those fares (applause). This condition of affairs has natural and inevitable consequences. Not only is the revenue earning power of the company, or rather the power of earning profits, but the financial position is affected. It is very difficult to put a precise value upon the vast number of securities held by the company. Many of them are not quoted, and cannot be quoted. Some of them represent concerns which, being in their infancy, are naturally not remunerative, but are, nevertheless, fully equal to the value at which they stand in the books. Others, and much older concerns, there are whose securities undoubtedly have greatly depreciated. In view of these facts only one policy is possible, a policy which shall have for its principal object the restoration of the full credit of the company. It has therefore been decided to hold over the payment of the interim dividend on the preference shares, and to reduce the payment for the year from 6 to 3 per cent. This enables us to carry forward £35,000 and to add £35,000 to the reserve. Dividends ought not to be withheld altogether unless their retention is absolutely necessary to the safety of the company. I do not think that necessity exists at the present moment, so far as we are concerned, provided it be clearly understood that, until the situation is re-established, the policy which has now been inaugurated must be continued, and may have to be extended. You will find in the body of the report the clearest evidence that the directors have realised what are the difficulties they have to face, and the report of the auditor confirms and strengthens the conclusions arrived at by the board. It is absolutely true, as stated in the report, that what may be called the purely financial position of the company is very strong. Its liabilities are trifling; its revenues large; its liquid assets ample and available. The last year has been, as you know, a very bad one for new enterprises. I do not think those conditions will continue. We are well qualified to take advantage of such opportunities as occur. We have command of the almost unrivalled experience and professional and technical accomplishments of our managing directors and staff. We can lay our hands on money which only awaits opportunity for profitable use. I trust, therefore, that the shareholders will give their full support to the policy which has been outlined by the chairman on behalf of the board.

Mr. CROFT said he thought the greater number of the shareholders would endorse the policy foreshadowed. The credit of the company has been to some extent depreciated, owing to a variety of circumstances, and there was need for restoring this credit.

Mr. LEA SMITH said he would have liked the question of fares to have been referred to. It was ridiculous that they should be carrying people in some places at unremunerative fares.

Mr. PARKER said he thought the chairman was justified in describing the financial position of the company as a strong one, but there was one serious grumble he wished to make. Reference had been made to the price of the company's securities—the present prices. He believed that was due to the fact that there was not yet complete confidence in the financial policy of the company from the point of view of outsiders. People who come in and took an interest in the company wanted to be convinced not only of the assets, but of the financial policy. This company was now really an investment company. It was said that they could not value their assets because they are in a transition state, some of them. But surely there was some method by which it could be done. Electrical investments were made on a 6 per cent. basis, and the suggestion he made was that the board should consider what the depreciation of their investments was at the present moment and try to deal with it in some way. He suggested it should be done by a reconstruction of the share capital on terms which would be equitable to both classes of shareholders.

A SHAREHOLDER thought it was premature to talk about reconstruction of capital. Their assets were improving, and they had many assets which, standing in our books at a million and a half, would show a good return in the future.

The CHAIRMAN, in reply, said we greatly appreciate the kindly spirit in which shareholders present have approached the consideration of our position. There have been greater disappointments, no doubt, and no one has been more disappointed than the directors themselves; but we have told you how we stand and what our position is, what our hopes and aspirations are. We have worked very hard in the past, and will continue to do so, and we shall exercise such judgment and intelligence as we can in the interests of the company. Mr. Parker has advocated the unification of our shares. That, without being exactly a policy of despair, appears to me entirely to prejudge the position and future of the company. We are continually writing down. We have taken, as you know, money this year for writing down considerably the deficiency in the value of our assets. We shall continue that policy, and I do not consider that the situation is at all so disheartening as might be inferred from a practical reconstruction of the company. It would have the worst possible effect on our credit, and I do not think such a step is warranted by the circumstances of the case (hear, hear). As to fares. This is a matter which is constantly before us. The fact is that changes can only be introduced very cautiously, very prudently, particularly in places where there is not much opposition, and where upon several occasions we have been practically boycotted when we have made attempts to raise the fares. This is a matter requiring very delicate handling. Another improvement we are gradually introducing, and from which I expect great things, is the transfer of parcels.

The resolution was then carried unanimously.

Globe Telegraph and Trust Co. (Ltd.)

The 35th ordinary general meeting was held on Tuesday, under the presidency of the Marquis of TWEEDDALE, K.T.

The SECRETARY (Mr. Sidney Collett) read the notice convening the meeting and the auditors' report.

The CHAIRMAN said: It would be a little misleading to compare the actual receipts of this year with those of last, because, as you will remember, I explained our accounts on that occasion covered a period of 13 months. Our receipts for the past financial year, after deducting expenses, amounted to £210,295. Three quarterly interim dividends of 2s. each have already been paid on the ordinary shares and the fixed dividends on the 6 per cent. preference shares. These dividends have absorbed £131,770, and we now recommend payment of a final dividend on the ordinary shares of 5s. 9d. per share net, making a total for the year of 5⅝ per cent., the largest distribution made in any year to our ordinary shareholders. This, with the final payment of 3s. on the preference shares, absorbs £77,885, leaving £27,206 to be carried forward. It will be seen from the accounts that we have received improved dividends from some of the companies in which our capital is invested, and in only one case a diminished dividend. We have received from our investment in the Anglo-American Telegraph Co. the same rate of dividend as formerly; from the Central and South American Telegraph Co. we have received this year 912 bonus shares, which has increased our income by over £1,000; from the Cuba Submarine Telegraph Co. we have received an increased dividend; from the Eastern and the Indo-European Companies the same rate of dividend as in former years; and from the Telegraph Construction and Maintenance Co. we have received an increased dividend representing £1,100 on our investment. From the Western Union Telegraph Co., however, we have to report a decrease in the dividend received, due, no doubt, to the effects of the recent telegraph strike as well as to the depression in business which still prevails in the United States. I now move the adoption of the report and accounts for the year to May 31st and the declaration of the dividends therein set out.

Sir JAMES PENDER, Bart., seconded the motion, which was carried unanimously.

The retiring director, Sir John Wolfe Barry, K.C.B., was then re-elected, as were the retiring auditors, Messrs. Deloitte, Plender, Griffiths & Co. and Mr. John Newton.

A cordial vote of thanks to the Chairman and Directors was carried unanimously, and the proceedings terminated.

Buenos Ayres Grand National Tramways Co. (Ltd.)

The annual general meeting was held on Friday last. Sir IRVING COURTENAY presided.

Mr. FORTESCUE THURSBY (the secretary) read the notice convening the meeting, and also the report of the auditors.

The CHAIRMAN then said: Gentlemen, I think you will consider the accounts for the year, under the transition circumstances that prevail to be satisfactory. Share and loan capital remains the same as last year, except that the conversion stock has been increased by £100,000, thus completing the issue of the £600,000 authorised for electrification purposes under the resolutions of March, 1904. The proceeds of this stock and the £300,000 conversion stock of the Buenos Ayres New Tramways Co., along with the additional amount of £109,250 on loan account, have been expended on the electrification works of the joint system. During the past year the sum of £207,577 has been spent on construction and equipment in Buenos Ayres and London. This amount is about £59,000 short of the previous year's expenditure, as owing to the stringency experienced in the money market a few months ago it was deemed expedient to temporarily curtail the construction works. Taking now the revenue statement, the results show a very marked improvement upon those of the previous year. The traffics include an amount of £2,100, representing the receipts from a small proportion of horse traffic, during, say, the two months April and May, before its final suppression, but as the sum was rather more than counterbalanced by the maintenance of horses and harness expenses, &c., amounting to £3,[illegible], for comparative purposes we may fairly take the figures appearing in the revenue account as representing the result of the first year's working under electric traction. The gross receipts of the joint system for the year amount to £386,969, an increase of £50,713 over last year's figures, or

13·58 per cent. During the last 12 months 44,380,221 passengers were carried, being 8,505,319 more than during 1906-7, and the car mileage amounted to 7,767,008 miles, an increase of 752,009 miles, or, say, 10·72 per cent. Taking the working expenses, exclusive of the small amount of coal and cargo traffic, the increase is £23,520, or 10·77 per cent. over the previous year. Putting the items alongside the figures for 1906-7 you will observe that the maintenance cost of buildings, plant, permanent way and cars is about the same as last year, and that consequent on the suppression of the horse traffic the items representing the maintenance of horses and harness have dropped from £18,797 to £3,267. The principal increases are: General traffic expenses and wages, &c., of £18,879. A large proportion of this amount is accounted for by the increased wages bill. The taxes and official imposts are £4,737 more. The principal item here is the municipal 6 per cent. tax on the gross receipts, the amount of which will, of course, fluctuate with the traffics. As to the purchase of current, the increase has been £12,790, but against this has to be put the increase of 10·72 per cent. in the car mileage. The percentage of working expenses to the gross receipts is 63·55 per cent. Last year the figures were 68·60, a reduction of, say, 5 per cent., which is extremely satisfactory. This Company's proportion of the pooled receipts of the joint system for the year amounts to £91,447, as compared with £68,406 for the preceding 12 months, an increase of 33·68 per cent. The total number of miles constructed for electric traction to the end of March, 1908, is 86·82 miles. There are still to be constructed 24·96 miles, making 111·78 miles. Of the above 86·82 there are 4·97 miles not yet operated. As regards the future, I regret that I must sound a note of warning against exaggerated expectations. The traffics of the system as a whole continue to show increases month by month as compared with the previous year, but a new and active competition on the part of a rival line is affecting certain of our services. The effect of this competition is that the services show a decrease as compared with last year, and consequently the growth of traffic on the system as a whole is not so rapid as we had every reason to expect. It is, however, too soon to form a definite idea of what the effect will be upon the current financial year, but I fear that it will tend to postpone the time when we shall be in a position to pay a dividend on the ordinary shares. I now move the adoption of the report and accounts and the payment of the dividend set out therein.

Dr. W. H. HARRIS seconded the motion, which was carried unanimously.

The retiring directors and auditors were then re-elected, and the proceedings terminated with a vote of thanks to the directors and management.

India Rubber, Gutta Percha & Telegraph Works Co. (Ltd.)

The half-yearly general meeting was held on Tuesday. Major DARWIN presided.

The SECRETARY (Mr. A. P. Crouch) read the notice calling the meeting.

The CHAIRMAN, after feelingly referring to the death of the company's legal adviser, Mr. Stirling, which took place in April, said: Our late chairman, Mr. Marsham, is unable to be present to-day, on account, I fear, of severe illness. This is not an ordinary meeting, when your board puts before you the report and accounts for the 12 months' trading, but is the half-yearly assembly, when a few remarks are made from the chair on the business done or in prospect, and any other statement the board may desire to make to the shareholders. The only business to be transacted is to obtain your sanction to the payment of the interim dividend which the board may recommend. The proposal on this occasion is the same as that which has been made for very many, probably 30, years. The board has no hesitation in making this recommendation. Although we have no definite knowledge on which to base our opinion, because no stock is taken at this period of the year, there is sufficient general information at our disposal to enable us, with our experience, to judge the dividend proposed has more than been earned and can be paid. I am glad to say that the high prices of raw material, to which I have referred on many occasions during the last four or five years, have shown decided symptoms of a permanent lowering, although since the beginning of our financial year there have been ups and downs, and even at the present moment a slight stiffening is taking place. Competition in our different lines does not show much sign of being less keen, although there has been some indication of a tendency in this direction. I now move that the distribution of an interim dividend of $2\frac{1}{2}$ per cent. or 5s. per share (tax free), on the 2nd prox. be approved.

Lieut.-Col. JARVIS seconded the motion, which was carried nem. con.

At an extraordinary meeting which followed,

The CHAIRMAN, in proposing the adoption of a resolution increasing the capital of the company by £250,000 as and when the directors may decide, said the company's business had increased tenfold, and the additional capital was required to enable them to cope with the increased demand for the company's manufactures. It was the present intention of the board that the ordinary shareholder shall have the option of taking up or renouncing his pro rata share of the issue which would be made if the shareholders approved the proposed increase.

Mr. MOORE seconded the motion, which was carried by the necessary two-thirds majority and the proceedings terminated.

CHADBURN'S (SHIP) TELEGRAPH CO. (LTD.)—For the year ended March 31 the balance at credit of profit and loss was £10,934. 6s. 2d. After payment of certain charges for management, depreciation, &c., £10,086. 14s. 9d. remains. The preference dividend and an interim dividend of 8 per cent. on the ordinary stock have been paid, leaving £4,086. 14s. 9d. The directors now propose a final dividend on the ordinary shares at the rate of 8 per cent. (less tax) for the half-year to March 31, making 8 per cent. for the year. £1,686. 14s. 9d. is carried forward. Whilst the volume of work executed during the year has been in excess of that of any similar period, profits have not been as satisfactory, owing to rise in prices of material, the unremunerative character of certain classes of the business, &c.

INDIAN ELECTRIC SUPPLY & TRACTION CO. (LTD.)—The report for 1907 states that capital expenditure has been in excess of the estimates, partly owing to the plague, which delayed completion of the works, and partly because revenue has not come in to meet the debenture interest so soon as was expected. It will be necessary in the early part of next year to raise further capital to pay off indebtedness incurred and to provide for extensions of mains. Cawnpore is the first city in the interior of India in which a tramway and electric lighting have been installed, and it is apparent that the natives are not so ready as those of the Presidency towns to make use of the facilities offered. Nevertheless there is an increasing desire on their part to take current for both lighting and power. The result of the first half-year's working has been a loss of £6,681. 16s. 3d., including payment of interest on construction debenture stock amounting to £3,750. The working loss is mainly due to the tramway, the returns from which have fallen far short of expectations, partly due to the drought, which occasioned a se ere famine, and depressed trade in the United Provinces. The supply side of the undertaking is more promising. At present the equivalent of over 8,000 8 c.p. lamps is connected to the mains, and this number is in course of being considerably augmented. Several of the principal streets in the city and one large grain market have recently been lighted from the company's mains, and the native shopkeepers are beginning to take an interest in both lighting and fans.

JOHNSON-LUNDELL ELECTRIC TRACTION CO. (LTD.)—At a meeting on Tuesday it was reported that for the 21 months to May 30 there was a balance at debit of profit and loss account of £55,855. The directors' report states that the funds are being conserved in order to keep alive the patents until a more favourable time, and that arrangements are being made with the principal promoters whereby effect will be given to their offer to make good to the shareholders the profit made by them in the promotion. The meeting was adjourned to enable these arrangements to be completed.

NEW GENERAL TRACTION CO. (LTD.)—At the meeting on Tuesday the directors reported that for the year ended March 31 the revenue was £18,892. 13s., against £14,767. 18s. 10d. in the previous year. General expenses were £2,508. 19s. 1d., against £2,482. 18s. 7d. in 1907. After paying debenture interest (£13,200), and interest on loans, &c. £3,292.13s.10d., against £1,836.5s. 5d.) there was a profit of £264 9s.8d., reducing the balance loss previously shown to £26,519.19s.4d. The Coventry system had shown satisfactory results, enabling that company, besides paying an increased dividend, to reduce its indebtedness to this company by £4,000. Norwich tramway traffic returns were disappointing. Returns from the Douglas property have again been satisfactory. The chairman (Baron Emile d'Erlanger) said there had been an increase of about £4,000 in receipts from the securities held in subsidiary companies. They had made a profit of £913 by way of commission on the new contract at Coventry. They were now really a trust company holding securities in different undertakings—the Coventry, the Norwich, the Douglas Southern Electric Tramways and the Philadelphia Street Railway undertaking. The Coventry Co. had given every satisfaction during the last two years, and had not only shown a large increase in receipts, but had yielded a very handsome return upon the capital invested. He was unable to say as much in regard to Norwich, which were very disappointing in their results. Instead of showing an improvement in receipts they from year to year showed a diminution, and all that they could do was to cut down expenses to the lowest possible point. The Douglas Southern was giving a steady return, and the Philadelphia undertaking, in which they had such a large sum monetary at stake, was fulfilling all its obligations under the lease.

OSWESTRY ELECTRIC LIGHTING & POWER CO. (LTD.)—At the recent meeting the directors reported that the available balance was £537, and recommended a dividend at the rate of 4 per cent. for the year. The question of audit was deferred, the auditor (Mr. Brayne) having tendered his resignation and suggested that as the accounts were also audited by the Board of Trade auditor it would mean a saving if they decided to accept the Board of Trade certificate.

J. G. WHITE & CO. (LTD.)—At the meeting on Monday the chairman (Mr. J. G. White) said that congratulations were offered to shareholders upon what had proved another successful year's trading. The difficulties arising from stringencies in the money and securities markets, and the severe competition existing in all branches of trade, had been very great; but those difficulties had been satisfactorily met. Investments aggregated a higher total than last year, owing to additional securities having been acquired; but since the date of the balance-sheet the figure had been reduced by sales at a substantial profit of securities valued in the balance-sheet at £24,752. In consequence, the present book value of securities owned was less than the figures shown in last year's balance-sheet. After deducting dividends and bonus paid and recommended in the report, amounting to 8 per cent. on all classes of shares for the year, the company's reserve fund would stand at £80,000, in addition to further accumulated profits

carried forward of £16,249, or total accumulated profits of £96,249. The directors believed that the investments had been valued on a thoroughly conservative basis. They would not be willing to sell the entire lot of securities owned by the company at their present book value. It was also believed that ample provision had been made for bad debts or possible contingent liabilities. Careful attention was given to the development of the properties in which the company was interested, with the general result that the average yield in interest and dividends during the year was equal to $6\frac{1}{4}$ per cent. on the average valuation of the securities owned. The whole of the securities were unpledged, and would be available for borrowing purposes should the needs of the company at any time require it. Ample provision had been made for depreciation, and the fourth item on the list of assets was conservative, plant and tools appearing at only about 25 per cent. of their cost. The item "purchase of business" remained as in former years, but that was less than half the reserve fund and profits carried forward after providing the year's dividends. Regarding the future, he was pleased to be able to say that the business in hand was sufficient to ensure thoroughly satisfactory profits for the current year, and negotiations for other important business were progressing favourably. The report and accounts for the year to Feb. 29, 1908, were adopted; a dividend at the rate of 6 per cent. per annum on the cumulative preferred shares for the half-year to Feb. 29, and a dividend of 6 per cent. per annum on the ordinary shares for the year to Feb. 29, 1908, together with a bonus of 2 per cent., were declared, making a distribution of 8 per cent. for the year.

NEW COMPANIES, STATUTORY RETURNS, MORTGAGES AND CHARGES.

NEW COMPANIES.

BAUXITE REFINING CO. (LTD.) (98,531.)—Reg. June 27, capital £100,000 in £1 shares, to carry on the business of manufacturers of and dealers in alumina or other materials or ingredients used in the production of aluminium, owners of mines and minerals, winners and workers of mineral substances, &c. First directors, Hon. Sir James Sivewright, K.C.M.G., J. E. Davidson and R. S. Portheim. Reg. office, Pandon-building, Newcastle-on-Tyne.

BROWN & PARSONS (LTD.) (98,501.)—Reg. June 25, capital £1,000 in £1 shares, to acquire business carried on as Brown & Parsons, and to carry on the business of electrical and mechanical engineers, manufacturers of electrical or other machinery, accessories and instuments, &c. First directors, F. E. Brown (managing) and two others to be appointed by the subscribers.

CHISHOLM, GRAY & CO. (LTD.) (98,465.)—Reg. June 23, capital £7,000 in £1 shares, to acquire the business carried on as the Chisholm Mfg. Co., to acquire the patents granted to A. Cripwell for improvements in electric switches, portière rods, &c., to adopt certain agreements and to carry on the business of brassfounders, electricians, manufacturers of electrical accessories, appliances and machinery, &c. First directors, G. Chisholm (managing) and R. Gray. Reg. office, Providence Works, Fleet-street, Birmingham.

DODD & OULTON (LTD.) (98.466.)—Reg. June 23, capital £20,000 in £5 shares (1,600 preference), to acquire the business carried on as Dodd & Oulton, and to carry on the business of brassfounders, manufacturers of and dealers in electric light and gas fittings, electrical engineers, &c. First directors, G. Oulton, W. F. B. Oulton, A. N. Oulton and J. B. Kidwell.

J. P. HALL & CO. (LTD.) (98,542.)—Reg. June 27, capital £35,000 in £1 shares, to carry on the business of electrical and mechanical engineers and machinists, manufacturers of electrical and other apparatus and appliances, boiler and economiser makers, &c. First directors, J. P. Hall and A. G. Hall (both permanent).

STATUTORY RETURNS.

BIRKDALE DISTRICT ELECTRIC SUPPLY CO. (LTD.)—The capital in return to April 28 is £30,000 in £5 shares, all of which have been taken up and paid for in full. Mortgages and charges, £3,000.

BRITISH L. M. ERICSSON MFG. CO. (LTD.)—In return to May 21 capital is £200,000 in £1 shares, of which 100,010 have been taken up. £1 per share has been called up on 50,010 and (?) 12s. per share on 50,000. £70,010 has been received. £30,000 (12s. per share) is considered as paid on 50,000. Mortgages and charges nil.

BROMLEY (KENT) ELECTRIC LIGHT & POWER CO. (LTD.)—Return to April 20 gives capital as £100,000 in £5 shares, of which 15,000 have been taken up. £75,000 has been received. Mortgages and charges, £70,000.

CHISLEHURST ELECTRIC SUPPLY CO. (LTD.)—In return to April 20 capital is £15,000 in £5 shares, all of which have been taken up and paid for in full. Mortgages and charges, £10,000.

LANCASHIRE DYNAMO & MOTOR CO. (LTD.)—Return to April 23 gives capital as £150,000 in 1,000 ordinary and 500 preference shares of £100 each, of which 850 ordinary and 470 preference have been taken up. £100 per share has been called up and £132,000 has been received. Mortgages and charges at date of return, £53,500. A further £500 debentures were issued on June 3, 1908 and an additional £15,000 is held by bank as security for possible overdraft.

OKONITE CO. (LTD.)—Return to April 14 gives capital as £120,000 in 32,000 preference and 16,000 ordinary shares of £2. 10s. each, all of which have been taken up. £525 has been paid on 100 ordinary and 110 preference and £119,475 is considered as paid on the remainder. Mortgages and charges, £43,400 (but of these £32,400 debentures are in hands of trustees for company).

MORTGAGES AND CHARGES.

SWITCHGEAR CO. (LTD.)—A mortgage and modifying deed, dated June 5, 1908, relating to an issue of £3,000 debentures, reg. Aug. 24, 1905, charged on £3,000 second debentures issued by Cowans Limited, has been registered. Holders, E. A. M. Bindloss and Mrs. E. Clarke.

CITY NOTES.

MEMORANDA (July 2).—Bank rate $2\frac{1}{2}$ per cent. (since May 28, 1908) Price of silver, $24\frac{13}{16}$d.—$24\frac{7}{8}$d. per oz. Consols $87\frac{13}{16}$—$87\frac{15}{16}$ for money and $87\frac{15}{16}$ – $88\frac{1}{16}$ account. Consols Pay Day, Aug. 6; Stock and Shares Continuation Days, July 13 and 28; Ticket Days, July 14 and 29; Pay Days, July 15 and 30; Mining Share carry-over Day, July 10.

PRICES OF METALS (London).—*Copper*, cash, $56\frac{7}{16}$—$56\frac{11}{16}$; three months, $56\frac{7}{8}$—58. *Lead*, English, 13; foreign, $12\frac{1}{8}$—$12\frac{3}{8}$. *Spelter*, foreign, 18—$18\frac{1}{4}$. *Tin*, English, 124—125; foreign, cash, $123\frac{7}{8}$—$124\frac{3}{8}$, three months, $125\frac{1}{8}$—$125\frac{5}{8}$. *Iron*, Cleveland, cash, 51/4; three months, 49/$7\frac{1}{2}$—49/$10\frac{1}{2}$.

BRITISH EMPIRE TRUST CO. (LTD.)—Invitations to an issue at par of 250,000 preferred ordinary shares of £1 in the above company have been invited during the week. The company, which was incorporated in 1902, was established, in the first place, to facilitate the placing of British capital in desirable colonial investments, and to protect the interests of British investors by acting as trustees. Amongst the companies for which the British Empire Trust Co. acts as trustee may be mentioned the British Columbia Electric Railway Co., the Toronto Power Co., the Shawinigan Water and Power Co., the Vancouver Power Co., and the Sao Paulo Tramway, Light and Power Co.

BRUSH ELECTRICAL ENGINEERING CO. (LTD.)—Extraordinary meetings are to be held on 7th inst. to consider resolutions altering the value of the existing shares from £1. 6s. 8d. to £1 per share and for dividing the 74,268 unissued £2 ordinary shares into two ordinary shares of £1 each.

CALCUTTA ELECTRIC SUPPLY CORPN. (LTD.)—The number of units delivered to consumers during the four weeks ended April 24 were 564,508, compared with 434,915 units in the corresponding period of 1907, and for the five weeks ended May 29 the figures were 700,232 in 1908 and 599,157 units in 1907.

EASTERN TELEGRAPH CO. (LTD.)—This company announce payment on 15th inst. of a dividend at the rate of $3\frac{1}{2}$ per cent. per annum (less tax) on the preference stock for the quarter ended June 30 and a first quarterly interim dividend of $1\frac{1}{4}$ per cent. on the ordinary stock (tax free) in respect of profits for the year ending Dec. 31, 1908. The transfer books will be closed from 7th to 14th inst. inclusive.

EASTERN EXTENSION AUSTRALASIA & CHINA TELEGRAPH CO (LTD.)—The directors have declared an interim dividend for the quarter ended March 31 of 2s. 6d. per share (tax free), payable 15th inst. The share register will be closed from 7th to 14th inst. inclusive.

ELECTRICAL POWER STORAGE CO. (LTD.)—The directors recommend a dividend of 5 per cent. on the ordinary shares for the past year.

O. C. HAWKES (LTD.)—The directors have declared an interim ordinary dividend at the rate of 5 per cent. for the half-year to June 30.

NATIONAL TELEPHONE CO. (LTD.)—The directors have resolved (subject to final audit) to recommend the following dividends for the half-year ended June 30 last, after payment of the dividends on the preference shares: At rate of 6 per cent. per annum on the preferred stock and on the deferred stock (less tax), carrying £140,000 to reserve and about £10,000 forward.

NOTTING HILL ELECTRIC LIGHTING CO. (LTD.)—The directors announce an interim distribution at the rate of 6 per cent. and a bonus of 1 per cent. (together 8s. per share) on the preference and at the rate of 6 per cent (6s. per share) on the ordinary shares for the past half year.

STOCK EXCHANGE NOTICES.—The Stock Exchange committee have appointed July 8 a special settling day in and have ordered to be quoted £250,000 5 per cent. first mortgage debenture stock of the *County of Durham Electrical Power Distribution Co. (Ltd.)* and have also granted quotations to 10,000 additional £10 fully-paid ordinary shares of the same company and a further issue of 25,000 £1 fully paid 7 per cent. cumulative preference shares of the *South Metropolitan Electric Light & Power Co. Ltd.*). The committee have been asked to appoint a special settling day in and grant a quotation to \$100,000,000 4 per cent. convertible bonds of the *American Telephone & Telegraph Co.* and to allow 20,000 £5 5 per cent. preference shares of the *Calcutta Electric Supply Corpn. (Ltd.)* to be quoted.

TUBES LIMITED.—The directors' report to April 30 states that their net profit is £9,185 2s. 3d. They recommend a dividend of 6d. per share (tax free), carrying forward £5,818 5s. 4d.

VULCAN BOILER & GENERAL INSURANCE CO. (LTD.)—The directors have declared an interim ordinary dividend of $2\frac{1}{2}$ per cent.

ELECTRIC TRAMWAY AND RAILWAY TRAFFIC RECEIPTS.

Line	Week ended.	Amount.	Inc. or Dec. (a)	Aggregate: No. of weeks.	Aggregate: Amount.	Aggregate: Inc. or Dec. (a)
		£	£		£	£
Aberdeen Corporation	June 24	1,438	+ 17	4	5,180	− 179
Airdrie	,, 19	220	+ 4	24	5,395	+ 55
Anglo-Argentine	,, 21	17,579	+ 1,876	25	462,326	+ 50,094
Ayr Corporation	,, 27	353	+ 34	6	1,909	− 32
Baker St. & Waterloo Ry.	,, 27	3,015	+ 310	26	79,410	+ 17,169
Barnsley	,, 19	159	− 51	24	4,182	+ 238
Barrow	,, 19	266	+ 12	24	5,558	− 63
Bath Electric Trams, Ltd.	,, 24	809	− 43	25	16,953	− 1,409
Birkenhead Corporation	,, 28	1,091	+ 20	...	...	...
Birmingham Corporation	,, 27	6,266	+ 149	13	81,417	+ 4,160
Birmingham & Mid.	,, 12	1,258	+ 429	23	19,046	+ 982
Blackburn Corporation	,, 24	1,213	+ 153	13	15,289	+ 788
Blackpool Corporation	,, 25	1,118	+ 27	§12	11,409	+ 552
Blackpool and Fleetwood	,, 27	777	+ 61	...	...	...
Bolton Corporation	,, 27	2,476	+ 231	13	30,762	+ 1,479
Bombay	,, 4	R36,671	+ R7,617	22	R799,970	+ R157,526
Bournemouth Corporation.	,, 24	1,519	+ 8	12	19,896	− 657
Bradford Corporation	,, 27	5,133	+ 528	13	60,783	+ 727
Brighton Corporation	,, 28	956	+ 74	13	11,158	+ 185
Bristol Trams & Carriage	,, 26	5,206	+ 177	31	120,492	− 2,040
Buenos Ayres & Belgrano	,, 21	3,804	+ 137	25	95,011	+ 609
Burnley Corporation	,, 27	1,270	+ 53	13	16,680	+ 727
Burton Corporation	,, 28	290	+ 2	13	3,465	− 235
Bury Corporation	,, 21	1,350	+ 198	‡12	14,430	+ 1,554
Calcutta Tramways Co.	,, 27	R10,562	+ R1,298	...	...	...
Camborne-Redruth	...	...	...	...	...	...
Cardiff Corporation	...	...	...	...	...	...
Cavehill	,, 19	96	− 9	24	1,983	+ 172
Central London Railway	,, 27	7,745	+ 2,124	26	162,503	+ 5,254
Charing C., Euston & H'stead	,, 27	3,450	+ 735	26	84,400	...
Chatham & Dist. Lt. Rys.	,, 25	852	+ 99	§25	17,961	+ 528
City & South London Rly.	,, 28	3,128	− 522	26	83,675	+ 5,575
City of Birmingham	,, 19	2,892	− 6	24	67,017	+ 407
Colchester Corporation	...	...	...	...	...	...
Cork Electric Trams Co.	,, 25	526	+ 23	§25	10,904	− 387
Croydon Corporation	,, 26	1,553	+ 81	13	18,554	+ 167
Devonport & Dist. Trams	,, 19	452	− 17	24	10,682	+ 11
Dover Corporation	,, 27	227	− 3	13	2,671	− 189
Dublin & Lucan Railway	,, 26	153	+ 29	26	2,912	+ 165
Dublin United	,, 25	6,265	− 255	26	139,005	− 2,810
Dudley-Stourbridge	,, 14	870	+ 41	24	19,184	− 1,053
Dundee Corporation	,, 24	1,236	+ 66	‡6	7,079	+ 590
East Ham Council	,, 27	893	− 9	13	10,986	− 549
Exeter Corporation	,, 26	333	+ 12	13	3,921	− 129
Gateshead & Dist. Trams	,, 19	951	− 44	24	23,937	+ 196
Glasgow Corporation	,, 27	19,133	+ 849	4	70,742	− 4,168
Glossop	...	...	...	...	...	...
Gravesend—Northfleet	,, 19	219	− 34	24	4,830	− 714
Great Northern & City Rly.	,, 27	1,469	− 301	26	43,783	− 3,423
Gt. Northern, Piccadilly, &c	,, 27	5,750	+ 1,320	26	141,130	+ 38,461
Greenock & Port Glasgow	,, 25	538	− 143	24	12,119	− 3,308
Hartlepool Tramways	,, 19	227	− 90	24	5,335	− 1,059
Hastings Elec. Trams Co.	,, 25	1,104	+ 116	26	22,730	− 208
Hong Kong	,, 27	$7,332	− $395	...	...	...
Huddersfield Corpn.	,, 27	1,668	+ 80	13	21,235	+ 730
Hull Corporation	,, 27	2,375	− 111	13	20,681	− 179
Ilford District Council	,, 27	478	− 21	‡13	5,731	− 367
Ilkeston District Council	,, 21	136	− 5	12	1,728	+ 36
Ipswich Corporation	,, 27	409	− 11	13	4,900	− 41
Isle of Thanet Co.	,, 27	824	+ 28	39	13,447	− 342
Jarrow	,, 19	110	− 18	24	2,438	− 362
Keighley Corporation	,, 25	195	+ 27	52	8,275	+ 386
Kidderminster & District	,, 19	131	+ 11	24	2,399	− 118
Kilmarnock Corporation	,, 27	157	− 1	6	960	− 92
Lanarkshire Trams Co.	,, 25	1,438	+ 163	25	32,235	+ 3,813
Lancashire United	,, 21	1,348	+ 59	25	32,012	+ 1,576
Leamington	,, 19	164	+ 2	24	3,652	+ 135
Leeds Corporation	...	...	...	...	...	...
Leicester Corporation	,, 27	2,384	+ 23	...	...	...
Leith Corporation	,, 27	605	+ 65	§6	3,399	− 37
Lincoln Corporation	,, 27	126	− 122	13	1,548	− 60
Liverpool Corporation	,, 20	11,036	− 151	25	261,323	− 1,866
Liverpool Overhead Rly.	,, 28	1,510	− 19	26	36,611	− 827
*London County Council	,, 20	35,692	+ 2,720	‡12	397,575	+ 40,246
London United	,, 27	7,917	+ 875	25	158,991	+ 3,565
Lowestoft	...	...	...	...	...	...
Maidstone Corporation	,, 27	202	...	13	2,472	...
Manchester Corporation	,, 27	15,975	+ 858	13	193,314	+ 9,245
Mersey Railway	,, 27	1,793	− 112	26	49,837	+ 1,562
Merthyr	,, 19	198	− [illegible]	24	5,027	+ 76
Metropolitan Dist. Railway	,, 27	9,734	+ 1,507	26	233,034	+ 25,401
Metropolitan Elec. Trams	,, 19	6,019	+ 904	24	129,172	+ 25,892
Middleton	,, 19	471	+ 139	24	8,402	+ 231
Nelson Corporation	...	...	...	...	...	...
Newcastle-on-Tyne Corp.	,, 27	6,277	− 434	13	50,292	− 4,857
Newport (Mon.)	,, 27	667	+ 28	13	8,756	− 861
Northampton Corporation	,, 25	484	+ 41	¶12	5,889	+ 349
Oldham, Ashton & Hyde	,, 19	605	+ 37	24	14,257	+ 4
Oldham Corporation	,, 28	2,038	+ 159	14	27,468	+ 675
Perth (N.B.) Corporation	,, 21	163	− 11	6	889	− 41
Perth (W.A.) Elec. Trams	,, 26	1,329	+ 2	¶26	36,296	− 944
Peterborough	,, 19	122	+ 3	24	2,799	+ 39
Portsmouth Corporation	,, 27	2,441	+ 212	13	35,043	− 125
Potteries	,, 19	1,662	− 135	24	44,001	− 87
Preston Corporation	,, 24	762	− 6	26	18,313	− 136
Rotherham Corporation	,, 25	580	+ 3	§12	7,629	+ 168
Rothesay	,, 19	232	− 56	24	2,538	− 178
Salford Corpn.	,, 29	5,137	+ 411	13	62,013	+ 545
Sheerness	,, 17	65	+ 1	24	1,262	− 5
Sheffield Corporation	,, 28	5,723	+ 299	‡14	77,087	+ 67
Singapore Trams	,, 27	$8,405	− $513	...	...	...
South Metropolitan	,, 19	859	+ 27	24	18,141	+ 456
South Staffs	,, 19	778	− 101	24	21,152	− 209
Southend Corporation	,, 24	456	+ 49	13	4,739	+ 312
Southport Tramways	,, 19	329	+ 22	24	6,056	− 327
Stalybridge, Hyde, &c., Jt. Bd.	,, 27	845	+ 41	‡13	10,084	− 35
Sunderland Corporation	,, 28	1,367	− 459	13	15,039	− 3,369
Sunderland and District	,, 21	441	+ 2	34	15,703	+ 1,399
Swansea Trams	,, 19	873	+ 12	24	21,541	+ 1,591
Taunton	,, 19	38	− 2	24	948	− 34
Tynemouth and District	,, 19	214	− 27	24	4,83	− 331
Wallasey District Council	,, 27	957	+ 71	‡13	11,308	+ 617
Walsall Corpn.	,, 27	517	+ 9	25	13,602	+ 1,331
Warrington Corpn.	...	...	...	...	...	...
West Ham Corporation	...	...	...	...	...	...
Weston-super-Mare	,, 17	161	+ 14	24	1,638	− 86
Wolverhampton Co.	,, 19	402	− 52	24	10,959	− 187
Wolverhampton Corpn.	,, 24	815	− 9	3	2,932	+ 438
*Worcester	,, 19	2·8	+ 1	24	6,271	+ 10
Wrexham	,, 19	95	− 10	24	2,376	+ 10
Yorkshire W.R. Trams	,, 28	1,247	+ 124	26	30,615	...
Yorkshire Woollen District.	,, 19	812	− 178	24	21,749	− 947

(a) These comparisons are with the corresponding period last year. § Plus 2 days. ¶ Plus 3 days. * Partly electrical. † Minus 3 days. ‡ Minus 2 days.

ELECTRICAL COMPANIES' SHARE LIST.

Shre	Last Dividend	Name.	Price Wed., July 1.	Rate % Yielded £	s.	d.	Dividend Due.	Business Week to July 1. Highest.	Lowest.
		ELECTRICITY SUPPLY.							
10	9/0	Bournemouth & Poole Elec. Sup. Ord.	10½–11	6	7	0	Mar, Sept,	..	..
10	4/6	Do. 4½ per Cent. Cum. Pref.	9¾–10⅜	4	7	0	Feb, Aug		..
10	6/0	Do. 6 per Cent. Cum. Second Pref.	10⅜–10⅞	5	11	6	Feb, Aug	..	..
St.	4½%	† Do. 4½ per Cent. Deb. Stock (red.)	100–103	4	7	6	Jan, July	..	..
5	3/6	Bromley (Kent) El. Lt. & Power Shares	4½–5	5	10	0	April, Oct	..	..
St.	4½%	Do. Do. 1st Debs.	94–97	4	12	9	May, Nov	..	..
5	5/6	Brompton & Kensington Elec. Sup. Ord.	7–8	6	6	6	March....	..	..
5	3/6	Do. 7 per Cent. Pref.	6¾–7¾	4	10	0	Mar, Sept		..
St.	4%	Central Elec. Sup. Co. 4% Guar. Db. Stock	98–101	4	0	0	June, Dec	100½	..
5	2/6	Charing Cross (W. End & City) El. Sup. Co.	3¾–4¼	5	17	6	Feb, Aug	4	3⅞
5	2/3	Do. 4½ per Cent. Pref.	4⅛–4⅝	4	17	0	Feb, Aug	..	..
St.	4%	Do. 4 per Cent. Deb. Stock (red.)	95–98	4	2	0	Jan, July	..	..
5	2/3	† Do. City Undertaking 4½% Cm. Pref.	3¾–4¼	5	7	6	Jan, July	..	..
5	2/6	Chelsea Electric Supply Ord.	3–3½	6	8	9	March ..	3[illegible]	..
St.	4½%	*† Do. 4½ per Cent. Deb. Stock (red.)	99–102	4	8	0	June, Dec	..	..
10	7/0	City of London Electric Lighting Ord.	9½–10½	5	16	6	Feb, Aug	10	9⅞
10	6/0	Do. 6 per Cent. Cum. Pref.	12–13	4	12	0	Jan, July	–	..
St.	5%	† Do. 5 per Cent. Deb. Stock (red.)	122–125	4	0	0	June, Dec	..	..
St.	4½%	† Do. 4½ per Cent. 2nd Deb. Stock (red.)	100–103	4	7	0	Jan, July	..	..
5	1/10½	County of Durham Elec. P.D. Ord.	2¾–3	8	9	7	April, Oct	..	..
5	5%	Do. 5 per Cent. non Cum. Pref.	3⅝–3⅞	6	13	4	April, Oct	..	..
10	6/0	County of London Elec. Supply Ord.	7¾–8¼	6	1	0	Feb, Aug	..	..
10	6/0	Do. 6 per Cent. Cum. Pref.	10⅝–10⅞	5	10	6	Mar, Sept	..	..
St.	4½%	† Do. 4½% Deb. Stock (red.)	105–108	4	3	6	Jan, July	..	..
St.	4½%	Do. Second Deb. Stock	98–101	4	9	9	May, Nov	99¾	98½
5	3/6	Folkestone Electricity Supply Co. Ord.	4¾–5¼	5	7	0	April, Oct	..	—
5	2/6	Do. 5 per Cent. Cum. Pref.	5–5½	4	11	0	Mar, Sept	..	..
St.	4½%	Do. 4½ 1st Deb. Stock (red)	95–98	4	12	0	Feb, Aug	..	..
5	4/6	Hove Electric Lighting Ord.	6–6½	6	11	0	April, Oct	..	..
5	5/0	Kensington & Knightsbridge Ord.	8–9	5	11	0	Feb, Aug	8[illegible]	..
5	6%	Do. 6 per Cent. 1st Pref.	6–6½	4	12	0	Jan, July	..	—
St.	4%	Do. 4 per Cent. Deb. Stock (red.)	96–99	4	1	0	..	..	..
St.	4%	Kensingtn. & Kngtbg. Co. & Notting Hill Co. (Joint Station) 4% Deb. Stock (red.)	97–101	3	19	0	April, Oct	..	..
St.	4½%	Kent Elec. Power Co.	88–92	4	18	3	Jan, July	..	..
3	1/6	London Electric Supply Ord.	⅞–1⅛	5	8	0	Mar, Sept	..	..
5	3/0	Do. 6 per Cent. Pref.	4⅝–4⅞	6	3	0	Mar, Sept	..	..
St.	4%	Do. 4 per Cent. 1st Mort. Deb.	89–92	4	7	0	Jan, July	..	..
5	3/6	Metropolitan Electric Sup. Ord.	4⅝–5⅛	6	6	6	April, Oct	..	..
5	2/3	Do. 4½ per Cent. Cum. Pref.	4⅝–4⅞	4	12	6	Jan, July	..	..
St.	4½%	Do. 4½ per Cent. Deb. Stock 1st Mort.	105–109	4	1	6	June, Dec	..	..
St.	3½%	Do. 3½ per Cent. Mrt. Deb. Stock (red.)	84–89	3	19	0	Jan, July	84	..
100	4½%	† Midland Elec. Corp. for P.D. 1st Mort. Db.	94–97	4	12	6	June, Dec	..	—
10	4%	Newcastle & Dist. Elec. Ltg. Ord.	7¾–8¼	5	0	0	Feb, Aug	—	—
100	4½%	† Do. 4½ per Cent. Deb.	94–96	4	14	9	Jan, July	..	..
5	8%	Newcastle Elec. Supply Ord.	5⅝–5¾	7	0	10	Feb, Aug	..	..
5	5%	Do. 5 per Cent. non Cum. Pref.	5¼–5⅜	4	14	1	Feb, Aug	..	..
100	4%	† Do. 4 per Cent. Mort. Deb. red. 1907.	95–97	4	3	4	Jan, July	..	—
1	3%	Northern Counties Elec. Sup.	—		..		Mar, Aug	—	..
100	4½%	† Do. 4½ per Cent. Deb.	93–95	4	15	9	Jan, July	..	..
10	6/0	† Notting Hill Electric Ord.	12–13	5	8	0	March ..	..	..
5	4/6	Oxford Electric Ord.	5¾–6¼	5	12	0	March ..	..	..
St.	4%	Do. 4 per Cent. Deb. Stock	94–98	4	1	6	Jan, July	..	..
5	5/0	St. James' & Pall Mall Elec. Ord.	7½–8½	5	18	0	Feb, Aug	..	..
5	3/6	Do. 7 per Cent. Pref.	6½–7¼	4	16	6	Feb, Aug	..	..
St.	3½%	Do. 3½ per Cent. Deb. Stock (red.)	83–88	4	2	0	Jan, July	..	..
5	..	Smithfield Markets Electric Sup. Ord.	¼–¾		..		Feb	..	..
St.	4%	Do. 4 per Cent. Deb. Stock	70–74	5	8	0	Feb, Aug	..	..
5	4/0	South London Electric Supply Ord.	2⅝–2⅞	5	19	0	April	2⅝	2 7/16
1	0/6	South Metrop'n Elec. Lt. & Power Ord.	⅜–⅝	4	0	0	..	..	—
1	0/8⅔	Do. 7 per Cent. Cum. Pref.	1 1/16–1 5/16	5	6	0	Feb, Aug	..	..
St.	4½%	Do. 4½ 1st Db. Stk. Red.	99–102	4	8	0	April, Oct	..	..
5	2/6	Urban Electric Supply Ord.	1–2	12	10	0	April, Oct	1	..
5	2/6	Do. 5 per Cent. Cum. Pref.	1⅞–2⅜	10	12	0	April, Oct	..	..
St.	4½%	Do. 4½ per Cent. 1st Mort. Deb.	87–90	5	0	0	April, Oct	..	..
5	5/0	Westminster Elec. Sup. Ord.	7¼–7¾	5	14	0	Mar, Sept	8[illegible]	8 7/16
5	2/3	† Do. 4½ per Cent. Cum. Pref.	4⅞–5⅛	4	4	0	Jan, July	..	..
		ELECTRIC RAILWAYS, TRAMWAYS, &c.							
St.	4%	Baker St. & Waterloo 4% Perp. Db. St.	90–92	4	7	0	Jan, July	91¾	91½
1	..	Bath Elec. Trams Pref. Ord.	¼–½	8	0	0	April	..	—
1	0/6	† Do. 5 per Cent. Cum. Pref.	⅝–⅞	5	14	0	Jan, July	..	..
St.	4½%	Do. 4½ 1st Mort. Deb. Stock (red.)	85–90	5	0	0	April, Oct	..	..
St.	4½%	† B'ham & Midland Trams 4½ 1st Db. Stk.	91–94	4	17	0	Jan, July	92¼	91¼
10	9%	Bristol Tramways & Carriage Ord.	10¼–10¾	8	7	0	Feb, Aug	..	..
10	4%	† Do. Cum. Pref. (fully paid)	8–8¼	4	16	6	..	..	..
St.	4%	† Do. 4 per Cent. Debs.	93–98	4	2	0	Feb, Aug	..	..
10	..	British Electric Traction Ord.	1⅜–1⅞		..		June, Dec	1½	1 7/16
10	1/5⅓	† Do. 6 per Cent. Cum. Pref.	4¼–4½		..		Feb, Aug	4[illegible]	4 7/16
St.	5%	Do. 5 per Cent. Perpetual Debs.	94–97		..		April, Oct	96½	..
St.	4½%	Do. 4½ per Cent. 2nd Deb. Stock	76–77	5	15	6	May, Nov	76½	75½
St.	3%	Central London Ordinary Stock	75–78	3	17	0	Feb, Aug	77	75
St.	4%	Do. 4 per Cent. Pref. Stock	90–92	4	7	0	Feb, Aug	90½	..
St.	2%	Do. Deferred Stock	55–58	3	6	0	Feb	58½	56
100	4%	Do. 4 per Cent. Debs.	103–106	3	15	6	Jan, July	..	..
St.	4%	† Charing X, Euston & Hmpstd Per. Db. Stk.	80–83	4	16	0	Jan, July	82	..
5	2/6	City of Birmingham Trams. 5% Cm. Pref.	4¼–4¾	5	5	0	April, Oct	..	..
100	4%	Do. 4 per Cent. 1st Mort. Debs.	97–100	4	0	0	April, Oct	..	..
St.	1¾%	City & South London Rly. Con. Ord.	38–40	5	0	0	Feb, Aug	40½	38¾
St.	5%	Do. 5 per Cent. Perp. Pref. (1891)	113–116	4	6	0	Feb, Aug	..	..
St.	5%	Do. (1896)	112–115	4	7	0	Feb, Aug	114	113
St.	5%	Do. (1901)	110–113	4	8	6	Feb, Aug	110½	..
St.	5%	Do. (1903)	104–107	4	13	6	Feb, Aug	..	..
St.	4%	Do. 4 per Cent. Perpetual Debs.	100–103	3	17	6	May, Nov	..	..
10	7/0	Dublin United Trams. Ord	12¼–13¼	4	10	6	Feb, Aug	..	..
10	6/0	Do. 6 per Cent. Pref.	12½–13½	4	9	0	Feb, Aug	..	—
10	..	Gt. Northern & City Rly. Pref. Ord. (4%)	¾–1¼		..		Feb, Aug	..	..
10	4/0	G. Northern, Piccadilly & Brompton Ord.	6–6½	6	3	0	Feb, Aug	..	..
St.	4%	† Do. 4 per Cent. Deb. Stock	87–90	4	9	0	Jan, July	90¾	88½
5	4/0	Hastings & Dist. Elec. Trams. 6% Cm. Pf.	3½–4	7	10	0	Mar, Sept	..	..
St.	4½%	Do. 4½ Db. St.	93–96	4	13	9	April, Oct	..	..
10	9%	‡ Imperial Tramways Ord.	10½–11½	7	17	0	Mar, Sept	..	..
10	6%	†‡ Do. 6 per Cent. Pref.	9½–10	6	0	0	Mar, Sept	..	..
St.	4½%	†‡ Do. 4½ per Cent. Debs.	91–92	4	18	0	Jan, July	..	..
5	..	I. of Thanet E. T. & Lt. 5 per Cent. Pref.	⅞–1⅛		..		Mar, Sept	..	—
St.	4%	† Do. 4 per Cent. Deb. Stock	55–61	6	11	0	Jan, July	..	—
10	6/0	Lanarkshire Tramways	9⅞–10⅛	5	9	0	Feb, Aug	..	..
St.	5%	† Lancs. Utd. Trams 5% Prior Lien Db. St.	88–91	5	10	0	Jan, July	..	..
10	..	Liverpool Overhead Railway Ord.	1⅛–1½		..		Feb, Aug	..	..
10	5%	Do. 5 per Cent. Pref.	5¾–6¼	8	0	0	Feb, Aug	..	—
St.	4%	Do. 4 per Cent. Deb.	83–88	4	10	0	Jan, July	..	..
10	5/0	† London United Trams. 5% Cum. Pref.	7–8	6	5	0	Jan, July	7⅝	..
St.	4%	† Do. 4 per Cent. 1st Mort. Deb. Stock	79–81	4	15	0	Jan, July	81	..
St.	—	Mersey Con. Ord. Stock	1–3		—		Feb, Aug.	..	—
St.	..	Do. 3 per Cent. Perp. Pref.	8–6		—		..	..	..
1	..	Metropolitan Elec. Tramways Def.	1/32–5/32		—		April.. .	[illegible]	..
1	0/6	Do. 5 per Cent. Cum. Pref.	11/16–13/16	6	3	6	Feb, Aug	¾	[illegible]
St.	4½%	† Do. 4½ per Cent. Deb. Stock	93–95	4	12	0	Jan, July	..	..
St.	½%	Metropolitan Railway Consolidated	37–38	1	8	0	Feb, Aug	40⅝	37½
St.	2½%	Do. Surplus Lands Stocks	68–70	3	19	0	Feb, Aug	69½	68
St.	3½%	Do. 3½ per Cent. Preference	86–89	3	19	9	Feb, Aug	..	..
St.	3½%	Do. 3½ per Cent. "A" Preference	75–78	4	9	6	Feb, Aug	75½	..
St.	3½%	Do. 3½ per Cent. Convertible Pref.	73–76	4	12	0	Feb, Aug	—	..
St.	3½%	Do. 3½ per Cent. Debenture Stock	91–94	3	11	6	Jan, July	93½	..
St.	3½	Do. 3½ per Cent. "A" Ditto	89–92	3	16	0	Jan, July	..	..

* In calculating the yield allowance has been made for accrued interest but *not* for redemption
† Ex Dividend

ELECTRICAL COMPANIES' SHARE LIST.—*Continued.*

ELECTRIC RAILWAYS & TRAMWAYS—*Continued.*

Shre.	Last Dividend	Name.	Price Wed., July 1.	Rate % Yielded. £ s. d.	Dividend Due.	Business Week to July 1. Highest	Lowest
St.	..	Metropolitan District Railway Ord.	12 —13	—	Feb, Aug	12 1/16	12¼
St	..	Do. Extension Pref. (5 per Cent.)	23 —28	..	Feb, Aug	..	..
St.	3½%	Do Assented Ext. Pref (Int. Guar. by Und. Elec. Rlys. Co. of London, Ltd.)	44 —48	7 6 0	Feb, Aug	..	..
St.	3%	† Do. 3 per Cent. Consoltd. Rent-charge	70 —75	4 0 0	Jan, July	74½	..
St.	4%	† Do. 4 per Cent. Midland Rent-charge	98 —102	3 18 0	Jan, July	..	..
St.	1¾%	Do Guar Stock 4 per Cent	44 —49	3 11 0	Mar, Sept	..	..
St.	6%	† Do. 6 per Cent Perp. Deb. Stock	117 —122	4 13 6	Jan, July	123	122½
St.	4%	† Do. 4 per Cent. Ditto	71 —76	5 5 0	Jan, July	..	..
5	..	New Gen. Tract. 6 per Cent. Cum. Pref.	¼—¾	..	May	..	..
1	0/9¾	Potteries Electric Traction Ord.	¼—½	8 0 0	April, Oct	..	..
1	0/6	Do. 5 per Cent. Cum. Pref.	⅝—¾	6 13 0	Feb, Aug	..	..
St.	4½%	Do. 4½ per Cent. Deb Stock	93 —96	4 14 6	May, Nov	..	..
1	0 7⅕	S. Met. Elec. Trams. & Ltg. 6% Cm. Pref.	¾—1	6 0 0	Feb, Aug	..	..
St.	4%	† Do. 4 per Cent. Deb. Stock	75 —79	5 1 0	Jan, July	..	..
100	5%	†Sunderland Dist. Elec.Trms.5%1stMt.Db.	74 —79	6 11 0	Jan, July	..	..
..	5%	Underground Elec. Rys. Co. of London...	40 —44	11 8 0	June, Dec	42⅛	42
5	..	Yorkshire (W.R.) Elec. Trams. Ord.	⅞ —1⅜	—	March ..	..	..
5	..	Do. 6 per Cent. Cum. Pref.	3⅛ —3⅝	—	..	..	..
St.	4½	Do. 4½ per Cent. 1st Debs.	82 —85	5 5 6	Jan, July	..	..

ELECTRIC MANUFACTURING, &c.

Shre.	Last Dividend	Name.	Price Wed., July 1.	Rate % Yielded. £ s. d.	Dividend Due.	Highest	Lowest
1	..	Aron Electricity Meter Ord.	3/16—5/16	..	..	..	..
1	1 4⅕	Do. 6% Cum. Pf. (ex on a/c arrears)...	21/32—[illegible]	7 13 7	April, Oct	..	..
1	2/4⅕	Babcock & Wilcox Ord........	3 11/16—4 1/16	4 17 6	April, Oct	4	3 31/32
1	0/7⅕	Do. Pref..	1 7/16—1 9/16	3 16 9	..	..	..
5	6/0	British Insulated & Helsby Cables Ord.	5¾—6¼	8 0 0	July, Feb	6 1/16	..
5	3/0	Do. 6 per Cent. Pref.	5¾—6¼	4 16 0	Jan, July	..	..
St.	4½%	† Do. 4½ per Cent. 1st Mort. Deb. (red.)	100 —103	4 7 6	Jan, July	..	..
St.	4½%	British Thoms'n-Houst'n 4½% 1st Mt.Db.	93 —98	4 12 0	Mar, Sept	..	..
5	..	British Westinghouse 6 per Cent. Pref...	[illegible]—11/16	..	Feb, Aug	—	..
St.	4%	Do. 4 per Cent. Mort. Deb. Stock	43 —48	8 8 0	Jan, July	..	..
2	..	Brush Electrical Engineering	½	—	March ..	..	..
2	..	Do. 6 per Cent. Pref. non-Cum.	3/16—7/16	..	Mar, Sept	¼	..
St.	4½%	Do. 4½ per Cent. Perp. 1st Deb. Stock	70 —75	6 0 0	Mar, Sept	..	—
St.	4½%	† Do. Perpetual 2nd Deb. Stock	53 —58	7 14 0	Jan, July	..	..
5	10 0	Callender's Cable Con. Ord.	9½—10½	7 1 0	Jan, July	..	..
5	2/6	† Do. 5 per Cent. Cum. Pref.	5¼—5¾	4 7 0	Jan, July	5½	..
St.	4½%	† Do. 4½ per Cent. 1st Mort Debs. (red.)	105 —107	4 4 0	Nov, May	..	..
1	1/0	Castner-Kellner Alkali Co.	1¼—1⅜	9 18 0	May, Nov	1 11/32	..
St.	4½%	Do. 4½ per Cent. 1st Mort. Deb. (red.).	101 —104	4 6 6	Feb. Aug	103	..
1	0 9¾	†Chadburn's (Ship) Telegraph Ord.	1 1/16—1 3/16	8 8 0	March ..	1⅛	..
1	0/7⅕	Do. 6 per Cent. Cum. Pref.	1 —1⅛	5 6 6	April, Oct	..	..
1	0/8⅕	Consolidated Electrical Co.	¼ ½	7 0 0	August ...	..	..
1	1/0	Consolidated Signal Co.	1⅛—1⅝	4 12 0	April, Oct	1 9/16	..
1	0/7⅕	Do. 6 per Cent. Cum. Pref.	15/16—1	6 0 0	April, Oct	..	..
3	3/0	* Crompton & Co. (Nos. 1 to 86,000)	1⅝—1⅞	8 1 6	Jan, July	1¾	1 11/16
100	5%	† Do. 5 per Cent. 1st Mort. Debs. (red.).	90 —93	5 7 0	Jan, July	..	..
1	0/7⅕	Davis & Timmins	⅞—1⅛	..	Mar, Sept	..	..
5	2/0	Dick, Kerr & Co. Ord.	1⅛—1⅜	7 11 0	Sept	..	..
5	0/7⅕	Do. 6 per Cent. Cum. Pref.	1 —1¼	4 16 0	Sept .. —	1 3/32	1 1/16
St.	4½%	† Do. 4½ per Cent. Deb. Stock	99 —102	4 8 6	Jan, July	..	..
5	2/6	Edison & Swan United ("A" Sh.) (£3 pd.)	½—¾	..	Feb, Aug	11/16	½
5	4/2	Do. (£5 paid)	1½—2½	5 0 0	Feb, Aug	..	—
St	4%	Do. 4 per Cent. Mort. Deb. Stock (rd.)	76 - 79	5 1 6	June, Dec	..	..
St.	5%	Do. 5 per Cent. 2nd Deb. Stock	85 —87	5 15 0	Mar, Sept	—	..
5	..	Edmundson's Elec. Corp. Ord.	⅛—⅜	..	Jan, July	..	..
5	..	Do. 6 per Cent. Cum. Pref.	½—1	..	May, Nov	..	..
St.	4½%	Do. 4½ per cent. 1st Mort. Deb. (red.)	63 —73	6 2 9	Jan, July	..	..
2	..	Electric Construction Co........................	¼ —½	..	Jan, July	..	..
2	..	Do. 7 per Cent. Cum. Pref.	1¼—1¾	..	July	..	..
St.	4%	Do. 4 per Cent. Perp. 1st Mort. Debs.	63 —66	6 1 6	Jan, July	63	..
10	5/0	General Electric (1900) 5% Cum. Pref....	7½—8	6 5 0	June, Dec	..	..
St.	4%	Do. 4 per Cent. 1st Mort. Debs..........	87 —90	4 9 0	Mar, Sept	..	..
5	10/0	Henley's Telegraph Works Ord.............	10½—11½	6 10 0	Feb, Aug	10 15/16	10⅝
5	2/3	Do. 4½ per Cent. Pref.	5 —5½	4 2 0	Feb, Aug	..	..
St.	4½%	Do. 4½ per Cent. 1st Mort. Deb. Stock	104 —106	4 5 0	Mar, Sept	..	..
10	15/0	India Rubber, Gutta Percha, &c., Wrks.	16½—16½	6 2 0	Feb, Aug	16¾	16 1/16
100	4%	Do. 4 per Cent. Debs. (red.)...............	98 —100	4 0 0	April, Oct	..	..
1	2/0	National Elec. Construction Co.	⅝—⅞	..	April	..	..
1	0/9¾	Richardsons, Westgarth & Co., Ltd. Ord.	7/16—9/16	7 2 0	Nov	..	..
1	0/7⅕	Do. 6 per Cent. Cum. Pref.	¾—⅞	6 17 0	May, Nov	..	..
St	4½%	‡ Do. 4½ per Cent. Perp. Deb. Stock ...	87 —90	5 0 0	Jan, July	..	..
1	..	Simplex Conduits Ord.	1½	..	..	—	—
5	..	Do. 6 per Cent. Cum. Pref.	5½	..	..	..	..
12	30/0	Telegraph Construction & Maintenance	31 —33	6 8 0	Mar, July	31½	31
100	4%	Do. 4 per Cent Deb. Bonds (1909) ...	100 —102	3 18 0	Jan, July	..	..
1	2/0	Vickers, Sons & Maxim, Ltd., Ord.	1 11/16—1 13/16	8 5 6	..	1 13/16	1¾
1	0/6	Do. 5 per Cent. non-Cum. Preference	1 —1⅛	4 9 0	..	..	..
St.	5%	Do. 5 per Cent. non-Cum. Preferred	102 —106	4 14 6	..	105	..
St.	4%	Do. 4 per Cent. 1st Mort. Db. Sk. (red)	102 —104	3 16 6	June, Dec	..	..
100	4½%	Do. 4½ per Cent. 2nd Mort. Deb. (red.)	102 —105	4 6 0	June, Dec	104	103½
100	15 6	Do. 5 per Cent. 3rd Mort. Debs. Scrip.	101 —103	..	..	102½	101⅛
10	6/0	J. G. White & Co. 6 per Cent. Cm. Pref.	7½—8½	7 1 0	..	..	..
5	1/0	Willans & Robinson Ord.........................	¾—1¼	4 0 0	Apr, Oct	..	..
5	3/0	Do. 6 per Cent Cum. Pref.	3¼—3¾	8 0 0	Apr, Oct	3½	3¼
100	4%	Do 4 per Cent. 1st Mort. Debs..........	72 —76	5 5 6	May, Nov	..	..

TELEGRAPHS.

Shre.	Last Dividend	Name.	Price Wed., July 1.	Rate % Yielded. £ s. d.	Dividend Due.	Highest	Lowest
10	..	Amazon Telegraph	2 —3	—	June, Dec	..	—
100	5%	† Do. 5 per Cent. Debs. (red.)	83 —86	5 16 0	June, Dec	..	..
St.	10/0	Anglo American	58 —61	5 12 6	F,My,Ag,N	..	..
St.	30/0	Do. Preferred	103 —104	5 15 0	F,My,Ag,N	104	103½
St.	1%	Do Deferred	15½—16	6 6 0	F,My,Ag,N	16 1/16	15 15/16
St	4%	†Commercial Cable 4 per Cent. Deb. Stk.	83 —86	4 13 0	Jn,Ap,Jy,O	85½	84½
10	6/0	Cuba Submarine Ord..................................	7½—8½	7 0 0	Feb, Aug	..	..
10	10/0	Do. Preference 10 per Cent................	16½—16¾	5 19 0	Feb, Aug	..	..
5	2/0	Direct Spanish Ord	3 —3½	6 4 0	April, Oct	..	..
5	5/0	Do. 10 per Cent. Cum. Pref.	8 —9	5 11 0	April, Oct	..	..
50	1½%	Do. 4½ per Cent. Deb..	00 103%	4 7 6	Jan, July	..	..
20	4 0	Direct United States Cable	13⅞—14½	6 9 0	Ja,Ap,Jy,O	13⅝	..
100	4½%	Direct West India Cable 4½% Rg. Db. (rd.)	98 —100	4 10 0	June, Dec	..	..
St.	15/0	Eastern Ordinary	133 —136	5 3 0	Ja,Ap,Jy,O	136	133¾
St.	17 6	Do. 3½ per Cent. Pref. Stock	84½—85	4 1 0	Ja,Ap,Jy,O	85¼	8[illegible]
St.	4%	Do. 4 per Cent. Mort. Deb. Stk. (red.)	100½—102½	3 18 0	May, Nov	102¼	101⅛
10	1/6	Eastern Extension	12⅞—13½	5 6 0	Ja,Ap,Jy,O	13 5/16	12⅞
St.	4%	Do. 4 per Cent. Deb. Stock	10[illegible]—102½	3 18 0	Feb, Aug	102¼	101
100	4%	Eastern & S. African 4% Mort. Deb. 1909	101 —103	3 17 6	Feb, Aug	..	..
25	4%	Do. 4% Mauritius Sub. Debs. (red.) ..	100 —102%	3 18 6	May, Nov	100	..
10	1 0	†G. N. of Copenhagen, ex Coupon 73	27 —29	6 15 0	Jan, July	28¼	..
100	4½%	†Halifax & Bermuda 4½% 1st Mt. Db. (red.)	98 —100	4 12 0	June, Dec	..	..
25	22 6	Indo European	64 —67	5 19 0	May, Nov	64½	..
100	$1	Mackay Companies Common	60 —70	5 11 0	Ja,Ap,Jy,O	..	..
100	$1	Do. Preference	60 —70	5 11 0	Ja,Ap,Jy,O	..	..
1		Marconi's Wireless Telegraph Co. ...	—	..	April	..	..
100	4	†Pacific & European 1st 4% Guar. Dbs. (red.)	97 —100	4 0 0	June, Dec	..	—
4	1 3	West Coast of America	1[illegible] —1[illegible]	4 5 0	May	..	—
100	4	† Do. 4 per Cent. Debs.	98 —101	3 19 0	Jan, July	..	..
10		West India & Panama	[illegible]—½	..	May, Nov	..	
10	6/0	Do. 6 per Cent. 1st Pref. .	8¼ —8¾	6 17 0	May, Nov	8¾	
10	20/0	Do. 6 per Cent. 2nd Pref. [illegible]	8½ —9½	..	May, Nov	..	..
100	5	† Do. 5 per Cent. Debs.	99 —102	4 18 0	Jan, July	..	..
10	2 0	†Western Telegraph .	13⅞ —13¾	5 1 0	Mr,Jn,O,D	13¾	13½
St	4	† Do. 4 per Cent. Deb. Stock (red.)	99½—101½	3 18 6	June, Dec	..	
..	4	Western Union Telegraph $1,000 4% Bonds	[illegible] —81	4 13 0	..	..	..

TELEPHONES.

Shre.	Last Dividend	Name.	Price Wed., July 1.	Rate % Yielded. £ s. d.	Dividend Due.	Highest	Lowest
100	2$	Amer. Telephn. & Telegh. Cap. St.	120 —124	6 12 6	..	122	..
..	4%	† Do. Coll. Trust $1,000 4 per Cent. Bds	89 —92	4 7 0	Jan, July	..	—
St.	5%	Anglo-Portug'se Tel. 5% 1st Mt. Db. Stk.	99 —102	4 18 0	Mar, Sept	..	—
5	3 0	Chili Telephone	7¼—7¾	5 2 0	August ..	..	..
1	0/7⅕	Monte Video Telephone Ord.	31/32—1 1/32	6 16 0	Nov	..	..
1	0/6	Do. 5 per Cent. Pref.	27/32—[illegible]	5 3 0	May, Nov	15/16	..
St.	6%	National Co. Pref. Stock	108½—110½	5 8 0	Feb, Aug	109⅜	108½
St.	6%	Do. Def. Stock......................................	113 —115	5 4 0	Feb, Aug	114½	113
10	6/0	Do. 6 per Cent. Cum. 1st Pref.	10½—12½	4 16 0	Feb, Aug		..
10	6/0	Do. 6 per Cent. Cum. 2nd Pref.	10½—12½	4 16 0	Feb, Aug	..	..
5	2/6	Do. 5 per Cent. non-Cum. 3rd Pref. ...	5⅜—5⅝	4 9 0	Feb, Aug	5½	5
St.	3½%	*†Do. Deb. Stock 3½ per Cent. (red.) ...	98 —101	3 9 6	June, Dec	..	..
St.	4%	† Do 4 per Cent. Deb. Stock (red.)	100½—102½	3 17 6	Jan, July	101¾	..
1	1/0	Oriental	1¼—1⅜	5 9 0	April, Oct	1 11/32	..
1	0/7½	Do. 6 per Cent. Cum. Pref.	1⅛—1¼	4 16 0	April, Oct	—	..
St.	4%	† Do. 4 per Cent. Red. Deb. Stock	88 —91	4 8 0	Jan, July	—	..
St.	4½%	Telephone Co. of Egypt 4½%Db.Stk.(red.)	97 —100	4 10 0	Jan, July	—	—
5	3/0	United River Plate..................................	6⅜—6⅞	5 16 6	July	—	..
5	2/6	† Do. 5 per Cent. Cum. Pref.	5 —5½	4 11 0	June, Dec	..	..
St.	4½%	† Do. 4½ Deb. St. Red.	99 —101	4 9 0	Jan, July	99¾	..

FINANCIAL, INVESTMENT, &c.

Shre.	Last Dividend	Name.	Price Wed., July 1.	Rate % Yielded. £ s. d.	Dividend Due.	Highest	Lowest
5	3/0	†Elec. & Gen. Investment 6% Cum. Pref.	3½—4	7 10 0	Jan, July	—	..
10	2 0	Globe Telegraph & Trust........................	10⅝—10⅞	5 1 6	SpDcMrJu	10 11/16	10 11/16
10	3/0	Do. 6 per Cent. Pref............................	13⅝—14⅛	4 5 0	SpDcMrJu	14	13⅞
10	6%	Submarine Cables Trust (Cert.)..............	127 —130	4 12 0	April, Oct	..	..

COLONIAL AND FOREIGN ELECTRIC RAILWAYS, TRAMWAYS, &c.

Shre.	Last Dividend	Name.	Price Wed., July 1.	Rate % Yielded. £ s. d.	Dividend Due.	Highest	Lowest
5	3/0	Anglo-Argentine 6% Cum. 1st Pref.	6⅛—6⅝	4 14 0	April, Oct	..	..
5	5/0	Do. 10% Non-cum. 2nd Pref.	8¼—8⅝	5 8 0	Jan, July	8 5/16	8¼
St.	6%	† Do. Permanent 6% Deb. Stock	138 —143	4 5 0	June, Dec	143	..
St.	5%	†Auckland Elec. Trams. 5% Deb. (red.)...	102 —105	4 15 6	Jan, July	..	..
5	4/0	Brisbane Electric Trams. Invest. Ord....	4¼—4½	4 10 0	May	4⅜	..
5	2/6	Do. 5 per Cent. Cum. Pref.	4⅞—5⅛	4 17 6	May, Nov	..	..
St.	4½%	† Do. 4½ per Cent. Db. Prov. Certs.	97 —101	4 9 0	Jan, July	100	9[illegible]
St.	8%	British Columbia El.Ry.Df. Ord.	125 —130	6 3 0	Mar, Sept	..	..
St.	65 0	Do. Pref. Ord. Stock	108 —112	5 6 6	May, Nov	..	..
St.	5%	Do. 5% Cum. Perp. Pref. Stock..........	107 —111	4 10 0	Jan, July	109	..
40	4½%	Do. 4½ per Cent. 1st Mort. Debs.	99 —102	4 8 0	April, Oct	..	—
100	4½%	Do. Vancouver Power Debs.	101 —104	4 6 6	Jan, July	..	—
St.	4¼%	Do. 4¼% Perp Con. Deb. St.	99 —102	4 3 0	..	100⅝	..
5	3/0	Buenos Ayres & Belgrano Ord.	4⅜—4⅞	8 1 6	April, Oct	..	..
5	3/0	† Do. 6 per Cent. "A" Cum. Pref.	4⅝—5⅛	5 17 6	April, Oct	..	..
5	3/0	† Do. "B"	4⅝—5⅛	5 17 6	April	..	..
St.	5%	† Do. 5 per Cent. Debs.	110 —116	4 6 0	Jan, July	—	..
St.	5%	† Do. 5 per Cent. 2nd Debs. (red.)	102 —105	4 15 3	Jan, July	..	..
St.	5%	†Buenos Ayres Elec. Trams (1901) Ltd. Deb. St.	93 —97	5 2 6	Ja, Jul ..	..	..
5	..	Buenos Ayres Grand National Ord.	2¼—2¾	..	..	[illegible]	[illegible]
5	2/6	Do. 5 per Cent. Cum. Pref.	3⅞—4⅜	..	Feb. Aug	4[illegible]	..
100	5½%	† Do. 5½ per Cent. Pref. Debs.	99 —103	5 7 6	Jan, July	104	..
100	6%	Do. 6 per Cent. 1st Deb. Bonds.	100 —104	5 14 6	April, Oct	..	..
St.	5%	Buenos Ayres Lacroze Trams 1st Mt. Db.	91 —94	5 6 6	Mar, Sept	—	..
St.	6%	Buenos Ayres Port & City Tram. 1st Mt. Deb. Stock £75 Paid	64 —68	6 12 0	Feb, Aug	..	..
5	2/6	Calcutta Tramways (1 to 137,610)	5⅞—6¼	4 15 0	Mar, Sept	6⅛	5¾
100	2/6	† Do. 5 per Cent. Cum. Pref.	5 —5⅜	4 13 0	Jan, July	[illegible]	..
1	4½%	† Do. 4½% 1st Deb. Stock (red.)	101 —104	4 6 6	Jan, July	..	..
St	..	Cape Electric Tram Shares	[illegible]—7/16	..	..	..	—
5	1/3	City of Buenos Ayres Trams Co. (1904) Sh.	5 1/16—5 5/16	4 6 6	F,My,A,N	5¼	5⅛
St.	4%	Do. 4 per Cent. Deb. Stock	97 —101	3 19 0	June, Dec	..	..
	5%	Colombo Tr. & Ltg. 5% 1st Mt. Db.	83 —91	5 11 0	May, Nov	..	—
100	5%	Electric Traction Co. of Hong Kong 5 per Cent. 1st Mort. Debs.	85 —90	5 10 0	June, Dec	..	..
1	5%	Havana Elec. Ry. Con. Mt. 5% $1,000 50 year Coup. Bds.	82 —87	5 14 6	Feb, Aug	..	..
1	..	Kalgoorlie Elec. Trams Sh.	¼—¾	..	..	..	..
100	5%	Do. 5 per Cent. "A" Deb. Stock	85 —87	5 12 0	Jan, July	..	—
5	6%	Do. 6 per Cent. "B" Ditto	69 —73	8 4 0	Jan, July	71	70½
5	1/0	Lisbon Elec. Trams. Ord.........................	1 —1¼	4 0 0	July	1	..
100	0/7⅕	† Do. 6 per Cent. Cum. Pref..................	1 —1¼	4 16 0	Jan, July	..	—
St.	5%	† Do. 5 per Cent. Reg. Mort. Debs	90 —95	5 5 0	Jan, July	..	..
St.	5%	†Madras Elec. Trams. 5% Deb. Stk.	93 —96	5 4 0	Jan, July	..	..
..	5%	Manila Elec. Ry. $1,000 Gold Bonds	86 —90	5 11 3	Feb, Aug	..	..
100	$1	Mexico Trams Co. Com. St.	102 —104	3 17 0	..	103½	101½
500	5%	Do. Gen. Con. 1st Mort. 5% Gold Bds....	91½—92½	5 8 3	..	91½	90½
St.	4½%	Montreal St. Ry. Sterling 4½ per Cent. Debs. (1922)	101 —103	4 7 6	Feb, Aug	..	..
1	1/0	Perth Elec. Trams Ord	½ —⅝	8 0 0	May	..	..
St.	5%	† Do. 1st Mt. Db. Stock	101 —104	4 16 0	Jan, July	..	—
5	3/0	†Rangoon Elec. Trams & Supply Co. 6 Cum. Pf.	5⅛—5⅝	5 6 6	..	..	—
St.	4½	†Do. 4½% 1st Mort. Deb. Stk.	96 —98	4 12 0	..	..	..
..	$2½	†Sao Paulo Tramway, Light & Power Co. $100 Stock..	130 —135	6 13 0	..	133	..
..	5%	Do. 5 per Cent. 1st Mt. $500 Db.	93 —98	5 2 0	June, Dec	96½	9[illegible]
100	4½%	Toronto Ry. Co. 1st Mt. 4½% Ster Bonds	98 —100	4 10 0	Feb, Aug	..	..

COLONIAL AND FOREIGN ELECTRICITY SUPPLY, &c.

Shre.	Last Dividend	Name.	Price Wed., July 1.	Rate % Yielded. £ s. d.	Dividend Due.	Highest	Lowest
5	3 0	Adelaide Elec. S'ply Co. 6% Cu. Pr.	4¾—5¼	5 11 0	Mar, Sept	..	..
10	5/2	Bombay E. S. & T. 6% Cm. Pf.	10½—10¾	5 11 6	..	10½	..
St.	4½	† Do. 4½ per Cent. Deb. Stk. (red.) .	92 —94	4 16 0	Jan, July	93½	93
5	4/9	Calcutta Elec. Supply Ord.	5½—6½	6 2 0	April, Oct	..	..
100	7/2	†Canadian Gen. Elec. Co. Com. St.	88 —90	7 16 0	..	89	88½
100	5%	†Castner Electrolytic Alkali Co. (of U.S.A.) 1st Mort. Stl. Debs.	92 —97	5 2 6	Jan, July	..	..
500	6	Elect. Development Co of Ontario	83 —86	5 16 0	..	..	..
5	..	Elec. Ltg. & Trac. Co. of Aust. 6 per Cent. Cum. Pref.	2 —2½	..	Feb, Aug	..	..
St.	5%	† Do. 5 per Cent. Deb Stock	82 —86	5 16 0	Jan, July	..	..
St.	5%	†Elec. Supply Co. of Victoria 5 per Cent. 1st Mort Deb. St.	90 —93	5 7 6	Jan, July	..	..
St.	6%	†Indian Elec. Sup. & Trac. Co. Constn Deb. St. Rd.	60 —60	10 0 0	Jan, July	62½	61½
100	0 3	Kalgoorlie Elec. Power & Ltg. Ord. ...	—	..	..	..	..
1	0/7½	Do. 6 per Cent. Cum. Pref	[illegible]	7 16 0	April, Oct	¾	..
St.	5%	Madras E. S. Corp. 5 per Cent. Constn Deb. St.	85 —90	5 11 0	April, Oct	..	..
500	5%	†Mexican Elec. Light Co. 5% 1st Mort. Gold Bonds	81 —[illegible]	6 2 0	..	84	81½
St.	$1	†Mexican Lt. & Power Co. Cap. St. .	54½—[illegible]	..	..	[illegible]	[illegible]
500	5%	Do. 5% 1st Mort. Gold Bonds	87 —88	5 11 0	..	87½	87
100	6%	Montreal Lt. Ht. & Power Co. Cap. St.	90 —91	6 1 0	F,My,A,N	90½	..
1	1/0	River Plate Electricity Co. Ord.	[illegible]—1	6 0 0	April .		
1	1 7½	Do. 6 per Cent non Cum. Pref.	[illegible]—1	6 0 0	May		..
St.	6%	Do. 6 per Cent. Deb. Stock ..	94 —97	6 3 6	Jan, July	..	..
5	3/0	Rosario Elec. Co. 6% Pref. (1-20,000)	4⅞ —5⅛	5 17 6	April, Oct	..	..
100	$1	Shawinigan Water & Power Co. Cap. St.	71 —73	5 10 0	..	..	.
.	5%	Do. 5 per Cent Bds.	100 —102	4 18 6	Jan, July	..	..
..	7 3/0	Victoria Falls Power Co. Pref..................	⅝ ¾	—	Jan, July	..	—

* In calculating the yields allowance has been made for accrued interest but *not* for redemption. † Ex dividend. ‡ The London Stock Exchange Committee have declined to quote these

THE ELECTRICIAN:

THE OLDEST WEEKLY ILLUSTRATED JOURNAL OF

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CONTENTS OF THE CURRENT NUMBER.

(For Contents to MINING SECTION see after p. 486.)

NOTES.

"The Electrician."—Mining Issue.

COMPLAINT is often made, not without justice, though it is hard to see how the fault can be rectified, that books dealing with engineering subjects are far from up-to-date. By the time an improvement has reached the pages of such a work its freshness has to a great extent worn off, and it has frequently itself been superseded by something better fitted to perform its duties. To call attention to the latest results of industrial research is, therefore, the duty of the technical journal. But, unfortunately, this leads almost necessarily to very scattered information, and to obtain a general idea of the position of one particular branch requires a great deal of laborious searching through many volumes. It is to avoid this, and at the same time to give a concise account of the application of Electricity in Mining Work, that we have prepared the special issue of *The Electrician* which we publish to-day. This issue contains not only a review of the latest improvements made by manufacturers in their specialities, which in themselves mark with great clearness the march of progress, but includes articles on special subjects written by men well qualified in these branches of the industry. We have endeavoured to include all shades of opinion within its covers, and if it fulfils its object by giving an idea of the increasing use of the electric drive in working one of the most important of our national resources we shall be amply satisfied.

Electric Cabs.

IT is now a good many years since electric cabs were placed on the streets of London; unfortunately, although generally appreciated, they came to an untimely end, for reasons which were not very fully explained. We are glad to note that a further attempt is to be made in this direction. The Electromobile Co., after many years' experience with private electric carriages, is promoting a company which will place at first 100 electric taxicabs on the London streets, the number to be finally increased to 500. The cabs are to be four-seated, and capable of carrying a good supply of luggage on the top; they are to be supplied by the Electromobile Co. at £360 each (excluding batteries, tyres and taximeters), and batteries at £60. As will be seen from the figures which we give elsewhere, a sufficient sum is to be placed to reserve to replace the chassis and bodies in seven years. The batteries and tyres are to be maintained entirely out of revenue. It appears that the Electromobile Co. is prepared to maintain and charge the batteries at the rate of 3d. per mile, and we gather that the cost of tyres is estimated at 1½d. per mile.

FROM the sum given for electricity and battery maintenance per day per cab—namely, 9s. 2d.—it appears that the daily run is expected to be on the average about 37 miles. Each cab is estimated to earn £2 per day. These figures we cannot take seriously. If they are to be realised, the earning power will be over 1s. per mile; not merely per mile run with passengers, but per mile run total. Certainly this would seem to be optimistic. Generally in such cases, the earning capacity is estimated at 35s. to 36s. per day, and the daily run per cab at 55 miles. Even having regard to extras, the sum earned per cab per mile is not likely to exceed 8d. per mile total, and the unproductive mileage is not likely to be less with electric than with petrol cabs, which do not necessarily return to the garage so often. Consequently to earn £2 per day would mean more nearly a run of 60 miles than 37. Moreover, receipts will fall off as such cabs become more numerous. In regard to tyres, the provision made may be sufficient, though the weight to be carried is, of course, greater than in the case of petrol cars.

With regard to the general question of electric cabs, there are, of course, well recognised difficulties. The chief of these is the fact that it is impossible to control the driver very effectively, and unless he is severely restricted to a mileage per charge very much below the mileage of which the battery is capable, he will be liable to damage the cells. There is also the competition with existing petrol cabs, and as the latter do not suffer from any restrictions as regards distance the electric vehicles are at a disadvantage. On the other hand, if the electric cab is to achieve success it is more likely to be successful in the hands of a company such as the Electromobile Co., which has large experience on which to work, though of a slightly different kind, than in any other way.

Testing Departments.

THE Paper presented by Mr. H. A. RATCLIFF before the I.M.E.A. last week will doubtless have impressed many station engineers, as it impressed us, with the fact that a testing and standardising department is an expensive luxury, which can only be indulged in by a large undertaking. It is the misfortune rather than the fault of electricity supply that it should need the assistance of a testing department. Certainly in the larger towns it would be advantageous if the cost of such departments could be entirely saved, a statement which postulates that for the small undertakings testing departments have no existence. Since the rise of technical schools, what may be termed the purely research work of an electricity department could very well be carried out with the equipment with which these institutions are provided. Whether the more tedious and protracted work of meter testing is really necessary at any other spot than the maker's works is another, and perhaps more debatable, matter. There must be many large electricity works in which the importance attached to testing and standardising is not taken so seriously as it appears to be at Manchester. The question of co-operation, raised by Mr. RATCLIFF, may be taken as a hint that his department should in this way earn some return for the expenditure made upon its equipment. Although we gather from the Paper that work of this character is undertaken for outside authorities and companies by the Manchester Corporation, no engineer contributing to the discussion spoke in favour of the centralisation of testing apparatus. Presumably the tests are considered accurate, despite the fact that considerable transport of the apparatus would be necessary. This in itself is the main difficulty, and one of the strongest arguments for independent test rooms in touch, in some way, with the nearest laboratory, which in its turn might well be allied with the National Physical Laboratory. We should have liked more time to have been spent at the Convention on the discussion of this important problem.

The Late Mr. London.—The five Mohammedan natives who applied to the Judicial Committee of the Privy Council for leave to appeal against sentences of death or imprisonment passed upon them in British East Africa for the murder of Mr. Tom London, have failed. Their lordships refused the application.

Cable Interruptions.	**Date of Interruption.**
Cayenne–Salinas	May 12, 1908
Las Palmas–Arrecife	May 18, 1908

The Daylight Saving Bill.—The Prime Minister stated on Wednesday night that no facilities would be given by the Government for passing this Bill.

Tramways and Light Railways Association.—The Duke of Argyll, K.T., presided at the annual congress of this Association yesterday, Thursday. The meeting was held in the Congress Hall of the Franco-British Exhibition. Sir Clifton Robinson lectured on "The Tramways of the World," and Mr. A. H. Gibbings read a Paper on "Tramway Rail Joints." To these we shall refer in our next issue.

Obituary.—We regret to record the death of Lord Blythswood, which occurred on Wednesday evening last at his seat, Blythswood House, Renfrewshire. The late peer was best known in scientific circles for the keen interest he took in the development of physical science. He had a finely equipped laboratory at Blythswood, and spent a great deal of his time in experiments on electricity and physics generally. In late years he was much occupied with problems of aerial navigation. He was elected a Fellow of the Royal Society in 1907.

University of Leeds.—On Tuesday last T.M. the King and Queen visited Leeds and opened a new wing of the University buildings. This extension has become necessary owing to the growing demands of the University, and contains as its special feature new rooms and equipment for the Department of Electrical Engineering. We understand that their Majesties were much interested in the various electrical apparatus, the details of which were explained to them by Mr. G. D. A. Parr, lecturer in electrical engineering at the University.

Automatic Telephony.—According to the Paris *Daily Mail* the French Postmaster-General has decided to try the Lorimer automatic telephone system. The experiment will be made at Lyons on an exchange with 200 subscribers. It will be remembered that the Lorimer automatic telephone, which is a Canadian invention, is fitted at the subscriber's end with a set of discs by which any combination of figures can be obtained and corresponding impulses transmitted to the exchange. These impulses are said to make the desired connection within 15 seconds, and the subscriber then rings up. Disconnection is effected in the ordinary way by replacing the receiver.

Marseilles Electrical Exhibition.—In connection with this exhibition an International Congress, dealing with the applications of electricity, will be held at Marseilles from September 14th-20th. The object of the Congress is the examination of the technical, commercial and administrative problems that have cropped up in practice during the last few years. The discussions will be divided into a number of sections presided over by eminent French engineers. Anyone wishing to become a member of this Congress should communicate with the Secretary at 63, Boulevard Hausmann, Paris. The subscription is 20 fr., and special reductions will be granted by the railway companies to members.

Mining Exhibition at Olympia.—The World's Great Mining Exhibition at Olympia opens to-morrow, July 11th, when Lord Strathcona and Mount Royal will perform the opening ceremony at noon. The vote of thanks to his lordship will be proposed by Lord Airedale and seconded by Mr. C. E. Rhodes, M.Inst.C.E., President of the Institution of Mining Engineers. This exhibition, which remains open until July 31, is attracting great interest in mining circles. The South Wales Institution of Mining Engineers, who are holding their annual meeting in London during the present week, will visit the exhibition on the opening day and will be entertained to tea in the Diamond Prospecting Camp.

The Alternating current Arc as a Frequency Transformer.—In a recent number of the *Elektrotechnische Zeitschrift* Peukert explains that the alternating current can be satisfactorily substituted for the direct-current arc in the Duddell circuit for the generation of high-frequency oscillations. For this purpose the author used an arc taking from 1 to 5 amperes on a 50 cycle circuit, thus obtaining oscillations of frequencies varying up to 10'. Greater power can be obtained from such a circuit by connecting a number of lamps in series or by enclosing the arcs in some inert gas. On a 3,000 volt circuit the author used 10 lamps in series, and obtained both steady and quiet burning.

Trawlers and Submarine Cables.—In view of the recent interruptions of trans-Atlantic cables in the waters off the south-west coast of Ireland, which are believed by the cable companies to be due to the operations of trawlers, the Postmaster-General, after consultation with the President of the Board of Trade, has appointed a small committee:—

To inquire whether injury is caused to submarine cables by the operations of trawlers; and, if so, to consider and report what steps it is desirable and practicable to take to prevent such injury.

The Committee is constituted as follows: Sir John C. Lamb, C.B., C.M.G. (chairman); Mr. W. R. Culley, I.S.O., Submarine Superintendent in the Engineering Department of the Post Office; Commander G. C. Frederick, R.N., Harbour Department of Board of Trade; Mr. C. E. Fryer, I.S.O., Superintending Inspector of English Fisheries; Mr. W. S. Green, C.B., Chief Inspector of Irish Fisheries; and Commander G. M. Marston, of the Hydrographic Department, Admiralty.

Mr. F. J. Brown, of the secretary's office, G.P.O., will act as secretary, and applications from persons desiring to offer evidence should be addressed to him. The first meeting was held on Wednesday, when the Committee decided that the press should not be admitted. The sittings will be resumed on Thursday next, when the evidence of cable companies' representatives will be heard, and on Friday, when evidence will be given on behalf of the trawling interests.

Hydro-Electric Development in India.—It is announced that a hydro-electric generating station is being erected on the river Jhelum in the Kashmir valley, which, when complete, will be capable of developing 20,000 H.P. The utilisation of the water power available has become increasingly necessary in this district, for coal is difficult to obtain and wood, which has been used up to the present, is becoming more and more scanty. The Jhelum has always plenty of water even in the dry season, being fed from the Himalayan streams and glaciers. The intake is at Rampur, and from this place a flume $6\frac{1}{2}$ miles long has been tapped off to the generating station which is 50 miles from Srinagen, the capital of Kashmir. It is proposed to supply power for lighting and traction purposes to the latter place and also to Rawal Pindi, a distance of 130 miles. The flume is capable of carrying 500 cubic ft. per second, and its internal dimensions are 8·3 ft. by 8·5 ft. At present only four 1,000 kw. generators are being erected. They will be driven by tangential water wheels fitted with Lombard governors. Current will be transmitted at 60,000 volts by a double-pole line. It is intended to use a part of the power for reclamation purposes, the capacity of the river being increased by the use of electrically driven dredges will greatly help this work.

Wireless Telegraph Notes.—The British Commercial Attaché at Yokohama reports that arrangements have been completed for a wireless telegraph service from a station at Choshi (Shimosa Province), near Cape Inuboe, the most easterly point in Japan. Messages can be despatched to vessels within 120 nautical miles of the station. The charges are treble the ordinary land rates, or double if the telegram does not pass over the land wires. It is intended to establish public wireless stations later at Shiwomisaki (Kishu), Osezaki on the Goto Islands and Tsunojima (Choshu). Wireless apparatus has been installed on the steamships of the Nippon Yusen Kaisha and Toyo Kisen Kaisha, which sail to the United States.

At the annual meeting of the Society of Wireless Telegraph Engineers, Boston, Mass., on June 1st, the secretary's report showed that at each of the 10 meetings held during the last year a Paper bearing upon the subject of wireless telegraphy was presented. These included the following: "On the 'Skin Effect' in Oscillation Circuits," by J. Stone Stone; "On Tubular Condensers," by O. C. Roos; "On the Field for Wireless Telegraphy in the Philippine Archipelago," by C. E. Russell; "On an Experimental Verification of Oliver Heaviside's Theory of the Induction of Currents in Cores," by Dr. Roy T. Wells; "On Experimental Observations on the Audion," by Sewall Cabot; "On Experimental Observations on the Loss of Energy in the Dielectrics of Coils in Oscillation Circuits," by E. R. Cram. The following officers were elected for 1908-9: President, Mr. J. Stone Stone; vice-president, Mr. E. R. Cram; secretary, Mr. C. E. Russell; treasurer, Dr. Roy T. Wells. The following are on the board of managers: Messrs. F. A. Kolster, A. P. Browne, C. C. Kolster.

The British Post Office authorities announce that on the coming into force of the International Radio-telegraphic Convention certain modifications in connection with the facilities offered for wireless communication with ships will take place. The charge for communication between the coast stations and ships as set out in the Marconi Co.'s monthly list will be increased to 10d. per word without any minimum per message. The ordinary rate of ½d. per word with a minimum of 6d. per message has to be added to the charge for a wireless telegram, making the charge for a message of, say, eight words 7s. 2d. A private message sent to one of H.M. ships through the Marconi stations under a similar modification becomes 4s. 6d. for eight words. The name for wireless messages is officially ordered to be "Radiotelegrams." Further arrangements are now perfected, and particulars can be obtained at telegraph offices throughout the country.

Reuter reports that the captain of the Italian despatch vessel "Staffetta," now at Mombasa, telegraphs that the wireless telegraph stations at Mogadoxo, Brava, Giumbo and Merka are open and working regularly.

The *Pall Mall Gazette* announces that the arrangements for the installation of wireless telegraphy at the Admiralty are virtually complete. A very long bamboo pole, 120 ft. long, has been put in position on the central dome of the new Admiralty building. The operating staff have arrived and, it is understood, will be independent of the Post Office in its communication with the various ships at the naval manœuvres hundreds of miles away. In connection with this installation, Mr. Claude Hay, in the House of Commons last week, asked whether the system of wireless telegraphy used by the Admiralty required so much horse-power for long-distance messages that it was not possible to send messages any considerable distance from ship to shore; whether there were other wireless systems which did not require as much horse-power; and whether the Government would appoint a Committee of experts to advise the Admiralty as to the best system to use in the Navy. Reply was given in the negative. So far as was known, there was no other system which required less horse-power than the Admiralty system to ensure reliable communication.

According to the *Electrical World*, the Detroit & Cleveland Navigation Co. has wireless telegraph stations at Buffalo, Cleveland, Detroit and Port Huron, and will establish another station at Toledo. All the steamers of the company are equipped with Clark wireless telegraph apparatus.

Wireless Telegraphy in Germany.—The German Imperial Post Office have published a list of German radio-telegraphic stations for public service. The total number of these stations (coast and board) is 135, having ranges between 100 km. and 600 km. Of these, 113 stations are equipped on the German Telefunken system, 16 stations on the Marconi system and six stations on the De Forest system. The coast stations at Arcona, Borkum, Bremerhaven, Buelk, Cuxhaven, Heligoland, Norddeich and Tsingtau are all open for public and limited public service, and also all lightship stations are open for public and limited public service. Further, all radio-telegraphic ship stations are obliged to communicate with other ships or coast stations irrespective of the system on which they may be equipped. The warship stations are only available for the service of the Imperial German Navy.

ARRANGEMENTS FOR THE WEEK.

FRIDAY, July 10th (to-day).

THE TRAMWAYS AND LIGHT RAILWAYS ASSOCIATIOL.

11 a.m. Short Address by Mr. A. L. C. Fell in the Congress Hall, Franco-British Exhibition.

11:30 a.m. Lecture on "Rail Corrugation," by Prof. C. A. Carus-Wilson.

7:30 p.m. Dinner in the Banqueting Hall, Garden Club, Franco-British Exhibition.

SATURDAY, July 11th.

THE WORLD'S GREAT MINING EXHIBITION.

12 noon. Opening Ceremony at Olympia by the Rt. Hon. Lord Strathcona and Mount Royal.

THURSDAY, July 16th.

JUNIOR INSTITUTION OF ENGINEERS.

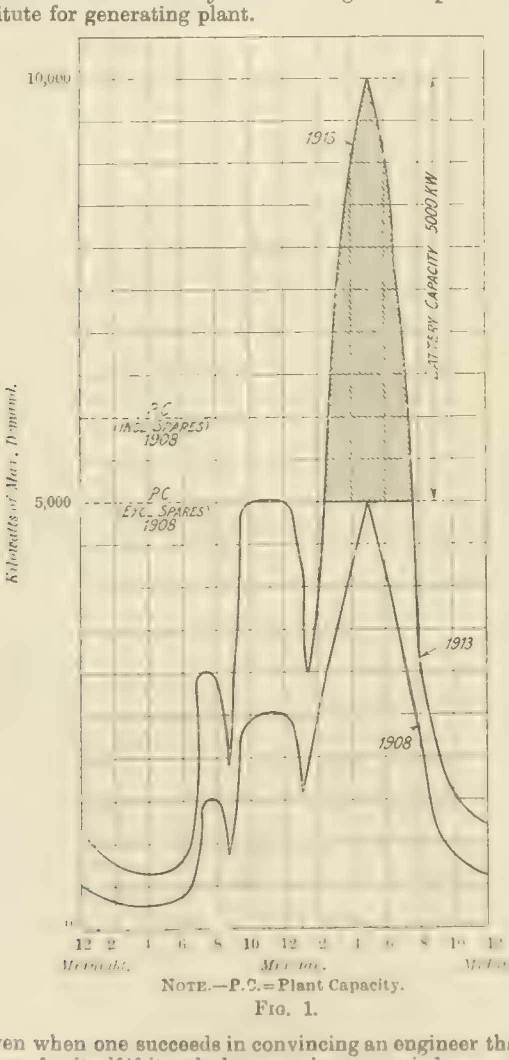
Visit to the new Luton Works of the Davis Gas Stove Co.

"A.C." ACCUMULATOR SUB-STATIONS AND THE USE OF ACCUMULATORS FOR PEAK LOADS.*

BY A. M. TAYLOR
Assistant Electrical Engineer, Birmingham)

Summary.—After referring to the very extensive use of accumulators in America and in Germany, the author considers the possibility of putting in accumulators instead of generating plant to deal with the peak load of a station as the output increases from year to year. He considers a special case in which the maximum load increases over a period of five years from 5,000 kw. to 10,000 kw., it being proposed to deal with this increased load entirely by means of accumulators. The author shows that there is a possibility of materially lower costs, and he advocates the use of batteries for such a purpose, even in the case of alternate current sub-stations.

1. *Introduction.*—Many causes have conspired to delay the introduction of accumulators into central stations in this country for the purpose of supplying energy for light and power during the time of peak load. The non-fulfilment of the great expectations raised some 20 years ago has had its reaction, and numerous failures in actual practice have caused central-station engineers to lose confidence in all cells of every make for light and power supply as a substitute for generating plant.



NOTE.—P.C.=Plant Capacity.
FIG. 1.

Even when one succeeds in convincing an engineer that a battery will pay for itself if it only lasts as short a period as, say, five years, and that, therefore, there cannot be much risk in installing it (as guarantees for much longer periods of maintenance can be had, at reasonable rates, and from responsible parties), the said engineer will hesitate to put it in directly it is brought home to him that, in order to ensure its paying under these conditions, it must be relied on as a real, and not merely a nominal, substitute for generating plant.

In Germany and the United States of America great confidence is shown in batteries; tables are given in the Paper from which it appears that the aggregate capacity of batteries used in the supply stations of Berlin is 46,180 kw. and in those of New York 49,000 kw.

2. *Energy Losses.*—A great deal is often made of the inefficiency of accumulators, and the author feels that this point is one that requires early attention in the present Paper. It requires to be realised by engineers that, if cells are installed exclusively to take the peak of the load, and are not discharged unnecessarily, the value of the energy wasted in the cells and accessories is only of the order of 1 or 2 per cent. of the value of the revenue introduced by said cells. Consequently, their inefficiency is not nearly so serious a matter as most people imagine.

Consider Fig. 1, the lower half of which shows a typical load curve for a station having a present maximum demand of 5,000 kw. All further extensions are assumed to be carried out with batteries till, in 1913, the maximum demand reaches 10,000 kw. Neglecting changes in the load factor, we may assume that, say, 5,000,000 units are sent out in 1908, and 10,000,000 units in 1913. The battery has thus introduced a revenue of, say, £31,200 per annum (taking 1½d. as an all-round price for light and power and neglecting losses in transmission in each case). What are the losses due to the inefficiency of the battery and adjuncts?

From figures published for the maximum demands at Neptune Bank by Messrs. Merz & McLellan the lower curve in Fig. 2 has been compiled, as a rough approximation to the relative periods of time which the station was working during the year on different loads.

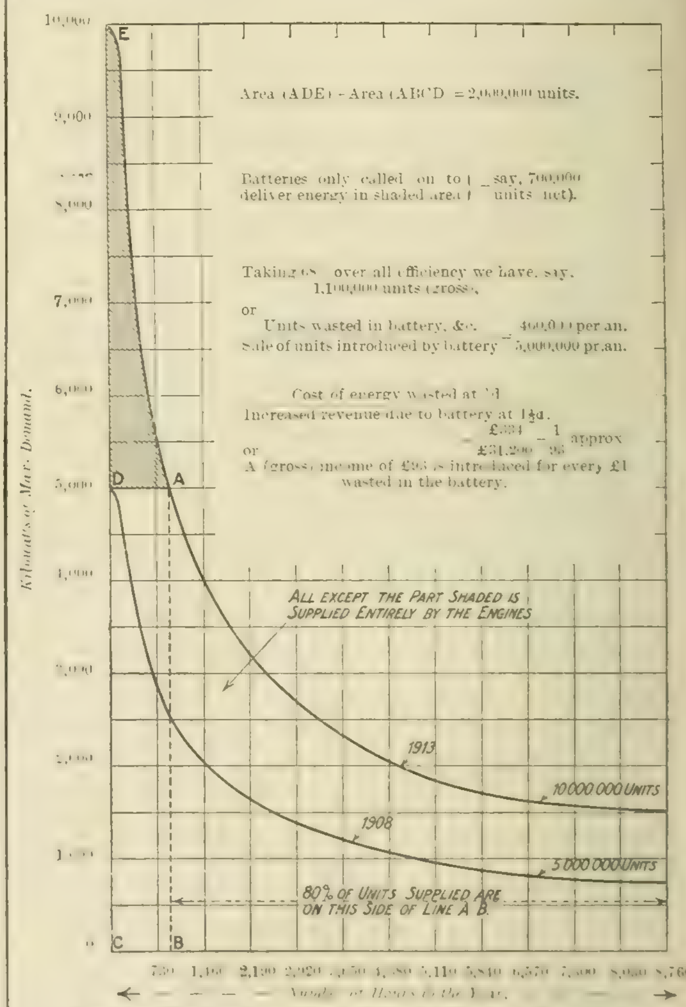


FIG. 2. DIAGRAM SHOWING MINIMUM USE OF BATTERIES.

Referring to the upper curve of this figure which embraces the extra 5,000,000 units "introduced" by the battery, it will be noticed that the batteries are only called upon to deliver energy when the peak exceeds 5,000 kw. They are, of course, charged when the load is small and the engines and boilers inefficiently loaded.

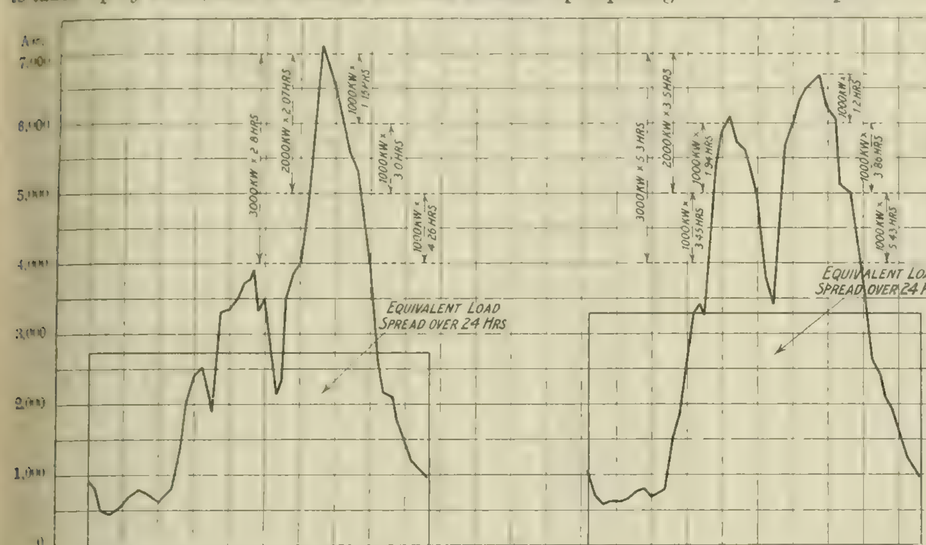
To simplify the question the author, in the notes accompanying Fig. 2, has only considered the emplyment of the battery in the winter, and for discharging at the heaviest peaks; the extra losses involved in the occasional charges and discharges required during the summer are not serious.

Referring to the notes accompanying Fig. 2, it will be noticed that some 1,100,000 units are put into the battery, of which some 700,000 are reclaimed as "useful" work. In the figures for the increment in fixed charges due to the introduction of the battery the author debits the "extra" units introduced by the battery with the whole of the increment in the fixed charges of the station, as well as with the capital charges on account of the cells; consequently it is unnecessary to debit the 400,000 "wasted" units with anything beyond the coal, water and petty stores consumed. These

* Abstract of a Paper read ... July 3rd, at the Convention of the Incorporated Municipal Electrical Association.

items are sufficiently covered by the ½d. allowed. The cost of 400,000 units at ⅕d. (or £334) is, then, the sum which we must set off against the revenue of £31,200, introduced by the cells, on account of the "wasted" units in the battery.

3. *Proportion of Peak taken up.*—The capital cost of the cells depends, of course, very largely on the proportion of the peak which is taken up by them, each successive kilowatt so taken up requiring a longer period of discharge. This will be evident from Fig. 3, the left hand diagram of which shows the peak load of a station in a large industrial town, and may be taken as a typical case. Referring to this figure it will be noticed that the first thousand kilowatts taken up require only an average duration of discharge of 1·15 hours, the second thousand kilowatts require three hours, and the third thousand kilowatts 4·26 hours. The average duration of discharge for 3,000 kw. taken up is as shown, 2·8 hours, and for 2,000 kw. it is 2·07 hours.



Mid-December Peak No Fog. Mid-January Peak, Heavy Fog.

NOTE.—Both curves refer to the same town

Capital cost of cells (only) to take up $\frac{3}{7}$ of the peak (Excl. Fogs) £8 10s. per kw.
" " (") " $\frac{3}{7}$ " " (Incl. Fogs) = £11 15s. per kw.
" " (") " $\frac{3}{7}$ " " (Excl. Fogs) - £10 per kw.
" " (") " $\frac{3}{7}$ " " (Incl. Fogs) - £15 per kw.

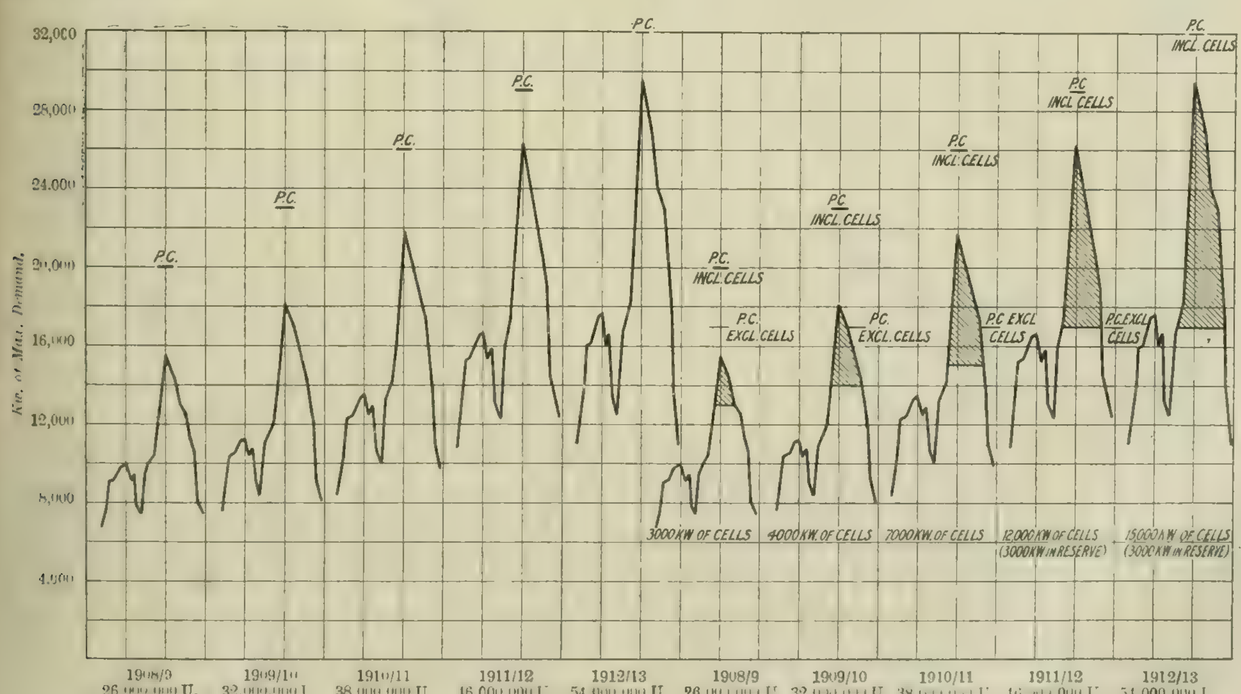
FIG. 3.

On the right-hand side of Fig. 3 is given a peak load curve for the same station during an exceedingly heavy fog, and the corresponding hours of duration for each successive thousand kilowatts on either of the two humps of this peak are given in horizontal figures, the equivalent hours of duration for the joint load of the two peaks being given in vertical figures; the notes at the top of the figure show the capital cost per kilowatt of maximum demand taken up by the cells, for different proportions of the peak, both for the left hand and for the right-hand diagrams. It will be noted that the cost for taking up $\frac{3000}{7000}$ of the peak in the right-hand diagram is very little in excess of that of taking up $\frac{3000}{7000}$ of the peak in the left hand diagram.

In the comparison which will now be made between the cost of generating plant and batteries, it is assumed that no provision is made for dealing with fog loads, there being numerous towns in the country where such loads are not materially felt. Even where the contrary is the case, the battery can still hold its own, provided that a smaller proportion of the peak is taken up.

4. *Cells* v. *Generating Plant.*—In order to obtain a clear idea of the various economies, both in capital cost and running expenses, which may be effected by the introduction of cells to take the peak of the load for light and power work, a typical station has been selected, in which the annual development is assumed to progress at a healthy rate, and the effect is noted of installing accumulators to deal with the peak of the load in place of generating plant, and the annual expenses are estimated in the two cases over a number of years.

On the left-hand side of Fig. 4 is shown the assumed annual development of the peak of the load for a large steam power station, and the plant capacity allowed (including spares) to meet same. On the right-hand side of Fig. 4 is similarly shown the same station carried over the same term of years by means of cells added to the existing generating plant, no further generating plant being put down. In both cases only sufficient spare plant has been allowed to cover the chance of a breakdown of one of the generating units. This may be criticised as insufficient, but owing to the large capacity of the battery for short-period discharges, the comparison would undoubtedly show still more favourably to the latter if a larger margin of spare plant capacity were allowed. In Table I. are given the estimated figures for the development of a steam station whose demands are shown by Fig. 4, no battery being considered. The annual costs are broken up into the items of running costs and fixed charges, and the various figures selected are taken from the fairly typical case of a large manufacturing town. The method of treating the figures is, the author thinks, clearly shown in the table, and consists in deducting from the so-called total costs an item for coal and stores representing the true running cost (which for 1907-8 is shown at £15,000).



NOTE.—U = Units. P.C. Plant capacity

FIG. 4.

The balance of the total cost (£41,030 for 1907-8) is divided by the kilowatts of maximum demand, and entirely debited as a standing charge. In dealing with interest and sinking fund charges, it may be explained that in these tables the figure given for the capital cost per kilowatt of maximum demand, represents that spent both on mains and generating stations, &c., up to date, plus a sum for the needful extensions for the next winter's load in each case.

It may further be explained that the drop in the kilowatt capacity for 1908-10 is due to the assumption that 2,000 kw. of old plant has been scrapped to make way for more efficient plant. This, of course, has no bearing on the real question at issue, and may be discounted, if desired.

In Fig. 5 the results obtained in Table I. are plotted in the form of ordinates for three years out of the series, and in Fig. 6 the corresponding expenses, with the accumulators considered in Fig. 4, are

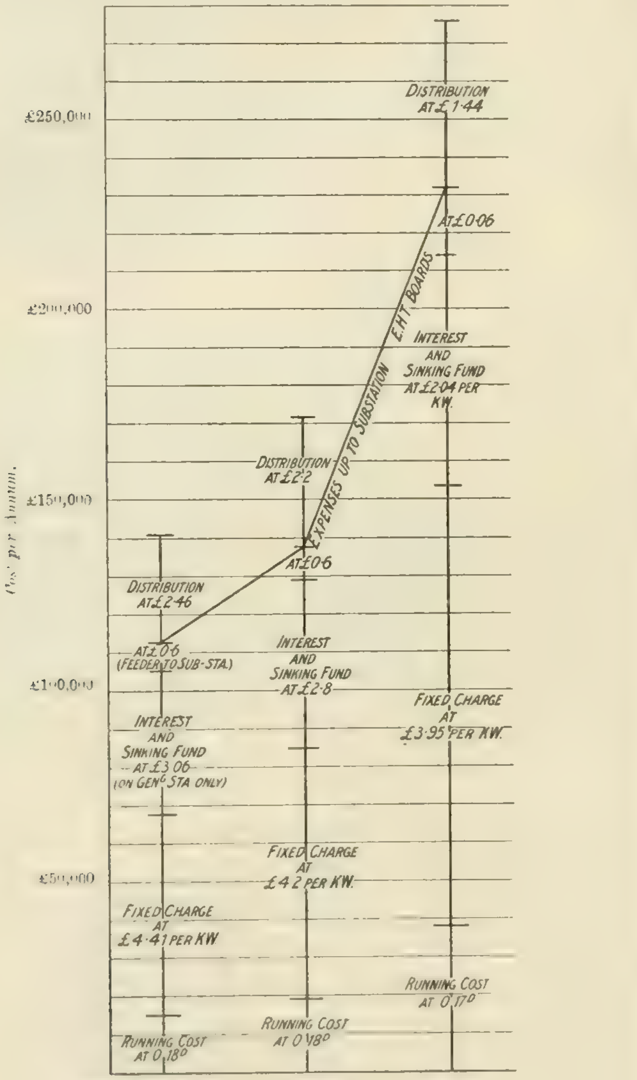


Fig. 5.—Annual Costs Incurred with Steam Extensions.

similarly expressed. It will be noted in Fig. 6 that the steam expenses incurred in the year 1907-8 are taken as the basis, and it is assumed that since no further generating plant is added, the fixed charges and interest and sinking fund charges will remain constant.*

To the total of the steam plant charges incurred in the year 1907-8 is added a sum representing 12 per cent. on the cost of the cells added during the year 1908, and the total so obtained is plotted as the cost for the year ending in March, 1909. The capital cost of the cells and their accessories, inclusive of building, has been put in at £15 per kilowatt throughout. In the years 1910 to 1911, 1911 to 1912 and 1912 to 1913 a small sum (£1,000) has been added to cover the cost of extra wages for attending to the cells and apparatus.†

With reference to the 12 per cent. taken on the cost of the cells in the above figures, it may be explained that interest charges on the cells are taken at 3 per cent. and depreciation and maintenance charges at 9 per cent. It will also be noted that in Fig. 6 the savings introduced by the cells, as against steam plant, are £12,000, £24,000, £37,000, £46,000 and £64,000 respectively, in the five years following 1907-8; a total saving of £183,000.

The author also showed a diagram in which he had taken the increments each year showed over 1907-8 in annual expense, and had divided these by the corresponding increments in units sold, with the result that for the steam plant the costs of each extra unit sold are 1·09d., 0·9d., 0·91d., 0·86d. and 0·85d., whereas with the combined steam and accumulator plant the corresponding costs are 0·62d., 0·44d., 0·40d., 0·42d. and 0·39d., with the result, as already stated, that the total net saving in five years is £183,000 after providing for the payment of interest, depreciation and maintenance on the accumulators, representing an average saving of £36,600 per annum. It may be pointed out that the £64,000 saving in 1912-13 would pay an additional 10½ per cent. interest on the total investment in cells and accessories, including that of 1912-13.

As a further illustration of the relative costs of the cells and of the steam plant, the author has resolved the cost into curves connecting load factor and price per unit, which are shown in Fig. 7. In this figure the cost for the battery itself and the increment in fixed charges introduced by it is shown by the curve AB, the corresponding curve for the increment in the generating plant (excluding distribution) being marked CD on the above figure (details of construction are given in Table II.). To show the difference that would be obtained in favour of the electric accumulator system, were we to compare its added costs with the existing costs of the steam system, we have only to compare curve AB with curve EF (the latter representing the costs for 1907-8 for any load factor, as deduced from the ordinate plotted for a particular load factor in Fig. 5). The author submits that, in estimating the saving introduced by putting down accumulators, it is not in certain cases unfair to take the difference in costs between the curves EF and AB as

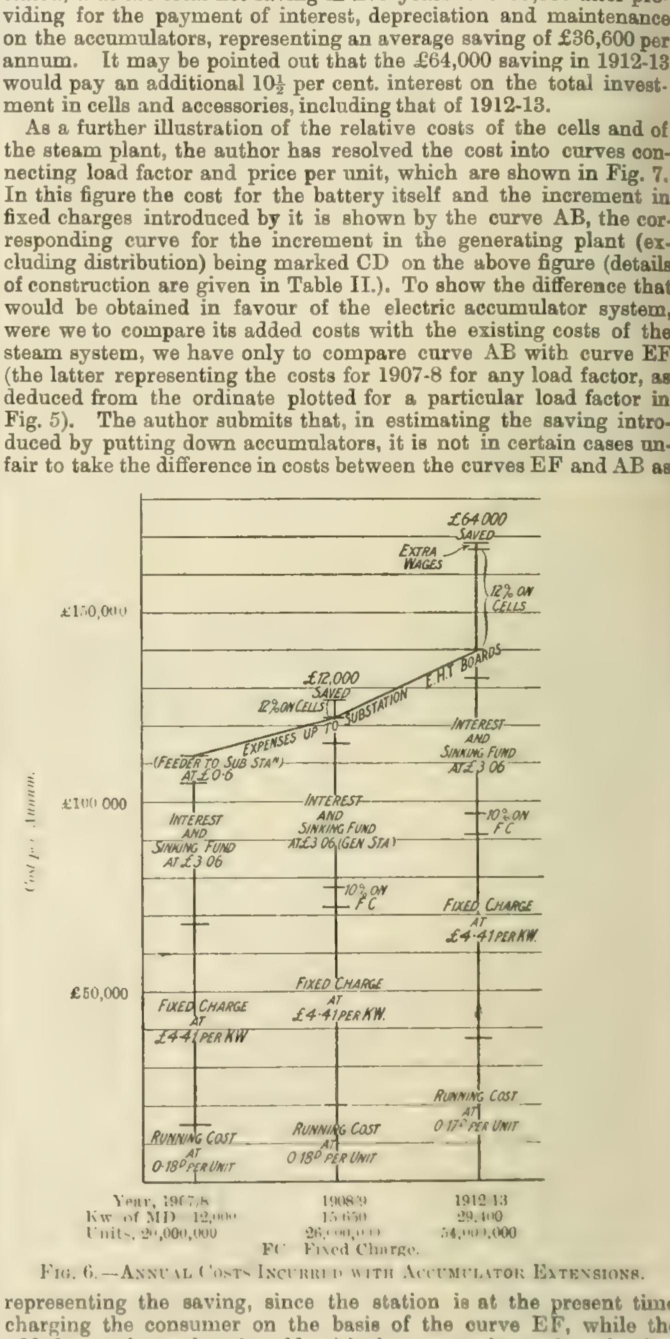


Fig. 6.—Annual Costs Incurred with Accumulator Extensions.

representing the saving, since the station is at the present time charging the consumer on the basis of the curve EF, while the added cost for each unit sold with the accumulators is only that represented by the curve AB. Each extra unit sold (due to the growth of the load) would therefore bring in, if present prices remained unaltered, a net profit represented by the difference between these two curves; or, say 0·85d. per unit on a 16 per cent. load factor.

5. *Alternating Current Sub-Stations.*—The author trusts that, in the examination of the energy losses incurred by the accumulator system (*see* sec. 2 of appendix) it will be conceded that the cost of the energy used in charging the cells is so very low that the inefficiency of the cells and accessories is much more than compensated by the gain in coal economy on the "interest-paying" units. The result of calculations which he has made in conjunction with the employment of sub-stations has satisfied him that there is a future for such a scheme (particularly in connection with long-distance transmission of power), the batteries being put down here rather than at the generating station.

* A consideration of Fig. 8 and the remarks in the Appendix will show that the author has been very liberal to the steam plant.

† This is apparent only in the last year in the figures, as we have found it necessary to omit intermediate years.—Ed. *E.*

Details cannot be here entered into, but, from inquiries made of accumulator companies, it is found that, where cells of very large individual capacity can be installed, it is possible to obtain a discharge representing 6 kw. (on a three-hour basis) for every square yard of floor space, for a single tier of batteries; and where there are two tiers this would be raised to 12 kw., or if three tiers 18 kw. per square yard of ground space. These figures do not include any space for the rotary converters, or the boosters or auxiliary apparatus; but where the units are of moderate size, the extra floor space required for these is not at all serious. A separate building could be erected, if desired, where the cells were on a single floor only, for something under 7s. 6d. per kilowatt, and even where the cells were arranged on two floors, or even three floors, the cost of such a building need not exceed, say, 15s. to £1 per kilowatt, and, of course, the cost of maintenance of such a building is trifling compared with that of the cells. As regards the cost of land, this could generally be obtained at about 12s. per square yard, which, for a single storey battery, works out at 2s. per kilowatt, which is really quite negligible compared with the cost of the battery. It is, however, of course, often a matter of the greatest difficulty to get the land just where it is required, and hence it is highly desirable to adopt any means whereby the floor space required for the accumulators can be greatly reduced. In the smaller sizes of sub-stations, such as would be employed for prospecting purposes, and, in fact, up to 2,000 kw., the author believes that his low-voltage system of accumulators will be found very useful in reducing floor space (as well as capital cost), and he has taken advantage of the facilities which the employment of alternating currents offers for stepping down the voltage to produce a scheme which is at once cheap, flexible and easily extensible with the growth of the load in the sub-station. By this means it is possible to use the batteries to deliver alternating current of high pressure into the line at times of peak load, while at the same time delivering direct current of suitable pressure to the 'bus bars of the sub-station, and the author believes that this and other combinations will be found to be valuable as a means of relieving the main generating station at the time of peak load, as well as the feeders. The efficiency to be obtained on discharge, as between battery terminals

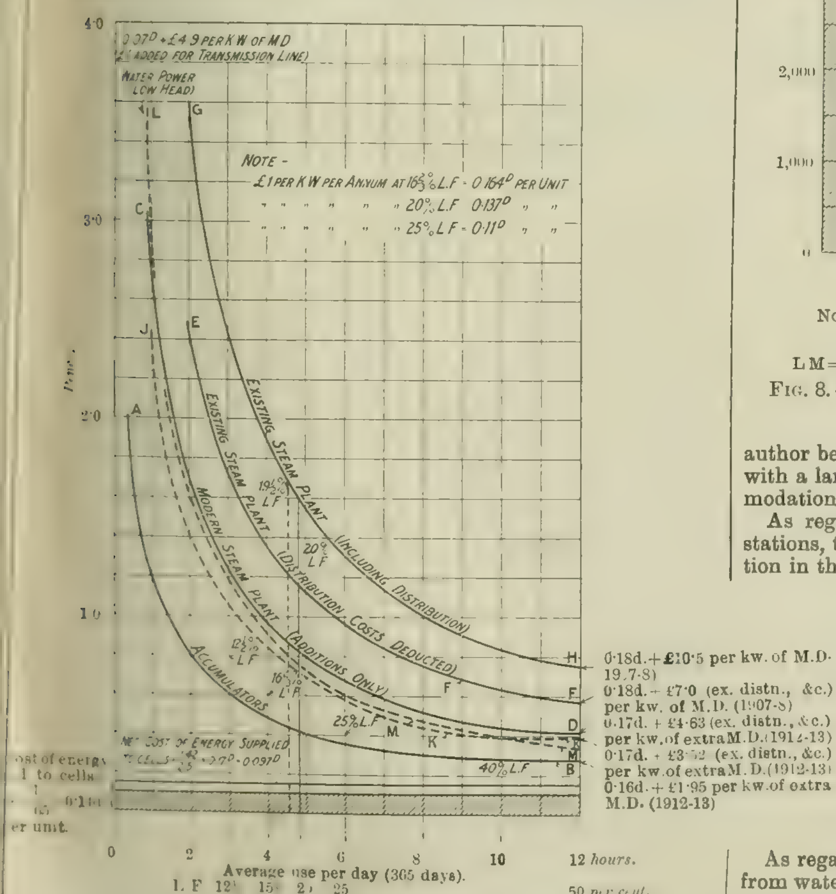
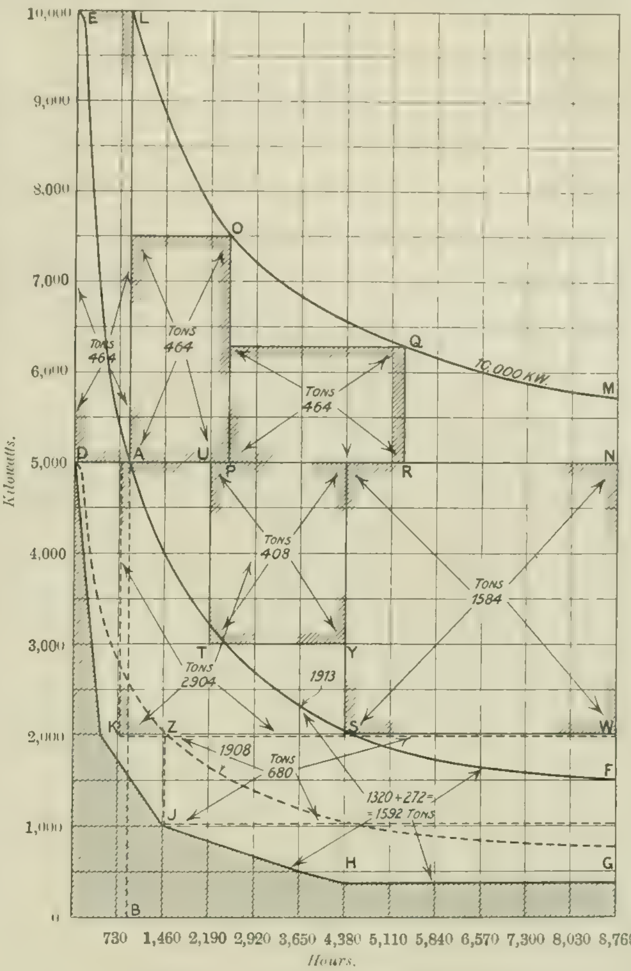


FIG. 7.—RELATION OF COST PER UNIT AND LOAD FACTOR.

and extra-high-tension alternating current 'bus bars, will, in a large sub-station, be found to be of the order of 93 per cent., and that between the battery and the sub-station direct current 'bus bars of the order of 87 per cent., and even in a small sub-station these figures would not be materially less than 90 per cent. and 82 per cent. respectively. It is further suggested that such a system may be found very helpful on long high-pressure lines, such as those on the outskirts of a power company, the accumulator in this case enabling a given amount of maximum demand to be met at a sub-centre for a very much less expenditure in extra-high-tension cables than would otherwise be incurred.

6. *Conclusions.*—The development which has taken place in the use of accumulators during the past nine or ten years in the United States has, compared with that in Great Britain, been prodigious, and is an answer to statements concerning unreliability, &c. The



NOTE.—All figures given on diagram are for boiler losses only.
Add for Engine Losses. { Area A F G J D = 165 + 34 = 199 tons. Area A D E L = 58 tons.
L M = Boilers under commission. E F = Kilowatts of demand.

FIG. 8.—DIAGRAM SHOWING EXTREME LIMITS TO WHICH THE USE OF BATTERIES MIGHT BE CARRIED.

author believes there is a strong case for accumulators in connection with a large modern station, where ample station and street accommodation for extensions does not exist.

As regards the introduction of accumulators into the smaller stations, the author believes that the causes of high coal consumption in these stations are not due altogether to the smallness of the engine and boiler units or even to their being of somewhat obsolete type, but rather to the greater proportion which the stand-by losses and the fixed charges bear to the total cost of operation. The use of cells, worked on the lines of his Fig. 8, would introduce great economies here.

The author suggests that Fig. 7 will be found helpful as showing at a glance and in a single diagram the net effect of using cells on the cost per (extra) unit for different (station) load factors, also the saving introduced by using cells as against modern steam plant.

As regards the transmission of power over long distances, such as from water-power centres, the author suggests that the facilities for increasing the radius of transmission (for a given limitation in E.M.F.) which the storage system offers, combined with the great advantage of having the reserve of power at the point where it is wanted, should be considerations of moment in introducing cells for such work.

Nine tables are included in the Paper. The first and second of these give particulars of the accumulators installed in electricity works in Berlin, Chicago, New York and other cities. In Table I. herewith we give the particulars contained in the following six tables, whilst the last table given by the author, which we reproduce as Table II. herewith, contains the basis of the particulars shown in Fig. 7.

Table I.

	1907-8.			1908-9.			1910-11.			1912-13.		
Units sold (estimated)	20,000,000			26,000,000			38,000,000			54,000,000		
Kilowatts demanded (estimated)	12,000			15,650			21,700			29,400		
Load factor (estimated)	19 per cent.			19 per cent.			20 per cent.			21 per cent.		
Plant capacity	14,000 + 3,000 kw. (new)			14,000 + 6,000			14,000 + 12,000			14,000 + 18,000		
	Per unit sold.	Per annum.	Per kw. of M.D.	Per unit sold.	Per annum.	Per kw. of M.D.	Per unit sold.	Per annum.	Per kw. of M.D.	Per unit sold.	Per annum.	Per kw. of M.D.
Coal	0·22d.	£18,300	...	0·21d.	£22,750	...	0·2d.	£31,700	...	0·19d.	£42,800	...
Oil, waste, &c.	0·019d.	1,580	...	0·02d.	2,170	...	0·019d.	3,010	...	0·019d.	4,280	...
Wages	0·132d.	11,100	...	0·13d.	13,000	...	0·10d.	17,400	...	0·095d.	21,400	...
		30,980			37,920			52,110			68,480	
Deduct— "Running cost"	0·18d.	15,000	...	0·18d.	19,500	...	0·17d.	26,900	...	0·17d.	38,200	...
		15,980	£1·33		18,420	£1·18		25,210	£1·16		30,280	£1·03
Repairs and maintenance, say	0·10d.	8,350	0·696	0·10d.	10,800	0·69	0·085d.	13,500	0·62	0·085d.	19,150	0·65
Rent, rates, &c., say	0·10d.	8,350	0·696	0·09d.	9,750	0·62	0·075d.	11,900	0·53	0·075d.	16,900	0·57
Management, office, &c., say	0·10d.	8,350	0·696	0·07d.	7,600	0·485	0·065d.	10,300	0·475	0·065d.	14,600	0·498
		41,030	3·41		46,570	2·98		60,910	2·79		80,930	2·75
Add— Depreciation or reserve fund, say	...	12,000	1·0	...	18,800	1·2	...	26,000	1·2	...	35,300	1·2
Total (excluding interest, &c.)			4·41			4·2			4·0			3·95
Interest and sinking fund	At 6% on, say, £102 per kw. of M.D. 3,000 kw. at £40 added during year at station + £90,000 for mains, &c.		6·12	At 6% on, say, £93 per kw. of M.D. ... 3,000 kw. at £30 added during year at station + £90,000 for mains, &c.		5·58	At 6% on, say, £82 per kw. of M.D. ... 3,000 kw. at £25 added during year at station + £75,000 for mains, &c.		4·9	At 6% on, say, £68·3 per kw. of M.D. ... 3,000 kw. at £20 added during year at station + £60,000 for mains, &c.		4·09
			£10·5			£9·78			£8·9			£8·04
Total cost (estimated)	0·18d. per unit + £10·5 per kilowatt of M.D.			0·18d. per unit + £9·78 per kilowatt of M.D.			0·17d. per unit + £8·9 per kilowatt of M.D.			0·17d. per unit + £8·04 per kilowatt of M.D.		

Table II. *Basis for Computation of Curve CD (Fig. 5).*

	1907-8.	1912-13.	Difference.	Diff'ence per extra kw. of M.D.
Running cost at 0·18d. (1907-8)	£15,000	...	...	...
,, ,, 0·17d. (1912-13)	..	£38,200	...	...
Expenses Directly Incurred with Steam Plant.				
Fixed charges on account of coal, wages and stores (75% taken to give generating plant, plus feeders to battery sub-stations only)	£15,980 = 12,000	£30,280 = 22,700	£10,700	0·61
Repairs and maintenance (66% taken, &c.)	8,350 = 5,560	19,150 = 12,750	7,190	0·41
Reserve fund (75% taken, &c.	12,000 = 9,000	35,300 = 26,420	17,420	1·0
				2·02
Interest and sinking fund on increment in plant capacity at 6% on, say, £25 per kw. of M.D.*	Nil	480,000	480,000 (18,000 kw. add')	say 1·5
Interest and sinking fund on feeders to sub-stations; 6% on £5 per kw. of M.D.	...		...	0·3
			Basis of curve JK	£3·82
Expenses Indirectly Incurred with Steam Plant.				
Rent, rates and taxes (whole of)	£8,350	£16,900	£8,550	£0·49
Management, office, &c. (87% of total in each year)	8,350 = 7,250	14,600 = 12,750	5,500	0·32
			Basis of Curve CD	£4·63

Note.—Increment in kw. of M.D. 17,400 kw.

* £25·6 is the average over six years covered by Table I.

APPENDIX.

The Paper is followed by an appendix consisting of three sections. In the first of these, dealing with true "running costs," the author shows the distribution of the heat energy contained in the coal, from the grate bars to the dynamo terminals, showing that the extra coal cost incurred by throwing on the battery charge is most unlikely to exceed 0·12d. per unit for small sets of, say, 500 kw. capacity. It is unnecessary to debit the units "wasted" in the battery with any other charges than the cost of oil and petty stores, and the figure of ·1d. taken in Fig. 2 to represent the inclusive cost of these wasted units is ample; in fact, the author believes 0·15d. to be justifiable.

In section II. the question is considered as to whether there is any coal economy to be effected by using the battery not merely to take the peaks in winter, and so save in generating plant; but whether, having installed the battery, it is not advisable to use it, both summer and winter, for the purpose of loading up the engines and boilers to their best working conditions, and also of saving the running of some engines and boilers entirely, and so eliminating the "constant" losses due to same. A heat and coal diagram is given to show the seriousness of these "constant" losses, and of their effect on the coal bill, but sceptics may still be found who doubt whether the poor efficiency of the battery and booster combination does not waste electrically what it saves in steam consumption.

Extreme cases of the use or non-use of the battery are, therefore, considered. In Fig. 2 we have the battery providing only some 700,000 units out of a total of 10,000,000, or 7 per cent. of the total. In Fig. 8 we have precisely the same battery used to provide some 7,500,000 units, or, say, 75 per cent. of the total. The station is also equipped with the same steam plant in the two cases. Considering first the peak load battery, it can be seen from the heat and coal diagrams, referred to above, that while the coal consumption on the whole output of the engine is reduced by adding the battery load, in the ratio of 2·5 lb. to 1·96 lb. (a reduction of 22 per cent.) the efficiency of the electrical system is decreased 18 per cent., leaving 4 per cent. in favour of the change. So that, considering only the application of the battery to the winter peaks, it can hardly claim to be much of a coal saver.

If, however, the battery were used on the lines indicated in Fig. 8 the case is very different. It will be clear from this figure that 60 per cent. of the running plant (or 3,000 kw.) could be entirely shut down over 11 months of the year and a further 20 per cent. over 10 months; whereas, in Fig. 2 the same 60 per cent. could only be shut down for six months and the 20 per cent. for, say, the equivalent of six months (more correctly, 40 per cent. for three months). The last 20 per cent. in Fig. 8 will, it is true, have to run longer hours daily, in order to generate the energy shown in the unshaded part of the figure; but the set will, throughout, be running under conditions of maximum economy, and the total amount of coal saved in the year would be quite considerable.

The author makes a rough estimate of this saving. For instance, for each engine shut down, the "constant" part of the loss thus eliminated (excluding that in the boiler) is represented by about 250 lb. of coal per hour. Consequently, if we shut down four such sets (3,000 kw.) for three hours daily, in the one case (Fig. 2) for six months and in the other (Fig. 8) for 11 months, the net saving on engines alone is 165 tons. Again, if we shut down one set, in the one case (Fig. 2) for six months and in the other case (Fig. 8) for 10 months, the net saving is 34 tons. But, if we take account of the large battery capacity available for short-period discharges (such as while steam is being raised in the early stages of a fog) we can further credit, for the net saving in boiler losses, for the extra

five months: 250 lb. × 4 boilers × 24 hours × 125 days = 1,320 tons; and for the extra four months: 250 lb. × 1 boiler × 24 hours × 100 days = 272 tons. The total amount saved is thus 1,791 tons, representing an annual saving of, say, £680.

It is, perhaps, advisable here to point out that the above saving is quite distinct from the corresponding saving on those steam sets which are entirely displaced by the battery. Figs. 2 and 8 both contemplate 5,000 kw. of plant so displaced. Thus, for instance, seven additional sets (equivalent of) for three hours per day for, say, one month give: 250 lb. × 7 sets × 3 hours × 25 days = 58 tons; and seven additional boilers for one month give: 250 lb × 7 boilers × 24 hours × 25 days = 464 tons. Half of this extra boiler power—*i.e.*, the equivalent of 2,500 kw.—would, if there were no cells, probably have to be kept going for another two months (to provide sufficient margin for fogs, &c.), making another 464 tons, and another quarter for, say, four months, adding another 464 tons. A total of some 1,450 (58 + 1,392) tons has thus to be added to the 1,791 tons already estimated, or 3,241 tons in all.

The saving on the running units, due to better loading up by means of the battery, has again to be added to the above. It may be taken as being, in the most favourable case, 22 per cent. of, say (10,000,000 units at 3 lb.), 13,400 tons, or 2,940 tons. The total saving would thus be some 6,180 tons.

Against this must be set off some 4,000,000 "waste" units at 1·91 lb. per unit, or 3,420 tons. A net saving of some 2,760 tons would thus appear to be what, under favourable circumstances, the battery might effect; but in his Paper the author contents himself with merely assuming that the gains balance the losses—an assumption distinctly favouring steam.

Section III. of the appendix deals with accumulators on consumers' premises. Although this subject may appear to be somewhat outside the limits of the present Paper, the author believes that it will be found in the future that large manufacturers, employing either alternating current or direct current motors, will find it to their interest to put down accumulators on their premises; and where their works are large these installations will take the nature of sub-stations. By means of the low-voltage system of supply which he has worked out, the author anticipates to be able to introduce accumulators of large capacity successfully on consumers' premises, and a reference to Fig. 7 will show the large margin that exists with which to pay for additional maintenance that might be necessary on the cells if placed in this position. In that figure GH represents the cost per unit, including delivery to the consumers' premises, and the greater part of the difference between this and the curve EF is available for meeting any additional expenses required in the form of extra capital cost, maintenance of cells, apparatus, motor-generators, &c.

DISCUSSION.

Mr. T. P. Wilmshurst (Derby), in opening the discussion, confined his comments to a few general considerations. He would leave financial criticism to speakers able to present it. The title of the Paper had reference to alternating-current accumulator sub-stations, but singularly enough only two pages were devoted to this subject; the rest of the matter related to the subject of accumulators taking the peak load of a station. This in itself was a bold proposal, and one likely to encounter much criticism; the foundation on which Mr. Taylor's main assumptions rested should be closely examined, as if these were unsound it followed that the deductions were equally so. He presumed that the scheme was only applicable to direct current systems.

Mr. Taylor: For both direct current and alternating current.

Mr. Wilmshurst: In the case of alternating current undertakings he thought that the capital and working costs of motor generator plant would minimise and probably wipe out the saving due to battery working. The proposed scheme should, he thought, be confined to direct current systems. There were fundamental differences, which would be obvious to those present, between steam and battery plant. Steam plant could be kept working at its maximum output continuously for almost indefinite periods. With a battery designed for a maximum discharge of one or two hours, after being discharged the cells were practically of no use for several hours until charged again. He regarded this as one of the most serious defects of the scheme. Dealing with the question of fogs, he thought that the larger the town the greater the risk of fog and the more battery capacity required. This increase still further limited the practical scope of the scheme. Mr. Taylor was presumably dealing with a large town, as he was considering a case of a maximum load of 5,000 kw., with a prospect in five years of 10,000 kw. Referring to Fig. 1, the author took a typical load curve and based his argument on it, proceeding then to give a curve five years hence which was practically the same curve twice the height with the same load factor. He considered that the load curve was not typical. It might apply to a lighting station, but for a large industrial area the peak was not broad enough. Taking his own case at Derby, he found that by superimposing his own curve on that of Mr. Taylor, it was 50 per cent. broader at the point at which Mr. Taylor based his argument. This would mean a 50 per cent. larger battery, and the saving practically disappeared at once. The question of change in load factor was also most important. Now that improved cooking and heating apparatus was being brought forward, it was unwise to make no allowance for a change in load factor in five years' time. With this larger battery installed to deal with an increased load factor Mr. Taylor's figures were further upset, capital charges and running costs being again increased. With regard to heavy discharges of one or two hours, the ampere hour efficiency of the battery at one hour rate was much lower than with a discharge of six to nine hours. He always considered that the proper function of a battery was that of a reservoir. Mr. Taylor did not say whether the enormous batteries at Chicago were used for rapid discharge work. He would like to know the working costs at Chicago. Modern British power stations had nothing to learn as to efficiency or economical working from either America or Germany. He could not go quite as far as Mr. Taylor in his advocacy of the use batteries as a substitute for steam plant. They would all agree that batteries had an enormous use as auxiliaries for taking light loads. In his own case he ran early workmen's cars entirely by batteries, and also a good deal of street lighting load at night.

Mr. Brookman (Chloride Electrical Storage Co.) spoke from the manufacturers' point of view, and said the admirable way in which the author dealt with relative allocation of plant with capital expenditure enabled one to follow his reasoning very closely, and there was no call for him to further the argument. Under suitable conditions storage batteries were capable of saving the total expenditure upon them in the first few years, but it was impossible to dogmatise on that point. No two stations were exactly alike. Suitable conditions had to be demonstrated in every instance. He was fully aware that there was much prejudice against storage. Extreme latitude in the manipulation of batteries and the use of unsuitable water had much to answer for. Automatic stills adapted for use with either steam or internal combustion engines would help to get over the water trouble. Absence of systematic records and of regular inspections had an important bearing on the subject. Regular inspections were the very essence of battery working. The overload capacity was great, and the important improvements alluded to by the author of the Paper warranted the extraordinary development in the use of storage batteries which was noticeable in the U.S.A. and on the Continent. Improvements had been more in the nature of evolution than of new inventions, and this continuity afforded better guarantee against antiquation than in the case of steam or gas generating plant. As to the question of discharge rates, 3,000 consecutive discharges at a one-hour rate had shown no ill effects. An abundant allowance of lead per cell was most beneficial and the practice of eminent engineers of buying batteries more or less by weight had much to recommend it. The lead weight per cell in pounds should be not less than 30 per cent. of its ampere-hour capacity on slow discharge. Changes for the better had been made in the methods of mounting. Plates were now suspended in tension with ample space below for deposits, which might be left undisturbed for long periods. The less frequently plates were removed for cleaning, &c., the better.

Mr. H. Richardson (Dundee) had considered a battery scheme in connection with his own town, and could not help admiring the concentration and attention given to the subject by Mr. Taylor. But he must say it was an academic Paper. It was one of those questions from which one could argue and deduce certain apparent truisms, but he thought it would never work out as a commercial success. Much experimenting had been done by engineers in the past, and as a result an appreciable uniformity of plant and apparatus had been reached. Valuable results were just beginning to show themselves, and on the score of standardisation something tangible was now apparent. It was now suggested that they should enter upon the same troublous periods as in the past, and the result would be—experiment—experiment. He agreed with Mr. Wilmshurst that they were all working away to improve the load factor. The rising part of the curve was just beginning to be apparent. From the results of the past few years he believed it was going to be a steep curve, and he was certain that before Mr. Taylor's scheme could be under way it would be a case of large power stations doing a little lighting, not large lighting stations doing a little power. The metallic filament lamp was already bringing down the maximum demand in his town. Mr. Taylor had mentioned that they could overload the battery 100 per cent. for a short time. This was where the trouble began. Even taking into account the improvements constantly being made in the battery, it was a necessary evil. Mr. Taylor had given them some interesting information regarding America, but they had nothing to learn from America, or from Germany, in regard to station management and the cheap generation and sale of current. Supposing they did want to try Mr. Taylor's plan, how were they to go about it? Were they to refer to Mr. Taylor, or to put themselves in the hands of the battery maker?

Mr. J. E. Edgcome (Kingston-on-Thames) asked how the author proposed to deal with a supply like the City of London, which was a big supply, mostly lighting, with a comparatively small amount of power. The peak load in winter was from dusk till about 5:30. There was no night load. There were practically no residents, very few manufacturers, and no shops open late. It was purely an office load, one big peak load, starting from dusk and closing down any time from 6 till 7:30. Then occasionally they had fogs, when every light was on from, perhaps, 8 a.m. until 7:30 p.m. Although this was a load which most engineers would like every day, he could imagine the feelings of a man who was going to discharge his batteries at full load all day. This was no exaggerated case. In winter it was quite a common thing to have all day fog three or four times a month. Under those conditions it was practically impossible to run such an area as the City of London except at enormous capital expenditure for spare batteries.

Mr. E. S. New (D.P. Battery Co.) said the author's figure of 9 per cent. for upkeep was too high, and should be 6 per cent. There was no material difference in the efficiency of batteries either with one hour or ten

hour rate. Mr. Brookman's information as to how batteries were made was interesting, but engineers would rather know something about the financial aspect. The maintaining of batteries for 10 years was a question of expense, not of how the batteries were made.

Mr. Jacob (Tudor Accumulator Co.) said there was immense prejudice against accumulators, due mainly to two causes. In the early days too much was expected from their use, and as the batteries were not as good as now they proved failures. Engineers scrapped small units of generating plant, but they would not scrap batteries, but overworked or spoiled them. Accumulators had, however, been much improved, and the cost had come down considerably. In regard to the question of high rate of discharge daily for taking the peak load, this was already done regularly in a large number of stations, not only in Germany, but in this country. There were one or two cases even in London where a large battery had been put in, some of them for 6,000 kw. or 7,000 kw. output, and had been useful both in times of fog and for taking peak load under normal conditions. Very little had been said about the question of security, which he thought very important, as, no doubt, although there had not been many breakdowns, there had been some which could have been avoided had batteries of reasonable size been put down. In reply to Mr. Edgcome as to what proportion the large battery bore to the plant of the station, Mr. Jacob said he thought about 20 per cent.

Mr. H. M. Taylor (Middlesbrough) said the conditions at Middlesbrough necessitated their taking supply from a local power company, and the terms of purchase would depend upon the sub-station load factor of the power company. This opened up a big question. On a load of about 2,000,000 units, half of which was, perhaps, power load, throughout the night the sub-station would be absolutely idle, and to get the current from the power company at a reasonable price they must have a good load factor at the sub-station. He asked what effect the new daylight saving proposals would have on Mr. Taylor's scheme.

Mr. F. C. Raphael asked for a little more information from the battery makers. To what extent did they back up the Paper? They had just been told that the ampere-hour efficiency was just as good at the one hour discharge rate as at the ordinary rate. He considered it rather a question of watt-hour efficiency. Would the makers tell them the watt-hour efficiency at 1 hour discharge? Mr. Taylor assumed 9 per cent. maintenance contract in his Paper. They had heard that some battery makers were willing to accept 6 per cent. Would the makers accept this if the battery were used as Mr. Taylor said it should be? If discharged daily at 1 hour rate, with risk of fog, when it might be discharged even for 10 minutes at ¼ hour rate, would makers be prepared to give not 6 per cent. maintenance, but 9 per cent.? He did not see how they could. The one-hour discharge had until recently been considered as the emergency rate, and not the normal rate. He did not think any battery maker would guarantee four times that rate for emergency rate.

Mr. S. J. Watson (Bury) said one or two points had been mentioned which he thought hardly dealt with the subject as put forward by Mr. Taylor. For instance, it had been argued that in foggy districts the battery would probably be totally discharged, and then, well—a fiasco. He did not see why much should be made of this point. Gas works had exactly the same question to tackle, and there should be no difficulty in so proportioning things that the batteries would be capable of handling it in conjunction with steam plant in a satisfactory way. The point raised by Mr. Wilmshurst was always raised when the question of steam plant versus batteries was considered. The capacity of the generating set was taken, and it was argued that it was capable of giving its output 24 hours a day for seven days a week, whereas a battery would only give its output for one, two or three hours, according to the rating. He did not think that point should be so often raised. If their peak was never going to exceed one, two or three hours, the total length of time they could use the generating set was of no consequence, and the battery, if it handled the peak, was equally as satisfactory as if they had the generating set itself in use. The question resolved itself into one of load factor. If they were going to eventually obtain a load factor of 25 to 35 per cent. he did not think the handling of the bulk of the output by means of the battery was likely to be of any use. In cases of purely lighting districts, where the load factor was only 10 to 15 per cent., the battery might be exceedingly useful. He was glad to see the question raised of bulk supply from power companies. The offers which the power companies put forward to local authorities were usually a standing charge of so much per kilowatt and a running charge of about ½d. In cases like that, where the load factor was comparatively small, no doubt excellent use could be made of the battery. Mr. Taylor's remarks on putting in more than one battery were rather interesting, and he had stated that in providing spare sections that were not perhaps necessary, but probably wise, they would have spare batteries for use when required. Referring to a few cases in connection with batteries with which he was acquainted, taking the one hour rate he found the capital cost of battery working, with buildings, &c., was £18 per kilowatt, and came up to £19 or £20 at a seven hour rate, so that if the one hour rate compared with capital cost of generating plant, it made excellent comparison also at the seven hour rate. Several questions had been asked concerning the efficiency, and he agreed with the last speaker that it was a question of watt hour efficiency and not of ampere hour, but if the battery was dealing with the peak only, the actual efficiency was not a very great consideration. If the battery was only handling 10 per cent. of the daily output, it mattered little whether the efficiency of the battery was 60 or 70 per cent.

Mr. P. J. S. Thomas (Stoke-upon-Trent) asked whether the 3 per cent. referred to for depreciation of battery was to be paid out of revenue. He thought that 10 per cent. would be a better figure, but even then small. Fogs were so indefinite that he did not think they could count on the full discharge of a battery for a fog. Something was required in reserve, as not more than 50 per cent. discharge of the battery capacity should be allowed for. Therefore a much larger battery would be wanted. He had found a battery very useful for burning out faults.

Councillor McGall (Birkenhead) spoke from a chairman's point of view, and expressed disappointment at the lack of confidence in batteries as brought out in the discussion. His engineer had always led them to believe that the battery was only an accessory, and they were not to look to it as a source of the energy for any given length of time.

Mr. C. Turnbull (Tynemouth) thought sufficient prominence was not given to the fact that batteries were used enormously in other countries. This showed that there was more in batteries than people seemed to think. Battery makers said only pure water must be used in the battery. He had asked one of the makers if there was any means of getting this pure water, and after some considerable time he received an elaborate drawing of condensing plant which would have cost some hundreds of pounds. The makers should go into the matter thoroughly and get out a pamphlet telling them what to do. When a battery man came round the station and was asked for some hints on the working, he could get nothing from him. It seemed to him that the only thing the makers were looking for was something whereby they could get out of the maintenance. The makers could do much to popularise the use of batteries. Mr. Taylor had said nothing as to the working of batteries on railways, where a good load factor could not be obtained. He thought batteries were best in those circumstances, and in the future, when the railways were electrified, one of the greatest uses for the battery would be in connection with those sudden and jerky loads.

Mr. F. A. Newington (Edinburgh) asked for works costs at stations in America where batteries were in use.

Mr. A. M. Taylor (communicated) replied that Mr. Wilmshurst had suggested that Fig. 3 did not give a representative peak-load curve, and pointed out that the curve at Derby had 50 per cent. more ampere hours per kilowatt. This statement did not coincide with a curve that Mr. Wilmshurst had once shown, and probably referred only to the proportion at the base of the peak. In such a case he should put in cells for, say, 40 per cent. of the peak only, instead of 50 per cent., and the data in the Paper would still hold. After analysing many peak loads, including stations having a tramway load, he invariably found that a three-hour battery rating would take up some 33 per cent. of the peak. This applied to stations having annual load factors of 20 per cent. and over, and showed that the load factor, except as regards the saving of coal, was of much less importance than Mr. Wilmshurst implied, owing to the fact that you got 100 per cent. more kilowatt-hours out of a battery on a three-hour rating than on a one-hour, and so on for longer discharges. As regards Mr. Richardson's main point, he (Mr. Taylor) had already shown that, as regards fixed charges, the battery scheme could face a large increase in the annual load factor with equanimity, and as regards the reduced saving in coal on a good load factor, he had not taken account of any saving on that score in his financial statement, and hence could face an improved load factor quite happily. Mr. Edgcome had run to the opposite extreme and rather condemned the scheme because it would not meet the case of a purely "lighting" station in London. He (Mr. Taylor) did not suggest that batteries should be applied universally; but he would be rather surprised if the saving on the City of London Company's coal bill, due to the poor load factor, did not go far to compensate for the larger battery power needed on a foggy day. One or two speakers seemed to doubt whether the peak load batteries at Chicago did really displace generating plant; also whether working costs were improved thereby. He had every reason to believe from first hand information that in all the cases cited in the tables the batteries were substitutes for generating plant. As regards the working expenses, these were recently given by Mr. Parshall as 0·25d. per unit for Chicago.

An Electrical Furnace for the Reduction of Alumina by Carbon.—To reduce refractory materials such as alumina, magnesia and silica in the electric furnace the following conditions are necessary: (1) The temperature should be brought nearly to the point of decomposition by the employment of the oxide and finely divided carbon in definite proportions. (2) The reduced metal should be immediately carried from the high temperature to a low temperature zone, these being in the case of aluminium about 3,000°C. and 800°C. respectively. A furnace, recently patented in the United States, by E. Viel, consists essentially of carbon plates, its bottom is built on a sharp inclination and at its lowest part water circulation is fitted. The material is placed in a hopper, at the upper part of the furnace, which is connected to the lower half by a helix through which the material passes. Two electromagnets fitted on the carbon carriers operate the arc, which plays on the material inside the furnace. By the use of suitable methods the arc may be directed to any one part of the furnace so that the material is quickly brought to a high temperature and descends rapidly towards the cool zone.

Electricity in Mining.

A SPECIAL ISSUE OF "THE ELECTRICIAN" DEALING WITH THE APPLICATIONS OF ELECTRICITY IN MINING WORK.

IMPORTANT NOTICE.

Extra Copies of "The Electrician" Special Mining Issue (July 10th, 1908) will be obtainable, after day of issue, price 1/- nett (post free U.K., 1/1; abroad, 1/6). After July 17th the price, post free in the U.K., will be 1/4.

CONTENTS OF "THE ELECTRICIAN" MINING ISSUE.

ADVERTISERS IN "THE ELECTRICIAN" MINING ISSUE.

Among the manufacturers to whom reference is made in this issue we understand that the following are exhibiting at Olympia:—

Anderson, Boyes & Co.	Heenan & Froude.
Brotherhood, P.	Hopkinson, Austin.
Diamond Coal Cutter Co.	Ingersoll Rand Co.
Hardy Patent Pick Co.	Mavor & Coulson.
Hart Accumulator Co.	Scott, E., & Mountain.

Electrical Applications in the Mining Industry.

Among the many fields of industrial work which have been invaded by the electrical engineer in recent years Mining is certainly one of the most important, and increasing interest is being taken in the subject. In some respects power for coal mining does not afford a field in which the advantages of electrical applications are obvious. The coal mine is essentially a place where power can be obtained cheaply; from the very nature of the case coal is abundant, and, therefore, steam power can be obtained there more cheaply than in other districts. Consequently, it is not obvious at first sight that the mechanical energy obtained from steam can be transformed with advantage into electrical energy and be again transformed into energy for mechanical purposes. Some coal owners appear to consider that coal is of very little value so long as it is being used for their own purposes, and doubtless on that account they are loth to spend money on plant with a view to economy. Thus steam is regarded as a very cheap commodity, and doubtless it is for this reason that blowing of leaky steam joints and the general evidence of steam in the atmosphere of power plants supplying collieries are associated in the minds of many people with the pit bank of a colliery. The steam plant is frequently old and of the most inefficient type, yet a moment's reflection will lead to the conclusion that it is worth while to put a stop to these sources of waste if this can be done without too large a capital expenditure, more particularly when competition is so keen and when the avoidance of waste means increased output for the market. There are, indeed, both direct and indirect advantages. Instead of the plant being scattered, as it generally is where steam is used, the generating plant can be put into one building and controlled at one point. The various plant for pumping, winding, haulage, ventilation, coal cutting and other purposes, although not necessarily showing economic advantages by electrical working when each is considered by itself, yet present considerable advantages when regarded as a whole.

It is thus being increasingly borne into the mind of the Mining Engineer that the subject is not merely worthy of attention, but is of the greatest importance. As showing the interest that is being taken in the subject at the present time, we may draw special attention to the Mining Exhibition at Olympia, London, which is opening to-morrow, and which is occupied to a considerable extent with electrical plant for use in mining work.

In industrial applications of this character it is often difficult for engineers to find out just what has been done and what is being done, and it is with the object of facilitating the quest of such engineers for information that we publish in the present issue of *The Electrician* a series of articles devoted exclusively to mining matters. These have been written by men who are in a position to express their opinions with authority, and we trust the information therein given will prove of value to our readers.

General Survey of Electric Power Applied to Mining.

BY W. S. TOPLIS.
(Of the British Westinghouse Co.)

The steadily increasing demand for power in connection with mining operations brought about by the advancing face and the mechanical cutting of thin seams has placed before the managers a somewhat difficult problem as to the most satisfactory and economical method of meeting this demand.

The solution of this problem involves the careful consideration of the conditions existing at the mine, and one of the first points raised is the comparative advantages and disadvantages of power purchased in bulk from the local power company, and the conversion of the waste energy existing at the mine into electrical power. Fortunately the two most common forms of waste energy met with at the collieries, viz., coke oven gas and exhaust steam, are easily converted into electrical energy suitable for use in the mine, and it is to be regretted that these valuable sources of power are so frequently neglected.

Gas Engines.

In the case of coke oven gas, enormous quantities are annually wasted; some idea of the magnitude of this waste may be gained by referring to a most interesting paper by Mr. W. H. Coleman, *Transactions* of the Institute of Mining Engineers, Vol. XXXIV., part 3, wherein he gives the following figures:—

Total coal coked in coke works, 1905, 19,479,196 tons; 1906, 21,410,741 tons.

Percentage of coal coked in recovery and non-recovery ovens, 1905, non-recovery 83·9, recovery 16·1; 1906, non-recovery 81·8, recovery 18·2

The end of the present year will show a marked improvement in these figures. Some of the larger coal and iron companies have now fully realised the advantages to be gained by converting their waste products into electric power.

An interesting case in point is the Brymbo Company, which is utilising a mixture of coke oven and blast furnace gas in the same engine. The engine is coupled to an electric generator, which supplies power to the collieries and works.

The amount of waste gas available naturally depends upon the quality of the coal being coked and the amount of gas required for heating the ovens. Assuming a fair average yield of 11,000 cubic ft. of gas per ton of coal and an absorbtion of 60 per cent. for heating the ovens, we have 40 per cent. of the gas evolved available for conversation into electric power.

Taking a battery of 30 ovens, the approximate yield of gas for power purposes will be

$$1,600,000 \times \frac{40}{100} = 640,000 \text{ cubic ft. of gas per 24 hours.}$$

By suitably cleaning and consuming this gas in a gas engine direct coupled to an electric generator similar to the plant shown in Fig. 2, we have available approximately 580 kw. of electrical power for use in the colliery.

The plant shown in Fig. 2 is the British Westinghouse Co.'s latest tandem vertical gas engine direct coupled to an alternating current generator. The plant is capable of developing 165 kw. as a normal load, with an extra 10 per cent. as an over load capacity.

These engines have been specially designed to meet the requirements of manufacturers, colliery owners, &c., who require an engine to run on coke oven or producer gases. The construction of the plant is extremely simple, and all parts requiring cleaning are easy of access. This engine is now well known, and a full description is unnecessary, except to mention one or two of its chief features, *i.e.*:

1. No water cooling is used on any of its moving parts.
2. Forced lubrication is used throughout.
3. Owing to its even turning moment no difficulty whatever is experienced when operating alternators in parallel.

Referring again to the assumed quantity of waste gas available, viz., 640,000 cubic ft., had this gas been used for firing steam boilers operating steam engines driving electric generators, the power in kilowatts available continuously would be approximately 240. From the above brief survey it is found to be more economical to utilise the waste gas direct for driving gas engines; moreover, the capital expenditure for the conversion plant, that is, the auxiliary plant necessary between the gas main and the switchboard, is still in favour of gas engines.

The old stock arguments, viz., tar and dust troubles, which are invariably brought forward against the reliability of the gas-driven plants, have practically disappeared. The modern forms of gas cleaning plant, mechanical washers, &c., have effectively swept away these troubles.

At collieries not equipped with coke oven plant there is generally a tremendous amount of exhaust steam blowing into the atmosphere which might well be saved and utilised with great advantage for additional power. Roughly speaking, the power to be obtained from the exhaust steam, from all winding and other engines, is capable of giving an additional amount of power when utilised in an exhaust steam turbine equal to that which it has already given up in the engine; that is to say, only about 50 per cent. of its available power has been used.

Turbines specially adapted for dealing with this question are of two distinct types:—

1. Plain exhaust turbines.
2. Mixed high and low-pressure turbines.

It is understood, of course, that under these two headings are various sub-headings dealing with the particular types of turbines on the market, all of which are more or less available for the purpose under consideration.

Under the heading "Plain exhaust turbines," it is necessary to state that they are designed for dealing with steam at an initial pressure of about 1 atmosphere absolute, and their maximum efficiency is only with this pressure. They can be used, however, for high-pressure steam by means of reducing the pressure of the steam through a reducing valve, so causing superheat. Only a portion of the superheat, however, can be abstracted in the form of useful work. Any gain through superheat by wire drawing through a reducing valve cannot be utilised beyond the point where the steam at the exhaust is just saturated. In practice this works out to a maximum of about 7½ per cent. of the steam consumption when working with dry saturated steam.

Under the heading of "mixed high and low-pressure turbine" we have at once a unit which is adapted to take either high or low-pressure steam, utilising both or either efficiently, and is so constructed that low pressure or exhaust steam will be always given preference of admission. When exhaust steam alone is available, it alone will be used, but when this is cut off high-pressure steam will be automatically admitted to the cylinder. Also, if only a limited quantity of exhaust steam should be available this limited quantity will be entirely used and the difference made up by high pressure steam. There are thus three distinct phases of this turbine:—

1. Working as a pure exhaust turbine.
2. Working as a mixed high and low-pressure turbine.
3. Working as a high-pressure turbine.

In case 1 the efficiency is not quite so good as when the turbines are designed expressly for low-pressure steam, but this is more than counteracted by its high efficiency as a whole.

In cases 2 and 3 this is a most flexible unit in every respect, and in every way suitable for colliery work. Where the amount of exhaust steam available is small and intermittent it is quite possible to use the whole of the exhaust steam without the assistance of a heat accumulator, or heat flywheel, as we may popularly conceive it.

A common "power time" winding engine diagram is as shown in Fig. 1 where *ae* represents a cycle or period from start to start of wind. The abscissæ *ab*, *bc*, *cd* and *de* represent respectively the periods taken in accelerating, winding at uniform speed, braking and decking, and the steam consumption can be taken roughly as equivalent to the shaded area between *a* and *c*. In reality the ordinates between *a* and *b* would be somewhat longer, and those between *b* and *c* shorter, and more nearly following the dotted line *amn*.

With a steam turbine designed to use only the exhaust from such a winding engine, it is necessary that somehow steam should be provided during the period *ce* when steam is shut off from the winding engine. In order to effect this, a heat accumulator is provided which will absorb the surplus amount of steam above the line *fk*, while the turbine runs with the amount below the line *fk* and gives up the former portion during the period *ce* of braking and decking. The line *fk* continued would then represent the steam line supply as modified by the accumulator for constant load. It will be seen that with such an arrangement the output of the exhaust turbo set will be limited by the height of the ordinate of the line *fk*, and that the unit is entirely dependent upon the supply of steam from the winding engine. If, however, a connection is provided from the high-pressure steam main through a reducing valve any temporary cessation of supply of exhaust steam will be automatically supplied from the high-pressure source. The maximum ther-

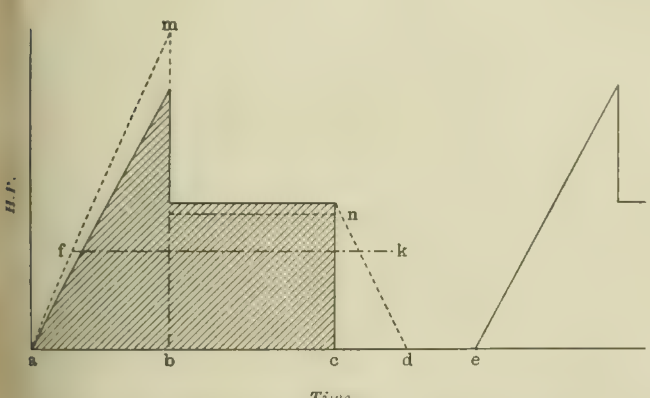


Fig. 1.—Power-Time Winding Engine Diagram.

mal efficiency is obtained when no exhaust steam whatever escapes into the atmosphere, but this is generally uneconomical from a commercial point of view, as it means the installation of a very large and expensive heat accumulator for a comparatively small gain. It is better to strike an average of commercial and theoretical standpoints rather than aim at extracting every available heat unit. In nearly every case there is a supply of exhaust steam of more or less continuous nature at a colliery which can be used as well as the supply from winding engines, and in many cases this supply is quite sufficient without any accumulator whatever, or so nearly sufficient that it would not pay to instal a heat accumulator but rather supplement with live steam.

This is where the mixed type turbine is especially applicable and adapted to accommodate itself to the varying supplies of steam under all conditions and work efficiently. Again, referring to the winding engine diagram above, it may be that the size of the turbo unit required is such that the line *fk* is so high that the shaded area above it is comparatively small. One or two old boilers in series between the winding engine and the turbine will so cushion the supply that the steam, if any, above the line *fk* will be brought to a negligible quantity and a mixed type turbine is again the most desirable unit.

Roughly speaking, the particular field for plain exhaust turbines is :—

1. Where there there is a continuous supply of exhaust steam of sufficient capacity to carry the load.

2. Where the supply is little more than sufficient but intermittent, in which case an accumulator must be used.

For all other cases the mixed high and low pressure is to be preferred.

Power House Auxiliaries.

Whatever form of prime mover and generator is installed, the switchboard, the brain of the system, remains practically the same and follows closely the lines adopted in large power companies. Descriptions of typical switchgear suitable for colliery practice appear elsewhere in this issue. One point, however, should not be missed, that is, the installation of some form of automatic voltage regulator, *e.g.*, Thury, Tirrill, &c. These regulators are capable of maintaining a steady voltage under the most trying conditions, in fact, lighting circuits may tap the power mains wherever convenient, and, although heavy fluctuations in demand for power are taking place, the lighting will be perfectly satisfactory. More important, however, is the maintaining of a steady voltage for the haulages. The motors operating haulages are subjected to severe service, and in order to assure their satisfactory performance a full and steady voltage should be maintained in the supply mains.

In the case of induction motors operating haulages the importance of this point is fully realised when the characteristics of this type of motor are studied. For instance, the torque or turning effort of the motor varies approximately as the square of the applied voltage, *i.e.*—

100 per cent. voltage gives 100 per cent. torque.
80 per cent. voltage gives 64 per cent. torque.
70 per cent. voltage gives 49 per cent. torque.

From this it will be clearly seen how essential it is to maintain normal voltage on the motors.

Lightning arresters are also important auxiliaries, and although it is usually stated that the storms occurring in this country rarely damage electrical apparatus, and in consequence the capital expenditure on arresters is unwarranted, it is nevertheless advisable to instal them in the power station and one or two in exposed positions on the transmission line. The writer has in mind several cases where motors, &c., have been damaged by lightning effects ; in one particular case the motor was a number of yards inbye, the high voltage having passed down the shaft cables and discharged at this particular motor.

In cases where collieries have fairly long lines, say, between two neighbouring pits or a long line to a pumping station, a most effective and cheap arrangement can be devised which will greatly relieve the apparatus from the effects of lightning. This arrangement consists of stringing up one or two iron wires about 12 in. to 16 in., or even higher, according to the working pressure of the line, above the highest electric conductor on the transmission line, these wires being frequently connected to the earth at suitable points along the route.

This earthed wire should be strong and well protected against corrosion, otherwise it may break and short-circuit the power lines, thus becoming a source of more trouble than it prevents. The success of this arrangement depends upon the quality of the earth connection ; if possible, this connection should be made in permanently wet ground. A convenient method of making an earth connection is to drive into the ground a number of $1\frac{1}{2}$ in. galvanised-iron pipes, about 6 ft. long. The pipes should be connected together by copper or brass wire well soldered to them, and the overhead shield wire connected to this earth connection by a stout wire.

These earth connections must be frequently inspected for corrosion and the breaking of the connecting wires.

In all cases where the overhead transmission is converted to underground cable of any material length, *e.g.*, passing through a village, &c., it is advisable to instal discharge gaps at these change over points. These gaps or arresters are required to relieve the high potential stresses likely to occur at these points during electrical disturbances. The concentration of potential

at these points is due to the different characteristics of the two types of transmission line.

The screens usually being in close proximity to the power house, coal dust becomes a great nuisance to those in charge of the plant. This nuisance is more prominent when turbo-generators are in operation. The violent air circulation through the various parts of the machine carry in the dust and deposit it inside the air ducts which eventually become so choked that the machine reaches a dangerously high temperature due to the reduced ventilation. Dust is deposited in 'bus-bar cubicles, and places of a similar nature are also a constant source of trouble. A small portable motor-driven vacuum cleaner will effectually remove this nuisance, and by using insulated nozzles the switchgear can be cleaned without shutting down the plant.

Transmission and Distribution of Electrical Power.

The installation of the transmission lines and distribution cables on the surface present no difficulty, and if carried out on the lines of modern practice no trouble is likely to ensue. In the case of the shaft cables, however, one cannot be too careful in selecting the type of cable most suitable to meet the conditions existing in the shaft. The cable makers, profiting by their early colliery experience, have now produced shaft cables which they are prepared to guarantee under fair wear and tear conditions. Usually a certain amount of water is to be found in the shaft; this water, probably being contaminated by either acid or alkali compounds, is very detrimental to the armouring of the shaft cables, and care should be taken to protect them from the action of the water. In the event of the shaft cables being damaged in the shaft, this surface water, getting into the bruised portion of the cable, will travel in both directions along the interstices of the cable and do great damage. A cable possessing a homogeneous section, even to the sealing of the interstices in the stranded copper conductor, will greatly add to the reliability of the system.

The feeder cables running inbye should be selected on similar lines to shaft cables. The method of supporting them in the roads will depend on the conditions existing in the roads. The usual method of suspending the cable in leather thongs secured to the props has proved satisfactory.

Application of Motors.

The application of electromotors to the screening plant, pumps, &c., presents no difficulty, and providing due care is exercised in selecting the type of motor to meet the service required, efficient and reliable running is assured.

As a general rule the squirrel cage motor is the most suitable type to meet the conditions existing at a colliery. The total absence of revolving slip-rings and gear of a similar nature incident to this type render it capable of withstanding rough usage and ill treatment.

Should the starting conditions of the plant be so heavy that the squirrel-cage type would not start up without drawing an excessive amount of power from the line, it is preferable to instal some form of reliable friction clutch between the motor and plant rather than resort to the slip-ring type of motor. There is a general tendency to instal slip ring motors whenever the starting conditions are abnormal; this is an easy solution of the problem, but it has the disadvantage of introducing a type of motor comparatively delicate compared to the more robust squirrel cage type.

The type of motor for the haulages is to be selected on similar considerations as for the main winders. The haulage cycles are generally so long that the installation of a flywheel set for equalising will not be advisable. The flywheel would become too heavy and the no load energy consumed by the flywheel would represent too high a percentage of the average load.

If polyphase 50-period current is available, induction motors of the slip ring type geared to the drums are advisable. If polyphase 25-period current is available the colliery manager and engineer should study and inspect the latest forms of single-phase commutator motors as applied to railway working. This new form of motor is well suited to the heavy service met with in main and tail hauling. As a general rule, two motors per haulage will be used; in a two-phase scheme a motor would be connected to each phase; in a three-phase scheme the three phases would be converted to two phases by means of the Scott transformer connection.

This type of haulage equipment has the following advantages:—

1. The speed control is *perfect and efficient with all speeds* from zero to maximum speed. Any creeping speed may be obtained.

2. Starting is effected without losses in resistances.

3. Overloads during starting and on higher inclines will be reduced by the series characteristic of the motor, and the power consumption can be limited by reducing the speed of the motors whenever it is necessary by voltage control.

4. The power-factor of the motors is high.

5. The phases of the three or two-phase system are loaded equally.

6. The electrical braking during retarding periods can be applied without complication.

7. Flash over on the commutator is out of consideration.

In comparison with the induction haulage motor the advantages are evident:—

1. *The induction motor has only one economical speed.*

2. The losses during starting periods have to be considered, and dissipation of the energy may be difficult in underground workings.

3. The overloads on the station at start and on steep inclines are excessive.

4. The power factor is low during starting and overload periods.

5. The saving obtained in comparison with the induction motor is in the station capacity during overload periods and in the capacity of the high-tension transmission line

In comparison with the direct-current haulage motor:—

1. The Ward-Leonard motor-generator, necessary to transform alternating current into direct current, is saved, and also the losses in this set.

2. There is considerable saving in the low-tension cables between the motor-generator and the haulage motor if the latter is underground and the former on the surface.

From the above it may be concluded that the introduction of this haulage system for 25 cycles will compete favourably both with the induction and the direct current motor.

When deciding if induction motors or single-phase motors have to be used for operating the haulage gear, it must be remembered that the induction motor is preferable in all cases where the motor load is a steady one. This will be the case when the incline is uniform throughout. Should, however, the incline be subject to variations in grade, producing excessive overloads, the single-phase motor is preferable.

Winding.

This section is treated elsewhere in the present issue, and the various systems now perfected by the leading electrical manufacturers fully explained. A few general remarks may not, however, be out of place. It is pleasing to note that the conservatism of the colliery managers of Great Britain is showing signs of giving way, and engineers and managers interested in electric winding will shortly be able to see winding engines of fair size operated by electric motors in this country.

The Great Western Colliery Co., of South Wales, will probably, before the close of the present year, be winding approximately 175 tons per hour from a shaft 1,110 ft. deep. The system used will be the British Westinghouse converter equaliser set system.

The Duffryn Rhondda Colliery Co., South Wales, also propose to wind 187 tons per hour from a shaft 2,001 ft. deep. The plant will be arranged for the Siemens Ilgner system.

In order to secure the full advantages of electric winding it is necessary to analyse fully the existing "mechanical relations," that is, the unbalanced load and the inertia of the system and the relation they bear to one another during a complete cycle of winding. Every effort should be made to so adjust the mechanical relations that the unbalanced load pro-

duces sufficient retardation to bring the cage to bank level without braking.

When high acceleration and high rope speeds are required the inertia of the system should be as small as possible, this requirement must be considered when applying the motor to the drum. In some cases this requirement will probably predetermine the type to use, whether a direct current motor or induction motor. In the case of a direct current motor no difficulty presents itself as the motor equipment can usually be made to suit the required conditions. The induction motor equipment, however, is restricted in certain directions for instance, the periodicity of the electric power supply limits the speed of the motor and also controls, to a large extent, the diameter of the rotating part, which dimension controls the inertia of the motor. Slow-speed induction motors of about 60 revs. per min. may be applied with a power supply not exceeding 25 periods, but not for a 50 period supply owing to the high price and poor performance of slow-speed motors operating on this periodicity.

In order to apply a satisfactory 50 period motor it would be necessary to increase the speed of the motor and introduce gearing between it and the drum; the introduction of this gearing, however, would so increase the inertia of the system as to render it unsatisfactory.

The induction motor, being of robust construction and presenting less complicated revolving electrical connections than the direct current motors, should be used whenever possible. It can be used most efficiently when the electrical losses in the starting resistance are a small percentage of the total power consumption or, in other words, when the period of acceleration is a small percentage of the total running time.

FAN MOTORS.

The nature of the load and operating conditions are ideal for the application of an electric motor and there should be no hesitation in adopting motor drive for this important piece of colliery plant.

Owing to the constant and continuous operation of the fan it is most essential that full advantage should be taken of these conditions to instal a type of motor capable of driving the fan and, at the same time, supply a portion of the wattless component of the energy consumed in the colliery motor installation. The type of motor most suited for these conditions is the self-synchronising synchronous motor, arranged with a suitable form of friction clutch, say, a coil clutch similar to the type used in cable tramway power houses. These clutches are quite reliable, and are capable of starting up the fan after the motor has been brought up to speed. During the present year a scheme has been perfected by the British Westinghouse Co. whereby the ordinary slip-ring induction motor fitted with a phase advancing device can be used. This system has considerable advantage over the self-synchronising synchronous motor; the clutch can be discarded and the fan started up by the induction motor in the usual manner.

In order to impress the importance of this scheme on the minds of colliery managers and engineers, the following example of an improvement effected by using this type of motor may be of service.

Assume that the capacity of a generating station is 1,000 kw. and that the generators are delivering 1,000 k.v.a. at 70 per cent. power factor. The generators are thus fully loaded but the engines have only 70 per cent. of their full load. It is desired to instal a 250 kw. motor for driving a fan. If an ordinary induction motor were installed, it would be necessary to increase the generator capacity and possibly the size of feeders, but by putting in an induction motor with a phase advancer the power factor of the load may be increased to, say, 95 per cent. with a total kilo-volt-ampere output from the generators of 1,000 k.v.a. and a load on the engines of 950 kw. Thus by the installation of the phase advancer the output on the station has been increased by 250 kw., with no increase in the size of the generators.

The cost of the motor with the phase advancer would be somewhat more than the cost of a motor without this device, but this increase in cost will be much less than that required to increase the capacity of the generators as would be necessary under ordinary conditions.

Pumping.—The application of electromotors to pumping plant has received great encouragement from colliery managers, and, in consequence, the results have been most satisfactory. The electromotor being essentially a high-speed machine, the advent of the high-lift turbine type pump has assisted in no small degree to the attainment of this success. The squirrel-cage type motor, with vertical spindle and turbine pump, make a most reliable combination. The reliability of this combination is unquestionable when one considers the good work done by this type of plant at the Cornish tin mines. Notable examples of squirrel-cage motors and turbine pumps are to be seen at Powell Duffryn and Newdigate Collieries.

Coal Cutting.—This most important subject is treated in detail in the present issue and the advantages of the various types enumerated. When installing electric coal cutters it should be borne in mind that the success of an undertaking depends upon, to a great extent, the reliability of the auxiliary or detail apparatus. In the case of coal cutters, reliable and substantial gate end boxes and trailing cables are essential. Cheap trailing cable and flimsy boxes will mean disaster and reduced output. Finally, the extent to which the advantages of the application of electricity to mining may be obtained depends upon the quality of the plant and the specialised experience brought to bear on each case.

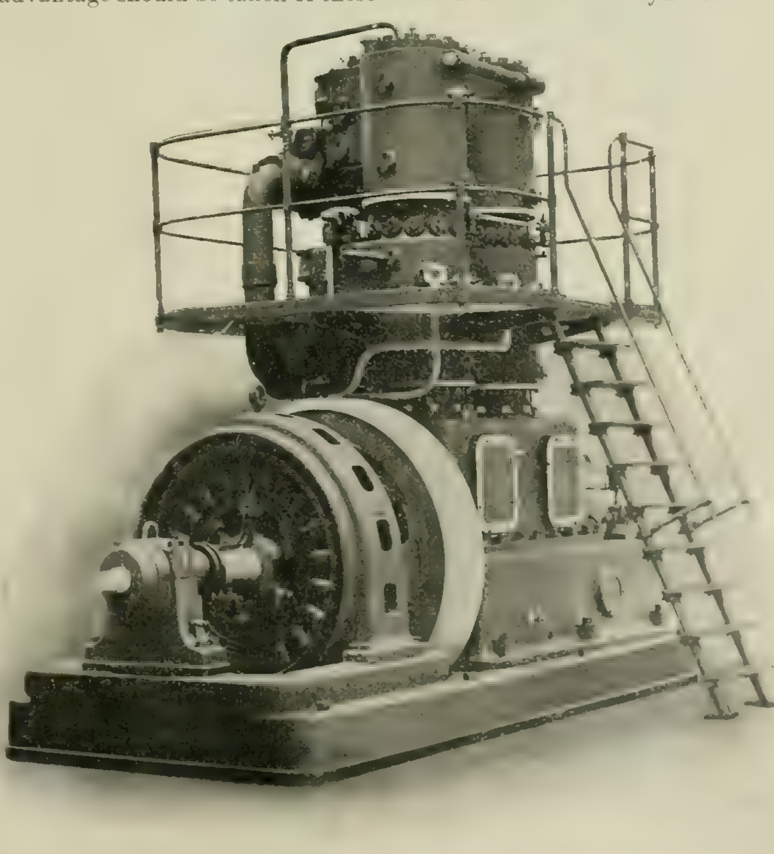


FIG. 2.—BRITISH WESTINGHOUSE VERTICAL GAS ENGINE COUPLED TO A 165 KW. ALTERNATOR.

Electric Pumping.

BY DR. R. HERZFELD.
(Of the Electrical Company.)

At the great Engineering Exhibition in Dusseldorf in 1902 it was, for the first time, brought home to the world at large that electricity would, in the future, play a very important part in the mining industry, and that the great inventions of the last decade of the nineteenth century had taken such a practical shape, that mining engineers could, with every confidence, introduce this new agent into their sphere of action.

It is most interesting to read the reports of this Dusseldorf Exhibition, to follow the descriptions of so many new forms of mining machinery, influenced by the appearance of the electric motor, and to see so many forces in action to carry out the promised revolution: it is still more interesting to contemplate all these big efforts of the engineering world of 1902 in the light of the year 1908—more especially in that one important item, the electric pumping machinery, which was largely represented at that exhibition.

How many efforts have been made to find the path where the slow movement of the old Cornish pump could meet the quick rush of the rotating parts of the electric motor, and where a speed of half a foot per second could be conveniently coupled to a speed of 100 ft. per second! We know how complicated and difficult the way has been, and how many disappointments and expenses had to be met before a satisfactory solution was arrived at.

Going closely into the matter we find that electric driving is only the last link in a chain of developments tending towards increased speed and minimised weight. England, the classical soil for the development of mining machinery, has amongst her collieries several plants which form quite a museum of the evolution of pumping machinery. For instance, the old Hathorn Davey Pump Engine with about four strokes per minute may still be seen, and is typical of all mining machinery during the best part of the nineteenth century. There are several reasons why mining engineers adhered so obstinately to this machine, the foremost being that it is well within the limits of the ability of the ordinary colliery hand—most parts of it can be practically built on the spot, and can be kept in repair without outside assistance. The other important reason was the fear of using steam underground. With the increased depth or quantity of water, however, the limits of the Spear Rod pump were soon reached, and the difficulty of controlling heavy masses of reciprocating machinery, and the reluctance to give up the valuable space which this type of pump occupies in shafts, forced engineers to adopt a quicker running system, even at the risk of taking steam underground and being more dependent on outside manufacturers

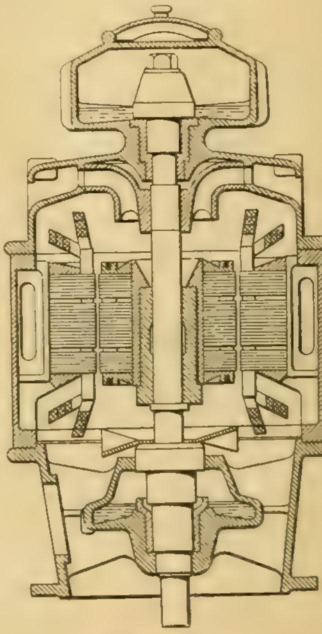
This was how the Duplex steam pump originated, with a speed of 40-50 strokes per minute.

Further developments in the direction of increased speed were largely influenced by the introduction of electricity into mines and the electric motor brought the pump up to the level of its own merits.

The problems which offered themselves to the designers of six years ago in this direction were manifold. The increased speed of the pump necessitated a quicker movement of the valves; the masses of these, therefore, had to be reduced to an unprecedented amount; some designers also thought it necessary, in order to retain the good volumetric effect of the slower pumps, to control the movement of the suction valves by gearing. A thorough investigation had to be made in order to secure satisfactory lubrication of all the moving parts, which, in the days of the slow speed pump, was a simple problem.

Special attention was given to the question of the sub-division of the cylinders and to the arrangement of the cranks, and it was not easy to combine simplicity of design and accessibility of all parts with the demands of an even turning moment, which is so essential for the undisturbed working of the supply system. It is evident that all these considerations necessitated additional outlay, and it is not surprising, therefore, that in this case, the increase of speed was generally not accompanied by a corresponding reduction in costs.

Another problem, which greatly puzzled the designers of six years ago, was the regulation of the quantity of water to be delivered: here the steam pump had established such a good example. As the consumption of power per stroke, other things being equal, depends on the speed, the smaller or larger acceleration of the masses determining the turning moment, a slight turn of the wheel of the steam valve was enough to regulate the required speed. This was what the designers of electric pumps were requested to compete with, and so keen was their desire to outstrip the omnipotent steam pump, that they planned those memorable power stations, where one generating set on the surface is permanently connected to one pumping set in the mine, each pump having its separate generator and cable. They sacrificed the greatest advantage of electric drive, the concentration of power generation and the common standby, for many purposes, for the imaginary advantage of a certain speed variation.



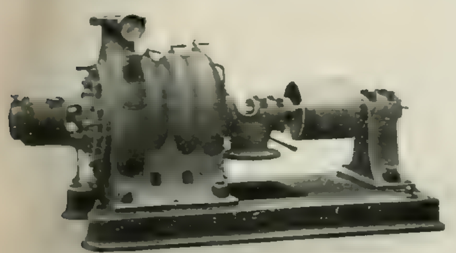
Scale ½ in. – 1 ft.

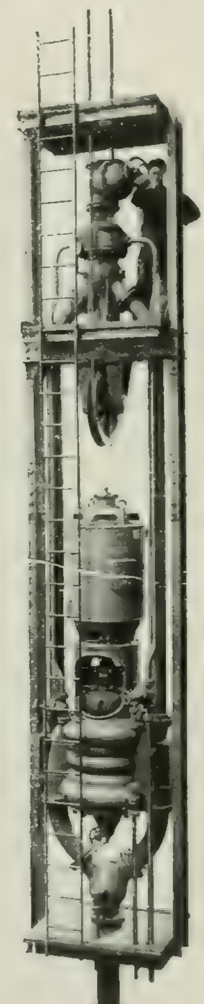
FIG. 1.—SECTION OF VENTILATED ENCLOSED HIGH-SPEED VERTICAL THREE PHASE MOTOR, 250 H.P.

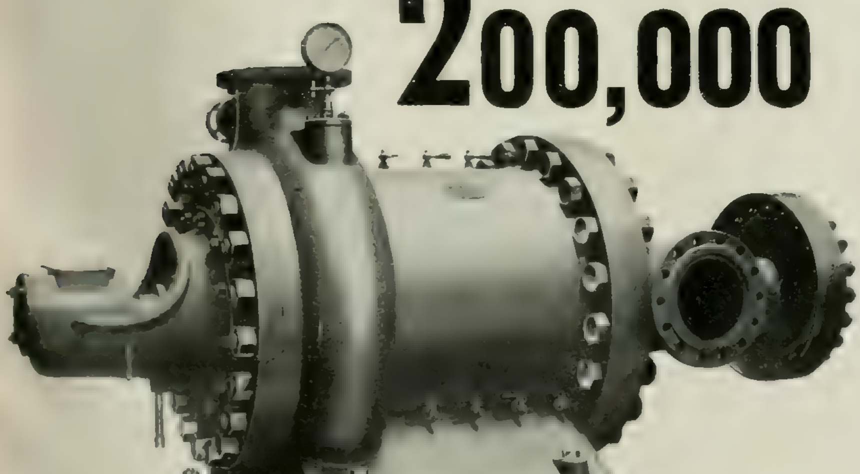
It did not take a great number of years to convince the mining world that this advantage could be gladly disposed of in favour of a simpler design of the generating plant, and that it is better practice to meet the varying requirements by splitting up the large units into a number of smaller ones and running these at a fixed speed only. This conviction was, of course, brought home with all the more weight, as the cost involved in these modern units is so greatly reduced when compared with those of a few years ago.

I am sure that few of those designers and exhibitors of 1902 would have dreamt that all their labour would be practically lost after so short a time and that only the professor of mechanical engineering or the historical writer would take the trouble to study its results. At any rate, for the moment, whatever may be the future developments, the rotating pump has almost entirely superseded the reciprocating one. There is a craze for the rotating pump!

The reasons for this development are numerous. Before I mention them, I should like to point out that the intrinsic qualities of electric motors have hardly anything to do with it. A popular explanation, which one hears and reads pretty frequently is, that it is so easy to couple a high-speed rotating pump to a high speed electric motor, and it is true that no other







machine offers similar facilities in this direction. But although one can safely say that without the electric motor, the centrifugal pump would never have experienced this sensational development, it must not be forgotten that those who have been engaged in the actual carrying out of this task have met with a variety of difficult problems for which they have only quite recently found a satisfactory solution.

It was found that the speed of these rotating or centrifugal pumps was so high, that in order to keep within the safe limits of the material, the diameter of the rotating parts of the motors had to be reduced unprecedentedly. The active parts of the machine became small in diameter and correspondingly wide, and while the electrical qualities were in this way improved, the mechanical problem became more complicated.

A special difficulty arose in the dissipation of the heat, which is developed in the electric motors and which is easily disposed of in the case of the slow-speed motor of the older type of electric pumps. This has led to the arrangement of special means for draining purposes, been raised from what it had been, viz., 30 to 35 per cent., to what it is, viz., 75 to 84 per cent.

Just as hydraulic engineers have learned to avoid the heavy loss of energy which occurs in the water wheel through the "pushing" action, and have adopted the "pressure" action instead, so the corresponding step has been made in the design of the centrifugal pumps, the fluid in the new design receiving its kinetic energy not by means of the "pushing" effect of high-speed blades, but rather by means of a pressure created by the special channels through which it is being forced.

Nevertheless, the efficiency of centrifugal pumps has not yet reached by a long way the efficiency of reciprocating pumps, so that the number of units which is required for the raising of a certain quantity of water is higher in the case of the rotating pump. There are, however, other advantages connected with it, which make it a commercial success

The space required in the lodge room is greatly reduced, a point which, to many mine owners, outweighs any number of

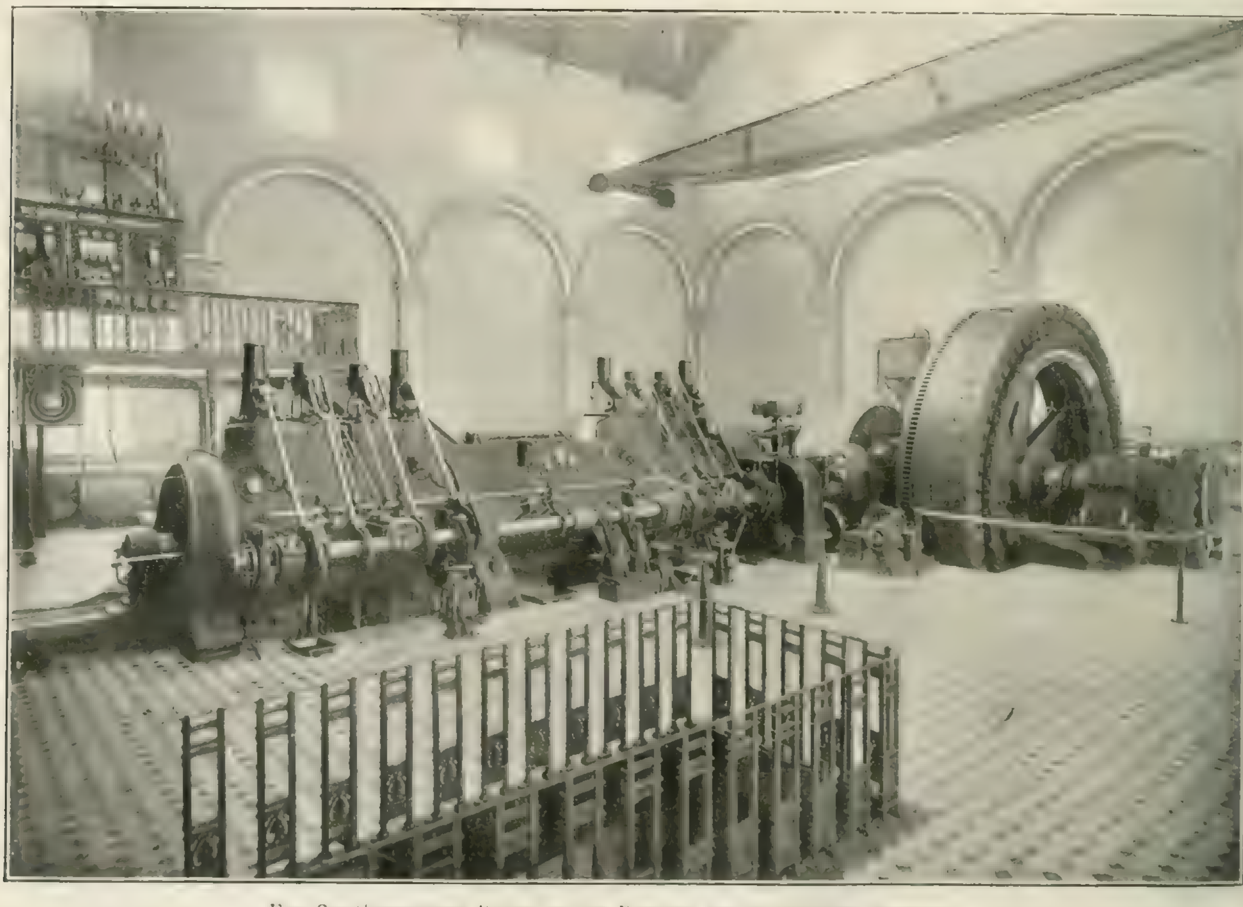


Fig. 2—Generating Plant at the Bargoed Colliery, First Portion.

ventilating devices which circulate fresh air past all the active parts of the motors through channels in the laminations. Fig. 1 shows a system of fans which serve to produce a draught of air, and also the channels through which it is forced, in the case of a 250 H.P. vertical motor designed for 500 volts, three-phase current, for direct coupling to a centrifugal pump running at about 1,480 revs. per min.

Fig. 3 shows the radical change which the electric motor had to undergo in order to meet the new conditions. Both machines develop 500 H.P. on the same system of supply, the one at 107, the other at 1,480 revs. per min., the one meeting the requirements of the average piston pump, the other one those of the corresponding centrifugal pump.

The desire to introduce electricity therefore did not give any particular inducement to the adoption of the centrifugal pump, nor was it, as we shall see, considerations of a purely monetary kind, although the efficiency of centrifugal pumps has [illegible] the attention of engineers was first directed towards their [illegible]

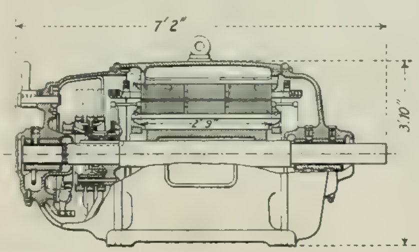
electric units. The arching of a large lodge room has often stood in the way of the introduction of underground pumps, and those who would not give up their Cornish pump for this reason, thus find the difficulty greatly reduced, if not totally overcome.

The erection of a direct coupled centrifugal set is nothing compared with the erection of piston pumps; the whole set can be mounted and tested on the surface and a few steadying pins is all that is required to make the final fixing of the set on its proper foundations a very simple matter. It must be remembered that one great difficulty in face of which the earlier electric pumping installations had to be carried out was the complicated construction of the motor, which, owing to the narrowness of the seams, had to be built in two or even more parts and necessitated weeks of strenuous work on the part of the erecting staff.

In the days of reciprocating pumps, there existed also a general reluctance to placing in the hands of the miners a highly

technical machine with many journals, pinions and valves to be attended to, while the maintenance of the old-fashioned Cornish pumps was well within the capability of the ordinary millwrights available in mining districts, and gave the mine owner a great feeling of security. The new type of rotating pump avoids all those complications, and a knowledge for its superintendence can easily be acquired, so that this feeling of security has been restored. This confidence has been still further intensified since it was realised that it is comparatively easy and cheap to keep complete spare sets of pumping machinery in store. Such provisions were rarely considered under the rule of any of the older systems, because the space required and the cost involved did not allow of it. Under the new system, however, it should not be a difficult matter to persuade mine managers to provide a sufficient standby plant to meet all emergencies. This would also greatly reduce the responsibility of electrical contractors, who do not yet always find, on the part of their clients, the necessary skill and that grain of enthusiasm which is all-important for the successful introduction of such completely new methods. The safe working of the new installation from the very beginning would thus be greatly facilitated. The duplication of the machinery will go a long way to removing the passive resistance which one meets very often on the part of the mining engineers of to-day against a plant, the features of which are not always understood, and certainly in advance of their earlier training.

We have seen that the history of pumping machinery for mines has made an important step since the above-mentioned exhibition, and out of the many propositions which were before the mine manager six years ago, something definite has developed in the meantime. The mechanical engineers, with their older aims for greater speed and consequent reduction in weight, and for rotation instead of reciprocation, have combined their efforts with the skill of the electrical engineers, the result being a complete revolution in pumping machinery.



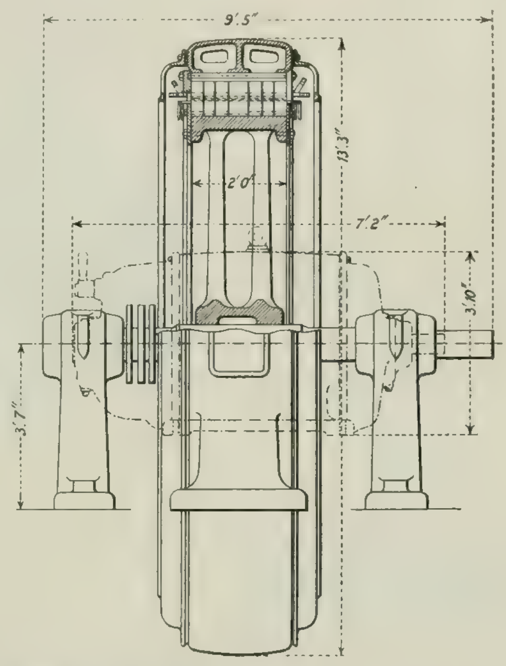
The belief in electrically-driven centrifugal pumps is growing so fast that lately the more difficult problem of portable pumps for sinking and unwatering purposes has been included in their sphere, and they have been adopted successfully in several places. Detailed descriptions of such installations have recently appeared in the press, and amongst the problems which have raised the greatest interest are the starting devices of the electric motors, which latter must of necessity be designed on the simplest possible lines and make more elaborate starting devices inadvisable. Perhaps the largest example of such an installation is the one which was erected at the Lindal Moor Mines in North Lancashire.

What has mining gained by this development? This is naturally the most important question. The time when mine owners will be inclined to make monetary sacrifices for the sake of convenience only, has not yet arrived in this country; and all the advantages of the modern form of electric pump as above described would hardly count, if those who are responsible for the profitable working of the mine were not convinced that some substantial saving could be effected.

How this saving comes about is not very clear on the face of it, as the energy accumulated in the steam of the boiler has to undergo four (or, counting the forces of the masses, at least six) changes before it reappears in the water raised; whereas, the process of the old Cornish pump is infinitely simpler and more direct. However, if the change into electricity—which is continually progressing throughout the world—has come to stay (and from all appearances there seems to be a unanimity of opinion on this point), the economic reasons for this change must indeed be powerful and indisputable; and the result must be substantial, if, as it appears, even the most conservative amongst the mining world are ready to part with their old and well approved plants.

The economical results of the introduction of electric pumps are still concealed in the pigeon-holes or log books of the mine managers. In many cases they have not yet been fully realised, as the process of electrification has not been completed, and the advantages of electricity grow with the increase of its sphere of operations. All the same they are already very encouraging, and the principal reasons for this are the following:—

Firstly, the prime movers in electric generating stations can be designed on purely economical grounds, with the one object of bringing the steam consumption down to the lowest possible minimum; whereas the prime movers, which are directly coupled to pumping machinery are subject to extraneous conditions in the determination of their dimensions. Local circumstances further, often prevent one from using the advantages of condensing plant to their full extent, whereas, electrical plants are singularly independent of locality, and can be installed where the balance of all the considerations of rent, water, coaling and ashing convenience and supervision is the most favourable.



Scale ¼ in = 1 ft.

Fig. 3.—Two Pump Motors of 500 h.p. That on the left runs at 1,480 r.p.m., that on the right at 107 r.p.m. (The dotted outline shows the smaller motor superimposed on the larger.)

It is very often found more convenient to collect the power required for the pumping machinery from a variety of sources, a problem which can only be solved by electricity.

Further, electricity is the best means of making use of that very considerable amount of energy, which, up to a little time ago, partly or totally, went to waste in most collieries, and which can now be saved by utilising the exhaust steam from the winding engines, and the waste heat of coke-oven installations. The former source of energy has been acquired through the invention of the exhaust steam accumulator and the establishment of the turbo-generator as a reliable prime mover; and the latter, through the adoption of the regenerative system of coke ovens and development of the larger units of gas engines. It is true that the waste heat from coke ovens could also be utilised under the old regime of steam, but the efficiency of such a system is necessarily bad. On the other hand, the larger size gas engines can hardly be used to greater advantage than where they have to cope with the almost ideal uniformity of load offered by mine drainage plants. In such a case the efficiency of the gas-driven electric installation is at least three times as high as that of a steam plant. A notable example of such an installation in this country is to be found at the Bargoed Colliery in South Wales; a description of which has appeared in the technical press. Fig. 2 illustrates part of the plant at this generating station.

Both systems—the exhaust steam turbine and the gas-driven electric plant—appeal to the mine owner by the undoubtable fact that the actual running expenses per power unit are minimised, and it depends on the value of coal in the first instance whether these reductions in running costs justify the capital outlay which the innovation involves. Of the two, I should think the latter will be a lasting one, whereas the system of exhaust turbines may possibly only be of a passing nature, and may fall with the more general introduction of organised supply of electric power, which would enable mine owners to look more favourably at the possibilities of winding electrically, and to avoid any steam raising plant on their own ground.

The third reason which I should like to mention in favour of a general adoption of electrical pumping plants, cannot be derived from the merits of these plants themselves: it is the necessity of securing a good load-factor on the electric generating station. The water in the mines, which is a continuous nuisance to the managers, and which involves such great risks, often endangering the whole property, is the most welcome side of a mining area to those who have made it their business to supply it with electric power. Water in the mines is the means of providing a steady load to power stations, which, with the aid of suitable lodge rooms, fills the intervals between the shifts and provides that continuity of power requirements which enables the supplier to use his plant with a higher efficiency, and to reduce the price of electricity to such a low level that it can successfully compete with the old-established methods of power distribution; and, considering the steady increase in the number of applications of electricity in all mining departments, this ast-mentioned reason is alone sufficient to guarantee the future of electric pumping in mines.

Examples of Electric Pumping Plant.

There is, perhaps, no part of the subsidiary machinery employed in mining work which it is more necessary should always be kept in an efficient state and in full running order than the pumps. In many cases the temporary cessation of any other part of a mine's economy is not likely to lead to more disastrous results than would be caused by a total stoppage of this important portion of the equipment.

It may, therefore, be considered in the light of a high compliment to the electric drive that it is more and more coming into use for this purpose. It is not necessary to supplement what Dr. Herzfeld has said elsewhere by entering with full details into the advantages of the electric motor in this connection, but, inasmuch as the proof of the pudding is in the eating, we shall content ourselves with describing some of the pumping equipment turned out by a number of well known makers.

One of the earliest adaptations of electrical power to mining work was probably in connection with pumping, for which the electrical drive is especially suited, whilst for the unwatering of flooded mines the advantages of electrical power are so overwhelming that further argument is unnecessary. For centrifugal pumps the high speed at which an electric motor attains its greatest efficiency renders direct coupling the obvious arrangement, whilst for ram pumps gearing is usually essential.

For many years past Messrs. W. H. ALLEN, SON & CO., of Queen's Engineering Works, Bedford, have been well known as the manufacturers of the "Conqueror" centrifugal pump, and during the last three or four years they have followed up their reputation with the development of a large business in the more efficient type, now usually known as the "turbine pump." Their long experience in this class of work has enabled Messrs. Allen to produce a pump which is said to be unequalled in efficiency, workmanship and quality of materials employed in its construction.

We illustrate herewith (Fig. 1) two large turbine pumps which have recently been manufactured by Messrs. Allen and supplied for some Durham collieries. Each pump has suction and discharge branches 18 in. in diameter, the casing being of cast iron. The spindle of the pump is of high grade nickel steel, completely encased with gunmetal sleeves. The disc, which is of the double inlet design, is of bronze, and likewise the fixed guide blades in the casing of the pump. The spindle is carried in bearings of the self-oiling type, arranged external to the pump casing, and at one end is provided with a small emergency collar-thrust bearing, which is also automatically lubricated and efficiently cooled by water circulation, drawn from the discharge branch of the pump. Each pump is driven through a flexible coupling by a three-phase motor of 200 B.H.P. of Messrs. Dick, Kerr & Co.'s manufacture, and is capable of delivering 5,000 gallons of salt water per minute against a total head of 86 ft. when running at 870 revs. per min. When on trial at the maker's works each pump developed the guaranteed efficiency of 78 per cent. under these conditions.

Water connections are also made between the discharge branch of each pump and the stuffing boxes through which the pump spindle enters the casing, in order to prevent access of air to the inlet of the impeller. As the pumps in this instance are situated at a good height above the water-supply level, Messrs. Allen have supplied one of their twin air pumps for the purpose of exhausting the air from the pumps prior to starting up. This air pump has two barrels, 10 in. in diameter with a stroke of 7 in., and is driven at a speed of 150 revs. per min. through chain gearing by a $7\frac{1}{2}$ B.H.P. three-phase motor. The pump barrels are of gunmetal and the buckets of cast iron, fitted with a gunmetal ring, and the bucket rods of forged naval bronze. All the bearings are lined with white metal, and are lubricated by means of spring grease cups. Fig. 1, which has been prepared from a photograph taken in the maker's works, shows the arrangement of the machinery, and gives a good idea of the compactness of the whole plant when the large amount of water dealt with is considered.

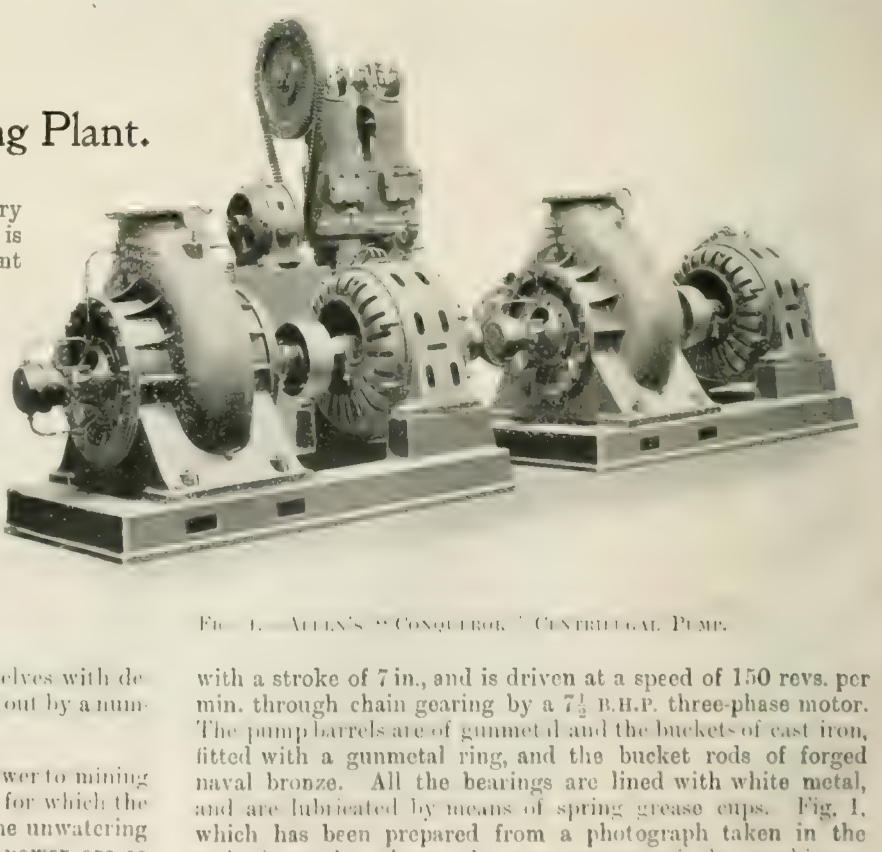


FIG. 1. ALLEN'S "CONQUEROR" CENTRIFUGAL PUMP.

When a mine can only be kept open by the use of pumps and by their use alone it becomes a matter of extreme importance to its owners that this equipment shall be as efficient as possible. The necessary degree of efficiency could only be obtained at the Lindal Moor mines by the use of electrically-driven pumps, and readers of *The Electrician* will remember how successfully great difficulties were overcome by the ELECTRICAL CO., of London.

As this installation represents *le dernier cri* in the Electrical Co.'s pumps, we cannot do better, in an issue such as this, in which we desire to give a summary of the latest electrical apparatus for mining work, than briefly recapitulate some of the more interesting details given in *The Electrician* of October 18, 1907.

Previous to December, 1903, steam pumps were installed which pumped 3,300 gallons per minute, as, however, the maximum inrush amounted to 7,000 gallons per minute and the normal dry weather flow was 3,300 gallons, this equipment was quite inadequate and the mines had to be shut down.

It was then decided to install an electrical pumping equipment and a special arrangement of high-speed centrifugal pumps and direct-coupled motors was devised and a contract for the complete plant placed with the Electrical Company. One of these pumps is shown in operation in Fig. 2. It is one of two, and is capable of delivering 4,000 gallons per minute against a total head of 395 ft. By joining them in series these pumps may be made to deliver 4,000 gallons per minute against a head of 780 ft.

Each pump has two wrought-iron delivery pipes, which are connected at the top by means of a pipe supporting a rising main 14 in. in diameter. The check valve has an internal diameter of 375 mm. (14 in.), and a foot valve 450 mm. (16 in.) internal diameter is fitted with a strainer. Each pump has a sheave, 4 ft. in diameter, mounted on suitable brackets, while each motor is capable of a continuous output of 750 B.H.P. on a circuit of 3,000 volts and a frequency of 50 periods.

Fig. 2.—An Electrical Co.-Sulzer Pump at the Lindal Moor Mines.

The equipment as at present installed will be able to deal with about 15,000 gallons per min. The pumps have all been built by Messrs. Sulzer, of Winterthur.

The most interesting part of the equipment from the electrical point of view is the voltage at the motor terminals, which is 3,000 volts. This makes necessary the provision of adequate protection of live parts, and we understand that such precautions have been taken so that there is no risk of danger from this cause.

The control arrangements are also rather out of the ordinary. Each of six pit motors is individually under the control of the power station engineer, the whole of the starting and stopping being carried out from the switchboard. Two sets of 'bus bars are provided, one for use at starting and the other for running at full pressure. The starting is effected by means of two transformers in series, one of which is an auto-transformer, reducing the voltage to half the working pressure, and the other, whose primary is connected in series with the first, has its secondary connected to a liquid resistance, which is gradually short-circuited on starting the motors. This avoids large rushes of current at starting, and facilitates the regulation of the station voltage. As soon as the motors have been run up to full speed on the auxiliary 'bus bars they are switched on to the main bars by change-over switches.

The motors are protected by automatic maximum current circuit-breakers fitted at the generating station, the only apparatus at the pithead being an isolating switch on each main, lightning arresters and a voltmeter to indicate when the current is on or off. Switches are also fixed close to the pump motors, so that in case of emergency the current can also be cut off there. Starting can, however, be only effected at the generating station.

The Sandycroft Foundry Co., near Chester, commenced nearly 70 years ago to supply the engineering wants of mines and other industries, so that when some 50 years later electricity was first introduced for power transmission and lighting in mines the firm were already well known, and soon took up the manufacture of electrical machinery, the result being that to-day their apparatus of all types is in very extensive use.

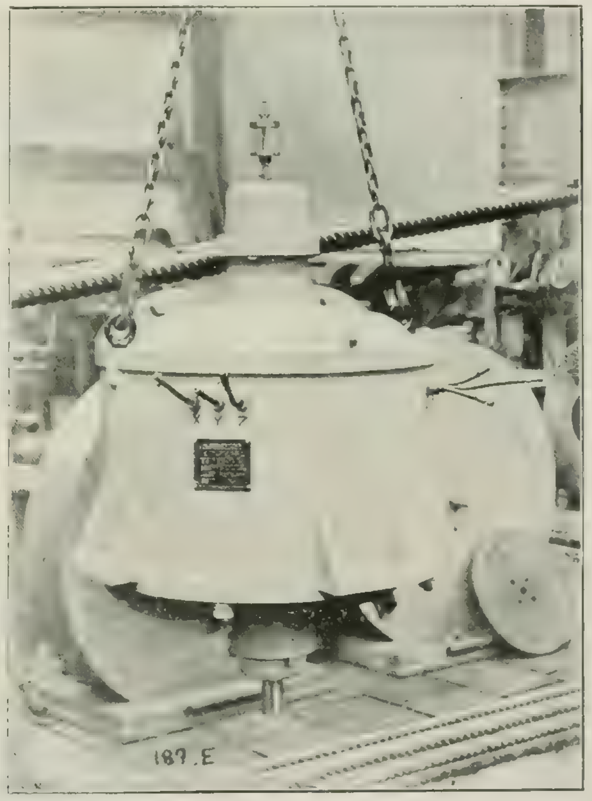


Fig. 3.—A Vertical Sandycroft Motor for Pumping Work.

Fig. 3 shows a Sandycroft 150 B.H.P. three-phase induction motor arranged for direct-coupling to a centrifugal pump, and it will be noticed that it is a vertical spindle machine. It is, of course, totally enclosed and is fitted with a ball-thrust bearing. The complete set is intended to be used for mine-sinking purposes.

A typical set is a 24 B.H.P. enclosed motor made by Messrs. J. H. Holmes & Co., of Newcastle-on-Tyne, driving a Gwynne "Invincible" vertical sinking pump. The pump has 5 in. suction and delivery branches, its capacity being 16,500 gallons per hour against a vertical head of 166 ft. The speed of the set is 1,800 revs. per min., and both pump and motor are fitted with ball bearings. The grooved pulley at the top of

the illustration, in which the upper casing of the motor is shown removed, is for slinging the plant in the shaft by wire rope. This equipment has been installed in a lead mine in the North of England.

The manufactures of the ELECTRIC CONSTRUCTION Co., of Wolverhampton, are so well known that any description would be almost superfluous. We may, however, mention in connection with pumping that they supply ram pumps, geared, belt-driven or rope-driven; direct-coupled centrifugal pumps and direct-coupled high lift turbine pumps; in all cases, of course, electrical motors are the motive power.

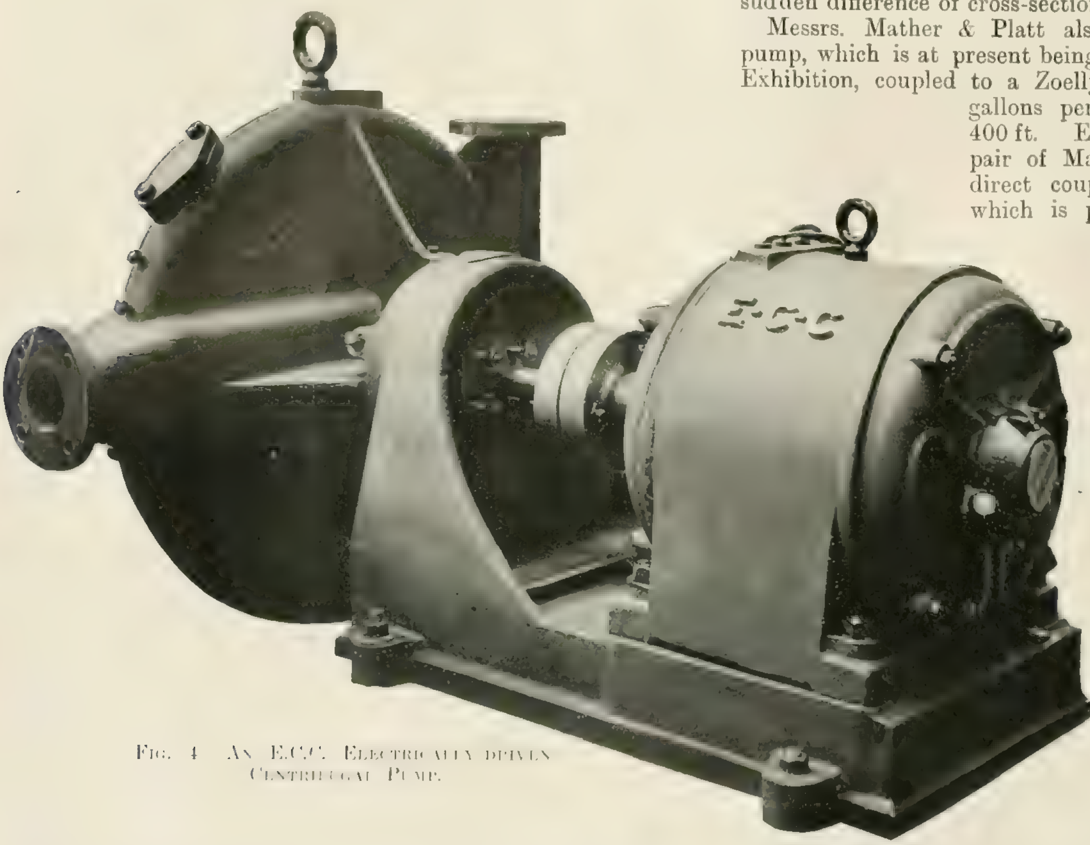


FIG. 4.—AN E.C.C. ELECTRICALLY-DRIVEN CENTRIFUGAL PUMP.

Fig. 4 illustrates an E.C.C. electrically-driven centrifugal pump, the motor and pump being of standard pattern and very suitable for mining work.

It is only in accordance with the eternal fitness of things that a man who has devoted himself to the design and manufacture of some particular piece of machinery should reap the benefit. The same applies to a company, though unfortunately this does not invariably happen in either case. We cannot, however, include Messrs. MATHER & PLATT in this unfortunate class, for their pumps, which are the outcome of much consideration and trial, are known throughout the whole world.

It will be remembered that in order to render rotary pumps suitable to high lifts Messrs. Mather & Platt some years ago introduced their multiple chamber centrifugal pump. This is capable of discharging water against heads with which the ordinary centrifugal pumps cannot deal. This pump consists essentially of one or more sets of vanes or impellers, each set running in its own chamber, but upon a common shaft, the delivery pressure of the liquid varying directly as the number of chambers used.

In the improved type of pump it is claimed that all axial thrust is eliminated; the water enters the revolving wheel axially, traverses the curved internal passages between the vanes, and is discharged tangentially at the periphery into a stationary guide ring of special construction; this conveys it to the annular chamber in the body of the pump, where the velocity head imparted to the water by the wheel is converted into pressure head. From this chamber the water is finally discharged into the pipe lines, or, if the pump be a multiple one, into the second and subsequent chambers.

A special feature of this pump is the provision of the stationary guide ring mentioned above. This is fixed concentric with the revolving vanes, and, owing to its design, enables the conversion of velocity into pressure head to be carried out in a much more perfect manner than is possible in the case of any other centrifugal pump; thus, not only is the possible height of lift, but also the efficiency of the pump, greatly increased.

Another point of interest is that with the special design of guide passages in these pumps the water is nowhere forced to undergo a sudden change of direction, or to meet with a sudden difference of cross-section in the passages.

Messrs. Mather & Platt also make a high lift turbine pump, which is at present being shown at the Franco-British Exhibition, coupled to a Zoelly turbine. It will lift 1,200 gallons per minute against a head of 400 ft. Exhibit No. 3 consists of a pair of Mather & Platt turbine pumps direct coupled to a 150 B.H.P. motor, which is placed between them. Each pump has six chambers, and the two in series are capable of pumping 400 gallons per minute against a head of 720 ft. By increasing the speed 600 gallons per minute can be delivered against a 2,000 ft. head.

A subject which always produces a fruitful discussion in a company of those interested in pumping apparatus is a comparison of the respective merits of the ram and centrifugal pump. We do not intend here to enter the lists. Our object is to put forward in as unbiassed a way as possible the properties of each type, and to leave our readers to judge between them.

Messrs. MAVOR & COULSON, of Glasgow, also take this middle course, in that they manufacture both types.

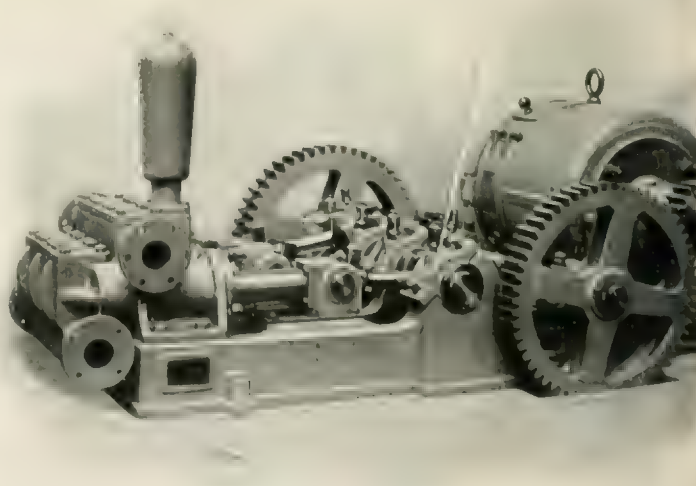


FIG. 5.—MAVOR & COULSON THREE-THROW PUMP.

Their three throw pump, illustrated in Fig. 5, shows the standard high-lift electrically operated treble ram pump, for use in mines. The motor, of enclosed ventilated type, is bolted

direct to the pump base plate, and drives the pump through machine-cut steel gearing. It will be noticed that the whole arrangement is very compact, and the valves are all conveniently situated for easy examination, a feature which will appeal to those who are to have charge of this equipment.

An electrically driven centrifugal pump, which we illustrate in Fig. 6, is also manufactured by the same firm. It is

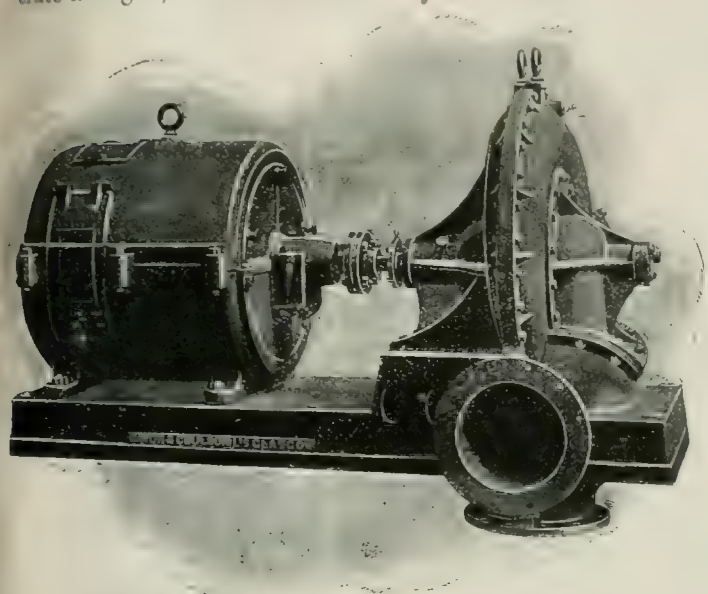


Fig. 6.—Mavor & Coulson's Centrifugal Pump.

specially suitable where a large quantity of water has to be lifted against a medium head. The motor is of the enclosed ventilated type, and is carried on the pump base plate, a flexible coupling being used to connect the pump and motor shafts.

It is a well recognised fact that the manufacture of certain articles is the special perquisite of one or, perhaps, two firms.

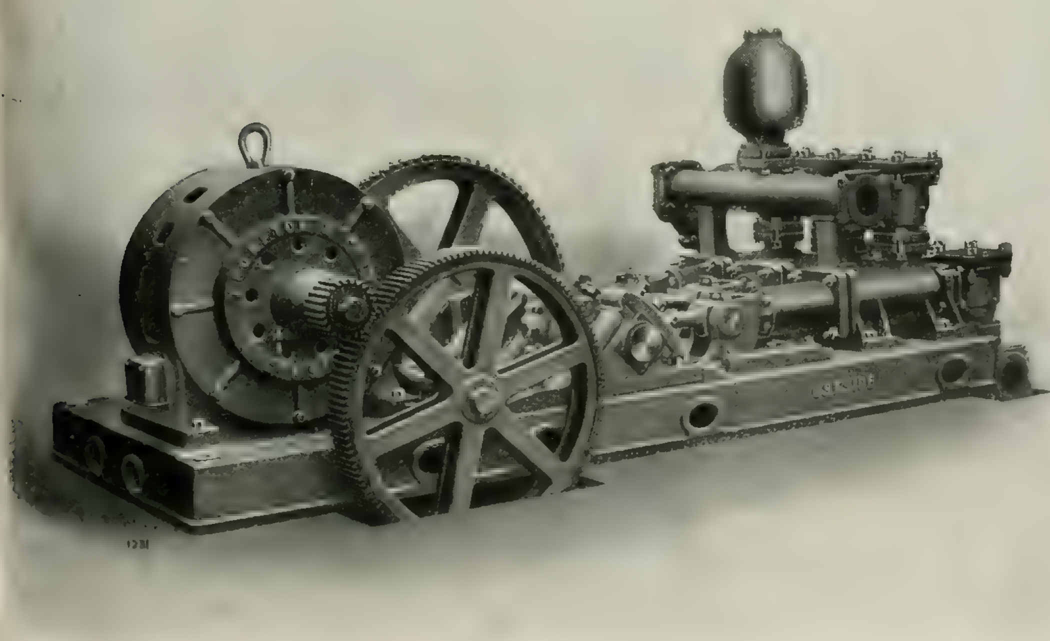


Fig. 7.—A Crompton High Lift Mining Pump.

This is the case in engineering as in other trades. Perhaps Messrs. Crompton & Co., of London, may be considered as of a special class, particularly in relation to Indian and Colonial work, for although, of course, their name is well known in this country it is unusually pre-eminent in British Dominions beyond the seas.

In these dominions, as in this country, there is ample scope for the electrically-driven pump, and we illustrate, in Fig. 7, one of Messrs. Crompton's most modern types of high-lift mining pumps, direct-coupled to a three-phase motor through double reduction gearing. It has three rams each 8 in. diameter by 12 in. stroke, and when running at a speed of 40 revs. per min. can deliver 250 gallons of water per minute against a head of 600 ft. The motor has an output of 65 B.H.P. when running at a speed of 750 revs. per min.

The pump parts are designed on the most liberal lines, and a great feature has been made of the interchangeability of parts. Further, the water ways are so proportioned that a steady and correct flow is obtained, thereby reducing friction to a minimum.

It is claimed that these pumps are specially suited for high lifts and constant running, and that their efficiency, unlike the centrifugal pump, is independent of head or duty.

Dr. Herzfeld in the course of his article on electrical pumping, gives an interesting comparison between the sizes of the slow-speed and high-speed pump motor. The Lahmeyer Electrical Co, of London, consider that both types have their uses, an opinion borne out by their long experience in these matters.

An example of their products is a Lahmeyer slow-speed motor coupled to a Haniel & Lueg pump. This pumping plant is capable of supplying 5·5 cubic metres of water (1,210 gallons) against a head of 450 metres (1,485 ft.). The pump is of the differential type coupled to a 650 H.P. asynchronous three-phase motor built by the Lahmeyer Company. It is designed for a voltage of 2,000 and runs at 60 revs. per min. The motor is of Messrs. Lahmeyer's well-known type, and is of more than ordinary size, the rotor being $15\frac{1}{2}$ ft. diameter by $16\frac{1}{4}$ in. wide. The frame and stator can be rigidly fixed by means of bolts to the shaft, so that the entire stator can be revolved with the machine. This arrangement allows the machine to be inspected and repaired in places where there is very little space. It is, therefore, specially suited for mining work. The total weight of the frame including the spider is 33·5 tons, and of the rotor 28 tons.

Another example is the pumps installed at the "Deutscher Kaiser" Mine. There are two sets, each capable of an output of 444 gallons per minute against a head of 1,210 and 1,540 ft. respectively. Direct current motors are used whose capacity is 220 H.P., and which drive the pumps through reduction gearing.

The recent introduction of the high-lift centrifugal pump allows a direct-coupled motor to be employed. This makes for compactness, as will be seen by a glance at a drainage plant of this description installed at the Wildberg Mine in Bohemia. There are two high-lift centrifugal pumps at this place, made by Messrs. Sulzer Bros., of Winterthur, each capable of delivering 330 gallons per minute against a head of 755 ft. when running at 1,460 revs. per min. The motors used are of the shunt type, developing 180 and 240 H.P. on 700 volts. Owing to the high peripheral speed, the commutator is held together by two shrunk rings, while the motor is ventilated by small fan mounted on one side of the armature.

Electric Winding.

BY T. CAMPBELL FUTERS, M.I.M.E.

In answer to the question, Is electric winding possible? we are now in a sufficiently advanced stage with regard to this application of electricity to reply emphatically, Yes! If, however, the question be put, Is electric winding from a commercial point of view entirely successful? we cannot answer so readily, but can do so in the affirmative with this qualification that "conditions are such as will justify the owners to spend the greater initial capital for an electric winding plant over that required for a steam plant." We say "greater" initial capital, as generally speaking electric winding plant is more costly than steam plant, though again this is greatly influenced by local circumstances. We will, however, return to this point later.

In order to discuss the question in all its bearings it is first necessary to understand the work to be done by the "winding" engine, which is the most important operation of colliery working, as not only the "output"—but the very lives of the workmen employed underground—depend upon this machinery.

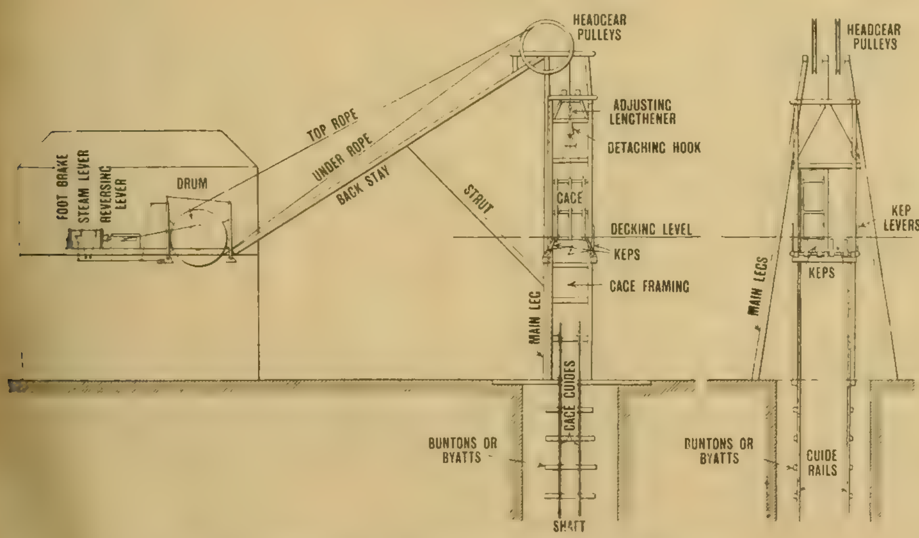


Fig. 1.—Diagram of Headgear and Winding Engine.

Driving a winding engine at a large colliery is probably the most arduous employment that any man can undertake. Passenger locomotive and "city" tramcar driving are undoubtedly responsible positions, requiring men with intelligence, good sight, and presence of mind, but the winding engineman must in addition to these qualities have a strong physique to enable him to handle easily the—often heavy—operating levers; a clear head, a cool nerve, and confidence in himself and his engine. Unlike the locomotive or "car" driver, whose principal duty after starting is to keep a sharp look out, and who can slow down and stop, in their own time so to speak, the winding man, no sooner gets his engine started than he must think of stopping, and to stop *exactly* at the same point at the end of every wind, whilst at the same time he has to attend to signals and watch his indicator and drum marks. At a busy colliery where the period of winding occupies, say, 40 seconds with, say, two-deck cages, the cycle of operations to be carried out would be something like the following:—

1. Start, reversing lever is put over and steam lever pulled full open.

2. After say 25 to 30 seconds steam lever is closed, and engine runs without steam.

3. After 5 to 7 seconds more reversing lever is pulled over, and brake lever pressed down.

4. If engine cannot be stopped exactly with brake, steam valve is quickly opened to put steam against engine, which will be stopped with ascending cage slightly above the "keps."

5. Reversing lever is now put over and engine is reversed to drop cage on to "keps."

6. After from 5 to 7 seconds for changing tubs and after receiving a signal from the pit bottom, engine is again reversed to lift lower deck, and

7. Is again reversed to put lower deck on to "keps."

8. Five to 7 seconds again elapse for changing tubs when the signal is received for starting, when engine is again reversed to lift cage off the "keps" which are then withdrawn, and

9. Engine is again reversed, and steam valve fully opened for the run in the shaft.

Thus in every 60 seconds no less than nine operations have to be performed employing both hands and one foot, in addition to watching the changing of the tubs, and listening for the signal from the pit bottom, and this work may have to be done continuously for five or six hours at a stretch, when winding coal. When winding men the operations are similar, but the signals are different, and every muscle and sense of the body is strung up to attention ready for any emergency or signal.

Fig. 1 shows a diagram of the general arrangement of winding machinery in ordinary use, which will enable the non-technical reader to understand better the conditions and technical terms used above. This is the ordinary arrangement of winding adopted in the majority of cases, with the rope unbalanced, and many engines work with full steam for the whole length of the stroke.

It has been asserted, and with much truth, that winding engines are very extravagant in steam consumption, and the diagram shown in Fig. 2 which is taken from an engine, having a short wind, occupying 15 seconds, and raising approximately 2,000 tons in 11 hours, may be taken as typical of very many engines working at the present day. It will be noticed that steam is put against the engine to bring it to rest, and again it will be noticed that as the engine gets up to full speed the exhaust is throttled. Such a state of things, however, may be very much improved, and colliery owners are now very much alive to the fact, that by spending money on improved valve gear, very much more economical results may be obtained and it is very seldom now that any new undertaking puts down a winding engine without some form of "cut-off" gear, whereby the engine takes full steam at the start, after which an automatic "cut-off" gear comes into operation, gradually increasing the amount of "cut-off" from full stroke to a quarter or even less as the speed increases. In addition to the actual steam consumption, there is the loss due to radiation, and condensation from a long length of steam pipe, when the engine is standing, which frequently happens. In the writer's opinion, however, too much has been made of the latter by the advocates of electric winding, and it serves no good purpose to make a mountain out of a mole-hill, as this loss cannot possibly be avoided, though it may be reduced; and this is very greatly influenced by the design and arrangement of the steam plant. The engine *must* stand, and unless the power supply can be entirely "cut-off," there necessarily must be some little waste, whether it be steam or electric winding.

Another factor which is to be seriously reckoned with is the class of fuel used. At many collieries the fuel used is of very

inferior quality, with absolutely no market value. It must either be burnt or put into a heap, with every probability of its taking fire and becoming a nuisance. The consequence is, naturally, that the owners being commercial men and not philanthropists, refuse to spend money over perfecting plant to save that which they cannot sell. On the other hand, however, there are many more collieries where every particle of coal brought to the surface can be sold, and others where, by putting down proper cleaning plant, coal which is now unsaleable may be rendered saleable. But even with the latter class of collieries, the owners must be fully convinced before adopting any radical departure in winding, that first, the proposed system will be as safe, as certain, and as quick; and secondly, that a fair return will be yielded upon the capital to be invested, over the system at present in use. These are the practical points which must be faced in dealing with electric winding from a commercial point of view, and any attempt to disguise the facts when putting forward a scheme for electric winding will only do more harm than good. Mining engineers may not be electricians, but they know very well what they are about, and are quite prepared to adopt any improvements, when they are convinced that it is to their advantage to do so. This is very well evidenced by the almost universal adoption of electricity for power transmission where it can be safely and economically employed.

We have already touched upon the operations to be carried out by the engineman, when winding, and we may now consider the problem of winding itself. In Fig. 1 the drum is supposed to be "parallel" with the ropes wrapped around it in opposite directions, so that one rope uncoils while the other coils on. The ropes pass over the headgear pulleys which are

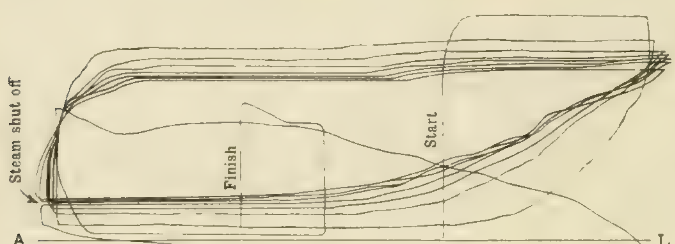


Fig. 2.

usually about the same diameter as the drum, and a cage is attached by chains to each rope, and at the start of the wind we have :—

(*a*) The loaded cage at the pit bottom, and

(*b*) The length of rope in the pit; against

(*c*) The empty cage at the pit top, and

(*d*) Only a very short length of rope;

(*e*) The inertia of the whole mass of drum, pulleys, cages and ropes, has to be overcome, and accelerated from rest to a very high velocity, in a very short period of time; and

(*f*) The momentum in the moving mass, and out of balance rope load, must be quickly and positively brought to rest at the stopping point within a fraction of an inch.

The full significance of the above will be understood when it is stated that drums weigh from 10 to 80 tons, headgear pulleys from 1 to 4 tons, cages from 1 to 7 tons, empty tubs from 5 to 15 cwt., and will carry from 8 to 40 cwt. of coal, and in a deep shaft the ropes may easily weigh 2 to 3 tons each; and that a speed of 60 ft. per second (40 miles an hour) is quite common. The what may seem extreme variation, for instance, in the weights of drums, is really the outcome of attempts to solve the problem which is to raise the largest amount of coal at a minimum cost in different directions, notably by the introduction of the large spiral drum. But the objection to many of the different methods of winding other than with the parallel drum lies in the fact that, to save at one end, a great deal more was lost at the other; or advantage in the shape of lessened capital cost, were more than counterbalanced by disadvantages resulting in loss or greater risk of accident in working.

The different systems are shown diagrammatically in Fig. 3, where :—

A represents the parallel drum.
B ,, ,, conical ,,
C ,, ,, Koepe pulley
D ,, ,, "Whiting" pulleys.
E ,, ,, parallel conical drum.
F ,, ,, flat rope reel drum.

The most popular drum is undoubtedly the plain parallel type, A, but the objection to it is that in the case of a deep pit it has to be large in diameter, if the rope is to be confined to a single layer, and it is not considered good practice to "overlie" the rope on the drum. Again, there is the angularity

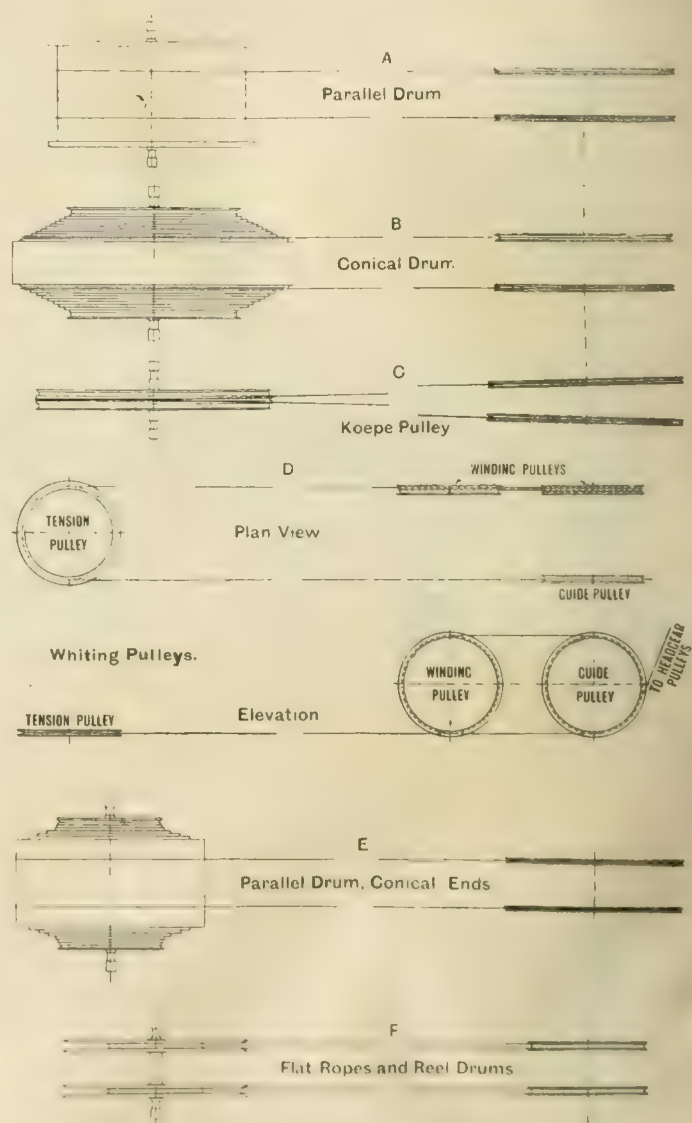


Fig. 3.

with the headgear pulleys to be considered, as this has a most detrimental effect on the life of the ropes. In order to reduce the diameter and, consequently, weight, one engine has been mounted on rails, so that for every revolution of the drum, it moves sideways a distance equal to the thickness of the rope. This answers its purpose well, as the rope is always exactly in a straight line with the pulleys, and the drum and engine are accordingly reduced both in size and weight. This method might with advantage be considered in drum design in connection with an electric winder. For many years the effect of the weight of the rope in shaft was never considered, but once the idea of counterbalancing this weight was put forward, two

or three methods were proposed and put into operation. Of these the conical drum is beautiful in conception, but very crude in operation, owing to its enormous size and weight. Some of these drums are over 30 ft. maximum diameter, and weigh as much as 80 tons. The full cage commences to wind on the small diameter, while the empty cage is suspended from the large diameter. After say, one or more revolutions the loaded rope begins to climb up the conical part of the drum to the large diameter, while the reverse goes on with the "empty" rope. One trouble however, with this drum lies in the difficulty of decking, necessitating the employment of special machinery, as the two cages move different distances for any given movement of the drum; and in the enormous loss of energy in accelerating the mass, at the beginning of the wind, which has to be absorbed by the brake or by putting steam against the engine to bring it to rest. A much better method of balancing the rope is, of course, to put a "tail" rope below the cages. The engine has then merely to raise the coal and accelerate the moving mass.

In order to get over the difficulty with the heavy drum, the "Koepe" system was introduced in Germany. This, as shown in C, consists of a single-grooved pulley lined with leather or wood, in which the rope lies. One end of the rope is attached to one cage, and after passing half round the pulley the other end is attached to the other cage, whilst a balance rope is fixed below them. The two cages, therefore, are suspended by one rope, and should this break, both cages would necessarily fall. Proposals have been made to use additional safety ropes, but of course this does away with the advantage of simplicity, which is one special feature of the system. Another disadvantage is the "slipping" of the rope, and it is found in practice that to prevent this the pulley has to be large in diameter, in order to increase the arc of contact, which necessarily increases its weight and inertia. The system has not found any favour in this country.

To get over the difficulty in regard to the arc of contact the "Whiting" system was introduced, which consists of wrapping the rope several times over a pair of pulleys, as shown in D. One end of the rope is attached to a cage, and after passing over the headgear and friction pulleys, is passed round a "tension" pulley, and from thence by a guide pulley to the other headgear pulley and the end is attached to the other cage. A balance rope under the cages is also necessary to this system. This has been applied to deep metallurgical mines, but as it has many disadvantages it is unlikely to come into general use.

Probably the best system is that shown at E, where the drum is for the most part parallel, with conical ends. The "loaded" rope commences to wind on the small diameter, then in two or three revolutions coils on to the parallel part, while the "empty" rope commences to uncoil on the large part, and descends to the small part when near the end of the wind. The advantages of such an arrangement is in the smaller and lighter drum as compared to the large conical drum, with an overbalance in favour of starting at the commencement, and in favour of stopping at the end of each wind.

The arrangement, shown at F, is popular in the north of France and Belgium where reel pulleys or drums are used in connection with flat hemp ropes. In our own northern coalfields there are also several old engines working with flat ropes, and reel drums, but here the ropes are of steel wire, and it is necessary to counterbalance them by means of heavy chains in a staple behind the engine. In France and Belgium, on the other hand, the ropes are of hemp, and are made tapered, being much wider and thicker at the drum end than at the cage end, and the thickness may be so adjusted that as the rope coils on the drum and on itself the diameter is so increased that an almost perfect counterbalancing of the ropes may be effected. A great objection to such ropes, however, is their enormous weight, expensive upkeep, and the uncertainty of their life. Some of these ropes weigh over 20 tons. Flat ropes in this country are rapidly going out of use.

Other methods of counterbalancing the ropes are by means of a heavy swinging pendulum, and a heavily loaded truck running upon an incline. In both these at the commencement of the wind the weight is suspended, and during the first half of the wind the load is helping the engine, it is then reversed and during the last half the engine raises it up, ready for starting again. So far, however, these have merely been designed to balance the weight of rope in the shaft, and either of the latter methods, as well as the tail balance rope, are to be preferred to either of the methods D, E, or F, as with these special machinery must be employed for decking. It is, however, the acceleration and retardation at the beginning and ending of the wind that causes the trouble, and this is all the more difficult where high speeds are aimed at; and if electric winding is to become a success, they should be designed for heavy loads and slow speeds. Of course, any speed in winding is possible, and it is a current opinion that if the load is a light one and the speed high a smaller engine will do the same work as a large engine and a slow speed. A simple calculation, however, will show the fallacy of such a view, as speed must be paid for, and very often is *dearly* paid for.

Suppose, for instance, it is required to raise 2,000 tons of coal in 10 hours from a depth of 1,000 feet and each tub containing a weight of 10 cwts. We may design the winding plant to deal either with one or two tubs, or a light load, in which case the speed will be high, or the cages may carry several tubs, or a heavy load at a slower speed. Take for thers fit a single-deck cage with two tubs per deck. Then it is evident there must be 2,000 winds in 10 hours, or $\frac{2{,}000}{10 \times 60} = 3{\cdot}3$ winds must be made every minute, each occupying 18 seconds. This time will also include that necessary for changing the tubs, and allowing, say, three seconds for this our winding period is reduced to 15 seconds, so that the average speed will be 66·6 ft. per second, and the problem is to so divide the time into periods for acceleration, full speed and retardation, that the most economical results will be obtained. If a short period be allowed for acceleration, a larger engine will be required than if a longer period be allowed, but the full-speed period will be lengthened and the engine will work expansively for a longer period, but on the other hand the stresses in the ropes will be increased.

If, now, the load be increased to say, 8 tons, the cages being designed to carry 16 tubs, the time required for each wind will be $\frac{10 \times 60 \times 60 \times 8}{200} = 144$ seconds, and allowing, say, 14 seconds for changing leaves, 130 seconds for the wind, or at an average speed of 7·7 ft. per second. In the first case, the horse-power works out $\frac{2{,}240 \times 66{\cdot}6 \times 60}{33{,}000} = 271$ useful horse-power and in the second case $\frac{2{,}240 \times 8 \times 7{\cdot}7 \times 60}{33{,}000} = 250$ useful horse-power, which is mainly due to the saving of time required for decking. An objection may be raised that the latter load would add to the capital expenditure in the shape of simultaneous decking machinery, heavier headgear, and a larger engine, which will be true to some extent though not anything like the amount that might be imagined, and there is no doubt that it would pay. This is not so clear at first sight, but a full investigation into the whole problem bears this out. High speed involves heavy stresses, and more wear and tear, and the headgear must be designed for the maximum stress, and wear and tear is to be paid for.

Electric winding in Germany has been pushed before the mining community in this country, until it has almost become nauseous. By some it has been applauded, by others ridiculed, but certainly it has not "caught on" and to any who has a full knowledge of conditions in this country as compared with Germany will not wonder why. The writer some little time ago visited the three best known German collieries with electric winders, viz.: Zollern, Preussen II., and Grand Hornu, which are probably the best examples of (*a*) the Ilgner system and (*b*) ordinary three phase. With regard to the former the lavish expenditure over the generating station, can only be described as "absolutely ridiculous," and the waste of money spent over the buildings generally far outbids the extravagance and mismanagement by some of our

municipalities. The question the Britisher asks is: Where-ever did they get the money from? The electric winder consists of a Koepe pulley driven by a continuous current motor, which receives current from the generator of a fly-wheel motor-generator placed near to. As is well known, the flywheel absorbs energy during the time the winding motor is standing, and gives it up by slightly reducing its speed when the winding motor starts. This latter is separately excited from the main circuit mains, and is kept constant. The generator of the motor-generator is also separately excited, but it is provided with a variable resistance which is operated by the engineman when starting the winder. Hence, with all resistance in, no current will be generated, and the winding motor stands; but as the resistance is cut out a heavy current is at once generated and supplied to the winding motor which starts, and of course generates a back E.M.F. approximately equal to that of the generator, so that the speed of the latter is regulated by varying the voltage of the generator by means of the shunt resistance. In order to give out energy, the flywheel drops in speed, and necessarily the speed of the motor of the motor-generator is likewise reduced, so that a shunt resistance is necessary to keep the current from the mains constant. This is obtained by a regulator operated by a small motor. The Ilgner system is very perfect in its working, and is the only system that anything like approaches the perfection in handling of the steam engine, and the only objections that can possibly be laid against it is that it is a little complicated, and that it is costly, the latter being the chief.

At Preussen II. pit, the winder consists of an ordinary three-phase motor coupled direct to a Koepe pulley. This motor is driven by two direct-coupled generators, the voltage of which is 2,000. So great, however, is the rush of current at starting, that both engines are pulled up, and the voltage quickly falls to 1,200, and remains there during the wind. After the load is started, the winder motor runs to a certain point, and the current is then cut off, a heavy flash taking place at the main switch, which is fitted with long horns to break the "arc." If the engineman has made a good guess, the cage may come to bank, but if not, then the current is switched on again for a second or two, much in the same way as an engineman would admit steam into the cylinders of an engine. Needless to say, as arranged at Preussen, this system is a failure, and need not be further enlarged upon.

At Grand Hornu, there are three electric winders—all being simple three-phase direct-coupled motors—worked from one main generating station, which contains two slow-speed direct-coupled massive flywheel generators, each capable of taking the whole load, and, as arranged, is very successful, local conditions as to the arrangement of the shafts lending themselves to this end. The winding drums are light reels and the ropes of flat hemp, being thicker at the drum end than at the cage end, so that they act as a counterbalance. Another feature which contributes to the success of Grand Hornu is the arrangement of the four-deck cages and hydraulic "keps," and there is no doubt that, were it not for the reel drums, flat ropes, four-deck cages and hydraulic "keps," the system would be just as great a failure as Preussen, as far as the winder is concerned. At Grand Hornu, however, owing to the mass in the flywheel generator, the winders may be started up, with merely a swing of the voltmeter pointer at the momentary rush of current, and the voltage therefore remains practically constant. As the ascending cage rope winds upon itself the diameter increases, and the current is on the motor almost to the end of the wind, as there is very little mass in the drum, and the load is practically increasing on one side and decreasing on the other. The cage is wound right up and received upon the hydraulic "keps" so that the *bottom* deck may be changed first, while the other cage at the pit bottom is also received upon hydraulic "keps" so that the *top* deck may be changed first. The "keps" have long rams, so that as soon as they receive the weight of the full cage at the pit top, the banksman opens a valve and lowers the cage deck by deck until all are changed, the same operation going on at the pit bottom, but in the reverse direction. The engine-man has nothing whatever to do with the changing except to put on and take off the brake, and the weight of the cage acting on the large diameter is enough to pull the drum and motor round when the brake is taken off. It is almost a perfect example of constant load winding, and were it possible to use similar ropes in this country, this method would undoubtedly be the one to adopt for electric winding.

With round ropes the ideal system would be either to design the winder with a conical-parallel drum with a balance rope below the cages coupled direct to a three-phase or continuous current motor. The cone ends of the drum would be designed to assist the motor when starting and accelerating, after which it would run with the ropes exactly balanced, and when approaching the end of the wind, the loaded cage then being on the large diameter of the drum while the descending cage would be on the small diameter, the overbalance would materially assist the retardation. Or an ordinary parallel drum may be employed with a loaded bogie, with the incline arranged with a steep portion near the end to give the required overbalance at starting and finishing. Some such means would so reduce the actual cost of the plant, and simplify the connections and machinery, as to make it a serious competitor with the most economical steam engine.

Turning now to the commercial advantages to be derived from the installation of electric winding, the first question the mining engineer will ask is, "What will be the saving in fuel consumption and working costs?" Which at once brings us back to the quality of the fuel used; and it may as well be admitted that, if this is of such a quality that it cannot be sold, or the putting down of special sorting and cleaning plant to treat it so as to render it, or a part of it, saleable, will not give a return on the capital outlay, then it is nonsense to think of adopting electric winding. If, however, the fuel can be sold, or by special treatment will have a marketable value, then the case is entirely different, and a full review of all the conditions and life of the colliery may show a saving sufficient to warrant a considerable expenditure of capital. One thing, however, must not be overlooked, and that is there can be no increased output with the installation of electric winding *per se*, as this mainly depends upon the facilities underground for getting the coal to the shaft bottom.

Premising then that conditions are such that economy may reasonably be expected, we must now consider how this economy is to be effected. A steam winder can be built that will work with a consumption of from 25 lb. to 30 lb. of steam per *useful* horse-power per hour, but such an engine would require to be very carefully designed and as carefully handled, and, moreover, would be very expensive; and this is possibly the best that can ever be expected to be obtained from a steam winder. The arrangements as regards counterbalancing may be the same either for steam or electric winding, and consequently will not affect the cost, so that we need only here consider the capital cost of the winder itself in comparison with that of a steam engine. An Ilgner winder will cost from 25 to 30 per cent. more than a steam winder of equal power, but if an electric winder be designed on the lines just described, wherein the flywheel motor-generator is not required, then possibly the electric winder will cost less than a steam engine; but at any rate it will be safe to assume it will not cost more. If the cost of a high class engine to work with a consumption of, say, 30 lb. of steam per *useful* horse power, is taken as a comparison, the electric winder would no doubt be the cheaper; but in the majority of the very best engines 50 lb. of steam per actual horse power per hour is considered a *very* low consumption, while for ordinary winding engines 75 lb. to 100 lb. is the average. A steam engine to deal with a 4 ton load from, say, 1,000 ft., as in the first example previously given, would cost about £3,500, and the guarantee consumption would probably not be less than 50 lb. of steam per actual horse-power hour or a total, taking the horse-power as 271, of 13,550 lb. per hour. If we take then 8 lb. of water per pound of coal which is a good average for colliery boilers—the fuel consumed will be 1,691 lb. or 0·75 ton of coal, which at 4s. per ton would represent 3s. per hour, and for eight hours per day the

sum of £1 4s. ; and two 8 ft. × 30 ft. Lancashire boilers will be required to consume this quantity of fuel.

With the Electric Winder, we may assume the cost of the winder will be the same as for the steam engine ; but the generation of the current is to be considered, and the worst case will be that in which a special generator is put down for the purpose of winding only. It is also assumed that the winder is designed to allow the actual load to be as constant as possible, in which case we may take it that our generator may not exceed 300 H.P., and that it will cost £10 per horse-power or £3,000. With a constant-running electric generator there ought to be no difficulty in getting a guarantee that the steam consumption per kilowatt per hour would not exceed 25 lb., which would bring the fuel consumption down to $\frac{300 \times 746 \times 25}{1{,}000 \times 8 \times 2{,}240}$ = 0·31 ton per hour, thus saving 0·44 ton, or nearly 60 per cent. If we take 300 working days, the cost of fuel for the steam engine would be $\frac{300 \times 24}{20} = £410$, and for the electric winder $\frac{300 \times 10}{20}$ £150, a difference of £260 in favour of electric winding. Unfortunately, however, this is not enough to cover interest on and redemption of capital and maintenance which, taken at 15 per cent. on £3,000, would amount to £450 per annum, and the result is therefore an annual loss of £40.

This is clearly a case where the current might be taken from an electric supply company, and it is necessary to determine the price of the current that would enable the colliery company to take advantage of such a course. Here we save not only the whole of the £410 cost of fuel, but all boilers and labour in connection therewith. Thus we have—

Saving in fuel	£410
Stokers' wages, say	150
Interest, &c., on cost of boilers, repairs, &c.	50
	£610

On the other hand, the annual consumption of current would be $\frac{271 \times 746 \times 8 \times 300}{1{,}000}$ 485,198·4 B.T.U., so that $\frac{610 \times 20 \times 12}{485{,}198 \cdot 4}$ = 0·3d. per unit ; and it is very questionable indeed if any supply company could produce and deliver current at this price. It is very evident, however, that unless the current can be produced and supplied to the winder at about ¼d. per unit it will not pay any colliery company to think of changing over from steam winding. It may be said we have assumed too low a price for the fuel, and that the selling price ought to be taken, which might be nearer 6s. than 4s. But we are dealing with the cost of production, and consequently it is only fair to take the price of the fuel as that at which it can be delivered at the boilers, which in most cases will not be more than 4s.

Hence the question resolves itself into that of the cost of generation of current, and the point to be considered is whether the inclusion of the winder along with other machinery would not so enlarge the central power plant, which could be more economically worked, that the cost of production would be materially lowered, to the general advantage of all the other plant. To carry this out effectively, however, work would have to be arranged to give as large a load factor as possible. So far, small installations have been put down to deal only with power transmission, and the cost of generation has never been considered, the principal reason for the adoption of electricity over compressed air being that of better efficiency.

The load factor as a rule is very small, and great economy in fuel consumption has not been aimed at. Unfortunately, the working of a colliery does not lend itself to the arrangement of a straight line 24 hours load curve, for, if the pit is only drawing coals for eight hours—which means that, in addition to the winder, the hauling, screening and other machinery must also be kept going—the plant must be capable of dealing with this load for eight hours, after which it may have little or nothing for the remaining 16 ; yet the plant must be kept running on account of the winder, as this may be required at any moment, during the night. There are, however, certain loads that may be taken, such as coal-cutting and pumping, during the time the pit is standing, which would help to remedy matters, especially where a large quantity of water has to be dealt with.

We may, for the sake of argument, assume that a colliery requires for haulage 200 H.P., screening plant 50 H.P., ventilating fan 100 H.P., coal-cutting 100 H.P. and auxiliary machinery another 50 H.P., making a total of 500 H.P., and that the pit works eight hours per day. With steam engines connected to the boilers with long ranges of steam pipes, the average consumption cannot be less than 60 lb. of steam per horse-power hour as, however carefully the pipes may be coated, condensation losses cannot be prevented, for the steam is never taken off the pipes. The fan is constantly running, so that we have—

Haulage	200 H.P., eight hours—day load
Coal Cutting	100 H.P., eight hours—night load
Fan	100 H.P., twenty-four hours load
Auxiliary and screening plant	100 H.P. eight hours—day load

so that for eight hours we have a day load of 400 H.P. and a night load of 200 H.P., and of this 100 H.P. is for the longer period of 16 hours. If the winder be added, we have a total of 700 H.P. to provide for, which might consist of four small units of 200 H.P. each, which would no doubt provide against temporary breakdown.

The total cost of the plant would be, say, £8,000, involving an annual charge for interest, depreciation, &c., of £1,200. Consumption of fuel for the full 24 hours may be estimated as 10 tons, which, at 4s., would cost £2, or, taking 300 days, annually £600. The total B.T.U. used per day may be taken as 7,000, or, per year, 2,100,000. We have, therefore—

Interest, &c., on capital	£1,200
Cost of fuel	600
Labour charges, say	250
Stores, &c.	50
Total annual charge	£2,100

which gives the cost of current as $\frac{2{,}100 \times 20 \times 12}{2{,}100{,}000}$ = 0·24d. per unit.

It will be noticed we have not even considered pumping, and, consequently, where a pumping load could be added to the night load, even better results would be obtained.

The foregoing is, of course, merely a very rough approximation, but it will serve to show that by concentrating the power plant in one large central station, fitted with constant-running economical engines, very great economy may be effected. It is here that the advantage is gained by adding the winder, as it so lowers the actual cost of current that all other electric driving is rendered more profitable, and where coke oven gases are available there can be no question but that electric winding will pay.

Electricity Applied to Mining in British Columbia.—At a recent meeting of the Institution of Mining Engineers, Mr. F. Keffer discussed the question of mining in British Columbia and pointed out that it has practically displaced steam in the Boundary District. Power is supplied from a plant some 25 miles distant from the centre of the district, and also from a station 85 miles distant. The former plant is located at falls on the Kettle river, and can generate at low water from 2,000 to 3,000 H.P., which is transmitted at 20,000 volts. The latter plant can generate from 12,000 to 15,000 H.P., and the power available at the falls is said to be, at low water, 60,000 H.P. The line-voltage at present is 40,000 volts, although arrangements are made for bringing this up to 60 000 volts should occasion require. Some of the motors installed at the mines are as large as 600 H.P., one of this size and another of 500 H.P. being used to drive air compressors. Motors up to 100 H.P. run the crushers, and several of the haulages are electrically driven.

Energy Calculations in Coal Winding.

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(Of Messrs. Dick, Kerr & Co.)

The following notes on coal winding apply particularly to the Thury system where the winding motor is supplied by a motor-generator fitted with a heavy flywheel, but the methods given for calculating the horse-power required are applicable to any system. In electrical winding the flywheel on the motor-generator set gives out energy for accelerating the winding machinery and absorbs the retardation energy. By this means the power supplied to the motor-generator can be kept quite uniform, and so the generating plant can be run at its most economical load. The average horse-power, the maximum horse-power and the weight and stored energy of the flywheel, are the values we wish to find. Admitting as they do of accurate solution the calculation of the different values becomes of great interest and some useful ratios will be observed when a large number of examples are worked out. In most cases the data given is as follows :—

Output per day of eight hours in tons.
Depth of wind in feet.
Time for changing trucks in seconds.
Weight of coal per wind in tons.

In order to keep the maximum horse-power down to as small a value as possible the weight of coal raised per wind should be as high as convenient. The amount which can be raised depends, of course, on the height of the roads and the diameter of the shaft. In most collieries the thickness of seam is such that trucks carrying 10 cwt. are as large as can be used. Then if changing is done on two levels and the shaft is of such a diameter that we can only get two trucks per deck, the maximum weight of coal which can be raised per wind is 40 cwt. In some of the Welsh collieries trucks carrying as much as 30 cwt. each can be used, so that with two-deck cages having two trucks per deck we can raise as much as 6 tons per wind. This amount, however, can only be settled when the fullest particulars of the mine are available, and should be decided by the mining engineer. The time for changing depends on the available means for handling the trucks, and in the case of two or three deck cages, on the number of levels at which changing takes place simultaneously. The following table gives the approximate time in seconds for different cases :—

No. of levels at which trucks are changed simultaneously.	Time for changing in seconds.					
	One truck per deck.			Two trucks per deck.		
	Single-deck cage.	Two-deck cage.	Three-deck cage.	Single-deck cage.	Two-deck cage.	Three-deck cage.
1	7	16	27	10	22	36
2	...	8	18	...	11	24
3	...	...	9	...	...	12

Of course special methods of handling the trucks might alter the above values considerably, so that they must be regarded as average values for the ordinary methods of handling the trucks. The next thing we must consider is the weight of the different portions of the equipment. The weight of the trucks and cages can be obtained from the drawings, and the size of rope and its weight determined from the maker's tables of weight and strength. In estimating the load on the rope a size of rope must be *assumed*, and 12·5 per cent. should be added to the total weight supported to allow for friction and acceleration. From this final weight a more exact size of rope can be obtained. This should be repeated until the size of the rope assumed agrees with the size obtained at the end of the calculation. The annexed table of wire ropes made by Cradock & Co. will be of use in the above calculation.

The working load should be taken as one-tenth of the breaking load. From the size of the rope we can now determine the diameter and width of the winding drum. A rule which is sometimes used is $D = 8 + \frac{c}{2}$, when D = diameter of winding drum in feet and c = circumference of the rope in inches. This rule, however, takes no account of the diameter of the strands of wire which compose the ropes. If the rope retained its original section when wound on the drum then the diameter of drum and the diameter of the rope ought to have a definite ratio to each other, but as bending takes place in each individual strand rather than in the rope as a whole the diameter of the strand ought to bear some relation to the diameter of the drum. The curves shown in Fig. 1 indicate the stress due to bending in steel wires of various sizes when wound on a circular drum. It is evident that the stress varies as d/D when d = diameter of wire and D = diameter of drum.

Taking into consideration the fact that the diameter of the rope *does* have an appreciable influence on the bending stress, and that the diameter of the strands varies with the size of rope, we must conclude that the diameter of the rope should determine the diameter of the drum for our preliminary estimates. A reasonable ratio for the diameter of rope to diameter of drum is 1 to 100. From the diameter of the drum, the size of rope and the depth of wind, the width of the drum follows. The drum must be wide enough to have only one layer of rope, and where a single drum is used the rope for one cage should not cover more than half the width of the drum. The weight and radius of gyration of the drums can now be calculated from the drawings of this portion of the equipment, and in connection with this it is of interest to note that the weight of the drum in tons is given by the following approximate formula—

$$\text{Weight in tons} = \frac{D.W.}{10}, \quad . \quad . \quad . \quad . \quad . \quad (1)$$

when D = diameter of drum in feet and W = width between flanges in feet. The above formula applies only to drums clad with wood, and having cast-iron centres and brake rings. The *radius* of gyration of the drum may be taken at 40 per cent. of the *diameter*.

Balance ropes when fitted reduce the maximum horse-power considerably, but at the same time they increase the average horse-power. This increase in average horse-power is certainly not good, and if it is not balanced by a corresponding reduction in the capital outlay is not economical. In most cases it

Circum. in inches.	Dia. in inches.	Approx. weight in lbs. per ft.	Breaking load in tons.			
			Cradock's improved plough steel.	Best plough steel.	Cradock's improved crucible steel.	Best Bessemer steel.
1	0·318	0·188	4·75	4·5	3·5	2·0
$1\frac{1}{8}$	0·358	0·21	6·25	5·75	4·5	2·75
$1\frac{1}{4}$	0·397	0·23	7·75	7·0	5·5	3·25
$1\frac{3}{8}$	0·437	0·26	9·0	8·25	6·5	4·0
$1\frac{1}{2}$	0·477	0·292	10·25	9·5	7·75	4·5
$1\frac{5}{8}$	0·517	0·417	12·75	11·75	9·0	5·25
$1\frac{3}{4}$	0·557	0·5	14·75	13·5	10·5	6·5
$1\frac{7}{8}$	0·596	0·583	17·25	15·75	12·25	7·25
2	0·636	0·75	20·5	18·75	14·5	8·5
$2\frac{1}{8}$	0·676	0·79	23·5	21·5	16·5	9·75
$2\frac{1}{4}$	0·716	0·875	26·0	23·75	18·5	10·75
$2\frac{3}{8}$	0·756	0·96	28·5	26·25	20·5	12·0
$2\frac{1}{2}$	0·795	1·08	32·0	29·5	22·75	13·25
$2\frac{5}{8}$	0·835	1·21	35·0	32·0	24·75	14·5
$2\frac{3}{4}$	0·875	1·29	38·0	34·75	26·75	15·75
$2\frac{7}{8}$	0·915	1·38	40·5	37·25	28·5	17·0
3	0·955	1·46	43·5	40·0	31·0	18·25
$3\frac{1}{4}$	1·034	1·75	50·0	46·0	35·25	21·0
$3\frac{1}{2}$	1·114	2·08	61·0	56·0	43·25	25·5
$3\frac{3}{4}$	1·193	2·33	68·0	62·0	48·5	28·5
4	1·273	2·67	78·0	71·0	55·0	32·5
$4\frac{1}{4}$	1·352	3·0	88·0	81·0	63·0	37·0
$4\frac{1}{2}$	1·432	3·33	101·0	93·0	72·0	42·25
$4\frac{3}{4}$	1·532	3·67	106·0	97·0	75·0	44·25
5	1·591	4·17	119·0	109·0	84·0	49.5
$5\frac{1}{4}$	1·671	4·5	134·0	123·0	95·0	56·0
$5\frac{1}{2}$	1·750	4·83	147·0	134·0	104·0	61·0
$5\frac{3}{4}$	1·83	5·33	160·0	146·0	113·0	66·0
6	1·909	6·00	173·0	158·0	122·0	72·0
$6\frac{1}{4}$	1·989	6·5	187·0	171·0	132·0	78·0
$6\frac{1}{2}$	2·070	7·00	201·0	187·0	145·0	85·0

is advisable to calculate the maximum horse-power, assuming that the ropes are *not* balanced. Even in cases where balance ropes are fitted it is advisable to do so, as there is always the possibility of the balance ropes being left off at some time.

As the winding rope only bends round a portion of the sheaves it is not strained to the same extent as it is when wound completely round a drum of the same diameter, so that we can make the sheaves somewhat smaller than the diameter of the winding drums. It will be quite near enough for our calculations to take the diameter of the pit-head sheaves as 75 per cent. of the diameter of the drum. The weight can then be found from the drawings.

Before leaving this portion of the subject the writer would like to point out some useful ratios which he has observed in connection with the weights of the various portions of a winding equipment. Mention has already been made of the approximate weight of the drums and the method of obtaining the weight of the rope. The weight of the cage will be found to be approximately equal to

$$\tfrac{1}{2}\,L + 500\text{ lb.} \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (2)$$

when L = weight of coal raised per wind in pounds. The weight of each truck will be equal to

$$\tfrac{1}{3}\,C + 350\text{ lb.} \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (3)$$

when C = weight of coal contained in one truck in pounds. The weight of each sheaf can be taken as

$$2D^2 + 150D + 500\text{ lb.} \quad . \quad . \quad . \quad . \quad . \quad . \quad (4)$$

when D = diameter of sheaf in feet.

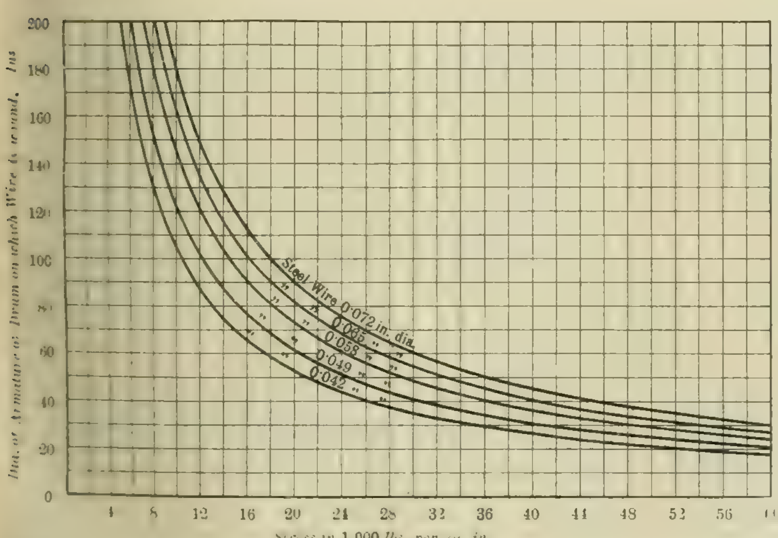


FIG. 1.—CURVES SHOWING STRESSES DUE TO BENDING IN STEEL WIRES OF VARIOUS SIZES WHEN WOUND ON A CIRCULAR DRUM.

The following table gives the radii of gyration for different diameters of sheaves:—

Diameter of sheaf in feet.	Radius of gyration in feet.	Diameter of sheaf in feet.	Radius of gyration in feet.
5	1·7	13	5·25
6	2·15	14	5·7
7	2·6	15	6·1
8	3·1	16	6·55
9	3·5	17	7·0
10	3·95	18	7·4
11	4·4	19	7·85
12	4·8	20	8·3

The above sheaves have a cast-iron rim, cast-iron hub and round wrought-iron rods for spokes spaced every 2 ft. at the rim.

We can now obtain the necessary pull on the winding rope due to friction. The diameters of the bearings for the drum can be taken as one-twelfth of the diameter of the drum, and for the bearings at the sheaves one-twelfth of the diameter of the sheaf, in the absence of full particulars of those parts. The total pressure on the bearings of the sheaves will be made up as follows:—

			lb.
	Weight of sheaves		,,
	,,	,, ropes	,,
2×	,,	,, cages	,,
2×	,,	,, trucks (including empties)	,,
2×	,,	,, coal	,,
		Total	A

Assuming a coefficient of friction for the bearings of 0·15 we have the pull on the winding rope to overcome the friction of the sheaves

$$P_s = \frac{A}{80} \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (a)$$

The pressure on the bearings of the drum will be the weight of drum and one rope, together with any gearing which may be used. Let this total weight = B. Then the total pull on the winding rope to overcome the friction of the drum, assuming a coefficient of friction of 0·15 will be

$$P_d = \frac{B}{80}. \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (b)$$

The pull on the winding rope required to bend the rope round the different pullies can be taken as 25 lb. per square inch of rope section per pulley.

Then if there are two cages we have the pull necessary for bending the ropes,

$$P_r = 78 \cdot d^2 \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (c)$$

when d = diameter of rope in inches.

The total friction will now be

$$P_T = a + b + c + 500 \quad . \quad . \quad . \quad . \quad . \quad (5)$$

the 500 lb. being allowance for windage and friction of guides.

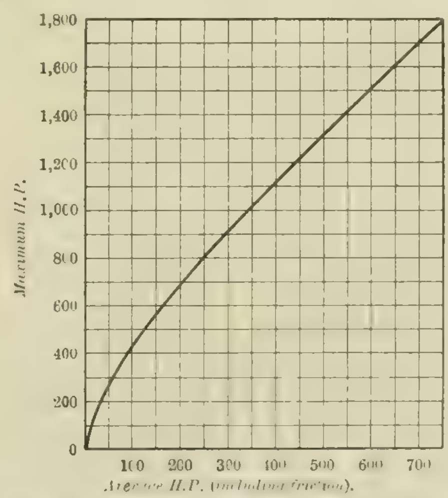


FIG. 2.—CURVE CONNECTING AVERAGE H.P. AND MAXIMUM H.P.

High-rope speeds may require a higher allowance for windage than the above, but as little experimental data is available on the windage of drums and cages running in a small shaft it is not thought advisable to work this out separately. It will vary with the size of the equipment and type of drum. For rough calculations the total friction is approximately 3 per cent. of the total weight of the equipment.

The total amount of work done during one wind will be

$$(L + P_T)D_s \text{ ft.-lb.},$$

when L = weight of coal raised per wind in pounds, P_T = total friction in pounds, D_s = depth of shaft in feet.

As the number of winds per minute is equal to

$$\frac{\text{total output (tons in eight hours)}}{480 \times L_T} = r,$$

when L_T = load in tons per wind, the average horse-power

$$\frac{r D_s (L_T + P_T)}{33{,}000} \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (6)$$

No allowance has been made in equation (6) for braking, as in the Thury system the motor during retardation runs as a

generator, and so forces energy back into the flywheel on the motor generator. The ease with which Thury motors can be started, controlled and reversed renders this type of motor ideal for coal winding. There is only one handle for starting, stopping and reversing, and the ease with which the power is controlled renders braking by mechanical means almost unnecessary. The method of controlling this type of motor, as is well known, is by rocking the brushes round the commutator.

Before we can estimate the horse power required during the acceleration period, we must make some preliminary estimate of the size of motor which will be required. This preliminary estimate is difficult to make in a simple way, but, with the aid of the curve shown in Fig. 2, we can immediately choose a motor of nearly the correct size. This curve is the mean of a number of cases which the writer has calculated, and only holds true for average winding speeds (about 2,000 ft. per min.) and for unbalanced ropes. Where the winding speed is more than 2,000 ft. per min., the horse-power must be increased, and reduced when the winding speed is less.

We can now calculate the maximum horse-power which will be taken from the winding motor. In order to simplify the calculation as much as possible, we reduce all the moving weights to an equivalent weight at the rope. We then deal with this total equivalent weight instead of considering each load separately. For example, if the weight of the drum is 10,000 lb. and its radius of gyration 4 ft., and the drum is 10 ft. diameter, then the equivalent weight of the drum *at the rope* will be $\left(\frac{4}{5}\right)^2 \times 10{,}000 = 6{,}400$ lb. The reason we take the square of the ratio of their respective radii is that the acceleration varies as the radius; but the torque also varies as the radius, so that the twisting moment necessary for any given rope acceleration will vary as the square of the radii.

In some cases the motor is geared to the winding drum, and in such cases we must multiply the radius of gyration of the motor armature by the gear ratio in order to get the radius in the same terms as the radius of the rope.

It may be useful to note at this point that the equivalent weight of the motor armature is equal to $\left(\frac{V_a}{V_r}\right)^2 W_a$, when V_a = velocity of armature at its radius of gyration, V_r = velocity of winding rope and W_a = weight of armature.

As the weight of the armature within certain limits varies inversely as the velocity, we can see how important it is to keep the velocity of the armature down as much as possible. The equivalent weight varies directly as the velocity of the armature, so that when the drums are direct driven it is sometimes economical to use two motors instead of one. In all cases it is good to use as small a diameter of armature as possible.

We can now proceed to calculate the horse-power required during acceleration. We must first decide on an approximate winding speed. The maximum winding speed should be high enough to give a reasonably long period for acceleration and retardation. The total time for acceleration and retardation will be

$$T = 2H - \frac{120D}{V} \quad . \quad . \quad . \quad . \quad . \quad . \quad (7)$$

when T = time in seconds, H = total time for winding in seconds, D = depth in feet.

If, now, we take as a reasonable value, T = 20, we have

$$V_r = \frac{60D}{H - 10} \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (8)$$

It must be borne in mind that this only gives a trial value for V_r. Other values must afterwards be taken to find which gives a minimum horse-power. To make the best use of the motor we must make the retardation period much shorter than the acceleration period. By this means we can have the horse-power given out during acceleration equal to the horse-power absorbed during retardation.

Let P = pull on rope at beginning of wind in pounds.
P_1 = pull on rope at end of wind in pounds.
W = equivalent weight at rope of total moving mass.
T = total time for acceleration and retardation (equation 7).
x = time for acceleration in seconds.
V = maximum rope velocity in feet per second.

then
$$x = \sqrt{\left(\frac{T}{2} - A\right)^2 + TA} + \frac{T}{2}A, \quad . \quad . \quad (9)$$

when
$$A = \frac{VW}{32 \cdot 2(P + P_1)},$$

and $P + P_1 \leqq 2$ (weight of coal per wind + friction).

From equation (9) we calculate the correct period for acceleration, and then we get

$$a = \frac{V_r}{x},$$

when a = acceleration in feet per second per second. This is assuming that the acceleration is constant right up to the maximum rope speed. Although this is not strictly true, the error introduced by its assumption will not be large. When we know a we can obtain the pull on the rope due to acceleration.

This will be
$$P_a = \frac{aW}{32 \cdot 2}. \quad . \quad . \quad . \quad . \quad . \quad . \quad (10)$$

The maximum horse-power will now be

$$H.P._{max.} = \frac{(P + P_a)V_r}{33{,}000}. \quad . \quad . \quad . \quad . \quad (11)$$

In connection with the velocity and distance moved through during the acceleration period, the following equation may be of use:—

Let a = accleration in feet per second².
v = velocity at any time t.
d = distance moved through in feet.

then
$$v = at,$$
$$d = \frac{at^2}{2}.$$

The horse-power we get from equation (11) is not necessarily the best value we can obtain. By increasing the maximum

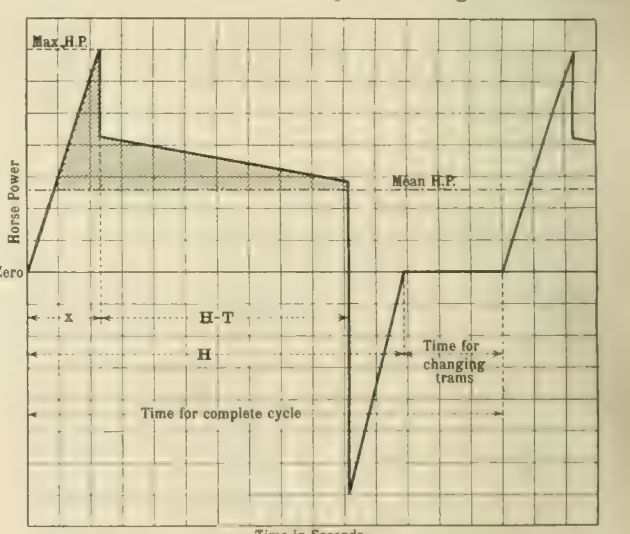


FIG. 3.

velocity, V_r, we obtain a longer time for acceleration, and so reduce the pull on the rope. If the increase in velocity is at a less rate than the reduction of the pull, then we should use a higher velocity, but if at a greater rate, then we must reduce the maximum velocity. By trying a number of values we shall obtain a velocity which gives as small a value to the maximum horse-power as we can obtain. This is the best rope speed for the case under consideration. As a rule the rope speed ought not to exceed a certain limit which depends on the construction of the shaft and guides. Winding speeds up to 2,500 ft. per min. are common, and in a few cases even higher speeds are allowed. The limit of winding speed can only be decided by the owner of the mine, however, so we must assume that this limit has been specified, and note when we have obtained the most economical speed that it does not exceed the limit specified. The next point we must consider is the weight of the flywheel. In Fig. 3 we have a load diagram of the winding motor. The portion shown shaded must be supplied by the flywheel. We can easily find the area of this

portion of the diagram. Let the vertical ordinates be in horse-power units and the abscissæ in seconds. Then from the particulars we have already worked out we can easily calculate the area in horse-power seconds. This multiplied by 550 will give the amount of energy in foot-pounds which must be given

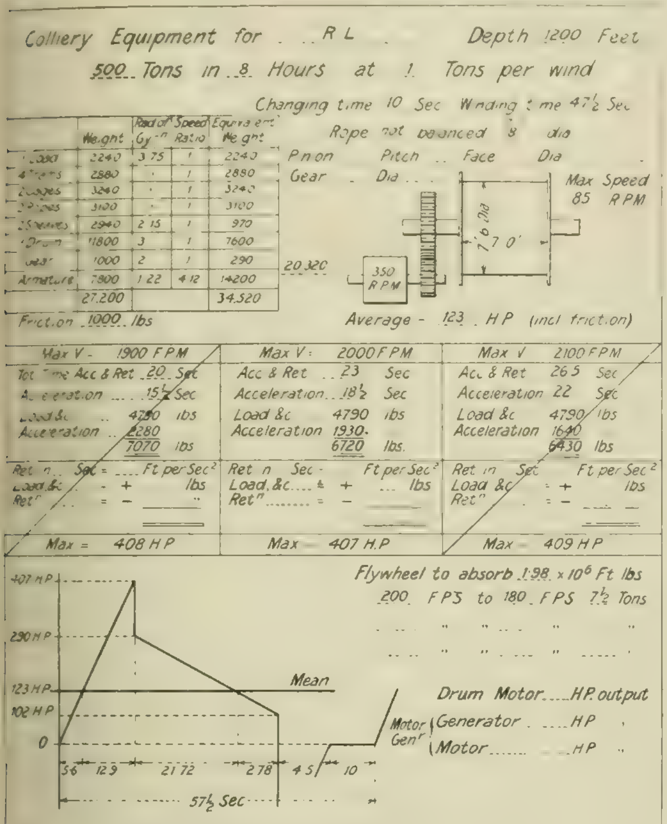


FIG. 4.—DATA SHEET WITH EXAMPLES.

out by the flywheel. It must be kept in mind that all our calculations are reduced to input at the drum, and take no account of the efficiencies of the motors or windage losses of the flywheel. It is convenient to make all calculations on data sheets. The form used by the writer is that shown in Fig. 4. By keeping to a definite form with all calculations, comparisons are easily made between different cases.

The preceding notes refer to parallel drums. This is the type of drum which is mostly used in this country. On the Continent Koepe's pulley is much used, and also drums with variable rope-roll. The calculations for the latter type of drum are of a very complex nature, but have been ably investigated by Prof. Paul Habets, of Brussels.* The method adopted is a graphical one devised by M. H. Dechamps.† A variable rope roll is almost essential where the depth of the mine is great and the output large, owing to the great weight of rope.

To illustrate the methods of calculation we will take the following example :—

Output per day of eight hours	500 tons
Depth of wind	1,200 ft.
Time of changing	10 sec.
Weight of coal per wind	1 ton

Single deck cages will be used, carrying two trucks per deck. Each truck will carry 1,120 lb. of coal, so that the weight of each truck will be (from equation 3) 720 lb. The weight of the cage will be approximately (from equation 2) 1,620 lb. The size of rope to support the above loads can now be determined by the method given. The required rope will be $\frac{7}{8}$ in. diameter plough steel weighing 1·29 lb. per foot. The size of drum required for this size of rope will be 7 ft. 6in. diameter by 7 ft. wide, and weighing $5\frac{1}{4}$ tons (equation 1).

The sheaves will be 6 ft. diameter, 1,450 lb. weight and 2·15 ft. radius of gyration.

We can now tabulate the weights, &c., of the different portions of the equipment on our data sheet, as shown in Fig. 5. The total load on the sheaves will be :—

Sheaves	2,900 lb.
Ropes	3,100 ,,
Cages (2)	6,480 ,,
Trucks (2)	5,760 ,,
Coal (2)	4,480 ,,
	22,720 lb.

Then $P_s = 280$ lb.

* *Proceedings* of Inst. Mech. Eng., No. 3 of 1905, p. 429.

† *See* H. Dechamps "Application de la Méthode graphique à l'étude de l'Equilibre des Cables d'Extraction." *Revue Universelle des Mines.* 3rd series, 1902, Vol. LVIII.

The weight of the drum, gearing and rope is 14,350, so that $P_d = 180$ lb.

For bending the rope the total pull will be $78\cdot5 \times 0\cdot875^2 = 60$ lb.

The total friction pull (equation 5) will now be $275 + 180 + 60 + 500 = 1{,}015$ lb. (say, 1,000 lb.).

We can now calculate the average horse-power taken at the drum from equation (6).

$$\text{Average H.P.} = \frac{1\cdot04 \times 1{,}200 \times 3{,}240}{33{,}000} = 123 \text{ H.P.}$$

And the average winding speed is 1,520 ft. per min., so that the maximum horse-power rquired will be approximately 450. The speed of a motor giving this output will be 350 revs. per

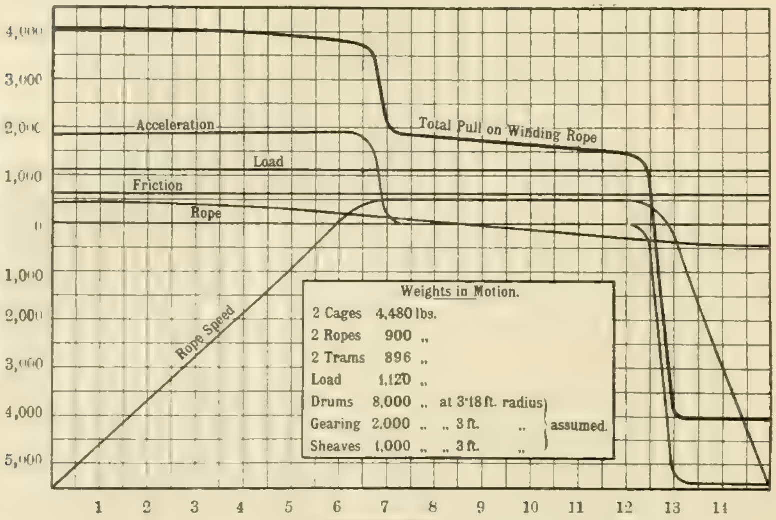


Fig. 5. —Load Diagram for a Winding Scheme.

720 tons per 8 hour shift at ½ ton per wind. Allowing 5 sec. for changing drums 8ft. 6in. dia. Depth 210 ft. Average torque = 33 H.P. at 45 R.P.M. Maximum torque = 147 H.P. at 45 R.P.M.

min. The armature, 7,800 lb., at a radius of gyration of 1·22 ft., giving a velocity at this radius of 2,700 ft. per min.

From equation (8) we obtain a trial maximum velocity of the rope of $V_r = \frac{60 \times 1{,}200}{37\cdot5} = 1{,}900$ ft. per min. The total equivalent weight at the rope without the armature is 20,300 lb., and at 1,900 ft. per min. the equivalent weight of the armature is $\left(\frac{2{,}700}{1{,}900}\right)^2 \times 7{,}800 = 15{,}700$ lb., making a total equivalent weight of 36,000 lb.

In equation (9) $P + P_1 = 6{,}480$

and $$A = \frac{31\cdot6 \times 36{,}000}{32\cdot2 \times 6{,}480} = 5\cdot45,$$

$$\therefore\ x = \sqrt{(10 - 5\cdot45)^2 + 109} + 4\cdot55 = 15\cdot95 \text{ seconds},$$

say $15\frac{1}{2}$ seconds.

The acceleration will be 2·04 ft. per second per second and the pull required for acceleration

$$P_a = \frac{2\cdot04 \times 36{,}000}{32\cdot2} = 2{,}280 \text{ lb.}$$

The maximum horse-power will now be

$$\frac{(4{,}790 + 2{,}280) \times 1{,}900}{33{,}000} = 408 \text{ H.P.}$$

Allowing for gear losses, this is sufficiently close to the assumed maximum horse-power, and we need not revise the calculations with a more exact weight of armature.

We will now try a higher rope speed of 2,000 ft. per min.

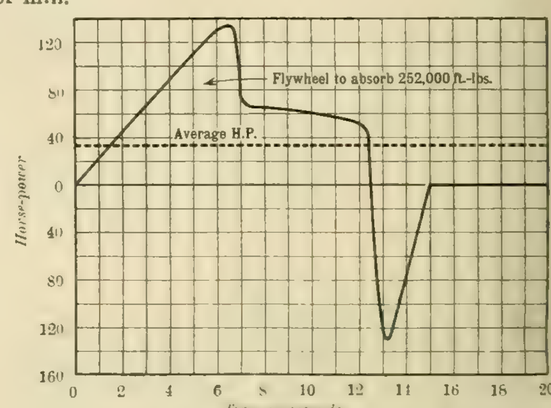


Fig. 6.—H.P. Curve corresponding with Fig. 5.

The total time for acceleration and retardation will now be (equation 7)

$$T = 2 \times 47\tfrac{1}{2} - \frac{120 \times 1{,}200}{2{,}000} = 23 \text{ seconds},$$

the equivalent weight of armature 14,200, making the total equivalent weight 34,500 lb.

In equation 9, $$A = \frac{33\cdot3 \times 34{,}500}{32\cdot2 \times 6{,}480} = 5\cdot5.$$

$$\therefore\ x = \sqrt{(11\cdot5 - 5\cdot5)^2 + 126\cdot51} + 6 = 18\cdot8 \text{ seconds},$$

say, $18\frac{1}{2}$ seconds.

Output in 8 hrs. Tons.	Depth of wind. Feet.	Coal raised per wind. Tons.	Time for Chang'g trams. Sec.	Rope balanced or unbal'n'c'd	Diam. of rope. Inches	Max. rope speed. F.P.M.	Motor geared or direct	Max. speed of Motor. R.P.M.	Size of drum in feet. Diam. × width	Input at drum. Av. H.P.	Input at drum. Max. H.P.	Flywheel. Energy abs. ft. lb./10^6.	Flywheel. Weight Tons.	Flywheel. Speed. variation F.P.S.	Flywheel. Material.	Double or single cage.
7	2,508	½	120	unbal'n'c'd	1·03	340	geared	440	10 × 6	9	86½	...	...	...	...	single
14	2,508	½	120	,,	1·03	760	,,	415	10 × 6	17½	202	...	...	...	...	,,
23½	2,700	1	120	,,	1·03	300	,,	500	10 × 6	16	103	...	...	...	...	,,
25	2,580	1	120	,,	1·03	300	,,	500	10 × 6	15½	101	..	...	...	...	,,
28	2,508	½	120	,,	1·03	1,800	,,	350	10 × 6	34½	505	...		...	...	,,
39	2,940	1	120	,,	1·03	575	,,	440	10 × 6	28½	223	...		...	...	,,
47	2,700	1	120	,,	1·03	700	,,	500	10 × 6	32	242	..	..	...	...	,,
50	2,580	1	120	,,	1·03	700	,,	500	10 × 6	31	243	...	...	...	...	,,
94	2,700	1	120	,,	1·03	1,300	,,	330	10 × 6	61	460	...	...	...	...	,,
100	2,580	1	120	,,	1·03	1,400	,,	350	10 × 6	62	500	...		..		,,
280	150	1·2	7½	,,	1·11	90	,,	665	8 × 2	7½	10	0·0634	0·95	100 95	C.I.	double
280	210	0 6	7½	,,	1	300	,,	600	8 × 2	11	20·5	0·1	1·5	100·90	C.I.	,,
350	582	½	10	,,	1	1,300	,,	600	8½ × 5	42	150	0·635	2·45	200·180	C.S.	,,
400	582	½	10	,,	1	1,900	,,	500	8½ × 5	53	228	0·91	3·43	200·180	C.S.	,,
445	843	1	5	,,	1	1,030	,,	700	7 × 7½	70	150	0·74	7·5	100·85	C.I.	,,
445	1,960	1	10	,,	1	2,400	,,	250	9 × 6	190	..	...		...	...	,,
700	1,590	1½	10	balanced	1½	2,600	,,	250	15 × 9½	293	900	4·7	14·2	200·175	C.S.	,,
720	210	½	5	unbal'n'c'd	1	1,200	,,	600	2 – 8½ × 2	33	147	0·252	4·1	116·108	C.I.	,,
750	1,590	1½	10	balanced	.	2,550	direct	60	...	310	1,470	5·0	..	...	...	,,
890	1,710	2	10	unbal'n'c'd		2,400	geared	...	10 × 6½	285	1,240	...	..	...	...	,,
1,000	960		..	,,		2,000	direct	75	8½ × 6½	175	530	2·15	.	...	...	,,
1,000	960	.	.	..	1½	2,000	..	58	11 × 6½	206	750	2·575	...	.	...	,,
1,200	1,590	3	10	..		2,550	,,	60	.	400	1,120	6·55		.		,,
1,200	1,800	6	20	..	1½	1,000	geared	200	2 – 16 × 6½	377	1,020	11·6	29·2	200 170	C.S.	,,
1,670	1,590		10	balanced		2,550	direct	60	13½ × 6½	520	1,850	6·6	..	...	...	,,
1,500	1,800	4	10	unbal'n'c'd	1·671	2,300	geared	200	15 × 14	543	1,270	9·0	33	200·180	C.S.	,,
2,000	2,000	6	10	balanced	1·909	2,100	,,	160	16 × 14	785	1,800	11·2	41½	200 180	C.S.	,,

Then, $a = 1{\cdot}8$ and $P_{,,}$ 1,930 lb.

$$\therefore \text{H.P.}_{\text{max.}} = \frac{(4,790 + 1,930) \times 2,000}{33,000} = 407.$$

We see that this is slightly less that the maximum horse-power at 1,900 ft. per min., so we will try a still higher speed—2,100 ft. per min. If this is worked out, we get a maximum horse-power of 409, so that this speed is slightly high, and the best speed is evidently 2,000 ft. per min.

We can now insert in the load diagram in Fig. 4 the various items, and we can see that the area of the diagram above the mean horse-powers is

$$\frac{407 - 123}{2} \times 12{\cdot}9 + \frac{290 - 123}{2} \times 21{\cdot}72 = 3,650 \text{ H.P. seconds.}$$

Therefore the flywheel must absorb

$$3,650 \times 550 = 1{\cdot}98 \times 10^6 \text{ ft.-lb}$$

Allowing a maximum speed of 200 ft. per second, and a drop in speed of 10 per cent., the energy given out by the flywheel will be $\frac{W(40,000 - 180^2)}{64{\cdot}4} = 118.W.$ ft.-lb.

$$\therefore W = \frac{1{\cdot}98 \cdot 10^6}{118} = 16,800 \text{ lb.}$$

say, 7½ tons.

Nothing has been said in the preceding with regard to the efficiency of motor-generator sets carrying a heavy flywheel. Mr. L. Becker* has investigated this question very fully, and finds that a most important loss is that due to windage of the flywheel, this loss, amounting to from 5 kw. to 10 kw., depending on the speed and form of the wheel.

The following table is a list of equipments which the writer has worked out from time to time by the preceding methods.

The table on p. 36 will be a guide in the choice of a suitable motor for preliminary estimates. In all cases the drums are plain parallel drums.

Fig. 5 shows a load diagram for a winding scheme and Fig. 6 the horse-power curve corresponding to this load curve.

Electric Winding Plant.

In the development of every industry some names stand out in special prominence. The electrical industry is more than usually rich in this respect, and not the least known name is that of Siemens; in fact, it is hard to find any branch of electrical engineering with which it has not been associated at some time or another, and in connection with the manufacture of electrical apparatus and equipment it has become a household word.

The above statements apply with equal force in those branches of electrical engineering connected with mining work. The Siemens-Ilgner system, originally invented by Mr. Carl Ilgner, of the Austrian Siemens Schuckertwerke, and supplied by MESSRS. SIEMENS BROTHERS DYNAMO WORKS, has been in operation for several years with considerable success, and there are at present over 100 of these equipments at work.

The general arrangement of this system comprises a converter set made up usually of a three-phase motor, which drives a continuous current generator, and of a heavy flywheel. A small exciter for the direct current generator is also mounted on the same shaft. The armature of the generator is connected in series with the winder motor, while, by means of a regulating apparatus, the excitation of the generator is varied from zero to a positive or negative maximum. The motor excitation is maintained constant throughout. The degree of excitation determines the voltage generated, the speed of the winding motor varying practically in direct proportion.

The winding motor may either be direct coupled to the drum or drive it through single reduction spur gearing. In large plants two motors are connected, one on each side of the winding drum. This arrangement has the advantage that should one motor break down the other is capable of winding at half speed. A typical Ilgner installation, fixed at the Mathias Stinnes mine at Carnap, near Essen, is shown in Fig. 1. The converter motors are placed in the centre and the variable voltage generators at the ends of the set. It is capable of driving four winding engines at half speed or two winding engines at full speed. One of the winding engines at the same mine is shown in Fig. 2. It has a Koepe pulley and two direct-coupled winding motors. The brake engine, with horizontal cylinder, is shown in the foreground. The vertical cylinder is for sustaining the weight of the emergency brake, described later. The control and brake levers are seen at the extreme right of the photograph.

The ultimate idea of improving any well-tried system is a saving in power or costs. In such an arrangement as a mine winding engine the power demand at starting is likely to be very considerable. If, therefore, this can be toned down in any way it is likely to be an advantage from an economical point of view. This object is secured by the Ilgner system, because the flywheel acts as an accumulator of energy; it gives out power when the winder is starting, instead of allowing the load to come upon the generating station, and regains this energy from the station when the winder is at rest, that is, when power is not otherwise required. It therefore levels up, as it were, the load on the generating station. It is said that with the winding motor excited to a given amount and supplied with an armature current of varying voltage its efficiency remains practically constant at all loads. Moreover, the power absorbed for acceleration at the beginning of the wind is regained at the end, as the motor then acts as a generator and gives back to the flywheel the power represented by the kinetic energy of the moving parts. In practice it is found that with this system the steam consumption at the generating station is only from one-third to one-half as great as with the most modern winding engines.

The control gear offers some points of interest. There are

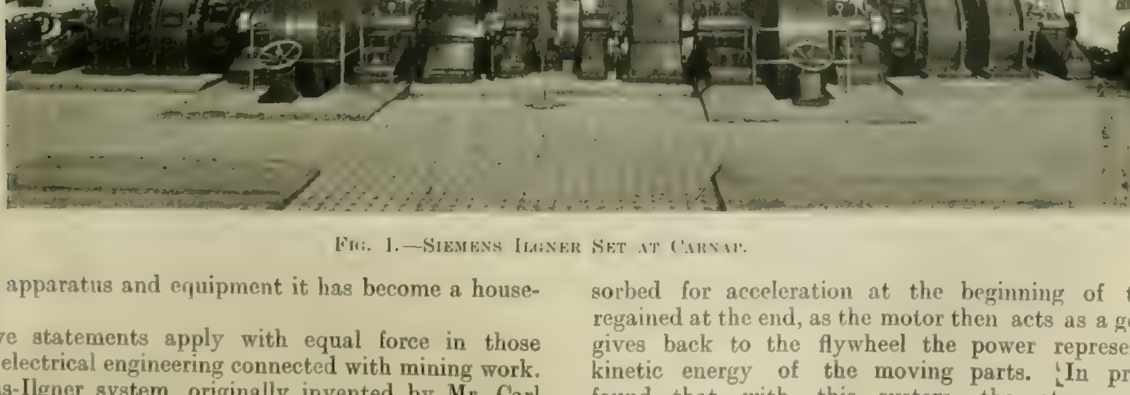


FIG. 1.—SIEMENS ILGNER SET AT CARNAP.

* "Elektrische Kraftbetr u. Bahnen," 5, pp. 485-493, September 4th; 508-513, September 14th; and 528-532, September 24, 1907.

only two levers necessary, one, shown on the right hand in Fig. 3, for the winding motor, and the other for the brake. These two levers are interlocked, so that when the machine is put in motion the brakes are released, but are instantly applied directly current is cut off. The reversal of the gear is easily effected by the control lever. This lever simply alters the excitation of the converter dynamo, and by its means very slow speeds, of the order of 1 ft. per sec., can be obtained. The speed of the motor is definitely determined once and for all by the position of the control lever nd is entirely independent of the continual changes in load.

It goes without saying that very terrible accidents are constantly liable to occur in winding if the plant is unsuitable, and everything should therefore be done to avoid any such occurrences. For this reason, in addition to the protective devices noted above, an arrangement has been fitted which it is claimed makes it impossible for the driver to start too fast. This is accomplished by connecting the control lever to cams

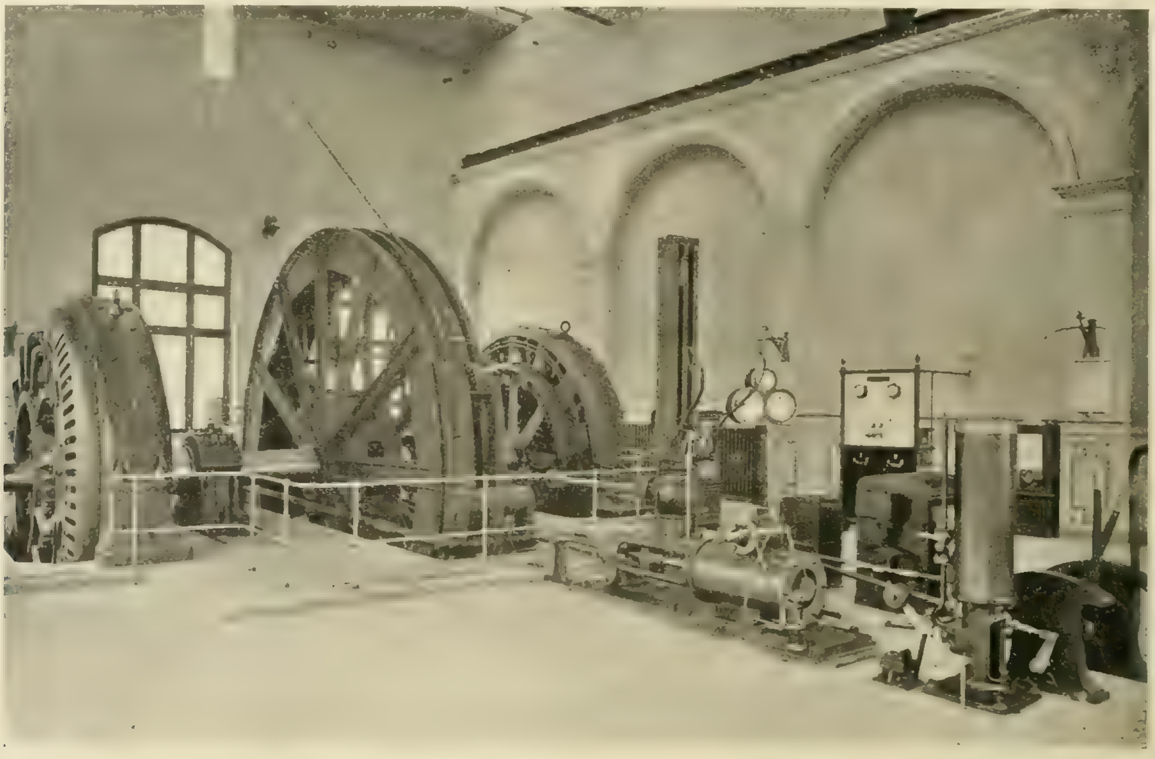


Fig. 2.—Siemens-Ilgner Winding Engine at Carnap.

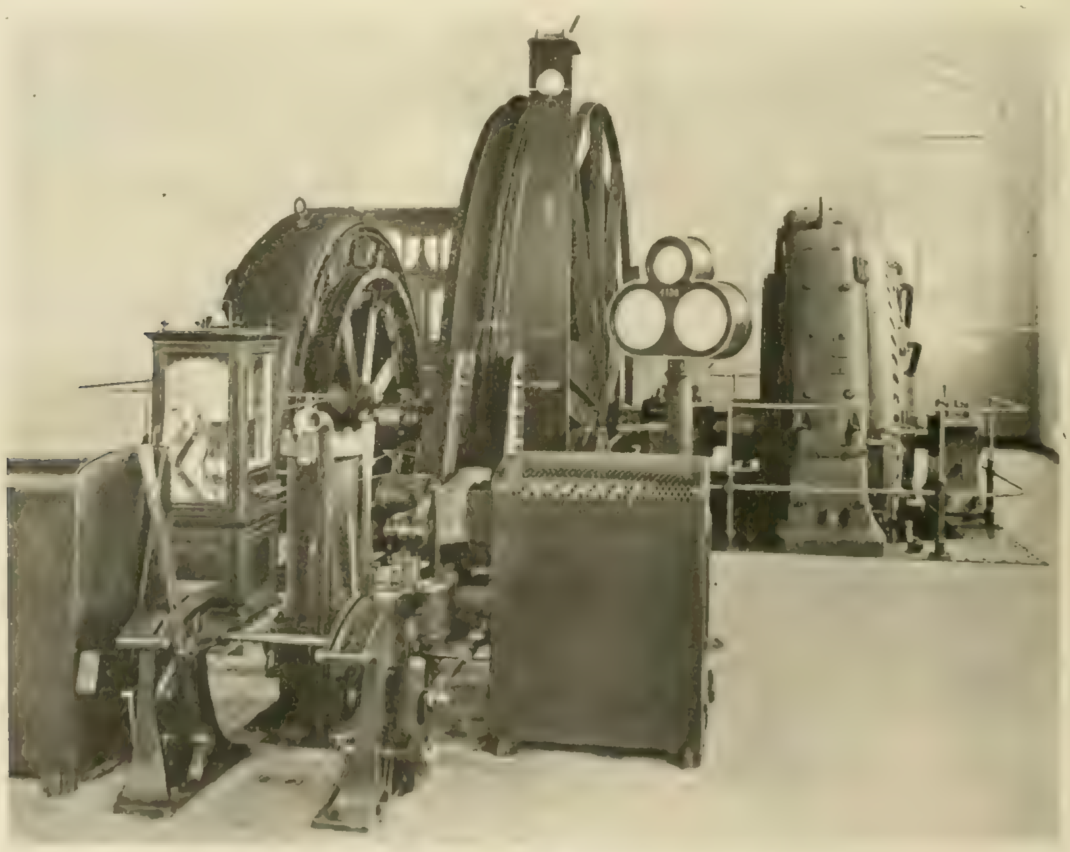


Fig. 3.—Showing Control Gear of Siemens-Ilgner Plant.

on the depth indicator. These cams are so proportioned that they admit of a certain maximum acceleration which can never be exceeded by the driver. The latter pushes forward the control lever a small distance until further motion is stopped by the acceleration cam. The winder then starts, and the attendant is only able to move his handle further forward at a rate determined by the shape of the cam.

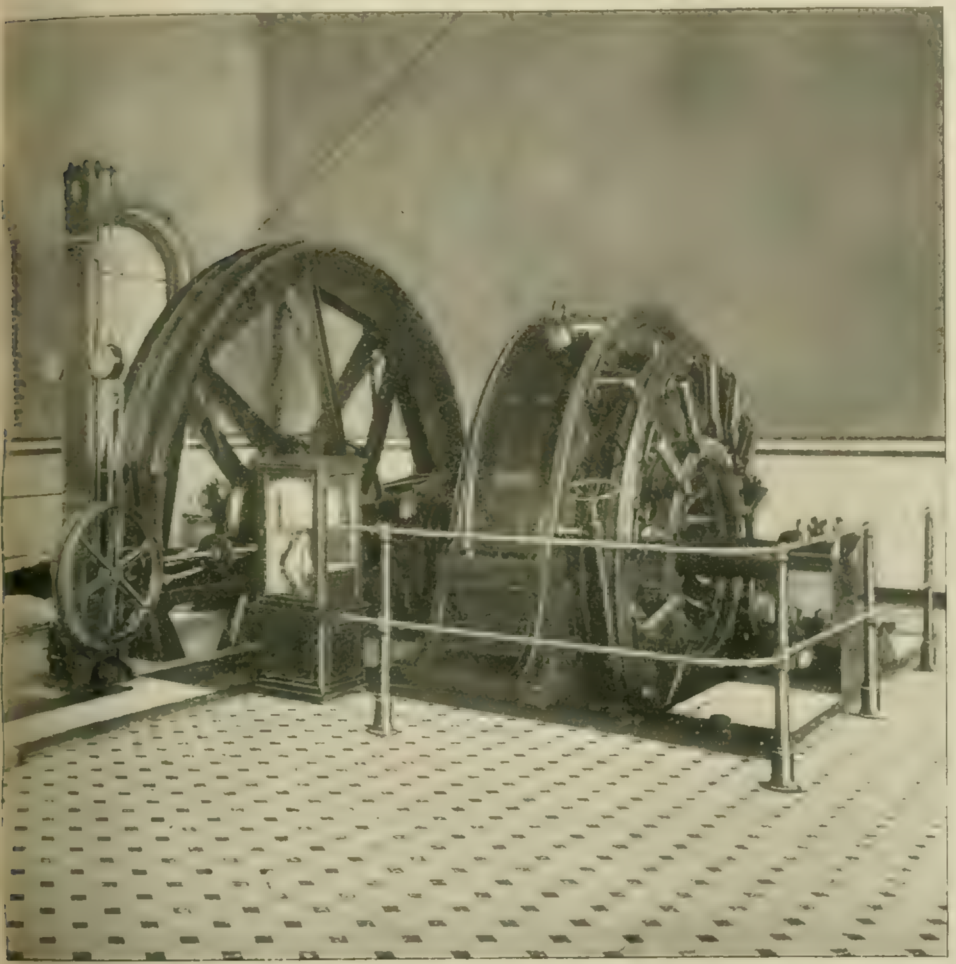


Fig. 4.—Winding Engine showing Automatic Brake Gear.

A suitable emergency brake is also provided, its operation being as follows: A counterweight actuating the lever of the safety brake is supported by compressed air acting on the piston in the brake cylinder, which is fitted with a three-way cock. Connection is made through this either with the air receiver or the atmosphere. So long as pressure is maintained in the receiver the safety brakes are held off and the working brakes are free to act. Should the pressure fall, the safety brake acts automatically on the drum, and the counterweight in falling throws over an emergency switch and breaks the exciting circuit so that no current is supplied to the winding motor. This arrangement is also put into operation should the bank be overrun. How this is done is shown in Fig. 4. The cams on the depth indicator are so arranged that when they force the control lever gradually back towards the "off" position the working brakes are automatically applied, and tend to slow down the gear. It is then possible for the driver to stop the motion by pulling the lever to the "off" position and then manipulating it so as to bring the cage slowly to the bank. The control brake and emergency levers of the automatic brake gear are shown at the extreme left of Fig. 4. To the right of these is the main control resistance for the field of the variable voltage generator, and further to the right and just in front of the engine are the depth indicator and tachograph. The latter instrument is enclosed in a glass case, and records on a roll of paper the number of winds made by the engine, the exact time at which each wind takes place and the speed of each wind.

The electrically-driven winding gear of the Sandycroft Foundry Co., illustrated in Fig. 5, is capable of raising a load of $2\frac{1}{2}$ tons from a vertical depth of 1,500 ft. on an incline of 45 deg. at a mean rope speed of 450 ft. per minute, the speed being reduced from the motor by two sets of spur gearing. The pinion on the motor shaft is made of raw hide, and engages with a machine cut spur wheel on the second motion shaft, whilst the pinion on the second motion shaft is of cast iron, with double helical teeth shrouded on both, sides and engages with a cast-iron spur wheel on the drum shaft.

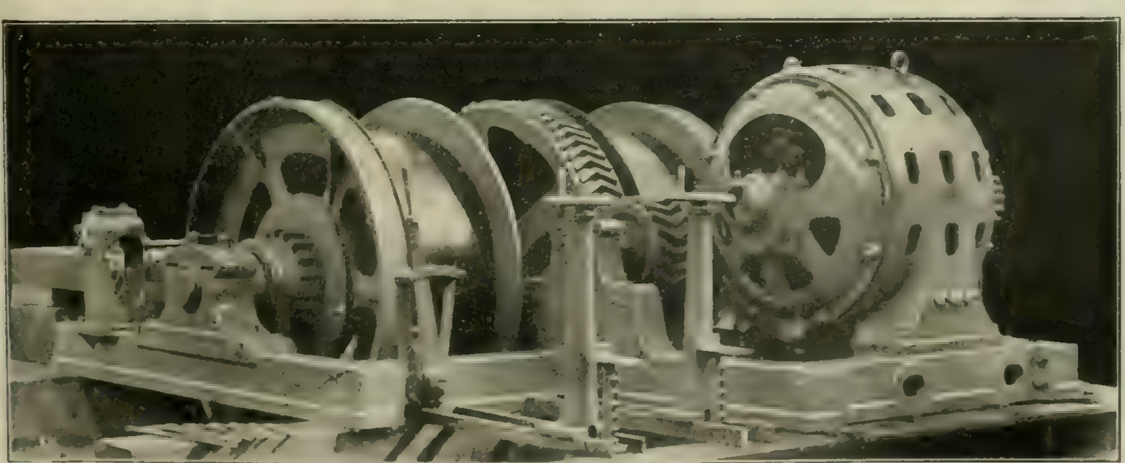


Fig. 5.—"Sandycroft" Winding Engine.

The two drums, each 5 ft. diameter by 2 ft. wide and about 5 ft. centre to centre, with cast-iron sides and mild steel lagging, are each capable of holding 2,200 ft. of $\frac{7}{8}$ in. rope. One drum is keyed on the shaft, and the other is loose with a gun-

metal bush, and is provided with a cast-iron clutch with 16 teeth, thus allowing for a close adjustment of the ropes. Each drum is provided with a band brake, complete with levers, &c., worked by combined foot and screw gear.

The motor and winding gear is self contained and mounted on strong cast iron framing, with massive pedestals fitted with gunmetal steps, there being a centre bearing between the drums, whilst the second motion and drum shafts are of mild steel and are turned all over. The three-phase induction motor is of the wound rotor type, capable of developing 100 B.H.P. when running at a speed of about 480 revs. per min., the terminal pressure being 400 volts. The stator windings of the motor are machine-wound "former" coils, special care being taken to ensure interchangeability of all coils. They are insulated and completely sealed up before insertion in the slots, and are held firmly in position by insulating "key" strips of a special material and design. All coils before being assembled are rendered oil and water proof by a special process. The rotor windings also consist of "former" wound coils.

At present, it is regrettable to state, the majority of winding plants in this country are, as yet, steam driven. But the advent of cheap electrical power in certain districts has not been without effect, and we may hope that it will not be long before modern methods are introduced. Such an introduction will, we feel sure, be not unaccompanied by substantial advantages.

Quite recently the Electrical Co., of London, have installed an electrical winding engine on the Ilgner system at Tribley pit. This pit is situated in the district served by the County of Durham Electrical Power Distribution Co., and consequently is able to obtain the necessary energy at a very cheap rate. We have already described this plant in the columns of *The Electrician* (Vol. LXI., p. 167), but it possesses several points of such interest to mining engineers, and also marks a distinct advance in mining history that it may be well shortly to recapitulate our remarks.

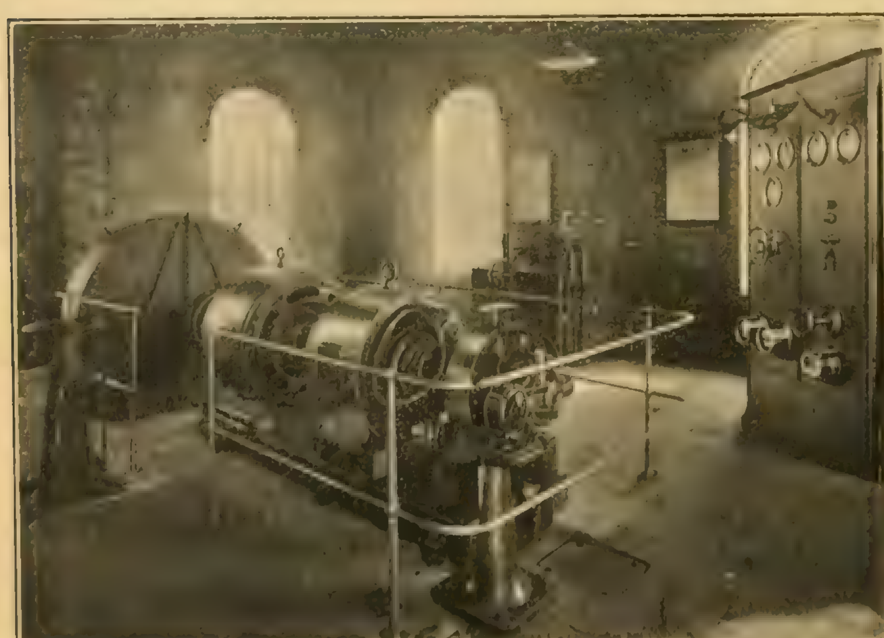


Fig. 6.—Main Converter at Tribley Pit.

The main converter set is shown in Fig. 6. Its motor is of the three phase type, working on a line voltage of 440 volts, and running at a synchronous speed of 1,200 revs. per min. The dynamo is of the interpole type, and gives a voltage ranging from zero to 300, and an amperage of 167 amperes. An exciter is also mounted on the same shaft, while at the other end is fixed the flywheel, which is the distinctive feature of the Ilgner arrangement. This flywheel weighs about $\frac{3}{4}$ ton, and the large amount of energy stored in it is shown by the fact that on test the set ran for 26 minutes after the current was switched off. The winding motor, Fig. 7, is a 12 pole shunt-wound machine, which can develop 60 H.P. at full load. The field of this motor is constant throughout, while its armature is connected directly to that of the generator, with only an overload circuit breaker between.

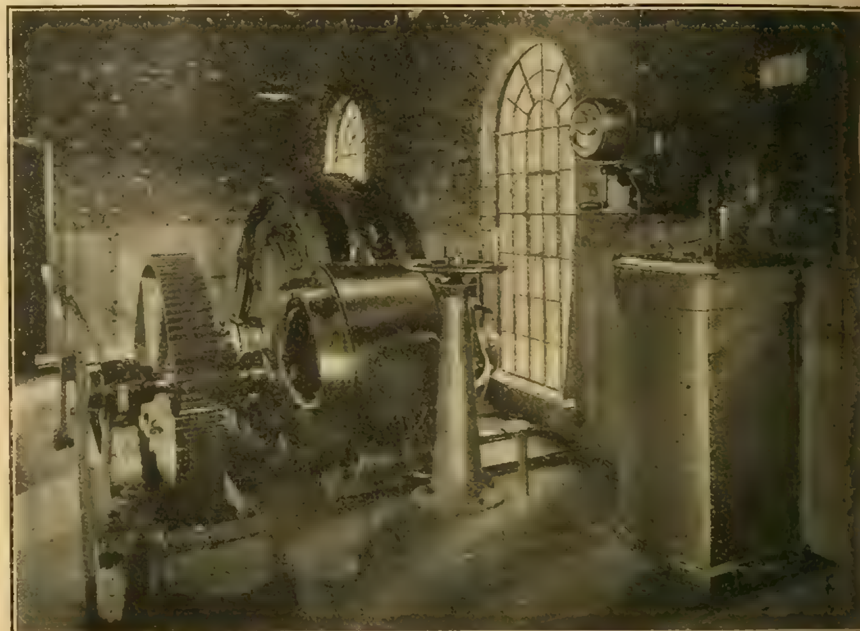


Fig. 7.—Winding Engine at Tribley Pit.

The duty of this winder is by no means light, for it lifts about 800 tons of coal per shift, besides changing the men. It has been found that in spite of the irregularity of the load, very little effect is noticed on the supply system, thus providing a very strong testimony to the efficiency of the Ilgner set.

This close regulation is obtained by means of a slip regulator placed in series with the stator of the Ilgner set motor. This slip regulator consists of a liquid resistance in each phase of the supply, the position of whose moveable plates is determined by the balance of what is virtually a torque dynamometer. This consists of an induction motor whose spindle is attached to an arm on which depends the gear holding the movable electrodes of the liquid resistance. Should the current through the stator of this motor exceed a specified amount it operates against the weight of the electrodes and raises them, thereby inserting resistance in the stator circuit of the motor. The current passing through the squirrel cage dynamometer is at all times proportional to the energy passing through the motor of the Ilgner set. It follows, therefore, that directly the demand on this motor becomes excessive its speed and output are dropped by the insertion of stator resistance and an opportunity is given to the flywheel to take up the load.

The winding motor is started and stopped by means of long distance control on the exciter circuit. In order to keep the exciter voltage constant the shunt regulator is operated by means of a small motor actuated by relays. As the speed of the Ilgner set rises resistance is put into the field, and, therefore, at any speed of the Ilgner set the position of the controller at the winder corresponds to the excitation of the generator,

and consequently to the speed of the winding motor. Starting is effected by raising the plates in the liquid resistance already mentioned as high as possible, closing the main switch and then re-lowering the plates. The rate of lowering is kept from becoming too great by the action of the torque dynamometer. The speed of the set is indicated in the winding house by means of a voltmeter supplied from a small dynamo on the main shaft. Two other dials indicating the voltage on the winding motor and the current it is taking allow the man in charge to see how things are, and prevent too heavy a strain being placed on the motor.

The special conditions in mining work that prevail make it difficult for a motor to be used without some intermediate arrangement and the Ilgner system fills the gap in an efficient manner.

THE LAHMEYER ELECTRICAL CO. of London are among the firms who use an adaptation of this system for their electrical winding engines. We illustrate in Fig. 8 a winding engine made by them in co-operation with Messrs. Louis Soest of Dusseldorf, for the Wenzeslaus Mine. It is intended for carrying both men and material, and its working load is $1\frac{1}{4}$ tons at a speed of 16·5 ft. per second. A wide speed regulation is available as the cage can run from about $\frac{7}{8}$ ft. per second to 16·5 ft. per second. The motor on the Ilgner set is of the three-phase type, supplied with current at 3,000 volts, and a frequency of 50. Its mean output is 110 H.P., and its speed 300 revs. per min. It is set in motion by a starter, with which is combined a high-tension reversing switch, the whole being connected with the emergency brake through an oil-release magnet directly connected to the 3,000 volt high-tension circuit.

brakes. In this case two brakes are used, one of them being a pneumatic band brake, actuated by the controlling mechanism mentioned above. The necessary air is obtained from a com-

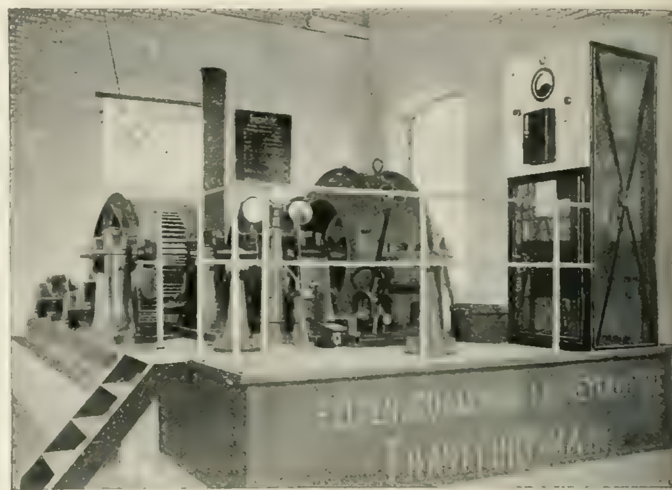


FIG. 8.—LAHMEYER WINDING ENGINE AT THE WENZESLAUS MINE.

pressor operated automatically by a small motor. The pressure being always kept between three and six atmospheres.

Another winding engine which was supplied by the Lahmeyer Co. to the Gewerkschaft "Concordia," at Dernbach,

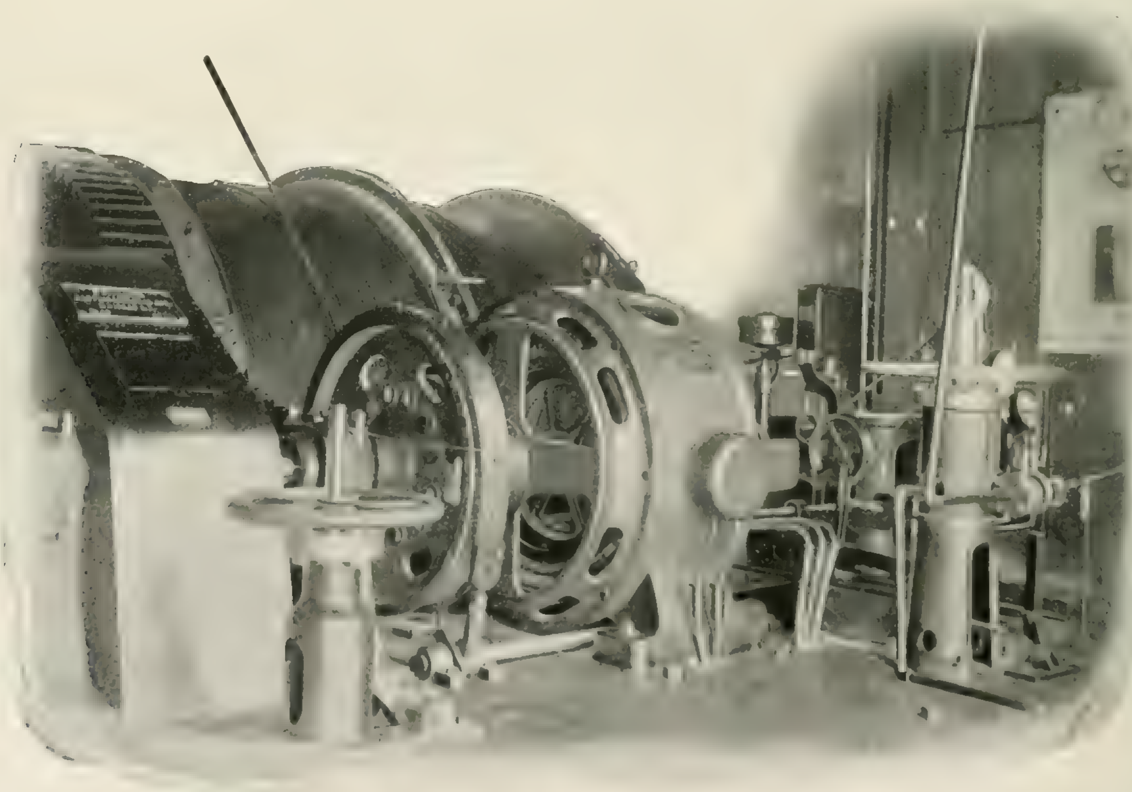
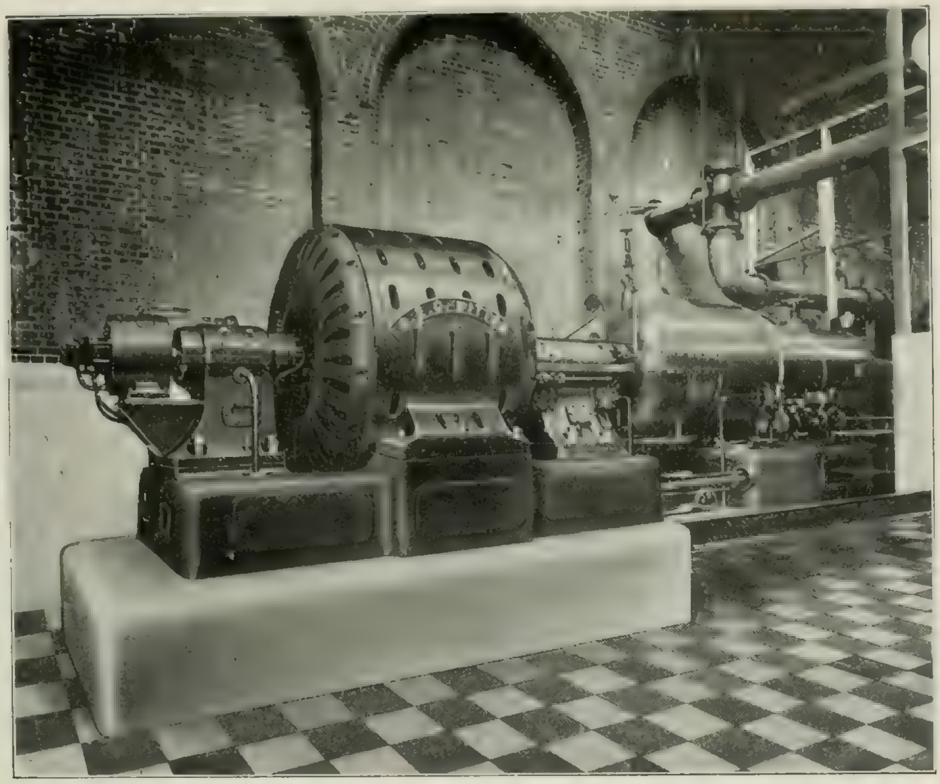


FIG. 9.—LAHMEYER WINDING GEAR AT GUNTHERSHALL.

Fig. 9 shows another type of machine supplied by this firm, which is adapted for rather heavier work. It is capable of raising rather over $1\frac{1}{2}$ tons at a speed of about 13 ft. per second. In this case an asynchronous three-phase motor is used for driving the Ilgner set, its capacity being 200 H.P. at 585 revs. with a frequency of 50. The line voltage is 500 volts, and it is claimed the set can reach full speed within 10 seconds of start ing. Power is transmitted to the winding drum through double reduction gearing.

A very important part of every winding equipment is the

has two drums, and is capable of dealing with a working load of about $1\frac{1}{2}$ tons. Reduction gearing with a ratio of 12 to 1 is used, and the speed of the cable is about $26\frac{1}{2}$ ft. per second. This engine is driven by a shunt wound motor, whose normal voltage is 470 volts, and runs at 530 revs. when raising the load, and 265 during the descent. The controlling gear and brakes are similar to those described above. The safety brake, which checks the cage should the cable become slack, holds the loose drum tight while the slack cable is drawn up by means of a hand wheel and hanging runner.



Electric Haulage in Mines.

BY W. C. MOUNTAIN, M.I.E.E.
(Of Messrs. Ernest Scott & Mountain.)

One of the most important uses of electricity for mining purposes is its application to haulage both on the surface and, particularly, underground, and during the last few years a very great amount of work has been done in this direction.

In considering the adoption of electric haulage one has to be guided by local circumstances in making a selection of the most suitable system, and these may be divided as follows :—

1. *Main Rope Haulage*, consisting of a single drum, and hauling up gradients exceeding, say, 3 in. per yard, so that the empty tubs are able to draw the rope back by gravity.

2. *Main and Tail Haulage*, by which the main rope usually draws the full tubs up an incline or along a road with a gradient in favour of the load of less than 3 in. per yard, the tail rope being used for taking back the empties or lighter load.

3. *Endless Rope Haulage*, which can be used on roads with a gradient in favour of the load or against the load, but this system can only be used where a road is wide enough to allow the full tubs to pass the empty tubs, except a special bye-pass arrangement is used, which is not generally satisfactory.

4. *By Electric Locomotives.*—These are generally used on nearly level roads.

There are various modifications of these methods of working and combinations for special cases, but the above generally represent the main four systems upon which haulage in collieries is effected.

Main Rope Haulage.

As previously stated, this system of haulage is adopted on single roads where there is not sufficient width to use an endless rope (as only one line of rails is required) and where the tubs are of sufficient weight to run back by gravity.

It will readily be understood that it is impossible to fix any definite gradient upon which the haulage will self-act, *i.e.*, run back by gravity, as this depends so very greatly upon the condition of the road, namely, upon whether the rails are of sufficient weight and are well laid, or whether—as is often the case—they are light and badly laid. In addition to this, the class of tub wheel has a very great deal to do with easy working. With heavy tubs, such as are used in South Wales, with large wheels, then the train will self act, *i.e.*, run back on a gradient of even less than 1 in. per yard. On a fairly good road and with the tub wheels of reasonable size, it is found that 2 in. to the yard is sufficient for self-acting, but this is working rather close to the line, and therefore something between 2 in. to 3 in. per yard, and over, is the gradient upon which a main rope haulage is usually applied.

Main and Tail Haulage.

Main and tail haulage is largely used in the North of England and also in South Wales, and in districts where, owing to the possible rising of the ground or the difficulty in maintaining a good roof, it is found impossible to make the roads of sufficient width to enable endless rope haulage to be used.

This system is being gradually discarded for endless rope, but there are still a good many mining engineers who believe in it ; this is generally in older collieries or mines where the roads are of considerable length and it is necessary to get the men inbye, *i.e.*, to their work, in the shortest space of time.

It will easily be recognised that in any system of intermittent haulage, such as main rope, in which the full load is usually drawn up and the empty load allowed to self act back, or in main and tail haulage where the full tubs are drawn outbye and then the empty tubs taken inbye, that a very considerable amount of time is wasted in making up the train of tubs, changing from the full to the empty inbye, and also going through the same operation at the pit bottom, or to whatever point the haulage gear may draw the coals or minerals, and approximately a gear of this type is worked at about full power for one-third of the time. It then stands for about one-third, and runs at a much smaller power for the other third. Consequently, the amount of power necessary for dealing with a given output with either main or main and tail haulage is very much greater than with endless rope, and a calculation will be given later on showing the comparative power necessary for the same output.

There are many positions, however, in a mine in which this system of haulage can and will be largely utilised, *i.e.*, to dispense with horses underground. In many collieries there are large numbers of horses kept for drawing coals along roads ; for example, say, from the working face to the main haulage roads, and for subsidiary work of this kind, a light, portable type of haulage which can be main rope when there is sufficient gradient, or main and tail where the roads are flat, and illustrations are given showing gears of this description.

Endless Rope Haulage.

The endless rope system of haulage is probably the simplest that can be adopted where the roads are of sufficient width and are also reasonably straight. In a system of this kind the rope passes round a rope wheel, usually two or three times to give a sufficient grip, the wheel being fitted with "C"-shaped trods, which are renewable. This gives a sufficient grip, and there is also a balancing arrangement ensuring that the rope is kept at a suitable degree of tightness.

There are, of course, many types of rope wheels, and many shapes of trods, these being largely governed by the particular

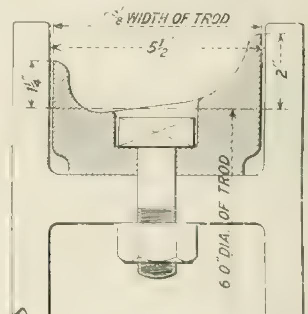


Fig. 1.—"C" shaped Trod.

idea of the engineer in charge, but there is no doubt that the simple "C" trod, with three or four turns of rope, is being very generally adopted, but, of course, good work is done by the "Cadzow" pulley, which consists of a single groove in which the rope grips, passing half-way round the wheel, but the wear and tear on the rope is usually greater with this type of pulley.

Fig. 1 shows the rim of a rope wheel fitted with a "C" trod. This trod is usually made of chilled cast-iron in segments, but is sometimes made of steel. Steel, however, is rather hard upon the rope, and it is better to occasionally renew the cast-iron trods than have to renew the rope.

Fig. 2 shows the single groove and it will be noted that the rope grips at each side of the groove. These pulleys are usually split down the centre at the rim so that the rim sides can be brought together as wear takes place.

Speed of Haulage.

The speed of haulage by any system is governed largely by the length of the road, the gradient, and the quantity of coal to be dealt with in a given time.

Main or main and tail haulage gears usually run at a rope speed of from 4 to 6 miles per hour in small gears, *i.e.*, say, up to 40 or 50 H.P., and from 6 to 8 miles per hour in gears from, say, 50 to 100 H.P. In larger gears the speed would probably be from 8 to 12 miles per hour. With endless rope the average speed is about 2 miles per hour. Some engineers prefer not to exceed 1¾ miles and others adopt 2 to 2½ miles, but about 2 miles per hour may be considered as a good average working speed. The speed, of course, greatly depends upon the work-

ing conditions. If the road is good and fairly level, it is possible to secure the tubs to the rope at a higher speed than can be done with a heavy gradient and the tubs probably close together, and it is only practical experience which can definitely determine the most suitable speed for any particular type of road.

Endless ropes can be of very considerable length, and this system of haulage also has the advantage that it is quite possible to control a number of districts from one haulage centre by fitting the haulage gear with a sufficient number of rope wheels.

Power Required for Haulage.

In order to enable engineers to arrive speedily at the horse-power required for dealing with any given quantity of coal or mineral by either of the systems, *i.e.*, main rope, main and tail, or endless rope, the writer has prepared two tables, which are as follows :—

Table I. gives the power required for main and tail haulage gears on gradients varying from 2 in. in favour of the load to 12 in. to the yard against the load, and this table may be taken as safely representing the horse-power which will be required under ordinary conditions, with a proper allowance to cover friction. The load in tons includes the weight of the tubs, coal, and rope.

With main rope haulage it is necessary to take the weight of the main rope only, but with main and tail haulage the weight of both ropes should be added to the weight of the coal and tubs on the incoming journey.

It will be noted that the power is given at a speed of 10 miles per hour, but by taking off the figure on the right, or using a decimal point, the table gives at once the horse-power required at a speed of one mile per hour, and if this horse-power is multiplied by the actual speed at which the train is running, the horse-power necessary will be given.

In calculating horse-powers for main or main and tail haulage the length of the road itself does not come into account.

Table II. *Endless Rope Haulage.*—With endless rope haulage, where the tubs are attached to the endless rope at regular intervals, it is sufficient to take the delivery in lbs. of coal per minute at the pit bottom, or to whatever point the haulage rope is required to deliver its load, and it will be noted that Table II. gives the horse-power required on a road 1,000 yards long, from a gradient 2 in. to the yard in favour of the load to 12 in. to the yard against the load.

In considering the horse-power of an endless rope haulage, it is also only necessary to take the average gradient, so that if the total length of the road is known and the total rise, this will give at once the gradient in inches per yard against which the load has to be drawn.

Assuming that the road is more or less than 1,000 yards long, the horse-power is in proportion to the length of the road. For instance, if the road is 500 yards long, the horse-power required will be one-half of that shown in the table ; if twice the length, then double.

Comparison of Power Required for Main and Tail and Endless Rope Haulage.

A comparison of the two systems of haulage as regards power required, based upon the above tables, will explain the application of the rules, assuming that the work to be done by each haulage is as follows :—

Capacity in 10 hours	600 tons.
,, per hour	60 ,,
,, per minute	1 ,,
Length of road, 1,760 yards	1 mile.
Gradient against load	4 in. to the yard.
Weight of each empty tub	4 cwt.
Weight of coal per tub	10 cwt.

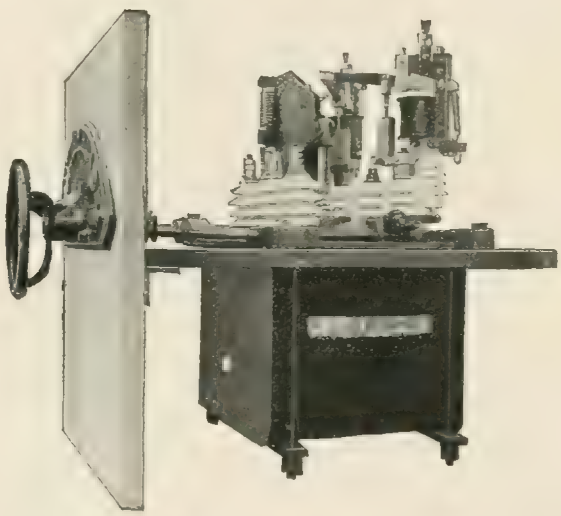
Table I.—*Horse-power required for Main and Tail Haulage at 10 Miles per Hour.*

Actual incline in inches per yard.	Virtual incline in inches per yard.	Load in tons.										
		5	7·5	10	15	20	25	30	35	40	45	50
−2	0	0	0	0	0	0	0	0	0	0	0	0
−1	1	8·3	12·5	16·6	25	33·2	41·4	50	58	66·4	75	80·8
0	2	16·7	25	33·3	50	66·6	83	100	116	133	150	166
1	3	25	37·7	50	75	100	125	150	175	200	225	250
2	4	33·4	50	67·5	100	134	167	200	233	270	300	334
3	5	41·5	62	83·5	125	167	208	250	290	334	375	416
4	6	50	75	100	150	200	250	300	350	400	450	500
5	7	58·3	87	117	175	234	294	350	408	468	525	588
6	8	66·3	100	133	200	267	333	400	465	532	600	666
7	9	75	112	150	225	300	375	450	520	600	675	750
8	10	83·5	124	166	250	333	420	500	580	664	750	830
9	11	91	137	183	275	366	459	550	640	732	825	918
10	12	99	150	200	300	400	500	600	696	800	900	1,000
11	13	108	162	217	325	433	542	650	755	868	975	1,080
12	14	116	174	233	350	466	584	700	815	932	1,050	1,168

Table II.—*Horse-power required for Endless Rope Haulage on Road* 1,000 *Yards Long.*

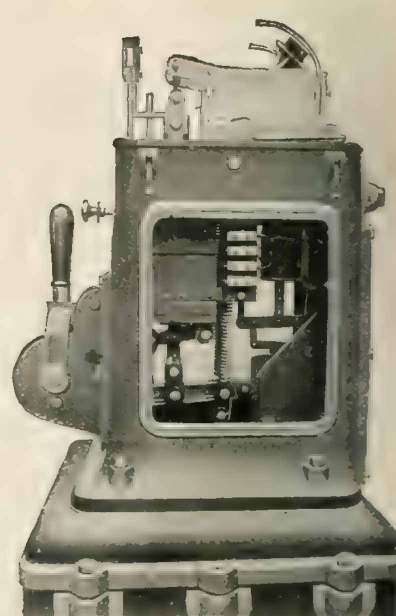
Actual incline in inches per yard.	Virtual incline in inches per yard.	Output in pounds per minute.															
		200	300	400	500	600	700	800	900	1,000	1,250	1,500	1,750	2,000	2,250	2,500	2,750	3,000
−2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
−1	1	·5	75	1	1·2	1·5	1·7	2	2·3	2·5	3·1	3·7	4·4	5	5·6	6·2	6·9	7·5
0	2	1	1·5	2	2·5	3	3·5	4	4 6	5	6·3	7 6	8·9	10	11·4	12·7	14	15
1	3	1·5	2·3	3	3·8	4·6	5·3	6	6·8	7·6	9·5	11·4	13·3	15·2	17	19	21	23
2	4	2	3	4	5	6	7	8	9	10	12·6	15	17·6	20	23	25	28	30
3	5	2·5	3·8	5	6·3	7·6	8·9	10	11·4	12·7	15·8	19	22·3	25·4	28	32	35	38
4	6	3	4·5	6	7·6	9	10·6	12	13·7	15·2	19	22·8	26 6	30·4	34	38	42	45
5	7	3·5	5·2	7	8·8	10·5	12·4	14	16	17·7	22	26·5	31	35	40	44	49	53
6	8	4	6	8	10	12	14·2	16	18·2	20·4	25·3	30·4	35	41	45	51	55	60
7	9	4·5	6·8	9	11·4	13·7	16	18	20·5	22·8	28·5	34	40	45	51	57	63	68
8	10	5	7 6	10	12·6	15 2	17·7	20	22·5	25·3	31·7	38	44	51	57	63	69	76
9	11	5·5	8·3	11	14	16·7	19·5	22	25	27·8	34·7	41·7	49	55	62	69	76	83
10	12	6	9	12	15·2	18·2	21·3	24	27·3	30	38	45	53	61	68	76	83	90
11	13	6·5	9·8	13	16·4	19·8	23	26	29·6	33	41	49	57	66	74	82	90	98
12	14	7	10·6	14	17·7	21·3	24·8	28	31·8	35·4	44	53	62	71	80	88	97	106

MINING

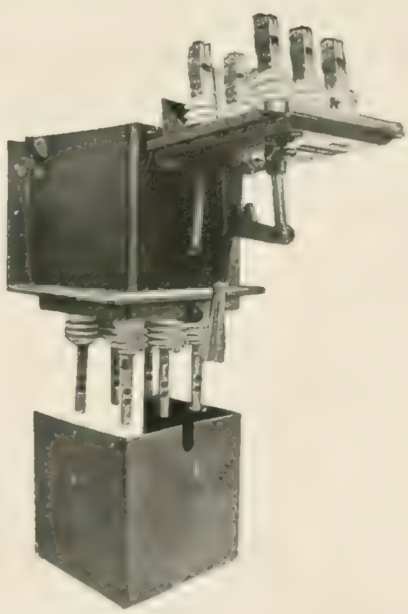


High-Tension Circuit-Breaker. Switchboard Type.

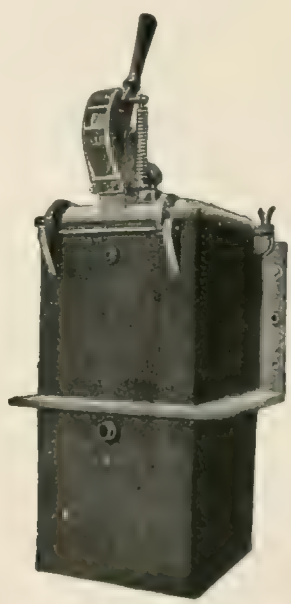
The overload coils are mounted directly on insulators and form part of the H.T. circuit. The adjustment of the overload release can be made from the front of the board.



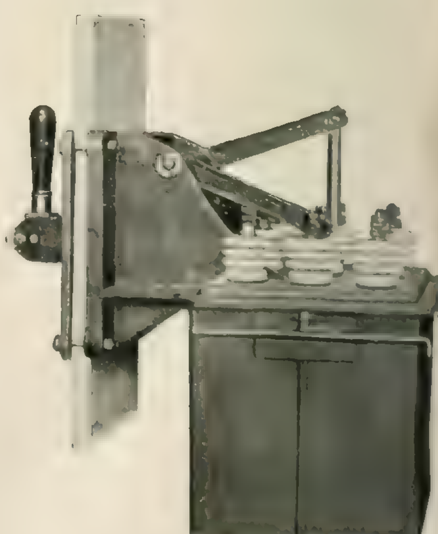
Gear of Remote Electrical Control Switch Pillar.



Combined Oil-Break Switch and Fuse. Opened for Inspection or Renewal of Fuses, shewing Terminals.
Pattern J.H.F.



Combined Oil-Break Switch and Fuse. Closed and in "On" Position.
Pattern J.H.F.



Change-over Switch. Type Z, Outfit V.

Union Electric Co. Ltd.

PARK ST., SOUTHWARK, LONDON, S.E.

NEWCASTLE, BIRMINGHAM AND GLASGOW.

Cables: ABEAM LONDON.

Main and Tail Haulage.—The power required for main and tail haulage will therefore be as under :—

Number of trains per hour	3.
Time allowed for hauling both tubs outbye	8 minutes.
Time allowed for hauling empty tubs inbye	8 minutes.
Hitching on full and empty tubs	4 minutes.
Total time per journey in and out	20 minutes.
Number of tubs per journey	40.
Capacity, 10 cwt. each	400 cwt. or 20 tons.
Weight of tubs, 4 cwt. each	160 cwt. or 8 tons.
Estimated weight of rope	40 cwt. or 2 tons.
Total weight of train, including coal, tubs and rope	30 tons.
Speed of haulage	1 mile in 8 minutes, or 70 miles per hour.

From the main and tail haulage Table I. it will be seen that if a load of 30 tons at a speed of 10 miles per hour is to be hauled up a gradient of 4 in. to the yard against the load, 300 H.P. will be required, so that at the reduced speed of $7\frac{1}{2}$ miles per hour the horse-power becomes $30 \times 7{\cdot}5 = 225$.

Endless Rope Haulage.—For the same duty by the endless rope system, the delivery of coal to the pit bottom being 600 tons in 10 hours, or 60 tons per hour, *i.e.*, 1 ton per minute, the power calculation is as follows :—

Speed of haulage in miles per hour.........	2.
Length of road, 1 mile	1,760 yards.
Gradient against the load....................	4 in. per yard.
Coal delivered per hour	60 tons.
Coal delivered per minute	1 ton.
Weight of coal per tub	10 cwt.
Number of tubs delivered per minute to pit bottom..............................	2.
Yards travelled per minute by rope on two miles per hour	58·6.
Distance of tubs apart on rope	29·3 yards.
Number of full tubs on rope...............	60.
Number of empty tubs on rope	60.

With the endless rope system the full and empty tubs balance each other, and it is therefore only necessary to deal with the actual weight of the coal.

On reference to the horse-power given in the endless rope power Table II. it will be seen that for an output of 2,250 lb. per minute, which is the nearest in the table to 2,240 lb., or 1 ton, on a road 1,000 yards long with a gradient of 4 in. to the yard against the load, you will require 34 H.P.

With the endless rope system the horse-power is increased in accordance with the length of the road. Therefore, the horse-power for a road 1 mile long becomes $34 \times 1{,}760/1{,}000 =$ 60 H.P.

In both systems it is desirable to add, say, 25 per cent. to the calculated power for contingencies, such as tubs coming off the road, abnormal friction and other contingencies, so that to be quite safe it is recommended that the motors for the above duty should be as follows :—

Main, or main and tail haulage, say	280 H.P.
Endless rope haulage	75 H.P.

These figures show the great economy of the endless rope system of haulage where the system can be adopted.

Having briefly described the systems of haulage, and having decided upon the type of gear to be utilised for the particular work, it is necessary to consider some points of design. In selecting the size of drum, it is desirable when using ordinary wire ropes to make the drum not less than 60 times the diameter of the rope to be used. In other words, the drum should be not less than 5 ft. diameter, *i.e.*, 60 in., when using a haulage rope 1 in. diameter, but the following sizes may be of service as a rough guide when the horse-power is known :—

Main and Main Tail Haulage.

B.H.P.	Diameter of drum (inches).	Width of drum (inches).
20—30	30	12
40—55	36	15
60—75	42	15
80—100	48	24
120—140	60	24
150	72	24

The width of the drum is, of course, governed entirely by the length of the rope which is to be coiled upon it, and the above widths are merely given as average standards.

Endless Rope Haulage.—For endless rope haulage the rope wheel requires to be approximately the following dimensions :—

Endless Rope Haulage.

B.H.P.	Diameter of rope wheel (inches).	B.H.P.	Diameter of rope wheel (inches).
20	48	50	66
30	54	60	72
40	60	100	84

The above dimensions are, of course, based upon the whole of the horse-power being transmitted from one rope wheel, but it is quite customary to fit endless rope haulage gears with a

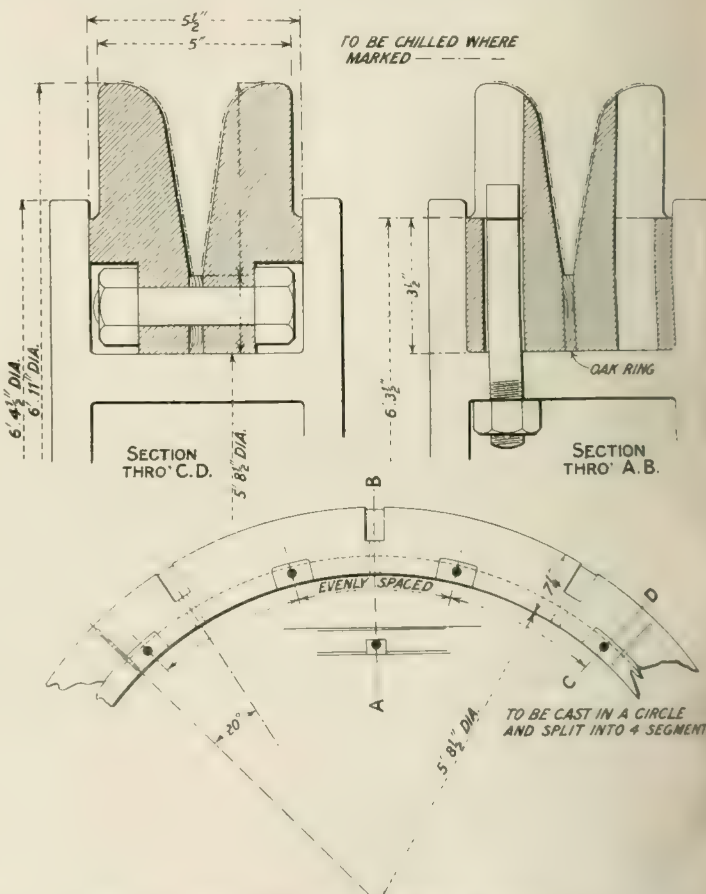


Fig. 2.—Wheel for Endless Rope Haulage.

number of rope wheels, and then, of course, it is desirable that they should all be of the same size, but the choice of a suitable size wheel can be made by referring to the above table, and usually the size is settled by the greatest horse-power which any particular wheel has to transmit.

Fig. 3 shows a main rope haulage gear with motor of 200 EFF.H.P. This gear is fitted with a drum 7 ft. diameter by 2 ft. wide, and was built for a rope speed of 6 miles per hour. The drum, it will be noted, is in halves and machined at the joints, bushed with gun-metal running loose on the shaft, the drum barrel being of sheet steel secured to the drum sides by countersunk bolts with nuts on the inside.

The friction clutch is of a type introduced by Messrs. Ernest Scott & Mountain, and known as "Hall's," and consists of an all round brake strap attached to the drum. This strap is lined with hard wood blocks, which can be very easily and cheaply renewed, one end of the strap being attached to the drum side and the other to a lever which is operated by means of a screw and handwheel from the driver's platform. In starting the gear the clutch is disengaged and the motor starts light, ordinary starting gear being all that is necessary. The clutch

is then gradually tightened upon the revolving brake rim which is attached to the shaft, and gradually takes up its load, so that the train of tubs is slowly started from rest, and with careful handling the current required for the motor will not rise appreciably above that required for normal full load.

This type of clutch has been very largely used. It has great advantages over any other type of friction clutch, due to the fact that the load can be started very gradually, and the only parts requiring renewal are the wood blocks, which can be easily and cheaply fitted by the colliery engineers.

With main, and main and tail, haulage, it is necessary, of course, to provide the drums with very reliable brakes, operated

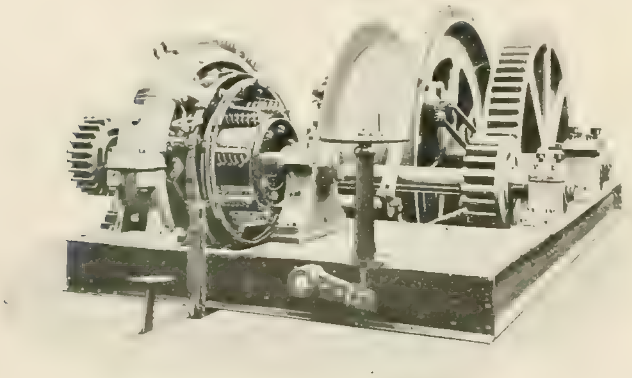


FIG. 3.—MAIN ROPE HAULAGE GEAR WITH MOTOR OF 200 EFFECTIVE H.P.

usually by foot or by foot and hand in the case of main and tail gears. These brakes are frequently of the all round type, *i.e.*, they entirely embrace the brake rim, but if made in this way they should be jointed in the centre, so that in the event of the strap breaking, one-half will hold the load, and the brake should be designed of sufficient dimensions to enable this to be done.

Some engineers prefer post brakes, this brake consisting of two upright posts with hard wood or cast-iron blocks. The bottom ends of the post are usually fitted with turned bolts

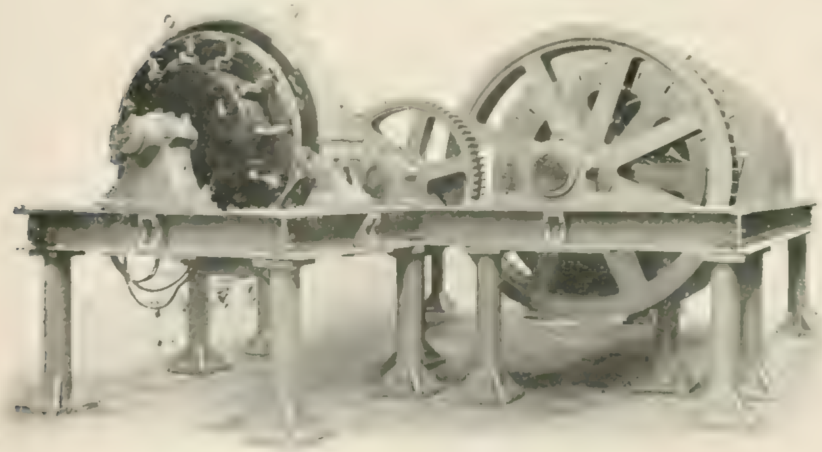


FIG. 4.—MAIN AND TAIL HAULAGE GEAR WITH C.C. MOTOR OF 300 EFFECTIVE H.P.

carried by a cast-iron soleplate, and the outer ends are brought together by means of a toggle joint operated from the driver's platform. This is an extremely powerful type of brake and very simple.

The brake rims are preferably fitted with renewable treads, so that in the event of any wear and tear taking place the treads can be renewed without renewing the whole drumside, which might be otherwise necessary.

In the design of haulage gears, particularly for main or main and tail work, it is necessary to keep the shafts and gearing of very ample strength, as gears are always liable to heavy shocks when tubs come off the road, or a heavy strain is very suddenly thrown on.

If the motors are arranged to drive direct through gearing on to the gears, it is necessary to use machine cut gearing, at any rate for the first motion, and in small haulage gears it is desirable to have the whole of the gearing cut, but in large plants this is an unnecessary expense for the main spur wheel and pinion.

The main spur wheels, if machine moulded and of cast-iron or steel, should be double shrouded and in halves. In fact, in all colliery work it is desirable that the spur wheels, haulage drums, and all parts of any size should be in halves, or so constructed that they can be readily got inbye, as frequently the roads are very narrow.

For small haulage gears raw hide pinions on the motors have been used in some cases successfully, but in all collieries gearing

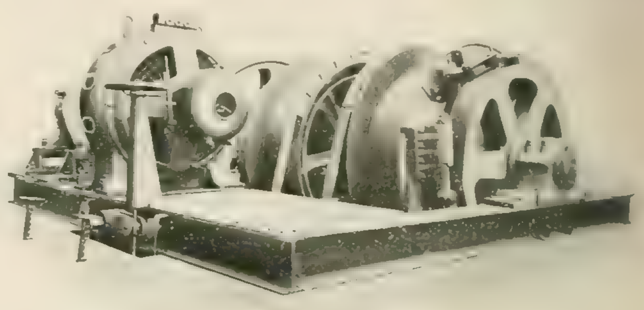


FIG. 5.—MAIN AND TAIL HAULAGE GEAR WITH THREE-PHASE MOTOR.

of this sort is liable to change of temperature, damp, oil and dirt, and machine cut steel pinions on the motors have been generally found to give the most satisfactory results, these pinions running into machine cut spur wheels on the intermediate shaft. If possible, this gearing should be run in an oil bath.

The writer has for many years recommended, where possible, that the power from the motor to the haulage gear should be transmitted by some elastic medium such as driving ropes or belts. Of course, belts are only suitable for very small haul-

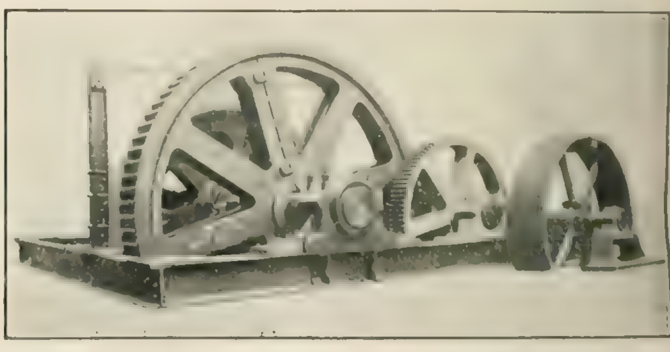


FIG. 6.—ENDLESS ROPE HAULAGE GEAR FOR ROPE DRIVE.

ages, and, therefore, ropes are generally preferable. By adopting this system of driving the vibration is taken off the motor, and with continuous current machines this is very important. Of course, with three phase motors where there are no commutators or commutator connections the vibration has not such a serious effect, but unquestionably for haulage gears of the fixed type, from, say, 20 to 150 H.P., rope driving gives extremely satisfactory results. For larger gears with very slow speed motors and with possibly only a single reduction between the motor and the haulage gear, direct geared motors run satisfactorily and without any great noise.

The bedplates of all haulages designed for underground work should preferably be of steel. They must be made in such a manner that they can be taken to pieces, got inbye, and re-erected in position without trouble, and the steel bed is lighter and stronger than cast-iron.

In designing such a bedplate it is important to see that suitable plates are provided at the corners, and also thickening plates under the bearings, so that the whole structure is very rigid.

Fig. 4 represents a main and tail haulage gear driven by a continuous-current motor of 300 EFF.H.P., the motor running at a speed of 300 revs. per min., and a rope speed of 8 miles per hour. This gear is fitted with two drums 6 ft. diameter by 2 ft. wide, the drums being driven through a train of gearing, the pinion of the motor being of forged steel machine cut running into a machine cut cast-steel wheel on the intermediate shaft, and upon this shaft a forged steel machine cut pinion drives into the double shrouded main spur wheel on the drum shaft. The drums run loose on the shaft and are fitted with friction clutches. The method of operating these clutches is clearly shown by reference to the hand wheel standing on the platform. It will be noted that the bedplate is of steel girders bolted together.

A suitable indicator is fitted, driven from the drums, to show the position of the train on the road.

Fig. 5 shows a similar gear, but driven by a three-phase motor. In this case the motor is placed upon the platform of the haulage, which, of course, makes the whole combination v. ry compact, but where the motor can be placed on one side—as shown in the previous illustration—it is to be preferred, as it prevents the oil and dirt being thrown over the motor from the ropes.

Fig. 7.—Endless Rope Haulage Gear with Four Rope Wheels.

Fig. 6 represents an endless rope haulage gear arranged for rope drive, and suitable for 150 to 200 EFF.H.P. at a rope speed of 2 miles per hour. The gear is of sufficient width to enable a second rope wheel to be fitted, but, as shown, only one wheel is provided. The rope wheel is 7 ft. diameter and is driven through a train of gearing consisting of a forged steel machine cut pinion on the pulley shaft gearing into a cast steel machine cut wheel on the intermediate shaft, with a forged steel machine cut pinion driving into the main spurwheel, which is 10 ft. 2 in. diameter by $4\frac{1}{2}$ in. pitch by $13\frac{1}{2}$ in. face.

It will be noted that post brakes are used in this case, these being operated from the driver's platform. The rope wheel is fitted with a friction clutch of the "Hall" type, worked also from the driver's platform by a screw and hand wheel.

Fig. 7 shows an endless rope haulage gear of the same general type, but fitted with four rope wheels, each rope wheel running loose on the shaft, and provided with friction clutches. This illustration shows how extremely simple it is to control four main roads from one central position and by one attendant. The friction clutches enable any of the ropes to be stopped or started as required without stopping the haulage, and the load on each rope can be started as gradually as required. Any sudden snatching of the rope due to a faulty clutch would probably throw the tubs off the road.

Fig. 8 represents a portable type of main rope haulage, which has been designed for subsidiary or auxiliary haulage underground in order to dispense with horses. At the present time it might be safely assumed that each horse, including the boy looking after it, and food, costs at least £1 per week, and in some collieries there are large numbers underground. It will readily be seen that if electricity can be applied by the use of small haulages, as illustrated, an enormous saving can be effected in working costs.

These haulage gears are required to give from 5 to 20 H.P., and are fitted with either continuous current or three-phase motors, and drive through machine cut gearing on to the main drums, which in the smaller sizes are 21 in. diameter and in the larger sizes 30 in. diameter, designed for a rope speed of about 4 miles per hour.

The bedplate in both types of gear is made of steel plates, so that the whole can be readily taken to pieces in case it is desired to place the haulage in any position underground where the roads are very narrow or very low.

The control of haulage gears where driven by three-phase or continuous current motors is a problem which has been very difficult to meet, but controllers are now being made, particularly for three-phase motors, which work very satisfactorily.

Electric Locomotives.

Electric locomotives have not been used to any great extent in this country, and there is no doubt that where endless rope haulage can be used the latter is very much more economical, as a locomotive necessarily weighs a considerable amount and a great deal of power is required to move the locomotive itself.

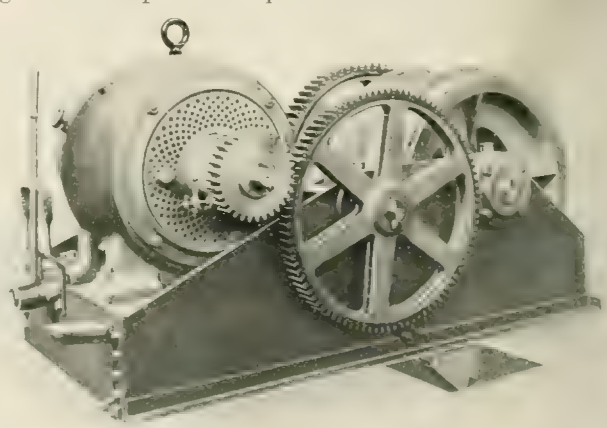


Fig. 8. Portable Type of Main Rope Haulage.

Under these circumstances, except for short roads which cannot be worked either by endless rope or main or main and tail haulage, there does not seem to be a very great future for locomotives in this country. They are used to a considerable extent in America, but it must be clear that unless the voltage is sufficiently low to prevent any possibility of danger through coming in contact with the overhead wires, there is considerable risk underground, and special regulations have been made by the Home Office as regards the use of locomotives in this country.

The Home Office have also recommended that the locomotives must be driven from an independent system, so that it involves a special dynamo for this work.

Fig. 9 shows the type of locomotive used in American mines and in other countries. It will be noted that the design is very compact and low in height. These locomotives collect the current from an overhead wire, and as this wire should be out of each of the men travelling along the roads, it follows that the roads must be about 7 ft. high, and this height—except on main engine plains—is frequently not possible without very heavy expense to the colliery owners. For intermittent service, however, or for use in suitable positions, the electric locomotive is likely to find favour in the future.

Controlling Apparatus.

The rapid increase of the size in motors applied to main haulages has rendered it necessary to design special controlling

gear to meet the conditions. It has been found in practice that the usual standard type of controller construction (viz., a series of segments on a drum with finger contacts pressing on them)

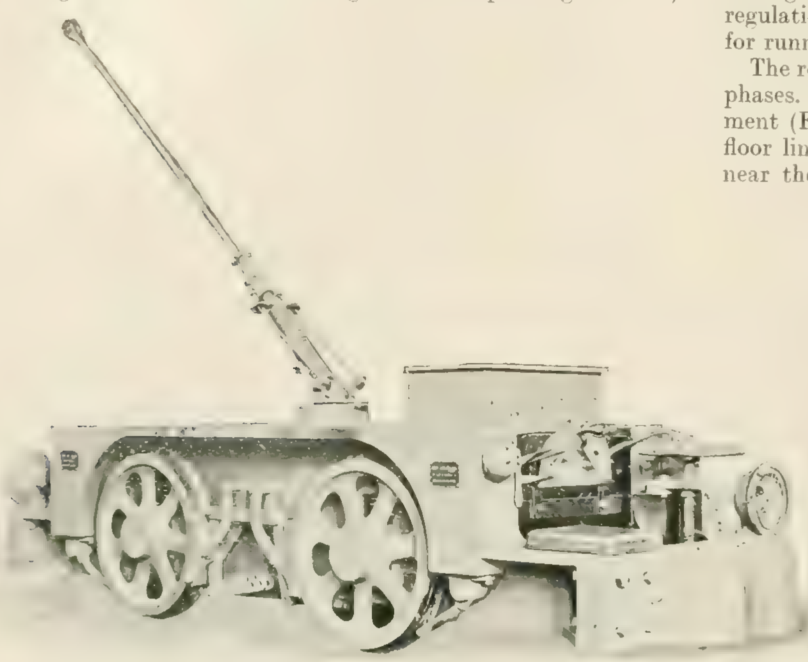


Fig. 9.—Electric Locomotive.

is not satisfactory for large motors owing to the difficulty of dealing with heavy currents with this type of contact and also to the very small break obtainable.

The supervision, upkeep and maintenance of this type with large powers has been a serious item in the running costs. In order to overcome these difficulties a special controller on new lines has been designed to meet heavy conditions of service.

The new pattern patent controller, illustrated in Fig. 10, is for operating a 400 h.p., 2,750 volt, three-phase reversible haulage motor, and it is designed to give 50 per cent. speed regulation at full load continuously, and also provision is made for running dead slow for winding in the haulage rope.

The reversing is done in the usual way by crossing two of the phases. It will be seen upon reference to the general arrangement (Fig. 11) that the reversing switch is placed below the floor line in the cable trench and is operated by a quadrant near the controller hand wheel. With this arrangement all

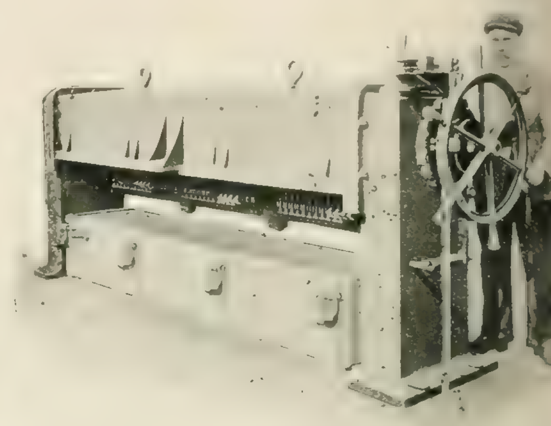


Fig. 10.—Controller for Operating 400 h.p. 2,750 volt 3-phase Motor.

the high-tension gear is situated away from the operator; the rotor of the motor is wound for 520 volts.

The reversing switch is interlocked with the controller hand wheel, and can only be operated when the hand wheel is in the off position and the motor at rest. The controller is arranged to cut resistance in or out of the rotor circuit, and is provided with 16 steps per phase.

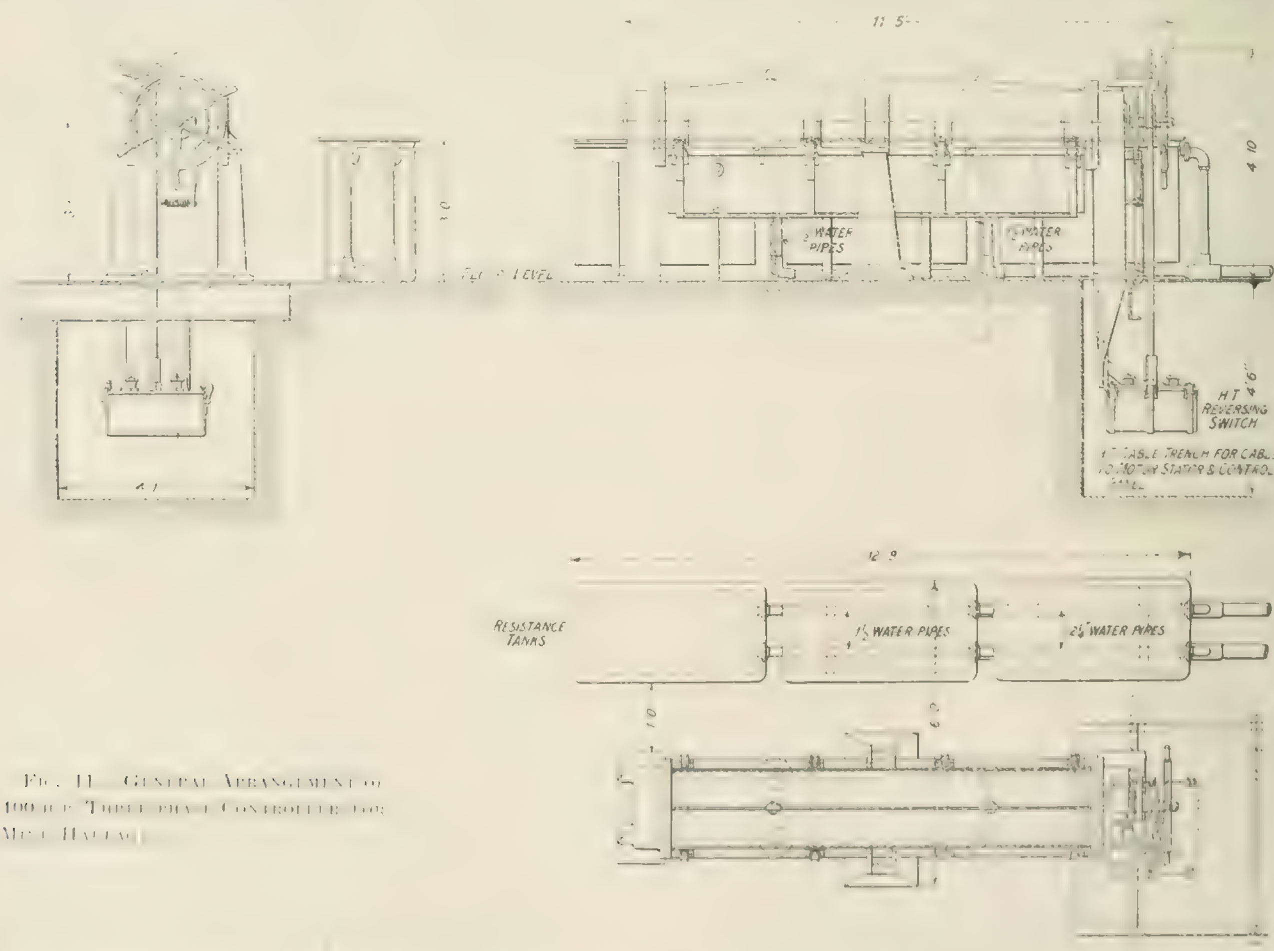


Fig. 11.—General Arrangement of 400 h.p. Three-phase Controller for Main Haulage.

Each step consists of a quick make and break knife switch giving a long break, and each switch is individually operated by its own cam fixed on the main spindle, the whole series of switches being oil-immersed. The controller is constructed on the loose handle principle, and the speed of the brake is independent of the operator and therefore the controller cannot be held in an arcing position.

With this type of apparatus the upkeep and maintenance is reduced to a minimum, and the same principle of construction has therefore been adopted for controllers of all sizes. The usual brake drum is provided to define the various steps.

The question of the resistances for use with these controllers has also received very careful attention. Where large amounts of energy have to be dissipated in resistances in confined spaces,

Fig. 12. Oil Switch.

such as haulage rooms, the question of providing space and keeping the temperature of the room normal have to be considered.

In order to deal with these problems and to produce resistances particularly suitable for colliery work the resistances have been placed in tanks filled with oil and completely enclosed, a system of copper coil pipes through which water is pumped being used to cool the oil (Fig. 10).

This arrangement keeps the space occupied by resistance to a minimum, and provides a flexible arrangement as more or less water may be used to cool the resistances according to the working conditions of the load, and the heat generated is conveyed out of the haulage room.

Liquid controllers are also largely used, and these consist generally of a cast iron casing containing water, and in collieries where a water supply is available it is desirable to run water through cooling pipes inside the tank. The quantity of water necessary depends, of course, upon the design of apparatus, but about three to four gallons per horse power dissipated per hour is the approximate quantity required. In the tank are three dippers which are kept under water, so that there is no sparking. These dippers are raised and lowered either by gearing or by a hand lever, and this enables the motor to be stopped and run at varying speeds as required.

Switchgear.—It is desirable that in all mining installations the switchgear underground should be of the strongest and simplest class possible. Whether for continuous current or alternating current, all live parts of the switchgear should be behind the switchboard and controlled from the front, so that it is impossible for the attendant to come into contact with any live metal work.

For alternating current oil-filled switches should in all cases be used, and these should be provided with overload relays in not less than two phases, and it is a great convenience to have these fitted with time limit relays, for the one simple reason that operating haulage gears the starting current frequently rises considerably above the normal, and if a circuit-breaker be used which trips quickly there is considerable difficulty in starting.

On all underground switchboards ammeters should be provided; in fact they are insisted upon in the latest

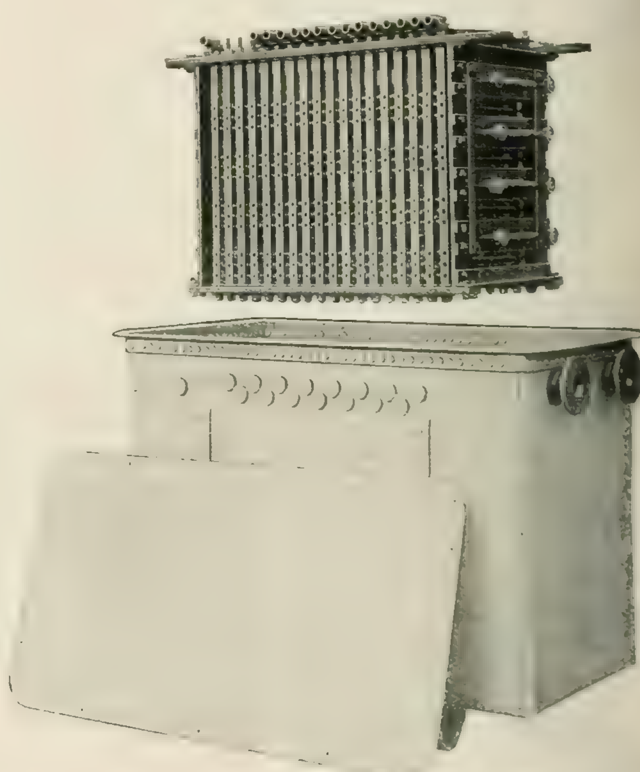


Fig. 13. Motor Resistance, Water Cooled.

Home Office Regulations, and voltmeters are strongly recommended, as it is very necessary for the attendant to be able to see that he has his full voltage.

Plant for Electric Haulage.

Mining engineers who have large outputs of either coal or mineral ores to transport underground have mostly arrived at the conclusion that it is in this particular department of mining engineering that electricity as a power agent is most useful to them. When electricity was first utilised in the mining field the application was in the direction of pumping plant, now, however, as already indicated, the premier position is held by its application to haulage problems. There is no doubt, however, that this is partly due to the fact that in mines, especially coal mines, which are operated by means of a shaft, and which have been sunk during recent years, the engineers have rightly adopted the method of tubbing the shaft where it passes through the water bearing strata; this, then, reduces the pumping problem to one of quite small

dimensions. Although electrical haulage has been and is being very extensively utilised underground, it is only in a comparatively few cases where the maximum advantage has been

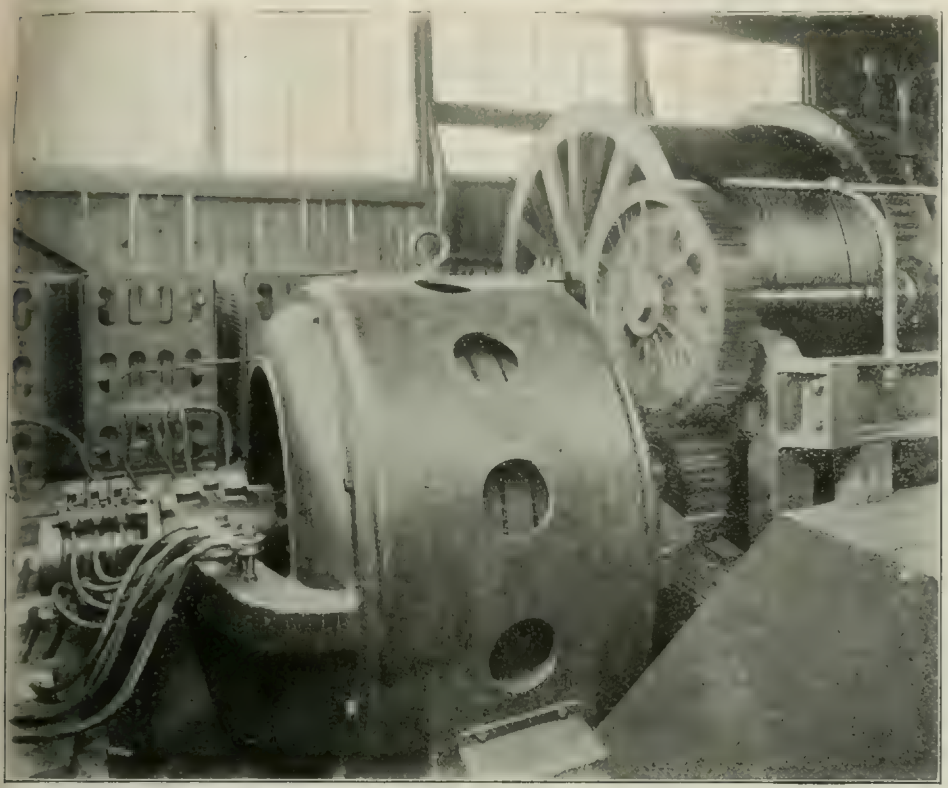


Fig. 1.—100 h.p. Main and Tail or Double Drum Haulage Gear operating Main Roads. (General Electric Co.)

taken of it, as, though all engineers know full well that the haulage problem consists of two main sections — viz., main and auxiliary haulage — few yet appreciate that electrically operated gears not only can be made, but also are made, to economically operate the auxiliary haulage necessary.

It may be as well here to indicate where the sub division takes place. This, of course, varies considerably, owing to the different methods that have to be adopted to meet the varied conditions and lay of the minerals. Broadly speaking, however, it may be stated that main haulage extends to the limits of the main roads or drives, and that all the primary haulage necessary to bring the minerals on to these main roads or drives is what may be termed the auxiliary system.

With regard to the gears themselves, the type to adopt, and the method of driving the "C" or driving wheel, the following points may be found useful.

It is generally advisable to have a slip ring type motor, with a reversing drum-type controller, or reversing link-starting switch, so that the rope may at any time be slacked back, if a tub or waggon comes off the rails. In this case it is not necessary to have a friction clutch to drive through, unless there is more than one rope wheel driven from the one shaft or motor. Friction

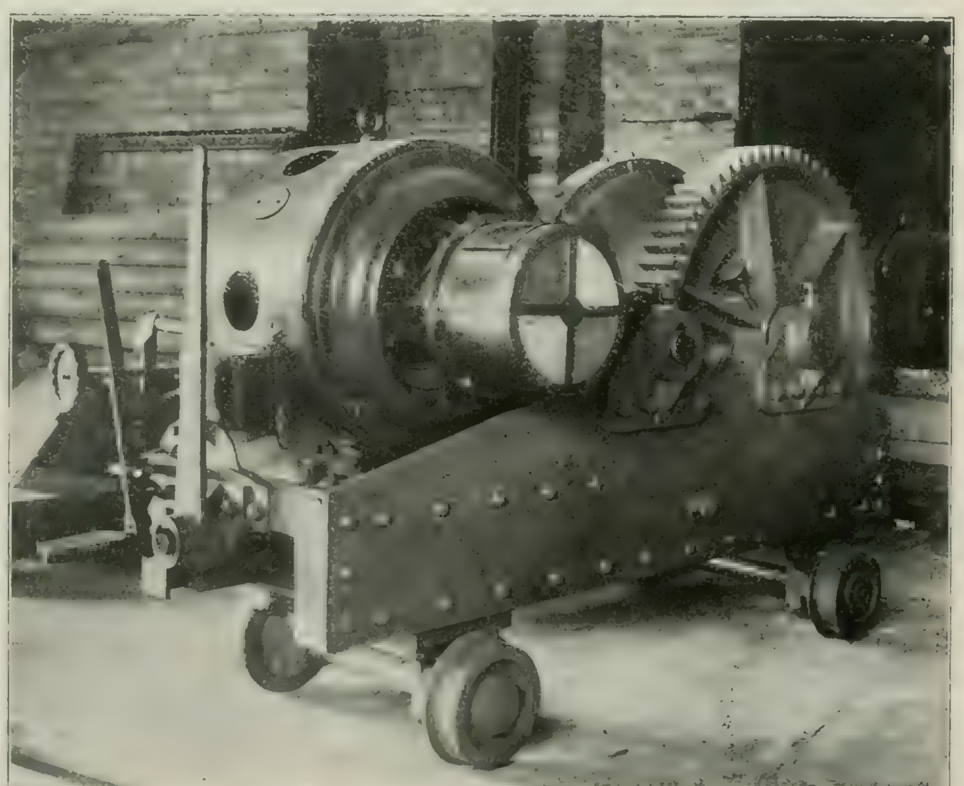


Fig. 2. 15 h.p. Portable Single Drum Haulage Gear for use on Subsidiary Roads. (General Electric Co.)

clutches, however, undoubtedly save the motor, but when electrical people advise them it is sometimes an indication of too light a motor or defective construction. The resistance of starters or controllers need only have a two-minute rating. The motors should always be continuously rated—*i.e.*, at least for six hours run on full load—and of as moderate a speed as possible, so as to keep down the speed reduction.

With regard to the main and tail haulage gears, these, of course, have to be of the double drum type, each drum being operated by a clutch. In the experience of many engineers the one that has proved the most serviceable is the ordinary four-jaw clutch, when made of cast steel, and with the solid steel centres of the drums used as the female end of the clutch. It is also found that it is better for these clutches to be double ended—that is, laid between the drums so that one drum is bound to be out of operation when the other is in. It is always advisable to pay particular attention to the method of driving this clutch. Feathers laid into the shaft on which the clutch slides have often been used, but this is a very disastrous arrangement owing to the constant reversals of the direction of rotation, and consequent strain on the feathers, causing the feathers to come out of their beds in a very short time.

The best method is to have a solid forged shaft with either a hexagon or octagon cut on it out of the solid, for the clutch to slide on, or have solid keys. This necessitates using a heavier shaft and machining out the portion between the keys, but it

is far better to pay the extra 5 or 10 per cent. on the cost of the gear and to have a really reliable article.

This type of gear is very much used in collieries where the mineral has to be brought a long distance underground, and also where the output off any given route is particularly heavy.

With regard to the electrical side of these gears a most important point is to watch the rated output of the motors. This should always be liberal, although it is not absolutely necessary that they should be of the continuous rated type.

The controllers and resistances should preferably be rated so that at any time in case of necessity the load can be brought out the complete distance at half speed, so that the motor regulation necessarily has to be capable of being brought down to 50 per cent. of full speed. This necessitates that the resistances should be rated for a period of time equal to twice the normal time taken for the trip.

For metalliferous mining, especially where the ore lies in veins and, as an instance of this, one may take gold mining, where a great deal of stoping and staple shaft working is entailed, this main-and-tail or double-drum type of gear is extremely useful for the auxiliary haulage, as if they are fitted with electromagnetic brakes in the original instance, and are supplied with indicators, they can at any time be used for winding purposes out of the staple shafts.

Further, in ordinary colliery work these double drum portable haulage gears can be used where coal is always brought down with the dip for operating several different sub roads, as either drum can be used separately as a single drum arrangement. This means that two roadways can be operated at the same time, by utilising the one drum as a hauling drum to take the empties up into the stall or face; and utilising the other drum to let the full coal down on the brakes by another rope operating the stall or face.

We have all of us heard more or less harrowing tales connected with haulage in mines. At first, as is well known, the tubs were pushed along by man or boy power, and after that horses or mules were used for the same purpose. For humanitarian as well as economical reasons both these arrangements have little to recommend them, and mechanical haulage was introduced, though somewhat gradually, into mines in this country.

As an example of electric haulage the equipment recently laid down by the The Electrical Co., at Tribley Pit, has some points of interest. At this pit there are about $1\frac{1}{4}$ miles of surface haulage. The tubs are run in sets of three at intervals of 60 yds. along the rope. Each tub contains 10 cwt. of coal, when full, the weight of the tub itself being 5 cwt. For 200 yds. from Tribley Pit there is a rise in gradient of 6 in., but beyond this point the gradient runs down, the total drop from Tribley to Pelton being 70 ft. The rope has a velocity of $2\frac{1}{2}$ miles an hour, being driven by a 60 h.p. three-phase motor running at 575 revs. per min.

Haulage in the underground working is accomplished by means of a 12 h.p. motor running at 770 revs. per min. This drives a 2 ft. 6 in. drum through single reduction gearing which is equivalent to 60 ft. per min. on the rope.

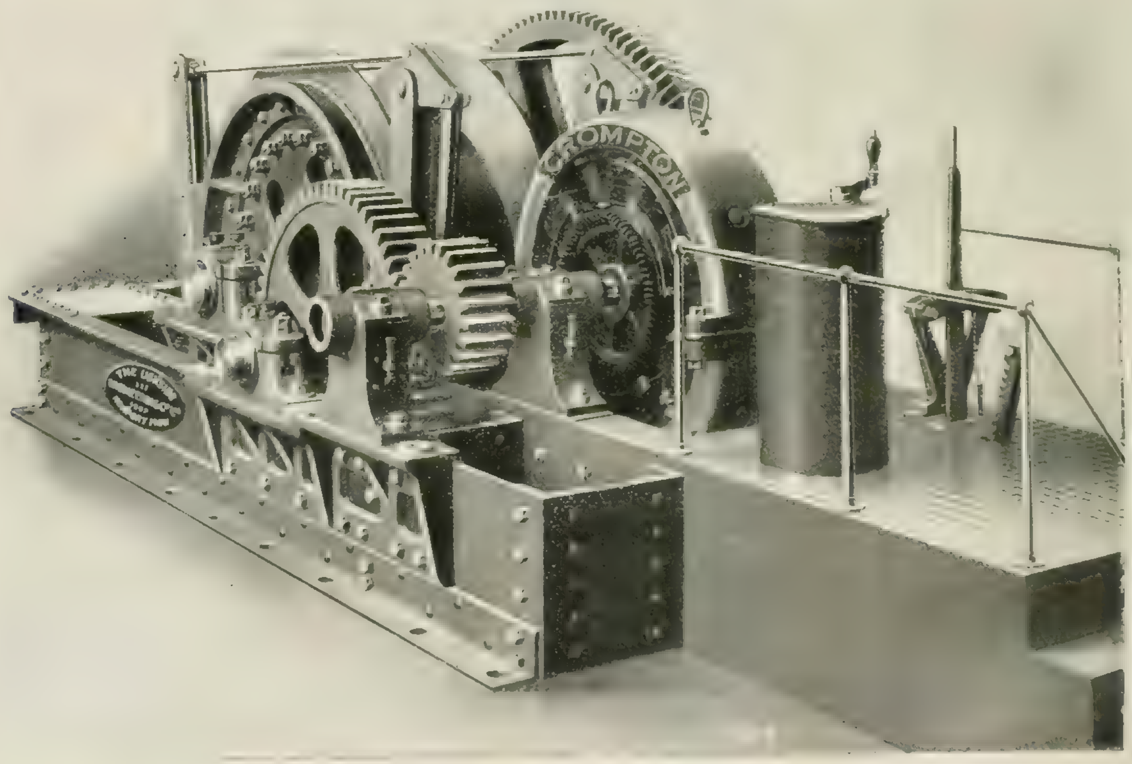


Fig. 3.—200 h.p. Crompton Motor coupled to Haulage Gear.

As another example of electric haulage constructed on modern lines we may refer to the haulage gear made by Messrs. Crompton & Co., of Chelmsford.

Fig. 3 shows one of their double-reduction single-drum haulage gears. It is of the self-contained type, and is designed for a normal horse-power of 200 with the motor running at 150 revs. per min. The gearing, which is of substantial construction, gives a rope speed of 6 miles per hour. The drum is 5 ft. by 2 ft. 3 in. and 1 ft. 3 in. wide. It is driven by means of a steel jaw clutch and is loose on the shaft. A strong foot brake is also provided. Great care has been taken in making the whole equipment rigid and so minimising the vibration often met with in many large haulage gears. It is a type which is being adopted for main hauling engines working a drift which has a good gradient all the way so that empty trains will run down on the brake.

Fig. 4 shows a somewhat similar but smaller gear. Its

normal is 10 H.P., but it is capable of dealing satisfactorily with loads considerably above this. Each of the two drums is loose on the shaft, being driven from the centre by a jaw clutch. The general get-up is very sturdy, and it should be admirably adapted for mining work.

Fig. 5 represents an endless haulage gear made by the SANDYCROFT FOUNDRY Co., and driven by a 60 B.H.P. Hunt's patent three-phase cascade motor. The motor shown is wound for a 440 volt, 50 cycle circuit and runs at a speed of 485 revs. per min. This haulage gear was supplied to a colliery in North Wales and includes triple-speed reduction, that from the driving motor having machine-cut teeth, while the others are of the double helical type. We understand that the results obtained by this combination are very satisfactory; in fact, the results of tests show that a very much higher efficiency can be obtained by cut gearing than is generally supposed.

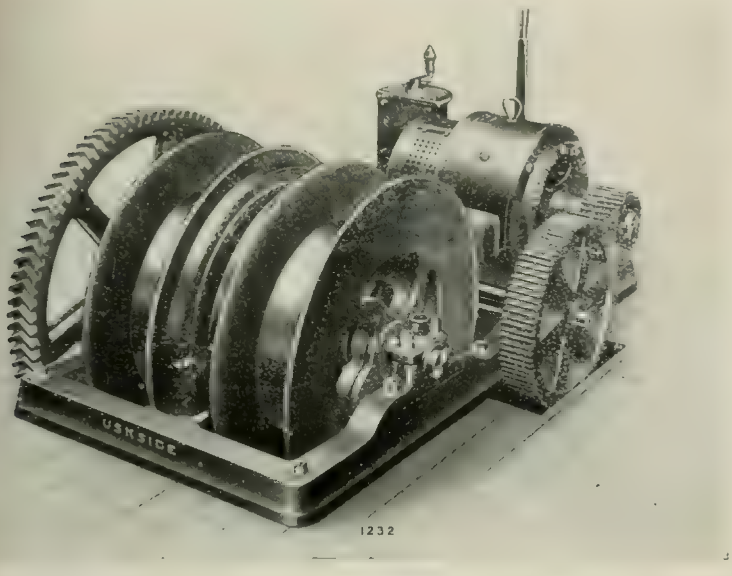


Fig. 4.—A Crompton 10 B.H.P. Motor driving Main and Tail Haulage Gear.

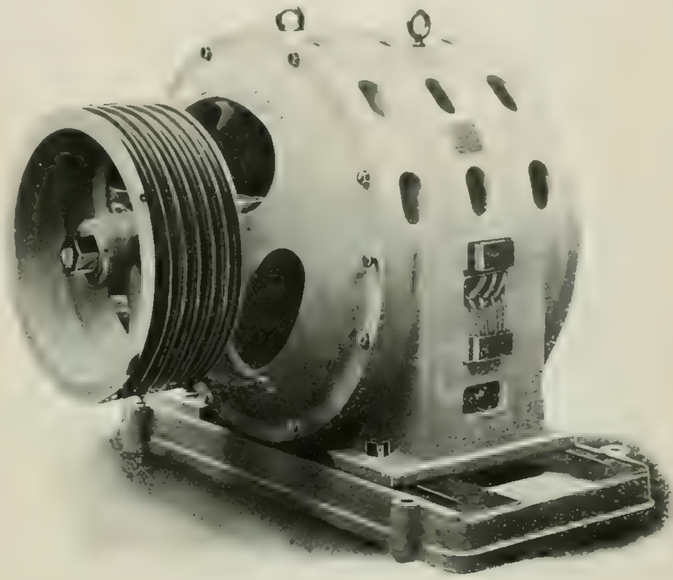


Fig. 6. "Sandycroft" Cascade Motor.

Induction motors have always been in favour with power users owing to their simplicity. The "H" type cascade motor referred to above is an improved type of induction motor made by the Sandycroft Company. It is claimed that these cascade motors have a considerably higher efficiency than ordinary induction motors. They are built in three types for variable speed work, a striking feature being that no slip-rings are required on the rotor shaft, the variable control being effected through resistances connected to the stator windings. In this simplest form the motor is provided with a short-circuited rotor winding and has the same characteristics as an ordinary slip-ring motor. The starting torque is controlled by resistances in the stator circuit, and the motor develops full-load torque when taking only full-load current. Thus, this motor combines the simplicity of the squirrel-cage motor with the good starting and speed regulation characteristics of the slip-ring machine. The speed can be regulated so that the rotor is only just moving, a very important point in many operations.

A modified type has the same stator arrangement as above, but the rotor has a double winding, and is provided with three slip-rings. It runs at two fixed speeds without any losses in resistances, and intermediate speeds are obtained by rheostatic control. The power-factor is but little reduced at the lower fixed speed. The rotor will start against twice full load torque taking only 1·4 times full load current, and it will develop full load torque with only 0·7 of full load current. Thus, since the losses in resistances are smaller than those of a slip-ring motor of ordinary design, the motor is well adapted for driving machinery which has to be frequently started and stopped, or where a large starting torque is required.

In the third arrangement, the motor is similar to the above, but with the addition of a change-over switch in the stator circuit for altering the windings and enabling the motor to run

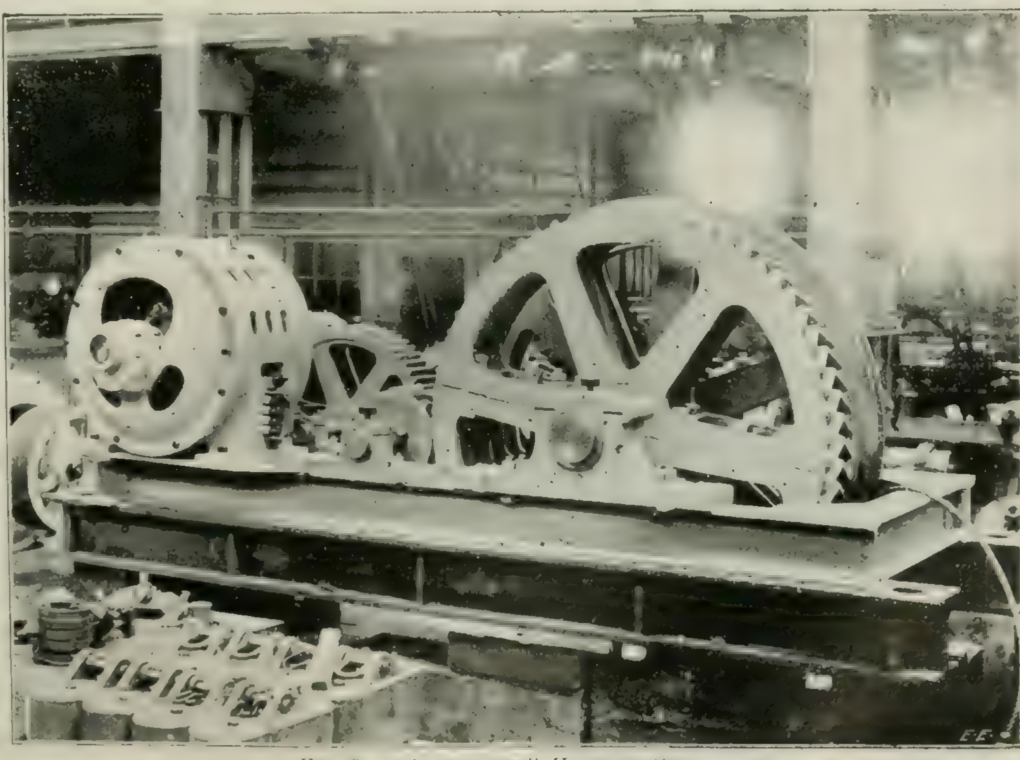


Fig. 5. "Sandycroft" Haulage Gear.

at three fixed speeds without rheostatic losses. Fig. 6 shows a 12-pole, three-phase, "Hunt's" patent cascade motor without slip rings; it gives 100 B.H.P. on a 500 volt, 50 cycle circuit, when running at 490 revs. per min. The motor illustrated is arranged for driving a pump, but these motors are eminently suited for most applications of electrical power to mining work, and are made completely enclosed when desired.

We illustrate in Fig. 7 a typical electrically-driven haulage gear manufactured by the ELECTRIC CONSTRUCTION Co., of Wolverhampton. It will be noticed that the controller is fixed adjacent to the gear so that the whole forms a very compact set. These controllers are usually arranged for starting,

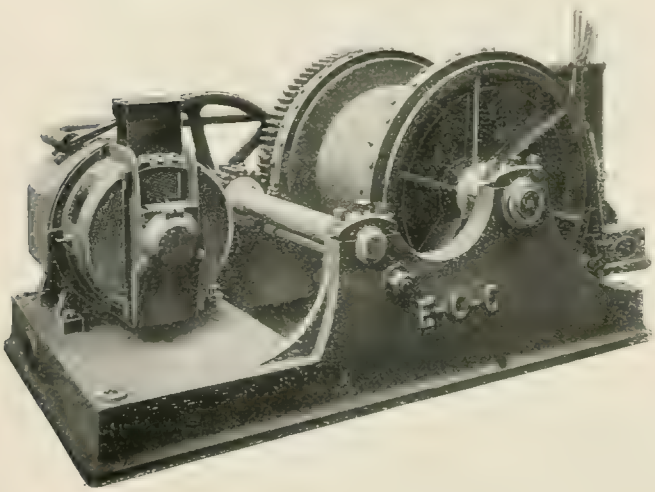


FIG. 7.—E.C.C. HAULAGE SET.

reversing, and regulating the speed of the electric motors supplying the driving power. The manufactures of the Electric Construction Co. are so well known that further description is unnecessary.

It may almost be considered as an axiom that few firms know more about the design of motors than the LANCASHIRE DYNAMO & MOTOR Co., of Manchester. It is, therefore, not surprising to find them prominent in this branch of mining work. In Fig. 8 we illustrate a slow speed induction motor made by this firm for coupling to a haulage gear. Its output is 400 H.P., and a distinctive feature is its gas-tight slip-rings which make it specially suited for underground installations. We are informed that a number of similar motors have been supplied to pits in the North-Eastern district, and that they can also be fitted for rope as well as direct drive.

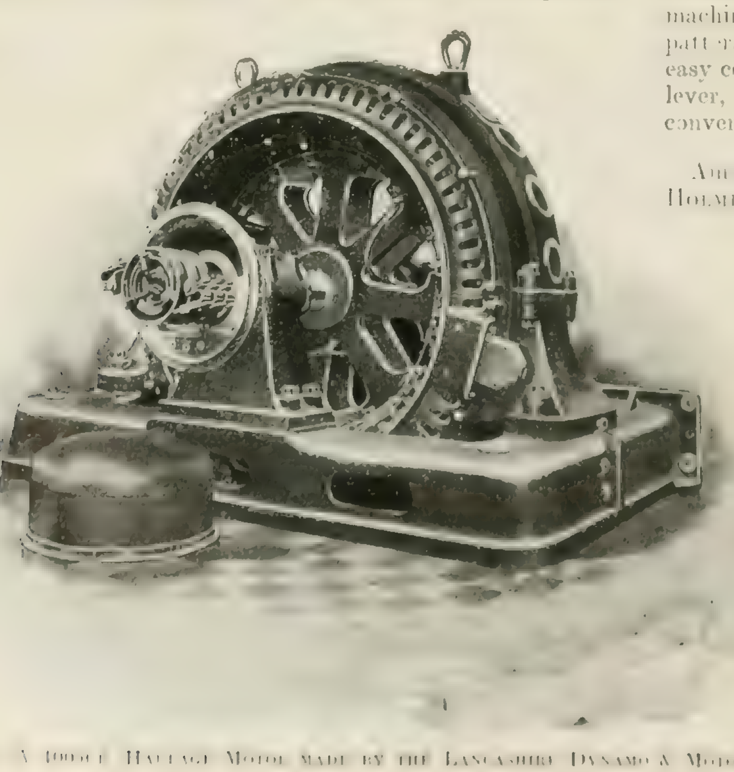


FIG. 8.—A 400-H.P. HAULAGE MOTOR MADE BY THE LANCASHIRE DYNAMO & MOTOR CO.

For haulage the electric drive offers special advantages and its employment for this purpose is becoming more and more widespread. Several firms make a speciality of this class of work and the haulage gear illustrated in Fig. 9 shows the standard electrically-driven single haulage manufactured by Messrs. MAVOR & COULSON, of Glasgow, for mining work. As will be seen the whole of the gear is of substantial construction, capable of withstanding the severe conditions under which this class of machinery works. The motor, of the open type, is bolted direct to the base plate, and drives the drum through machine cut steel gearing. The controller, of the tramway pattern, is also mounted on the base plate, thus allowing an easy control. This is further obtained by so fixing the clutch lever, hand brake lever and controller handle that they are conveniently placed for easy operation by the attendant.

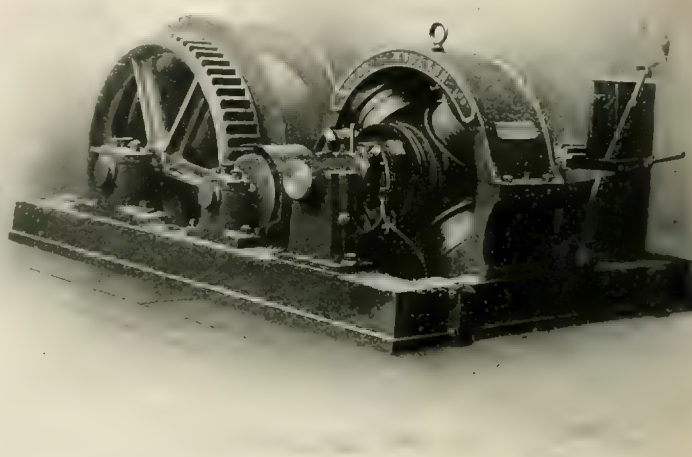


FIG. 9.—MAVOR & COULSON SINGLE HAULAGE GEAR

Among the mining installations equipped by Messrs. J. H. HOLMES & Co., of Newcastle-on-Tyne, are many in which haulage gear is in use; among these we may mention those for Ackton Hall Colliery Co., Featherstone, where four 25 H.P. d.c. motors (100 H.P.) are employed for haulage purposes, the Pelaw Main Collieries, Birtley, eight d.c. motors (240 H.P.) being used for driving haulage plant, and a 90 H.P. motor for an endless rope haulage; the Bradford Colliery Co., where two 65 H.P. d.c. motors are driving endless rope haulage gears, a load of 30 to 40 tons being hauled by each set on gradients of 1 in 5 at a speed of $2\frac{1}{2}$ miles per hour; it is interesting to note that this plant is situated more than 2,000 yds. from the generator supplying the current. As evidence of the large amount of mining machinery equipped for electrical driving, pumping, &c., by this firm, we notice that in one of their recent lists of installations in connection with mining, particulars are given of 182 machines, of a total capacity of 6,892 B.H.P.

Electric Locomotives for Mining.

In this world there is a general tendency, natural no doubt, to take more notice of big things and to disregard things which though just as useful are not so patent to the eye. For instance, if we speak of an electric locomotive the mind of our listener is apt to think instinctively of a main line engine and to forget the humbler mine locomotive. The latter, however, is of great utility, and in what follows we hope to show our readers that a locomotive, and especially an electric locomotive, is a by no means insignificant part of the mining economy.

In mining work the electric locomotive offers special advantages for light shunting operations, especially if the mines be already electrically equipped. The ordinary steam locomotive for such a purpose is an inefficient machine, and great economies in working may often be effected by using electric power for haulage work in this way.

One example of these methods is furnished by Messrs. SIEMENS DYNAMO WORKS, who have lately supplied a locomotive for overground haulage operations. This locomotive, which we illustrate in Fig. 1, is used for transporting coal from a drift at Whittonstall to the Consett Iron Co.'s Colliery at Chopwell, where the coal is transferred to standard railway trucks. The length of the line is 2 miles, and is very undulating in nature, the maximum gradient being 4 per cent. The locomotive draws some 40 tubs, of an aggregate gross weight of about 24 tons, at a speed of from 9 to 14 miles per hour. It is equipped with two 56 H.P. motors, which transmit their power to the axle through gearing. The motors are operated on the usual series parallel system. Continuous current at 500 volts is conveyed to the motors by means of two Siemens bow collectors. The over-head equipment comprises two trolley wires in parallel, each of 80 sq. mm. fig. 8 section. They are supported on steel lattice poles and bracket arms. The rails are earthed and form the return for the current. The trolley wires are fed through duplicate underground feeders from the generating station, which is equipped with a 200 kw. Siemens-Belliss generating set.

FIG. 1.—SIEMENS COLLIERY LOCOMOTIVE AT WHITTONSTALL.

It is not so long ago since we noticed in *The Electrician* the twenty-fifth birthday of the Allgemeine Elektrizitäts Gesellschaft, of whom THE ELECTRICAL COMPANY are the English representatives, and it is only to be expected that such a veteran company should have done much towards increasing the use of electricity in mining. This is, in fact, the case, for not content with dealing with one branch only, this company are manufacturers of all kinds of electrical appliances for colliery work.

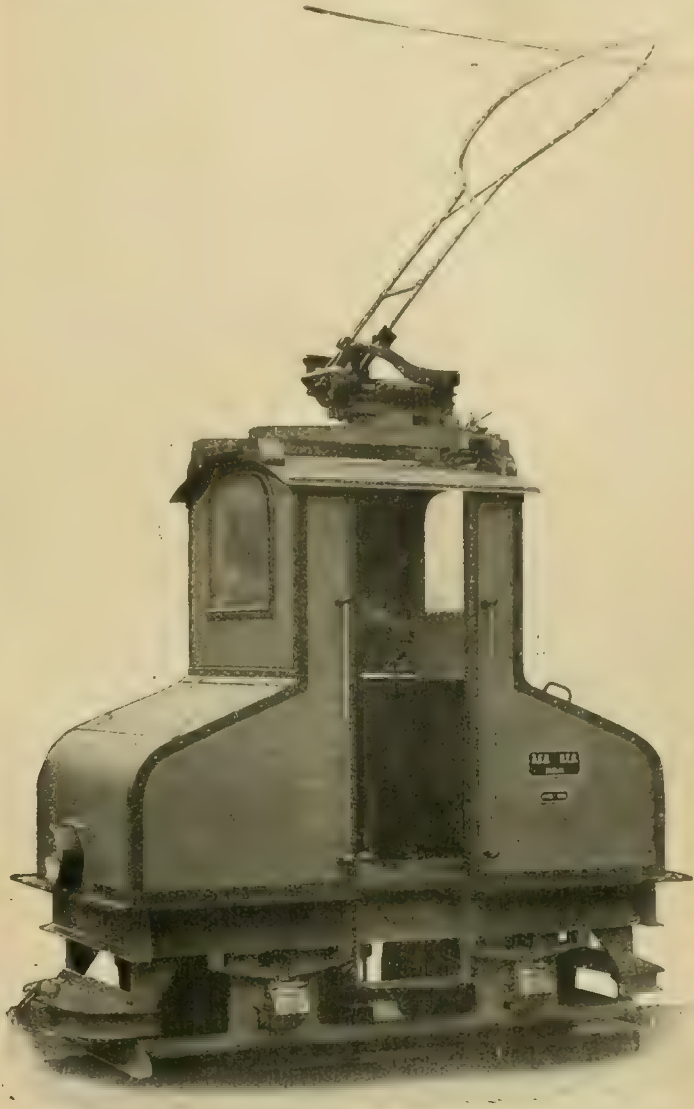


FIG. 2.—ELECTRICAL CO.'S STANDARD NARROW GAUGE LOCOMOTIVE.

In this section we shall deal only with their small electric locomotives, which, though undoubtedly useful, stand out in striking contrast to the mammoth which this company have recently constructed for main line working on the Prussian State Railways.

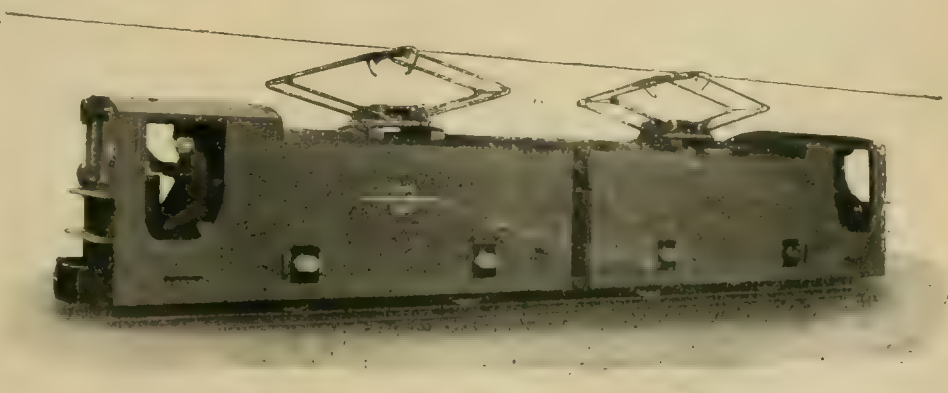


FIG. 3.—ELECTRICAL CO.'S UNDERGROUND LOCOMOTIVE.

Locomotives for colliery work are for the most part of the two-axle type, and are usually equipped with one motor per axle, except in cases where very small loads have to be dealt

with. The motors are naturally fully protected against damp, dirt and dust, are mounted on the frame and drive the axles through suitable gearing. They are so dimensioned according to the gauge used that they and their gearing are wholly contained between the locomotive wheels. Control is effected in the usual way by a tramway-type controller fitted with reversing switch and notches so that the two motors may be worked with both series and parallel connections. The controlling arrangements and motor design are carried out fully in accordance with the best practice and to the well-known rules of the Verband Deutscher Elektrotechniker.

Having described the general features of these locomotives it will now be of interest to give some details of the special types which have been turned out from time to time to suit individual requirements.

Fig. 2 shows the standard narrow gauge locomotive for use above ground and fitted with a bow collector. This is so arranged that it adapts itself automatically to the height of the trolley wire. The gearing may be single or double reduction according to the maximum speed required.

Another A.E.G. locomotive would not disgrace a proper railway. It is of standard gauge and is used at the Gräfluch Henckelschen Bergverwaltung Antoinenhütte for transporting coal from the Kenzel Pit to the station at Kochlowitz. It has a running weight of 35 tons and is capable of drawing a train of 25 empty wagons up a gradient of 1 in 50. It is especially interesting as it forms what is claimed to be the first application of single-phase current for this type of work. A large central station at the Antoinenhütte generates three-phase current at a frequency of 42 and a voltage of 4,600, which is transmitted to a convenient transformer station containing two transformers. From one phase of each of these transformers single-phase current at 4,600 is taken, and is stepped down to the trolley wire voltage of 2,200. Owing to to the small current used, both trolley wire and bow are of reduced dimensions, and the latter is capable of easy reversal from the driver's cab. The trolley wire is doubly insulated and supported by means of a span wire, also insulated with porcelain insulators, between wooden masts.

The above examples are all of locomotives specially designed for surface work, though numerous similar but more compact types are employed underground. In fact, their use has so increased that in the last two years the A.E.G. has supplied no less than 200 of these locomotives.

Fig. 3 shows a small underground locomotive equipped with two small bow collectors which change over automatically when the direction of running is reversed. These particular collectors have been specially designed for sparkless operation, as the locomotive works in a dangerous area.

In certain cases the employment of an accumulator locomotive offers special advantages. For instance, it avoids the use of a trolley wire or third rail, though as regards economy the saving is not so marked. In one case an accumulator locomotive made by the A.E.G. for working on standard gauge has now been in operation for five years, and the running costs have thereby been reduced by 50 per cent.

The design of a locomotive capable of being used in the circumscribed area of a mine, and at the same time possessing sufficient tractive effort to perform its work in an efficient manner, is by no means easy. Up to the present the tramway practice of single reduction gearing has been followed, but the difficulties of making a satisfactory locomotive on these lines is increased by the small gauges usually employed in mining work.

In the accompanying illustration (Fig. 4) we show an electric locomotive designed and built by the BRITISH WESTINGHOUSE ELECTRIC & MFG. Co. on somewhat novel lines. It is intended for a 30 in. gauge mineral railway, and is equipped with one direct current series motor, which drives the axle through double reduction gearing. Both the countershaft and axles are provided with crank discs, and the former drives the latter through coupling rods.

This construction, it is claimed, has the following advantages: Owing to the use of double-reduction gearing, the motor can be run at high speeds, while, as the equipment is on the deck of the locomotive, it is more accessible than is usually the case. The whole of the locomotive is entirely spring-supported, and its centre of gravity being higher than usual improves the riding properties of the machine.

FIG. 4.—BRITISH WESTINGHOUSE LOCOMOTIVE.

The motor can exert 95 H.P., its terminal voltage being 500 volts. The full-load speed is 6 miles per hour and the maximum speed 20 miles per hour, the tractive efforts at these speeds being 5,000 lb. and 6,500 lb. respectively.

As mentioned elsewhere, the conditions of mining in this country do not permit the extensive use of electric locomotives.

FIG. 5. MATHER & PLATT OVERGROUND LOCOMOTIVE.

Notwithstanding this fact, some British firms are sufficiently enterprising to build locomotives, although they must look abroad for any serious market for such plant. Among these firms are Messrs. MATHER & PLATT, of Manchester, who, it will be remembered, supplied the original locomotives for

the City & South London Railway in 1890. They have, therefore, had as much experience as any firm in the design of these machines.

The locomotive which we illustrate in Fig. 5 was supplied for shunting operations in a mine in Sweden. It is fitted with a double collector arch for taking direct current at 300 volts from an overhead conductor, the rails forming the return circuit. There is only one motor fitted which is provided with a double-wound armature, the driving being effected through spur gearing with a speed reduction of 10 to 1.

The above locomotive is intended for overground operations, but this firm also makes a locomotive for work underground. One of these recently built was intended for employment in a tunnel 5½ ft. high by 5¼ ft. wide. The frame

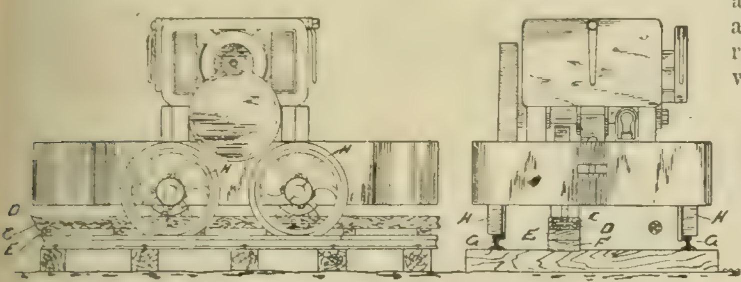


FIG. 6.—GOODMAN COMBINATION RACK LOCOMOTIVE.

is of steel, as are the axles and tyres, the wheel bodies being of cast iron. It is equipped with two totally enclosed direct current motors mounted one on each axle, being partly borne on the axle and partly by springs attached to the underframe; the drive being by a single reduction gear. The current at a pressure of 500 volts is collected from an overhead conductor by an ordinary trolley-arm, the return being through the rails. The locomotive is fitted with a series-parallel controller of the barrel type and electric brake, as well as with a screw hand-brake and the customary lightning arresters and instruments.

Unfortunately for the technical journalist an electric locomotive falls naturally into one or two distinct classes, and whether it be used on a main line or for light mining work, its constructional features only vary in degree, thus making it difficult to avoid sameness in such a description as follows.

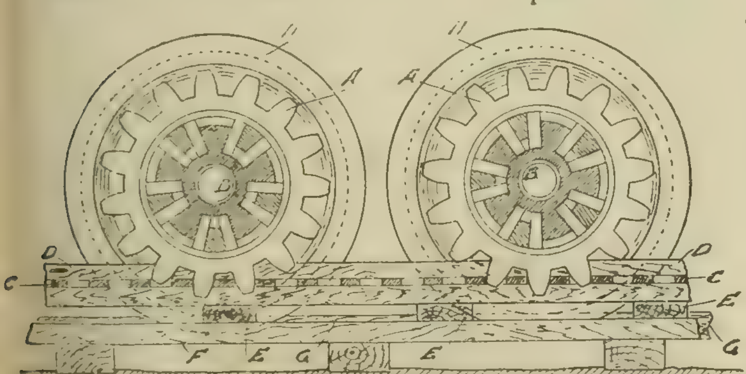


FIG. 7.—SECTION SHOWING GEARING ARRANGEMENT EMPLOYED WITH GOODMAN LOCOMOTIVE.

We are, therefore, indebted to the GOODMAN MANUFACTURING Co., of Cardiff, for inventing a type which possesses some unusual details.

Their system, which like many other things now employed in this country, emanates from the United States, consists essentially of two elements, a stationary third rail and a powerful locomotive working it on a modified rack principle. This, it is claimed, allows light rails to be used, while working on the heavy gradients met with in mines is made much easier. We illustrate a Goodman combination rack locomotive in Fig. 6.

The essential principles of the Goodman arrangement are a live iron rack anchored to the ties between the track rails and so arranged that it is impossible for accidental contact to be made with it, and an electric locomotive equipped with a sprocket wheel which runs in this rack. The gearing arrangement is shown in Fig. 7, while the rack itself may, as indicated above, be used as a third rail or simply for mechanical purposes.

The plain rack-rail locomotive is equipped with a direct current series motor, which is fixed to a four-wheel truck. A sprocket wheel is mounted on each axle, and revolves loosely upon it, the motor armature being connected by gearing to the sprocket wheels. The track wheels are used only for carrying the weight of the locomotive, as no adhesion is necessary, and this is reduced as much as possible, so that very light rails can be used. The sprocket wheel and gear have a certain amount of longitudinal play, being held in a central position by springs. This arrangement compensates for any alteration in the relative position of track rails and rack.

The combination locomotive differs from the type described above, in that their track wheels, as well as sprocket wheels, are driven by the motor. When the rack is used as a "third rail" the rims of the sprockets are insulated from the hub by wood blocks.

The rack, which is shown in Fig. 7, is laid between the

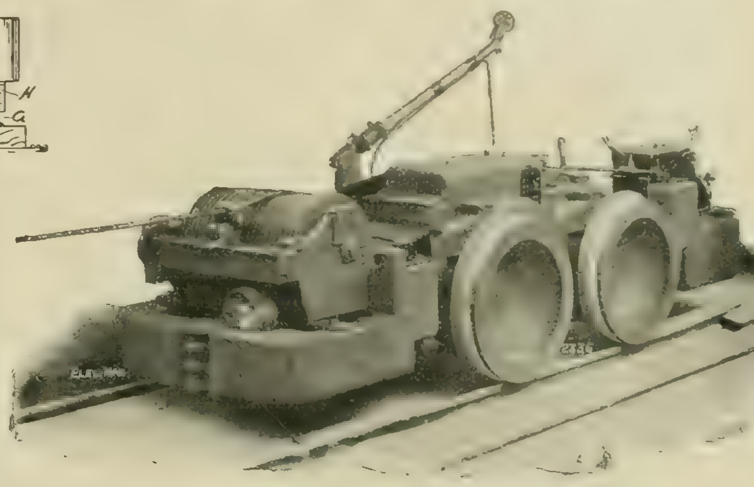


FIG. 8.—GOODMAN "SPIDER" LOCOMOTIVE.

track rails, and consists of bar iron ⅝ in. thick, and varying in width from 4 in. to 4½ in. This is perforated with holes 1⅝ in. square, and is made up into straight pieces 16 ft. long. These lengths are built up into a continuous rail by means of fish-plates, and in a similar manner to that employed in ordinary rail construction. This, of course, needs modification when the rack is used as a third rail; it is then placed on wooden stringers. When the rack is used for haulage only, it is supported on malleable cast-iron chairs clamped to a bottom stringer.

In the case where the combination locomotives are used the rack is only necessary on heavy gradients, and it terminates at each end in an "approach," made up of a heavy steel casting bolted securely to the rack, and so shaped that it forces the sprockets to mesh properly with the latter.

This interesting system is at present in extensive use in the United States, where it offers special advantages on account of the small depth of the mines. The openings to some of these are made in the hill side, and a fairly sharp gradient thence allows the workings to be reached without any winding equipment being necessary. But this system can be used only where there is a trolley wire, which imposes upon it certain limitations, and does not allow it to be brought close up to the workings. This distance has up to the present been bridged by mule haulage, but the Goodman Company have recently put on the market a locomotive, a view of which we give in Fig. 8, which works on the "spider" principle, and runs forward on more or less temporary rails.

This is in general arrangement practically the same as ordinary locomotive, with the addition of a gathering reel, allowing it to work beyond the end of the trolley wire. The locomotive derives its current from a trolley wire through the conductor cable on the automatic reel. The return terminal of the duplex cable is attached to a heavy hook, which can be inserted under the track rails, and takes from the pull of the cable in unwinding from the reel. The other terminal, in the form of a copper hook, hangs loosely on the trolley wire.

When this arrangement is in use the trolley arm is pulled down, while a change-over switch puts the hook into connection with the motor. It can then go forward to the extreme length of the cable on the drum.

The question of accumulator traction is likely in a company of electrical engineers to give rise to as much heated discussion as that of Tariff Reform in a more general assembly. But in spite of its many drawbacks we have lately seen it successfully applied in the streets of London, and in what follows we give some details of its efficient working over a period of three years in a German mine.

On the fourth bottom of the Grillo Mine at Kamen, in Westphalia, is a rope railway which is $\frac{3}{4}$ mile long. From the end of this railway is a cross passage divided into three, through which the coal waggons used to be brought by horses to the railway, but about three years ago an accumulator locomotive, made by the GESELLSCHAFT ELECTROMONTA and the LAHMEYER ELECTRICAL CO. was adopted for this purpose. The number of locomotives has since been raised to three, and for more than two years the whole of this work has been carried on by their means. The installation has given good results, both as regards efficiency and safety in working, and is, therefore, of much interest.

The locomotives, as shown in Fig. 9, are of the two-axle type, and are provided with a driver's platform, which is arranged at one end of the frame. On it are the controller and handbrake. The locomotive can be run in either direction, and the maximum speed is 7 miles an hour. On each end of the frame is a spring buffer block and coupling, and above these is a reflector for lighting the track. There are two motors which drive the axles through gearing having a reduction ratio of 1 to 5·75. They are of the totally enclosed type, and have a normal capacity of 8 H.P. This enables the locomotives in regular work to draw 15 waggons having a tare weight of 7 cwt. loaded with 10 cwt. of coal. The platform of the locomotive is equipped with four drums capable of rotation, which are connected together by chain wheels and chains.

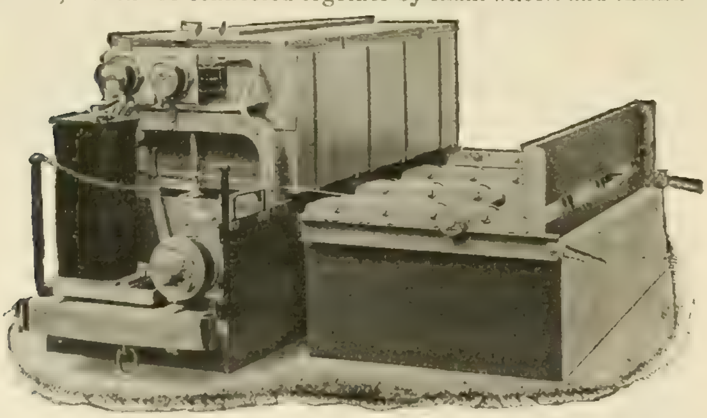


FIG. 9.—LOCOMOTIVE SHOWING BATTERY IN PLACE.

The spindles of these drums lie in an open bearing, which allows them to be lifted out without any difficulty. This arrangement permits of free inspection of the brakes, motors and gearing. Any alterations to these parts can, therefore, be made in quite a short time, and there is no need for running pits.

On the drums is placed a wooden box, strongly bound with iron, to contain the accumulator batteries, and this can, by means of the rollers, be easily drawn off the locomotive. Adjacent to the track is a charging table, arranged as shown in Fig. 9, and it is equipped with the same drum arrangements as on the platform of the locomotive. If the chain on the locomotive is placed round the chain wheel on the foremost drum of the charging table and the hand-wheel turned round, the battery is drawn off the locomotive and on to the charging table. In the same way a second battery, which is placed on a second charging table, can be easily drawn off the locomotive, and the first one can then be recharged. In some cases the charging tables are placed on one side of the track only, and there must then be one more of them than there are locomotives. With this arrangement when the battery is removed from the locomotive, the latter has to be moved along to the next table before a charged battery can be placed on it. Such a change can be made by the driver alone in one or two minutes. Another arrangement is to place charging tables on both sides of the track, and these can be so fitted that as the discharged battery is drawn off the charged battery is drawn on. The chain on the locomotive has in this case to be placed over the chain wheels on both charging tables.

In order that the battery may not slide off the locomotive during working it is held fast by two strong cross-bars, which fit into rings and between which the battery is fixed. These cross-bars are provided with springs which move in slots and can be released by a lever when it is necessary for the battery to be removed. A socket provided with a fuse is also fitted into which a plug connected to a flexible cable can be placed and thus connected it to the controller. For charging the battery similar sockets and plugs are used, which connect the battery through a flexible cable to the charging switchboard. This board is provided with a switch, an ammeter and a series resistance, while a portable voltmeter allows the condition of the battery to be tested.

The charging current, which formerly used to be taken off the lighting circuit, is now obtained from a motor generator connected to the three-phase network, the voltage at the switchboard terminals being about 210. The regulation of the charging current is effected automatically by a special series resistance, the driver having only to connect the battery to the board. The charging is finished when the meter reading becomes a minimum. The driver can then switch the battery out. If he forgets to do this there is, of course, a small loss of current, which cannot harm the battery, for it will be required for another locomotive before too long a time has elapsed. The charging of the battery takes from two to three hours, and this gives quite sufficient time for one battery to be charged while the other is in use. The capacity of each cell is about 30 ampere-hours at a one hour discharge rate, and there are 80 cells of this size in one battery. The weight of the locomotive frame is so designed that with that of the battery the total weight is just what is necessary for adhesion. The weight of a complete accumulator battery is $1\frac{3}{4}$ tons, the weight of the locomotive slightly more, the total weight being $2\frac{3}{4}$ tons. In the battery 16 cells are built up into one box, which is acid proof. Five such boxes are placed in a large case and make up the battery. The connections between the separate boxes are made by easily removable plug contacts, which are also protected against the acid. This allows the quarterly inspection of the boxes to be carried out without any soldering or lead burning having to be cut. Each cell consists of a vulcanite case with one positive and two negative plates, the latter being connected to the plates in the next cell by strong lead strips.

The locomotives can be run five miles with 15 wagons on one charge. The batteries are generally changed over every $3\frac{1}{2}$ miles, and it is arranged that no battery shall run more than $3\frac{3}{4}$ miles on one charge. It is possible for a locomotive of this type to run 88 ton miles in an eight hour shift; in fact, not enough coal is drawn to give the locomotive enough work, about 56 ton miles being the average amount performed.

The mining conditions existing in this country, unlike those in the United States, do not usually allow the products to be brought to the surface by simple haulage alone. It is, perhaps, for this reason that the use of the electric locomotive has not been so extended as it might otherwise have been, though we are pleased to see that British manufacturers have found it worth their while to do something in this direction.

Among these are Messrs. HEENAN & FROUDE, of Worcester, who have recently built a very neat accumulator locomotive. It was not, it is true, intended for mining work, but is being used in a Government dockyard. It is adapted for a gauge of 1 metre and is equipped with two 6 H.P. motors.

Messrs. Heenan & Froude have also supplied to the Electrical Construction Co., of Wolverhampton, a locomotive which is specially suitable for both surface and underground work. It is adapted to a 2 ft. track and is equipped with E.C.C. motors. In addition to these there is, of course, the necessary controlling gear and brakes, together with headlight and sanding apparatus. This locomotive can be operated from either end, sitting room being provided for the driver.

Electrical Coal-Cutting Machines

BY F. W. HURD.

(Patentee of the Hurd, or "Pickquick," Coal Cutter.)

Although during the past few years the adoption of coal-cutting machines has made rapid progress there is still a great field open, as not more than 10 per cent. of the yearly output of coal in Great Britain is as yet machine cut.

Generally speaking, if the coal can be mined and filled tor 2s. to 3s. per ton, few colliery managers care to adopt machines. The seams which can be worked at this price are, however, being gradually worked out, and the introduction of coal-cutting machines to work the more costly seams is becoming an absolute necessity.

The usual reason given for the introduction of machines is that the holing is too difficult to be done by hand. It has, however, been proved over and over again that a great number of seams which are easily and cheaply worked by hand can be worked a good deal more cheaply by machines. The writer is of opinion that even in seams worked at the low prices above mentioned a saving of 6d. to 1s. a ton can easily be effected by the use of machines; and in several cases which have come under his personal observation this has actually been accomplished.

Apart from the question of cheapness of working, there is the fact that almost without exception much less "small" is made with the machine as compared with hand got coal, and the difference in the value of the product would in many cases give an advantage to the machine even if the actual costs per ton of coal won were greater than by hand.

Another point is the presence in many seams of bands or streaks of inferior coal. The machine can be adapted to hole in these bands, completely destroying them and leaving the clean coal intact, thus saving a great deal of expense in picking and washing the coal and, further, preventing many vexatious disputes between master and men as to the quantity of "dirt" filled along with the coal.

Many machines are introduced to hole in the pavement below the coal, and in most cases where this is done it will be found that when hand holed the miners worked in the coal itself, and apart from the cost of cutting there is an extra yield of round coal of from 10 to 25 per cent. The working places are higher by the thickness of the machine cut and this extra height would in some cases allow of the coal hutches being run along the face instead of only to the road heads.

There are other incidental savings effected by machines, such as concentration of the output to a comparatively small section of the mine. It may be taken for granted that from the same length of face treble the output can be obtained, with a consequent reduction in the cost of roadways, haulage and general supervision. In the majority of cases the quantity of explosives required to bring down the coal is reduced, and the more systematic timbering and consequent greater safety of the working places must also count in. Altogether it must be, or should be, admitted by mining engineers that given the total cost of the machine at the face is equivalent to the same work done by hand, there must still remain a considerable margin in the total costs in favour of the machine, and any actual saving at the face can only represent a certain percentage of the total reduction in costs. Any seam which can be worked long-wall by hand, in faces of 40 yards length and upwards can be worked much more profitably by machines.

Considering the great variety of coal seams to be operated upon, the different reasons for the adoption of the machine and the various positions in the seams in which it may be desirable to cut, the question of the type of coal cutter to adopt is one of great importance, and particularly so to the large colliery concerns working a great number of different seams, which are so variable that a machine bought for one particular set of conditions may be of no use whatever under other conditions. That machine which will meet the greatest variety of conditions must be considered the most practicable and serviceable one.

The writer's patent bar type machine is undoubtedly the machine which best meets the great variety of conditions in practice. With it the cut can be made in any position and at either side of the machine. It is contended by some people (not disinterested) that the bar machine does not do so well in a hard holing as a disc machine; the contention is completely wrong. In numerous cases where both types have been tried on the same face the bar has done equally as well as, and in some cases much better than, the disc machine, and this with invariably less power. From the mechanical point of view, also, the bar must be considered as the best cutting instrument available, as there are no parts subjected to the friction of the debris made by the cutters; there are no inaccessible bearings below the coal, while the arrangement of the gearing allows of complete protection from dirt by strong substantial casings forming part of the machine. The whole of the gear runs in oil and ample oil supply is provided at the main bearings.

With the disc machine it is well known that the expensive gunmetal quadrant used to keep the circular rack on the disc into gear with its driving pinion lasts only for a few shifts, and at the best requires very frequent renewal. The gearing of the bar machine is of mild steel, machine cut and case hardened, and, being enclosed, is immensely superior to the cast steel gearings used on the disc machines and open to all the dust and grit inseparable from the work performed.

Again, the bar can be adjusted to cut exactly where it is required as against the disc being allowed to cut generally where it will, and, as previously stated, for the work done much less power is used by the bar type machine; consequently less expensive generating plant, cables, &c., are required for the same output of coal, and where the power is purchased from a central supply station, this difference would cover the cost of the machine in a few months. The difference in power is, of course, due to the superior mechanical design of the gearing and to the total absence of friction in the holing.

There is another point in connection with machine cutting which is often overlooked—the taking out of the cut the debris made by the machine. When holing in coal, and in a seam with a good natural parting from the roof, it is not of great consequence, but where the coal sticks to the roof and when holing in inferior coals or fireclays, the matter is of importance, as on an ordinary machine face at least two men are required to clear out this debris and leave the coal ready for dropping or blowing by the miners. With a bar machine the bulk of the cuttings are brought from below the coal, and, where it is necessary, about 90 per cent. of the cuttings can be brought out to the front of the holing ready for casting into the waste. The one or two men's work raking the debris from the back of the holing is thus done away with. Nothing like these results are attainable with any other type of machine.

Coal-cutter makers are indebted to the Americans for the introduction of skids to the machine in place of the ordinary double-flanged wheels which ran on rails specially laid for the machine. With this system the machine is mounted on two long angle-iron skates or skids, side fenders are also fitted to keep the machine from getting too close to the face on one side or too far out from the face on the other. This innovation is one of great importance, and has done away with the most laborious part of machine cutting; the machine men now have certainly a much easier task than in the old rail-laying days. Extra work has, however, been put on the coal-cutter motor, and its chances of being overloaded considerably increased as any carelessly put in guide prop may cause jamming of the machine between the outside guide props and the coal face.

With the many advantages admittedly to be gained by the use of machines, it is strange there should be any failures in the introduction of them. During the old days of the pioneer electrical coal-cutters in perhaps the majority of cases the machines were to blame, being too weak in vital parts, and the electric motors giving considerable trouble. Now, however,

there are several machines on the market which may be relied upon to stand up to their work and do it well, yet in spite of this there are still some failures of machines to come up to expectations, and nowadays these failures are, I think, mainly traceable to the want of proper preparation and regulation at the machine face. The machine should have a reasonably good chance of doing its work, and absolutely the first and foremost essential to good machine cutting is a straight face to begin on; yet we see machines set to work on faces more crooked than the proverbial "dog's hind leg." More troubles, annoyances and mistakes occur with one machine set to work on a crooked face than with a dozen machines starting on straight faces. No machine can possibly do justice to itself on a crooked face, yet one finds times without number machines sent down the pit to work on faces as they have been left by the miner without any attempt being made to straighten them. The correct face is perfectly straight, or is left so that there is a straight fairway from one end to the other. When preparing a face the outer guide prop can and should be set to a line, so that with the first cut across the back of the holing will be parallel with the guide props and with the following cut a full depth holing will be made. Each end of the face must be cut or holed for the machine to run clear. This is another item of great importance, as should the end place of the face not be kept well forward, the face will very soon get out of line and the machine will be working under difficulties at the beginning and the end of each cut, cutting round the corners which are developed. If machine makers are to be held responsible for the performance of any machine supplied, they should most decidedly decline to start any machine to work on a face which is not made straight to begin on.

Motors.—The motor of an electrical coal-cutter must be very well built. The vibration is at times excessive, and the standard sizes of shaft and spider of an ordinary motor are not nearly strong enough for coal-cutter work. The armature shaft must be of extra diameter, the field coils must be specially insulated and clamped firmly to the magnets. In the bar machine the motor shell is the main frame of the machine, and is therefore superior to those machines in which the motor is bolted to a frame.

All connections between motor and switch and the cross-connections between the field coils should be inside the framing of the machine and all leads must be specially protected by rubber tubing or tape and whipcord.

The starting switch must be of strong and substantial design, totally enclosed in gas or flame-tight casing. A new design of starting switch with resistance coils of manganin wire and a drum type double-pole switch has given excellent results, the fewness of its parts and its complete accessibility to all parts whenever the cover is removed being special features.

Wherever possible the machine frame should be earthed, and the concentric (uninsulated return) system is by far the best and safest to adopt both for machine and attendants.

Now that three-phase alternating plant is coming into vogue many coal-cutting machines have been made to suit this system, and in the writer's experiences the three-phase motor-driven coal-cutter is the best possible one. With direct current, most of the motor trouble originates at the brushes, and usually from dirt, and by doing away with the brushes as is done with the ordinary squirrel cage three phase motor an undoubted advantage is gained. The three-phase system will certainly be greatly extended. Up to 18 B.H.P. the motor can be switched direct into circuit without use of resistance. The operation may be a little severe on the generating plant, if not of ample size but the overload is only momentary with the bar machine, which is very easily started.

One cannot write on coal cutting machines without referring to the use of compressed air. Thirty years ago many successful coal cutters were at work driven by compressed air, and most of the electrical machines are simply the old compressed air machine gearing reproportioned for drive by an electric motor in place of the compressed air engine. In Lancashire and in South Wales, where the mines are considered very fiery, the compressed air machines are still in use, and will always be serious rivals to the electrical coal-cutter wherever the putting of machines into fiery mines is being considered. Compressed air has many points in its favour, and a number of bar type machines have been made for its advocates. The machine is a very simple one, the engine being enclosed and taking the same position on the machine as the motor on the electrical machine, while, owing to its working with considerably less power than the disc machine, there is considerable economy possible in the size of the compressor and piping.

Some Well-known Coal Cutters.

There are probably few subjects on which opinions differ so much as that of coal-cutters. This, no doubt, is due partly to the varying types that have been produced and to the difficult conditions under which they must work. Also from the point of view of the colliery manager the subject is not one that is straightforward. To the engineer who is cognisant of the working conditions and of the limitations of electrical plant, the features that must be embodied to ensure success will be recognised much more easily than by the mining engineer unacquainted with electrical machinery. In the preceding article Mr. F. W. Hurd deals with some of these essential features; in what follows we do not propose to discuss such questions further, but we give an account of some of the well-known forms of coal-cutter now on the market.

The evolution of the coal cutting machine, like the building of Rome, did not take place in a day, but it has now reached such a stage that a demand for the better class of machinery is assured. At least this has been the experience of Messrs. A. Hirst & Son, of Dewsbury, who have developed and perfected a machine known as the "Crescent," which they are confident will be capable of doing the work imposed upon it, and, more important still, at a less cost for maintenance than has hitherto been possible.

They make cutters of both the disc and chain type, which are designed with the following objects in view. Complete enclosure of, and protection to, all vital parts, while at the same time having all parts easy of access. These advantages are combined with strength, where it is required, and with such reduction in weight as is consistent with the efficient working of the machine. Further, the machines are reversible, and are lubricated in such a way that the working parts have a maximum life. The machines can also be divided into sections for easy transportation about the mine, while in operation their manipulation is very simple.

We illustrate one type of disc coal-cutting machine made by this firm in Fig. 1, which gives a good idea of its general proportions. It is of the sledge type and can be made to cut at any height above the floor level, and also as an over-cut machine. Its length is 8 ft. 6 in., width 3 ft. 8 in., and height 1 ft. 10 in., when cutting on floor level. The motor for such a machine is of the four pole-series type with drum armature, and is built up in the form of a box, shown in the illustration, fitted with loose top and end covers, the armature shaft being, however, carried on a pedestal quite independently of the end cover. Messrs. Hirst also keep their fundamental objects, enumerated above, in view in designing the gearing, motor starter and haulage gear.

The design of the machine itself is very simple, and being built in box form conduces to strength with a minimum of weight. This method, it is claimed, also gives more stability to the machine than if it were mounted on side frames, while the shafts are not strained or bent by the load. Each of the three sections is complete in itself, and any one of them can easily be detached from the others, even at the coal face. The ends of each section are planed, and the sections are fitted together with turned bolts in reamered holes, ensuring perfect alignment of all parts.

The direction of rotation can be reversed by reversing the motor, the hauling rope being taken up over guide pulleys at the top of the machine. The tenders which keep the machine

in position on the coal face fit either end of the machine and are easily reversed. The starter and haulage-feed motion have controlling handles or wheels at both ends of the machine. The feed motion has an arrangement for varying the speed of traverse along the coal face; this has a range from six cogs down to nothing of the racking gear, and can be adjusted when the machine is working by simply turning a small handle.

The cutter wheel is in two parts, with tongued and grooved joints; these parts are securely bolted together with turned bolts in reamered holes. The cutters are alike in form, and are fixed in a patent cutter holder, which is attached to the rim of the wheel in a simple manner and held in position by a strong pin.

action may be likened to that of the humbler mowing machine, and is capable of doing its work automatically without it being necessary for a man to guide the direction of the blows. Its construction is simple as it consists essentially of a stationary frame, which can be fixed to the floor by jacks, and on whose upper surface are slides in which a motor may be fixed. Sprockets at the side allow the motor to be moved in a longitudinal direction along the frame, and a certain effective area is thus obtained without it being necessary to shift the frame. The operating part of this machine—*i.e.*, the chain—is attached to a travelling frame, on the outside of which it runs, and which is itself attached to the motor. The cutters are fixed at different angles on the chain in such a manner that the lowest just clears the floor, while the highest

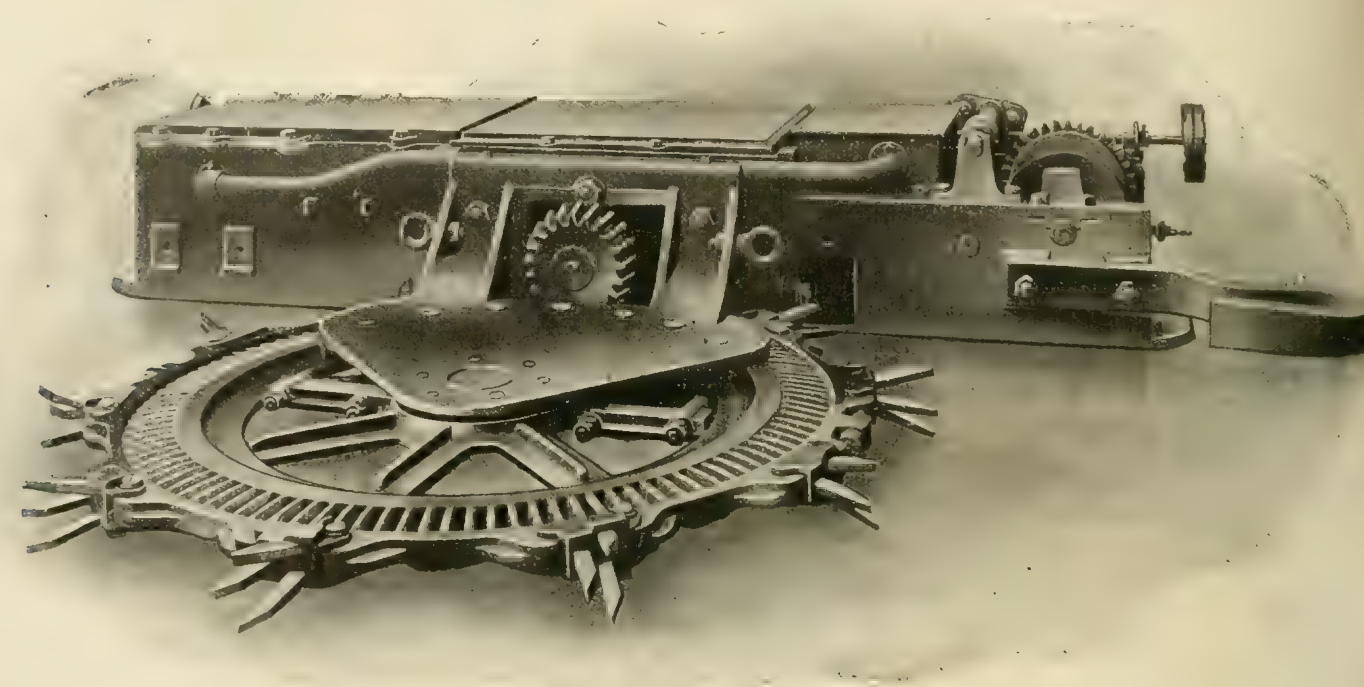


Fig. 1. A Crescent Disc Coal Cutter. (A. Hirst & Son.)

In the design of these machines strict attention has been paid to the requirements of the new mining rules. All current-carrying parts are efficiently protected and insulated. The starting switch is double pole, and the cables which run from it to the motor are drawn through a pipe bolted on to the switch and motor boxes, and this pipe has substantial insulating bushes at each end. A two-pin connecting plug to attach the trailer cable is fitted, and this is interlocked, so that when the current is switched on the plug cannot be withdrawn.

This firm also manufacture a chain-type machine which possesses several advantages over the disc type. These are set out in full elsewhere. The chain is fitted with patent cutter holders in alternate links; the intermediate connecting links are special steel stampings, which give a large wearing surface to the pins. Each holder carries two cutters, which are all alike and easily replaceable when dull. The gearing is all machine cut from solid steel blanks and runs in oil; a simple single-valve pump ensuring a plentiful supply of lubricant to all bearings. The machine is, in general, constructed in a similar manner to that described above.

The Goodman Manufacturing Co., of Cardiff, were among the pioneers in the electrical coal cutting field, their machine, one of the earlier of the pick type, gaining a gold medal and high honours at the Paris Exhibition of 1889. Since that time much water has flowed under the bridges, and the "Goodman" coal cutter has not only drifted with the stream, but forged ahead on its account.

The Goodman machine is of the chain breast type, whose

runs about 4 in. above this point. This arrangement enables a kerf of sufficient width to be cut in the coal for the frame to enter after the cutter. The changing of the cutters can be very easily effected, as it only involves the loosening of a few set screws.

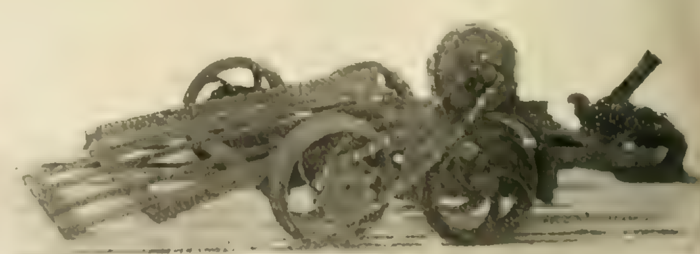


Fig. 2. Standard Truck for Goodman Chain Breast Machine.

The train of gearing which is driven by the motors performs two operations. It drives the cutter chain round the movable frame and at the same time moves this frame forward into the cut. A cutter of this type will make a kerf about 4 in. high and equal in width to that of the cutter head, while its depth may reach 7 ft., depending on the length of the machine. When it has reached its full extension the feed forward is automatically stopped, and the machine can then be withdrawn by reversing the motor and is ready for another

cut. The current taken by an equipment such as this is 25 amperes on full load if the machine is in good condition and clean, about 10 amperes of this being required for moving round the machine on no load, the voltage being 220.

The fact that the weight of the motor and gearing, when the cutting equipment is drawn back is taken up by rollers greatly decreases the labour of moving the machine to a new cut, and thus makes for greater ease in working.

The stability of a machine of this description is, of course, all important, and the Goodman Co. provide for this by employing jacks as mentioned above. Further, the rear jack is so arranged that when set against the roof it automatically locks the roller. This practically makes the whole system one rigid body, and it is claimed that the machine is as stable under these conditions as if the frame were made of solid castings. Another advantage is that the rear jack can be removed from its socket, but, if not so removed, will remain inclined to the vertical, and there is no chance of it falling upon or damaging the motor or cutting equipment.

The arrangement of the travelling frame allows, by adjustment of the supporting shoe in front, the cut to be made at varying heights above the floor. This is not possible where the movable frame slides between two fixed ones, and permits slaty bottom coal to be disregarded if need be. It also ensures that a perfectly level bottom is cut, and leaves no coal for the loaders to take up.

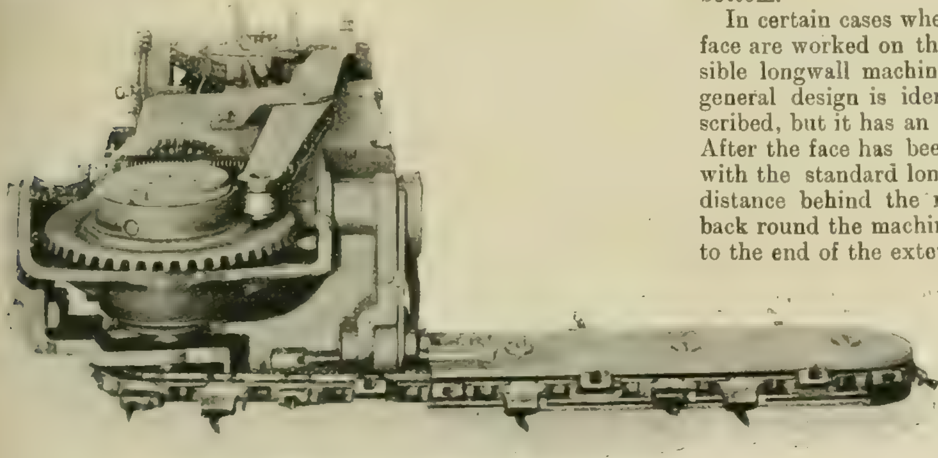


Fig. 3.—Goodman Standard Longwall Machine.

A special feature of this machine is that a compound-wound motor is used, thus permitting an automatic speed regulation and allowing hard work to be done with a minimum expenditure of power. Accessibility is a point that is well recognised, the commutator being easily got at, while the armature may be quickly withdrawn by removing a few bolts without disturbing the pole-pieces or field coils. The main motor switch and starter are combined into one case, the contacts being brought into the field of a magnetic blow out, so that all arcing or burning is avoided.

Gearing is reduced to a minimum, while the frame is strong and compact and at the same time light. This allows a heavy type of chain to be used, and the Goodman Company claim that no heavier is at present being employed on mechanically operated coal cutters.

An essential part of every Goodman machine is the truck on which the cutter is moved about the mine. It is manufactured in two types, one of which is "man-driven," while in the other the cutter motor is connected to the road wheels by chain gearing. We illustrate one of the latter type in Fig. 2. By means of a suitable drum with ratchet and chain, which is placed at one end of the truck, the cutter can be loaded or unloaded in the least possible time. The "power" truck offers special advantages where the gradients are heavy, while the additional time required for connecting up the motor is practically negligible.

The Goodman Manufacturing Co. also make a longwall machine, which, owing to the fact that it has also to mine the fire clay underlying the coal, must be of a more than usually powerful type. A cutter built on this plan is illustrated in Fig. 3, and consists of a steel frame about 7 ft. long and 32 in. wide. This frame is finished smooth on the long side, which slides along the coal face, and is supported by steel shoes. The motor for driving this cutter is mounted on the frame with its shaft longitudinally, and is geared at one end to a sprocket driving the cutter chain round a steel cutter arm which is at right angles to the frame. These arms are supplied in three lengths—viz., 33 in., 44 in. and 50 in.—and can be tilted up or down from the horizontal position to enable any specially hard substance to be over or undercut.

The machine is kept in position against the coal face in an exceedingly ingenious fashion. It is, at the beginning of the cut, forced under the coal by a small jack, and retained there by the friction of small pieces of clay or coal. At the same time a wire rope from a drum on the cutter frame is led round a sheave some distance away, so that by winding in the rope by means of the motor the cutter can be moved along the coal face. It, therefore, requires no rail or other contrivance to keep it against the face, while its narrowness also offers special advantages when the props are close up. Great stress is laid on strength of frame, powerful motor and durability of the cutter arm in this machine, which can perform an average of 500 linear ft. undercut per shift, though this amount, of course, varies with the character of the coal and bottom.

In certain cases where parallel headings of 200 ft. to 400 ft. face are worked on the block system, the "Goodman" reversible longwall machine has been exceedingly successful. Its general design is identical with that of the cutter just described, but it has an extended frame at the cutter-arm end. After the face has been undercut and the coal loaded out, as with the standard longwall machine, the jack is set a suitable distance behind the machine, and the feeding cable carried back round the machine through the jack sheave and fastened to the end of the extended frame. Rollers at the back of the machine and on the extended frame, as shown in the illustration, protect the cable from wear. Reversing the motor feeds the machine back across the face, making an undercut in the opposite direction, the extended frame serving to hold the machine close to the face. The machine truck is only used when it is necessary to move the machine to another section of the mine.

The "Hurd" coal cutter manufactured by Messrs. Hurd, McKendrick & Co., of Motherwell, N.B., has been on the market since 1898, and the general features of its construction are pretty well known. A new design (Fig. 4) was brought out last year embodying several new features, which, the makers claim, will, in the thin seams now being worked, give

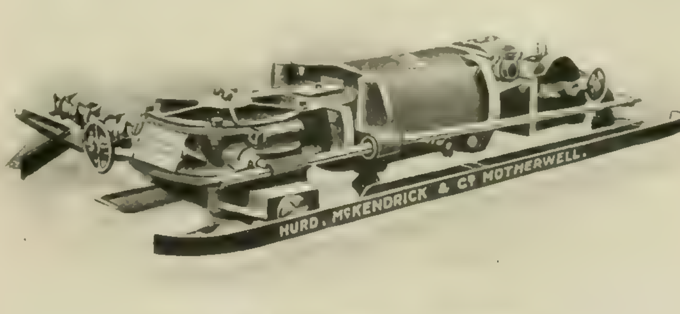


Fig. 4.—16 b.h.p. Hurd Coal Cutter.

better results than any other machine on the market.

We will briefly refer to these new features. As regards the cutterbar, in addition to the conveyor thread formed on the body of the bar for bringing the cuttings out of the holing, the new bar has a short secondary thread fixed immediately in front of the main bearing, as shown in Fig. 5. This thread

works in a shield, corresponding with the packing box of the old design, and as it rotates it presses the debris brought out by the conveyor thread away from the main bearing, protecting it entirely from dirt, and so preventing undue heating. The cutterbar packing gland is done away with, and the constant attention to cleaning and lubrication hitherto required at this part of the machine is eliminated. The cleaner blade behind the cutterbar can be broadened, and a larger percentage of the cuttings brought out of the holing, leaving a clear space for the coal to drop, while continuous shovelling to keep the bearing clear from dirt is now not necessary. The rear end of the machine is mounted on two screwed columns jointed to the skids. Means are provided for raising and lowering the machine upon each of these columns through side shafts workable from both ends of the machine, and the cutterbar is readily tilted or adjusted in level sufficiently for all practical purposes in a simple and effective manner. The new adjustment is free from backlash, and the operating hand wheels or ratchet spanners on the side shafts are in the most accessible and the safest positions.

The machine cuts right down on the pavement. A rearrangement of the gear case enables the cutterbar to be set on a lower plane than heretofore, and, by the improved facilities

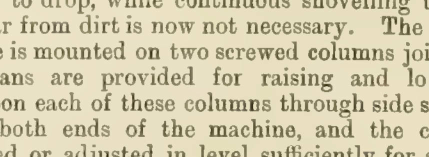


Fig. 5.—Hurd Cutter Bar, showing the two Threads.

provided for its adjustment, the cutterbar is more easily kept on the pavement level, while the absence of any backlash in the adjusting gear does away with the unevenness of pavement which was possible with the original design.

The makers recommend three-phase motors, in preference to continuous current, as being less liable on a coal cutter to get out of order. The direct current machine of 16 h.p. size works in a 17 in. seam, whilst the three-phase machine works in a 20 in. seam.

The coal-cutting machines now in use for "longwall" working are of three types—viz., disc, bar and chain—there being naturally supporters of each class.

Messrs. Austin Hopkinson, of Guide Bridge, however, believe in the use of the last of these, and consider that both of the former types possess certain inherent disadvantages which no amount of care in design and construction can overcome. Any improvement in the disc machine is not to be expected, and as it at present exists its many defects compensate for the advantages accruing by the use of mechanical coal cutters.

The reasons for this state of affairs are: The disc is heavy and bulky, so that, besides being difficult to move and fix, its use in such a circumscribed area as a mine is not to be recommended. Its weight also makes it necessary that the machine body should be of substantial construction. If the coal is "tender" the disc may get wedged, with the result, in too many cases, that the armature burns out. It does not clear the cut from debris, and loose pieces are carried round, thus putting extra work on the motor. If the floor is unlevel the disc may get locked, while its actual action in cutting leads to the production of a great deal of dust, and it negotiates with difficulty such obstacles as lumps of pyrites.

It will thus be seen that a very strong case has been made out against this type of machine, and practical experience so far justified it that the bar machine was introduced to surmount the wedging difficulty. While, however, it avoids this disadvantage it introduces several others on its own account. Among these may be mentioned the disastrous results which arise should one of the cutting tools be broken. A portion of the bar has then no cutting edge, and soon comes up against a part of the material being holed. The bar is even less efficient than the disc in clearing out debris from the cut, and is apt to become dangerously hot in churning up loose pieces, so that its adoption has not been a success, except in seams of the softest possible description.

Messrs. Hopkinson, therefore, have no diffidence in recommending the use of the chain machine which, it is claimed, is free from the disadvantages enumerated above. It is also specially adapted for the electric drive and can be used on either direct or alternating current. The jib on which the chain is carried is sufficiently narrow to allow the coal to be spragged up within 18 in. of the cut and at the same time sufficiently flexible to accommodate itself to irregularities due to varying gradients on the face road. The jib and chain of such a machine can, it is claimed, easily be removed from the framing and carried by two men. The movement of this equipment, therefore, presents no great difficulties. The action of this machine, which is "picking" instead of "grinding," also makes for greater efficiency, and besides being more economical is very effective in bringing all debris into the road, thus avoiding the employment of a special man for this purpose as is necessary when the other two types are used.

Although chain machines are, in general, best, some types are, of course, better than others. And Messrs. Hopkinson claim that the chain used on their machine, which is manufactured by Messrs. Hans Renold, of Manchester, is stronger, and more suitable to the conditions in English mines than any other used. American machines especially suffer under the disadvantage of a weak chain, and are quite unfitted for holing the hard dirt found in English mines. This chain has its wearing surfaces case hardened, and every part is of specially selected material. The cutting tools are all of the same shape, are small and easily forged. They are held in a Hopkinson patent cutter box and can be changed in a few minutes. This gives them a great pull over the bar machine, in which the tools are both dearer and less easily changed.

Though the machine is so compact and its weight is reduced to a minimum, this lightness has not been obtained at the cost of weakness in the mechanical or electric parts, steel and bronze being used for all portions under stress. The jib can be instantaneously detached from the machine and slewed through 180 deg. It can thus cut its way into the coal from the start, and avoids the necessity for cutting a "stable," such as is required with a disc. Perhaps the greatest advantage of this machine is that anyone can work it, two men in most cases being amply sufficient to run the cutter, laying their own rails and setting their own timber, in which respect it is said to be unique.

If continuous current is available, a series motor developing 27 b.h.p. on continuous open rating is required for such a machine, while, if three phase is used, the continuous open rating of the motor would be approximately 28 b.h.p. In the latter case, also, squirrel-cage or wound rotors may be used, according to circumstances. The over-all dimensions of such a machine are: Length, 6 ft. 6 in.; width, 24 in.; height, 22 in.; weight, 25 cwt., and maximum under-cut, 5 ft. 6 in.

The coal cutters made by the Hardy Patent Pick Co., of Sheffield, are essentially different from those that have, so far, been described. This is brought out in the name of the machines, for they are known as the "Little Hardy" coal cutters, and are, indeed, more of the nature of drills than cutters. It is sad to relate that they do not, so far, appear to have been adapted to the electric drive, compressed air being employed instead.

The "Little Hardy" coal cutter consists essentially of a patent reciprocating air drill, whose most striking feature is the valve. This is automatically locked in position by the full air pressure, and thus fluttering and chattering is avoided. By this arrangement 650 to 700 blows per minute can be struck, using air at 60 lb. pressure, while at the reduced pressure of 45 lb. the blows decrease to about 500 per minute. The care that has been expended in the design of this equipment has been well spent, for very few repairs are required. The cutter can be moved round the central column by the worm handle, and is fed up into the coal by a special

screw at the rear end of the machine. The size of this machine and its lightness make it exceptionally valuable for the circumscribed spaces met with in mining work.

Another type of cutter made by this firm is known as the "Hardy Puncher." This, though no heavier, has greater power at low pressures than has the "Little Hardy" described above. This is obtained by the use of a new patent distributing valve, which enables a machine of large cylinder diameter and long stroke to be obtained without increasing the weight or general overall dimensions. The makers are confident that this is the machine of the future for long wall work, especially for thin, inclined or faulty seams. It will cut up to 20 ft. wide from one setting, the cutting speed being from 60 to 100 sq. ft. per hour.

Messrs. ANDERSON, BOYES & Co., of Motherwell, have the advantage of being in the very midst of the Scottish coal fields, and are thus able to gauge the requirements of mine owners in that district with great accuracy. They claim that the greater proportion of machines working in Scottish coal fields are of the Anderson-Boyes type. Again we are face to face with the disc and chain type, the former being subdivided into rail and skid, the difference between these being that the first is adapted for running on rails, while the latter slides along the floor.

The standard skid machine of the disc type is designed for heavy, continuous cutting in hard underclays. This machine makes its own floor, and, with the standard size of cutting wheel, holes to a depth of 3 ft. 6 in., the height of the cut being $3\frac{3}{4}$ in. The total height of this machine is $18\frac{1}{2}$ in. and it weighs about $2\frac{1}{4}$ tons. All machines made by Messrs. Anderson, Boyes & Co. are supplied with either continuous or alternating motors.

The Anderson Boyes chain machine is shown in Fig. 6. Its use is recommended in places where an easy coal holing or soft fireclay has to be dealt with. It is not claimed to be so well suited for cutting in hard material as the disc type, nor yet for cutting to depths greater than 4 ft. 6 in., but where the circumstances are favourable, it will do more rapid work than any other class of machine and requires less labour. In friable coal the narrow width of the chain jib allows the coal to be spragged close up to the cut. The machine cuts its own floor and does not require a stable to be made for it. This machine has a total height of $16\frac{1}{2}$ in. if a continuous current motor is used, or $20\frac{1}{2}$ in. should alternating current be available. Its overall length is 8 ft. $8\frac{1}{2}$ in., its width 2 ft. 11 in. and its weight about 37 cwt.

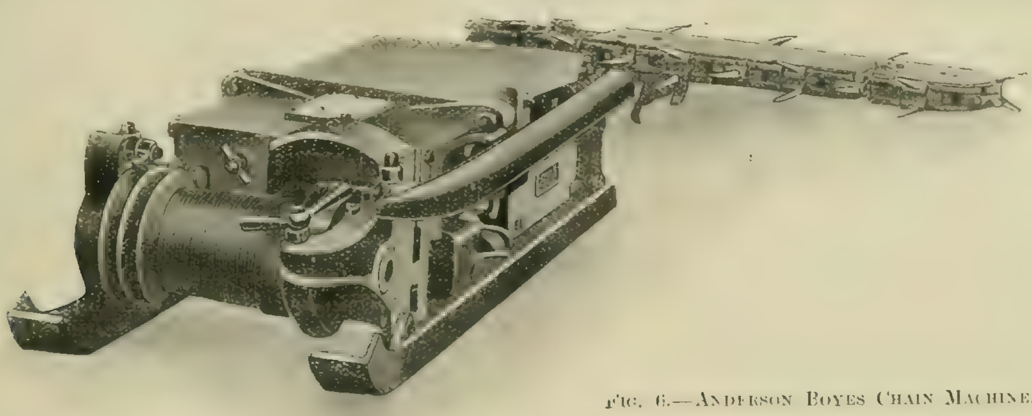


FIG. 6.—ANDERSON BOYES CHAIN MACHINE.

As we indicate above, the introduction of the mechanically-operated coal cutter is not alone due to a desire to work everything by machinery, but has certainly been accelerated by a variety of social problems. In accordance with this general tendency the DIAMOND COAL-CUTTER CO., of Wakefield, have made experiments on holing machines for their own use, and the practical success achieved has resulted in their present machine being placed on the market. It is claimed that the design of this machine is the result of actual experience in the mine, and is fully in accordance with the teaching of pit requirements.

In reviewing the products of this firm we are again face to face with the three main types, disc, chain and bar, though one or other of the two former types is recommended, to suit special requirements. The disc machines are recommended where hard cutting has to be done on account of their rigidity in construction and low peripheral speed. These properties conduce to a minimum of breakdowns, though the coal must be fairly strong to enable it to hold up when undercut, and free from "slippy" partings above the cut. On the other hand, chain machines should be used when the coal is tender or liable to settle immediately it is undercut, and the holing dirt should not be too hard. This type, it is said, is also preferable when polyphase electric motors, which do not readily give the starting torque necessary for a disc machine holing in hard material are used. The bar type has been now practically discarded, partly owing to mechanical weakness, but chiefly to its objections from a mining point of view —viz., increased width or thickness of cut (a serious consideration when coal cutting in a thin seam), low efficiency in removing its cuttings, incapacity for holing at floor level and liability to break down when meeting any hard substance.

In general diamond longwall disc machines can be adapted for driving by continuous or polyphase current. These machines can hole a kerf $4\frac{1}{2}$ ft. deep at floor level and are equipped with a 20 B.H.P. motor. Their overall height is 22 in., maximum width 3 ft. 4 in. and length $7\frac{1}{2}$ ft. Its approximate weight is 36 cwt. A similar design, though varying in detail, is made for use with polyphase current, two 10 B.H.P. motors being used. This allows the machine to be used for cutting in either direction, and easy reversing is thus obtained. The motor used is of the slip-ring type, with a resistance in the rotor circuit, thus enabling a maximum starting torque to be obtained with a minimum starting current. A low frequency is recommended for this work, 25 being the most suitable.

The diamond longwall chain machine has been designed for under-cutting very soft or friable coal and for other conditions unfavourable to the disc type of machines, though in general design it is not very different from them. It can cut in both directions without the machine having to be altered in position, while the holing dirt is swept direct to the goaf side of the machine by the cutters. The cutting tools are both readily reversible and simple in construction. Each cutter box link holds two tools, thereby ensuring an even pressure, and avoiding the serpentine motion common to chains having single cutters. The chain itself is of patent design, and is made of toughened steel throughout and entirely free from rivets, thus allowing a link to be replaced without difficulty. The tension of the chain can be adjusted by turning a nut. The standard depth of undercut is 4 ft. 6 in., the width of cut about $4\frac{1}{2}$ in., and the extreme width of jib under the coal 18 in. It is claimed that there is no tendency for this machine to climb or dip, and that it cuts its own way under the coal by means of a patent screwing-in frame. This is done without impairing the rigidity of the chain jib.

Electric Drills.

In the preceding article of this issue we have dealt with the application of the electric drive to coal-cutters. In the overground world its application to drilling machinery, especially of the portable type, is already well known, while underground its use for this purpose is becoming more and more extended as a necessary preliminary to blasting operations. Compressed air is, we regret to say, still employed; but the electric drill is a factor which has to be reckoned with.

The ELECTRICAL Co. are very much in favour of the purely electrical drill for work involving hole sinking in coal or any kind of rock, and are able to make out an extremely good case for their "Diamond," in contradistinction to the ordinary compressed air type.

Its great advantages are claimed to be that it can run at considerable distances from the generating plant without great cost for mains, while the losses in these mains is considerably less than with compressed air. Further, the space taken up by the "Diamond" is much smaller, and the working expenses are not greater.

These drills, though in general of the same construction, are made in three types for soft, medium and hard rocks. Those used in the first case are rotary drills, in the second diamond drills, and in the third percussion drills. The "Diamond" drill possesses some features of interest. It consists of a drilling device with motor attached, this latter being designed for both continuous and alternating current on voltages up to 220 volts. The driling device consists of a drill spindle supported on a frame work, and provided with a steel crown set with diamonds. The spindle and crown, run at about 750 revs. per min. The spindle is fed in by hand and without any extra attachment a hole 5ft. deep can be bored. These machines are easily fitted to stands of the ordinary type, and only require about 1 H.P.

It is absolutely necessary to run water through the drill head when working, as the drill ing crown is otherwise liable to choke up and wear itself out. In cases where the water supply is scanty a filtering apparatus can be fitted, so that the water can be used a second time.

The following table gives data collected by the Electrical Co. from experiments made on different kinds of rock:—

Rock or stone.	Rate of drilling per min. Inches.	Av. renewal expenses of the drill crown only, per foot.	Power consumed. H.P.	Av. length drilled per day per machine. Feet.
Soft slate...	2·0–2·4	0·18d.	0·7	60—80
Hard Jura limestone..	1·3–1·7	0·55d.	0·7	40—50
Greenstone, diabase and basalt	0·8–1·0	1·02d.	1·0	40—50
Spathic ironstone rich in quartz...	1·2–2·4	1·76d.	0·8	33–65
Quartzy conglomerate red sandstone	2·8–4·6	2·12d.	0·7	65–8[illegible]

We are pleased to be able to record that in drilling work the electrical drive is by no means hopelessly out of it. The INGERSOLL RAND Co., of London, are fully aware of the difficulties of producing a satisfactory electric drill, and therefore they have taken the matter in hand on rather different lines, and the "electric-air" drill is the result. This, as its name implies, is not an electric drill pure and simple, or an air drill pure and simple, but a combination of the two. It consists essentially of an electrically driven pulsator or compressor driven by a motor. The pulsator is a vertical duplex single acting self-oiling type without inlet or discharge valves, and therefore not limited in either speed or endurance by these parts. The whole equipment, motor and pulsator, is mounted on a steel truck which can be easily moved either along the mine track or simply on the floor. Fig. 1 shows the arrangement complete. The pulsator is connected to the drill by two short lengths of hose line. The drill itself is of the utmost simplicity, consisting of a plain cylinder with a piston in it, mounted on a standard Ingersoll column, shaft bar, quarry bar or tripod. It is claimed that this machine is nearly as wear-proof and "foolproof" as a working machine can be.

As mentioned above, there are two lines of hose connecting pulsator and drill, putting the two ends of the pulsator cylinder in connection with the two ends of the drill cylinder. Through these two hose lines alternating impulses of air at a pressure of 30 lb. to 40 lb. are communicated to the drill piston and thence to the steel. One impulse throws the piston forward; the other throws it back. For every revolution of the pulsator shaft there is a blow and a return of the drill piston. The air is not used in the ordinary manner—compressed and then released—but is compressed, expanded and recompressed over and over again. When one pulsator piston is compressing air behind the drill piston, the other pulsator piston is exhausting air before it. The effect on the drill piston is, therefore, greater than indicated on the pressure gauge on the pulsator.

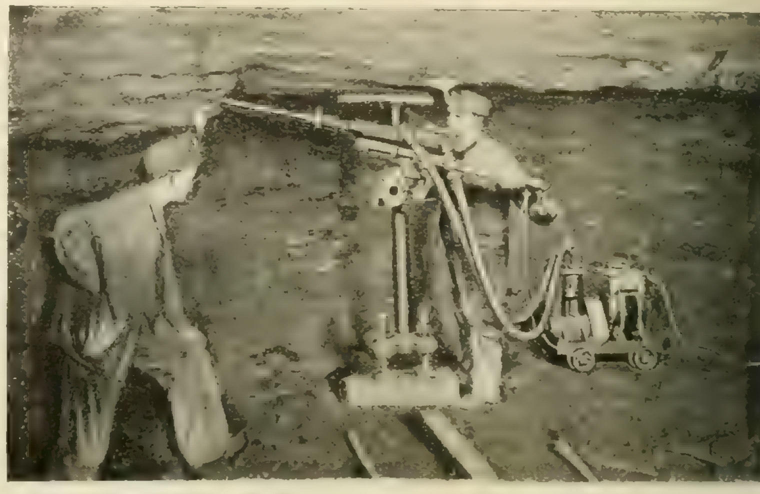


FIG. 1.—TEMPLE INGERSOLL "ELECTRIC AIR" DRILL.

The electrical connections are naturally very simple, while the motor used can be either of the continuous or three-phase type. Owing to the absence of exhaust, the machine is said to be practically noiseless in operation. It is recommended that the current, whether direct or alternating, be used at a pressure of 220 volts wherever possible, and the Ingersoll-Rand Co. make this their standard, although motors can be provided for any voltage up to 500. When direct current is used four speeds are available, and when alternating current there are two speeds. The controller is wholly enclosed, and is mounted on top of the motor. The latter is started, stopped or controlled by a cord within easy reach of the drill.

A glance at the attached illustration will show that this drill is not meant to be a fixture. In fact, it is specially designed for getting about, and the truck carrying the compressor and motor is specially adapted to the standard mining gauge. It can, however, be moved over the ordinary mine road, while the length of hose gives it a certain additional radius of action.

The chief feature of the electric air drill, however, and one which will appeal to all mining engineers, is its very low power consumption. It is said that one of these machines takes only about one-third of the power required by a compressed air drill of equivalent size doing the same work.

From our descriptions of drilling machinery now in use in mines it will be seen that compressed air is more favoured than electricity. The DIAMOND COAL CUTTER Co., of Wakefield, are, however, believers in the latter method, and that their products are not unwieldy will be seen by a reference to Fig. 2.

The drill is of the ordinary pattern, and is suitable for drilling holes up to 1¼ in. It is driven by a motor which in the

ordinary course of events is wound for 400 to 500 volts. A starting switch, with automatic overload and no voltage release, is fitted to the stand. The feed nut is of the split type, and is furnished with a brake which is readily adjusted while the machine is at work. The stand is mounted on flat wheels or skids, and can be easily drawn along the coal face by one man. The motor and drill are mounted in a revolving stand, and can be readily raised or lowered, so that boring can take place at any required angle.

The fixing of this machine is said to be very simple. It takes no time and various lengths of serrated pipe are provided in the tool box so that it can be erected at a number of places where the roof varies in height. Three drills are provided to bore to a depth of 5 ft., and the machine is specially designed for boring shotholes for inserting charges to bring down the coal after it has been undercut by the longwall coal cutter. (Various types of these machines are described in the article dealing with coal cutters in this issue.)

This machine has given the following results in actual working. In a 2 ft. seam shotholes had to be bored 7 ft. apart on a 500 yd. longwall face to bring down the coal after the cutter, over 500 holes being bored per week. The cost of boring the holes 4 ft. 6 in. deep by hand cost 5d. per hole, while by using this electric drill the cost was reduced to $1\frac{3}{4}$d. per hole, representing a saving of over $1\frac{1}{2}$d. per ton.

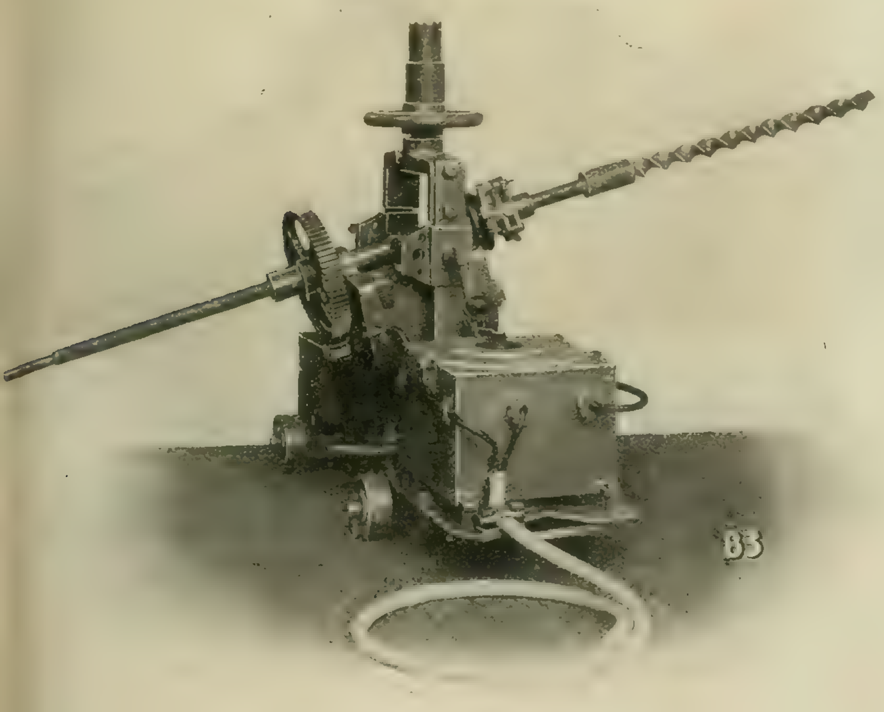


Fig. 2.—"Diamond" Electric Drill.

In spite of their name the Consolidated Pneumatic Tool Co., of London, have found it worth their while to put several types of electric drill on the market, and find that their confidence in this direction has not been unjustified. In these drills the company has endeavoured to embody those mechanical features which have contributed to the success of their pneumatic tools, while at the same time securing efficiency and durability in the electrical portion.

A feature of great importance in the Consolidated Company's drill, which is specially designed for coal and iron ore boring, and is illustrated in Fig. 3, is the patent automatic withdrawal and re-feed arrangement by which the bit on coming against a hard substance is withdrawn 2 in. and then advances again, continuing this motion until the hard material is penetrated. The same action occurs if the drill breaks, with the modification that the drill is entirely withdrawn, while should fossils cause jamming it is also withdrawn and re-fed until free.

It is claimed for this method that the machine must either withdraw or feed forward, it cannot simply rotate by the clutch slipping, as is the case with the friction feed. This avoids waste of time due to the fact that the drill is slipping instead of feeding and this has not been noticed.

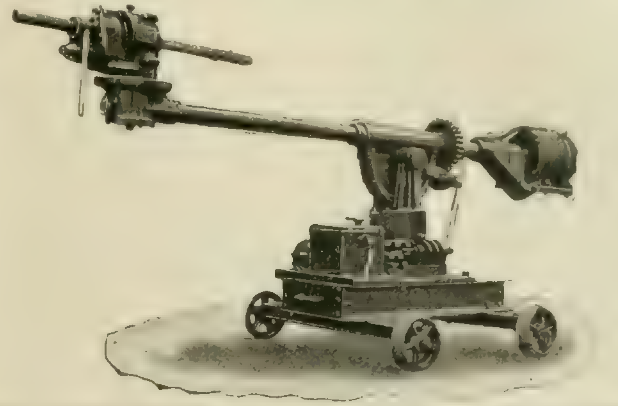


Fig. 3.—Consolidated Pneumatic Tool Co.'s Drill for Coal Mines.

This drill is capable of drilling 2 in. holes at the rate 6 ft. to 8 ft. deep per minute and exerts approximately $5\frac{1}{2}$ H.P.

As mentioned in the coal cutter section of this supplement, the Hardy Patent Pick Co. are great believers in the policy of *multum in parvo* and its application in mining work. How excellently this policy is worked out in this case we leave our readers to judge, the "Hardy Simplex" hammer drill being illustrated in Fig. 4.

The ordinary reciprocating piston drill has, it is said, always been open to reproach on account of its weight and the time lost in fixing, while the "Hardy Simplex" is quite independent of the operator's skill, and is exceedingly easy to carry about. It consists essentially of a cylinder in which a piston moves actuated by compressed air. This strikes ouhe drill about 1,500 to 2,000 times per minute, the patented valve motion permitting this high speed with a complete absence of "fluttering." It is claimed to be in action as nearly as possible a hand drill worked by air.

The boring speed is up to 2 ft. per minute and the weight of the drill is 22 lb. A special feature is made of the patent chuck plate or drill holder. With this the expensive upkeep hitherto associated with this particular part is, it is said, obviated, as there are no screw threads to strip. The plate is merely pushed backwards or forwards to release or fasten the drill steel, and a new one can be fitted and the machine started within a few seconds.

The drill steels are hollow, and a supply of air can be forced through to the cutting edge, which is thus kept free from dust. When coal is being worked solid drills are supplied, and water sprays can also be used, though the Hardy Patent Pick Co. consider this an unnecessary complication. The "Hardy Simplex" drill only requires a low air pressure to work it, actual tests showing a boring speed in hard sandstone of 8 in. to 10 in. per minute, with an air pressure of 45 lb. to 50 lb.

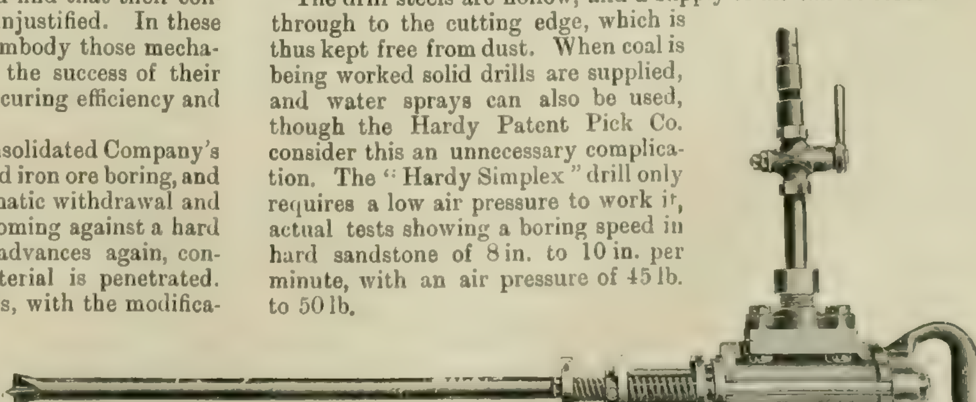


Fig. 4.—"Hardy Simplex" Drill.

Exhaust and Mixed Pressure Turbines for Mining Work.

Up to the present it has been usual to utilise non-condensing engines for winding, pumping and hauling in coal and other mines, and owing to the large increase in the electrical power required for mining work it has been found possible to utilise the exhaust steam from these non-condensing engines and obtain electrical power at exceedingly low rates.

Until recently the question of coal economy in collieries has been greatly neglected, as it was generally assumed that only smudge coal was burned under the boilers, and a great deal of this fuel would prove unsaleable or not worth the carriage on the railway. Owing to the rise in the price of coal, the increase in the use of briquettes made from coal dust and the utilisation of small coal in patent coke ovens, the coal usually used for steam-raising in coal mines has obtained a definite market value. The question naturally arises as to whether it will be more economical to obtain the power from one of the power supply companies or local authorities in the neighbourhood, or to generate the power on the spot by means of exhaust turbines or similar plant. It should be remembered that while the cost of coal in a large generating station has been reduced to below 0·2d. per unit, the capital cost of the plant and the cost of distribution in many cases bring up the total cost far above the mere cost of coal, and therefore the utilisation of low-pressure steam on the spot, without the use of any extra fuel, coupled with the absence of any material transmission losses, makes the exhaust and mixed turbines very serious competitors of the power company.

After allowing for auxiliary plant, the exhaust steam turbine takes from 30 lb. to 50 lb. of steam per kilowatt-hour, the machines being at present manufactured in sizes from 150 kw. to 1,500 kw. The use of an exhaust turbine does not increase the coal consumption of a non-condensing engine; in fact, under certain conditions of load, there may be a slight vacuum in the exhaust of the engine itself. It is well known that it is impossible to get the maximum amount of work out of steam below the atmospheric line with the modern steam engine, as in order to do this the low-pressure cylinder would have to be of enormous capacity, which would in itself lead to heavy losses from friction, &c., and at the same time the valves and passages would have to be made very large to take a large volume of very low-pressure steam.

The exhaust steam turbine, on the contrary, is capable of taking steam at atmospheric pressure and utilising it right down to within a quarter of an inch of the pressure in the condenser. Taking, for instance, two or three non-condensing electric lighting engines, using, say, 30 lb. of steam per kilowatt-hour, one is enabled to utilise this steam in an exhaust turbine, and obtain a kilowatt-hour for about 40 lb. of exhaust steam, or three-quarters of a kilowatt-hour more than the non-condensing engine alone.

When steam is utilised from a winding engine, it is necessary to use some form of accumulator for the purpose of tiding over the pauses between the winds, the pauses under actual working conditions rarely exceeding 60 seconds in duration; in fact, when a mine is busy, the pauses should not exceed about 30 seconds. The exhaust accumulator is manufactured in various forms, but the theory of the plant is that the steam gives up a portion of its latent heat during the period of winding to a body of water or mass of iron, a certain quantity of steam being condensed in the process. As soon as the supply of steam from the non-condensing engine is cut off, the pressure drops slightly and the portion of the steam which has been condensed by the masses of water or iron is evaporated and is found to be capable of running the exhaust turbine through short periods until the supply of steam is again turned on through the re-starting of the winding or other engine. The accumulator is made up in several forms, one form consisting of a steel cylinder containing a large number of water trays, the trays being capable of exposing a large surface to the incoming steam, and therefore giving opportunity for condensing a considerable quantity, the trays immediately evaporating part of their contents as the pressure drops. In another form of accumulator the steam is carried into a cylindrical chamber through a number of small ducts or flues, the steam blowing into the water through a number of perforations. Another form of accumulator is made up of a chamber containing a large quantity of old rails or scrap, the heat of the water being taken up rapidly by the iron, owing to the large amount of surface available. A still further form of accumulator is arranged with a water-spray, the water being circulated in the chamber by means of a special centrifugal pump. This latter type of accumulator is at present being adopted on one or two collieries on the Continent.

The exhaust turbine is capable of working up to its full output with low-pressure steam, and can also use high-pressure steam when required, by means of reducing valves. This latter method of procedure will naturally be found somewhat inefficient when the non-condensing engines are shut off for any lengthy period. It is usual in many collieries to do the winding during the day and all masonry work, clearing up, &c., during the night. During this latter period the winding engine will not be in use, and, therefore, when electric pumping or other work is to be done, high-pressure steam only will have to be used with an exhaust turbine in the event of other generating plant not being available.

In order to meet these special conditions, Messrs. Willans & Robinson, of Rugby, have introduced the mixed type turbine. This turbine was designed in the first case with the collaboration of Messrs. Scott & Legatt, of Cardiff, South Wales, the first machines being put in hand for the Oakdale Collieries of the Tredegar Iron Company. These machines are capable of working economically with low-pressure steam during the day, and at night, when the main winding engines are not at work, high-pressure steam can be used with great economy through special high-pressure valves in the turbine. The turbine consists essentially of a horizontal single-cylinder machine, with both high-pressure and low-pressure governor valves, the steam being admitted both at the high-pressure end and at the low-pressure end, in accordance with the quantity of steam available. In special cases high-pressure steam can be turned through the high-pressure valve to make up for any deficiency in low-pressure steam.

It should be noted that, in order to utilise exhaust steam economically, it is of primary importance to have an efficient condensing plant. Messrs. Willans & Robinson have taken up the question of condensing plant for this type of prime mover, and have laid down special plant in their Rugby works to deal with large surface condensers of the type required for exhaust and mixed type turbines.

It is unusual in colliery work to find any quantity of circulating water available on the spot, and therefore a cooling tower or cooling ponds have to be used. The question of the arrangement and correct design of plant of this character is of great importance to the efficient working of turbine plant, and in the past any out-of-the-way corner has been deemed to be sufficiently good for this purpose. It should be noted that the efficient cooling of condensing water is a difficult operation, and that matters of this kind require as much attention as questions of boiler-house arrangement, steam pressure, &c.

Messrs. Willans & Robinson have at work or on hand a number of exhaust and mixed type turbines for various parts of the country, including two 1,350 kw. exhaust turbines for Messrs. Samuelson's Ironworks, Middlesbrough; two 1,000 kw. mixed type turbines for the Tredegar Ironworks in South Wales; a 500 kw. exhaust machine for an ironworks in Staffordshire, and other smaller machines for various parts of the country.

It may be pointed out that in cases where a colliery is fitted with existing winding or pumping engines the exhaust and mixed type turbine can compete very favourably with any electric winding plant, especially where the power is to be obtained from an outside company or municipality, the cost of the complete exhaust turbine and accumulator being in most instances far below the cost of the electric winding installations, with the flywheel balances and the complicated control gear.

The Employment of Storage Batteries in Colliery Power Stations.

BY WM. MAURICE.

(Manager of the Hucknall Torkard Collieries, near Nottingham.)

During recent years there has been what may be termed a high efficiency epidemic; a demand on all sides for machinery that would perform its work with less waste of power and at less cost. In pursuit of efficiency, low-pressure boilers have given place to those working at high pressures, and simple engines are superseded by compound and triple-expansion types; these in their turn are challenged by turbines and heat accumulators, the latter are met by producer gas plants and gas engines and gas turbines constructed for the utilisation of waste heat from blast furnaces, coke ovens and similar sources.

Passing from the point of generation to that of power distribution it is seen that the distribution of steam through long lines of piping and of power through long lines of shafting are now universally recognised as belonging to the engineering practice of other days.

Small engines for the local application of power are obsolete, or nearly so, and the electric motor reigns supreme.

In no industry has more rapid progress been made than in that of coal mining; indeed, it may be doubted whether any other industry can offer such remarkable scope for the development of power economies, and in no branch to any greater extent than in that relating to the applications of electricity.

There is, however, considerable reason for the conjecture that in many cases an academically high efficiency has been secured at a price out of all proportion to its actual commercial value. What is wanted in industrial concerns is machinery with a high commercial efficiency—which term includes all the factors that make for commercial success. Many devices of super-average mechanical efficiency cost so much more in interest on capital outlay, in maintenance and renewals, and in labour charges, that their commercial efficiency frequently proves in the long run to be considerably lower than that of average or even sub-average machinery. In modern colliery power stations, boilers, engines, generators and systems of transmission and distribution are all designed for the purpose of securing that efficiency which is deemed the best obtainable under given local conditions. Yet, even if these local conditions are such that it is possible to employ the most perfect machinery known, it is often the case that both the mechanical and the commercial efficiency are extremely low compared with results that are commercially obtainable.

A moment's reflection will make it clear that this must almost necessarily be so, by reason of the low load factor which obtains in the majority of colliery stations.

Colliery engines scarcely ever run at their most efficient load, nor could it until recently have been expected that they should do so at any mine where fortunate conditions of work prevailed. The power supply is distributed amongst motors for haulage, screens, pumps, ventilating and other fans, coal cutters and coal conveyors, workshops, saw mills, briquetting and coking appliances, and sundry other purposes. The bulk of this machinery only runs for some seven or eight hours out of each 24, and most of it is intermittent in its demands on the power station. Thus, main and main and tail haulage motors only run at intervals during the coal turning shift, and even endless rope systems are often idle at times when they should be running.

Screen motors on the whole may be assumed to work throughout the coal turning day, less a dinner interval of half an hour or so during which the generators are for the most part running on practically no load. Pumps may only be started up for a few hours per day or per week, or, on the other hand, they may form the principal constant load on the station. Ventilating fans must, of course, be run all the hours there are, and it is questionable practice, though it is often done, even to run them at reduced speed over the week end. Other fans, as employed for example in the production of forced draught for the removal of waste from wood-working and other shops, for smith's forges, and for dust extraction from loaded tubs, tipplers, coal screens, &c., will consume power for a few hours each day or all day long, according to the nature of the work to which they are applied.

Coal cutters, although making heavy demands on the capacity of the power station, owing to the large starting currents required, are not as a rule actually undercutting for more than about half the number of hours during which they are nominally at work, so that the current consumption in units per day is much lower than might at first sight be supposed. Saw motors, again, although there has to be allowed from 20 to 50 H.P. for each of them (according to size of saws) in determining the output of the generator, only take their full load during the moments of heaviest cutting, and in many cases run for hours every day on light load. With this constantly varying load it is found in practice that the steam engine, or the electric power plant supplying current to the mine, which must be designed to supply the maximum demand, runs at an average of only 20 to 30 per cent. of full load, and this without taking into consideration the fact that there is usually a suitable amount of reserve provided, which is available in case of breakdown.

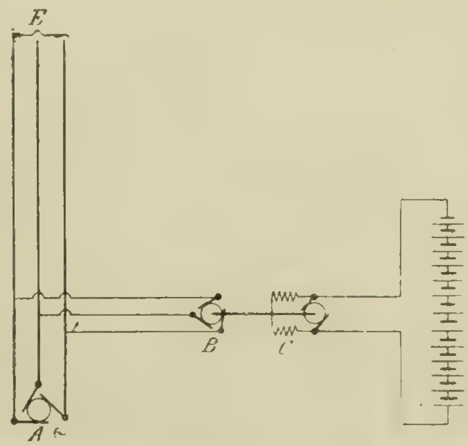


Fig. 1.—Diagram showing Battery in Use on a Three-Phase System.

The result of this excessively unfavourable load is that the fuel consumption with mining machines is exceedingly high in proportion to their output, and this can only be reduced by equalising the load—that is, by storing the excess of energy available at times of low load and utilising the energy so accumulated at times of heavier load.

In electrical plants in mines it has been found advantageous to accomplish this storage by means of electric accumulators, for not only do these take up the variations of load very satisfactorily, but at the same time they form a standby, which instantly comes into action in case of a breakdown. Besides, accumulators can be employed for supplying current for lighting and power at times when it is convenient to shut down the generating plant.

By the use of accumulators for equalising the demand and so improving the load on the generators, the fuel consumption of the engines is reduced, and, in the case of new generating plant, it can be made smaller and cheaper. These advantages are not, moreover, confined to direct current plants, as is often supposed, but can be obtained likewise in alternating plants, which for various reasons are often preferred in mining installations.

In a Paper read before the Electrotechnical Association of Berlin, Mr. L. Schroeder has described a number of methods whereby a storage battery may be utilised for equalising the load on a three-phase system. The simplest is that shown in

Fig. 1, where the network E fed by the three-phase generator A is connected to a motor-generator B, C, of which the secondary side C is coupled in parallel with a battery of accumulators.

If no regulating apparatus is provided, the battery cannot come into action unless the speed of the main generator, and

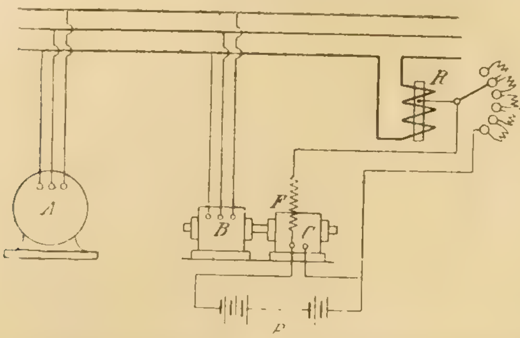


Fig. 2.—Diagram showing Use of Relay Regulator with Buffer Battery.

therefore that of the motor-generator, is reduced, in which case the direct current machine generates a lower E.M.F. and is driven as a motor by current from the battery, the generator B then supplying current to the network. On the other hand, in order to charge the battery, the speed of the motor-generator must be increased.

winding F of the direct current side of the motor-generator. The Accumulatoren-Fabrik Aktiengesellshaft, of Hagen i/W. (the German Tudor Accumulator Co.), supplied a buffer-battery for the Constantine Mine at Dortmund, to equalise the peaks of a winding gear driven by three-phase currents, and for this

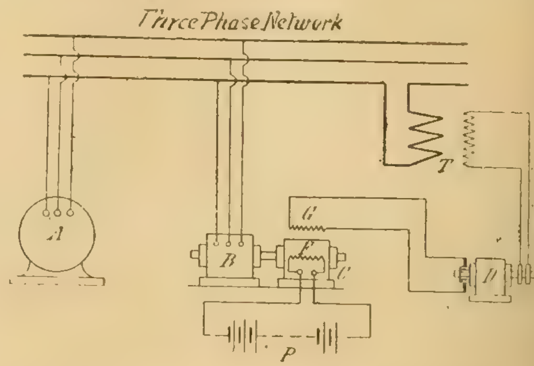


Fig. 4.—Diagram of Schroeder's Arrangement.

purpose the arrangement shown in Fig. 2 was adopted. The winding motor is driven by three-phase currents and is started with the aid of a resistance in series. When starting, the motor requires 700 h.p. whilst the generator is only of 400 h.p. rating, so that the battery has to provide 300 h.p. The relay used is the Tirrill automatic pressure regulator. The connections of

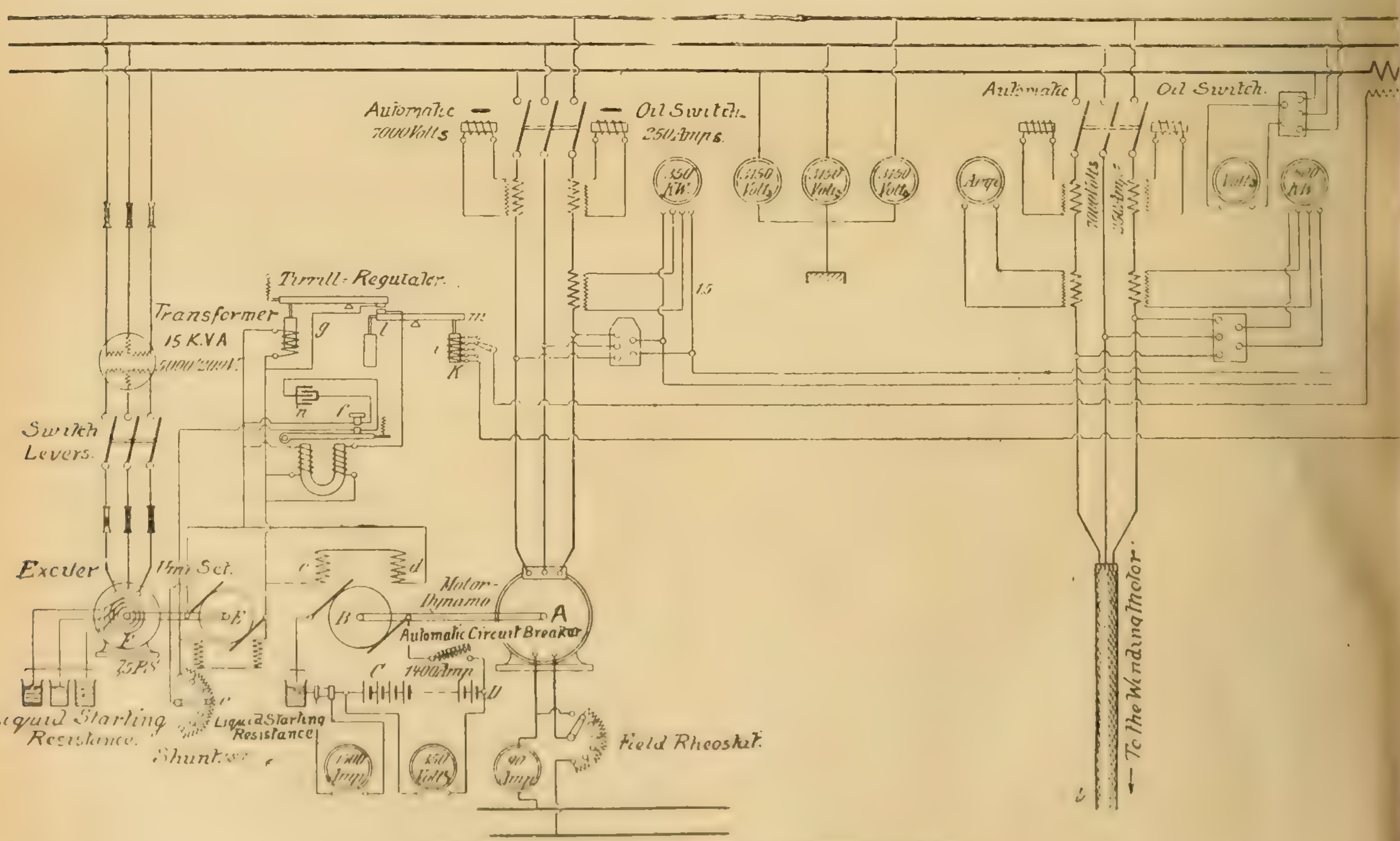


Fig. 3.—Diagram of Connections at the Constantine Mine.

One can, it is true, improve matters by providing a reverse-wound coil on the direct current side of the motor-generator, but even then the regulation only takes place on the lowering or raising of the speed of the motor generator. Additional means must, therefore, be employed to produce satisfactory operation, and in Fig. 2 a relay, R, is shown for this purpose, which automatically controls the regulator N of the shunt field

the above named installation are shown in Fig. 3. The cable to the winding motor is marked *ab*. A is the alternator and B the dynamo of the motor generator, the battery CD being connected in parallel with the latter. The field-magnet winding *cd* of the dynamo B of the motor generator is energised by the exciter E, which is driven by a three phase motor F. The shunt regulator *e* of the exciter E is arranged so that the

machine is only feebly excited. In parallel with the rheostat is connected the contact maker *f*, which is opened and closed several hundred times per minute by the Tirrill regulator; thus the regulator of the exciter is short-circuited with the same frequency, and consequently the exciter E is more strongly excited, so that the excitation of the dynamo B of the motor-generator is also increased. In proportion to the longer or shorter duration of the short-circuiting of the field regulator the dynamo B is more or less strongly excited, and thus the opportunity is afforded for the battery to come into action. The duration of closing the contact-maker *f* is controlled by the transformer *h* connected in the circuit of the main three-phase generator; this energises the solenoid *i* which, according as the main current is stronger or weaker, attracts the iron core K more or less. By this means the lever *lm* is moved, with the result that the contact-maker *f* remains closed for a longer or shorter period. A condenser, *n*, is provided for the purpose of preventing sparking as far as possible.

In Mr. Schroeder's patented arrangement, with which no relay at all is required, and which allows of the use of reasonably large forces, so that delicate sensitive apparatus is avoided, the circuits are as shown in Fig. 4. In series with the line fed by the three-phase generator, A, is connected a transformer, T, which supplies the rotary converter D. In consequence of the fact that the transformer T is in series with the three-phase network, the rectified current generated in D is directly proportional to the current supplied to the network, and it flows round the magnet of the direct-current side C of the motor-generator BC in opposition to the shunt winding F. Hence, when an increase takes place in the current strength in the three-phase network, the pressure of C is reduced, so that the battery discharges on C; if the current in the three-phase line falls, the pressure of C rises and the battery is charged. The converter D is mounted on the same shaft with the motor-generator BC. As considerable interest attaches to this arrangement, which was employed in a Siemens-Schuckert installation at the Carlsfund potash mine, detailed reference to it will subsequently be made.

Equalising Apparatus.—The question of employing equalising apparatus with three-phase current will as a rule arise in connection with the installation of batteries for equalising purposes in existing installations, which either are no longer capable of coping with a projected increase of load or whose pressure variations become too unpleasantly noticeable.

The first storage battery installed at a mine, for use as an equaliser of load, was the one that was put to work in July, 1897, at the Santa-Ana silver mine, near Catorce, in the State of San-Luis-Potosi, Mexico. This has been working uninterruptedly ever since, with only native labourers (Indians) to look after it, as an equaliser in connection with the winding engine. The battery has completely fulfilled its purpose of reducing the cost of coal, which, owing to the expense of transport, cost 20s. to 25s. per ton at the mine, a saving in working costs of about 30 per cent. having been effected.

In view of the success of the equalising battery at Santa-Ana, the German Tudor Co., who have pioneered this class of work abroad, was in 1901 entrusted by the Compania Minera de Penoles, of Mapimi, Mexico, with the supply of a similar battery, which was put to work in September of that year, and a second battery was put in for the same company in June, 1904.

In Germany also, although the cost of fuel is not such an important point as in Mexico, the employment of batteries in mines for taking up variations of load has aroused considerable interest, and excellent results have been obtained.

In January, 1902, an equalising battery was put to work by the Kgl. Berginspektion Grund. i. Harz. In July of the same year they were followed by the Justus I. in Volpriehausen, Prov. Hanover. The good results that were obtained with these plants induced other mines to follow their example, notably the Kgl. Berginspektion Clausthal, the Gewerkschaft Carlsfund, Gross Rhuden, and the Gewerkschaft Burbach, Beendorf.

At the colliery of the Gewerkschaft Ewald Herten i. W. a battery was installed for lighting in 1900. In August, 1903, they converted it into an equalising battery, which rendered it possible to supply their electrically-driven machinery, which had previously required 300 H.P., with an engine of 120 H.P.

As a large number of colliery power stations are running with polyphase current, a description of the accumulator plant at Carlsfund, though it is now fairly well known, may here prove of interest to a new circle of enquirers.

Fig. 5.—Tudor Battery at Gewerkschaft Carlsfund Gross-Rhuden.

The Carlsfund electric supply was originally only intended to be employed for lighting, and for power in places where the provision of a separate steam engine would have been uneconomical and the transmission of power by mechanical means would have involved difficulties. It was eventually extended to mining machinery and lighting underground, to motors and lighting in the shops, as well as to the lighting of the offices and private residences.

It was the intention of the management to provide a plant designed to secure the highest economy, while avoiding unnecessary refinements, and yet it was soon found that the generators, and consequently the engines driving them, were running under very unfavourable conditions of load. At certain times of the day a 100 kw. three phase generator, belt driven by a Corliss engine, was hardly able to meet the demand, and yet its average output throughout the day was only 30 per cent. of its full load. There were two other generators with outputs of 50 kw. and 35 kw. respectively, which were available as spares, but which, for special reasons, could not often be put on load; hence the running of the plant was not economical.

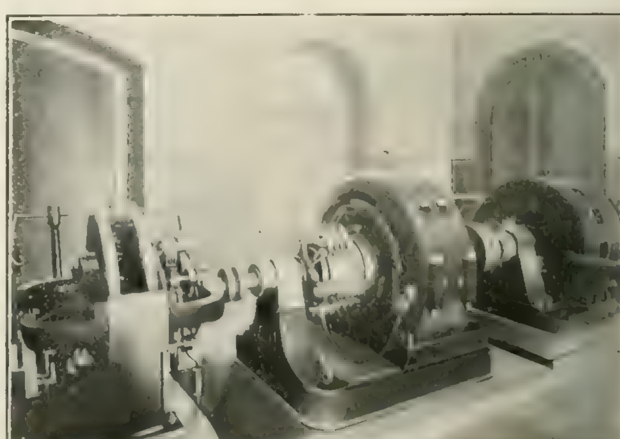
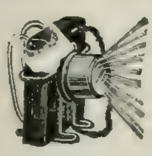
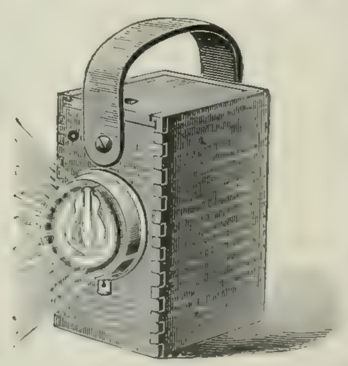


Fig. 6.—Three-phase Direct Current Motor Generator with Rotary Converter at Carlsfund.





In order to increase not only the economy but also the reliability of their electric power supply, the company decided to put in a battery of accumulators, so as to obtain a steady load for their generators and a standby in case of interruption of supply.

For this purpose the existing 35 kw. generator was adapted, and, by means of the method of connections devised and patented by Mr. Schroeder and already described, was connected between the three-phase mains and the battery. The battery, which was supplied by the German Tudor Co. (the Accumulatoren-Fabrik Aktiengesellschaft), consists of 120 cells, having an output of 648 ampere-hours when discharged at 216 amperes for three hours, the charging rate being 216 amperes.

The battery is connected without regulating cells, regulating switches or resistances, direct to the terminals of the direct current machine, by means of which it is charged when the load on the mains is light—*i.e.*, when less current is demanded than the power station is capable of supplying—and is discharged when the load on the mains is heavier and the consumption of energy for motors and lighting together is greater than the output of the power station. The battery and motor-generator are illustrated in Figs. 5 and 6.

There are altogether 1,024 incandescent lamps, 25 arc lamps, 30 motors with a total capacity of 250 H.P., as well as some other apparatus. This represents a total of 370 H.P., or 300 kw.

The connections are arranged as shown in Fig. 4, to which reference has already been made. As previously explained, the direct current supplied by D is proportional to the total alternating feeder current passing through the primary of the transformer T. In order to make use of this current for the regulation of the motor-generator, it is passed through a field coil, G, on the direct-current end, this coil being wound in opposition to the separately-excited main field coil F. If the current in the three-phase feeders increases, the field of C is weakened by the increase of current in the coil G, and the voltage of C is thereby lowered, so that the accumulator discharges through C and drives it as a motor; the alternating end B becomes a generator and so supplies current to the three-phase circuit. On the other hand, if the current in the three-phase feeders drops below the mean, the voltage of C is raised, C becomes a generator and B becomes a motor, power is absorbed from the three-phase mains, and the accumulator is charged.

As already mentioned, the 100 kw. generator used to be run constantly, although it had only a daily average of 30 per cent. of its full load.

After the installation of the battery, however, the 50 kw. machine was sufficient, and even had power to spare; in fact, this machine is only required to run 17 hours a day, whereas the 100 kw. generator had to be run continuously. The battery plant has fulfilled all expectations, not only as regards increased economy but also in respect of increased reliability, since, in case of any failure of the main alternator, the battery would take up the load automatically, without requiring the operation of any apparatus by hand, and thus it forms an excellent standby, since it would supply the motors and lighting for a considerable time after the shutting down of the generator, by means of the energy stored in it.

The writer, who desires to record his thanks to the Tudor Accumulator Co. and the Accumulatoren Fabrik Aktiengesellschaft for facilities so readily placed at his disposal, regards the application of storage batteries in the manner indicated in this article as a development of great practical importance. He is himself installing a battery of Tudor accumulators and a motor generator combined with a reversible booster of the Lancashire type to take up the surplus power from a Rateau exhaust steam driven turbo alternator at the Hucknall Collieries, and offers this short statement of the advantages to be derived from the use of accumulators and of the work already done in this direction, in the hope that other mining engineers may be the better enabled to appreciate this simple and valuable means of economising, improving and enlarging the capacity of colliery electric power stations.

Flywheels *versus* Storage Batteries for Equalising Fluctuating Loads

BY G. C. ALLINGHAM.

Flywheel storage systems have recently been coming extensively into use for taking up fluctuations of load, especially in connection with mining work, and in many instances remarkable results have been obtained. But it may be worth while to point out that the field of usefulness of flywhee equalisers is very limited, and that their employment is only economical under special conditions.

The duty for which flywheel storage is best adapted is that of equalising the power demand of an individual machine, such as a winding engine or a rolling mill, which goes through a definite cycle of operations, repeated throughout the period of working, so that very short periods of heavy and of light load recur alternately in regular succession. In such cases the actual amount of *energy* that has to be stored is very small (although the *power* to be dealt with may be large) and it has to be kept stored up for a very short space of time. Again, the amount of energy to be stored can be calculated fairly closely, and the flywheel equaliser can be designed to suit the load-curve of the machine, so that it is storing and giving out energy alternately almost all the time, and running idle as little as possible. In other words, it is possible to arrange to work the flywheel equaliser at a comparatively high load-factor.

On the other hand, in cases where the overloads are irregular in frequency and amount; where they may last for longer periods or occur in rapid succession, and may also be separated sometimes by comparatively long periods of low load, flywheel equalisers are not suitable, on account of the small amount of energy they are capable of storing, and their heavy no-load running losses. In such cases, the load-factor on the equalising plant is of necessity low, and the constant running loss being high, the working efficiency must consequently be low. A haulage gear is an instance of a machine whose load-curve is usually extremely irregular, and for which fly-wheel storage would, therefore, not be well adapted; a coal-cutter is another.

In the case of a coal-cutter, for example, the load-curve shows successions of heavy peaks, alternating with intervals of no load varying from a few minutes to half an hour or more while the cutter is being shifted. Consider what occurs in one of these intervals. Within a minute or two the flywheel is brought up to full speed, by which time it has taken up all the energy it is capable of storing, and afterwards current has to be wasted to keep it turning round at full speed churning the air until a heavy load comes onagain.

If, on the other hand, an attempt is made to save no-load running losses by shutting down the flywheel set during a period of low load, all the energy stored in the flywheel has to be thrown away, and it will also take a considerable time to get the set started up again, so that if a sudden overload comes on there is a risk of being caught unprepared.

Again, when the peaks are liable to endure for some time, or to come on in rapid succession, the flywheel equaliser is handicapped by its small storage capacity; and if an attempt were made to overcome this drawback by increasing the size of the flywheel, the fixed running losses due to friction and windage would be correspondingly increased, and the efficiency of working would be greatly reduced. The amount of energy which would have to be expended every time the flywheel was started up would also be increased. For these reasons, not to mention the practical difficulties in the way of making flywheels of enormous size, and their prohibitive cost it is impossible to construct flywheel equalisers having any considerable storage capacity combined with a high working efficiency.

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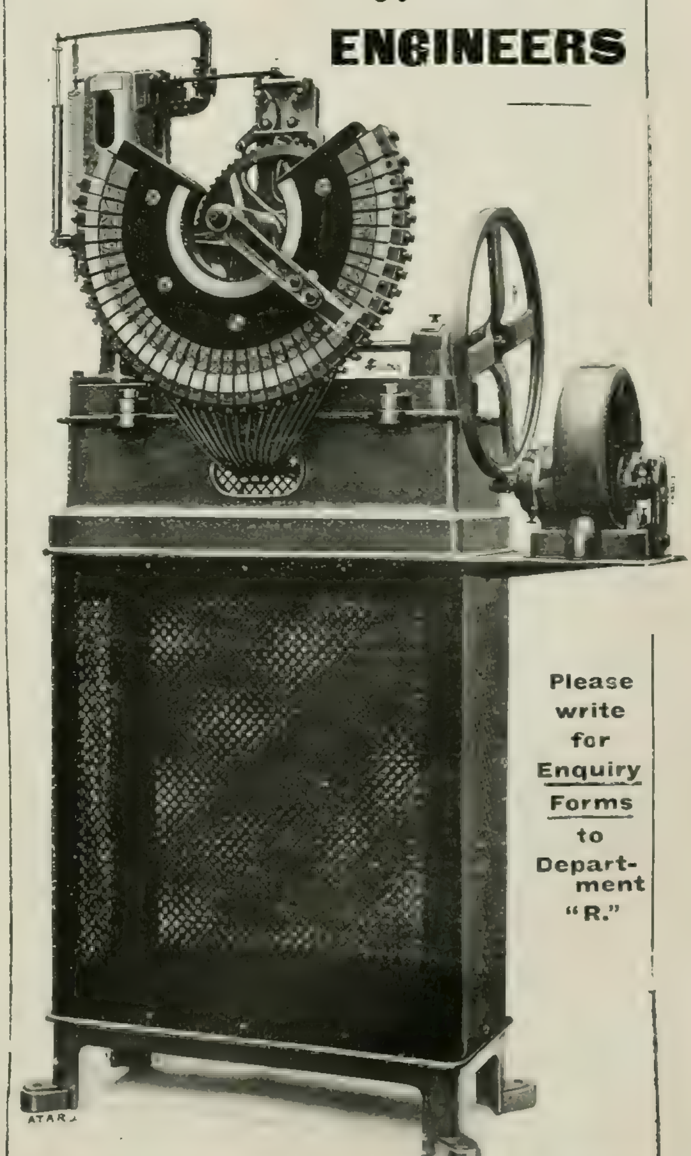

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From the foregoing considerations, flywheel storage would appear to be unsuited for equalising the load on a power station supplying a number of motors, since the fluctuations of the power demand on such a station are always quite irregular. Attempts are being made to apply flywheel storage to power plants for electric traction, but, for the reasons he has given above, the author does not consider them likely to meet with success.

The alternative to flywheel storage is the use of a storage battery, preferably in combination with an automatic reversible booster. In special cases, such as those mentioned in the second paragraph of this article, where the storage capacity required is very small, a flywheel is of course a cheaper means of storage than a battery. But where the power demand to be dealt with is irregular, the battery equalising plant has the advantage, for, firstly, it has sufficient storage capacity to deal with any combination of peaks and depressions in the load-curve that could possibly occur; and secondly, its no-load running loss is quite insignificant compared with that of a flywheel equaliser, so that the working efficiency of the battery plant is almost independent of load-factor.

As a matter of fact, there is of course no such no-load loss in the battery itself, the only such loss being that involved in keeping the automatic booster running, and at times when the load is not heavy enough to make it worth while to run the booster, the latter can be shut down, without any waste of stored energy, and the battery alone will still have a considerable steadying effect on the load.

A storage battery has the further incidental advantages that it serves as a standby which is capable of supplying power for a considerable time in case of a breakdown, or of an unusually heavy load on the generating plant, and that it often enables the generating plant to be shut down entirely at times of light load, as, for instance, at nights or over week-ends.

The point is often raised that storage batteries can only be used on direct-current systems, whereas a large proportion of power plants are three-phase. But it should be borne in mind that most systems of flywheel storage involve conversion to direct current, and that such conversion can be carried out equally well in connection with storage batteries.

It may be pointed out that, when a storage battery is employed for equalising an alternating power load, it is not necessary to convert the whole of the power load to direct current, but only that portion of it which has to be stored in the battery, so that it is only on that fraction that conversion losses are incurred. An automatic reversible motor-generator or rotary converter may be connected across the three-phase mains, and arranged to keep the three-phase load constant by alternately charging and discharging the battery which is connected to its direct-current end. In the case of most flywheel storage systems, on the other hand, the whole of the fluctuating power load which is to be dealt with by the flywheel has to be converted into direct current; this is notably the case with the well-known Ilgner system.

The author has not attempted to deal with the subject at all exhaustively; his object has been merely to draw attention to the fact that flywheel storage has its limitations, and to suggest that the employment of storage batteries, which has proved so successful in traction generating stations, may often be worth consideration in connection with power plants for mining and other purposes, even in cases where the supply is three-phase.

Electric Mine Locomotives. According to the *Engineering News* the number of electric locomotives employed in the anthracite coal regions of the United States have with three years—*i.e.*, 1903 1906 increased from 84 to 205, compressed air locomotives increased from 67 to 104 during the same period, while the number operated by steam decreased from 19 to 11. One of the primary causes of the increase in mechanical haulage is the extension of the mines and consequent increasing length of underground haul.

Switchgear for Mines.

BY H. W. CLOTHIER, A.M.INST.C.E.

(Of Messrs. A. Reyrolle & Co.)

One often hears the expression "Oh! that's good enough for a colliery," applied by the impatient to something which is not quite right but near enough for them. The term may survive, but the chances are that it will be understood in another sense. The colliery industry has of recent years been steadily gaining experience in the use of electrical power, and such experience cultivates a greater respect for electricity, and leads to a more careful selection of apparatus for controlling it; hence, whilst switchgear for mines should be of the simplest form the quality of the design, material and construction must be beyond question. It is difficult to conceive working conditions more severe than those which have to be contended with by some of the gear. We have to face the risks of injury to men and plant resulting from dirt, fire, water and mistakes. Taking these into consideration no work should require a better recommendation as to its quailty than that "It is good enough for a colliery"; therefore, the study of the requirements in mines is of no small interest, and a review of the trend of mining requirements may be useful even to users of electricity altogether outside the mining field.

Taking, as an example, one of the simplest installations having its own low-tension direct current generating plant of modest dimensions. The main switchboard is likely to be of the flat back type, the diagram, Fig. 1, being sufficient to explain the connections which comply with the general requirements. In diagram, Fig. 2, a main feeder cable leads down the shaft to a room at the pit bottom and is connected through a quick break double-pole hand-operated switch to the 'busbars of a distribution board, branch feeders being led away through plug fuses. In some of the early installations these distribution boards are enclosed in wooden cases; in others they are quite open, the rooms being fairly free from dust, &c., but in more modern installations the distribution may be effected from ironclad boxes of the type shown in Fig. 3. These boxes occupy less space and, being of strong external construction, they may be placed in any situation and so save a considerable amount of cutting which would be necessary if a room had to be made. Reverting to the diagram, Fig. 2, and tracing the respective branch cables which are loosely tied to props at the side of the road, the shortest of them terminate in switch panels, including ammeters, switches, fuses, and starting and regulating devices for pumps and haulages respectively. Under ordinary conditions the scheme so far does not differ a great deal from those seen above ground, but it must be remembered that it is working a few hundred fathoms below the surface of the earth and must have surroundings to suit.

Despite the authorised regulations we sometimes find open switches having an entire disregard for protection; occasionally a water trough having a rough bit of iron with a cable attached hung on a wooden rope, serves for a motor starter, because, maybe the proper starter has broken down and the improvised starter stowed away in an out of the way place, works, and it there remains until something serious happens or some Official chances to see it. These, however, are only incidental. The best designs are enclosed in covers, preferably those which make joints sufficiently tight to keep out the dust and water dripping from the roof, and they are made to preserve their insulation in a damp atmosphere. It is true that many places are quite dry and the air is fairly free from moisture and dust. This, however, is not always so, and much trouble may be spared by adopting standards throughout which will withstand the worst circumstances.

Proceeding further into the mine, the cable is branched off in several ways, and at the ends of these branches gate-end boxes are fixed conveniently near to the coal face. These boxes usually contain a quick break switch, two single-pole fuses, and plugging arrangement to take the flexible cable or "trailer" which joins up to the coal cutter motor starters. These plug boxes are moved outwards as the coal face recedes; there being a limit to the length of the trailer, and sufficient length of it must be available for the travel of the machine along the coal face. The gate-end boxes need to be exceptionally strong, for they may be used in dark and cramped situations a long way from the pit shaft and the treatment received is of the roughest; they are subject to injury through overloading because the miner is tempted to put in heavy fuses and force the motor in order to get through his piecework quickly, and also on account of the surroundings, mounted as breakages. Fig. 4 shows a section through one of these, but to be on the safe side in regard to convenience in re-fusing and for mechanical strength, nothing less than the ordinary 100 ampere size of handle should be used.

The last apparatus is the starter which is mounted upon the coal cutter frame. Although it is not a common practice at present, either the starter should have a strong design of no-voltage release or a no-voltage device should be included in the gate-end box, as very ugly accidents may occur if the starting switch is left on and the motor starts due to the circuit being closed at the wrong time. Such accidents occurring in a mine become protective remedies in themselves by virtue of the warning to others and the fact that the occurrences become history long to be remembered. The lessons are, however, costly. On the other hand, no-voltage releases are a difficulty on account of the excessive vibration of a coal cutter, and they

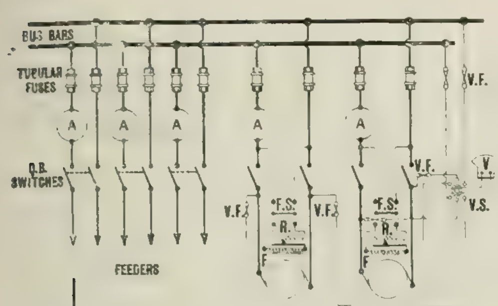


Fig. 1.—Diagram of Simple Generator Switchgear for a Direct-Current Private Installation.

V.F., Voltmeter Fuse.
V.S., Voltmeter Switch.
F.S., Field Switch.
F., Field.
R., Regulator.

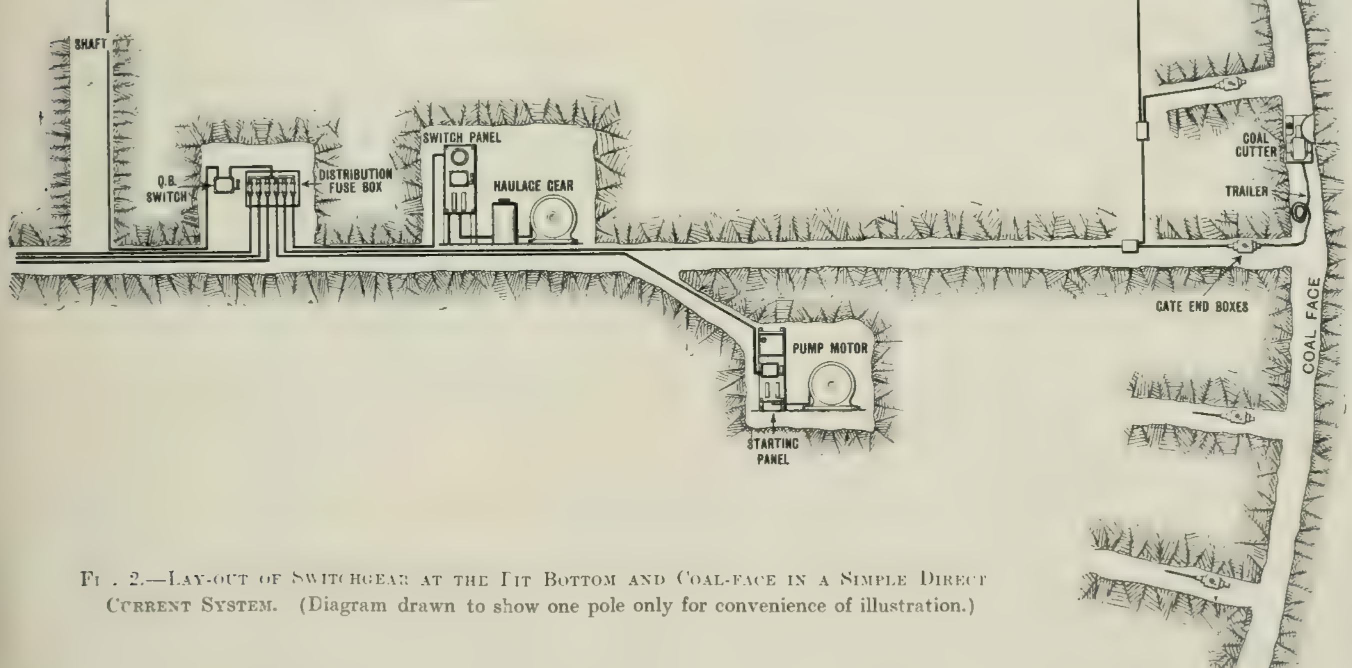


Fig. 2.—Lay-out of Switchgear at the Pit Bottom and Coal-face in a Simple Direct Current System. (Diagram drawn to show one pole only for convenience of illustration.)

they are in a narrow passage way, perhaps a quarter of a mile or more below daylight, with a roof of shale or rock which as likely as not is loose and may fall in. The men who operate cannot be experienced electricians; they are miners, and have to learn by experience, which is costly to some of them, for the coal cutter is not always a safe and easy thing to handle, it frequently gets jammed and then fuses blow and have to be repeatedly re-wired. Various systems of interlocking on the switches and fuses have been applied to prevent mistakes, but to arrive at perfection is extremely difficult. An example of an improved system is described later; in the meantime it is suggested that the switches and fuses, when used, should be designed for at least double the working current and voltage for which they are originally intended. As the fuses must be easily replaced the ordinary cartridge fuses are out of the question, the cost involved by replacements being too high. Porcelain handled fuses are as suitable as any provided they are of a very strong design to fulfil the service without constant must of necessity lead to more complication in the design and also in the use thereof. No doubt these are the main reasons why they are seldom found in use on coal cutters, but they may be combined with the gate-end switch, and this problem is dealt with by the new system described later. Fig. 5 shows a suitable form of motor starter with its cover removed. It is operated by a hand wheel and includes a starting resistance and rheostat interlocked with an automatic double-pole switch. The resistance used on this drum type starter consists of graphite sandwiched between metal plates having a large cooling surface. The construction withstands a considerable amount of overloading, and the operation is simplified as, thanks to the negative temperature coefficient of the resistance material, there is an automatic current growing effect which enables the motor to be started at all loads by holding the hand wheel upon the first stop position.

The cramped position in which the coal cutter has to be worked offers great temptation to the designer to cut down

dimensions. It is a fact that the coal cutter maker will place a restriction upon the space occupied by the starter and the motor starter maker has to fit his design into the dimensions or lose the order. The essence of sound design in such an apparatus is liberal space for good insulation and for the resistance to enable it to deal with the excessive loads with which the miners force their work. Electric driving of coal cutters has been brought into disrepute on account of the troubles experienced by the electrical design being cut too fine. In fact, many pitmen positively refuse to work the machines on account of the risks involved thereby.

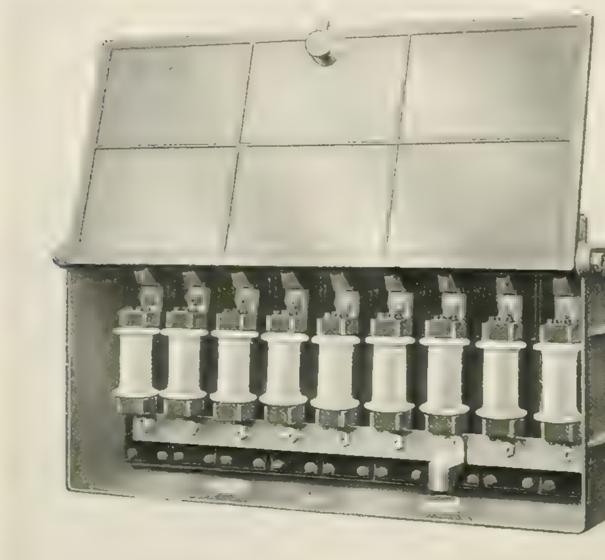


Fig. 3.—Ironclad Distribution Boxes.

On small installations the voltag is very erratic on account of the sudden fluctuation in the load occasioned by the starting and stopping of the haulages and c al cutters, which form a large proportion of the total load. This fluctuation is bad for the lighting and runs up the cost of lamp renewals, as it is difficult for the engine man to maintain a satisfactory regulation by hand. Such instances have been improved by the use of automatic voltage regulators which adjust the voltage by controlling resistances in the generator field circuits.

Lay out of Protective Gear for Bulk Supply from Local Power Stations.

Many large collieries in the north of England are equipped wi.h sub-stations at the pit bank taking supply of electricity

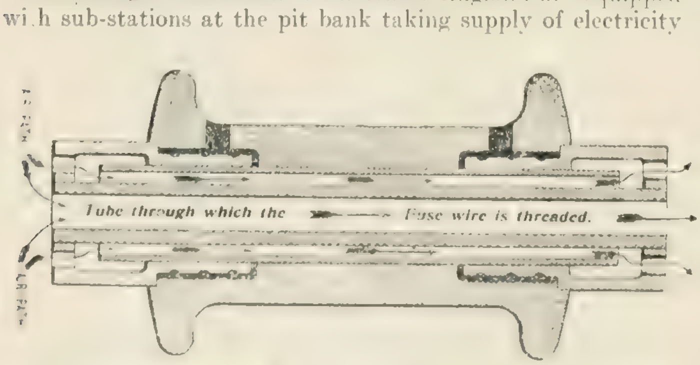


Fig. 4.—Section through Serviceable Tubular Fuse, Porcelain Handle Type.

in bulk from local power stations. In the Northumberland, Durham, and Cleveland districts, the engineering of these power stations is concentrated under one administration and the several power stations in different parts of these counties are all inter-connected, the aggregate capacity of the generating plant in the power stations at present amounting to about 50,000 h.p., and during the next year or so this amount is likely to be doubled. Under these circumstances collieries can obtain power at very cheap rates, they are relieved of the responsibility of their own generating plant, they effect a great saving in capital cost when starting a new pit, and they are assured of a steady supply, having behind them a source which will withstand the most erratic demand almost without flinching.

Considered from the colliery point of view, the power must be continuous under all exigencies, and from the supplier's point of view a fault occurring in one colliery, however serious, must not cause any cessation of supply to the others. A review, therefore, of the high-tension section of switchgear will not be complete without an explanation as to the method of connecting the colliery sub-station on to the cable network. Fig. 6 is a diagrammatic bird's-eye view of a power transmission scheme, one feature of the high tension and extra high-tension network being to ensure against the isolation of any sub-station due to a fault on any cable forming the network. Assume, for example, that a fault occurs at F between Marypit and Longthon, there will be a rush of current through the feeder No. 3, and also by the other way round through the overhead feeder from Distington, and with the ordinary overload protective devices the whole ring would be cut off from the power station. Also, in such cases, reverse current relays are useless for reasons which have been fully discussed elsewhere.

The system adopted, therefore, to give efficient protection is that now known as the "Merz-Price" discriminating system. This consists of inserting a current transformer at each end of

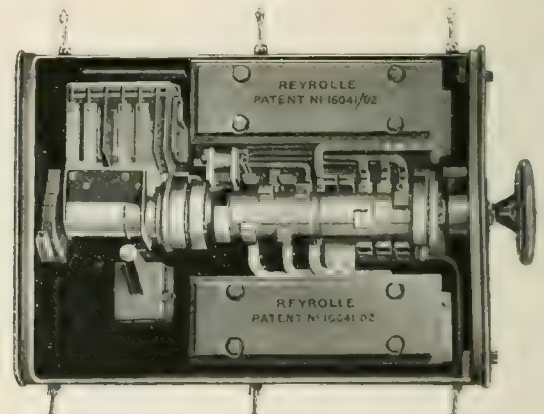


Fig. 5.—Drum Type Coal-cutter Motor Starter.

each cable forming the network. The secondaries of these current transformers are joined by pilot cable (*see* diagram Fig. 7), and connected so that, under normal conditions the E.M.F. at the two ends balance and there is no current flowing in the pilot. Should, however, a fault occur within the protected sphere the equilibrium is upset at once, current flows in the pilot and indirectly opens the switches at both ends. For example, referring to the diagrams, with a fault between Longthon and Marypit, the direction of the current at the respective ends is opposite, and therefore current will flow in the pilot and trip the relays at these sub-stations which in turn open the switches at each end cf the faulty cable instantaneously. Consider now what happens between Marypit and Distington; there is a momentary excess current through the overhead line, but it is equal in amplitude, phase, and directions at both end, that is the balance in the pilot is maintained and, therefore, the relays do not trip and there is no interruption. Thanks also to the instantaneous action, the fault does not hang on long enough to allow the pressure to fall and so even the synchronising machines at Distington remain in step. The rapidity in action is accomplished by decreasing the lag of the several components which operate when a fault occurs. Now, with this system the only components are the relays (lifting an armature about one sixteenth of an inch), and the mechanical parts of the switch which are to move in order to open the circuit. The former occupies such a minute interval of time that it

may be almost neglected and so the lag is really dependent upon the time taken by the switch in opening circuit. A switch (as mounted on the switchgear in Figs. 8 and 9), used exten-

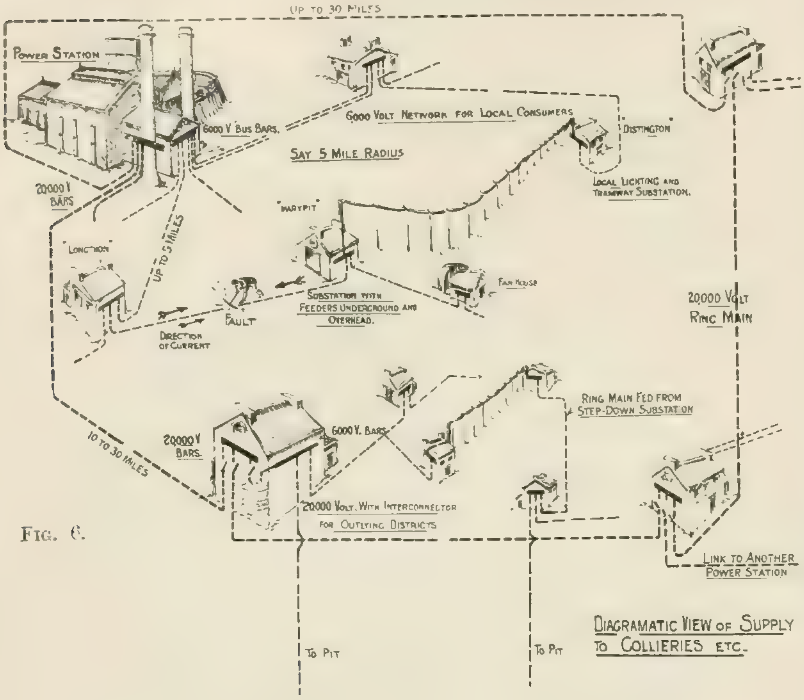


Fig. 6.

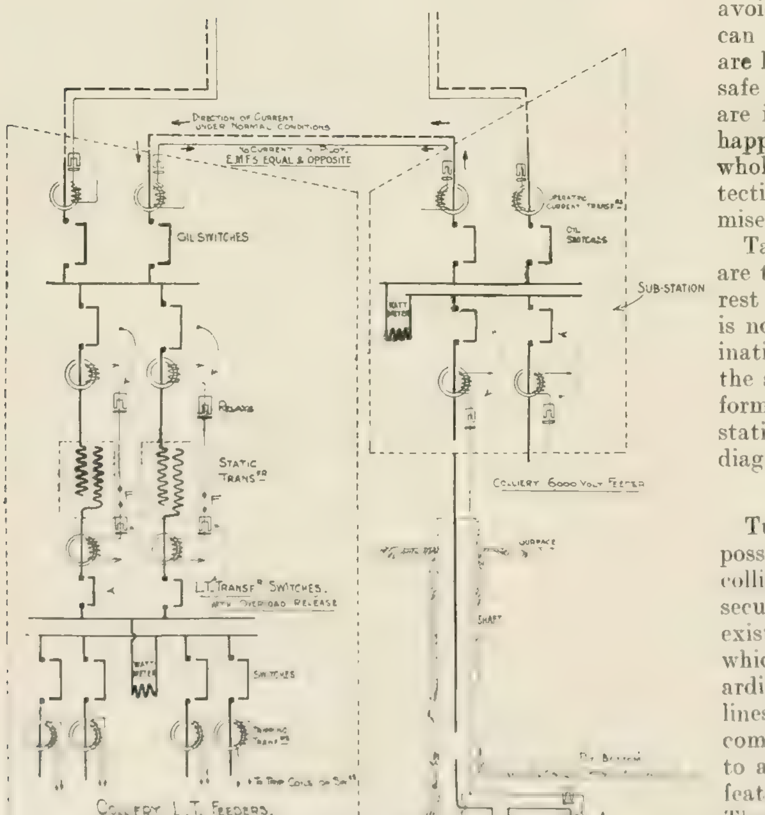


Fig. 7.—Diagram Drawn to show One Pole only to Save Complicating the Illustration.

sively in the Northumberland and Durham area, was tested and proved to operate in about one tenth of a second, this being the interval between the action of the relay and the complete interruption of the current. When compared on the same basis at the same time with several other well-known switches in common use, this was found to be at least one-half, and in some cases one quarter, of the time occupied by other designs. The quickness of action is of primary importance in clearing a fault, as thereby the amount of current taken by a fault is limited as also is the drop in voltage, and upon this depends the continuance of the supply throughout. On this reasoning devices which introduce intentional time elements into their action are to be avoided wherever possible. At the same time it is admitted that the Merz-Price system involves the cost of a pilot cable and on existing mains; this is a difficulty. On existing systems it is, therefore, a momentous matter for the supply undertaking to decide whether the cost of the pilot is justified by the advantages to the derived therefrom, but there is not so much doubt when laying a new network, because the system makes ring mains possible and so effects a great saving in the initial cost of the mains, which more than compensates for the cost of the pilot.

The other problem is to cut off a fault on one consumers' premises without interference with the others. Fig. 7 shows diagrams of two kinds of colliery sub-stations, one for stepping down, and the other taking the supply directly into the pit to step down sub-station or high-tension motors at the pit bottom. A fault occurring on the static transformer will be cleared by the same system as described for feeder protection; a fault on the secondary 'bus-bars will be cleared by the pilot fuses at F. There will be a slight time lag on these, but the choking effects of the static transformer between the fault and the high-tension network limits the fault current and so avoids external disturbance. The colliery low-tension feeders can also be protected with time limit overload and as these are likely to be set for a much lower rating, they are fairly safe to trip out before the two transformer switches which are in parallel, but if not (as a remote contingency this may happen with a very bad short close up to the switchgear), the whole pit will be isolated, but, thanks to the main feeder protection, it will only inconvenience the consumer on whose premises the fault has occurred.

Taking the second sub-station, the high-tension leads which are taken directly down the pit cannot be (with safety to the rest of the system) protected by over-load devices, but there is no reason why they should not be protected by the discriminating system, the pilot cable being taken down the shaft by the side of the main cable. In this instance the current transformers and relay are made to protect both the cable and the static transformer and would be connected as shown in the diagram.

Switchgear Construction.

Turning now to the detailed construction it would not be possible here to give a *résumé* of the many types employed in collieries. On some an attempt has been made to obtain security, and with others it is evident that the essence of their existence is cheapness in first cost. It requires time to show which type of design will survive, but, unfortunately for standardisation, we have too many authorities acting on diverse lines instead of taking a standard course, and so each job that comes along affords scope for the several minds engaged thereon to attempt something fresh, having fixed upon some specific features which put other considerations in the background. Thus, as time goes on, the fashions in designs are blown about by the demand, and hundreds, even thousands, of ideas are developed. There are at present employed in dozens, one might almost say hundreds of draughtsmen and others occupied in scheming out new designs and estimates for switch work, not to mention many ingenious thinkers outside drawing offices and switchgear manufacturing concerns, who direct their thoughts to this apparently simple subject. Of the thousands of ideas put on to paper only a very small percentage survives and then, having gone through the expensive process of development and manufacture, many of them fizzle out of practice through some unforeseen defect, or because something else is found to do the work at a lower cost.

However, it may be safely said in future that the predominating factors will first be the rules and regulations enforced by the Board of Trade, the Home Office, fire insurance companies, &c., and secondly the amount of power behind the switchgear and the resistance of the cable between the substation and the source of power, or, in other words, the measure of the explosive effect occasioned by the switchgear operating under fault conditions.

Briefly the switchgear requirements may be stated as follows :—

1. Accidental contact with metal whilst alive must be impossible.

FIG. 8.—REYROLLE E.H.T. IRONCLAD SUB-STATION SWITCHGEAR.

2. The insulation must at all times withstand the impressed pressure, whether under normal or abnormal conditions

3. The design should not allow dust, dirt, moisture, or vermin to diminish the insulation.

4. Fire risks must be reduced to a minimum.

5. There should be a minimum amount of cleaning necessary to maintain the gear in a good condition.

FIG. 9.—HIGH AND MEDIUM PRESSURE IRONCLAD SUB-STATION SWITCHGEAR.

6. Parts requiring inspection and cleaning must be readily and absolutely detached from the gear to enable such operation to be carried out with safety.

7. The sectional area of conductors must be such as to carry without deterioration the maximum overload to which they are liable.

8. Moving parts such as switch mechanism must be situated where it can be observed, and chance of switches sticking must be reduced to a minimum.

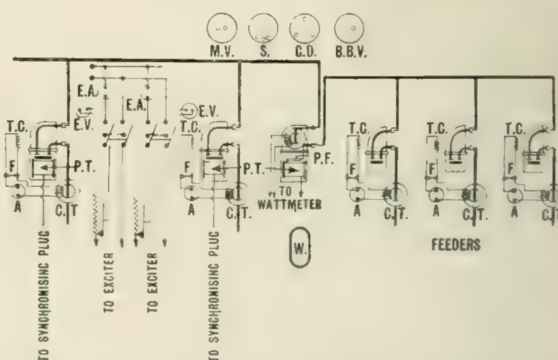
9. Automatic protection to be included which will isolate the faulty section without interference with healthy sections.

10. The construction to be mechanically strong in order to resist rough usage and accidental impact.

11. The switches must be capable of breaking, without disturbance to other parts, the maximum power which may instantaneously pass through the switch when acting under the worst fault conditions.

12. The simplest construction is required consistent with economy in operation and low maintenance costs, and the cost of building work consequential to the gear must be a minimum.

Figs. 8 and 9 show designs manufactured by the writer's company to comply with the foregoing conditions, and, incidentally, this is the type of gear which has been used, to a large extent, in the districts before mentioned. The former illustration is from a photograph of a three-phase 6,000 volt switchgear with two incoming feeder panels (to the left) and three static transformer panels (to the right). It consists of a complete set of iron castings which very thoroughly enclose the whole of the conductors, and also the insulators. The 'bus bars and transformers are sealed in insulating compound. The oil break switches are mounted on rollers and can be quickly withdrawn (this being only a "one man job"). In the event of a switch being withdrawn, the orifices on the fixed part of the gear are automatically closed up by iron doors which may be padlocked off, thus effectually preventing the switch from being pushed home again at a time when men may be engaged on the line. The main object in the construction has been to fulfil the ideal for such conditions as colliery working, either above or below ground.



G.D., Ground Detector. S., Synchroscope. P.T., Potential Transformer. C.T., Current Transformer. F.B., Fuse Box. W., Wattmeter. A., Ammeter. M.V., Machine Voltmeter. B.B.V., 'Bus Bar Voltmeter. T.C., Trip Coil. E.V., Exciter Voltmeter. E.A., Exciter Ammeter. F., Fuse. P.F., Voltmeter Fuse.

FIG. 10.—DIAGRAM OF CONNECTIONS, SINGLE-PHASE SHOWN FOR SIMPLICITY.

The cleaning factor is of great importance because one of the most common occasions for accidents is during cleaning operation, and sectionalising for cleaning makes the general lay out of the gear more complicated and costly. In this respect the type of ironclad gear described above is of great value and it would be an oversight not to take such points into account when considering the initial cost of switchgear.

The second illustration is of a high-tension and medium pressure switchgear to correspond, and it embodies the same general features except that the 'bus-bars are not sealed in compound. It will be noted, however, that the whole set of connections are securely covered from the point where the cables enter the transformer panels at the distant end to the cable glands sealing the ends of the outgoing feeder panels which are to the right of the summation wattmeter panel. It will also be noted that neither the extra high tension or medium pressure gear needs any special building or concrete work, and, having no exposed connections, there is no occasion for a passage way behind; considerable economy in building and space occupied is thus effected.

High tension Installation.—Pressures which exceed 650 volts but cannot exceed 3,000 volts between any two conductors or between any one conductor and earth are deemed high tension

by the special Home Office Rules for the Installation and Use of Electricity in Mines. Three phase, 2,750 volt, between phases, appearing under that heading, is a convenient system, and has been adopted in several mines in the North of England and Wales, both for private installations and for collieries taking bulk supply. Figs. 10, 11, and 12 illustrate an instance of a main generator switchboard for the former and similar constructed gear may be used for main distributing centres. According to the regulations, this system allows the larger motors in the mines, such as are required for pumping, haulage, &c., to be supplied direct, and step-down transformers can be installed in the pit for the supply of low or medium pressure for other purposes. The switchgear required in connection

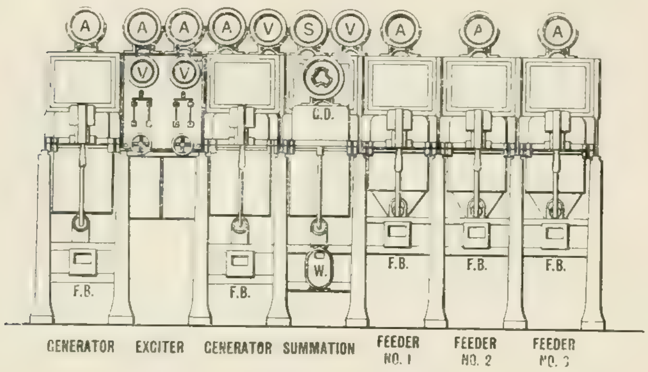


Fig. 11.—Front Elevation.

with the motors exceeding 10 b.h.p. in a machine room underground, must be provided with a switch and ammeter fixed near to the motor, and must be capable of protecting the motor and its starting switch. These are not fixed in gaseous positions, and so very perfect tight joints are not essential, but they should be sufficiently enclosed to keep out dirt and vermin, and must also be locked to avoid the human element risks. A pan l to comply with these conditions is shown in Fig. 13. This panel is also provided with a small lighting transformer for the purpo e of lighting the room, and the lamps indicating that the panel is alive. It has been called a "wall type panel" the title describing its method of support.

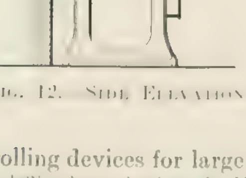


Fig. 12.—Side Elevation.

Starting and controlling devices for large high-tension induction motors are very difficult to deal with. Heavy current rushes and pressure rises occasioned by the repeated switching operations impose a severe strain upon apparatus, and call for scrutinous attention to details in mechanical construction and insulation. Liquid resistances are used to a large extent on account of the low cost when compared with a metallic resistance or choke coils. But even the best liquid resistances are somewhat risky and difficult to maintain; the risk of leakage, the evaporation of the water, and corrosion occasioned by the salt all tend to deterioration and trouble. The grid resistance, as shown in Fig. 14, provided it is well made and not over loaded, is a more serviceable form of resistance for dealing with large currents. Special care has to be given to the mixture of the metal, and cast metal grid resistances cannot compare

in first cost with the liquid resistance, and when the latter practically saves the cost of the controlling rheostat, the user must have some very decisive local objection to the use of liquids before he will entertain the use of metallic resistances. However, there are many undoubted advantages to be derived from the use of the latter and, therefore, the type shown in Fig. 15 will be of interest. This consists of a multiplying rheostat with connections for regulating a resistance in the rotor circuit, the drum and contacts are completely immersed

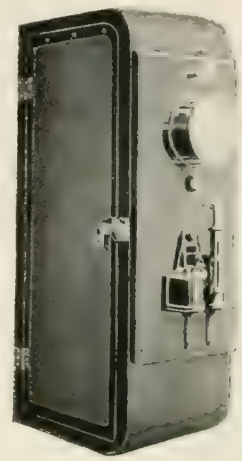


Fig. 13.—High-Pressure Motor Panel with Three-phase Automatic Switch.

in an oil tank on the right side of the frame, the other tank surrounds the high-tension oil-break switch which is interlocked with the drum, and the whole is operated by motion of the hand wheel. The controller is arranged for reversing the motor and for speed regulation in either direction, this being effected by merely turning the wheel in the clock-wise or anticlock-wise direction.

Enclosure of Switchgear.—Protection against explosions on switching apparatus used in very fiery places has been met by ventilating the closed boxes by a form of louvre made of sheet-iron strips placed one above the other with a small air space in between. This arrangement, however, is more serviceable for the ventilation of motors than switchgear, the narrow space

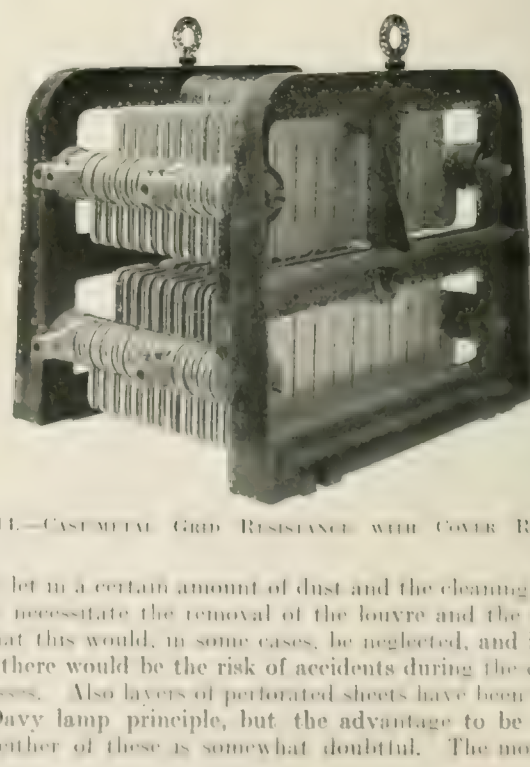


Fig. 14.—Cast-metal Grid Resistance with Cover Removed.

would let in a certain amount of dust and the cleaning process would necessitate the removal of the louvre and the chances are that this would, in some cases, be neglected, and in other cases there would be the risk of accidents during the cleaning processes. Also layers of perforated sheets have been used on the Davy lamp principle, but the advantage to be derived from either of these is somewhat doubtful. The most usual

devices have rubber, felt or rope joints on doors, &c. These may be called gas-tight, but the term is open to question as, though a good explosion proof joint may be made in the first instance, it cannot be maintained for all times, and in the case of boxes often opened the best of rubber or packed joints are likely at some time to be no better than a plain metal to metal surface contact. It is imperative, however, that the design should not allow water to drip from above or dust to get inside. It is

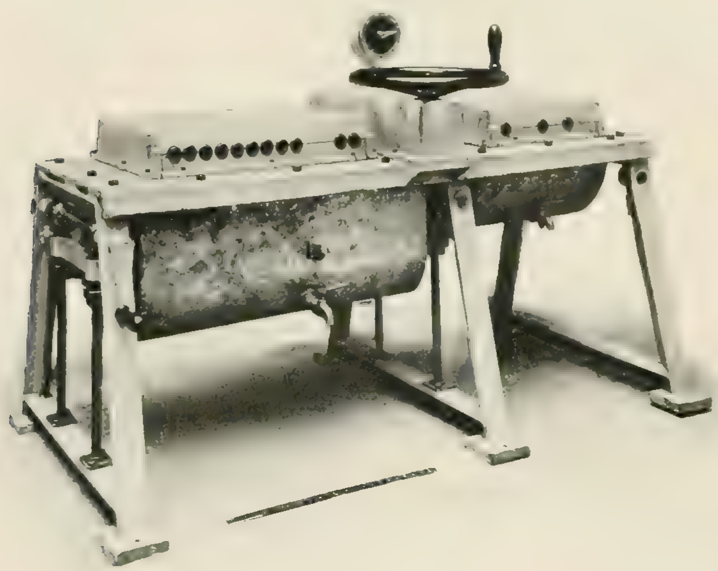


FIG. 15.—HIGH-PRESSURE CONTROLLER FOR LARGE HAULAGES, &C., IRONCLAD AND OIL BREAK.

an open question as to what is actually necessary to avoid danger due to explosion of gases. But it is certain that men cannot work in places where the condition of the air is such as would cause an explosion in the event of a flame proceeding from a switch box, and to make everything absolutely pressure tight and to insure that the joints would be always so would

enable the circuit to be broken satisfactorily and without burning or serious arcing when acting under the worst conditions. A standard reference to clearly discriminate the meaning of the several terms in general use such as protected, semi-enclosed, water-tight, gas-tight, flame-proof, totally-enclosed, explosion-proof, &c., used would be very useful.

Earthing and Gate-end Boxes.—The earthing of coal cutters is one of the serious difficulties coal mining engineers have to face at the present time. There are many mining installations which have no proper earth connections to the cases of the motors or switchgear, and so in the event of a fault occurring within such apparatus, the case is alive and persons touching it are subjected to shocks. Fatal accidents have been recorded on account of this defect, and at the coal face the danger is specially prominent. Some trailing cables are used without any pretence to an earth connection, in other cases the trailer has an earth wire armouring wound on the outside. Even the latter does not ensure safety, because the wire is very liable to be severed by rough usage and then the earth circuit is incomplete. A better plan is to have the ea th conductor within the trailer. It may be of interest to colliery engineers to know that a system is now in use which will not allow the gate-end switch to close unless the earth connection is complete, this will also have the additional advantage that the gate-end switch may be opened by operating a small lever attached to the coal cutter. Also the switch cannot be closed unless there is voltage and it will open automatically in the event of the pressure failing for any reason. Fig. 16 illustrates a gate-end switch for use in conjunction with this system, this consisting of a time limit automatic overload switch with a cast-iron tank and cover, with a sealing bell on the one side for an armoured cable and a socket on the other to receive a plug with pilot leads attached to the trailer. Such a device should overcome the objection to electric motor-driven coal cutters which has been so serious that the removal of the electric motor from the actual coal cutter frame has in some places been threatened.

To conclude it may be said that whilst economy in first cost of switching apparatus is a powerful factor, at the same time there is an urgent demand for safe designs and the trend has for some years called for accessories well made and completely ironclad. We now see before us the same possibility in the

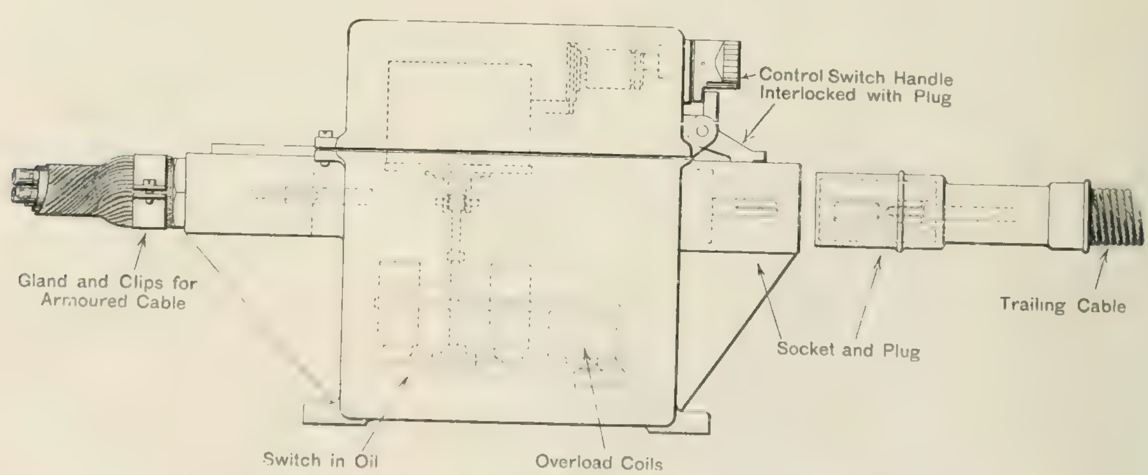


FIG. 16.—CAST-IRON GATE-END BOX, WITH AUTOMATIC SWITCH.
(Coates' design for use with Fisher's patent protective system).

be difficult. Then, if such boxes are made pressure tight they are in danger of exploding due to the expansion of air within the box when a circuit is automatically opened as by a fuse when acting on a short circuit. It would seem that the main objects should be to avoid the use of inflammable mat rial and to have complete enclosure to prevent risks of shocks, and to prevent deterioration of insulation by keeping out dirt, wet and vermin and also to allow such clearance, &c., inside to

main switchgear, and so the future may see the universal adoption of a complete and continuous metallic screening from the generator, through all the intermediate switchgear, transformers, &c., to the motors and so the conductors throughout will be like an ideal cable, and the object in switchgear design should be to carry the simile as far as it is possible in order to make the switchgear also resemble an ideal cable in simplicity.

Some Examples of Switchgear for Mines.

When electrical power was first adopted for colliery work, the pressures employed were usually very low, the engineers being content to transmit current at low pressure over considerable distances, with the consequently extensive losses in the transmission cables, rather than face the risk of trouble that was at one time incidental to the use of high pressure. Colliery engineers are, however, now being slowly but surely convinced of the fact that with properly-designed switchgear, and with the recent improvements in the insulation of cables and motors, &c., that it is actually easier and safer to handle comparatively small currents at high pressure than to handle large currents at low pressure. Besides the greater facility in handling, the first cost of a plant of any magnitude is considerably less and the losses of transmission reduced almost to nil by the use of current at a suitably high pressure.

Houston Co., the 6,000 and 2,000 volt boards being designed on the cellular system. The switchgear and apparatus is totally enclosed in cells built up of incombustible moulded stonework, the apparatus being rigidly fixed in the interior of the cells. Any section of the switchgear can be entirely cut off and isolated from the system without interfering with the remainder, and can be inspected, cleaned or repaired without danger.

The apparatus is not covered with any insulating compound or viscous fluid, but is perfectly accessible, and all parts are easily inspected and, if necessary, replaced with the minimum of inconvenience. The switches used for making and breaking current are oil immersed, but the design is such that the oil tank can be readily lowered away from the switch, leaving it exposed for inspection. Fig. 2 shows a similar switchboard suitable for a pressure of 3,000 volts and for dealing with 2,000 kw. This board was installed by the B.T.-H. Co. to the order of the Powell Duffryn Steam Coal Co., at their Tredegar Colliery, and is also of the cellular type, and interlocking devices are provided whereby it is absolutely impossible for anyone to obtain access to any bare metal carrying current until

Fig. 1.—H.T. Switchboard at the Murton Colliery.

An excellent example of a colliery equipped according to the most modern engineering practice is the Murton Colliery of the South Hetton Coal Co. Three-phase current at 6,000 volts pressure is brought to the colliery main switchboard which is designed to deal with 3,000 kw. This board is shown in the centre of Fig. 1. The current is transformed down to 2,000 and 500 volts respectively by means of transformers situated in the basement below the switch room. The 2,000 volt circuits are dealt with by the switchboard shown on the right-hand side of Fig. 1 and the 500 volt circuits by the switchboard on the left-hand side of the illustration. The larger motors for haulages, pumps and fans, both on the surface and underground, are fed direct by the 2,000 volt circuits. The smaller motors on the surface are fed by the 500 volt circuits. The switchboards were made by the British Thomson-

the current is completely cut off from the section of the board which it is desired to inspect, clean or repair. The enormous advantage of being able to carry current at high pressure right up to the motors themselves with the feeling of security that has been proved to be justified in the use of the type of switchboard described above should appeal very strongly to the colliery engineer.

In considering the lay-out of a mine distributing system it must not be forgotten that it covers a very extensive area and that the distribution losses, if the supply voltage be low, are likely to be considerable. As a set off against this, the danger involved by the use of high-tension currents must be taken into account and to make their employment possible very special precautions must be taken throughout.

The Union Electric Co., of London, have made a speciality of this class of work, and in Fig. 3 we illustrate one of their high-tension mine distributing boards suitable for erection in a mine gallery. An essential feature is that all live parts are

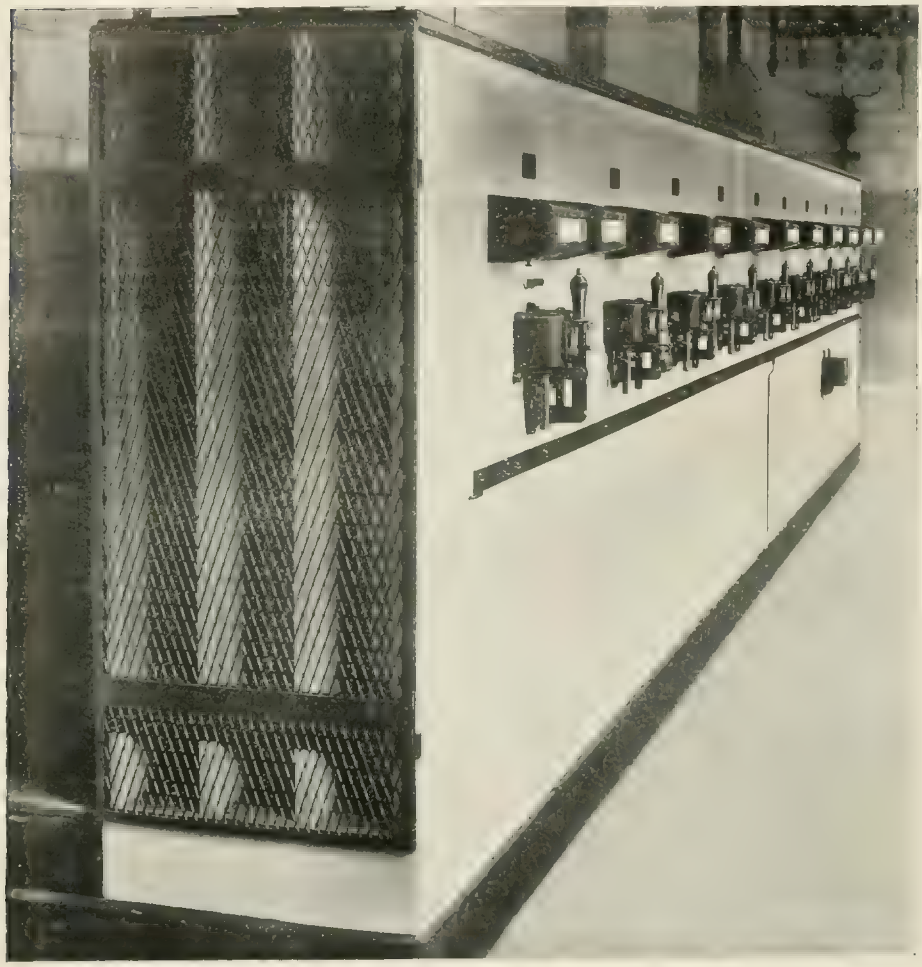


Fig. 2.—B.T.-H. Switchboard at Tredegar Colliery.

totally enclosed. The lower case, which is made of sheet iron contains the high-tension 'bus bars from which tappings are taken off to the various switch fuses. From these bars the lighting of the gallery and the board itself is supplied through voltage transformers, while the ammeters are connected in the usual way through current transformers fixed on the appropriate circuits. The switch fuses are of the oil-bath type. To render the 'bus bars dead for periodical inspection and cleaning, an isolating switch is fixed in the lower case and interlocked with the doors in such a manner that it must first be pulled out before the doors can be opened. Also, these doors must be closed before the 'bus bars can be again connected to the system.

Another speciality supplied by the Union Electric Co. is an arrangement for regulating the current in the shunt coils of generators working in parallel. This allows each regulator, or any number of regulators, to be operated from one central position.

This arrangement is easily adapted for hand working. The centre wheel is the "master," and the separate regulator shafts can be locked with it by turning the small lever which is arranged in the centre of each individual regulator hand wheel through an angle of 180 deg.

The arrangement for automatic control which is shown in Fig. 4 is not essentially different from that described above. A small series wound motor is connected to the main shaft through suitable gearing, its control, and, therefore that of the field regulators, being effected in the following manner. A special form of contact voltmeter is so connected that any variation in the line pressure causes the circuits through the relays to be made or broken (*see* Fig. 5). If the pressure of the circuit rises, the voltmeter completes the circuit through the relay r_1. This closes the solenoid switch e_1 and thus the motor circuit. If the line voltage drops connection is made through r_2 and e_2, and the motor revolves in the opposite direction. The lamps connected across e_1 and e_2 are for the purposes of absorbing the current induced when the field circuit is broken, and, to prevent damage to the apparatus, contacts are also fixed and connected to a solenoid switch (r_3). Should the regulator arm inadvertently, or otherwise, be moved beyond the end contact the motor circuit is broken by means of this switch. The motor drives the main shaft through a claw coupling, and can be thrown out of gear by a small lever fixed on the front of the board, thus allowing regulation to be effected by hand if need be.

The provision of some type of automatic regulator is almost a necessity in a mine generating station. Its advantages are obvious, for it does away with constant attendance on the board, and allows a much better voltage regulation to be obtained, as the continually varying load makes an efficient and exact hand regulation extremely difficult. The arrangements above described allow a constant ratio of excitation to be maintained automatically. For instance, when two machines of different outputs are working in parallel, we understand that there is no chance of the smaller taking more than its share of the load while at the same time regulation can be effected in accordance with power requirements.

Another arrangement allows the pressure across the armature terminals to be kept constant. The apparatus, which is applicable to both direct and alternating currents, consists essentially, as shown in Fig. 6, of a solenoid, to the core of which is attached a trough of insulating material containing mercury. The ends of the resistance spirals

Fig. 3.—Union Electric Co.'s H.T. Distribution Board for Mining Work.

are fixed above this trough in such a manner that as it moves down or up more or less of the spirals are placed in circuit. This solenoid is fitted with a damping device for the purpose of preventing excessive oscillation, and the sensitiveness of this arrangement may be altered by filling the dashpot with glycerine more or less diluted with water. The stability of the movement can be changed by altering the position of the weight on the lever seen near the top of the figure.

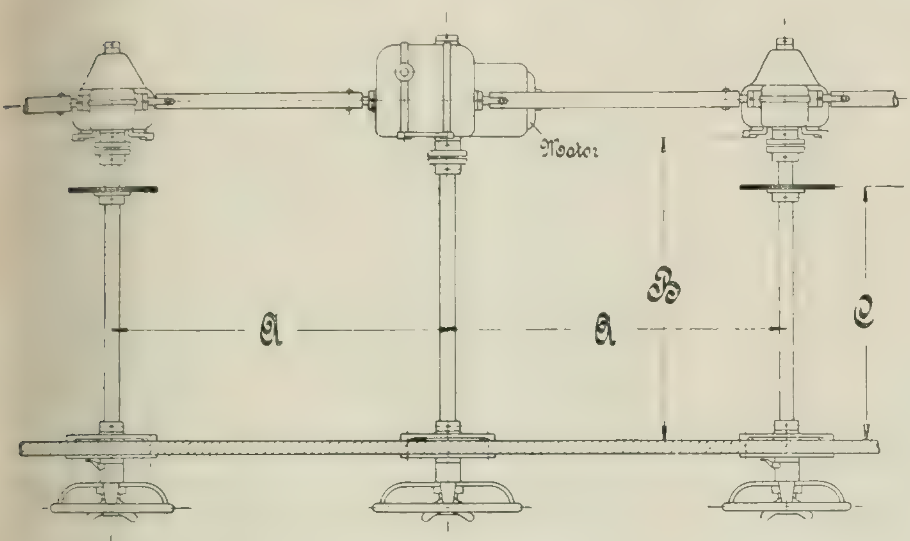


Fig. 4.—Diagram of Union Electric Co.'s Arrangement for the Automatic Control of Generators.

The operation of this switch is as follows: When the pressure falls the magnetic pulls naturally become less, and the balance weight is enabled to lift the core. This short circuits more resistance spirals, thereby decreasing the external resistance and raising the pressure to its normal value. Any further motion of the lever is checked by the increasing strength of the magnetic pull.

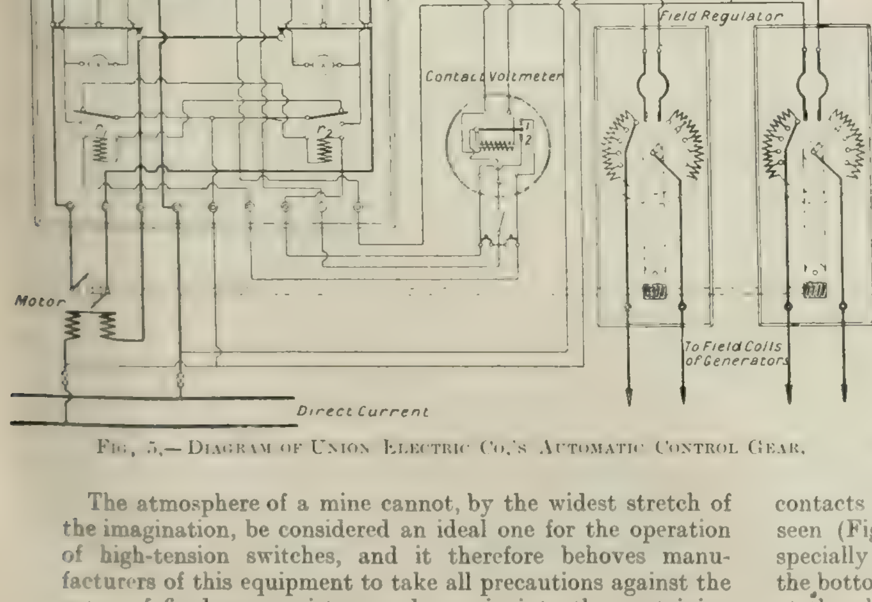


Fig. 5.—Diagram of Union Electric Co.'s Automatic Control Gear.

The atmosphere of a mine cannot, by the widest stretch of the imagination, be considered an ideal one for the operation of high-tension switches, and it therefore behoves manufacturers of this equipment to take all precautions against the entry of firedamp, moisture and vermin into the containing boxes. The Electrical Co., of London, have made a wide study of this subject and have produced some very interesting apparatus specially designed for this work.

The types described below are the outcome of long experience, and special stress has been laid on the compactness of all the switch arrangements, the small types being contained in cast-iron boxes, while those of large size are fixed in chambers made up of sheet and angle iron. An interesting point about

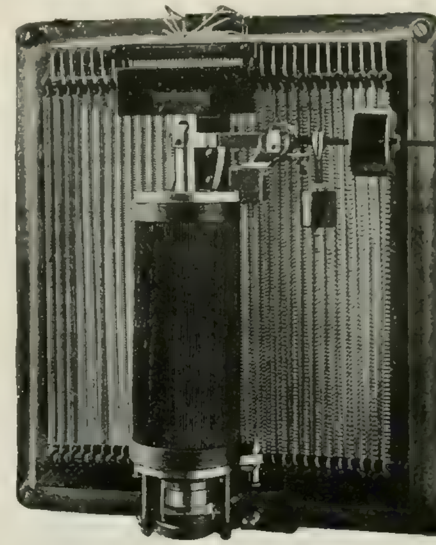


Fig. 6.—The Union Electric Co.'s Control Rheostat.

this switchgear is that it is impossible to operate it with the door of the case open. And at the same time fuses can be changed or the switches repaired without danger to the attendant so long as the door is open.

A typical switchboard for mining work contains five panels fitted with these switches, adapted in this case for three-phase working. The switch box consists of a strong wrought iron case containing the necessary switchgear fuses and ammeters. This presents great advantages, especially in mining work, over more open equipment. These switch boxes can also be used in other places than mines where sparkless operation is especially desirable, and they are further made watertight so that their employment in the open is also possible. These switches are constructed in several standard sizes up to a capacity of 200 amperes at 7,500 volts. These extra high-tension switches consist of a three-pole remote-controlled oil switch and fuse

Fig. 7.—Electrical Co.'s Oil Switch for Mining Work.

contacts together with the necessary terminals. As will be seen (Fig. 7) its design is very compact, thus making it specially suitable for use in mines. The cables are led in at the bottom of the case, a gas and water-tight joint being made at the glands.

As is well known, the British Westinghouse Company have for some years been devoting a considerable amount of time and money to the development of switch and control gear of all kinds to cope with the exacting conditions met with in industrial and, sepecially, mining work. In our Industrial Supplement, Dec. 13, 1907, we described their inverted-type unit-pillar switchgear formines, and this particular pattern of switch pillar has been—and is being—very extensively used. The switches, &c., are completely enclosed in substantial cast-iron pillars, which afford a very complete mechanical and fire-risk protection. A unit type of construction is employed so that the pillars may be utilised either as single units or mounted together upon 'bus-bar chambers to form distributing boards for any required number of circuits. The whole of the interior fittings are accessible through the door at the front, so that the pillars may be placed against a wall, the cables being run to the leading-in boxes on the top of the pillars. This arrangement reduces the necessary floor space to a minimum. These pillars are suitable for use on circuits up to 3,300 volts.

The Westinghouse high-tension three-phase switchboards for underground work are also widely known, and such have been installed in a number of collieries. The rear of these high-tension switchboards is usually divided up by slates partitions in such a way as to form a separate cubicle at the back of each panel, each cubicle being provided with an iron door. The back of the switchboard is, therefore, entirely enclosed and dustproof.

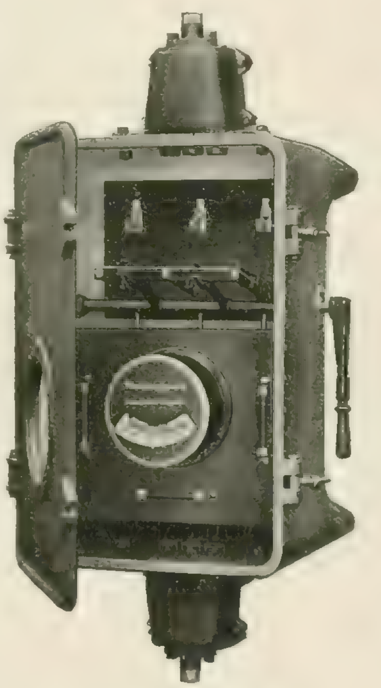


Fig. 8. Westinghouse Switch Box for Non-fiery Mines.

Two switchboards for 3,000 volt services have been erected by the British Westinghouse Co. in the West Elliott Pit of the Powell Duffryn Steam Coal Co., South Wales. Each board consists of two incoming and four outgoing feeder panels, each of which carries an automatic oil-break circuit switch. A second oilbreak switch is also provided on each panel for isolating from the 'bus bars the apparatus contained in the corresponding cubicle, this switch being interlocked with the door of the compartment behind in such a manner that access cannot be gained to any particular cubicle until the apparatus within has been rendered "dead."

For non-fiery mines, the switchbox illustrated in Fig. 8 can be used for controlling polyphase induction motors or isolated circuits. It is provided with a quick-break switch, enclosed-type fuses and ammeter. Trifurcating boxes, forming extensions to the box, are fitted at top and bottom to take the incoming and outgoing three-core cables. Such switch boxes are suitable for voltages up to 600 and for currents up to 200 amperes.

The standard Westinghouse unit-type motor control gear for continuous current circuits up to 600 volts is already very well known and may be used in non-gaseous mines; but a new and improved type, specially suitable for use in fiery mines, and adapted for both alternating and continuous current circuits has recently been introduced and is shown in Fig. 9, as well as a special fuse box. Both are flame tight and explosion proof, and in Fig. 9 are shown mounted on a channel iron frame and surmounted by an ammeter in a dust proof case, thus forming a convenient arrangement for the control of motor or lighting circuits in mines, &c. This type of box is ribbed in the interior to make it strong enough to withstand any internal explosion, and an important feature of the design is the provision of a V-shaped metal projection on the underside of the rim of the cover and a corresponding V-shaped groove in the rim of the base. This tongue and groove are accurately turned and fitted, and together form a deep joint, the dimensions of which were only finally determined after much experiment. The arrangement provides a long and narrow metallic path from the inside to the external atmosphere; and any gases that tend to escape in the event of an internal explosion are cooled as they force their way round the V, their temperature being sufficiently lowered to prevent the explosion of exterior gases. The leads and the switch spindle are made gas-tight by being carried through stuffing boxes. An important feature which prevents careless handling is the fitting of an interlock, which makes it impossible either to open or close the switch unless the cover is properly screwed down in position. Hinged bolts and winged nuts are used for fixing the covers.

The explosion-proof fuse box shown below the switch in Fig 9 is similar in design to the switch box, and an additional interlock is fixed, so that the fuse box cannot be opened except when the switch is "off." We understand that this type of apparatus is giving every satisfaction in very fiery mines.

As is well known, the British Westinghouse Company make a speciality of the manufacture of oil-break switches, and

Fig. 9.—Flametight and Explosion-proof Interlocked Switch and Fuse Boxes.

Fig. 10. Westinghouse Oil-Break Switch.

they are constantly developing improved patterns. One of the latest of these is that illustrated in Fig. 10, where it is shown mounted on angle-iron battens. This new construction is exceedingly compact, strong, and reliable, the case being of cast iron, and weather, water, and dust-proof and gas-tight. This switch is suitable for any voltage up to 3,300, is made either two or three pole and can be fitted with no-voltage release when necessary. The handle has a "loose action"—that is to say, the switch cannot be held in the "on" position if the circuit conditions are unfavourable. Trifurcating or junction boxes or glands for any type of cable can be attached to the case, and either an ammeter or voltmeter (or both) can be mounted on the top thereof. This switch is said to be eminently suitable for use in fiery mines, as it conforms to the Board of Trade regulations in every particular.

In order to comply with the regulations, the British Westinghouse Company are developing an entirely new line of cheap industrial control panels with totally enclosed oil-break switches and no-voltage releases; also face-plate motor starters for polyphase motors—with or without no-voltage and overload release, and, lastly, a new type of air-break circuit breaker, for small currents and with no-voltage release. This can be fitted in a cast iron case when necessary.

In connection with switchgear, a description of the Woollis croft liquid starting resistances, made by the SANDYCROFT FOUNDRY Co., may not be out of place here. They differ from all other liquid starting resistances in being totally enclosed, and consist essentially of a metal drum mounted on two centres about which it can freely revolve. In the lower part of the drum is a solution of caustic soda which remains stationary as the drum is rotated in the operation of starting and stopping the motor. In the upper part of the drum and

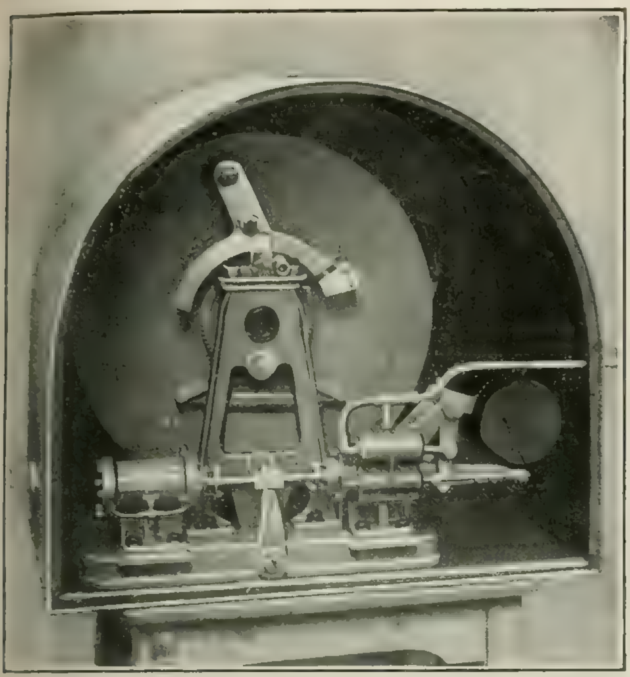


FIG. 11. SANDYCROFT LIQUID STARTER.

attached to, but insulated from it, are blades which dip into the solution and are short-circuited when fully immersed, thus cutting out the resistance. The apparatus is particularly suited for starting up machinery working intermittently.

Thus, in the case of the starter shown in Fig. 11, this controls a motor-driven air compressor and is operated automatically by variation in the air pressure. For this purpose two limits are fixed for the air pressure at which the motor is automatically started or shut down. The starter is enclosed in a watertight box, the cover of which is shown removed in Fig. 11, so as to allow the arrangement of the apparatus to be seen.

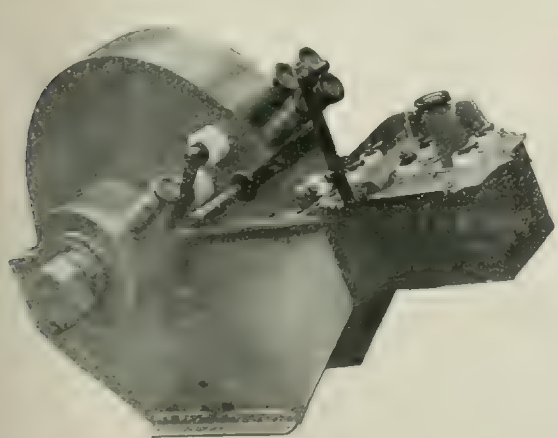


FIG. 12. SANDYCROFT GAS PROOF LIQUID SWITCH.

Fig. 12 illustrates the latest development in three-phase water-cooled reversing controllers. It has been designed by the Sandycroft Foundry Co. especially for use in fiery mines, in connection with underground haulage gears, and it is capable of controlling the speed of a 100 H.P. three-phase motor down to half the normal for 30 minutes in each hour without the liquid boiling. All the contacts are immersed in oil, and the reversing switch, in the stator circuit, is interlocked with the controller which is in the rotor circuit, so that it is impossible to reverse the motor without first bringing the controller handle to the "off" position.

The controller consists of two separately insulated blades connected to two slip rings of the motor, the containing vessel being connected to the other slip-ring. The blades are spaced so that the resistance between blades is equal to the resistance between a blade and the containing vessel, this latter being "earthed." Ordinary mine drainage water may be passed through the cooling tank as it does not come into contact with the electrolyte.

The advantages claimed by the makers for this type of controller are: (1) Freedom from sparking; (2) practically no evaporation or creeping of the liquid; (3) they cannot be burnt out; (4) they can be adopted for any voltage up to 500 by altering the density of the solution. It is also stated that the water-cooled starters will dissipate 20 times the energy of an air-cooled liquid starter of the same size without boiling.

The advantages of three-phase current for electrical machinery in mines are now very generally appreciated, and consequently there is a considerable demand for accessories adapted for three-phase working. Messrs. ECKSTEIN, HEAP & Co., of Manchester, are making a speciality of all types of oil break switches for three-phase work, and are constructing them in five standard sizes for low tension currents—viz., for 15, 50, 200, 500 and 800 amperes per phase—and in 200 ampere size

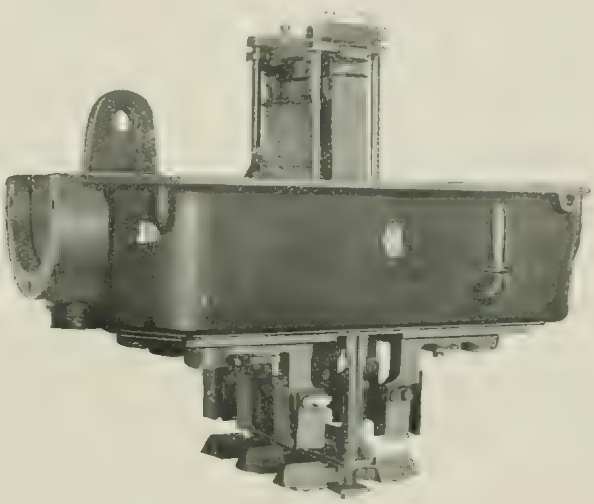


FIG. 13.—ECKSTEIN, HEAP & CO.'S OIL BREAK 3-PHASE SWITCH.

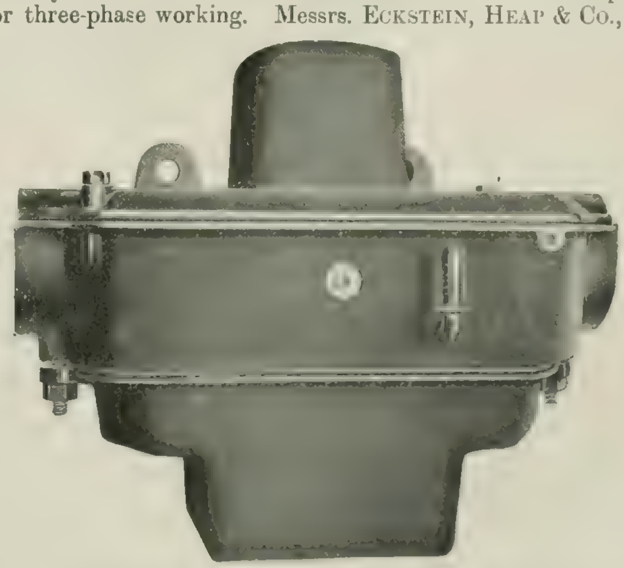


FIG. 14.—ECKSTEIN, HEAP & CO.'S TOTALLY ENCLOSED OIL-BREAK SWITCH.

for 3,000 volt and 10,000 volt pressures. Tripping devices in two or three phases are usually fitted, as is also a no-volt release.

Any of the above switches can be supplied in cast-iron water-tight boxes or gas-tight cases, which are specially suitable for the severe conditions prevailing in mining and colliery practice. They are also built up in sheet steel cases, for use in textile factories. Figs. 13 and 14 illustrate a solenoid-operated oil-switch in cast-iron tank with iron cover.

In order to overcome the difficulty experienced with the use of fuses and ordinary overload tripping devices in connection with oil-break switches used with three-phase motors of the short-circuited rotor type, Messrs. Eckstein, Heap & Co. have recently developed and patented a special form of relay which can be readily fitted to any of their oil-break switches. As is well known, owing to the large starting currents which these motors take, fuses have to be so large that they are practically useless to protect the motors from ordinary overloads. In the same way, automatic overload tripping devices have to be set so high that they, also, do not protect the motor. With this new relay this difficulty is claimed to be entirely obviated. The action is as follows :—

During the operation of starting up, while the motor is taking large a current, the relay is automatically set, so that it requires, say, three to four times full-load current to operate it. When the motor has got up to speed, and the operating switch is turned into the full running position, the relay automatically sets itself to operate with a current corresponding to, say, 25 per cent. overload. With this device it will, therefore, be seen that the motor is thoroughly protected under all working conditions.

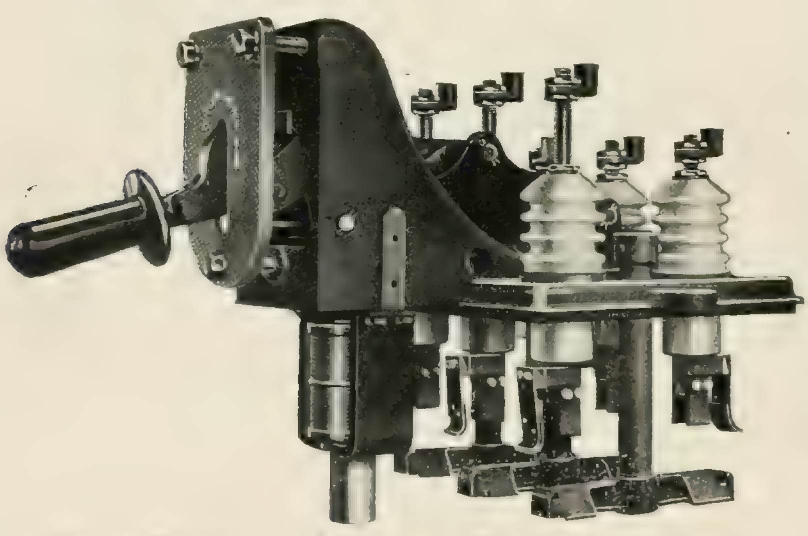


Fig. 15.—Eckstein, Heap & Co.'s Handle Type Oil Break Switch.

Messrs. Eckstein, Heap & Co. have also made a speciality of the construction of three-phase cast-iron cased distribution boxes. These distribution boxes are complete with the necessary trifurcating chamber, which, when desired, can also be fitted with disconnecting links. This chamber can also be filled in solid with compound, and they are, therefore, suitable for use with paper insulated cables. The boxes are also provided with the necessary earthing rings for use in connection with lead-covered armoured cables. The fuses are arranged so that all three controlling on out-going circuit are adjacent to one another, thus facilitating the connecting up and doing away with any crossing of the cables. The fuses are of the standard porcelain handle type.

The particular type of high tension switch box, specially designed by Messrs. Eckstein, Heap & Co. for use in collieries consists of a cast iron case with solid hinged front and clamping nuts. Inside is mounted a high-tension oil-break switch, as seen in Fig. 15 which can be fitted with overload tripping devices when required. The switch is provided with outside operating handle, which is interlocked with the door in such a way that the latter cannot be opened unless the switch is in the "off" position, and vice versa. The isolating switches are fixed so that when the door is opened the apparatus inside is rendered dead.

The standard apparatus of the Adams Manufacturing Company comprises many designs suitable for mining work. One of the most interesting of these is the three-phase, oil immersed, motor starting switch, with automatic no-volt and overload release and worm gear slow movement. All the parts of the switch and resistance, with the exception of the operating handle, are enclosed in a galvanised-iron tank which is filled with oil, so that not only is the resistance oil cooled, but injurious or dangerous sparking is also effectually prevented.

To operate this switch, which is illustrated in Fig. 16, the attendant must first bring the worm gear into mesh by moving the horizontal lever to the right and, while holding it in mesh by means of the horizontal handle, he must cut out the resistance by turning the handwheel which is fixed on the vertical shaft. When the switch is in the "full on" position, and all the starting resistance is short-circuited, it is held in that position by a magnetic detent which constitutes a no-volt release. Consequently, the attendant may loose his hold on the operating handles, thereby allowing the worm gear to fall out of

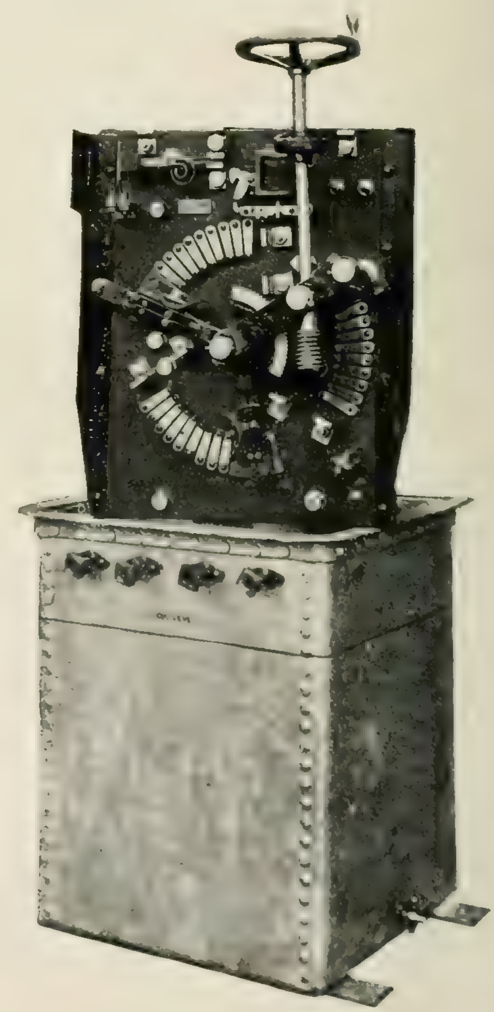


Fig. 16.—Adams Manufacturing Co.'s Oil Bath Switch.

mesh. Should the voltage of supply fail the no-volt magnet would be de-energised, and would release the contact lever, which would be impelled by a spring in its hub to the "off" position, thereby re-inserting all the starting resistance. In the case of an overload, the no-volt magnet would be short-circuited by a thermal overload device, which may be seen in the upper left-hand corner of Fig. 16, so that the contact lever would be released, and would fly to the "off" position, thereby re-inserting the starting resistance. This overload device possesses a valuable time-lag feature, the result of which is that it will not open circuit immediately on a slight overload, but will open circuit eventually if the overload is maintained long enough to become dangerous to the motor. In the case

of a serious overload or an actual short circuit it would open circuit immediately.

In Fig. 16 the switchgear is shown lifted out of the oil and placed on the top of the tank, and this gives a full view not only of the starting switch and the worm gear, but also of the no-volt and overload release features.

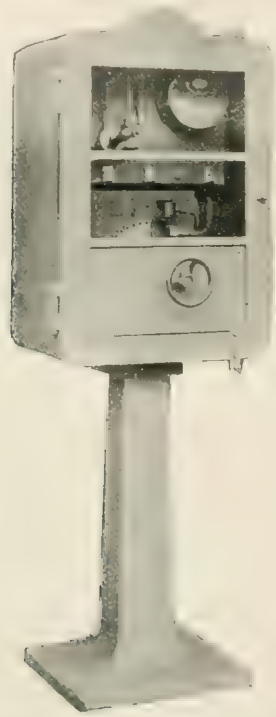


FIG. 17.—ADAMS MANUFACTURING CO. MOTOR STARTING SWITCH.

Fig. 17 shows a motor starting switch with double pole switch and fuses and ammeter, enclosed in a cast-iron lock-up box with hinged glazed front, mounted upon a cast-iron pillar, so as to be suitable for bolting to the floor, and standing independently of other support. In this case the leads are brought to the switch up the interior of the cast-iron pillar. The starting

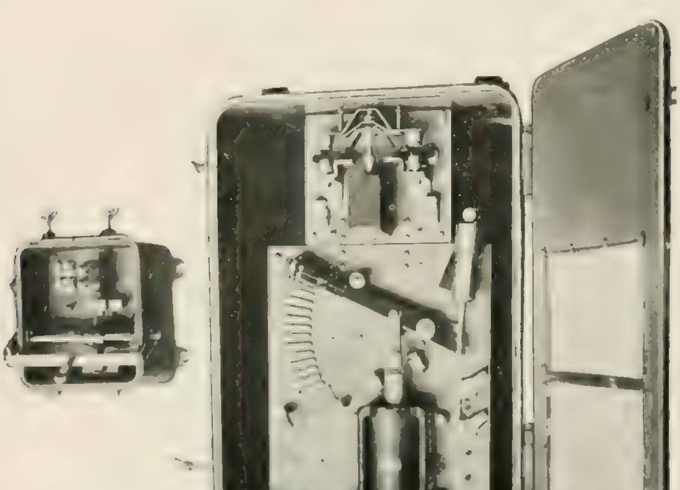


FIG. 18.—AN "IGRANIC" SELF-ACTING MOTOR RHEOSTAT.

switch is operated from the outside of the cover by means of a hand wheel, but the double pole main switch can only be operated by opening the cover. In this case it was intended that the double-pole switch should be in charge of the foreman who could lock up the case and carry away the key, thereby, preventing the motor being started without his knowledge or permission. It could, of course, be stopped if necessary by means of the starting switch.

Fig. 18 shows an "Igranic" self-acting motor starting rheostat, together with a solenoid main switch mounted together in a cast-iron watertight case, with inspection panel in the front, and at the side is a pedal switch, which, when used in connection with the self starter, constitutes a most efficient and reliable electric capstan controller. The pedal switch, like the self-starter and solenoid switch, is in a watertight cast-iron cover.

In addition to their well-known manufactures in connection with all types of electrical machinery, the ELECTRIC CONSTRUCTION Co., of Wolverhampton, have carried out many notable switchboard installations, not only for generating stations but also for the control of electrically-operated mining apparatus. As a typical example of a motor-control panel suitable for mines we may refer to the illustration Fig. 19. This shows a motor panel for controlling a 275 B.H.P. two-phase low-tension motor. The panel is equipped with two ammeters and fuses, also with an oil-type starter for the rotor, the switch and resistance coils being submerged in oil. In order, however,

FIG. 19. E.C.C. MOTOR PANEL FOR CONTROLLING TWO-PHASE MOTOR.

that the cables may not dip into the oil, the terminals in connect on with he starting switch are arranged to stand above the oil l vel. It will be noticed that the whole forms a compact and convenient arrangement. Another interesting design of switchgear apparatus manufactured by this firm for mining work is a controller for starting, reversing and regulating the sp'ed of polyphase slip ring motors, all the contacts being submerged in an oil tank—the latter being easily lowered for the adjustment and examination of the contacts. In the case of continuous current motors an ironclad dust-tight starter is provided. This is of the slow-motion type, the slow motion being obtained by means of a ratchet motion wh ch enables ea h section of the resistance to be cut out smartly and so that hovering on the contacts is prevented. This switch is fi.ted with a no-voltage and overload release, which will act not only in the "full-on" position but also during the "switching on" process.

It is obvious that any electrical apparatus installed underground for mining work must be capable of withstanding damp and rough handling, and, consequently, must be of substantial construction. As regards distribution boards, these

can be rendered water-tight without difficulty. The accompanying illustration (Fig. 20) shows such a fuse board manufactured by Messrs. SPAGNOLETTI. The case is made of cast iron, whilst the lid can be either solid or glass panelled as desired, and

Fig. 20.—Spagnoletti Fuse Board for Mining Work.

is fitted with a rubber seating and a lock and key. The panels are made of enamelled slate or marble mounted on, and insulated from, iron battens. It can be seen that, with the lid

Fig. 21. Spagnoletti Rotary Oil Break Switch.

closed and securely locked, no trouble should arise in connection with this section of the installation.

In cases where a high-tension supply is obtained from one of

Fig. 22.—Spagnoletti Oil Break Switch.

the large power companies, high-tension oil-break switches are required. Messrs. Spagnoletti manufacture several types of such switches, which are particularly suited for mining work. Fig. 21 shows a rotary type of oil-break switch for currents up to 100 amperes, which can be supplied for automatic operation if desired, fitted with trip coils. This type, the designation of which is "R," is manufactured in standard patterns for all pressures up to 5,000 volts, and higher pressures in special cases. Fig. 22 illustrates an oil-break switch of type "S" fitted with a trip coil, and manufactured for pressures up to 15,000 volts. An approximate idea of the amount of oil required in these "S" type switches can be obtained by allowing 2½ gallons per pole of the switch.

We believe it is the right thing for the technical journalist when writing on electrical instruments to refer, at any rate once in the course of the article, to the fact that science is measurement. Having thus acquitted ourselves of this duty we shall now proceed to deal more directly with those instruments which are particularly useful in mining work.

The "Special Rules [for the Installation and Use of Electricity in Mines" indicate a number of tests which have to be performed as part of the routine work.

Messrs. EVERSHED & VIGNOLES, of London, whose name is well known to our readers in connection with instrument making, have introduced some very neat apparatus for this purpose. Among these is the combined portable volt and ammeter for direct currents (Fig. 23). By its means a fault can be localised, the only extra apparatus required being an "adjusting tank" with an iron bottom, and filled with soda solution, so that the current can be conveniently adjusted to any required amount. The voltage drop is taken on both branches of the looped cable, and the position of the fault is then easily deduced.

Fig. 23.—Evershed Combined Volt and Ammeter.

Another regulation requires that any inequality in the insulation of the mains shall be continually indicated, and also that there shall be means of determining the value of the insulation and the value of the leakage current. This is easily done with Evershed's leakage indicator, which is very simple in construction. By means of the keys the relative insulation of the positive and negative main can be determined and the actual values determined from a table supplied with the instruments. Other mining regulations provide for the use of ammeters and voltmeters in certain fixed places, but in this connection Messrs. Evershed & Vignoles' name is so well known that we need say no more on the subject.

The instruments of Messrs. ELLIOTT BROS., of Lewisham, are so well known to the readers of *The Electrician* that it is almost an insult to suppose that they are ignorant of any of this firm's justly celebrated productions. For mines, as for all purposes, they doubtless have their uses, and that they are capable of doing the work imposed upon them no one who has had anything to do with them will deny.

We may, however, refer again to the Century portable mains testing set which will doubtless be found as useful below as above ground. The things it can do are many, while at the same time it only needs one man, or perhaps only one boy, to carry it.

The subject matter of this article has been perhaps more wholly electrical than any other in the Mining Issue, so that it will not be out of place to mention Messrs. VICKERS, SONS & MAXIM, of Erith, who, although not specialising in any one branch, are manufacturers of electrical generators and motors for all classes of colliery work and contractors for complete installations for power and lighting in mines.

Notes upon Mining Cables.

BY J. H. C. BROOKING.
(Of Messrs. W. T. Glover & Co.)

The use of electricity in mining work has done more to test promptly the trustworthiness of the plant used than any other branch of industry. And especially is this the case with the cable part of the installation. The fine-weather birds are very quickly found out when brought underground, and only those types that are designed to stand up to their work under severe mechanical, electrical and chemical conditions can hope to be regarded as successful. And especially must it be noted that it is not enough merely to increase factors of safety in design, but it is necessary that the designer should be conversant, from actual inspection of operation, with the conditions under which electrical plant is worked in mining practice.

These few words are necessary for an appreciation of the fact that the most suitable cables for use in mines differ from those in use elsewhere, and it may be bluntly stated that what is good enough for general electrical distribution is seldom good enough for use in mines.

To compare the conditions against, for instance, town lighting: here the mains are laid at a safe depth underground, usually protected by pipes or laid solid; but in mining work they are either fixed in an exposed position in a pit shaft or are hung up in a roadway. In both shaft and inbye situations the chances of mechanical damage are greater than with a public distribution main, either from falling bodies, chemically affected water, accidents with runaway trucks, breakage of suspension attachments and miners' thoughtlessness. Also, the electrical conditions are less satisfactory, in that skilled inspection of plant is not so easily available and the chances of overloading are more likely than in any other situation. Cut-outs and fuses can be set to anything, and they often are. The following is one instance of many: The driver of a haulage gear was asked why his motor was always breaking down, but he could not explain. He mentioned, however, that it was the practice to find out how many trucks a "set" would take, and although the original arrangement was 20 per journey (for which the equipment had been designed), it had been found by a process of gradual increment that the motor would pull up to a total of 39 before anything went immediately wrong with it. Consequently 38 was made the standard load, and the driver could not understand why the motor should be sometimes burnt out at this!

The main requirements for mining cables vary according to the situation or conditions of use. In the shaft, the chief trouble is usually water, or that mixture of water and chemicals which has upset so many cables.

The shaft cable must therefore be designed to combat this source of trouble, and the question of insulation or protection by rubber, bitumen or lead sheathing is often determined by the nature of the fluid to be encountered.

In the underground roads the chief chance of trouble is mechanical injury, and this is the point to be watched here.

At the working face both mechanical injury and dampness must be reckoned upon for the trailing cables.

The above are the three main situations in which cables are worked, and in a number of mines these three classes of insulated cables are used, one for each stage, as the most satisfactory arrangement. That is to say:

Shaft cables are paper insulated, lead covered.

Inbye cables are bitumen insulated.

Trailing cables are rubber insulated.

This is not the writer's idea of the ideal arrangement, but it should be mentioned that a considerable difference of opinion exists upon this subject. Some have used bitumen cables and have found them to give trouble through decentralisation or cracking. Others have used paper or jute-insulated lead-sheathed cables, and have had earths and shorts due to the damp getting inside and saturating the hygroscopic insulation; or damage has been occasioned by electrolysis, usually as a secondary cause to a fault. And others have used rubber cables, and have had them eaten away by bad water.

In the last case it must be said that good rubber cables properly protected are the best for almost any situation, and it is seldom that they give trouble under such conditions. But the price is about double that of either bitumen or paper lead-covered cables, leaving armouring, &c., out of the question of cost. The advantage of flexibility is peculiarly suitable for the rough and tumble work of trailing cables, and this is the class of cable for which rubber is still largely used.

Paper-insulated lead-covered cables are more used for shafts than elsewhere, as their waterproofedness is an important point for wet shafts, but with the improvements in bitumen cables that have been made within the past few years, their use is not now so general.

Bitumen cables are very largely used all over mines, and they are made in two classes. One class provides a paper or other fibrous separator between the conductor and the bitumen sheath. The reasons for this intermediary are various: (1) It prevents the sulphur in some vulcanised bitumen compounds from acting upon the copper; (2) it prevents some of the heat, generated upon an over-run cable, from affecting the bitumen; (3) it gives a higher insulation resistance to the bitumen cable.

The other class of cable is insulated with bitumen only, and the conductors are tinned to prevent any chance of sulphur acting upon them.

This is the class of cable recommended by the writer for either surface, shaft or inbye use, providing it is properly made. It must be borne in mind that there are bitumen cables *and* bitumen cables, and the recommendation of this class does not include those bitumen cables which must be treated like meringues to ensure safety from cracking, decentralisation and corrosion at the first opportunity.

An improvement in the conductor which is now being largely used consists in coating each wire with a waterproof compound, and the operation of stranding them results in the whole conductor being one solid mass of copper and compound, which effectually prevents the passage of any intrusive damp along the strands. Without this strand-filling compound, it is possible for damp to travel almost any distance inside a cable along the interstices of the wires, and the action of the electric current upon this moisture is deleterious to the inside surface of the insulation, particularly when the moisture is of a chemical nature. Cables to be used in damp places should be protected against injury by being thus strand-filled.

The question often arises, in connection with three-phase schemes, as to whether it is better to use three single cables or a three-core cable where the load is heavy and the shaft is deep. Undoubtedly, a three-core cable is preferable, if it can be made in a sufficiently long length to avoid joint making in the shaft, but considerations of weight and bulk often arise which prevent this long piece being used. In such a case, the three singles are preferable if the shaft conditions are such that they will not be damaged if left unprotected. But if it is necessary to protect them against mechanical damage then it should be borne in mind that they cannot be armoured without a grave loss in electrical efficiency; and the provision of troughs or casing will be a considerable expense, especially if the shaft is not provided with buntons at short intervals, say, every 10 ft.

In most cases it will be found best to split the cable up into smaller units, and one advantage of this is that one of these cables can be cut out at light loads for testing, and in the then unlikely event of one cable breaking down the other cable or cables can carry the load for a certain length of time with only a reduced efficiency of transmission as a drawback. It is the principle of having one's eggs in separate baskets.

The question of the very wet shaft is one of considerable controversy, and this has been a deadly matter for many cables. A fairly safe way is to use lead covered cable, with the lead of an

increased thickness to ensure no chance of water getting through; and, providing this cable has been tested by hydraulic pressure and the cable is used in a shallow shaft, there is little improvement to suggest beyond exceeding carefulness in handling. There is, however, another form of cable now in use, called Glover's Solid Bitumen cable, in which the packing spaces between the cores are filled up with bitumen entirely, instead of the usual fibrous packing. This fibrous packing, in ordinary bitumen cables, acts as a duct for the pit water, which in no great time penetrates the braiding and armour and circulates around the three insulated cores, in some cases finding weak spots and in others making them. The advantages of having a double sheathing of bitumen, and of using bitumen packing instead of fibrous material are considerable in wet shafts.

The merit of flexibility in cables is useful when suspended inbye, and more particularly at the working face where coal-cutters are used. In the former case, where cables are run along roads that are "moving," subsidences or falls of stone often occur, and the cable that is merely strong will break like a carrot, but the cable that is flexible will give way easily until relieved from pressure. Troubles from decentralisation on inbye cables are often heard about, as having happened upon bitumen cables which have been suspended at an insufficient number of points in their length, and these have decentred with or without assistance from an insecure roof. It is somewhat strange for a mining manager to buy expensive cables, and to risk their usefulness and the expense due to shutting down of the plant to save a few pounds in erecting additional props or hanger bolts.

It may be taken as an electrical mining maxim that cables can hardly have too many supports.

The trailing cable question has been a serious one for years, and many and varied have been the attempts to preserve this hardly-used class. It is generally acknowledged that rubber-insulated cables must be used, but opinions are somewhat divided as to whether it pays to buy ordinary grade rubber to last a certain time or to buy the best class rubber, which may last longer but which may be mechanically damaged in an equal time. Besides the heavy usage these cables get, there is the effect of alternate wetting and drying that they experience, which variation in humidity is very bad for rubber. It is of little use, at most wet faces, to try to protect the rubber from damp by covering it with tarred jute, by rope, or braided whip cord, or even leather. The damp gets through all these, and more easily when the cable is bent.

Protecting the trailing cable by armouring with wire is often a snare. Efficacious enough, perhaps, when subject only to frictional abrasion, the dropping of a weight or the jamming of a coal-cutter upon it so permanently flattens the wire as to make it press into the rubber insulation of the cable, and to wear this through in a short time. The designing of trailing cables is of great interest to some mining engineers, and the latest type may be here mentioned. This has rubber insulation, sheathed entirely with bitumen and the spaces between the cores filled up with bitumen instead of ordinary fibrous packing. Any form of protection may be used, though the makers of this special type, W. T. Glover & Co., recommend leather braiding as the most suitable. This type of cable, as may be seen, is an adaptation of Glover's Solid Bitumen cable, but with the inner insulation composed of rubber. It will be appreciated that while the rubber is entirely protected from damp by the bitumen, this bitumen must be exceedingly flexible to be efficient. That this flexibility is part of the nature of this brand of vulcanised bitumen is assured from the results of exceedingly severe bending tests made upon it, and from the way the original Solid Bitumen cable has stood bending in actual work. Otherwise the excessive bending of bitumen cables as ordinarily made is not to be recommended, especially in cold weather.

The protecting sheathing of the various classes of mining cables also needs reference, in that it differs (or should differ) from that usually accorded to the ordinary type of power main. The latter is encased in steel tape, put on in two layers to overlap, but this tape is apt to cut into the cable when bent, and in mining work it is bound to be bent. It is better to use a galvanised steel wire armouring, either singly or in two layers, depending on the conditions of use. In shaft work, where the weight of the cable should be taken by the armour, the tape is useless and dangerous.

The fibrous coverings, such as tapes, braids and lappings of cotton or jute, should be well impregnated with preservative, and Stockholm tar should be applied to them at intervals after erection depending on the nature of their situation. These coverings are generally meant to protect the armour from corrosive influence when put on over it, but it is unlikely that any fibrous material will resist a continuous flow of water long, however well soaked in compound.

Where unarmoured cables are run down shafts in wood casing, being malletted in, it is desirable for them to have an extra layer of jute to act as a pad, and the whole should be well coated with a preservative and water-resisting compound. Where three-phase mains are run as single cables, in situations where wood casing is impossible, they should be given several layers of jute, as armour would produce heavy inductive losses, as previously mentioned.

The protection of trailing cables, as previously touched upon, is a point allowing of considerable variation. Nearly every material has been brought into use for this purpose in the form of lapping, braid or tube. The trouble with lapping is that if it gets cut or abraded through, it unravels quickly, and the insulation inside is apt to get injured. It is easily repaired, however. With braiding, while not so quickly unravelled after a cut, it is harder to make a neat repair. With tubing, such as leather or canvas bound around and sewn with a longitudinal seam, a cut quickly extends all around the tube, and necessitates careful patching. Some use is made of rubber canvas hose pipe, into which trailing cables are drawn, and this makes a strong but expensive job.

While it is certain that cables require to be designed by experienced men to give good results in mining work, it is equally positive that such cables must also be fixed, jointed and maintained by experienced men, to ensure their permanent well-being. This point is often overlooked by colliery engineers, who consider anyone competent to handle cables who may have done wiring jobs, or who may not have advanced even so far upon the electrical highway. The conditions about a colliery are such that the best cable ever made may be left on its last legs for want of an occasional test, by the provision of unsuitable jointing material, by bending the cable at too small a radius, or by the omission or commission of a dozen incidentals vital to the cable's life. To the man who has been there before, the largest diameter guide pulley available, the provision of a strong lash-to rope, the bevelling of the cleat tops, the dryness of jointing conditions, &c., are items that bitter experience gives a proper value to.

It is advisable to have at least the first cables to be used in a pit laid by an experienced man, whether contractor's or cable-maker's engineer; and the joints and connecting up should be done by a jointer experienced in colliery cable work. Lengths of cables have been ruined for want of experience in this, and the use of a cheap and unsuitable compound for filling in joint boxes, has cost hundreds of pounds in cases within the writer's knowledge.

In mining work there is considerable chance of heavy overloads, and the question of overloading cables brings up the advantage of fibrous insulated cable as being less likely to be troubled by heat. If it were necessary to habitually and excessively overload cables, there would be a stronger argument in favour of this fibrous type. But the limitations of overloading are not so much in the insulating material as in the conductor, which becomes expanded by the heat generated, and is found to move bodily, to the detriment of joints, and of itself eventually.

A fair amount of overload can, however, be borne by the best bitumen cables, and experiments made by a well-known colliery engineer upon that class of cable called Glover's Solid Bitumen Three-core showed no evil result upon the insulation after run-

ning for four hours upon it at a current density equal to 6,000 amperes per square inch. This Solid Bitumen cable is normally run by this engineer at a current density of 2,000 amperes per square inch, which, however, cannot be recommended for general practice. It is not claimed, however, that all bitumen cables can stand these overloads.

As mentioned, trouble has been caused upon overloaded cables by the expansion and contraction of the conductor, and an effort has recently been made to overcome this, by allowing space between the conductor wires for their movement locally. Thus one or more wires are omitted from each layer in building up the strands, so that any movement among the wires can be taken up in these spaces. The centre wire is omitted also.

To summarise: the writer recommends the use of bitumen cables everywhere in a mine, on the ground of initial cheapness, low maintenance and the less chance of permanent damage from unavoidable faults upon them. (Trailing cables should have rubber insulation under the bitumen moulding, as mentioned.)

This point of view will doubtless be challenged by those few fortunate people who have used cables of the fibrous insulated type, lead sheathed, with success. But it will usually be found that their installations have been attended to by skilled men, and that the cables have been used in carefully selected situations. Bitumen insulated cables would have done equally as well under those circumstances, and better under worse conditions.

Some Cables and Cable Accessories for Mines.

We understand that in a company of mining engineers, when the topic under discussion is the relative merits of various types of cable, the atmosphere is likely to become charged with electricity, and ruptures of the dielectric are not unknown. Being of a peaceable turn of mind we have no wish to be drawn into the fray on this occasion, but in what follows we leave various well-known makers to state their own cases, and to exhibit their preference, if any, for a particular type of cable. Some makers have developed special types, whereas others rely upon their standard lead-covered cables, which they consider fully meet all requirements.

A few years ago the cables used for supplying power throughout the workings of a mine were in nearly all cases either vulcanised bitumen or rubber covered and braided. Messrs. SIEMENS BROS. & Co., however, took the bold step of using lead-covered paper-insulated cables, and we understand that their experience with such cables throughout the last four years has proved entirely satisfactory, notwithstanding the then prevailing opinion that paper impregnated cables were doomed to failure. In fact, in most instances where these had previously been used for conveying current down pit shafts, the junction boxes at the foot of such shafts were burst by the gradual descent of the oil in the impregnated paper.

Messrs. Siemens Bros. & Co., therefore, took special precautions in impregnating their cables. The paper was first wrapped round the conductor and dried at a low temperature in a vacuum to remove all moisture from the pores, and it was then impregnated, also in a vacuum, the surface liquid being afterwards drained off. With these cables, long lengths have been suspended vertically with perfectly satisfactory results. The lead-covered cables for shaft work are always double wire armoured, whilst in the workings single wire armouring is found to be sufficient.

Several methods are adopted by Messrs. Siemens Bros. & Co. for fixing the cables in vertical shafts. Probably the most satisfactory is that in which cleats, as shown in Fig. 1, are fixed vertically about every 20 yds. The cables are, in other cases, completely encased in troughing throughout the shaft, each length of troughing being filled with bitumen before the length next above is fixed in position.

The easiest system is, of course, that in which the whole length of cable is allowed to hang from a special suspender at the top of the shaft. Fig. 3 shows such a suspender as used by Messrs. Siemens Bros. & Co. It will be seen that the whole weight of the cable comes upon the steel wires of the armouring, and, provided a suitable girder is available, this method is said to prove perfectly satisfactory, even for lengths of

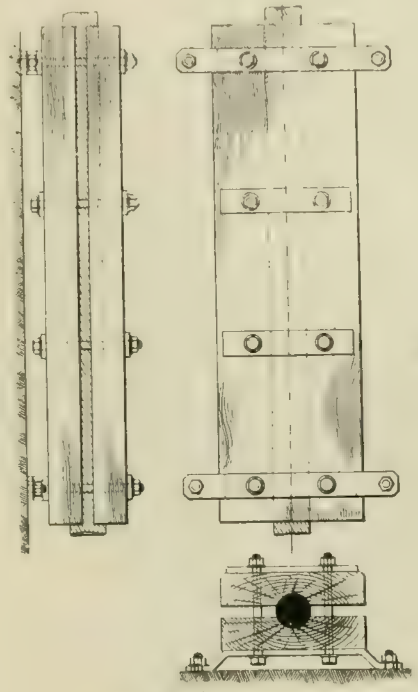


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FIG. 1.—SIEMENS PITCH PINE CABLE CLEATS.

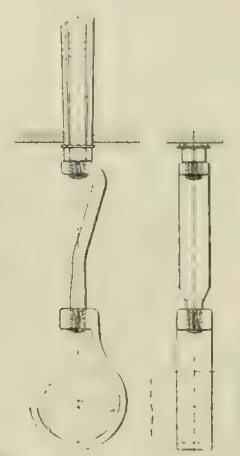

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FIG. 2.—SIEMENS CABLE SUPPORT.

400 ft. of cable. This suspender can be used in conjunction with the cleats shown in Fig. 1. for lengths of 600 yds. or 700 yds. The suspender is termed a "bucket suspender."

For suspending cables throughout the workings leather loops are usually employed, so that in the case of the walls or roof falling in the cables come away easily; whereas, if the cables

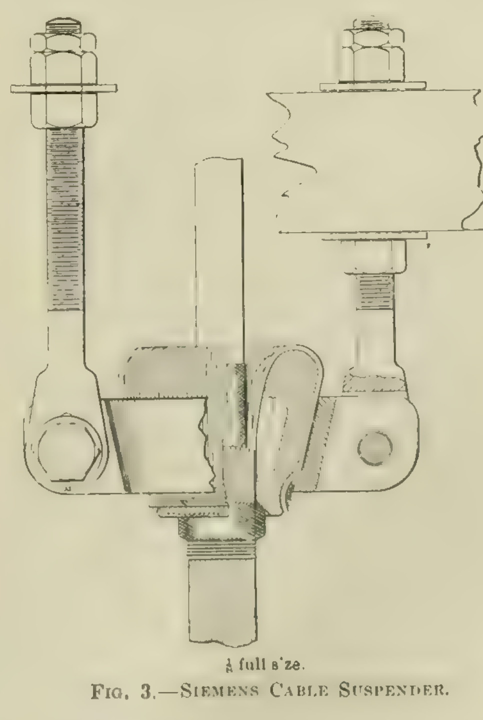

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FIG. 3.—SIEMENS CABLE SUSPENDER.

are very rigidly supported, they are very liable to be considerably damaged in the event of such an occurrence. Where, however, a firm and reliable roof exists, Messrs. Siemens use a support of the type indicated in Fig. 2.

It is sometimes thought that lead-covered cables are not

suited for positions where they are subjected to moisture containing traces of acid or salts, but Messrs. Siemens find that their standard cables are perfectly satisfactory in such positions, most probably on account of the larger amount of compound which is put on top of the armouring. They therefore use their standard cables for all mining work and have not found it necessary to introduce any special types, and at the present time they are supplying large quantities of paper-insulated lead-covered cables to collieries and mines in the north of England.

Among the oldest established cable firms Messrs. W. T. Henley's Telegraph Works Co., of London, hold a prominent position. They were connected with some of the earliest telegraph work, and their name is familiar in the equipment of the most modern systems of power supply.

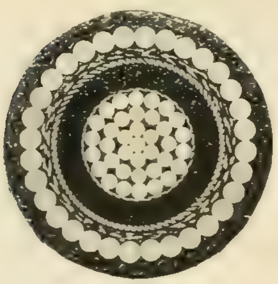


Fig. 4.—Henley's Single-Core Armoured and Vulcanised Bitumen Cable, as supplied to the Fife Coal Co. and Messrs. W. C. Carr.

Fig. 5.—Henley's Three Core Paper Insulated Cable for Mining Work, as supplied to the Clifton Colliery Co., Nottingham, and the United Collieries.

In connection with the installation of electric power in mines, one of the most important questions to be considered is that of suitable cables, as the efficient working of the plant is naturally greatly dependent upon an uninterrupted supply of current. To do this requires cable of the best manufacture erected in the most careful and suitable way. Messrs. Henley's long experience in cable manufacture stood them in good stead when the question of the use of electricity in mining came up for consideration, and in what follows we give some details of the cables they have specially designed for this work.

Fig. 4 shows a cable used in direct current work. Its insulation is vulcanised bitumen, which is placed either directly on the cable or separated from it by a paper or jute separator. It is then taped with two coatings of tape, strongly braided and served over all with preservative compound and armoured with steel wires. It is specially suitable for suspension in shafts or workings where there is either strain or risk of injury. A cable of this type was recently supplied to the Fife Coal Co. where it is suspended in a shaft nearly ½ mile deep. It is considered necessary, in the case of a long length of heavy cable without cleating to the shaft, that two layers of galvanised iron wires should be used served over all as a protection for the armouring against chemical action, which is usually more pronounced in mines than under ordinary conditions.

Fig. 5 shows a three-core paper-insulated cable also for mining work. This type is considered to have advantages over vulcanised bitumen in certain cases, for it possesses greater dielectric strength and there is no danger of decentralisation. With paper, however, the danger of moisture is always present.

Fig. 6 shows a concentric type of cable, which by some engineers is considered more suitable than two single cables, partly on account of there being less liability of receiving a shock in the case of a fault developing. It may be mentioned that in the case of all three-core and twin cables made by Messrs. Henleys each core is distinguished by a different colour. This arrangement is undoubtedly greatly appreciated by jointers and testers, as it allows easy recognition to be obtained. The cable illustrated (Fig. 6) has both inner and outer conductors insulated with impregnated paper. It is further sheathed with vulcanised bitumen and finished as in the case of other cables.

Messrs. Henleys have recently made a new departure in applying the bitumen directly to the core of the cable. This method, it is claimed, prevents any moisture from directly reaching the cable. The cables so insulated are laid up round a common bitumen core. No tapes or wormings are employed, all the interstices being filled up with bitumen, forming one solid mass of this substance.

In Fig. 7 we illustrate an exceedingly interesting cable, its particular feature being its size. Its insulation is paper sheathed with lead. Under the lead is a B.O.T. copper earth shield, while it is further protected with galvanised iron wires. Its overall diameter is 4¼ in.

A very useful part of a mining equipment is the trailing cable, especially in regard to the operation of coal cutters and similar machinery, while the rough usage to which they are necessarily submitted makes it important that their insulation should be particularly sturdy. Fig. 8A shows a type of cable for this purpose. It is specially flexible and insulated with pure rubber. Its protective covering is very close, being composed of a number of fine hemp yarns braided into a cord, thus making a specially hard and strong covering. This covering is braided on, preferably over a covering of jute or hemp, and is finally served with waterproof compound. Another arrangement, the leather braided type, is shown in Fig. 8B. The leather is specially cured, and is put on in the form of a complete sheath or strips of about $\frac{3}{16}$ in. wide, laid on in the form of a braid, served with waterproof compound if required.

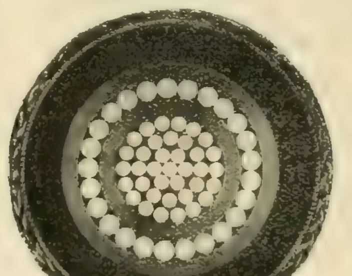


Fig. 6.—Henley's Concentric Paper Insulated Cable.

Messrs. Henley also make shot-firing wires of various types. These are in general of the twin-core type, which vary from No. 22 to No. 16 S.W.G. The insulation may consist of impregnated cotton, pure indiarubber, vulcanised indiarubber, or gutta percha covered with suitable braiding saturated with waterproof compound.

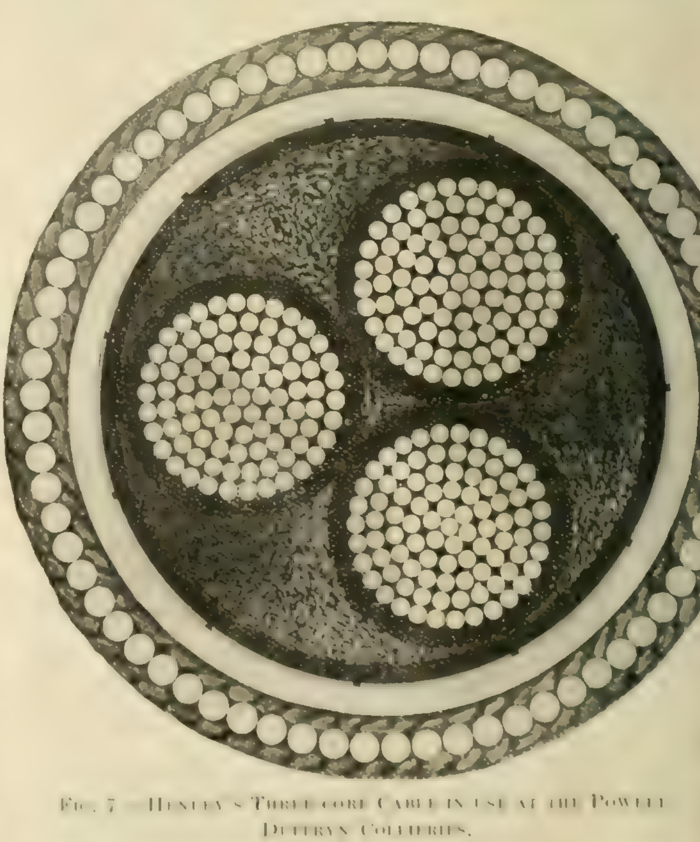


Fig. 7.—Henley's Three-core Cable in use at the Powell Duffryn Collieries.

The boxes used by Messrs. Henley in connection with colliery installations are to be specially adapted in order to comply with the somewhat stringent conditions prevailing in

mines. When it is necessary to joint lengths of cable, straight through boxes are used into which the cable is brought and firmly clamped to the glands. The cores in the cases of a twin or three core cable are carefully separated from each other, the connections made by mechanical joints which must also be electrically efficient, the joints then thoroughly insulated, and the box filled up solid with specially adapted compound. In cases where long runs of cable occur it is advisable to insert disconnecting boxes at intervals to facilitate testing, and at the same time care should be exercised to ensure that the boxes are thoroughly watertight when the cover is fixed. Terminals of opposite polarity must be as widely separated as possible, and completely surrounded with compound, which must be entirely impervious to moisture, non-inflammable, and which retains its liquid form for a considerable time after heating, in order to ensure all parts of the box being thoroughly filled. The links must be so arranged that they are readily removable by means of insulated handles. Shields should also be placed between the links of opposite polarity, and suitable arrangements made to efficiently earth the boxes. Plug boxes for use in connection with trailing cables for coal cutters, &c., are of a somewhat

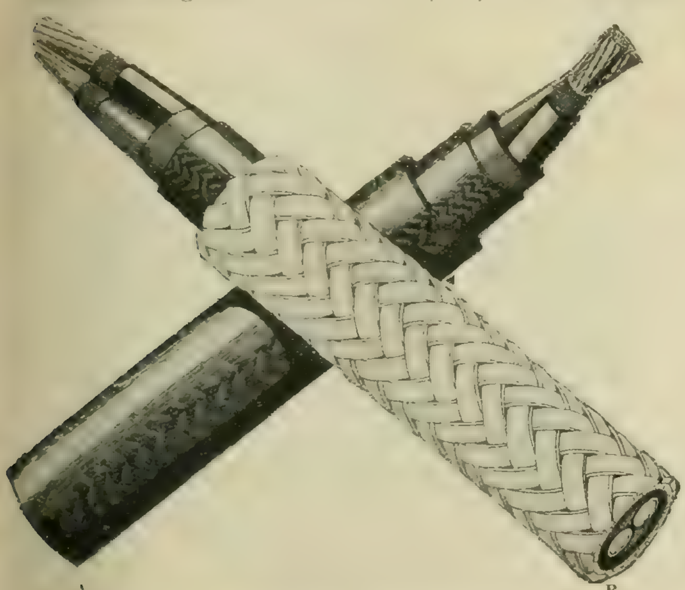


FIG. 8.—HENLEY'S TRAILING CABLES.

A, Rubber-covered Trailing Cable, protected with Hemp Braiding.
B, A similar Cable, protected with Leather Braiding.

complicated nature on account of the various precautions which must be necessarily made. It is hardly possible to describe here the details of the various types of boxes used, not to speak of cleats, suspenders, and drums for lowering cables down shafts.

One of the oldest and best-known names in connection with cables is that of Messrs. JOHNSON & PHILLIPS; this firm have supplied large quantities of their Paterson's vulcanised bitumen cables, for which they have the sole right of manufacture, to many collieries in this country, and, as proof of the satisfaction which this type of cable has given, we may mention that up to the present not a single complaint has been received. This particular type of cable is especially suitable for use in mines, owing to its lightness and flexibility, which, of course, render it very easy to erect in pit shafts, &c. Other advantages are that it is absolutely non-hygroscopic, unaffected by acids, and has great dielectric strength. Refined Trinidad bitumen of the highest quality is employed, and it is important to notice that the dielectric is not brittle at ordinary low temperatures or unduly soft at the highest temperatures met with in practice. Fig. 9, herewith, shows a three-core high-tension cable for colliery work at a pressure of 2,000 volts, each conductor being covered with a separator of special impregnated paper, insulated with vulcanised bitumen and lapped with two bitumen tapes, and the whole being double wire armoured with galvanised steel wires and served overall with yarn and thoroughly compounded.

Other cables manufactured by Messrs. Johnson & Phillips in connection with mining work are those for shot firing and trailing cables, while Paterson's patent fire-resisting cables also find favour with a number of colliery proprietors.

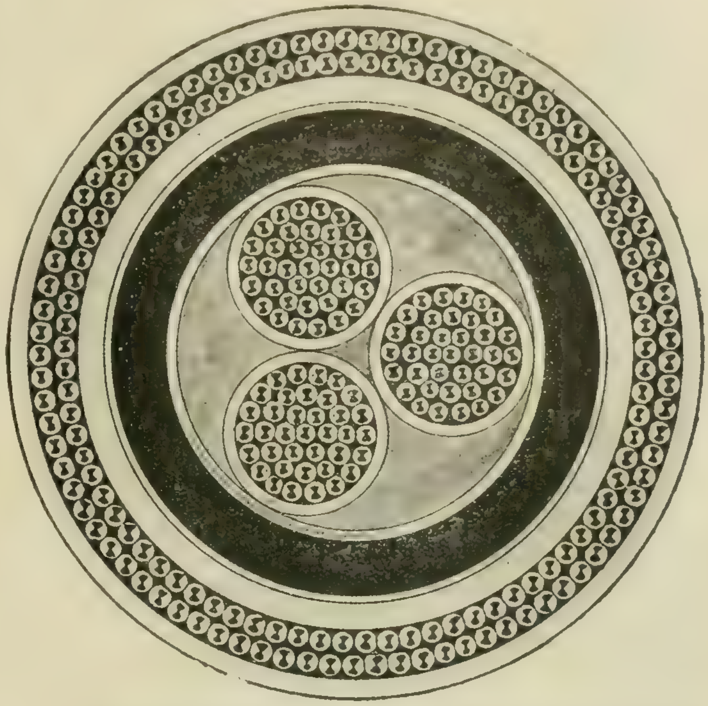


FIG. 9.—JOHNSON & PHILLIPS' HIGH-TENSION CABLE FOR COLLIERY WORK.

The method of suspension adopted where cables are fixed in mines is of great importance, and may seriously affect the life of the cables. Fig. 10 illustrates a cable suspender which is supplied by Messrs. Johnson & Phillips. The suspender is

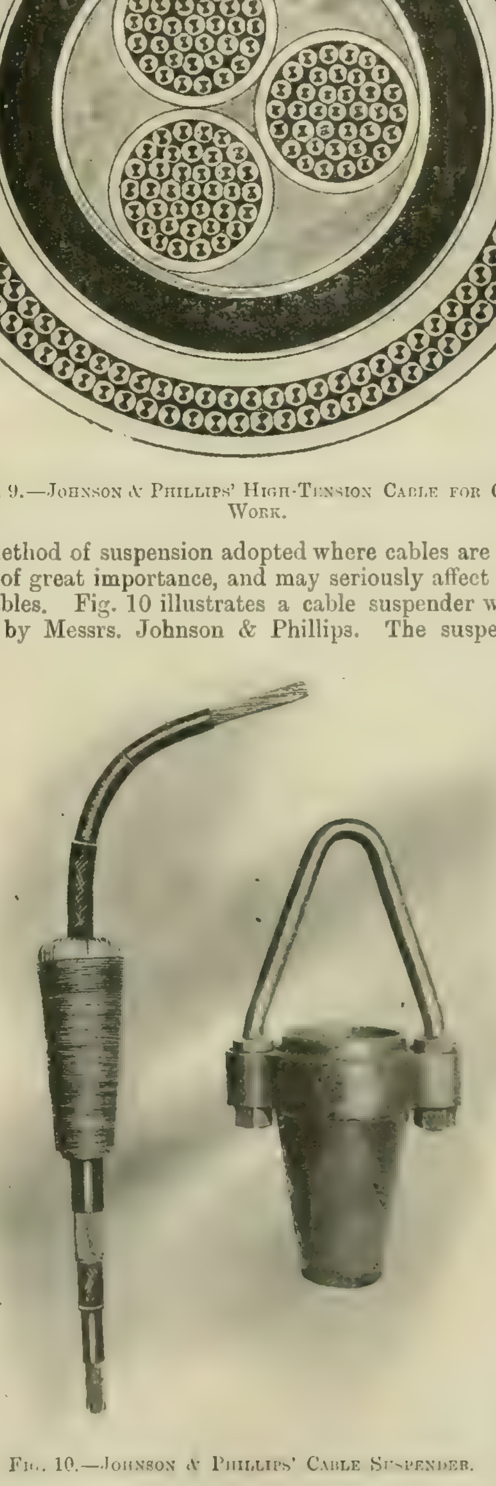


FIG. 10.—JOHNSON & PHILLIPS' CABLE SUSPENDER.

designed for use in pit shafts, and its main feature is that very little pressure is put upon the bitumen or other insulating material. A slight improvement in connection with the use of this suspender, but one of considerable importance has recently

been made, namely, that it is fastened by chains about 3 ft. long, thus doing away with any tendency to bend the cable.

The method of fixing is as follows :—The split cone of the suspender, as seen in illustration Fig. 10, is fitted on to the armouring wires, which are carefully brought down over the cone and are secured below the cone by binding wire. The body of the suspender which has been previously slipped down the cable is now brought up and the suspender is fixed on to a beam or other suitable support. Special precautions are taken in the machining of the cone and body, so that in use the weight shall be spread evenly by each wire being securely wedged.

Messrs. CALLENDER'S CABLE & CONSTRUCTION CO. have recently introduced and placed on the market a new type of cable specially designed for use in coal mines. Where steel wire armouring has, in the past been used either in the shaft or underground roads, it is replaced by a double "armouring" or "sheathing" of hard Manilla cords. It has been recognised that the use of ordinary Manilla rope is open to several objections ; the company, therefore, have been experimenting for some time, and have been able to produce a rope armour which is non-shrinkable and at the same time water resisting.

The insulation of the cable is Callender's Vulcanised Bitumen, and is in all respects similar to that of their standard cables. The substitution of the rope armouring for the wire armouring largely reduces the weight of the cable, which is in many places an important consideration. The rope armouring gives a very efficient protection against mechanical damage, and, being non-metallic, single conductor cables of this type can be employed for alternating work, which is an important consideration in view of the large adoption of three-phase working in collieries.

The great development of electrical work in collieries is causing a steady increase in the size of the cables required down the shafts and in the workings, and in many cases the conductors required are so large as to make the use of one three-core cable almost prohibitive on account of the great size and weight. In such cases it is necessary either to use a number of small three-core cables or else single-conductor cables of the full section required. The objection to single-conductor cables in the past has been the difficulty of installing them when used for alternating work, as they cannot be armoured without incurring heavy losses, but the introduction of the rope armour removes this difficulty, and enables such cables to be used up to any size that may be required.

A cable which is well suited for mining installations and which is in great demand among mining engineers is the "Indestructible" cable (Hackethal patent), manufactured by the INDESTRUCTIBLE CABLE CO., of 47-51, Park-street, Southwark, S.E. As the name of the cable implies, it is practically indestructible, and neither atmospheric nor chemical influences are said to affect the insulation. On the contrary, the longer this cable is exposed the better the insulation is said to become ; in fact, after the composition with which these cables are treated has gone through its oxidising process, the insulating mass forms a hard crust around the copper wire, and it is difficult to even file it away.

This special treatment of "Indestructible" cables renders them especially suitable for overhead conductors, and they will be found of the greatest value for installations in tunnels and other damp localities and all places where acid fumes prevail or where the atmospheric conditions have a tendency to destroy the ordinary cables after a comparatively short time.

The insulation consists of a jute covering, impregnated with a composition of red lead, linseed oil and some other patent ingredient. The hardening process previously referred to results, it is said, in an increased insulation resistance—that is to say, the insulation resistance after the cables have been installed and exposed to the air for some time is greater than when first put up.

In order to meet the many requirements, "Indestructible" cables are, we understand, being manufactured with five standard insulations, some of these being found very suitable for telephone and telegraph work where such lines have to cross high-tension overhead mains.

The ST. HELENS CABLE & RUBBER CO., of Warrington, are one of those fortunate firms who possess an excellent speciality which they find exceedingly useful in the course of their work. In this case the particular speciality is the well-known "Dialite." Since its first appearance on the market the St. Helens Cable Co. have found it uniquely suitable for mining work, and its use has grown to a very considerable extent. It is claimed that by its use the diseases that the mining cable is heir to are, in the main, overcome and that such cables are the cheapest.

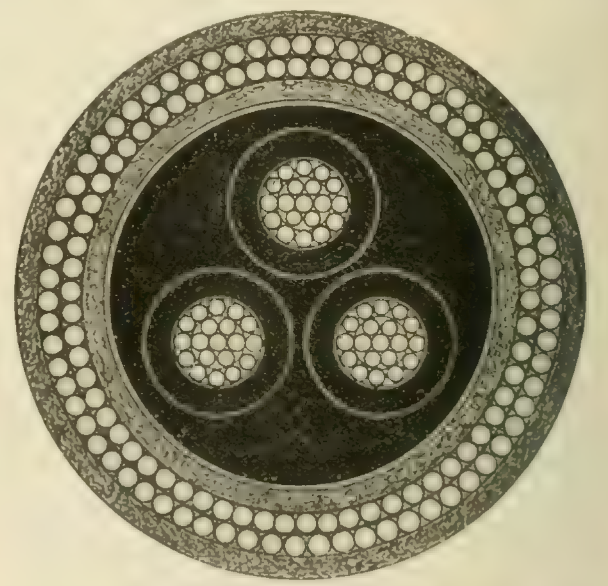


FIG. 11. ST. HELENS CABLE CO.'S "DIALITE" MINING CABLE.

Fig. 11 shows a cable of this description which is being used in a mine shaft. It is designed for three-phase working and is insulated, wormed and sheathed with "Dialite" and is further protected by a double armouring of galvanised-iron wires. Such a cable is tested at an alternating voltage of 3,000 after 24 hours immersion in water.

At the Helsby works of the BRITISH INSULATED & HELSBY CABLES (LTD.), a special cable suitable for use in collieries is manufactured. It goes by the name of "Helsby Hard Cord Braided Trailing Cable," and is illustrated in Fig. 12. The distinctive feature of this product is the armouring, which consists of hard cord braided on to the cable in place of a metallic covering, thus doing away with the risk of sparks caused by a metallic covering striking any hard material. This safeguard has not been obtained by the sacrifice of durability and flexibility, so that this cable should be found very convenient for fixing in many positions where the use of a metallic sheathed cable might be attended with a certain amount of risk.

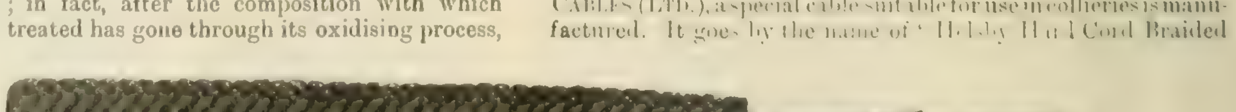


FIG. 12. HELSBY HARD CORD BRAIDED TRAILING CABLE.

Electrical Signalling in Mines.

BY F. HIRD, B.A., M.I.E.E.

(Of Messrs. Siemens Bros. & Co.)

The operations of hauling and hoisting materials and men, which are common to all mines, cannot in general be carried out without a clear and reliable system of signalling, by means of which the engine or motor driver is informed when he should start or stop and when a lower speed is required, &c. Any misunderstanding of the signals or failure in the signalling apparatus is liable to result in danger to life or damage to property.

It is obvious that there is here a considerable field for the application of electric methods which are more flexible and more certain than mechanical devices, and which can be arranged to give signals in a more convenient form.

We will commence by considering systems of electrical signalling as applied to the control of hauling operations. Here the conditions to be complied with are so readily met by electrical methods, that these have long since been very generally adopted. In general, a signalling installation consists of two bare overhead wires carried on porcelain insulators and running along the routes on which hauling takes place, up to the hauling engine, where a single stroke bell or gong is provided. The connections are so arranged that the gong is sounded by connecting together the two bare wires at any point of their length, either by actually bringing them into contact or by bridging them with any piece of metal that is handy. In some cases bell pushes are also provided at certain places.

Crude as this device appears to be, it is undoubtedly well suited to the needs of the case. The track rails in mines are generally very roughly laid, being often only intended for temporary use, and derailments of trucks are necessarily frequent. It is therefore necessary to be able to signal to the driver to stop, from any point of the route. The bare wire arrangement serves this purpose very satisfactorily.

There are, nevertheless, several defects in the system when carried out in its simplest form, as above described, which have made themselves felt in practice. In the first place, it is highly desirable that the driver should know from what point of the line a signal has been given, and secondly, that he should not start again until he receives a signal to do so from the same point. By dividing the line into sections, to each of which a particular number is assigned, the driver can identify the sending section by counting the strokes on his bell. The liability to mistakes on this system and the readiness with which the number code system can be abused for the purpose of shifting blame to another quarter, render it, however, very unsatisfactory. This is particularly the case in extensive workings where high speeds are in use. In fact, wherever modern methods and high speed of production are in vogue, the need for more complete, thorough and reliable signalling makes itself felt.

A method of electrical signalling which is free from these disadvantages was described by Mr. J. Willis in a Paper read before the North Staffordshire Institute of Mining Engineers in May, 1905. In this system the bare wire circuit is divided into sections as usual, but a resistance of about 50 ohms is inserted in one of the wires wherever it passes from one section to the next. In this manner it will be seen that the sections are distinguishable from each other by the different strength of current obtained when connection is made. The receiving apparatus at the driver's station consists of a set of relays so adjusted that each responds only to a particular strength of current. The relay which operates lights up a small lamp on a local circuit, at the same time it interrupts the circuits of all the relays which are set to respond to a weaker current than its own, and so prevents them working. A bell is provided which is also relay-operated on a local circuit and which responds to signals from all the sections. This system was first installed in the Leycett Collieries, and is said to have given satisfaction.

The principle of depending upon differences in current strength is, however, generally admitted to be undesirable in signalling work, and forms an element of weakness in this ingenious solution of the problem.

The most complete and reliable system yet devised was first installed at the Royal Mines at Brüx, in Austria, by Messrs. Siemens & Halske, of Vienna, and is described by Herr Gustav Ryba in the *Oesterreichische Zeitschrift fur Berg und Hutten wesen* in November, 1905. In this case the principle of two bare wires along the whole route is retained, but one of these wires is cut up into lengths, one for each section, and each such length is connected directly and independently to the hauling station, by means of an insulated wire. The other wire serves as a common return for all sections. It will be seen that the cost of the wires must be somewhat greater on this system, but the amount involved is not usually great, and the advantage of direct and positive operation more than counterbalances the additional cost.

The accompanying diagram (Fig. 1) with a few words of explanation will make the system clear. The diagram shows for the sake of simplicity only three sections; the bare wires are indicated by dotted lines. At the end of each section there are provided a bell push and a bell, both of which are water, dust and gas-proof. In the haulage station there are also a push and bell and in addition a board containing for each section one plain drop indicator, and one drop indicator serving also as a relay for switching on a small indicator lamp. There is also a line battery and a local battery for the lamps.

The operation is as follows:—Suppose the push on section 2 to be pressed, or, what comes to the same thing, the two bare wires in section 2 to be connected together, a circuit is established from the line battery through the two magnets a_2 and b_2 causing both shutters to fall and the lamp c_2 to light up, through the line and bare wire 2 across the push to line V, here dividing itself amongst all the bells including that in the haulage station to earth and back to the battery. The effect, therefore, is to ring all the bells along the line, as well as the bell in the haulage station (which is of lower resistance than the other bells) and to show by means of two drop shutters and a signal lamp that the signal to stop has come from section No. 2. The driver stops the motor or engine and replaces only the upper indicator drop, leaving the bottom one down and the lamp alight, until he receives a signal to proceed, which signal he accepts only from section No. 2.

The object of having two indicators for each section is to enable the driver to keep on record before his eyes the indication which was first received, as a reminder to him to accept starting instructions only from that point.

This system has been widely adopted and found to be both convenient and reliable. The reliability is no doubt due to the fact that no apparatus is used which has not been specially designed for mining conditions. All apparatus is enclosed in substantial metal cases capable of resisting a considerable amount of rough usage, and carefully made water, dust and gas-proof. For this purpose the membrane type of push and of bell is particularly suitable as it enables all working parts to be absolutely enclosed. It is only in this way that regularity of working can be ensured, for it takes very little dirt or rust to prevent a bell or a push from working, and the failure is rarely discovered except at the expense of stoppage, delay or, worse still, accident.

Turning now to the subject of signalling as applied to the control of hoisting, we find that a much less general adoption of electrical methods has as yet taken place in this country, although on the Continent electrical methods are now well established. The matter will be best understood by first shortly considering the mechanical methods in use and the disadvantages attending them.

The mechanical signals for shaft signalling usually consist of a "pull bell" arrangement. A rope hangs down the shaft and is attached to a bellcrank lever at the pit mouth, a balance bob is provided which overbalances the weight of the hanging rope

by some 10 or 15 lb. and serves to bring the lever back promptly after each pull. By a system of rods, ropes or wires and bell cranks the motion is transmitted to the engine room and is there used to operate a bell or gong.

A complete set of such apparatus is provided for each shaft compartment, and the engineman distinguishes between the different sources of the signals by means of the difference in tone of the bells. In addition to the bells in the engine room a further set is provided at the pit mouth, which are operated simultaneously with the engine bells and by means of the same mechanical motion of the rope.

In order to convey the necessary information to the engine-driver a code is used, in which definite meanings are attached to various numbers of bell strokes. For instance :—

1 stroke means " raise " when the engine is at rest,
1 stroke means " stop " when the engine is in motion,
2 strokes mean " lower,"
3 strokes mean " men in the cage,"

and other special signals consisting of various numbers of strokes, and spacing intervals are used to meet the particular needs of the case.

It may be mentioned here that there is some lack of uniformity in the codes in use in different mines or at least in different districts, which in itself may be a source of some danger. The system described has undoubtedly the merit of great simplicity, and has furthermore proved itself handy and sufficiently reliable in the case of shallow workings ; it is, however, clearly inadequate for modern requirements.

We may pass over for the present the obvious disadvantage of a code of signals depending on the number of strokes on a bell, and the risk of misunderstanding the signals, especially when several bells may be ringing in the engine room at once which are only to be distinguished by their different tones, and turn to other defects which are still more serious.

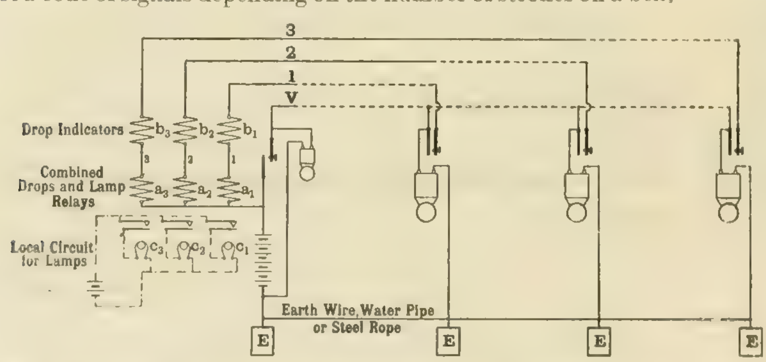


Fig. 1. Diagram of Signalling Installation for Hauling in the Austrian Mine at Brux. Showing Three Sections only.

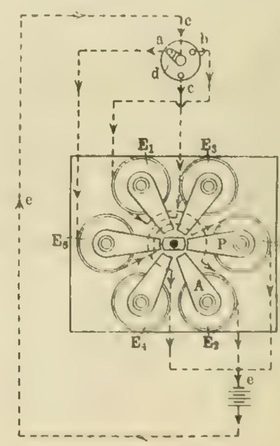


Fig. 2.

In the first place, no means of answering back or acknowledging the receipt of a signal are possible, so that the sender has no certainty that his signal has been correctly transmitted, for the bells cannot be heard at any great distance down the shaft. Again, there are serious mechanical difficulties due to the reciprocating motion of many long parts in positions which are not readily accessible, and are yet considerably exposed to damage or dislocation, from various sources. These latter difficulties increase rapidly with the depth of the shaft and soon become so serious, that the mechanical system ceases to be reliable. In many cases where the depth is too great for a single pull bell arrangement, the signal is sent in stages and passed on till it reaches the driver. Special indicators are sometimes provided which count the bell strokes received, and count backwards those which are sent on, so that the indicator should always come back to zero if the attendant has correctly passed on the signals. The unsatisfactory nature of such an arrangement, however, hardly needs pointing out.

It is not surprising, therefore, that at an early date the substitution of an electric bell, push and battery, with a pair of insulated wires for the pull rope and bell cranks, should have been made, the system in other respects remaining unaltered. Such substitutions have in many cases proved successful, and have resulted not only in greater security and less maintenance, but also in increased speed of working.

It must, however, be confessed that in other cases the reliability was not improved, and constant trouble was experienced in maintaining the installation in working order. This was due to the use of apparatus which, though suitable for use in factories and other buildings, had never been designed for the special conditions which obtain in mines, and therefore frequently broke down when subjected to them.

Where the conditions happened to be particularly favourable or where the services of competent electricians were available, the difficulties were in time surmounted, and reliable electric bell signalling became established ; in other cases it became discredited in the eyes of the management, and either the mechanical plan was reverted to or a substitute found in the use of compressed air.

The compressed-air systems which have been put into use correspond exactly with the pull-bell system as regards the mode of signalling and the results achieved ; a pipe is run down the shaft in which a pressure of air is normally maintained, and discharge valves provided at the various levels, permit the pressure to be momentarily reduced. The reduction of pressure actuates a diaphragm which in turn opens a valve in the engine room and admits compressed air to a whistle.

This arrangement is certainly free from the mechanical objections of the pull-bell system, and is no doubt more reliable than an electric installation in which cheap and unsuitable apparatus and wire have been used ; it is, nevertheless, as a system, liable to just the same objections as the pull-bell system, no answer back is possible, there is liability to miscounting of the signals and to confusion if several shaft compartments are being dealt with.

It is claimed, indeed, that the hissing of the air at the discharge valves indicates to the sender that the signal has been received, but it can hardly assure him of more than of the fact that it has been sent. In this case, as in that of hauling, experience shows that simple and even crude methods may be sufficient for shallow mines and small outputs, but are quite inadequate for deep mines and high rates of production.

The principles to be observed in a modern signalling installation for hoisting purposes may be enunciated as follows :—

(*a*) Bell or gong signals must be supplemented by visible indications.

(*b*) Means must be provided by which the receipt of signals is acknowledged by repeating back to the sender.

(*c*) Signals from underground levels to the engine house must be confirmed by identical signals from the pit mouth, and must not be acted on until so confirmed.

The following system complies fully with these conditions and provides certain additional safeguards. It has been developed by Messrs. Siemens & Halske, of Berlin, and has already been installed in no less than 70 shafts in various parts of Germany and Belgium. The signals are given in two distinct forms, first visible signals indicated by a pointer on a dial, and secondly audible signals indicated by the number of strokes on a bell.

In order to make the system clear it is necessary first to describe the sender and receiver for the visible signals. These are shown diagrammatically in Fig. 2. The receiver consists

of six electromagnets, E1, E2, &c., with radial poles between which a small armature can rotate. The opposite pairs of magnets are connected in series, the free ends of E6, E1 and E3, are connected by separate wires to the contacts *a*, *b* and *c* of the sender switch and the free ends of E5, E2 and E4 are joined to a common return *e*. It will thus be seen that four leads are required. As the sender arm *d* is rotated the pairs of magnets are successively excited and the armature turns round on its axis following the excitation, and stops wherever the sender arm does so and in the corresponding position. The spindle on which the armature is carried is geared by means of a small worm and wheel to a pointer which passes over a dial on which the visible signals are painted.

This form of telegraph has found many industrial applications, but we will confine ourselves to its use for shaft signalling. When applied to this purpose the gear is usually so arranged

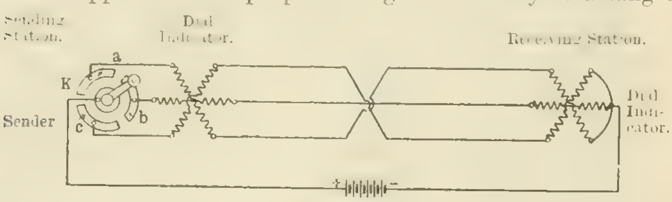


Fig. 3.

that one complete revolution of the sender switch corresponds to half a revolution of the armature and moves the pointer one step on the dial.

In order that the operator at the sending station may know that his signals have been correctly sent and received, two methods may be adopted. Fig. 3 shows one of these methods. The sending station is provided with a receiver, which is connected in series with that at the receiving station, so that every signal is shown at both ends. In Fig. 4 each station is provided with a sender and a receiver which are reciprocally connected, and in this case each receiver dial is provided with two pointers, one of which is operated by the receiver armature, as above described, and the other by gearing from the sender handle.

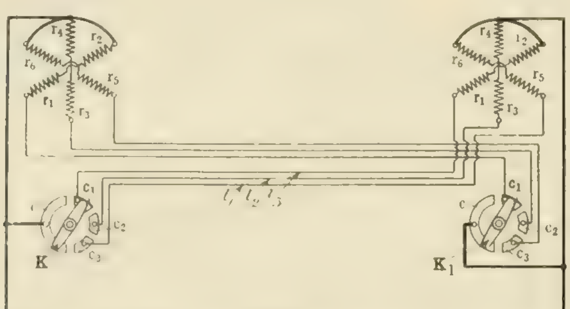


Fig. 4.

The attendant who receives a signal repeats it back, thus bringing both pointers at both stations in agreement, any disagreement of the pointers at once shows:—

(*a*) Neglect to attend to the signal,

(*b*) Misreading of the signal, or

(*c*) Some defect in the transmission.

It will be observed that in this case seven wires are required instead of four as in Fig. 3.

The application of the system to shaft signalling is shown in Fig. 5. The signals are given in two distinct manners, first by the dial indicators, and secondly by means of a number of strokes on a bell. In the usual case there are three stations, one at the bottom of the shaft, one at the pit mouth and one in the engine room. The two shaft stations are both provided with a sender, a dial indicator, a single stroke bell and bell pushes, the station at the pit mouth has, in addition, an order switch O.S., and the station at the winding engine has a dial receiver but no sender and a single stroke bell.

In addition, a vibrating bell V.B., is provided in the engine room and at the pit mouth, which can be operated by a push E.P. either from the pit mouth or from the bottom of the shaft, and which serves as an emergency signal independent of the ordinary signalling arrangements. The sounding of this bell instructs the driver to stop immediately.

Referring to Fig. 5, it will be seen that by operating the senders K_1 or K_2, visible signals can be mutually sent between the pit mouth and the bottom of the shaft, and that these signals are also received on the dial indicator I_3 in the engine-room. It will also be observed that the single stroke bells SB_1 and SB_2 at the bottom of the shaft and at the pit mouth are connected in one of the leads in such a manner that for each complete revolution of the sender one stroke on the bell is given. The number of strokes therefore corresponds with the signal indicated on the dial. The single stroke bell, SB_3, however, which is located near the winding engine, is not normally in circuit unless the order switch OS at the pit mouth is closed.

The operation of signalling is conducted as follows: A signal is sent from the shaft bottom by operating the sender K_1. This signal appears on the dials I_1, I_2 and I_3, and is struck on the bells SB_1 and SB_2, but not on the bell in the engine-room SB_3. Suppose the order is for hoisting, the attendant at the pit mouth when satisfied that all is clear, operates the switch OS, and gives the number of strokes corresponding to the signal

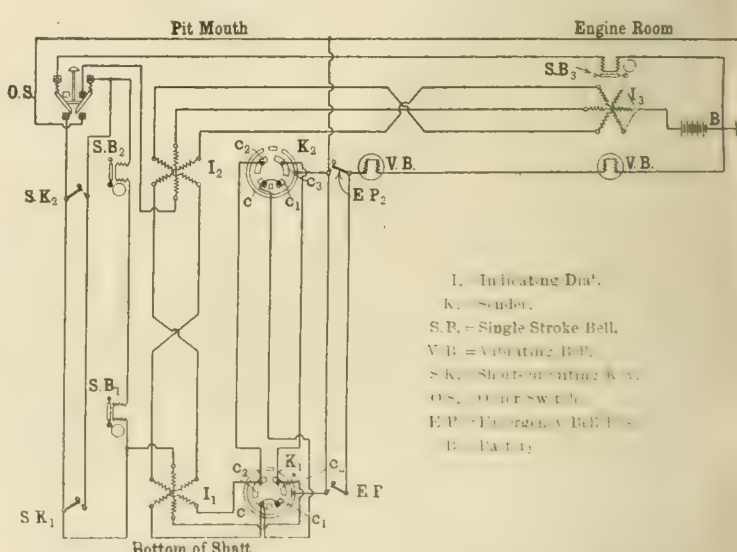


Fig. 5. Diagram of a Standard Shaft Signalling Installation.

for hoisting. All the bells SB_1, SB_2 and SB_3, respond, and the driver proceeds to execute the order. The driver is instructed to obey only bell signals, and these only when they correspond to the indication on the dial, and never to act on dial indications.

During the execution of an order, and until another signal is required, the dial indicators are left in position. When another signal is to be sent either from the top or bottom of the shaft the sender K_1 or K_2 is first turned back to the off position, thus bringing the pointers of all the dials I_1, I_2 and I_3 back to zero. During this operation the push SK_1 or SK_2, as the case may be, is depressed, thus short-circuiting the bells and avoiding the confusion which might arise from unnecessary bell ringing. The apparatus is then in readiness for the next signal.

The use of the order switch OS gives great security in working and has the following advantages:

(*a*) While permitting the free use of signalling in both directions it limits the actual giving of orders to one responsible man.

(*b*) It serves as a means of acknowledging signals to the sender by an independent method.

The system can be readily applied to cases where hoisting is to be carried on from several different levels, the apparatus provided for the bottom of the shaft being simply repeated at each level.

It is sometimes desired to reduce the signalling to a simple bell stroke system when handling material, and to bring the dial indicators into use only when hoisting or lowering men. When this is desired an extra signal key X, Fig. 6, is provided at each level by which the change in system is announced.

Fig. 6 shows diagrammatically a signalling installation for

hoisting from two different levels, and for using only bell signals when handling material, the arrangement is quite similar to that already described, the only additional apparatus being the cut-out switches S, which serve to cut-out the bell at the station which is not concerned.

The system of working having been explained, a few words may be said about the form of the apparatus itself. The dial indicators, senders, bells and pushes for each station, are mounted together in a strong metal case with water and gas-tight fittings, and a watertight terminal box receives the multi-core cable and distributes the connections. The bells and pushes are of the diaphragm type. The cables are made up with the necessary number of cores, and are well insulated and armoured. At the pit mouth and the various levels the apparatus is of the wall pattern, but in the engine-room it is usually mounted on a suitable standard.

We have now dealt with the two principal applications of electric signalling in mines, viz., for hauling purposes and for hoisting purposes. There are many other cases, however, in which intercommunication is either necessary or desirable, and

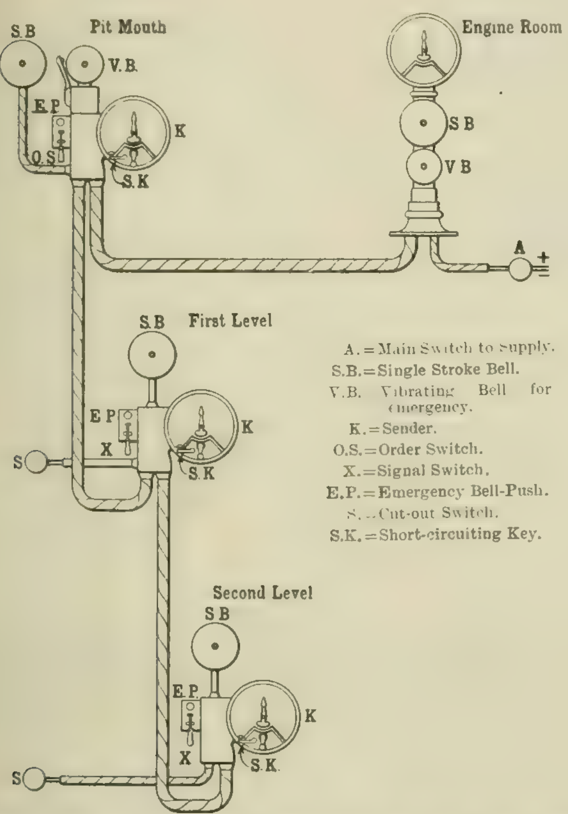


Fig. 6. Shaft Signalling Installation for Two Levels, arranged for Simple Bell Signals when raising material, and for Combined Bell and Dial Indicator when hoisting men.

in which electricity provides the safest and most convenient means. It is not possible to deal with all these, but it may be pointed out that the requirements can nearly always be met either by a set of dial indicators similar to those described, or by a simple installation of bells and pushes or by telephones, or, finally, by a combination of these.

To deal adequately with the subject of telephoning in mines would lead us too far, but it may be remarked that the advantages offered by the telephone should be more fully recognised, since a well-arranged telephone service effects not only a great saving of time and a more complete control for the management, but also may be the means of giving warnings of danger and so averting loss of life.

Here, as with other apparatus, specially designed apparatus, amply protected against damage from water, dust or mechanical injury is essential, it is only in rare cases that the conditions in a mine are such that ordinary telephone apparatus will continue to give satisfaction.

Ventilation of Mines by Electric Fans.

BY J. W. GIBSON, A.M.I.E.E.
(Of Messrs. Davidson & Co

Pumping and ventilation have always claimed the first attention of mining engineers who have given these subjects a large amount of care and forethought. Thorough reliability has generally been aimed at in preference to economy, although the latter has not been lost sight of. With the pump a sudden temporary stoppage would not usually be a serious matter, as in most mines there is at least standage for a few hours or possibly days' drainage, sufficient to permit of the pumping installation being shut down for repairs or replacement of parts.

In the earlier days of mining engineering the ventilation was generally obtained by using a furnace to induce a current of air through the workings. This method, although costly, proved to be reliable and satisfactory as long as the resistance of the workings was such that the draft power required was well within the capacity of the furnace. Owing to the extensive development of collieries, wider areas are covered and more mechanical appliances are used in the winning of coal and other minerals; the air courses are longer, and generally of greater resistance, and frequently water gauges are required which are much beyond furnace capacity. Furnace ventilation was not entirely free from trouble and risk of stoppage. The breaking away of water from behind the tubbing in the shaft has been known on several occasions to cool down the rising column of hot air to such an extent as to reverse the ventilation in the mine. Fires have frequently broken out in the neighbourhood of the furnace or drift connecting the latter to the upcast shaft. Such fires are very difficult to deal with, and in some cases have been known to burn or smoulder for years.

Owing to the high temperature and presence of the products of combustion in the upcast shaft considerable difficulties are presented against winding operations, and the use of the shaft for the general purposes of the mine. Timber cannot be employed to any great extent in this shaft without frequent renewal, and ironwork is subject to excessive corrosive action due to moisture in combination with the products of combustion from the furnace. Finally the shaft cannot be examined in the same thorough manner that is possible under pure air and reasonable temperature conditions.

These difficulties are successfully overcome by adopting mechanical ventilation, and the upcast shaft can then be made full use of as well as the downcast shaft. Power, lighting and telephone cables can be fixed in each, thus providing a convenient standby in the event of an accident in one of the shafts.

About 30 or 40 years ago slow speed fans of large diameter came into more general use, and were usually direct coupled to engines of the simplest possible construction. Many of these old fans have given a very good account of themselves, and have worked almost continuously for a large number of years with a few hours stoppage each fortnight for the usual inspection.

With the advance of the science and practice of mining, and the important developments in connection with mechanical and electrical engineering these large slow-speed steam-driven fans are giving place to the more efficient high-speed electrically-driven combinations, of which there is now a large number in successful and satisfactory operation.

A centrifugal fan is looked upon as being a very simple piece of apparatus; it has however, had to pass through a period of development in common with other branches of mechanical engineering. Present day practice demonstrates that if high efficiency is required the fan must be specially designed to suit the particular duty upon which it is intended to operate.

At an old colliery in county Durham a 36 ft. diameter Guibal fan has been in use for ventilating purposes since 1874, and is direct coupled to a single cylinder steam engine of 30 in. diam., and 30 in. stroke, and arranged to run at a speed of 50 revs. per min., steam was supplied from a battery of three Lancashire boilers. The running of this installation required the services of two men, working 12 hour shifts each.

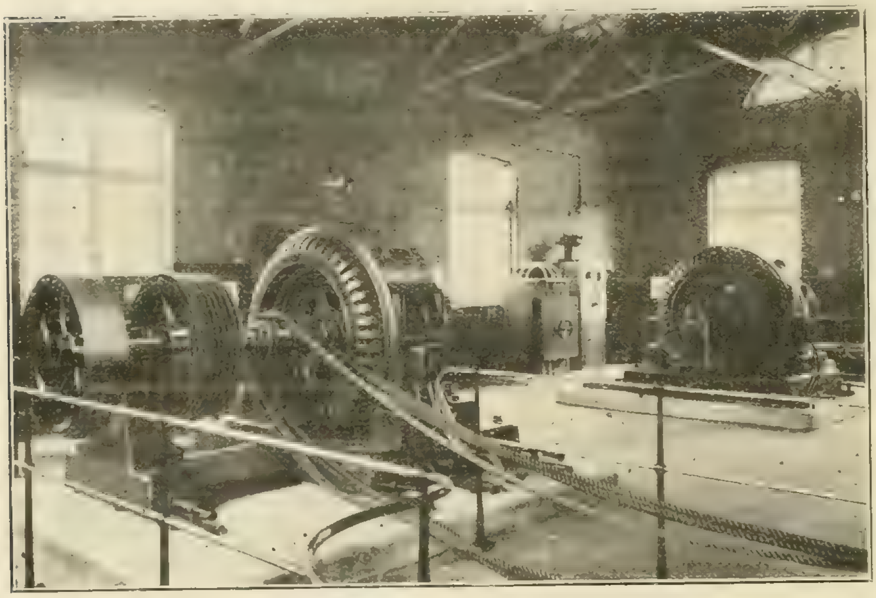


Fig. 1.—Interior View of Fan House.

About two years ago a fan of more recent construction and design was put down for exhausting a volume of 150,000 cub. ft. of air per minute whilst setting up 4 in. water gauge, and running at a speed of 225 r.p.m. It is arranged for rope or belt drive from a Siemens three-phase motor capable of developing 150 B.H.P. At present, however, the requirement of the mine is met by running at a speed of 165 revs. per min.; the volume necessary flows through the mine for a water gauge of 2 ft. 6 in. As all bearings are provided with automatic ring lubrication the continuous presence of an attendant is not necessary, and the plant is merely inspected two or three times during 24 hours. The current is supplied by the County of Durham Power Distribution Co.

Fig. 2 shows a view of the old fan engine house with boilers in the foreground, and the new electric-driven installation, which, although being of larger volumetric capacity, covers a considerably smaller place, can be seen between the chimney and the end wall of the old fan engine house.

In Fig. 5 are shown two fans which are used for the ventilation of a mine in Scotland; one is a steam driven Guibal fan, 40 ft. diameter, and almost alongside is a new 98 in. diameter "Sirocco" double inlet fan, arranged for rope drive from a 150 B.H.P. Westinghouse three phase motor. This mine requirement calls for a circulation of about 220,000 cubic ft. of air per minute, and a water gauge of 2·75 in., and the duty is easily handled by the smaller fan when running at a speed of 183 revs. per min. The difference in size between the fans is very significant, especially in view of the fact that the smaller electric-driven fan is capable of fulfilling the same duty as the other, both being connected to the same upcast shaft.

The third installation is situated at a north country colliery and is designed to exhaust 180,000 cubic ft. of air per minute from a mine setting up 3 in. water gauge, the fan is double inlet type, 70 in. diameter, and direct coupled to two three-phase motors, one serving as a standby to the other. Power is supplied by the Durham Collieries Electric Power Supply Co. The diagram in Fig. 3 indicates the arrangement of drift connecting the upcast shaft to the fan suction.

In this case the area of the upcast shaft is rather small compared with the volume of air passing through it, and at present a water gauge of 4 in. is required to exhaust a volume of 140,000 cubic ft. per minute, but after the area of the upcast shaft has been increased, which it is proposed to do, the full volume will be obtainable for a much less water gauge. This fan, however, whilst working upon a duty considerably different for which it was designed to handle, is operating at an efficiency of 74·6 per cent. When the expected alterations are carried out the fan efficiency would be improved.

Amongst the electric-driven mine installations in South Wales, mention should be made of the important installations in operation at the Ferndale Colliery of Messrs. David Davis & Sons, who are the proprietors of nine collieries in this district. The electric equipment of these collieries is being carried out by the company's consulting engineer, Mr. W. H. Patchell, M.I.M.E The fan at Ferndale Colliery is a double inlet type, 98 in. diameter, and has a capacity for dealing with 300,000 cubic ft. of air per minute at 4 in. water gauge, when running at a speed of 260 revs. per min. It is arranged for rope drive from two motors, one acting as a standby to the other. A portion of the fan house is used as a substation from which current is distributed to small motors for surface work and lighting. An interior view of the fan house is shown in Fig. 1.

It has been occasionally remarked that three-phase driving for mine ventilators is rather inflexible, as it does not lend itself favourably to speed reduction should the mine requirement at week-ends and holiday times permit of this. Mr. Patchell has designed and applied special arrangements to the Ferndale fan by which the energy required at week-ends, &c., can be reduced, aud considerable economy is thereby effected.

Fig. 2.—Old Fan Engine House.

There are now some hundreds of these electric-driven mine installations in operation, and are found to be thoroughly reliable and economical in operation. A slight drop in efficiency on a continuous running duty such as mine ventilation would

represent a considerable loss over one year's working, and when a specially designed mine ventilating fan is used in combination with a first class electric motor the two should form an installation of maximum efficiency, combined with thorough reliability.

The electrification of collieries has also brought forward the advantages to be gained by using auxiliary fans for ventilating local districts in certain areas of the mine. It frequently happens where there are three or more seams or districts of a mine that a different pressure head is required for ventilating each seam. For instance, we may take a mine having three seams, and requiring a total air circulation of, say, 200,000 cubic ft. per minute at a water gauge of 4 in.

Let us assume that A seam is a shallow seam and with small air-roads requires a volume of 50,000 cubic ft. of air at a water gauge of about 4 in. Seams B and C are thicker deposits of coal, and the air-roads through same are such that a good deal less resistance is offered to the flow of air, and each requires, say, 75,000 cubic ft. at a pressure of 1 in. water gauge The water gauge being too high for B and C, resistance has to be placed in the air circuit by throttling in order to reserve the necessary pressure for operating on seam A. Where a supply of electric power is available an auxiliary fan could be placed in seam A to deal with 50,000 cubic ft. per minute with a pressure head from, say, 2 in. up to 4 in. water gauge according to requirements. The fan on the surface could then be arranged to operate at a lower pressure to supply seams B and C, and also to handle 50,000 cubic ft. of air per minute required for seam A at the same pressure which is necessary for seams B and C.

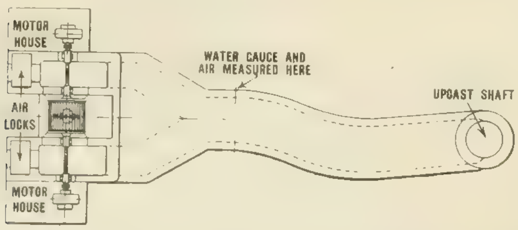


Fig. 3.—70 in. Diameter "Sirocco" Double Inlet Mine Fan exhausting 140,400 cubic ft. of Air per Minute and maintaining a Water Gauge of 4 in. when running at a speed of 338 revs. per min.

With this arrangement throttling at B and C could be dispensed with, and a very substantial saving in power would result. Further, if the upcast shaft is used for winding purposes, the amount of air leakage is very considerably reduced compared with what it would be at the higher water gauge.

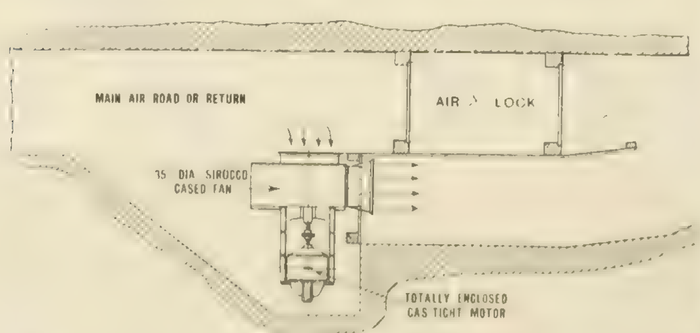


Fig. 4.—Diagram showing Method of Applying an Auxiliary Fan to the Main Air Road or Return of a District requiring Increased Ventilation.

These auxiliary fans are generally of the full housing type, and built up in convenient sections to facilitate transit in the mine or moving to new positions when necessary.

Fig. 4 indicates the method of applying the fan to the main air road or return. A large number of these electrically driven high-speed fans are now in use on this class of work for pressures of ½ in. up to 6 in. water gauge, and they form a convenient and effective means of overcoming ventilating difficulties.

Districts remote from the shaft which could only be partly ventilated by the main ventilator on the surface can be provided with a vigorous circulation of air without placing any serious increase of load on the surface fan.

Fig. 5.—View showing Comparison between a 40 ft. Steam-driven Guibal Fan and a 98 in. Sirocco Double Inlet Fan.

Electric driven centrifugal fans are also used for shaft ventilation during sinking operations, as a large volume is not necessary, a small amount of power only is required, and this is usually available from the lighting dynamo. A variable speed motor should be used for this class of work so that extra speed and, consequently, extra air pressure will be available as the shaft is deepened.

It is also an advantage to have extra speed available in order to cause a vigorous circulation of air in the shaft immediately after blasting, so as to clear the fumes away quickly.

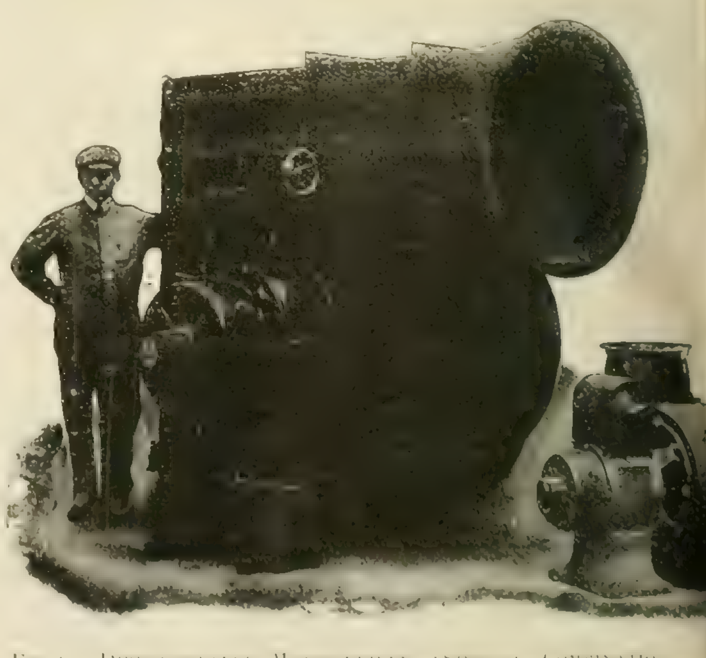


Fig. 6.—Direct-coupled Motor-driven "Sirocco" Combination.

The fans are generally arranged in the form of direct-coupled sets similar to that shown at Fig. 6, and they have the advantage that they can frequently be used as auxiliary ventilators at a later stage in the development of the mine.

Some Examples of Ventilating Machinery.

Anyone who has had anything to do with mining work, or has paid a casual visit to a colliery, will know the absolute necessity of an efficient scheme of ventilation. Its value is so obvious as to be an axiom, so that in what follows we simply describe some plant designed by various makers for this purpose, leaving their merits to speak for themselves.

Fig. 1 shows a British Thomson-Houston 100 h.p. three-phase motor coupled to a forced draught fan manufactured by Messrs. Davidson & Co. The motor is supplied with a starting compensator, whilst in the centre of the illustration will be seen a B.T.-H. combined oil-break switch.

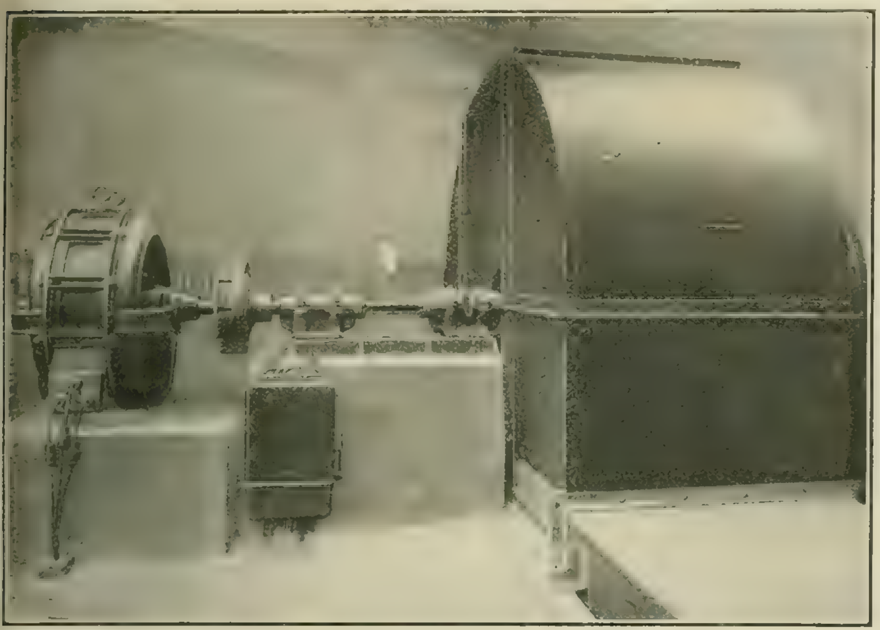


Fig. 1.—B.T.-H. Motor driving "Sirocco" Fan.

Until recent years it was the general opinion of mining engineers that the fans required for the ventilation of mines must necessarily be of large diameters. When, however, the "Sirocco" mine fan was placed on the market by Messrs. Davidson & Co., of Belfast, it became very evident that, in view of the claims made by the makers of that fan, this opinion needed considerable modification, and it became still more obvious when the results obtained with this fan under actual working conditions were made public. The very first installation where the "Sirocco" was used bore out the makers' claims, a 75 in. diameter fan of the double inlet type not only doing the work of two other fans, whose aggregate diameters amounted to 10½ times that of the "Sirocco," but even delivering a 12 per cent. larger volume of air. This was only the first of many similar instances. At another mine a 77 in. diameter "Sirocco" is replacing a fan measuring 44 ft. in diameter, while many others of less than 100 in. are being installed for fans of the old type measuring 30 to 40 ft.

Interesting though this question of reduced diameter undoubtedly is from the mechanical standpoint, it would be of little value if it could not show some advantageous features when considered also from a commercial aspect. The chief advantage of fans of small diameter lies in the fact that they can be run at comparatively high speeds, making it possible to couple them directly to motors or engines which develop the required power at high speeds. The first cost of the motor or engine is consequently very much lower than in the case of a slow running fan, which often could not be direct-coupled, owing to the slow speed necessitating the use of a large size motor or engine with the proportionate increase of cost. With belt-driven fans this characteristic is possibly not quite as important, as the difference in speed between fan and motor can be adjusted by pulleys of different diameters. With high-speed mine fans, such as the "Sirocco," a considerable latitude of speed can be obtained by the judicious selection of a single or double inlet type. This is particularly valuable where there are speed limitations, as, for instance, in the case of direct-coupled sets, when for the same duty a choice between a single inlet fan at a slow speed, and a double inlet fan of smaller diameter at a high speed may prove a great advantage, both as regards initial outlay and running costs.

The reduced dimensions of the high-speed fans lead to very marked economy in the cost of erection, owing to the small amount of brickwork and masonry necessary to provide their housing, and this fact is clearly evidenced when taking the actual space occupied by the fan wheels into consideration. Thus, taking as an example an actual installation where a wheel occupying a space of 325 cubic ft. is replacing another of 15,000 cubic ft., it is obvious that the amount of brickwork required to enclose the former is very much less than that needed by the latter. Furthermore, an additional saving is frequently effected in the reduced size of the engine and motor house, due to the use of a high-speed in place of a low speed and consequently larger dimensioned machine.

Although the "Sirocco" fans are small in diameter they are capable of fulfilling large duties, as is borne out by a number of installations in operation in this country. As instances may be quoted a double inlet fan 119 in. in diameter, which is capable of passing 300,000 cubic ft. per minute at 3 in. water gauge, while another measuring 140 in. can deliver 375,000 cubic ft. per minute at 4 in. water gauge. Furthermore, a "Sirocco" is now in course of construction which will have an output of half a million cubic feet at 6 in. water gauge, and will be direct-coupled to a motor of 1,000 h.p.

Finally, it has been sometimes argued that the slow-speed fan of large diameter shows far better efficiency than the smaller high-speed fans. This, however, cannot be the case, considering that the "Sirocco" is able to give an efficiency of 70 per cent. and over, when tested under actual working conditions in mines.

A large number of the most interesting installations of "Sirocco" fans are described in a mining pamphlet which has just been issued by Messrs. Davidson & Co., these fans are so well known to all interested in the mining industry that it is unnecessary to describe their main features.

Fig. 2.—Lancashire Dynamo & Motor Co.'s Motors Coupled to "Sirocco" Fans.

In connection with ventilating it seems impossible to get away from the "Sirocco" fan. The only obvious variant is the coupling of this fan to different makers' motors. This is done in a number of cases.

In Fig. 2 we illustrate several continuous current motors made by The Lancashire Dynamo & Motor Co. for this pur-

pose. These are specially suitable for supplementary ventilation in mining work.

In construction, the fan manufactured by the WADDLE PATENT FAN & ENGINEERING Co., of Llanelly, may be considered as a light hollow disc, the two sides of which are strongly braced together by the blades, which are rivetted to them. The periphery is open all round, and the air is discharged equally from every part of it. The load on every blade is therefore steady, and it is claimed that there is a complete absence of the vibration which is frequently found, to a greater or less extent, in most enclosed fans. This absence of vibration, of course, not only reduces the wear and tear and ensures immunity from breakdown, but also enables the fan to run at a high speed with perfect safety in mines which require a powerful suction to produce the necessary ventilation. The air is taken in at one side of the fan only, thus allowing the connection from the upcast shaft to be a short straight passage and avoiding the bends in the air drift necessitated by two inlets. The fan being very narrow in proportion to its diameter and capacity, it is easy to design a self-contained arrangement allowing of the fan with its motor being mounted on one bedplate.

Another firm who have dealings in these matters are Messrs. HEENAN & FROUDE, of Worcester. A fan lately supplied by them to a leading colliery in Scotland was 7 ft. in diameter and 3 ft. 6 in. wide. It was constructed of steel plate fully housed and arranged with a single inlet for a belt drive. It was fitted with ring-lubricated self-centring bearings, lined with anti-friction metal and capable of delivering 50,000 cubic ft. of air against a pressure of 2 in. water gauge when running at 230 revs. per min. and absorbing about 30 H.P.

Messrs. PETER BROTHERHOOD, of Belvedere-road, S.E., manufacture high-speed engines, with forced lubrication, driving fans for ventilating purposes and for producing induced and forced draught. These engines are of course very well known and need no description; they can, moreover, be fitted to fans manufactured by any of the leading fan makers.

The Use of Explosives in Collieries.

BY WM. MAURICE, F.G.S.

(Manager of the Hucknall Torkard Collieries, near Nottingham.)

About 20 millions of shots are fired annually in Great Britain, mostly by persons who know nothing whatever concerning explosives or shot-firing beyond the simple procedure necessary to produce an explosive effect.

Accidents to shot-firers and others caused through neglect to take proper precautions are of fairly frequent occurrence. These accidents are almost wholly inexcusable, since they might all, or nearly all, be prevented by forethought and obedience to the regulations contained in the Mines Acts and Special Rules. Injuries to operators are, however, merely incidental, and discussion of the means for averting them does not lie within the scope of this article, the purpose of which is to review the more serious risks involved in the practice of blasting in mines.

Shot-firing in coal mines is a much more responsible operation than it is in metalliferous mines or quarries, mainly because of the more potentially dangerous atmosphere in which the work is conducted.

The greater dangers, evidence of adequate knowledge of which ought to be produced by every candidate for the position of shot-firer, arise from the presence of firedamp and coal dust, either separately or conjointly.

It is for the most part impracticable to entirely abolish the use of explosives in mines, and means of blasting with a reasonable degree of safety have therefore been sought in a more searching study of the properties of explosives under conditions similar to those which obtain in practice, and in the consequent evolution of explosive combinations capable of being fired with safety in explosive atmospheres.

IMPROVEMENTS IN EXPLOSIVES.

Twenty years ago gunpowder and dynamite were almost the only explosives used in mines, although it had even then been more or less generally recognised that gunpowder was a dangerous agent to use in the presence of firedamp and coal dust.

After many disasters had been traced to the use or misuse of explosives, the Secretary of State availed himself of sec. 6 of the Coal Mines Regulation Act, 1896, to issue an order making it unlawful to use any explosive other than a "permitted" explosive under certain specified conditions on and after July 1, 1897. Concurrently a testing station was erected at Woolwich, following on the report of a Departmental Committee appointed "to inquire into the testing of explosives for use in coal mines."

Explosives to be tested are sent by the manufacturers to this testing station, and if 20 charges of any sample are fired into an explosive mixture of gas and air, under certain specified conditions as to weight and stemming, without causing ignition, the explosive is then entitled to be placed on the "permitted list."

As it is to be feared that many workmen regard the fact of an explosive being "permitted" as being somewhat in the nature of an official certificate of safety, the following remarks of the officers in charge of the testing station cannot be too often repeated. "There is not a single explosive on the permitted list which has not at some time or other caused an explosion of the gas at the testing station when fired without stemming. It is impossible to get an explosive which will be absolutely safe under all conditions. The safety of any particular explosive depends not only upon its composition and physical characteristics, but even in a more marked degree upon the conditions under which it is used. There must be

1. Complete and immediate detonation of the charge.
2. Correct proportioning of the charge to the work to be done, and avoiding the use of unnecessarily heavy charges.
3. Careful stemming to ensure that there should be sufficient length, firmness, moisture and closeness of consistency.

Thus the only difference as regards safety from mine explosion risks between one explosive and another is the difference in degree; the most that can be said is that one explosive is less dangerous under certain conditions than another.

Modern explosives are divided into five principal groups:—

1. Nitro-glycerine explosives, which are relatively easy to detonate under normal conditions.
2. Ammonium nitrate explosives, which occupy an intermediate position between the dynamites and the carbonites.
3. Nitro-glycerine and ammonium nitrate explosives, which detonate more freely than class 2.
4. Non-detonating mechanical mixtures, mainly represented by Bobbinite, which is a high-grade gunpowder mixed with starch and paraffin wax; and
5. Gunpowder, the principal characteristic of which is its low velocity of explosion, rendering it very suitable for work where a slow heaving action is required.

All these classes are represented on the permitted list with the exception of gunpowder, which will not pass either the Continental or Woolwich tests.

DETERMINING FACTORS IN THE IGNITION OF FIREDAMP.

The time occupied in detonating a given quantity of an explosive is determinable, and is known as its rate of detonation. All explosives on detonation develop flame, of different extent and duration.

M. Bichel, the inventor of carbonite, has conducted elaborate and extensive experiments to ascertain the determining factors in the ignition of firedamp, and finds them in a comparison of

the ratios of the safest and least safe explosives as to rate of detonation, length and duration of flame, after-flame ratio, and temperature. M. Bichel has shown that the flame of all explosives outlasts the time of detonation, but that of the "safe" explosives does so in a much less degree than in the contrary case.

"In general" (*see* M. Bichel in "New Methods of Testing Explosives") "safety explosives should show a minimum rate of detonation and a minimum of length and duration of flame at a given pressure; none of these should exceed certain limits, as the detrimental effect of one of them cannot be counterbalanced by the others, however favourable. Thus it is the long contact between flame and gas mixture which is fatal to gunpowder in spite of its low calorific value. The heated gases remain too long in contact with the inflammable gas mixture, and thus, even at low temperature, ignition is unavoidable."

BLASTING IN THE PRESENCE OF COAL DUST.

It was not until a number of serious explosions had occurred, the cause of which could not be traced to the presence of firedamp, that attention was strongly turned towards the possibility of exploding a merely dusty atmosphere. The wholehearted acceptance of the danger of coal dust by the mining community comes, however, very slowly. It is now nearly 100 years since the Rev. J. Hodgson referred to the coal dust in the Felling Colliery explosion. Prof. W. Galloway has been working and writing on the subject for 30 years, innumerable researches have been conducted both at home and abroad for the purpose of determining the explosibility of various kinds of dusts, and yet Messrs. W. H. Atkinson and J. Dyer Lewis, H.M.'s Inspectors of Mines, in a Parliamentary Paper on the Dinas Main Explosion (which occurred on December 14th of last year) find it necessary to say that "general opinion, if there can be said to be such a thing as general opinion, as to what constitutes a dangerous amount of dust in a mine is probably very wide of the truth."

What Constitutes a Dangerous Amount of Dust in a Mine? Experiment has shown that as little as $\frac{1}{3}$ oz. of coal dust per 35 cubic ft. of air will suffice for the production of an explosion, and that it is more a question of fineness of division of the dust than the weight. In addition to fineness of subdivision the percentage of volatile matter in the coal dust has an important influence on its inflammability, and the same also applies to the ease with which these volatile matters are disengaged under the influence of heat.

The Commission appointed by the Societé de l'Industrie Minérale to investigate the causes of coal-dust explosions have pointed out that the great danger of explosion presented by floating coal dust is evident from the fact that a mixture containing 111 grammes of dust per cubic metre of air (*i.e.*, in the proportion furnishing carbon dioxide on combustion) develops a pressure of 15·5 atmospheres on ignition, as compared with the pressure of 8·9 atmospheres produced by the combustion of an explosive mixture of firedamp and air. Even when the amount of coal dust is double the above figure, so that carbon monoxide is produced, the pressure generated amounts to 6·7 atmospheres. The fact, moreover, should not be lost sight of that the dust danger is by no means eliminated merely by removing coal dust.

Any powdered substance in a state of suspension as fine dust may, by occluding, and so acting as a substitute for, air or oxygen, cause an atmosphere to become explosive. Dust from oil-bearing shales might be especially dangerous.

Proposed Classification of Mines.—Having regard to the facts now known concerning the use of explosives in dangerous atmospheres, the Commission above referred to have suggested that non-fiery mines should be divided into safe and dangerous according to their condition as regards dust, the dangerous class being subdivided into damp and dry mines.

Watering and Alternatives.—In Great Britain the present alternative to watering lies in the conditional use of a permitted explosive. The French Commission approve of local, but not of general watering, and recommend that shot firing be allowed in coal up to charges of $13\frac{1}{2}$ oz. without previously laying or removing the dust. Watering may be dispensed with by using explosives (in the coal) with a detonation temperature not exceeding 1,500°C., in charges of not more than 4 oz., this being permissibly increased to $13\frac{1}{2}$ oz. if covered with clay stemming to a depth of 8 in.

Coal Dust in Shot Holes.—There is nearly always a certain amount of coal dust left in holes bored in coal, the amount depending on the hardness of the coal, the inclination of the hole, and the care bestowed on cleaning it out.

According to some tests carried out by the French Commission the conclusions were drawn that the contents of blasting cartridges may become mixed with coal dust in shot holes bored in coal and that miss-fires under these conditions may cause the deflagration of the mixture, in which case any firedamp present is certain to be ignited. This danger is also present to a smaller extent in the case of complete detonation, the carbon present increasing the temperature of detonation and producing carbon monoxide, thereby facilitating the ignition of firedamp.

In view of the probability of accidents arising from this cause, the Commission recommend that shot holes bored in the standing coal should be carefully cleared of dust; that the practice of ramming the cartridges so hard as to break the envelopes and mix the contents with coal dust should be abandoned, and that the size of the detonators should be increased.

Prevention of Risks.—The risk of causing an explosion by the use of permitted explosives is practically confined to the use of blown-out or improperly stemmed shots.

Experiments made in Austria show that a vacuum resulting from a blown-out shot may amount to as much as $\frac{1}{2}$ in. of mercury, which is equivalent to 8 lb. to 9 lb. to the square foot. This reduction of pressure creates an increase in the flow of firedamp in the ratio of 235 to 100, so that a blown-out shot may itself be the means of furnishing a considerable amount of gas that otherwise would not have escaped from the coal.

A blown-out shot also, of course, produces an immense volume of flame, which, coming into contact with the coal dust on the roof, floor and sides of the road, is liable to raise and ignite it, and so bring about a disastrous explosion.

Such safety as is at present obtainable appears to lie in entrusting the charging, stemming and firing of shots to selected men, insisting on the use of a sufficient length of proper stemming and of efficient detonators.

Mechanical Plant for Steam Generation and on the Pit Bank.

In the previous sections of this issue we have tried to bring out the advantages of Electricity in Mining, and have considered its applications mainly as regards underground work. There is, however, another very important place where labour-saving appliances can find a position—namely, in the generating station and especially in boiler house. Messrs. E. BENNIS & Co., of Little Hulton, Bolton, have applied themselves to the solution of the problem of how coal can be most economically carried from store to the boiler house. They have also considered how the fuel may be fed to the boilers in a manner conducive to its complete combustion and the ash then removed and dumped into bunkers, trucks or pits as the case may be. It is generally admitted that a complete conveyor system allows a good return on its initial cost, while at the same time the upkeep is small.

An example of this is provided by the machinery laid down at the Grimethorpe and Frickley Collieries of the Carlton Main Co. At the latter there are 18 boilers of various types supplied with "Bennis" stokers and fitted with pneumatic gear and self-cleaning compressed air furnaces which are adapted for burning a low grade slack such as is in many instances thrown to waste. In this installation the fuel is delivered into the

mechanical stoker hoppers by means of a combined elevator and conveyor (Fig. 2). The speed of the conveyor is under easy control, and the distributing shoots which admit the coal to the boilers are fitted with simple cut-off slides, so that should it be thought desirable to take any boiler out of service the supply can be stopped without interrupting the feed of others constituting the battery. This plant has been so satisfactory in operation that six of the 18 boilers are only used as a standby.

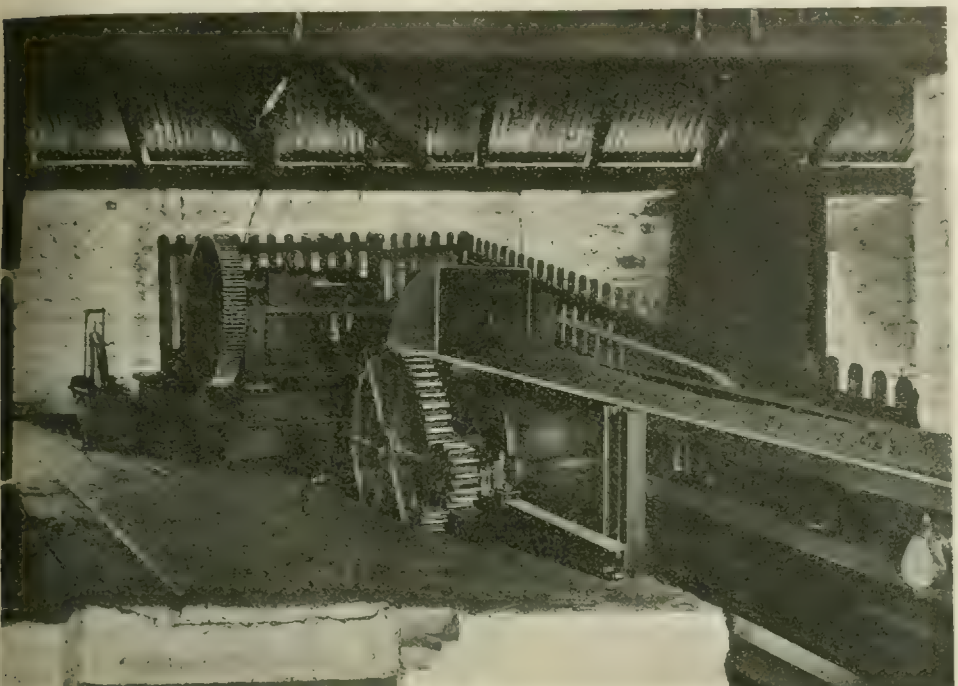


Fig. 1.—The "Bennis" Conveyor at the Powell Duffryn Steam Coal Co.'s New Tredegar Colliery, Loaded and Passing over the Drum.

Messrs. Bennis have also supplied us with an interesting example of the saving effected by the substitution of electric for steam drive. The plant is a band conveyor installed at the New Tredegar Colliery of the Powell Duffryn Steam Coal Co. An old push plate scraper conveyor, driven by a steam engine, and requiring 70 H.P. to transmit from 35 to 40 tons of damp small fuel from the washery head to the storage bunker for the coke ovens, was superseded by the present band conveyor, which is 288 ft. long and travels up a gradient of 1 in 15 (Fig. 1). At its delivery end it shoots the fuel on to two distributing chain conveyors. The main conveyor working fully loaded delivers the coal off the end of the conveyor without using the throw-off table. It takes 8 amperes at 400 volts, or practically 4·3 H.P. When the throw-off table is put into operation 11 amperes at 400 volts, or about 5¾ H.P. is used. The two cross-conveyors are driven by a 5 B.H.P. continuous current motor, and when delivering all the fuel taken up, the band conveyor requires 6 amperes at 400 volts, or equal to 3·32 H.P. The total horse-power therefore taken is 8·97 under the most unfavourable conditions, and this, when taking 60 tons of coal per hour as against 35 to 40 tons by the old conveyor, a saving of no less than 60 H.P.

In addition to this saving it may be stated that the old scraper conveyor had constant breakdowns, whereas the band conveyor runs smoothly and continuously without interruption or trouble of any kind, doing easily the work in two shifts that was formerly done with difficulty in three.

By no means an unimportant part of a colliery equipment, at any rate from the financial point of view, is the weighbridge. If it goes against the consumer, as weighbridges are popularly always supposed to do, its sin will one day find it out with disastrous results to its owner. If, on the other hand, it operates in the reverse direction, the fact will undoubtedly be clearly shown in the balance sheet.

Expedition and accuracy are therefore two important factors in the weighing of trains of trucks containing coal, and Messrs. W. & T. Avery, of the Soho Foundry, Birmingham, have laid themselves out specially to meet this requirement. The type of machine supplied by them is of the usual railway weighbridge pattern, and varies in size and capacity from 2 tons with a platform measuring 4 ft. by 2 ft. 6 in. to 5 tons with a platform 6 ft. by 4 ft. The trucks must be of a uniform tare weight, and this is balanced separately on an adjustable tare bar and slide, graduated from zero to 10 cwt. by 7 lb. divisions at the back of the steelyard. The machine is of the improved three-lever type, which allows the platform to oscillate in the direction in which the traffic moves, prevents undue shock and avoids all torsional stress and considerably prolongs its working life.

Weighing is carried out on the self-indicating system, the equipment being composed of Avery's patent self-indicating steelyard and quadrant, which automatically indicates the actual net weight of the coal. The steelyard is graduated from zero to 35 cwt. by

Fig. 2.—Boiler House at Frickley Colliery, with "Bennis" Stokers and Compressed Air Furnaces and Elevating and Conveying Plant.

1 cwt. divisions and the quadrant from zero to 5 cwt. by 14 lb. divisions.

In actual practice the range of weighing for any one train of trucks is 5 cwt., *i.e.*, a minimum weight of the contents of the trucks is decided upon and balanced on the steelyard and the quadrant indicates 5 cwt. over that weight, thus allowing a variation of 5 cwt. in the weight of the loads, *e.g.*, taking the fixed minimum weight at 25 cwt., the quadrant is marked from 25 to 30 cwt., and any weight between this is indicated on the quadrant. If a greater range is required for different trains of trucks, the quadrant can be marked accordingly, and the minimum weight can be balanced on steelyard to suit the different trains. We understand that large numbers of these weighing machines have been installed at different collieries throughout the country and abroad.

We have given some account above of an economical plant in which the coal is transferred from store to power house in an exceedingly expeditious manner by means of electrically-driven conveyors. These conveyors may also be used for other purposes on the pit bank and Messrs. Plowright Bros., of Chesterfield, have found the electric motor admirably adapted for driving them. The actual transportation of the coal offers no special points of novelty, but there are some details such as are set out below which have to be considered in the design and erection of such a plant.

Fig. 3.

The coal as it comes from the pit is frequently of various qualities, which, upon arrival at the surface, are separated in order to suit various markets. The coal also requires to be divided into various sizes, and any stone or foreign matter must be eliminated. Speaking broadly, there are two systems of handling the coal, the one termed the "hand-picking system" and the other the "overhead system." In the first method the coal is usually tipped from the pit trams on to a long picking band running between two lines of railway tracks, the various qualities are then picked by hand from the picking band and stowed in the various trucks, the residue being passed forward and screened into various sizes. The second system is used where the coal is of not more than two qualities. This system consists of tipping the coal directly on to a screen which separates it into its various sizes, these various sizes passing on to picking bands on which the dirt and foreign matter are eliminated, and on which any special coal or any inferior coal may be removed.

For these plants the electric drive is most economical, and the most commonly used form being the three phase motor. The electric drive is specially suitable for this class of work, as the driving power has frequently to occupy a somewhat confined space, and it is often convenient in many cases to drive these plants in different sections.

As will be seen above the present day need in coal mining is to avoid handling as much as possible, and to carry this out to its logical extreme some form of truck-tipping apparatus is quite essential. Messrs. Sheppard & Sons, of Bridgend, make Davison's patent truck tipping apparatus, an arrangement which we illustrate in Fig. 3. Its important features are that it is specially adapted for the electric drive being conveniently operated by motor, while at the same time the rails remain unbroken. It is further claimed no stop block is required, so that the apparatus can be fixed on a siding without interfering with the other traffic. It is evident that there are a number of situations where such an apparatus would be of great service, such as generating stations, collieries or any industrial concern where material in bulk has to be unloaded.

It will be seen that the truck is of the end-tipping type. The rear axle is brought over the ram head A and the lever B is pulled over. This causes the friction clutch to engage with the worm shaft actuating the barrel, and thus wind the chain lifting up the ram. Radius rods C are provided fixed to the ram head, which prevent the truck moving out of position. The ram passes through a long cast-iron sleeve D, with trunnions allowing it to follow the course given by the radius bars. When the truck is tipped the lever is put over to the opposite side, causing a reversal of the gear and lowering the truck down to the rails. It is said that the time taken to tip a truck of small coal is about one minute.

Messrs. Sheppard & Sons also supply such useful gear as coal washing, screening and crushing plant, conveyors and elevators, in the working of all of which the motor can find a useful place.

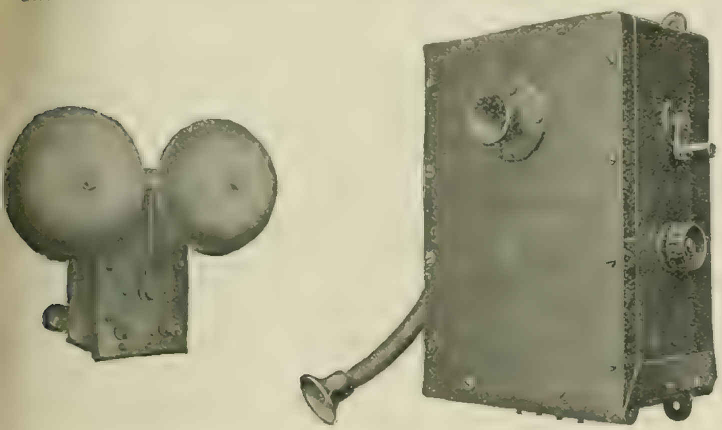
Some Accessory Plant.

Signalling Apparatus.

The use of the telephone in mines has produced a demand for an instrument in which special precaution must be taken to insure that the presence of corrosive acids and gases, as well as the damp condition of the air in such places, will not cause the insulation of parts to deteriorate, metal parts to corrode or wood parts to decay. The structure should be such that the usefulness of the set will not be impaired by rough usage or by falling rocks. Provision should also be made for local battery service, since with a central battery system in mines, slight leakages in the line rapidly develop into crosses and seats of extensive corrosion, because of electrolysis. It has been found in certain localities that the life of an ordinary sub-station set when used in mines is less than three months.

In order to meet the demand for a substantial set for mining purposes, the Western Electric Co., in co-operation with the engineers of the American Telephone & Telegraph Co., have brought out a special set. The parts are enclosed in a stout box; the box is constructed of wood saturated with oil to prevent de

cay and covered with metal to prevent mechanical injury. Sheet lead is used for this purpose because of its non-corrosive properties. The metal parts of the set are plated with lead, also to prevent corrosion. All magnet and coil windings are additionally protected by coatings of shellac and layers of tape. The wires are rubber-covered. The box is sealed by a rubber gasket under the lid, and all openings of the box through which movable parts project are sealed by stuffing boxes. The generator crank is insulated from the generator, and the receiver ear piece is insulated from the remainder of the set. The receiver and transmitter are located within the box for



Figs. 1 and 2.—Western Electric Telephone Set.

protection from injury and corrosion. It is not necessary, however, to open the case during the use of the set as the receiver is connected to an ear piece by means of a flexible tube, a special mouthpiece for the transmitter also being provided.

The set is adapted for local batteries and a two-wire line. It is wired for use with a bridging bell, which is mounted in a separate case. The bell, which is of the loud ringing type, is made separate from the telephone set so that it may be mounted in any desired location where it will be more likely to be heard than if placed inside the case of the set. The construction of the bell case is like that of the subscriber set described above. The battery circuit is closed during the use of the set by turning a knob which projects at the right of the box. The apparatus is shown in Figs. 1 and 2.

Blasting Apparatus.

There are two systems of electric shot-firing—the high tension and the low tension—but the method of application is practically the same in each case.

The batteries and frictional electrical machines have now been superseded by magneto-electric and dynamo-electric exploders, and one of the best-known names connected with these exploders is that of Messrs. Siemens Bros. & Co. This firm manufacture magneto exploders wound for firing tension and quantity fuses, the machines being similar in the two cases, except, of course, that the shuttle armatures of the high-tension machines are wound with a smaller wire than in the case of the low-tension machines. Fig. 3 shows the interior of one of these magnetos.

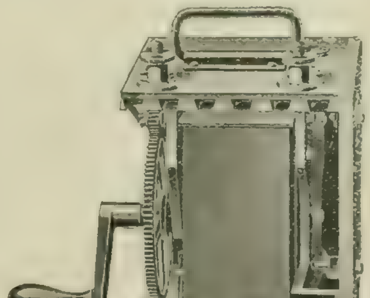


Fig. 3.—View of Siemens Magneto-electric Mine Exploder.

In the dynamo electric exploders, electro-magnets are employed in place of the permanent magnets of the magneto ex ploders, and Messrs. Siemens' instruments are arranged to break the short-circuit existing in the instrument after every two revolutions of the driving handle, thereby causing the current to pass out into the line, through the distant fuses and back by the return or earth to the instrument. These machines are of three kinds: (1) Tension exploders, (2) quantity exploders and (3) "twist" exploders. The last named is the latest form and differs greatly from the other two, the construction of which is obvious from what has been said above.

In external appearance the "twist" exploder is a wooden case 14½ in. high, 8¼ in. long and 5¾ in. wide, weighing about 26 lb. Inside the wooden case K (*see* Fig. 4) is fixed a series dynamo electric machine, and on the axis of its armature, which is vertical, is fitted a pinion which gears into a wheel, C, mounted by a ratchet and pawl coupling on a screw spindle or "twist," B. The latter is fitted to revolve in two bearings, and has rapid screw-threads engaged by a nut, D, which is on a crosshead connected by two rods, E, to a handle, F. These rods, which are carried through guides G, project through the upper part of the machine.

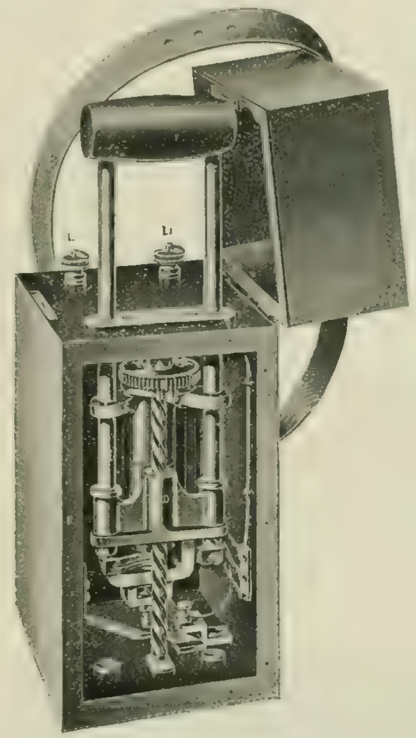


Fig. 4.—Interior View of Siemens "Twist" Exploder.

In operation, the handle F is first pulled up as far as it will go; this causes the "twist" to revolve, but owing to the interposition of the ratchet and pawl the armature of the dynamo remains stationary. The operator then pushes the handle quickly down, causing the "twist" gear and armature to revolve rapidly, the current passing round the magnets and through the resistance at the side until the crosshead D strikes the upper spring H, thus breaking the contact at the bridge and allowing the current, which has by then reached its maximum strength, to pass out to the line.

To ensure successful working of shotfiring apparatus the provision of suitable and reliable insulated wires and cables is of the utmost importance. The British Insulated & Helsby Cables have paid great attention to this subject, and recommend the employment of gutta percha insulated wires for subaqueous work and in mines in which a quantity of water and dampness is present, whilst for ordinary mining work and surface blasting indiarubber covered wires will be found suitable. Although, of course, the cost of the leading wires and cables form an inappreciable item of the whole expense of blasting, the question of economy is frequently of the greatest importance, and consequently this firm have introduced a substitute for gutta percha or indiarubber, which is said to give excellent results, being at the same time less expensive. It is designated "Mersey cable," and is very greatly in demand.

Among the well-known magneto mine exploders are those manufactured by the British Insulated and Helsby Cables. We illustrate in Fig. 5 one of these machines. It resembles in construction the usual magnetos employing permanent steel magnets, between which the armature is rotated by means of a handle outside the case and toothed gearing. If desired, these cases can be made gas proof.

The British Insulated & Helsby Cables also manufacture "twist" exploders on the same principle as the one just described. These are recommended for use where a more power-

ful apparatus than the ordinary magneto exploder is required, and the B.I. and H. "twist" exploder is capable of firing up to 25 high-tension fuses in parallel and 15 in series. But when 15 or more shots have to be fired in series it is recommended

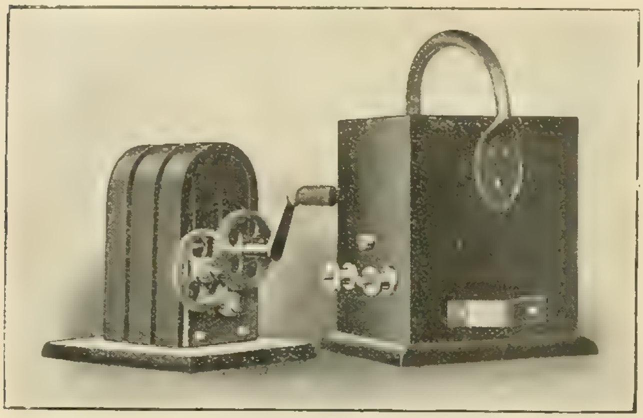


Fig. 5.—British Insulated & Helsby Cables (Ltd.) Magneto Exploder.

that low-tension fuses should be used, when at least 50 shots can be fired in series simultaneously.

The Bowie Safety Lamp Relighter.

The Davy lamp, in spite of its many and well-known advantages, is like lamps of a less scientific nature, prone to go out at inconvenient times. It is, therefore, a necessity that some means should be invented for relighting it without exposing a

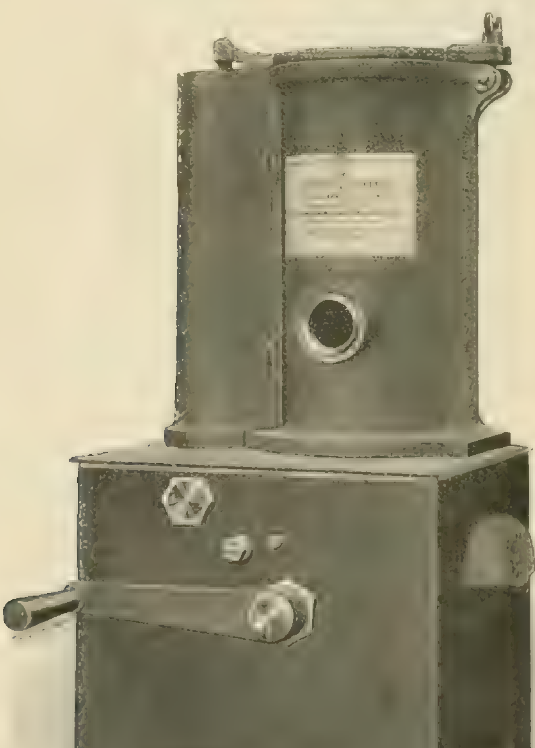


Fig. 6.—Bowie Safety Lamp Relighter. Manufactured by Messrs. Spagnoletti, of London.

naked flame, and for this purpose the Bowie safety lamp relighter has been invented by Dr. J. C. Bowie, of Cardiff. It is claimed for it that it can be used with absolute safety in those parts of a mine where there is most danger of explosion, while its employment avoids the use of secondary batteries and their attendant disadvantages.

The operation of the Bowie relighter is briefly as follows: By means of a small magneto generator sufficient voltage can be generated to cause a stream of sparks to pass from the case to the wick of the lamp, thus lighting the latter. This apparatus, it will be seen, is practically the same in character as that of the electric gas lighter common some years ago. It is, of course, highly necessary that the container of such an apparatus should be able to withstand the explosion of a volume of gas equal to its internal capacity. It is claimed that the Bowie relighter can do this, and any trouble from this cause is not possible. It is, further, impossible to turn the generator handle and so produce a current as long as any terminals or electrical contacts are exposed to the atmosphere of the mine, by reason of its automatic locking action.

The method of lighting a lamp is as under: It is put into the receptacle and placed upon the electric contacts at the base of the lighter. The lid is then closed, and the arm of the locking gear is brought down over the lid and firmly secured by the butterfly nut attached to the side of the receptacle. This action renders the receptacle air tight, and permits the handle of the speed gear, which is attached to the side of the lighter, to be turned in the right hand or forward direction. The apparatus is locked in its backward or left-hand direction. As the generator is geared up to a high speed, all that is necessary to ignite the lamp is to give the handle one or two sharp turns to the right. This causes a number of sparks to pass from a rod, which is connected with one of the contacts at the base of the lamp, to the top of the wick holder, which is connected with the other contact. These sparks serve to ignite the wick, which can be viewed through a small window in the metal case, inside which the lamp has been placed, so that the miner is enabled to see when the lamp is lighted.

The air capacity of the lighter is calculated upon a basis which will only permit the ignited lamp to remain lighted for one minute. If the lamp is allowed to go out by keeping it in the receptacle, it is not possible to re-ignite it until more air has been admitted.

Chain Drives.

In cases where electrical driving is adopted the method of transmission of the power has to be considered. Direct coupling is not often possible on account of the high speed of the motor, whilst spur gearing may occasion much noise. For the transmission of power the chain has now been so far developed as to offer many advantages.

Messrs. Hans Renold have supplied many chain drives for mining purposes in South Africa. In the case of some sets of deep mine pumps, each set of 150 H.P. being driven by a motor running at 360 revs. per min., the pump speed being 90 revs. per min., two strands of silent chains, each 6 in. wide, were used, running side by side on double wheels having 24 teeth and 96 teeth respectively, the diameters of the wheels being 13 in. and 53 in. The chain speed was 1,260 ft. per min., and the factor of safety 26. Owing to the unsteady nature of the drives, the large driven wheels were made of the flywheel type, with heavy rims, and each weighed about 34 cwt.

In the case of a speed reduction drive for a 45 H.P. tailings-wheel, the speed of the driving shaft was 75 revs. per min., the speed of the driven shaft 19 revs. per min., the chain speed 805 ft. per min., the factor of safety 41, and the shaft centres 10 ft. 2 in. apart. Owing to the slow speed of the shafts, large driven wheels were necessary in order to keep the chain speed as high as possible; but so as to get a sufficiently high factor of safety for the chain, it was necessary to use two strands of chain of $1\frac{3}{4}$ in. pitch, each 6 in. wide, running on double wheels having 27 teeth and 15 in. diameter, and 106 teeth and 59 in. diameter. Owing to the large quantity of sand flying about on the mine where this tailings wheel is situated, the entire chain drive was enclosed in a sheet steel oil tight gear case.

Messrs. Hans Renold have also given much attention to chains for driving coal cutters and pit bank locomotives.

THE WORK AND EQUIPMENT OF A TESTING AND STANDARDISING DEPARTMENT.*

BY H. A. RATCLIFF.

(Testing and Standardising Department, Manchester Corporation Electricity Works.)

Summary. The author gives a collection of notes on various features of practical interest in connection with the testing department of an electricity supply undertaking. Suggestions are made regarding the necessary equipment and the supply and regulation of the current required, and an interesting "phase shifter" for altering the power factor in alternating current testing circuits and devices in connection with mains tests are also described.

The necessity for, and value of, a well-equipped testing department are beginning to be realised, and there is no doubt that the time is not far distant when such a department will be regarded more as a valuable financial asset than as a scientific luxury, since by a judicious testing of mains, meters and distributing apparatus generally, the proportion of units sold to units generated may be considerably increased. It is probable that there will always be a few small stations where it would not pay to sink the necessary capital in a sufficiently extensive testing equipment, and it should, therefore, become possible for the necessary work to be undertaken by a larger neighbouring authority possessing the requisite equipment. That the scheme is practicable is shown by the fact that the Manchester Corporation undertake the testing and calibrating of a considerable number of meters for other authorities and companies, &c., and the prices charged are far less than would be the case elsewhere, although leaving a fair margin of profit on the work. Such a department should also be able to test the candle-power of lamps, &c., and check and calibrate ammeters, voltmeters and other instruments for consumers and contractors.

As regards its duties, it would appear to be advisable for the testing department to be responsible for, and to carry out, the whole of the electrical and chemical testing necessary. Mechanical and steam tests, &c., would usually be undertaken by the station staff, but even for this work the co-operation of the testing department is desirable for the checking and certifying of any electrical data involved in the calculations. The Paper contains a detailed list of work undertaken by the department at Manchester, comprising the testing, calibrating and repair of all meters, instruments, transformers, switches and fuses, the testing and repair of motors, starters, &c., mains tests, photometric tests of lamps, tests for tramway department, &c.

Supply of Current for Testing.—For direct current work, secondary cells fulfil all requirements. A very usual arrangement is to have a small number of very large cells, and generally some arrangement of links or plugs for putting them in series or parallel, for obtaining different output currents, &c. The disadvantages of this method are that, owing to the low voltage available, it is difficult to maintain the discharge current constant, unless all the joints and contacts, &c., in the circuit are exceptionally good; very little spare E.M.F. is available for regulating resistances. There is also considerable difficulty in measuring the output of the various cells, with the consequent probability of their not all receiving their proper charge.

These difficulties have to a great extent been overcome by the arrangements adopted at Manchester, and which are as follows: The batteries are arranged for two separate classes of work, one consisting of tests which require a small current at voltages up to 500, such as voltmeter calibrations, incandescent lamp tests and for exciting the shunt circuits of watt-hour meters. The cells used for this work have a maximum discharge rate of about 6 amperes. This battery is divided into four sections of 100 volts each, four sections of 20 volt batteries and 10 sections of 2 volt cells, all the sections being joined in series. This arrangement enables the voltage to be raised by one-cell steps from 2 volts to the full 500, only 20 conductors being required. By the additional connections to a battery of larger auxiliary cells and a potential regulating resistance any voltage from 0·2 to 500 volts may be obtained, rising by 0·2 volt steps—*i.e.*, 2,500 different voltages. For the heavy or main current work large cells are used; they are connected in groups of 10, each group constituting a unit and feeding a separate panel on the testing circuits switchboard. For larger currents than the above the units are put into parallel at the switchboard. Under no conditions does any unit ever feed more than one circuit at the same time. The small pressure cells are charged in 100 volt sections off the 200 volt mains through lamp resistances, about 145 volts being required. The large batteries are charged from a special motor-driven low-voltage generator.

The supply of the necessary alternating current is not quite such a simple matter. The best source is undoubtedly a small motor three-phase generator combination, preferably with a rather slack belt drive, and the addition of a flywheel on the alternator shaft, should the motor only be comparatively light. Inverted rotary converters are occasionally used when the energy is obtained from direct current mains, the principal objections being that all fluctuations on the direct current side are reproduced on the alternating current side, and there is not the same independent control of alternating current voltage and frequency.

Test Rooms.—The author does not favour the use of elaborately constructed stands and racks in a test room. For testing ampere-hour meters of the mercury motor type, and generally all those which are made to stand on brackets, the most simple and convenient arrangement is to have long narrow tables on which two rows of meters can be placed back to back with reasonable clearance between. The table should be long enough to accommodate about 20 meters in a row. Meters of the watt-hour type are generally constructed for fixing on a vertical board, and for testing purposes the most simple and convenient arrangement is to have long wooden partitions or boards fixed to the wall. Watt-hour meters when on test require to have all the shunt coils excited from a circuit independent from the the one feeding the main coils. The author describes a convenient form of vertical test board, having both sides available for holding meters and with four potential 'bus bars on each side so as to enable meters of different voltages to be tested at the same time; the main current coils all being connected in series, and the shunts excited off different bars accordingly to the respective voltages required.

In addition to the above tables and racks, one or two plain deal tables for miscellaneous work are also convenient.

Regulation of Testing Current and Voltage, &c.—The author considers it an advantage for this to be centralised as much as possible in preference to having switches, resistances and instruments, &c., scattered about the test rooms. For the actual control of heavy or main current circuits, rheostat switches connected with wire resistances, undoubtedly constitute the most satisfactory arrangement. Water and carbon resistances are by no means so convenient; the former owing to the current fluctuations produced by the evolution of bubbles, and the latter owing to their high negative temperature coefficient. Wire resistances may be constructed of metal, having an almost negligible temperature coefficient.

Resistance frames may be connected up to the rheostat switches controlling them, either in series or parallel; in the one case, therefore, the current is increased by cutting resistances out of circuit, and in the other by putting them into circuit. The principal objections to the first method being the greater difficulties involved in the design and construction of the resistance frames, &c., and the much greater expense of construction, owing to the greater amount of resistance wire required. The parallel controllers are rather more expensive than the simple rheostat switches, but are far more reliable in their working, and, moreover, the increased cost is not so great as might be supposed on first consideration, since each of the contacts has only to carry one tenth of the full current.

A very convenient arrangement is to have the rheostats in three groups, one group having 10 approximately 1-ampere steps, the second 10 10-ampere, and the third five 100-ampere steps. These would all be connected in parallel, and also in parallel with them again should be a resistance capable of carrying a maximum current of 1·5 amperes, and having a practically infinite range of variation; about the most convenient resistance of this type is the "Kelvin" drum rheostat, which consists of two cylinders, one with a metal surface, and the other insulated; the cylinders or drums are connected mechanically through spur-gearing to a common pinion. The resistance wire is wound on the outer surface of the drums, and can be transferred from one to the other, by rotating them, the proportion of wire on either being varied to any required extent.

The diagram, Fig. 1, shows an arrangement which has been found to be very convenient for all classes of alternating current meter and instrument testing. The voltage of the alternator may be varied by almost imperceptible steps, from practically zero up to 450 volts. The fine control rheostat in the alternator field can be used for maintaining the watts in the testing circuit absolutely constant. The main current circuits are controlled in the same way as in direct current work, except that the fine control is obtained by a resistance in the primary circuit of the current transformers. As in the case of the direct current system described above, the main current circuits, and the volt or shunt circuits are quite distinct, there being no electrical connection between them. The former are fed off the secondary side of step down transformers, the voltage being about 20, these transformers are built in two halves, and both the primary and secondary windings may be connected in series or parallel, as shown in the diagram. It is thus possible to utilise them with a large range of alternator volts. The volt circuit is not connected directly to the alternator, but to the piece of apparatus designated "phase shifter," the uses of which are fairly obvious, but its advantages are possibly not quite so self-evident.

A common method of altering the power factor in alternating current testing circuits is to make use of choking coils, &c., but this method has the great disadvantage that alteration in power factor

* Abstract of a Paper read on Friday, July 3rd, at the Convention of the Incorporated Municipal Electrical Association.

also produces changes in the volts and amperes. The "phase shifter" overcomes this difficulty. The main portion of the device consists of the armature of a 10 H.P. 400 volt four-pole direct current motor, complete with windings, commutator and shaft, &c., the armature being of the toothed core type, with former wound coils. In order to form a closed magnetic circuit, thus avoiding excessive magnetic leakage, and at the same time keeping down the magnetising current, sheet iron stampings, in the form of annular rings, and separated by paper in the usual way, were pressed over the armature, making good magnetic contact with the iron core stampings. These ring stampings were built up the full depth of the armature, with suitable ventilating ducts at intervals, the whole being clamped between two annular gun-metal end plates, by means of four bolts passed through insulated and bushed holes in the plates and stampings. The armature being four-pole the three-phase mains are lead in at six points, as shown. A loose sleeve is fitted on the shaft, and on the sleeve two arms are clamped. These arms are provided with wooden handles and support insulated spindles carrying brush-holders, as shown in the figure. The brushes are made of copper, and are filed to a knife edge, so that they can only touch one commutator segment at a time, and, moreover, cannot cause a short when moving from segment to segment. It will thus be seen that by loosening the clamping screws, the brushes may be moved relatively to each other, and consequently, the voltage between them varied by steps equal to the volts between two adjacent segments of the commutator. When the handles are clamped to the sleeve the combination as a whole may be moved round the commutator, thus producing any desired phase difference between the "pressure circuit" fed from the phase shifter, and the "current circuit" connected to the low-tension side of the step down transformers. Fig. 1 shows the complete connections of the phase shifter to a meter-testing circuit.

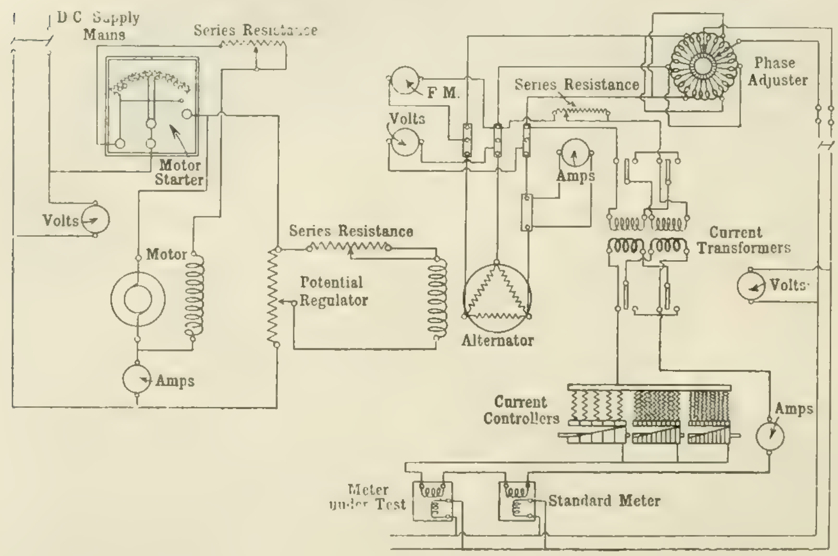


Fig. 1.

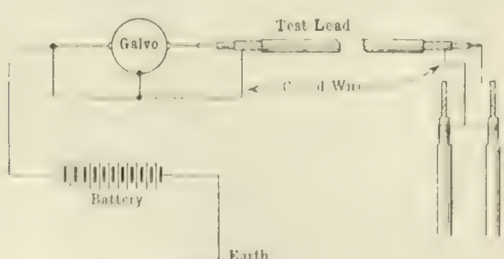


Fig. 2.

Measurement.—The author emphasises the necessity for definite discrimination between standards and sub standards. Instruments which are intended to be standards should be kept as such, and must not be in continual use for the ordinary routine testing work.

For direct current work the most suitable sub-standards are undoubtedly direct reading instruments of the "moving coil type," provided that well made instruments are used. A great advantage possessed by this type of instrument is due to the fact that by constructing suitable shunts or series resistances the range may be varied practically *ad libitum*. Ammeters are for preference fixed on the main control board, but voltmeters may with advantage be of a portable type.

For alternating current work "hot wire" instruments form most convenient sub-standards, and possess the great advantage of being unaffected by frequency and external magnetic fields; they may also be checked against the direct current standards. Wattmeters used as alternating current sub standards should preferably be of the dynamometer type, and astatically wound, since this type of instrument may also be checked against the direct current standards.

The most convenient standards for the checking of current, volt and watt-measuring sub-standards are undoubtedly the "potentiometer" and "Kelvin balances." A most reliable method of measuring alternating current volts accurately is by means of a sensitive multi-range electrostatic voltmeter, the *modus operandi* being as follows: The deflection on the voltmeter when connected to the alternating current circuit is noted, the instrument is then switched over to a direct current supply, and the previously noted deflection reproduced by suitable adjustment of the pressure, which can at the same time be measured on the potentiometer. This method eliminates all scale and zero errors of the voltmeter.

All standards and sub-standards, &c., should be permanently connected up to suitable switches, links or plugs, so that they can easily be thrown into circuit for checking or measuring purposes without unnecessary delay. A diagram showing the general scheme of connections is given by the author. The cables should be run as much out of sight as possible; for this purpose culverts in the floors, fitted with easily removable lids, are very convenient.

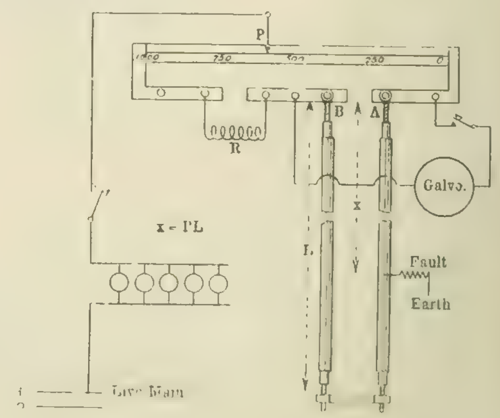


Fig. 3.

Laboratory.—It is a distinct advantage to have an entirely separate test room or laboratory, in which any special tests and all work of a technical or scientific nature may be carried out. All standards should be kept in the laboratory, with the exception of the Kelvin balances and the large shunts for the potentiometer, which may with advantage be located in the meter room.

The author also shows a suggested arrangement for cable testing, the chief feature of which is the use of "Price's" guard wire. This is a very old and rather neglected device for overcoming the difficulties which arise in connection with the measuring of high insulation resistances, owing to the leakage from apparatus and test leads. He has also found it useful for preventing the trouble sometimes experienced with galvanometers of the moving coil type, due to the electrostatic action between the moving coil and the poles of the permanent magnet. The principle is the prevention of leakage from apparatus, &c., by reducing the "difference of potential," producing such leakage, to zero. The diagram, Fig. 2, explains this better than words. If a concentric cable is used as a test lead, the outer conductor may be used as a guard wire, and there will then be no necessity for the elaborate paring and drying of the ends. The same applies to the ends of the cable under test, if suitable guard rings are used as shown. The author has in this way found it possible to absolutely eliminate any leakage deflection on an unshunted galvanometer, having a constant of 1,000,000 megohms when connected to a 400 volt battery, and using a test lead over 100 yds. long with damp ends. In practice it is advantageous to have the guard wire as well insulated as possible. A convenient method of doing this is to mount all the apparatus on copper gauze or tinfoil, which again rests on shellaced paper, pressphan or micanite.

To be completely equipped for carrying out the various tests which experience has shown to be necessary, the following instruments and apparatus will also be required: One or two good Post-Office bridges, dead-beat moving coil galvanometer for resistance work, standard high-tension electrostatic voltmeters, sub-standard low-tension moving coil voltmeters, sub-standard low-tension alternating current voltmeters. One or two "portable combination

sets" with various current and volt ranges are also extremely useful for an endless variety of work.

Chemical Laboratory.—A small room, or a corner of one of the larger test rooms, should be provided with a few of the principal chemical re-agents and a fairly good balance. Such an equipment will be found most useful for testing the purity of mercury, pentane, accumulator acid, bitumen and box compound, &c., and for various rough tests of a similar nature.

Photometric Work.—The author refers to apparatus which is actually in use under his personal supervision and has proved to be satisfactory, and prefers the "Harcourt" 10 c.p. pentane lamp as a standard, with metallic filament incandescent lamps as sub-standards. For comparing lights of different colour, such, for instance, as a mercury vapour lamp and a carbon filament lamp, the author prefers the Simmance Abady patent flicker photometer, whilst for the ordinary work of comparing incandescent lamps with a standard incandescent lamp excellent results may be obtained with a grease spot photometer, and also probably with less fatigue to the eyes and in less time than would be possible with the flicker type.

As regards street measurements, there is much doubt whether a portable photometer should indicate the intensity of the illumination on a horizontal surface, the vertical illumination, or on a plane at 45 deg. to the horizontal. The author has never been able to quite appreciate the arguments brought forward in favour of the above methods, and until such time as the recognised authorities on the subject can come to some agreement, he prefers to use a photometer which, when fixed in any position, can be focussed on any desired light, and permit of measurements being taken of the actual illuminating value of the direct focussed ray from that light in candle feet. The "Simmance Abady" flicker photometer is made up in a most convenient form for work of this description, and readings may be obtained with great ease and a relatively high degree of accuracy. Either a pentane lamp or a metallic filament electric lamp may be used as a standard.

Mains Testing.—This may be divided into insulation testing, high-pressure tests and fault localising. The author suggests for insulation testing a "Silvertown" or "Kelvin" set, and refers to the "Raphael," the "Russell" and the "Frisch" methods for testing live networks.

In Manchester they have a very complete portable set for making high-pressure tests, all the necessary machinery and apparatus being installed in a specially constructed van, which may be drawn by two horses. Briefly the arrangement is as follows: A 10 kw., 500 volt, single-phase alternator is direct-coupled to a 16 B.H.P. direct current motor. The alternator is connected to the primary of a "Cowan-Still" patent regulating transformer, and the secondary of this transformer is connected to the primaries of three oil-insulated and cooled step-up transformers. These are wound for 500 volts on the primary side, and the secondary on each is in five sections of 2,000 volts each, so that 30,000 volts may be obtained.

As regards fault localising, the author gives a list of the necessary apparatus for simple tests of the usual character and further reference is unnecessary. He also refers to a simple, but little used, method for making a slide wire bridge practically direct reading, and at the same time utilising the full length of the slide wire. Fig. 3 is almost self-explanatory. The faulty cable is connected to the terminal A, and the loop or return cable to B. The other gap of the bridge is closed by a resistance R, exactly equal to the resistance of the slide wire, and preferably constructed of the same size and class of wire. It will be seen that the available length of scale is exactly doubled, since if the extra resistance was not used no reading beyond 50 cm. could be obtained.

Motor Test Room.—Experience has shown the importance of tests, since about 50 per cent. of the motors delivered require adjustment in some form or other, and it is frequently necessary to reject machines altogether.

The author illustrates a switchboard equipped for two test beds, and also the connections for testing six starting switches in rotation, all on the same motor. An ohmmeter fulfils all requirements of insulation testing.

As regards the workshops, detailed description is unnecessary.

DISCUSSION.

Mr. G. WILKINSON (Harrogate) opened the discussion, and said it was becoming more important to have accurate standards and metering apparatus, because the tendency of the time was to reduce tariffs, to cut down margins of profits and to improve the efficiency of all the current-taking devices supplied through their mains. The question of testing and standardising instruments appeared to be almost entirely neglected in some stations. He was opposed to a co-operative testing station, as suggested by the author. It would mean greatly increased cost in the shape of fees for testing, and there was the great difficulty of transporting backwards and forwards the apparatus requiring attention. Many of the smaller individual tests which were of importance would be entirely neglected. With co-operative working it would also be difficult to carry out "routine" tests—*i.e.*, the systematic bringing into the test room of meters, taking street by street and examining the meters in a definite and methodical way. A substantial increase to the revenue at Harrogate had been obtained by this systematic routine testing, which could not be carried out under co-operative working. They occasionally found a fast meter, but for one fast one there were dozens which ran slow. On this consideration alone, he was entirely opposed to the co-operative scheme. He also did not agree that the instruments should be made and that armatures should be rewound or reconstructed in the testing department. At Harrogate they had, for a capital expenditure of something like £250, sufficient instruments to carry out all the operations mentioned by the author of the Paper, excepting the high-tension portable testing apparatus. The author emphasised the importance of having the work accurately and thoroughly done. When buying meters, if they found the certificate varied from their own findings they should agree to refer to one of the standardising institutions. He had done this on several occasions, making arrangements with the makers that whoever was farthest from the standard should pay the fees. He was pleased to say that, so far, the makers had had to pay the fees in every case. The "phase shifter" mentioned was evidently a home-made instrument, and he asked if any similar apparatus was upon the market and purchaseable. There was needed, too, for single-phase stations a simple and reliable power-factor indicator. He had made inquiries for such apparatus, but had never been able to find a really good and simple instrument. He had not touched upon the extra plant required for direct current testing, but thought that would largely consist in the provision of a small battery.

Mr. HAYDN T. HARRISON said he had been responsible for laying out some big testing equipments, including that of the meter testing department of the City of London five or six years ago. The phase-shifting device to which Mr. Wilkinson had called attention was very ingenious. He did not know, however, where this was purchaseable. The author said he had never been able to quite appreciate the arguments in the technical Press as to what a portable photometer was supposed to do. The argument was not what the instrument was supposed to do, but the best way of doing it. The best way to measure was with a horizontal screen. It was necessary to have as few adjustments as possible when measuring in the street. He found errors in photometry in different testing rooms due to the use of the Harcourt standard. All standards should be sent to the National Physical Laboratory to be checked.

Mr. A. J. CRIDGE (Sheffield) said that, although testing departments ought to do more than most of them did, they should not go in for manufacturing work. The phase-shifting instrument described by the author attracted his attention because one or two months ago he had been struck by the necessity of such an instrument. He would like to know what chemical testing the author of the Paper referred to; he did not think there was much done in standardising departments of electricity stations. In regard to photometer heads, he had used a screen consisting of a wedge of chalk, with the thin end towards the eye of the operator and the light falling on the surface at an angle of something like 45 deg.

Mr. H. R. BURNETT (Barrow-in-Furness) thought the author had not mentioned one rather important instrument, and one which some might possibly think was unnecessary; this was a good stop watch. He recently found a whole batch of meters that on testing did not agree with the certificates which accompanied them, and on investigating the matter he found the error occurred in starting the watch. Tests were usually, of course, over a very short time, possibly only 20 seconds or so, and it was astonishing on examining a number of watches to find there was usually an error of nearly a second at the start. He, therefore, advocated that a thoroughly reliable watch should be obtained. It was also important that a dial test should be made in addition to the ordinary test of meters. On one occasion he had found dials to be 25 per cent. wrong.

Mr. HORNBY (Siemens Bros. & Co.) considered the Paper raised an important point on the question of accurate standards. He could quite understand the author's idea of a co-operative system, but thought the routine work of the department was best carried out in a test room situate in each district. The best way of getting the advantages of a co-operative system would be in some way or other to link up the existing testing institutions, so that the standards used by the different test rooms might be easily checked. Speaking from the manufacturers' point of view, he found that most of the disputes on questions of accuracy arose either through the standard instruments not having been recently checked or through stop watch troubles. He thought it would be quite simple to "link up" the universities, and perhaps other private testing laboratories, with the Board of Trade, so that standard instruments could be sent to the nearest institution and would not have to stand the longer transport to London. These institutions should themselves occasionally get a check against the Board of Trade standard. In regard to Mr. Wilkinson's inquiry as to phase shifters, there were several which could be bought in the ordinary way. They were rather expensive, and there was little demand for them. A simple device could be constructed by simply making a sort of bipolar arrangement, hinged at the bottom and wound with a series coil, so as to get a shifting series field. Such a device could be made for 25s. or 30s. In regard to power-factor meters—he preferred to call them indicators, as he did not know of any device which could really be called a meter in the sense of practical measurement—the best way was to use a wattmeter, a good one, unaffected by variation in frequency, temperature, and so on, and simply compare true watts against the volt-amperes.

A cordial vote of thanks was given to Mr. Ratcliff, who was asked by the chairman to send in his reply to the *Proceedings*.

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"THE ELECTRICIAN" INDUSTRIAL SUPPLEMENT.

With "THE ELECTRICIAN" for Sept. 14, 1906, was issued the first of a series of "Industrial Supplements," to be published from time to time with "THE ELECTRICIAN." The twenty-fourth issue of the Supplement was issued (Gratis) with "THE ELECTRICIAN" for June 26.

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ACCUMULATORS FOR PEAK LOAD.

We need scarcely say that the use of accumulators for taking the peak load of a station, instead of using generating plant for this purpose, is no new problem. The subject has been discussed many times before, but during the last few years has remained somewhat quiescent. In the days of small generating stations accumulators were put in as a matter of course, though not necessarily for dealing with the peak load in particular. Their advantages, at least theoretically, were well understood, but some years were necessary to produce that confidence so essential for their use on a large scale. After this period of uncertainty had passed, many electricity stations had grown into undertakings of large output, in which the need for a battery was in some respects not so apparent, and thus the accumulator has not taken such an important position as might have been expected for it some years ago.

In his Paper on "The Use of Accumulators for Peak Loads," read last week at the Convention of the Incorporated Municipal Electrical Association, Mr. A. M. TAYLOR raises this important problem once more. It will be admitted that the ground for uncertainty has now vanished. Every maker of accumulators is prepared to enter into guarantees for maintenance, and in the case of a battery supplied for use in a generating station these terms are more favourable than for any other conditions of use. There is, therefore, no difficulty in estimating what the annual expenditure in maintenance will be. At the same time, some speakers in the discussion had the impression that maintenance contracts were not altogether to be depended upon.

We think that most of our readers, after perusing Mr. TAYLOR'S Paper, will find some difficulty in coming to a very definite conclusion. Although we do not doubt that the subject is perfectly clear and familiar to Mr. TAYLOR, so many figures are given that the reader feels a little confused by the time he has come to the end of them. Leaving figures on one side and passing to generalities, the problem is not so difficult. If the load on a station is increasing, it is necessary to put down more plant simply to meet the increased peak load. On the one side we have a choice of steam plant costing, say, from £20 to £40 per kilowatt to instal complete. The cost per kilowatt-hour with such plant, as far as costs of generation are concerned, may be quite low, but unfortunately the capital costs per unit are high, and the lower the load factor the higher these costs become and the more are they a determining factor of the whole cost. The capital cost of a battery on a one-hour rating, on the other hand, is low, and may be put at £15 per kilowatt, including buildings and all accessory apparatus; but, on account of the low efficiency of the battery, the cost per unit of the units which it handles is not likely to be so low as that of units supplied direct from generating plant, even having regard to the better conditions of working of the steam plant on account of the battery. It is a comparatively simple matter, however, to consider how far the reduction in capital costs per unit overbalance any increased cost of generation in each particular case. In some cases the generating plant may be of such a type—for example, steam turbines—that the cost per kilowatt will be but slightly higher than that of batteries. If an alternating current sub-station, as suggested by Mr. TAYLOR, is under consideration, the problem is more difficult. The use of batteries will effect a saving in the feeders, but it will necessitate the provision of rotary converting plant, and this may discount much of the advantage.

The whole question of using batteries in generating stations or sub-stations is one which depends very largely upon the character of the load to be handled, and therefore no general solution can be given to the problem. The objection on the part of those who have no faith in batteries—namely, that a battery is incapable of generating electrical energy, and is, therefore, not so valuable as a generator of any kind—has some force in it when one considers possibilities of the future. Mr. TAYLOR gives a number of station diagrams extending over the years 1908 to 1913, but is it not a rather bold assumption to make that the load curve in 1913 will be the same in form as that in 1908? The use of electrical energy is extending very rapidly. If we may consider an analogous case, many engineers realise that a battery is very valuable in a small traction station, although they would not think of putting one into a station where the load is 20 times as large, simply because the fluctuations on the larger system practically neutralise one another. Similarly, it is quite possible that in another five years the lighting peak load will be comparatively unimportant on our large generating stations owing to the much more extended use of electrical energy. This was pointed out by several engineers contributing to the discussion, whose remarks will be found in another column. The whole question, after all, is one of load factor, and as this is steadily improving with the extension of electricity supply, particularly for power purposes, the problem which Mr. TAYLOR has so assiduously tackled is likely to assume an entirely different aspect with the passage of years. In that case, batteries would not be so applicable, and for this reason, although we feel there is much to be said in favour of accumulators, we think engineers generally will consider it necessary to go somewhat more slowly than Mr. TAYLOR would suggest.

REVIEWS.

(Copies of the undermentioned works can be had from *The Electrician* Office, post free, on receipt of published price, adding 3d. for books published under 2s. Add 5 per cent. for abroad or for foreign books.)

The Steam Turbine. By ROBERT M. NEILSON. 4th edition. (London: Longmans, Green & Co.) Pp. xxvi. 588. 15s. net

In this book the peculiarities of the different types of steam turbine now on the market are brought together, analysed and compared, and at the same time the general scientific principles which govern the application of steam to drive a turbine are set forth and are well illustrated by reference to the prevailing practice. After a chapter on the elementary fundamental notions concerned with the action of a steam turbine, including a simple explanation of the triangle of velocities, the author plunges into the history of the development of the steam turbine, and besides a general description of the various contrivances which have from time to time been proposed, gives some historical information regarding the development of details which considerably adds to the interest of the chapter. An exposition of the kinetic energy of steam includes the usual propositions regarding the flow of steam, and a free use is made of the entropy temperature diagram in dealing with the matter. No mention seems to be made of the useful Mollier diagram in which the total heat of steam is plotted against the entropy. This diagram is particularly useful in connection with the thermodynamics of the subject. Chapter IV. is devoted to the classification of the well-known types, and this is followed by a chapter on the difficult subject of losses and efficiencies. Vane speeds and bucket efficiencies are considered, and then a detailed examination of turbines belonging to each of the five classes into which the author places the different types is undertaken. Special consideration is given to mixed type turbines, to low-pressure turbines, and to the effect of superheat and the vacuum on the efficiency. The last few chapters are devoted to general descriptions of turbine plants in connection with generators and power stations, and with the results of tests of steam consumption. An interesting chapter is added finally on the subject of ship propulsion. There are two appendixes, the first giving the values of various quantities expressed in different units, and the second being a list of patents up to and including the year 1905. The book can be recommended to students of the subject, the many figures and illustrations adding considerably to the interest of the work.

Die Elektrizität auf den Dampfschiffen. By E. BOHNENSTENGEL. 3rd edition. Vol. LVII. of "Bibliothek der gesamten Technik." (Hanover: Dr. Max Jänecke.) Pp. 122. M. 1.80.

A very clear and satisfactory survey of the use of electricity on board ship is given in Vol. LVII. of the series known as the "Bibliothek der gesamten Technik." This volume has now reached its third edition, and has been considerably amplified and well brought up to date. The subject matter is divided into a number of sections which contain a large amount of reliable and practical information in a condensed form.

The book starts with the usual theoretical considerations, and then, under the heading "Electric Lighting," information of a general character is given on steam engines and turbines, dynamos, alternators and parallel running, with practical hints on installing, handling, maintenance and testing. Electric motors and starting switches are next briefly considered. Accumulators, glow lamps, fittings, arc lamps, searchlights,

switches and fuses are then described, after which follow sections devoted to wiring systems, the wiring of machine, boiler and other rooms, the Peschel and Kuhlo systems being given in detail, and the calculation of the sizes of wires.

In the remaining sections of the book will be found particulars of electric indicators, telephones, ship's telegraph and signalling apparatus, wireless telegraphy, wireless telephony, and some systems of conducting signalling at night by the aid of electricity. The book is well arranged, contains a number of excellent illustrations and diagrams and forms a very practical little handbook on the subject.

The Elements of Electrical Engineering. By T. SEWELL. (London: Crosby, Lockwood & Son.) 4th edition. Pp. xv. + 450. 5s. net.

This revised edition does not differ very materially from the last except that some description is given of the newer forms of arc and incandescent lamps, and a short appendix has been added dealing with the three-wire system of distribution. In his revision, the author might well have expanded the part on electromagnetism. The magnetic effect of a current is explained very briefly; the reader who knows the subject will recognise the short cuts taken by the author, but other readers will be apt to memorise without clearly understanding what is meant. We notice that H and B are both said to represent strength of field, and on page 77 something might be said about the demagnetising effect of magnetised bars. On page 67 no mention is made of the fact that the length of conductor is 1 cm. On page 88 the area of the hysteresis loop is said to be a measure of the *power* expended in taking the cubic centimetre through a cycle of magnetism. In considering electrolysis, the author speaks of passing a current through water, thus giving a rather erroneous idea of the properties of water, and in stating the theory of Grotthus some qualification is expected at the present time. Some rather unusual equations are given showing the formation of sulphate on unformed pasted plates, and the curve showing "charge" is rather misleading. The author gives the impression that the positive plate generally suffers by loss of charge, whereas it is the negative that fails in this respect. Many of the diagrams would be much clearer if there were lettering on them. Several of the points here mentioned are trivial, but we hope the author will correct them in the next edition.

THIRTEENTH ANNUAL CONVENTION OF THE INCORPORATED MUNICIPAL ELECTRICAL ASSOCIATION.

In our last issue we gave an account of the proceedings at the Convention, including part of those on Thursday of last week, and an abstract of the discussion on Mr. Richardson's Paper. Elsewhere in our present issue will be found abstracts of Papers by Mr. A. M. Taylor and Mr. H. A. Ratcliff, and in what follows we give a general account of the remaining events of the Convention.

During the past few years the meeting place of the Municipal Electrical Engineers has been fixed uniformly in the Midlands. Consequently the selection of Nottingham gave but little further opportunity for visits of industrial interest other than those within the city itself. For this reason there were no trips to manufacturing works, nor were the members made the guests of any particular industrial establishment in the neighbourhood. In a general way various factories in and around Nottingham were thrown open to casual inspection, and at such times as were available members took the opportunity of fulfilling their obligations to those responsible for the kind invitations issued. Through the courtesy of Mr. H. Talbot and the proprietors of the particular establishments mentioned later we were given facilities for going over several very interesting works which take electrical energy for power purposes from the Corporation mains. The skin and leather works of Sir John Turney contain a quantity of special machinery for the splitting of sheep skins and their treatment during the further processes of tanning and de-greasing, &c. The works themselves are, we were informed, the largest of their kind in the world, and for this reason they cannot fail to be of interest from the point of view of the electric drive. There is still a considerable number of small steam engines installed at different parts of the works, but as these appear to give satisfaction, and also by reason of the fact that steam is required for a quantity of the special processes employed, no drastic steps have been taken to convert the entire works to electric driving. Group drive has been adopted with excellent results. We were informed that an improvement in the running of the skin-splitting machines, which are an invention of Sir John Turney, has been most marked since electric motors have been installed. Something like 15 of these machines are in operation in one of the buildings, and the drive is taken from two motors which are bolted on brackets near the ceiling. We understand that the management has found the electric drive a valuable asset, and they have come to place reliance upon the service given by the Corporation.

The printing offices and works of the *Nottinghamshire Guardian* were also thrown open through the courtesy of the management. Here also some portion of the equipment is steam driven, but the greater number of machines are operated entirely by electric motors. The most modern portion of the establishment contains several large Hoe rotary presses for the production of the morning and evening editions of the *Guardian* and *Post* respectively. These are driven on the Holmes-Clatterworth system by equipments which are placed below the floor level. The motors can, however, be conveniently inspected from a spacious basement, into which the duplicate service of the Corporation is also led. The greater portion of the electrical equipment is laid out for group driving, the motors being placed in any convenient position. Numerous presses in the printing department, where a very large amount of colour work is carried out, are operated by individual motors directly geared to the machines. In the composing room there are two rows of linotype machines, which can be driven either from steam or from one of two duplicate motors, so that every precaution is taken to ensure a supply of power for this department. Electric hoists and lifts are used throughout the building, and are found exceptionally serviceable for transport between the floors. It speaks for the reliability of the service given by the Corporation that an establishment of this nature, in which the consequences of breakdown would be very serious, should depend almost entirely on an outside source of power.

We were also given an opportunity of what proved to be an all-too-brief inspection of the tobacco works of Messrs. John Player. In this instance, what was formerly a lace mill has been converted for the purpose of turning out cigarettes and cigars by highly efficient and apparently complicated machinery. A large amount of power is needed for this work, and, although the whole of it is not taken from the Corporation mains, still, to all intents and purposes, the company is dependent upon the Corporation for keeping its works going. A horizontal steam engine, which was originally installed for the driving of the lace mill, is still in position and is coupled up to a jack shaft, to which a couple of direct current generators are belted. These serve to furnish the lighting of the factory. Group driving is also in vogue here, and the machinery itself is of a highly interesting character. The heaviest work appears to be done in the cutting department, where large quantities of tobacco are cut up from tightly-packed leaf, either for putting up into boxes or for the manufacture of cigarettes. It has not been found possible to adapt the individual motor drive, but group motors have proved quite successful for the purpose in view. The distribution and the general wiring installation have been carried out very thoroughly, and reflect considerable credit on the contractors. Large sub distribution boards have been erected in various parts of the building, and these constitute the main feeding points of the installation. It is not possible at the present time to devote much space to this subject, but we hope to give at an early date a fuller description of the numerous large installations on the Nottingham Corporation mains.

On Thursday and Friday last the British L.M. Ericsson Manufacturing Co. intimated to the members of the Association that their works would be open during the afternoon of these days for inspection by any interested engineers. The

response to this kind offer was not so great as it might have been, but a fair number of visitors took train to Beeston, and went round the shops. This telephone factory is situated amid pleasant surroundings, and the conditions under which the employés carry on their duties appear to be in every way ideal. The factory itself is not new, but extensions have been made from time to time, particularly last year, when a large cabinet works was erected and equipped with modern woodworking machinery. We do not need to remind our readers that the bulk of the work carried out by the company is in connection with large telephone switchboards and standard telephone instruments. The parts which make up this class of apparatus require to be produced in very large quantities, so that a considerable amount of repetition work is involved. These particular conditions are admirably suited to the installation of automatic tools, and the operation of these was one of the most interesting items of the works' visit. The tools themselves are of a general standard pattern, but have been specially adapted to the requirements of the telephone factory by the makers. In several instances three or four operations were going on at one time, and the production of the finished article from the raw material, either in the shape of a rod or tube proceeding with remarkable rapidity. Adjoining the buildings is a large power house containing a number of turbo-generators of the De Laval type, which we understand have run absolutely without hitch since their installation. An interesting feature of the boiler equipment is a special furnace for the burning of shavings and wood chips from the cabinet works. This combustible material is brought over from the shops through a conveyor to a large hopper outside the boiler house building, and from this hopper it feeds into the fires below. The amount of detail work carried out in the factory is a matter with which we cannot deal in the space of these notes, but we may possibly return to the principal features of these works' equipment at a later date. Meanwhile we take this opportunity of thanking the management for the courtesy extended to us on the occasion of our visit.

On Thursday evening, the 2nd inst., about a hundred guests sat down to the annual dinner, which was held in the Exchange Hall, Nottingham. The President of the Association, Mr. Herbert Talbot, occupied the chair, and was ably supported by the Mayor (Mr. J. T. Spalding, J.P.), the Sheriff (Mr. W. H. Carey), and Alderman Sir John Turney. Mr. S. L. Pearce proposed the toast "Nottingham and other local authorities," and generally supported the principle of municipal trading, backing up his remarks by figures regarding municipal electricity works. The Mayor suitably replied, and drew attention to the electrical industry as a good field for the younger generation. Sir John Turney gave the toast of the evening, "Incorporated Municipal Electrical Association," and coupled the name of Mr. Talbot with the toast. The latter suitably responded.

In our last issue we gave the discussion on **Mr. Richardson's** Paper by telegraph from Nottingham, but were not able to include the remarks of all the speakers. We append these remarks herewith. By an inadvertent error in our telegram last week we reported Mr. LEONARD ANDREWS as saying that "gas engines were *not* altogether reliable." Obviously this should have read "gas engines were altogether reliable," and we take this occasion to correct the mistake. We feel, however, that Mr. Andrews' wholehearted advocacy of the use of large gas engines will be sufficient to correct any wrong impression which our report may have created. In touching upon the general question of gas engine reliability, he thought a chart indicating diagrammatically the confidence placed in such engines might be of interest to engineers. The diagram herewith shows all orders received by one firm of gas engine makers alone. The figures at the side show the dates of orders, and letters A to C represent installations. The diameters of the circles represent nominal brake horse-power of engines, circles joined by vertical lines represent repeat orders, and those in contact show two or more engines ordered simultaneously. Many large gas engines were installed in iron and steel works, and it was most difficult to obtain figures of running cost, because considerable reticence was felt at giving information of any kind. He found that a very large proportion of the orders given for gas engines were repeat orders.

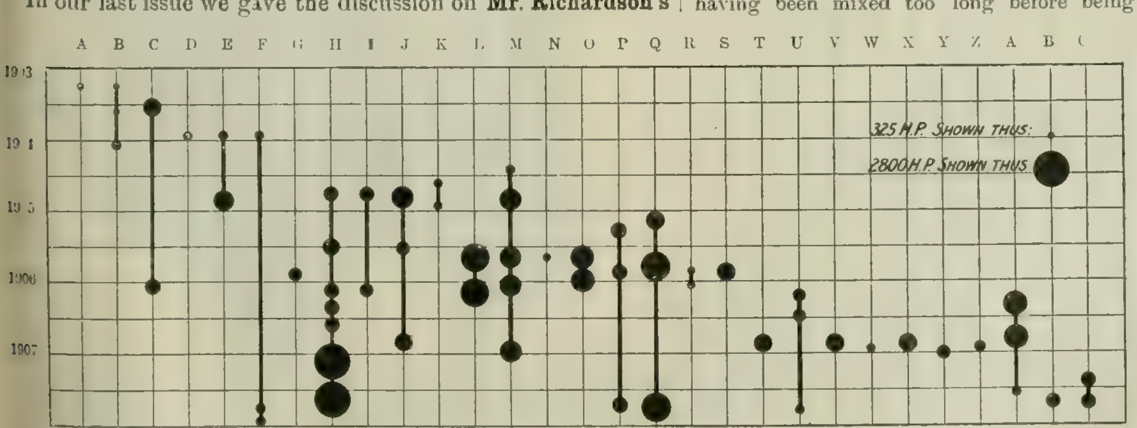


DIAGRAM EXHIBITED BY MR. LEONARD ANDREWS.

Some Considerations on the Design of a Generating Station.

DISCUSSION (*continued.*)

Mr. C. O. MILTON (Maidenhead) asked for information in regard to the working of small engines of, say, 150 H.P. or 200 H.P. In many small stations there existed a day load sufficient to make it economical to run small gas engines, but not big enough for economical production of electricity by steam engines. This seemed to him a field for the use of gas engines of moderate size. He was thinking of going into the matter himself.

Mr. J. K. BRYDGES (Eastbourne) referred to the air leakage occurring between sliding dampers and frames. With two sliding dampers fitted to Stirling boilers, he found the equivalent area of a 4 in. pipe left. So he built up with brickwork, leaving only a small hole for wire rope. In reference to the pump chamber, the author lined the cast-iron tank with concrete. What was the object of this? [Mr. Richardson, interposing, said the lining was on the outside of the tank to keep it from corroding.] The author had come to the conclusion that the chain stoker was the best; did he know the underfeed? He had tried this type, and had found great advantage from the fact that it burned practically any sized coal, which was not the case, he thought, with any chain grate or other automatic stoker. The repairs also were not so much as with other types.

Mr. W. A. VIGNOLES (Grimsby) said the method of making a raft on which to build the station was successful in some cases, but it had very often, he thought, led to more or less disaster. A case he had in mind, where the raft was built and carried the building successfully until the walls were up to a certain height, when one corner of the ground under the raft began to give way and the whole building tipped over and had to be pulled down and piles driven in. The raft was unbroken. Piling was, he thought, a much safer method. The question of concrete and ferro-concrete piles, as well as of ferro-concrete work, was one that required careful consideration. In a large dock the other day he had noticed there were no ferro-concrete poles. Timber piles were being used in all cases, with a small monkey and a long drop. The difficulty appeared to be with ferro-concrete that under certain circumstances the concrete opened up and there was a liability of the wet getting in and the iron rusting away. This might happen through the concrete having been mixed too long before being put in position. In regard to gas engines, he absolutely confirmed the author's conclusions that gas engines were not practical for his particular purpose. In regard to the author's reference to the measuring of coal in the boiler house, it seemed curious to him to weigh all the coal coming in and then to measure it in the boiler house. What was the objection to automatic weighing? He had found this to work satisfactorily. The author had given a long list of diseases which the chain grate stoker appeared to be heir to. In his opinion, the whole difficulty was that of the moving parts in the fire, for which the repairs seemed to be heavy. He would also like to ask if the author had considered the underfeed stokers. He had adopted this type because there were no moving parts in the fire, which he thought a great advantage. He did his driving by motor, and believed that with that type of stoker, and

proper mechanical driving, the repairs were brought down to a minimum: practically any quality of coal could be burned and satisfactory results were obtained. He mentioned that in their case the Local Government Board sanctioned a loan for a galvanised-iron end to the engine room.

Mr. H. RICHARDSON (in reply) said there had been a good deal said about forced draught. He had distinctly said that what he advocated or preferred was pressure draught, which he thought was entirely different to forced draught. With regard to the chimney, he had stated that the Paper was intended for discussion, but he might say that he had decided to erect a brick chimney. He had no doubt about the infinite superiority of a well-made centrifugal pump, and he was surprised to hear of any other pattern being installed. He reserved further reply for the *Proceedings*.

We gave in our last issue an abstract of **Mr. C. M. Shaw's** Paper which was read on Thursday afternoon, and now give an account of the discussion which ensued.

The Reconstruction of an Electric Lighting Scheme with Observations on the Working of a Combined Steam and Water-power Plant.

DISCUSSION.

Mr. E. E. HOADLEY (Maidstone) said that Mr. Shaw's case was one of the best examples in which a station could be turned from a bad failure into a very great success. Mr. Shaw had in one and the same undertaking all the elements of failure and a great many of the elements of success. With regard to the former Mr. Shaw had a very high, and to a large extent useless capital expenditure, with a very large proportion of it in bricks and mortar. A single-phase, high periodicity, a.c. system practically debarred what was the only hope of salvation at Worcester, a power load. There was a power load to be obtained, provided the consumers could be met in the two vital matters of conditions of supply and price. The original station was some two or three miles out of the town, and was originally intended for and designed as a water power station, but became a steam-driven station with a lot of useless capital expenditure on the water plant. When Mr. Shaw took the matter in hand there were very heavy capital charges, which for some time precluded any large expense being sanctioned to make use of the water power he already had, but with what Mr. Shaw had done and intended doing, he (Mr. Hoadley) felt sure a very profitable undertaking could be built up with the existing continuous current plant, and by carefully changing over the single-phase 100 period to two-phase 50 period, which would enable the fairly scattered power load of Worcester to be met. When Mr. Shaw had the load to enable him to use his water power, as the running expenses of the water power plant were exceedingly low, it would pay much better than it paid in smaller south country towns. Summing up, he thought Mr. Shaw had put practically the whole of the debatable portion of his Paper in the two last paragraphs, and considered that the very great improvements brought about at Worcester were—that much larger use was being made of the water power, which cost practically nothing, and by doing away with steam generation at Powick a great deal of money had been saved in two ways; firstly, and to the greater extent, by the improvement in the boiler load factor, and, secondly, the generation of the steam units by economical plant.

Mr. J. K. BRYDGES (Eastbourne) said that when his Corporation took over the electric lighting station in 1900 it was a sight to see. The switchboard was in very dangerous surroundings and the boiler plant was very poor. They decided that it was best to take entirely new works, to move the best of the plant and to do away with the rest. The result was that the works costs were reduced by 1¼d.

Mr. W. A. VIGNOLES (Grimsby) said it was extremely interesting to see the way in which the author had altered his station from one in which many poor results were being obtained to one showing a profit. At the same time he did not think the author had quite made out a case for water-driven machinery in England, and it was probable that if he was starting again he would consider carefully whether he would put down a water turbine station at all or whether he would not rather confine the whole of the output to one station and generate it with larger steam units, in which case the works costs might be brought down considerably below what they were at present between the two stations. The capital cost would also be lower. It was stated that the governing of the turbines was effected by hand. This being the case, very large motors could not be connected, as it would not be possible to maintain very satisfactory voltage regulation. The statement that the level of the tail water having risen 2 ft. had reduced the power available by 25 per cent. showed one of the difficulties to be encountered with water power plants.

The CHAIRMAN (Mr. H. Talbot) said Worcester seemed to be one of those places where water was running to waste. In Nottingham there appeared to be some [illegible] of some local weirs was [illegible]. He recalled the warning of the late Sir Frederick Bramwell who advised engineers to be cautious in taking up any water power scheme.

Mr. SHAW (in reply) said Mr. Vignoles had asked whether it was advisable to make use of water power. He remarked that the water power station at Worcester was decided on with such knowledge as was available at that time. With the knowledge he now had he was not quite sure that such a station would be the most economical. There was no doubt, however, that as soon as the capital charges were paid off the water power station would be particularly useful.

LOUD-SPEAKING TELEPHONES.

Amongst the manufacturers of telephonic apparatus, and especially of the types suitable for use in mines, on board ship, in military works, in docks and at power stations, &c., are Messrs. Alfred Graham & Co., of Crofton Park, London, S.E. We have made a small selection of the apparatus manufactured by the company from patented designs of the company's own inventions, and it will be seen that a wide range of usefulness is covered by these telephones. Fig. 1 shows an improved drum form of "pillar" telephone designed for numerous special uses, such as the navigating bridge on board ship. This apparatus consists of a watertight casing in the form of a drum, containing the transmitter, receiver and switching device all mounted on a bracket piece which revolves on, and is carried by, a gun-metal or brass standard. A bell plunger for calling attention at the distant position is conveniently fitted at the lower part of the bracket, and the operator, by raising one of the side hearing tubes (as shown in the illustration) brings the transmitter into position for speaking, whilst the ear is placed against one or other of the ear pieces as desired. Under ordinary circumstances the use of one tube is sufficient, but where noise or a high wind or rough weather is encountered both tubes are available. When it is desirable to communicate with several positions combined switches and indicators are fitted to the apparatus; two, three or four-way independent lever switches with automatic replacement to

FIG. 1.

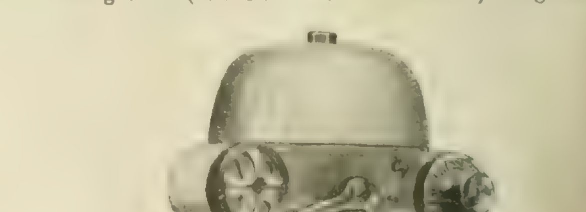


FIG. 2.

the indicator are generally provided. Fig. 2 shows a new model of navy type telephone provided with watertight bell indicator and plug and socket fittings. This apparatus is suitable for fitting in position where there is not a great deal of extraneous noise. Speech is reproduced under ordinary circumstances so that it can be heard fully 20 ft. or 30 ft. distant from the instrument, which is absolutely watertight. The switching device for the transfer of the circuits from the signal lines (bell, or bell and indicator as the case may be) is the transmitter and receiver connections, is actuated by movement of the lever at the right hand side of the sound director covering transmitter, and is of the most positive description. The receiver is of improved design and is provided with a patent micrometer adjustment allowing the maximum of efficiency in voice production. An indicating device with push replacement is arranged in combination with the bell when several instruments are in proximity, so that the calling station may be readily determined.

Numerous accessories for use with the wide range of telephone equipment which Messrs. Graham & Co. supply include switches, and we illustrate in Fig. 3 a five-way combined switch and indicator. In connection with the special uses to which loud speaking types of telephones are employed it is necessary that special designs of certain accessories shall be adopted. The object to be sought in connection with these accessories is simplicity of design and operation and reliability. The arrangement shown in the illustration provides an independent lever for each distant station, and is so devised that the indicator is automatically replaced when the necessary connection is effected by a movement of the lever. With this form of switch it is possible to communicate with any number of outlying positions at the same time. Fig. 5 shows a special telephone motor generator set of the totally enclosed type with the covers removed. After considerable experiment Messrs. Graham claim that they have perfected a system whereby ordinary telephonic installation may be supplied by current direct from the lighting supply, or, for large installations, by the medium of such a motor generator equipment as is here illustrated. The current generated is rendered suitable for telephonic working by the introduction of coils of a certain inductive value, so that commutation and other noises are not reproduced in the apparatus. These motor generator sets are specially designed with this object. In large telephonic installations, such as in extensive works, or on board war vessels, the ordinary low pressure supply is used as a stand-by to these special telephone motor generators, while a central battery is provided as a further stand-by. In the water-tight motor generator switchboard, which forms part of the equipment (as is shown in Fig. 4), each source of supply is controlled in an entirely automatic manner, the board being completely fool-proof. The illustration shows a switchboard arrangement for supply from special telephone generator with low-pressure and central battery stand-by.

Fig. 3.

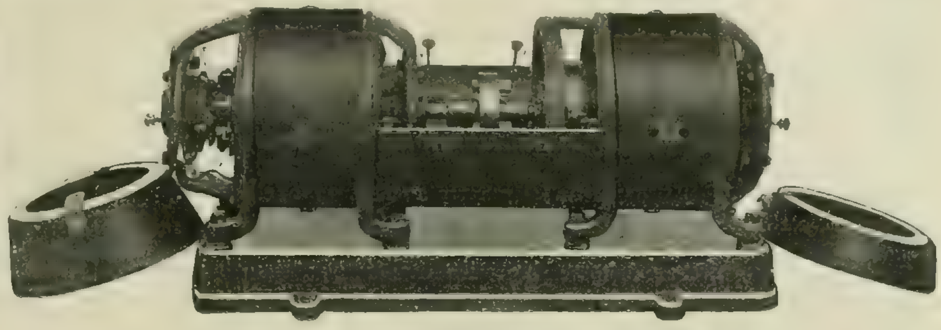


Fig. 5.

Fig. 4.

CORRESPONDENCE.

MARCONI'S SYSTEM OF WIRELESS TELEGRAPHY.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: With all the goodwill in the world I cannot own to any misunderstanding on my part.

The original question raised by Mr. Charles Bright in his words, again quoted by him in *The Electrician* of July 3, ["The duplex-automatic system is, for long distances, only applicable to wire telegraphy at present"] was not to what extent auto and duplex are in vogue or in general or extensive use, but whether or no they be applicable to radio-telegraphy.

My frank but friendly contention—fully justified, I think, in this correspondence—has been that, at the present time, both auto and duplex *are* applicable to long-distance work.

The instance of long-distance work quoted by me from the *Electrical Engineer* and *Elektrotehnik und Maschinenbau* I, after due enquiry, can authoritatively state to have been authentic, and it is a fact that, with the Poulsen radio-telegraph system, duplex is feasible where simplex is feasible.

Mr. Bright makes what is practically a fresh enquiry, and one quite outside the points raised by me in reply to his friendly animadversions on my *Morning Post* letter. He asks for full particulars, from my personal experience, of comparative results with radio duplex-automatic and cable duplex-automatic. This is a rather tall order.

First of all I would prayerfully deprecate this constant reference to automatic working which, being universally applicable, is altogether outside discussion.

Secondly, when the long-distance systems have settled down to work under the new *Convention* rules, and have got their installations—now in course of erection or of alteration—into order, and have tuned *down* or *up* within the *lower* or the *upper* margins of wave-length scope left to them by an exacting Admiralty, who have—doubtless rightly—appropriated the lion's share and largest slice out of the syntonic cake . . . when all this shall have come to pass, the comparative statistics pertinently desired by Mr. Bright will certainly be forthcoming.

Diplex certainly is easy, as Mr. Bright truly remarks (witness the De Forest and Poulsen systems at Cullercoats working in parallel from the same antenna), but undamped-wave duplex is equally so.

Yet when we have taken all this into account, cable working, with its present very high standard of efficiency daily developing fresh possibilities, ... fresh actualities in high and constant speed-rates, remains paramount and practically untouched.—I am, &c.,

Wimbledon, July 6. E. RAYMOND-BARKER.

THE INSTITUTION OF ELECTRICAL ENGINEERS.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: In June, 1904, the Council presented their annual report and congratulated the members on becoming owners of an excellent freehold site in Westminster. Laudatory speeches were made and everyone seemed satisfied.

In June, 1908, the Council relinquish all idea of building on this site, on the ground that it is quite unsuitable, and purchase an expensive leasehold building. I do not propose to discuss the suitability of the building, or the bargain made; it is now approved and members must make the best of it.

But the recent action of the Council in my opinion justifies a gentle protest. It is, of course, easy to criticise, and the position of a member of Council is frequently a thankless one. At the same time, it appears to me that they have only themselves to blame if many of the Institution Members cannot help feeling that the Council have somewhat overstepped the trust which has been placed in their hands.

The Articles of Association in clauses 62 and 63 give the Council the right to call a special general meeting at five days' notice at any time, and clause 68 ensures that the sale of property, &c., must be sanctioned at a special meeting. There is thus nothing to prevent a council any day calling a meeting and enabling a few members, who can attend a hurriedly summoned meeting, to endorse any scheme which may have caught the passing enthusiasm of a newly elected council. It is, therefore, possible that in June, 1912, we may find ourselves committed to the purchase of the Albert Hall.

There are some 6,000 members who contribute to the Institution's funds, and it cannot be other than a matter for regret that the articles of association have been so drafted as to enable about three per cent. of the members at the meeting on June 30th to definitely accept a proposal, which, however excellent it may be, must involve the Institution in heavy financial responsibilities.

The Council are elected to carry on the ordinary work of the Institution, and the mere fact that special meetings are required for specific purposes is a proof that they are not expected to do everything. Members have the right to be consulted, and though it is their own fault if they fail to attend special meetings, even at personal inconvenience and expense, the Council should give consideration to busy members and to country members.

It is somewhat amusing to find that at least two members of the Council, who are also members of the Institute of Civil Engineers, have recently joined a committee to protect the members of that Institution against their Council! But the Council of the Civil Engineers not only gave a fortnight's notice of their recent special meeting, but also supplied a postcard upon which members could record their opinion.—I am, &c.,

London, July 7. MEMBER.

REPORT TO THE BOARD OF TRADE ON THE TRAMWAY ACCIDENT AT OLDBURY.

The Board of Trade Inspector (Col. H. A. Yorke) has issued the report on his enquiry into the accident which occurred on February 20th last at Brades Lock, near Birmingham, on the system of the Birmingham & Midland Tramways Co.

It will be remembered that a car travelling slowly down an incline of 1 in 16.5 left the rails and turned over at the entrance to a loop near the bottom of the hill. The conductor and one passenger were killed and several others injured. The car was of the four-wheel double-deck type, with top cover. It was fitted with hand and electric brakes, trigger life guard, and four sanders, two at each end. After the accident the left hand trailing wheel was found to be broken, though the tyre was perfect, while two of the other wheels were cracked near their connection with the rim.

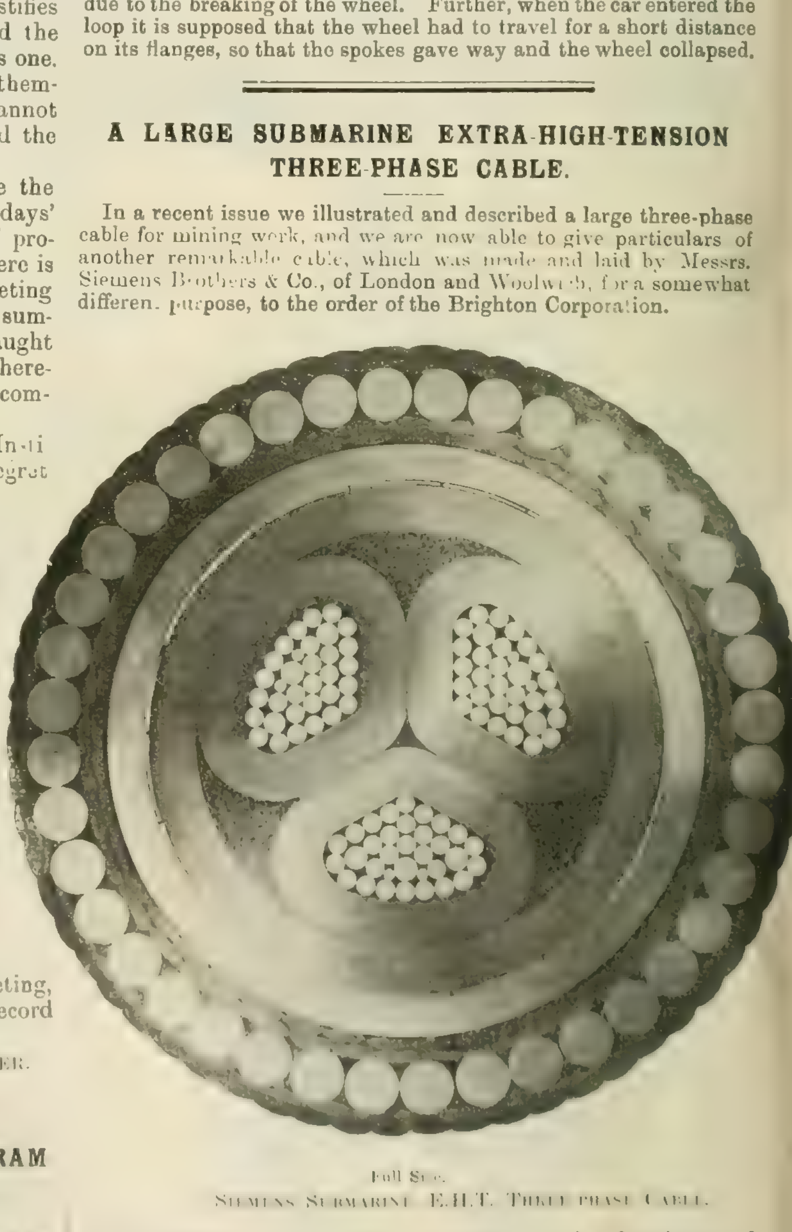
From the evidence it appears the car was approaching Brades Lock Bridge at about seven miles an hour and apparently well under control, for it had stopped a few yards higher up owing to a restive horse. The entrance to the loop is straight and the car passed over the points correctly, but soon swung to the right and came to a stand across the two tracks, afterwards falling over on its left side.

An examination of the track showed that it was in good condition, though the left hand rail was slightly lower than the right at the points, a difference which increased for a short distance along the loop.

After the accident the left-hand trailing wheel was found to be broken, and it is considered that this breaking occurred at the entrance to the loop. This caused the left-hand trailing corner of the car to drop and the leading end to slew slightly to the right. The result of this was that the right-hand leading wheel took the wrong side of the crossing, where the inner rails of the two tracks intersect. The leading end then became derailed, and the car swerved still more to the right until it was right across both tracks, when it turned over. The accident was, in the inspector's opinion, due to the breaking of the wheel. Further, when the car entered the loop it is supposed that the wheel had to travel for a short distance on its flanges, so that the spokes gave way and the wheel collapsed.

A LARGE SUBMARINE EXTRA-HIGH-TENSION THREE-PHASE CABLE.

In a recent issue we illustrated and described a large three-phase cable for mining work, and we are now able to give particulars of another remarkable cable, which was made and laid by Messrs. Siemens Brothers & Co., of London and Woolwich, for a somewhat different purpose, to the order of the Brighton Corporation.



Full Size.

SIEMENS SUBMARINE E.H.T. THREE-PHASE CABLE.

In our issue of June 5, 1906, in connection with a description of the Brighton Corporation's new electricity works, we referred briefly to the new feeders for connecting the Brighton low tension network and sub-stations with the new power house at Southwick, on the further side of Shoreham Harbour. For this purpose a trench was made across the bottom of the harbour, 110 yds. long by 6 ft. wide by 6 ft. deep. After dredging out this trench to a certain depth a bed of lignite was encountered and boring had to be resorted to. With the aid of divers several hundred charges of gelignite were placed in the bore holes and exploded, and after this the dredger was able easily to complete the trench to the required size.

The laying of the cables in the trench had also to be carried out under considerable difficulties. A winch was securely anchored on one side of the harbour in line with the trench. The drum of cable to be laid was jacked up at the side also in line with the trench, the end being made fast to a steel rope from the winch by means of a stopper. The cable was then hauled on a barge and made fast in such a way that it could readily be slipped over the side at a later stage. From this barge two 3 in. ropes were attached to anchors laid out east and west on the shore, the barge being kept in the desired course by this means. A small barge containing the diver's pump and attendants was moored alongside. The cable and barges were hauled across by the winch, the course being regulated by paying out more or less on two stern ropes to the instructions of the engineer on the barge and the diver's signals from below. After allowing sufficient slack for dipping into the trench on the further side, the cable was lowered from the barge into its place.

In all 16 cables were laid—namely, six 8,000 volt 0.25 sq. in. three-phase cables, four low-tension 1 sq. in. cables, two low-tension 0.5 sq. in. cables, one 10 pair telephone cable and three pilot cables. After these cables were lowered they were covered with a foot of concrete.

The extra high-tension cable in question, which is shown full size in the accompanying illustration, is composed of three stranded conductors laid in "clover-leaf" fashion, and each is insulated to a radial thickness of 0.25 sq. in. with layers of impregnated manilla paper. After being twisted together the scores were filled in with jute to make a circular cable, which was then covered with impregnated paper to a further radial thickness of 0.25 sq in. An earth shield of copper strips was then applied and the whole was then lead-covered under heavy pressure to a radial thickness of 0.20 sq. in. The lead-covered cable was then served with a stout bedding of tarred jute yarn and sheathed with 40 galvanised soft steel tarred wires each 0.280 in. diameter. Finally the cable was covered with two layers of tarred jute yarn alternating with coatings of compound. The finished cable weighed about 79 lb. per yard and withstood a testing pressure of 50,000 volts.

THE TELEPHONE SERVICE IN FRANCE.

In Paris the agitation caused by the inefficiency of the telephone service continues to find expression in the Press and in public meetings of protest. The Association of Telephone Subscribers, organised four years ago to voice the complaints of the exasperated telephone users, has recently circulated a petition to Parliament calling the attention of the Government to the many defects of the present telephone service and praying either for a complete reorganisation of the telephone branch of the French Post Office or, failing that, for the return of the telephone service to private enterprise, from which it was taken by the Government nearly 20 years ago.

The new central battery exchange in the Passy district of Paris has increased the volume of public complaint against the telephone service; owing to the mistaken policy of the French Administration in maintaining in service the old instruments at the subscribers' stations, which are of a variety of types, and are not adapted to central battery working, the service of the new exchange is even worse than that of the old.

The interest of Parliament having been aroused by the intensity and persistence of the public complaints against the telephone service, a Parliamentary Committee of Members of the Chamber of Deputies for the various divisions of Paris last week invited the Council of the Association of Telephone Subscribers to attend the Committee with a view to giving detailed information regarding the existing difficulties with the telephone service. At this meeting the Association of Telephone Subscribers was represented by the Marquis de Montebello, president, Mr. Archdeacon, vice-president, and Mr. H. Laws Webb, consulting engineer to the Association. The Parliamentary Committee, presided over by M. Georges Berry, consisted of some 15 members representing various divisions of Paris, who gave a sympathetic hearing to the case for the telephone-using public. M. de Montebello explained that the principal difficulties arose from the fact that the telephone service is at present operated merely as a branch of the Postal and Telegraph Administration, and he urged that for efficient working it was necessary to organise the telephone service as a separate department in all respects. A complete reform was necessary not only in the technical methods of the telephone administration, which had been allowed to fall far behind the times, but also in the selection and training of the staff, in the general business administration of the department and in its financial management. Mr. Archdeacon followed along the same lines and gave examples of the disorganisation at present existing among the staff of the telephone branch of the French Post Office and quoted figures showing the greatly higher development of the telephone in the other principal European countries and the more favourable tariffs for telephone service which are offered to the public of other countries. Mr. Laws Webb explained to the Committee the essential difference between the telephone service and the postal and telegraph services, and pointed out that for an efficient city telephone service uniformity of plant and special training of the staff are essential requisites. He confirmed the arguments of Messrs. de Montebello and Archdeacon to the effect that no serious progress could be made with the telephone service in France until the service was placed in charge of a separate telephone department, with a special staff and organisation devoted exclusively to telephone work.

The Committee asked numerous questions of the deputation, and several members made short speeches, in which, while strongly opposing the suggestion that the French telephone service should be handed back to private enterprise, they stated that they fully agreed with the views of the deputation that the telephone branch of the French Post Office should be entirely reformed and should be organised and conducted on the same lines as a commercial concern. Members of the Committee themselves complained very forcibly that they were unable, as matters were now conducted, to obtain any figures or information giving precise data of the results of the telephone branch of the French Post Office; the Administration did not know itself what it was doing so far as finance was concerned. The Committee unanimously promised to support the Association of Telephone Subscribers and to take the matter up actively in Parliament with the object of securing the appointment of a special commission of Members of the Chamber and representatives of the telephone subscribers for the purpose of making a thorough investigation of the difficulties under which the French telephone service now labours.

THE FARADAY SOCIETY.

At a meeting of the Faraday Society, heldon June 9th, Dr. ALBERT FRANK read a Paper

On the Utilisation of Atmospheric Nitrogen in the Production of Calcium Cyanamide, and its Use in Agriculture and Chemistry.

The practical manufacture of calcium carbide in the electric furnace in 1894 by Willson and Moissan furnished Professor Frank and Dr. Caro with the ideal base required for fixing atmospheric nitrogen in the place of the metallic base which they had previously used (barium) in their experimental search for a commercial method of producing cyanide of potassium for the recovery of gold in mining. As a result of these researches the Cyanid Gesellschaft was founded, which has supplied such a large proportion of the cyanides used in gold extraction in South Africa, Australia, and the United States. They also led to the production of calcium cyanamide (nitrolim), a genuine substitute for sulphate of ammonia and nitrate of soda for all agricultural purposes, and which can be produced in unlimited quantities wherever limestone, coal and air are available, containing up to 28 per cent. of nitrogen. The only other practical method of fixing atmospheric nitrogen which has been perfected of recent years for similar uses to calcium cyanamide, is known as lime saltpetre, and has been invented by Prof. Birkeland, of Christiania, but this process, though successful from the scientific point of view, requires considerably more expenditure of power than the Frank-Caro process, and the product possesses, for agricultural purposes, several drawbacks which calcium cyanamide does not.

The author proceeded to describe the practical features of the manufacture of nitrolim. The carbide is first ground to powder in air-tight mills, filled into furnaces which are kept full of nitrogen, and raised to and maintained at a temperature of 800°C. to 1,000°C. for several hours, then allowed to cool slowly, and finally re-ground into a fine slate-black powder, which is sent out to the farmer in paper-lined bags, containing from 57 to 63 per cent. of pure cyanamide or 20 to 22 per cent. of nitrogen with about 20 per cent. quicklime, 14 per cent. of carbon and 7 to 8 per cent. of silex iron oxide and alumina. To replace the present consumption of Chili nitrate by calcium cyanamide would require something like 800,000 H.P., and works are springing up all over the world to produce it wherever water power is abundant and cheap. The first works established for producing and selling 3,000 to 4,000 tons a year, working for the last three years, were in Italy, at Piano d'Orte (Abruzzi), and are now being enlarged for an output of 10,000 tons. Another works is just being erected at San Marcel (Val d'Aosta), for another 4,000 tons, and the great Terni carbide works are laying themselves out for the production of some 10,000 tons in the near future. Dalmatia has followed the Italian example at Sebenico, at Fiume (each for an initial 4,000 tons), and at Almissa, where 50,000 H.P. are available, and a further 10,000 tons output is being planned, all the product being required in the Balkans, Hungary and the Mediterranean coast of Africa and Egypt.

Mr. HENRY COTTRELL pointed out that a great advantage of these artificial nitrogenous manures is that they are alkaline, whereas the

native nitrates are acid and produce in time sickness in the soil. It was difficult to persuade the farmer, however, to use new manures.

Mr. WALTER REID, referring to some tests he had made on calcium cyanamide, drew attention to the moisture in the soil as having considerable effect on the results of such tests. With regard to the use of calcium cyanamide in smokeless powder, he had found it rather too efficient in slowing the explosion.

Dr. H. BORNS hoped the author would furnish some fuller details regarding the efficiency and construction of the electric furnaces in which combination of nitrogen with carbide took place.

Dr. J. H. VOELCKER said farmers could not be expected to use new manures until they were perfectly satisfied as to their cost and effect. There were, for example, at present certain disadvantages connected with the use of nitrolim which would have to be eliminated before it could become entirely satisfactory. Beyond that the situation was determined entirely by price.

Mr. W. MURRAY MORRISON asked whether the cyanamide could not be made direct from limestone and coal in one operation.

Mr. J. L. F. VOGEL asked what fear there was of a charge of carbide not being completely nitrated.

The CHAIRMAN drew attention to the use of cyanamide in synthesis, and hoped that some of the very interesting and important compounds that could be made from it would be manufactured in this country.

Dr. FRANK replied to the points raised by the various speakers. Cyanamide was 10 per cent. cheaper than ammonium sulphate. Its stability was good; although the lime absorbed moisture, there was no loss of nitrogen. Up to the present its manufacture in one operation had not proved successful.

At the meeting held on June 23rd, a Paper was read by Mr. J. Härdén on the Kjellin and Röchling-Rodenhauser electric furnaces. This we hope to give at some length in a future issue.

THE ELECTRIC TAXICAB CO.

As briefly announced in our last issue, a company (the chairman of which is Lord Westbury) bearing this title is in process of formation. Its capital will be £300,000, divided into the same number of £1 shares. Its object is to provide London with a service of four-seated electric cabs with luggage roof capable of carrying as much luggage as the ordinary four-wheel cab.

The Electromobile Co. have entered into a contract with the new company, and cabs will be supplied by them, exclusive of batteries, tyres and taximeters, at a cost of £360 each. The necessary batteries for the first 100 cabs will be supplied by the Electromobile Co. at a cost of £60 per battery.

An interesting estimate of the working expenses, which we give below, has been made by Mr. T. G. Chambers, managing director of the Electromobile Co. The average gross earnings are taken at £2 per cab per day, which, deducting 7s. for the driver, leaves an average gross profit per cab per day of £1. 13s. The running costs are estimated to be as follows:—

	Per cab per day.
Garage accommodation and operating costs	2s. 8d.
Maintenance and upkeep of the chassis and bodies	2s. 8d.
Electricity and maintenance and replacement of the batteries	9s. 2d.
Tyres (supply and maintenance)	5s. 0d.
	19s. 6d.

This estimate is based upon minutely kept records of carriages which have actually run over 2,000,000 miles. These expenses are calculated on the basis of a cab-mileage estimated to be sufficient to earn the above sum of £2 a day. Thus

Gross profit per cab per day	£1 13 0
Less expenses	19 6
Balance of profit per cab per day	13s. 6d.

SUMMARY.

100 cabs at 13s. 6d. profit per cab per day (reckoning six days a week, say		£105,630
Less annual charges—		
Taximeters to be rented at £7 per cab per annum	£3,500	
Licences £2 15s per cab per annum	1,375	
Insurance against fire, accident and third party risks per annum	12,500	
Provision as reserve to replace the whole cost of the chassis and bodies in seven years (the batteries and tyres being maintained out of revenue on the basis of the sum which would be required if invested at 3 per cent. per annum compound interest	23,490	
		40,865
Leaves		£64,765

It is anticipated that 500 cabs will be running on the streets within two years, while the first 100 of these can, it is thought, be ready in about eight months' time. The Electromobile Co. agree to charge, renew and maintain the batteries for 3d. per mile run.

WIRELESS TELEGRAPH REGULATIONS.

The Postmaster-General has issued the following regulations (dated June 20, 1908), which came into force on July 1:—

WIRELESS TELEGRAPHY (FOREIGN SHIPS) REGULATIONS, 1908.

1. *Definitions.*—In these regulations, unless the context otherwise requires, "wireless telegraphy" has the same meaning as in the Wireless Telegraphy Act, 1904. "Naval signalling" means signalling by means of any system of wireless telegraphy between two or more ships of His Majesty's Navy, between ships of His Majesty's Navy and naval stations, or between a ship of His Majesty's Navy or a naval station and any other wireless telegraph station whether on shore or on any ship. "Territorial waters" means such part of the sea adjacent to the coast of the British Islands as is deemed by international law to be within the territorial sovereignty of His Majesty, and includes harbours. "Harbour" includes harbours properly so called, whether natural or artificial, estuaries, navigable rivers, piers, jetties and other works in or at which ships can obtain shelter, or ship and unship goods or passengers.

2. *Rules to be Observed.*—When communications are made by means of wireless telegraphy between a foreign ship in territorial waters and a wireless telegraph station in the British Islands, the rules in force for the working of wireless telegraphy at that station shall be observed.

3. *Interference with Naval Signalling or with Other Stations.* All apparatus for wireless telegraphy on board a foreign ship in territorial waters shall be worked in such a way as not to interrupt or interfere with (*a*) Naval signalling, or (*b*) the working of any wireless telegraph station lawfully established, installed or worked in the British Islands or the territorial waters abutting on the coast of the British Islands, and in particular the said apparatus shall be so worked as not to interrupt or interfere with the transmission of any messages between wireless telegraph stations established as aforesaid on land and wireless telegraph stations established on ships at sea.

4. *Working Apparatus in Harbour.*—(1) Except with the special permission in writing of the Postmaster-General no apparatus for wireless telegraphy on board a foreign ship (other than a ship of war) shall be worked or used whilst such ship is in any harbour in the British Islands. (2) Without prejudice to the operation of the general provisions of these Regulations, the use of wireless telegraphy on board a foreign ship of war while in a harbour in the British Islands shall be subject to such rules (whether prohibitive or regulative) as may be made by the Admiralty from time to time.

5. *Control of Apparatus on Emergency.*—(1) If at any time in the opinion of one of His Majesty's principal Secretaries of State an emergency has arisen in which it is expedient for the public service that His Majesty's Government should have control over the transmission of messages by wireless telegraphy, and notice to that effect is published by the Postmaster-General, after the publication of such notice, and until further notice, the use of wireless telegraphy on board foreign ships whilst in territorial waters shall be subject to such rules as may be made by the Admiralty from time to time, and such rules may prohibit or regulate such use in all cases or in such cases as may be deemed desirable. (2) Such notice as aforesaid shall be published in the *London Gazette*, the *Edinburgh Gazette* and the *Dublin Gazette*, and in such other manner, if any, as to the Postmaster-General may seem fit.

6. *Penalties.*—(1) Any person who shall offend against any provision of these Regulations, or of any rules made by the Admiralty thereunder, shall be liable on conviction under the Summary Jurisdiction Acts for every such offence to a penalty not exceeding £10, and upon such conviction the Court may order that any apparatus for wireless telegraphy installed or worked on board the ship on which the offence was committed shall be seized and forfeited. (2) For the purposes of any proceedings under these Regulations the master or person being or appearing to be in command or charge of any foreign ship shall be deemed to have authorised and to be responsible for the use or working of any apparatus on board such ship. (3) Any summons or other document in any proceedings under these Regulations shall be deemed to have been duly served on the person to whom the same is addressed by being left on board the ship on which the offence is charged to have been committed with the person being or appearing to be in command or charge of the ship.

7. *Signals of Distress.*—These Regulations shall not apply to the use of wireless telegraphy for the purpose of making or answering signals of distress.

These Regulations may be cited as "The Wireless Telegraphy (Foreign Ships) Regulations, 1908."

BOOKS RECEIVED.

(Copies of the undermentioned works can be had from *The Electrician* office, post free, on receipt of published price, adding 3d. for books published under 2s. Add 10 per cent. for abroad or for foreign books.)

"Industrial Electrical Measuring Instruments." By Kenelm Edgcumbe. (London: Archibald Constable & Co.) 8s. net.

"Electric Bells." By S. R. Bottone. 7th edition. (London: Whittaker & Co.) 2s. net.

"Field Telephones for Army Use." By Lieut. E. J. Stevens. (London: Crosby Lockwood & Son.) 2s. net.

"The Gas Engine Manual." By W. A. Tookey. (London: Percival Marshall & Co.) 3s. 6d. net.

DUMBARTON EXTENSIONS.

Our readers may recall the fact that some 12 months ago a system of electric lighting and tramways was opened at Dumbarton, the entire undertaking being put down by Messrs. Crompton & Co. We have received particulars from the same firm of a large extension set which they have recently installed in the power house, and an illustration of which is given herewith. It will be seen to comprise an enclosed high-speed engine direct coupled to two direct-current generators. Either of these two machines can be connected for service to the lighting or traction mains. The engine is by Messrs. Belliss & Morcom, and is of standard pattern with the usual features of forced lubrication, balanced valves, &c. It is of the three-cylinder three-crank triple expansion type and runs at a normal speed of 330 revs. per min. with 180 lb. steam pressure while running condensing. The rated output at full load is 720 B.H.P. Each dynamo is a multipolar machine having an output of 240 kw.; the windings are compound and interpoles have also been introduced. The rating allows for a 30 per cent. overload for two hours. The generators are mounted on sole plates and the armatures are built up on a shaft having a coupling in the centre between the two machines. The commutators are assembled at the outer sides of the machines. The makers inform us that during its trials the combined set gave a total output of 600 kw. The fact that the traction and lighting loads will be dealt with by two dynamos driven by a single engine will materially assist in the running of the unit at an efficient load.

720 B.H.P. BELLISS-CROMPTON SET AT DUMBARTON.

THE MANCHESTER ELECTRICAL EXHIBITION.

This long-looked for and much expected exhibition is now beginning to take definite shape. It had crystallised so far on Tuesday last that the promoters were enabled to give a luncheon to Press representatives. This luncheon took place in the temporary building, erected specially for the exhibition at Platt Fields, Rusholme, Manchester, under the chairmanship of Councillor W. Kay (deputy chairman, Manchester Corporation Electricity committee), who was supported by Councillor W. Barrett, of Salford. Among the municipal engineers present were Messrs. S. L. Pearce, H. Talbot, A. A. Day and S. J. Watson. Messrs. F. H. Nalder and H. H. Berry represented the National Electrical Manufacturers' Association and Messrs. C. S. Northcote and W. Davenport the manufacturers.

Contrary to usual procedure, though, perhaps, natural under the circumstances, the chief toast was that of "The Press," which was proposed by the chairman. He dealt with the progress of the exhibition from the historical point of view, indicating the reasons for holding the exhibition in Manchester and the benefits which he hoped would arise therefrom. The object of the exhibition was not private gain, but the good of the industry at large, and for this reason his committee had supported the idea. Mr. H. Talbot also dwelt on the suitability of Manchester for exhibition purposes, while Mr. S. L. Pearce gave the scheme the official blessing of the I.M.E.A. Within a 30-mile radius of Manchester were many of the largest manufacturing concerns who were actively supporting the exhibition, a fact which combined with the assistance of some 30 or 40 municipalities, should go towards making the show a success. Mr. H. H. Bevis considered that exhibitions, though productive of good, should be administered homeopathically and should not be held more than once in three years. Mr. W. Davenport briefly explained the scope of the exhibition, which is very wide. The lighter side will not be forgotten, as illuminations have been planned and the band of the Coldstream Guards will be in attendance.

AN ENCLOSED MOTOR FOR MINING WORK.

The atmosphere of a mine is scarcely the ideal one for motor operation, though there are some worse places. The disadvantages can, however, be overcome, and we illustrate herewith a motor specially designed for use in mines. The photograph shows a totally-enclosed motor manufactured by the Electric Construction Co., of Wolverhampton, which should prove very satisfactory for mining work. The ribbed construction of the motor casing is a striking feature, and by providing an extensive radiating surface it should end to keep down the temperature rise of the machine when subjected to continuous loads. The motor illustrated has ball bearings, but it can be fitted with ordinary cylindrical bearings.

E.C.C. TOTALLY ENCLOSED MOTOR.

PARLIAMENTARY INTELLIGENCE.

SOUTH WALES ELECTRIC POWER BILL.

On Monday a Select Committee of the House of Commons passed this bill.

Mr. Lloyd, K.C., gave a sketch of the history of the company and of its financial troubles. An attempt was made to prevent the supply of power ceasing, and local authorities and power users agreed for a time to pay higher rates than they were bound to pay. Eventually a plan was arrived at which had been embodied in the bill. The company had four generating stations, and they proposed dealing with them separately. On the Neath station they had spent £42,000, and they had agreed to sell the station to Neath Rural Council for £7,000. On the Bridgend station they had spent £36,000, and that would be sold to the Urban Council for £5,000. At Treforest they had a number of customers who had invested money in plant so as to take power from the company, and it was proposed to form a limited company of those customers who would carry on the Treforest station. The fourth station was the Cwmbran station, and they had been carrying that on owing to customers paying higher rates. So far no arrangements had been made for transferring the station, but powers were taken in the bill to enable the company to do that with the consent of the Board of Trade. As to the creditors for £84,000, they proposed to give them £150 of preference shares for every £100 of debt, and creditors to the extent of £80,000 had agreed to that. The holders of the £200,000 debenture stock had also met the company in a fair spirit.

In order to satisfy Pontypridd Council, who opposed the bill, certain clauses were inserted. Instead of the guarantee to take at least 30,000 units, it was agreed that the amount should be somewhat smaller and should be expressed in kilowatts, and that the supply to any consumer should not exceed 20 per cent. of his total supply for lighting. The promoters also undertook to put in a clause giving Pontypridd the right to have a supply if needed on favourable terms.

LEGAL INTELLIGENCE.

Brush Electrical Engineering Co. v. West Hallam Colliery Co.

At Nottingham Assizes on Tuesday plaintiffs sought to recover £400 from defendants, the price of an electric coal cutter, which defendants had returned as useless.

Mr. Hugo Young, K.C., and Mr. Pritchard for plaintiffs; and Mr. H. Y. Stanger, K.C., and Mr. McCardie for defendants.

Evidence and correspondence were put in to show that defendants, after repeated trials, were unable to make the machine work satisfactorily. Defendants stipulated that the machine must cut at floor level, but when it was constructed and delivered they found it would not cut at floor level, and mounted from 10 in. to 12 in. in the coal. Defendants alleged that the cutter cost them 9s. a ton for coal, or three times as much as coal cut by hand, and involved an expenditure of from £60 to £80 a week.

The case for plaintiffs was that all the machine needed was to be properly adjusted, and this could only be done while it was at work.

Mr. N. Taylor, C.E., who was employed by plaintiffs at the time of the transaction, said he saw the cutter at work, and the average depth of the coal left on the floor for the whole of the seam was only about 3 in. In adapting a coal cutting machine to colliery work local conditions must be taken into consideration. He considered the machine was taken out of the pit without sufficient time being given for adjustment.

Mr. F. W. Hurd, electrical engineer, said the machine could be adjusted so as to cut at practically floor level.

Mr. A. Crawford, colliery under-manager, formerly at the Digby Colliery, said the machine was made according to specification. The cause of difficulty in that case was the hard "pavement." A month should be stipulated for in order to make experiments.

For the defence Mr. T. Williamson, manager of West Hallam Colliery Co., said the machine was given over a fortnight's opportunity, but he did not once see it work at floor level. By knocking timber out it made the work dangerous.

After consultation between the parties, it was agreed that judgment should be given for defendants, with costs, on the claim, and also for defendants for £25, with costs, on the counterclaim.

Hills Patents (Ltd.) v. Dick, Kerr & Co.

On Tuesday this case came before Mr. Justice Channell.

Mr. Colefax, for defendants, said the point was whether Mr. H. J. Hills, one of the two plaintiffs in the action, should not be struck out on the ground that the statement of claim disclosed no right of action by Mr. Hills. Defendants took out a summons to have Mr. Hills dismissed from the action. Master Chitty ordered that [illegible] and that order was confirmed by Mr. Justice Ridley. The action has been brought for infringement of [illegible] patent 23,082, 1902, the patent being [illegible] apparatus for use in overhead electric tramways. [illegible] of the patent, and had parted with his interest in it to a company [illegible]. Defendants sought to get security for costs against the company, but failed on the ground that there was [illegible], although he did not think there was any suggestion that he could satisfy defendants as to costs. Although the assignment was not registered until after the date of infringement of the patent, he submitted that Hills ought not to be a co-plaintiff.

After hearing Mr. P. Hastings, for plaintiffs,

Mr. Justice Channell said he should be very reluctant to strike out the name of Mr. Hills and deal with the case piecemeal. He was quite clear that Mr. Hills ought either to be plaintiff alone or joint plaintiff in respect to damages prior to the actual assignment. He dismissed the motion, the costs to be costs in the cause.

E. Scott & Mountain v. Kent Collieries.—Mr. Bousfield, K.C., on Tuesday, applied to a Divisional Court (the Lord Chief Justice and Mr. Justice Ridley) on behalf of defendants for a stay of execution pending appeal.

Mr. C. A. Russell, K.C. (for plaintiff), objected, unless the amount of the judgment was brought into Court by defendants.

Their Lordships granted a stay on the terms that defendants brought the amount of the judgment into Court.

MUNICIPAL, FOREIGN & GENERAL NOTES.

APPOINTMENTS VACANT AND FILLED.

A second assistant is required in the engineering department of Woolwich Polytechnic to take up duties in September next. A knowledge of electrical engineering is essential. Commencing salary £180. Applications to the Principal (from whom further particulars can be obtained) by July 15. See an advertisement.

Foreman electrical instrument maker is required, well acquainted with modern requirements and rapid production of work. See advertisement.

An assistant lecturer and demonstrator is required in the department of physics and electrical engineering at Huddersfield Technical College. Salary £120. Particulars from the Secretary.

The Pacific Cable Board invite applications for the post of general manager. The candidate must have experience in ocean and other telegraphy and in the business conduct of an undertaking similar to that of the Board. Applications, accompanied with statement of age and qualifications and salary expected, to the Chairman of the Pacific Cable Board, Queen Anne's-chambers, Westminster, S.W., by July 20.

Warrington Electricity and Tramways committee have appointed Mr. H. B. Jackson chief assistant engineer at £150 per annum, and Mr. F. V. Jordan has been appointed mains engineer at £130, rising by annual increments of £10 to £150 per annum.

Mr. Z. L. Kingdon has been appointed electrical engineer at the Devonport Dockyard.

Mr. E. Greenhouse has been appointed acting charge engineer at Dover.

EDUCATIONAL NOTICES.

City and Guilds of London Institute.—The courses of instruction at the Institute's Central Technical College, Exhibition road, are for students not under 16 years of age and those at the Institute's Technical College, Finsbury, for students not under 14 years of age. Entrance examination to both Colleges are held in September and the sessions commence in October. Particulars of the entrance examinations, scholarships, fees and courses of study may be obtained from the respective Colleges or from the head offices of the Institute, Gresham College, Basinghall-street, London, E.C. The Central Technical College is for higher technical instruction for day students preparing to become civil, mechanical and electrical engineers, chemical and other manufacturers and teachers. The college is a school of the University of London and also forms the engineering section of the Imperial College of Science and Technology. The Finsbury Technical College is for instruction for day students preparing to enter engineering and chemical industries and for evening students.

Heriot Watt College, Edinburgh.—At this college there is theoretical and practical training for mechanical, electrical and mining engineers, technical chemists, &c. The training for engineers consists of three years in the college and a three years' apprenticeship on the "sandwich" system in a local engineering works. The total cost, including apprenticeship premium and fees at college, is from £120 to £200. There are complete courses of instruction, extending over four years, for students studying for the fellowship of the Institute of Chemistry. The classes are recognised by the University of Edinburgh as qualifying for science degrees. Full information may be obtained from the Principal, Mr. A. P. Laurie, M.A., D.Sc.

University College of North Wales.—A systematic course of instruction in electrical measurement and practical electricity is given at this college for students proposing to enter the electrical engineering profession. The physical laboratory is well equipped, and the course commences in October next. Prospectuses, &c., from the secretary, Mr. J. E. Lloyd, M.A.

Australasia.—The "Australian Mining Standard" states that, although the Postmaster-General of the Commonwealth (Mr. Mauger) stated, when inviting tenders recently for 50,000 small porcelain insulators, that he would be willing to pay a preferential price for goods of Australian manufacture, only one tender was received, and that from a firm in Germany.

Senator Best stated, in reply to questions in the Commonwealth Senate recently, that the loss on the Melbourne-Sydney telephone for the nine months ended April 10 last was £526. 15s. 4d.

Southern Cross (Western Australia) Council have recently taken over from Messrs. Saunders & Stuart a 35 kw. generating set, with gas producer plant and a Tudor accumulator. This is said to be the first producer gas plant used for public electric lighting in Australia.

The Royal Commission appointed to deal with the requirements of the Australian Commonwealth for telegraph and telephone purposes have issued an interim report.

The report states that it is impossible to provide the necessary funds from the annual revenue, and that the telegraph and telephone systems are little better, so far as construction is concerned, than when they were taken over. On the estimates for 1907-8 £547,155 was wanted for new telegraph and telephone works, and, although that only represented the portion of the work which, it was estimated, could be carried out during that year, the central office and the Treasury reduced the amount by £209,688. Under the present system, funds are provided by annual votes which must not be anticipated, and the balances, if any, cannot be carried forward to succeeding years. Under such a system it is impossible to carry out satisfactorily a comprehensive scheme of telegraphic or telephonic development. The requirements of capital by the Commonwealth telegraph and telephone departments during the next three years are estimated at £2,125,335. £329,345 is required immediately for special works in 1908-9. Some system of extending capital costs over a number of years, say two-thirds of the life of the works, should (the report suggests) be at once introduced.

A proposal to form a company to acquire a concession obtained by Mr. A. E. Clarke from the Municipal Council for the construction and working of electric tramways in Launceston (Tasmania) has been favourably received in Launceston business circles.

A proposal by a company to provide electricity works for Brunswick and Coburg (Victoria), and also electric tramways for Coburg, has been approved by Coburg Council.

The report of the directors of the Mount Lyell Mining & Railway Co. (Tasmania) states that a new Ilgner electric winding plant had been ordered, a third electrically-driven pump had been added, and an electric transmission line from the reduction works power station to the North Mount Lyell shaft had been erected to supply current to the Ilgner winding plant and for driving air compressors and pumps. An electric air drill had also been installed at the company's limestone quarry.

Beckenham.—The Council have decided to give a bonus to the stokers at the electricity works equal to £10 for each 0·1d. reduction in the coal costs for the year.

Bo'ness.—In a recent report to the Council, the contractors and lessees of the electricity works (the National Electric Construction Co.) stated that the demand for electricity had been growing in a satisfactory manner, each year showing a marked advance.

At Dec. 31 last the applications equalled 12,571 8 c.p. lamps, an advance of 3,533 during the year. At the end of April last there were applications in hand for 1,300 additional 8 c.p. lamps. In order to cope with the present demands upon the station, the company proposed to instal a 350 H.P. triple-expansion condensing engine coupled to a 300 kw. d.c. generator, and other machinery, which would enable them to effect other economies in the present running of the plant. The extensions are estimated to cost over £6,000. The Council have agreed to proceed with the extensions, as recommended, subject to sanction to borrow being obtained.

Braunton (Devon).—The Council are considering an electric lighting scheme submitted by Mr. A. A. Jenkins.

Bristol.—The Royal Edward Dock, which was formally opened yesterday by H.M. the King, is equipped with electric cranes, conveying machinery, &c. The electrical energy for the dock is supplied from the Corporation electricity works. The electrical equipment has cost about £30,000. There are electric cranes on the roofs of the two transit sheds (each 500 ft. in length), and there are also electric cranes and electric conveying machinery on other parts of the dock, and the Co-operative Wholesale Society's new mill now being erected on the dock is to be worked by electricity. Below the wharf fronted by the transit sheds is an underground gallery with grain-conveying plant communicating with a huge granary behind the dock. This granary will also be connected with the wharf by above-ground plant for conveying full sacks by mechanical means.

Burnley.—The Electricity committee have been authorised to purchase a 750 kw. generating set.

China.—The "Indian and Eastern Engineer" states that over 2,000 telephones have been installed in Peking, and extensions are still being made.

Coal Smoke Abatement Society.—At the annual meeting on Friday of this society the report stated that several recent Parliamentary Bills, especially in connection with electricity supply, had contained clauses which, in the opinion of the society, were inimical to the interests of the public, as the aim of the promoters was to obtain exemption from liability for nuisances caused by the emission of smoke, &c.

During the past year complaints were made to or by the Society in regard to 35 works, and of these 20 were electricity generating stations maintained and worked by local authorities. The difficulty of dealing with nuisances with regard to smoke was increased by the decision of Mr. Curtis Bennett on the summons of the Chelsea Council against the Underground Electric Railways Co of London in connection with their Lots road generating station. If the decision that the blackness of the smoke must be scientifically established were generally acted upon there could be no doubt that the movement for smoke abatement would have received a great check. The Committee were making an effort to induce the electricity, gas, and smokeless fuel companies to combine in establishing a permanent exhibition of apparatus, methods and fuel for the abatement of smoke from dwelling houses as distinguished from industrial purposes. Under the auspices of the Society a series of lectures for the education of stokers had been instituted.

[Our readers will remember that the House of Lords Committee which recently considered the three London Electric Supply bills inserted in the London and District Electricity Supply Bill a clause proposed by H.M. Commissioners of Works which, it was thought, practically covered the Coal Smoke Abatement Society's requirements, but the Committee was not disposed to insist on the insertion of the same clause in the London Electric Supply Bill (promoted by existing London Electricity Supply Companies), although it was suggested that the promoters should confer with the Commissioners of Works and try to come to some agreement.]

Colchester.—Last week the Council in committee reported the receipt of replies from Messrs. Mordey & Dawbarn and Messrs. Kennedy & Jenkin that they would be prepared to advise upon the question of alleged vibration at the electricity station and the future development of the undertaking at fees of 50 and 100 guineas respectively, plus out-of-pocket expenses. It was resolved to ask Messrs. Mordey & Dawbarn to furnish a report, and that the question of engaging the services of Messrs. Kennedy & Jenkin remain in abeyance.

Croydon.—The Corporation is to invite tenders for mechanical stokers for two additional boilers.

Dewsbury.—The salary of the assistant electrical engineer (Mr. W. E. Rogers) has been increased to £170 per annum.

Dover.—The Council have obtained sanction to a loan of £9,774 for extensions of the electricity undertaking and £1,000 for free wiring.

Application is to be made for sanction to a further loan of £1,000 for free wiring.

Eastbourne.—The Motor Omnibus committee received an offer to supply four electric 'buses, chassis and body complete, for £778, and to purchase the Corporation's four old type petrol 'buses for £500.

Should the Council decide not to purchase, the company asked for a licence to run four electric 'buses on a certain route in the town. The company also asked to know how the committee would eventually receive a proposition for the company to take over the motor omnibus service of the Corporation, undertaking to convert same into an efficient electric omnibus service within a stipulated period, the proposition to contain an offer of cash repayment of all sums spent by the Corporation on the motor 'bus undertaking and instituting an efficient electric omnibus service throughout the town.

The committee recommended the Council on Monday not to entertain the offer of supplying and purchasing 'buses, and that the question of granting a licence to the company be referred to the Watch committee, with an expression of opinion that the Motor Omnibus committee consider the public necessities are already fully met. With regard to the offer to purchase the Eastbourne service, the committee informed the company that, without prejudice to the Corporation, they were at liberty to submit any proposals they wished to make.

The report was adopted.

Edinburgh.—The Electric Lighting committee recommend the Council to sanction the reduction of the charge for electricity for ordinary lighting by ½d. per unit, and also for electricity supplied during restricted hours, and to motors used from three to four hours per day throughout the year.

Electric Lifts.—On the occasion of the opening of the new offices of the National Pension Fund for Nurses by the King and Queen on Saturday the new automatic passenger lift, installed by Messrs. Archibald Smith & Stevens, was used by their Majesties.

For this lift no attendant is required. On each floor served is an ordinary button push, momentary pressure of which will call the lift if it is not already in use by another passenger. When the lift cage arrives at the landing the door may be unlocked and opened and the cage entered. After entering the cage, the landing door must be again closed and locked by the simple movement of a lever; if the door is not locked the control circuit is interrupted and the cage cannot be moved. In the cage are placed a number of button pushes corresponding to the number of floors served. Momentary pressure of any button will send the cage to the corresponding floor, where it stops

and the door may be opened and the passenger can alight. A stop button is also provided to stop the cage if a wrong button has been pressed. When the lift is in use all the controlling buttons are dead, so interference with the passenger using the lift is impossible. No door can be unlocked or opened when the cage is not standing opposite that particular door. The action of locking a door simultaneously restores the electric circuit.

We are informed that Messrs. Archibald Smith & Stevens have recently erected eight lifts worked on this principle at the new offices of the "Morning Post," Strand, London.

Electrical Legislation in India.—"Indian Engineering" states that the Government of India are considering a revision of the Indian Electricity Act, and as this will entail the revision of the rules under the existing Electricity Act, a draft of the rules has been prepared by the electrical adviser to the Government of India (Mr. J. W. Meares) for consideration by a technical advisory committee which has been appointed to examine the revised rules and to report.

This committee consists of: Messsrs. H. W. C. Carnduff (president), M. G. Simpson (electrician, Government Telegraph Dept.), W. B. MacCabe (chief engineer, Calcutta Corporation), W. H. Moore (superintendent of machinery, Calcutta Port Trust), G. M. Clark (Calcutta Electric Supply Corpn.), C. C. T. Eastgate (electrical engineer, Messrs. O. Steel & Co.) and R. Mr. J. Browne (also secretary). The local Governments and Administrations have also been asked to nominate a local expert to whom the draft of the revised rules could be sent for examination and suggestions, and to also advise the committee with reference to local conditions.

Embezzlement.—At the Birmingham Quarter Sessions on Wednesday, Cecil Frank Guy, 28, secretary, pleaded guilty to embezzling sums of £12, £4. 8s. and £1. 5s., received by him for and on behalf of his employers, the British Prometheus Co. A sentence of 12 months' hard labour was passed.

Hampstead (London).—The Council have decided to fix Berry series gear in all their sub-stations, and also to purchase a number of new transformers at an estimated cost of £688.

An arrangement has been made with Isler & Co. to endeavour to obtain an increased supply of water from the artesian well at the electricity works.

Heywood (Lancs.).—The Council have applied for sanction to loans of £16,008 for electricity supply and £4,015 for tramways.

Hove.—On Thursday last week Mr. Sims Williams completed taking evidence into the Council's application for a reduction in the price of electricity supplied by the Hove Electric Lighting Co.

Col. Crompton (whose evidence in chief we gave last week) supplemented his figures to show that on a 7 per cent. dividend basis the cost of electricity, including provision of a redemption fund, &c., worked out at 5·65d. per unit, while on a 10 per cent. basis it would be 6·41d. In cross examination he said that, owing to the introduction of new lamps, he did not at present see much chance of keeping the dividends up, unless there were some new method of charging. The new lamp was such a serious question that it might spell ruin to some companies, but he did not think it would to the Hove Company. The basements in Hove were so well lighted that there was little need for the use of electric light during the daytime. That affected the load factor, and was a reason why Hove should charge a higher price than other towns. In a great many houses 50 per cent. of the electric light bill was for lamps used in the hall, staircase, basement and dark places—what were termed "long hour" lamps.

Mr. C. B. Smith, the company's resident engineer since it started in 1892, put in a schedule dealing with the company's business and a table of comparison with other South Coast towns. By far the largest item in the works cost was coal, and the price the company were now paying was an increase of 3s. 5d. a ton on the average, and comparing 1907 with 1906 represented an increase of £500 in the cost of fuel. The company's present flat rate charge was 5½d., and about 80 per cent. of the consumers paid that. The company had voluntarily made reductions in price for lighting and power since 1892, when they had a flat rate of 8d. with rebates. He did not think there was an available market for used plant except at break up prices; and, as an instance, he mentioned that in May, 1907, he was offered for £1,625 dynamos at Brighton which cost £3,300 and had only been in use four years. Two other sets which had cost £2,200 each, and had been in use six years, were also offered him by Brighton for £850 and £800 respectively. He did not buy. Last quarter there was a decrease in the company's output of 1,977 units compared with the corresponding quarter of last year, owing to the economy of the new lamps. He gave instances where there was a falling off in consumption of 50 per cent. When the Corporation made their request for a reduction of 1d. per unit he prepared a table demonstrating that had the company made the reduction they would in 1906 have only had a balance of £3,505, out of which they would have had to provide on capital, reserve, and renewals and contingencies. In the course of the next few years witness considered that a large sum would be required for renewals as distinguished from maintenance repairs.

The Inspector then adjourned the inquiry to a date to be fixed for the hearing of speeches by counsel.

International Exhibitions.—In accordance with the recommendations of the Departmental Committee on International Exhibitions the Board of Trade propose to form a new branch of their Commercial Department, to deal with matters relating to the participation of this country in future international exhibitions and to superintend the organisation of British exhibits, &c. The President of the Board has appointed Mr. U. F. Wintour, at present secretary of of the advisory Committee on Commercial Intelligence, to be officer in charge of the exhibitions branch.

Kendal.—Application has been made for sanction to a loan of £10,000 for the erection of new electricity works and a refuse destructor.

Leyton.—Meter rents are to be reduced from 1s. 6d. to 1s. per quarter. The Council do not consider the demand is sufficient to justify the expense which would be incurred in organising and maintaining a motor-hiring department, more especially as motor manufacturers are now prepared to supply motors on hire purchase terms.

Light Railways.—York Corporation Light Railways Order has been submitted to the Board of Trade for confirmation. Objections by July 16.

Llandudno.—On Monday the Council were summoned for allowing black smoke to be emitted from the electricity works chimney, the complainant being a councillor, Mr. Bone. An order to abate the nuisance was made. It was explained that the boilers had been overworked to provide current for the electric tramways, but that more plant is to be provided.

London County Council.—On Tuesday it was agreed to lend £3,462 to Islington and £22,180 to Poplar for electric lighting.

Tramways in Wandsworth.—The Highways committee brought up their adjourned report recommending the expenditure of £32,110 on the electrification of the Nine Elms-lane to East Hill, Wandsworth, tramways—Agreed.

A report of the Highways committee on the reconstruction of the tramways from Euston-road, via Camden-road to Holloway-road, the capital estimate being £118,560, was adjourned.

Provisional Order Revocation.—The Board of Trade have revoked the Margam Electric Lighting Order, 1898.

South Africa.—The "British and South African Export Gazette" states that in spite of the opinion expressed by Mr. W. A. Harper (consulting engineer to W. Beardmore & Co.) that the gas plant for driving the Johannesburg electric generating plant could be put into efficient working order the Corporation adhere to their decision to go to arbitration. A subsequent protest lodged by Mr. Harper has, however, been referred to a special committee for consideration.

Mr. J. F. I. Thomas, general manager of Johannesburg Corporation electricity supply, tramway and gas undertakings, has resigned.

East London Corporation have decided to erect and equip a new power station at a cost of £35,000 and tenders for the plant (estimated to cost £20,185) are to be invited immediately.

Additions to the plant at Krugersdorp electricity works are contemplated.

Southwark (London).—The Council are spending £250 in excess of the £1,000 originally allocated for free wiring of consumers' premises.

Stretford.—The Council have asked the Board of Trade to sanction a loan of £11,350, estimated cost of carrying out a part of the West Manchester Light Railways (New Lines, &c.) Order, 1906.

Tunbridge Wells.—At the Council meeting last week the Lighting committee reported that the charge for public arc lamps (including incandescents attached to the arc lamp posts) was to be reduced from £21 to £18 per annum, and that it was proposed to light 414 of the remaining 828 public lamps electrically at a charge of £3. 3s. per annum.

The gas company was asked if it was prepared to light the remaining 414 lamps at the same charge, but replied that the proposed reduction in the number of gas lamps and the upkeep of a smaller number of lamps in outlying and isolated positions would necessitate a charge of £3. 13s. 6d. per lamp, but it would light the existing gas lamps on a year's contract at £2. 17s. 6d. each, or on a contract for three or more years at £2. 15s.

The committee recommended that the company's offer to light a minimum of 414 lamps at £3. 13s. 6d. each for 12 months from Dec. 24 next be accepted.

Councillor Hicks said the action of the committee towards the company had been unfair. If there were an electric main in a road where light was required they had given the preference to electricity even at 10s. per lamp above the gas company's charge. At 3 guineas a lamp, and a reduction of £3 for arc lamps they were going to supply at a loss. He proposed that the gas company's offer at £2. 17s. 6d. per lamp on a one year's contract be accepted.

Councillor Brown said it was stated by the engineer (Mr. Horace L. P. Boot) that the public lighting was supplied at a profit.

Councillor Tyson said the load factor showed that the committee could supply the street lighting considerably under 3 guineas per lamp. By means of the sinking fund they gradually became the owners of their own lamp posts, but in the case of the gas lighting they would still belong to the company.

Ald. ROBB said if had not been for the agitation of the Lighting committee they would never have got the gas company down below their original price of £3. 19s.

The MAYOR said it was not right to argue that the electricity undertaking and the gas company were on the same footing. The time would come when they would still further lower the charges for electric light.

Twelve members voted for the amendment and 14 against, and the committee's recommendation was then adopted.

Willesden. The Board of Trade has consented to the Council altering the system of supply from direct current to alternating current in part of the area.

Woolwich.—The Council will apply to the L.C.C. for sanction to a loan of £2,610 for extensions of mains, &c.

Workhouse Lighting —Edmonton Guardians have decided, on the recommendation of Messrs. May & Hawes, to enter into a five years' contract with the North Metropolitan Electric Power Supply Co. for supply of electrical energy for the new infirmary and nurses' home, as well as for the existing buildings, at 2½d. per unit.

Sports, Outings, &c.—Croydon Corporation Tramways Athletic Club held their annual sports at Brighton on Wednesday. In addition to numerous club events, there were seven open races and an open tug of war, while a special feature was a cycle parade with riders in costume. The Thornton Heath Town Band was also an attraction. Part of the receipts go to Croydon General Hospital.

The employés of Newport (Mon.) electricity and tramways department had their annual outing on Saturday last, when a large party travelled to Blackpool. In the absence of the borough electrical engineer (Mr. H. Collings Bishop), Mr. W. L. Thain (station superintendent) took the chair at the dinner. The outing secretary (Mr. G. H. Woodhall) is to be congratulated on the success of the event.

ELECTRICITY SUPPLY AND TRAMWAY ACCOUNTS.

Brighton.—Last week the Council adopted the accounts of the electricity department, which were abstracted in our issue for June 26.

The Chairman of the Lighting committee (Ald. Carden) congratulated the Council on the improved condition of the undertaking. The loss during the year was £3,600, against £10,000 in 1906-7, and this was largely caused by exceptional circumstances—about £1,390 in law costs and £300 in connection with Shoreham Harbour. The remainder of the loss was caused entirely by an unfavourable coal contract. They had this year a more favourable contract which would benefit them by £2,000, and they hoped to make both ends meet, and next year to make a profit. The electricity undertaking had never come on the rates yet, and he did not think it ever would. They had materially reduced the Southwick works cost—from just under 1½d. to 1¼d., and hoped to reduce it still further.

Colchester.—For the year ended March 31, the total income of the electricity department was £14,405. 14s. 8d.

Total costs were £9,467. 9s. 8d. (1·64d. per unit, against 1·54d.). Works costs were £8,151 (1·41d.), against £6,593 (1·3d.). Interest absorbed £2,109. 8s. 4d. and repayment of loans £2,850. 13s. 7d., leaving a deficit of £21. 16s. 11d., against a profit of £1,224. The total capital expenditure is £76,923, against £71,277 in 1906-7. The maximum load was 886 kw., against 852 kw., and the load factor 17·75 per cent., against 16·33 per cent. The equivalent of 47,370 8 c.p. lamps is connected (against 42,376), and 1,381,842 units were sold, against 1,218,637.

Hove.—The past year's accounts of Hove Corporation's Aldrington electricity undertaking (which obtains its current in bulk from Brighton Corporation) shows that the capital expenditure is £8,698, increase £273.

Income was £488. Expenditure was £493. Interest required £285 and sinking fund £214, so that the deficit was £503.

Longton.—For the year ended March 31 the total revenue of the electricity department was £2,585.

Expenses were £1,089, leaving gross profit £1,496. After paying interest £849 and sinking fund £627 there was a net profit of £20 on the year's working. 201,584 units were generated, an increase of 44,283, and the total units sold were 188,573, against 126,242. The average price per unit for motive power was 1·64d., and for lighting 4·21d.

Oldham.—The total revenue of the electricity department for the year ended March was £40,015. 11s. 5d. and the expenses £20,425. 12s. 8d., leaving £19,589. 18s. 9d.

Interest and sinking funds absorbed £17,866. 4s. 1d , leaving a net profit of £1,723. 14s. 8d. Capital expenditure during the year was £3,352. 5s. 7d., making the total £284,431. 14s. 3d. The units sold (exclusive of traction) were 1.382,648, an increase of 22·58 per cent., and receipts were £15,120. 16s. 9d., increase £1,218. 14s. 10d. The units sold for traction were 3,888,404 and the revenue £24,302. 10s. 3d., increase £2,721. 0s. 8d. The equivalent of 117,182 8 c.p. lamps is connected, increase 23,524, and there are 932 consumers, increase 74.

Rathmines.—For the year ended March 31 the income of the electricity department was £11,039. 8s. 6d.

Total expenses were £5,295. 2s. 5d., leaving £5,744. 6s. 1d. to meet interest (£3,445. 4s. 1d.) and sinking fund (£2,356. 15s 7d.), or a small deficit of £58 on the year. 683,467 units were sold (339,806 to private consumers and 343,661 for public lighting) The total maximum supply demanded was 377 kw.

St. Pancras (London).—At the meeting of the Council on Wednesday, the Electricity committee reported that

The gross income for the year ended March 31 was £77,602, increase £3,430. After meeting working expenses, interest and repayment of loans, the net profit was £9,454, against £6,495 in 1906-7, but in the latter period law costs came to £3,585. The credit balance of £10,332 is to be carried forward as a working balance. The net balance in the reserve fund was £29,541. Total capital expenditure is £525,149.

South Shields.—The annual report of the borough electrical engineer (Mr. J. H. Cawthra) states that the past year's revenue was £25,607. 19s. 5d , increase £2,907. 14s. 7d. on 1906 7.

Expenditure amounted to £13,537. 14s. 10d., increase £4,139. 18s. 6d., leaving gross profit £12,070. 4s. 7d., decrease £1,232. 3s. 11d. After paying interest and sinking fund charges the net profit was £1,358. 15s. 5d. The decrease was £1,785. 8s. 1d. The number of units sold was 2,954,990, increase 663,378. Total operating costs were 1·04d. per unit, an increase of 0·13d. Mr. Cawthra recommends that the whole of the available balance, after deducting one small item, should be placed to reserve, bringing this to £8,782. 6s. 8d., equivalent to 5·5 per cent. of the capital. The Electrical Committee have endorsed Mr. Cawthra's views and recommend the Council to place the whole of the net balance to reserve.

Sunderland—The annual report of the borough electrical engineer (Mr. Alfred S. Blackman) states that the works costs for the past year were £21,066 1s., and the standing costs £14,158. 16s. 8d., total £35,224. 17s. 8d. Revenue was £58,202. 13s. 11d., leaving gross profit £22,977. 16s. 3d. Sinking fund required £12,749., interest £11,831, and after providing £306 for special purposes, there was a deficit of £1,908. 4s. 6d., but in this sum is included £1,144. 2s. 2d. for special expenditure.

The report and accounts were presented to the Council on Wednesday, and, in the absence of the chairman, consideration of the matter was deferred for a month.

Swansea.—The total revenue of the electricity department for the year ended March was £20,824.

Total costs were £10,578 and gross profit £10,246, or 7 per cent. on capital (£144,316). After paying interest £5,371 and sinking fund £3,580, there was a net profit on the year's working of £1,231 (against £741). The maximum load was 1,007 kw. for ordinary supply and 300 kw. for traction. The load factor was 18·8 per cent. There are 1,127 consumers, representing a total of 102,930 8 c.p. connected (against 86,274 in 1907). 2,161,799 (1,909,856) units were sold, including 843,371 for private lighting, 610,592 for power and heating, 215,091 for public lighting and 492,745 for traction. The average price obtained was 2·24d. (against 2·27d.) per unit. Works costs were 0·88d. (0·86d.) per unit sold and total costs 1·17d. (1·17d.).

Warrington.—The income of the electricity department for the year ended March 31 was £17,234. 7s. 8d.

Working expenses were £9,701, leaving gross profit £7,533. Interest absorbed £2,730 and sinking fund £2,802, so that the net profit was £2,214. There are 338 consumers, and the equivalent of 77,878 8 c.p. lamps (excluding tramways) is connected, against 64,711 8 c.p.; the number of units sold was 2,064,995, against 1,839,912; the maximum load was 1,301 kw., against 1,239 kw. Capital expended is £92,085, compared with £86,522. Works costs were 0·607d. per unit, against 0·540d., and the total costs 0·809d., against 0·749d.

In his report the borough electrical engineer (Mr. F. L. Mathias) expresses regret that the Electricity committee have abandoned their policy of completely making up the reserve before contributing to the rates. £2,000 has been contributed to the rates from this year's profits, and this, added to £770, the amount of assessment for local rates, makes a total of £2,770, which is the equivalent of approximately a 3d. rate, a large sum for a comparatively new undertaking.

Willesden.—For the year ended March 31 the gross profit on the electricity undertaking was £8,198, and after paying interest and sinking fund the net profit was £725. Taking into account the deficiency on previous years the net profit to date is £182.

Worcester.—On Tuesday the accounts of the electricity department (briefly abstracted in our last issue) were adopted by the Council.

The chairman of the Electricity committee said there was only a deficit of £439 on the undertaking since the start. The capital expenditure now stood at less than £100,000, and he had no doubt they could easily obtain £120,000 for the undertaking.

The Council have referred back a recommendation of the committee to allow the use of the electric lamp pillars for supporting electrically lighted signs on such terms as the committee might approve. The committee are to bring up a report showing what advertisements it was proposed to allow and the price to be charged.

IMPORTANT NOTICE.

Extra Copies of "The Electrician" Special Mining Issue (July 10th, 1908), will be obtainable, after day of issue, price 1/- nett (post free U K., 1/1; abroad 1/6). After July 17th the price, post free in the U.K., will be 1/4.

TRADE NOTES AND NOTICES.

READY.

"THE ELECTRICIAN" ELECTRICAL TRADES' DIRECTORY AND HANDBOOK.—The 1908 Edition of the Big Blue Book, price 15s., or post free in the United Kingdom, 15s. 9d. The new and enlarged volume brings a great mass of statistical and technical data quite up to date, and the Directorial Division has been thoroughly revised and amplified.

All branches of Electrical Engineering and Industry are fully treated, and Electro-Financial matters have received every attention in the new volume, which aggregates more than 2,000 pages. The Directory Division is complete and thoroughly accurate, and has been completely revised. All mere lists of members of Societies and Institutions (so easily and cheaply available) are excluded, as quite unreliable for Manufacturers' and Dealers' purposes. The full set of valuable Statistical and Engineering Tables, &c., have been very carefully revised and extended, and remodelled into handy book form; these are included in the 1908 Blue Book, making it the most complete book of the kind ever published

TENDERS INVITED.

The Governors of Canterbury College, *Christchurch* (N Z.) invite tenders for supply of (*a*) a 20 H.P. experimental Pelton wheel, with direct-driven dynamo, (*b*) an 8½ H.P. experimental low-fall turbine, and (*c*) a Venturi water meter. Specifications from the High Commissioner for New Zealand, 13, Victoria-street, Westminster, S.W. Offers to the Board of Governors, Canterbury College, Christchurch (N.Z.), by noon Sept. 24. See also an advertisement.

London County Council want tenders by 11 a.m., July 21, for road work and platelaying for reconstruction or construction for for electric traction of (1) existing tramways from Euston to Holloway, (2) and from Loughborough Junction to Norwood, (3) new tramway from Hammersmith Broadway to Putney. Specifications, &c., from the Chief Engineer.

London County Council also require tenders by 11 a.m., July 21, for supply of six electrically propelled stores transport vehicles. Forms of tender, &c., from the County Hall.

St. Pancras (London) Council invite tenders for additions to their low-tension switchboard at King's-road generating station. Tenders to the town clerk (Mr. C. H. F. Barrett), Town Hall, Pancras-road, N.W., by noon Monday, July 13.

Dublin Lighting committee invite tenders for supply and erection of sub-station switchboards, transformers and accessories Tenders to the Chairman of the Lighting committee, 3, Cork-hill, Dublin, by noon July 13.

The Lighting committee of *Dublin* Corporation are also prepared to receive tenders for supply and erection of boiler plant, &c., at Pigeon House generating station. Tenders to the Chairman of the Lighting committee, by noon July 18.

Felixstowe and Walton Council want tenders by noon June 15 for overhead lines and services. Specifications from Mr. R. P. Wilson, 66, Victoria-street, London, S.W.

Manchester Tramways committee want tenders by 10 a.m. July 14 for supply of granite setts. Specifications from Mr. J. M. M'Elroy, Piccadilly, Manchester.

Birmingham Tramways committee invite tenders for the erection of a tramway depot. Tenders to the Chairman by noon of July 20.

Fulham (London) Council want tenders by noon July 15 for supply of coal to the electricity works. Particulars from Mr. A. J. Fuller.

Tenders are invited by *Melbourne* City Council for supply of 600 arc lamp globes. Copies of specification, conditions of contract, and form of tender on application to the agents for the city council, Messrs. McIlwraith, McEacharn & Co., Proprietary, Ltd., Billiter-square buildings, London, E.C., to whom tenders by noon Monday July 20.

TENDERS RECEIVED AND ACCEPTED.

Belliss & Morcom are supplying to the Electric Lighting & Traction Co. of Australia two 750 kw. Brush c c. generators coupled to 2,100 H.P. Belliss engines, surface-condenser plant and motor-driven air and circulating pumps.

St. Pancras Electricity and Public Lighting committee has provisionally accepted the tender of John Spencer Limited for pipework at £235. E. Le Bas & Co.'s tender was £297. 10s. and John Fraser & Son's £486.

Westminster Baths committee have accepted the tender of Balshaw & Co. (at £16. 18s.) for additional switches for the Buckingham-road baths.

Battersea (London) Lighting committee have placed an order with Babcock & Wilcox for rearranging the boiler house steam range at the electricity works at £220.

Canterbury Council have accepted the tender of E. J. Philpot & Son at £40 for electrical work for six months and for illuminations at the public buildings during the cricket week.

The D.P. Battery Co. have secured the contract for doubling the storage battery installation of the Suffolk Electricity Co. at Woodbridge.

The contract for constructing the Portsmouth and Hayling Island light electric railway has been placed with Wm. Kennedy (Ltd.), of Partick.

In connection with the Moscow electric tramway scheme it is stated that contracts have been secured by Dick, Kerr & Co. and the British Insulated & Helsby Cables to the value of £83,000.

Felixstowe Council have placed an order with the D.P. Battery Co. for a storage battery of 110 cells.

Willesden Electricity committee have accepted the tender of the British Westinghouse Co. for converting plant.

York Council have accepted the tender of Callender's Cable & Construction Co. for cable at £335.

Foleshill Council have accepted the tender of the Electrical Trades Supply for wiring the local isolation hospital at £243.

Croydon Corporation have accepted the tender of Babcock & Wilcox for supply of materials for alterations to feed mains.

Hornsey Education committee have decided to accept the tender of F. Cottrell for wiring the North Harringay schools at £179. 2s. 10d.

Salford Council have accepted the tender of W. T. Henley's Co. for single rubber-covered cable for a year.

Sussex Electricity Co. have accepted the tender of the D.P. Battery Co. for the supply and erection of a storage battery at Crawley.

Leyton Council have accepted the tender of Venner & Co. for 12 months' supply of electricity meters.

Burnley Council have accepted the tender of Riley Limited for a cooling tower at £123. 10s.

Malton Council have accepted the tender of the Northern Counties Electricity Supply Co. for public lighting at £400 per annum.

St. Austell Council have accepted the tender of the local electric light company for public lighting.

Buxton Council have accepted the tender of Drake & Gorham for a switchboard for the destructor works at £39.

For wiring the extensions to Carlisle infirmary the tender of J. B. Meiklejohn has been accepted.

The British Westinghouse Co. have received an order from Messrs. Tweedales & Smalley, Castleton, Lancs., for one of their latest type tandem vertical gas engines, to be direct coupled to a direct current generator of a combined capacity of 500 kw. when running at 110 volts, with switchboard complete, forming an extension to the 235 kw. gas engine sets, recently put into operation.

The Postmaster-General's Department, Perth, Western Australia, have accepted the tenders of J. M. Ferguson for 500 fuses and Unbehaun & Johnstone for six non-polar relays (£1. 8s. 9d. each).

The Postmaster-General's Department, Melbourne, have accepted the tender of the Western Electric Co. for 20 miles of telephone cable at £490 per mile and 150,000 paper sleeves at 2s. 6d per 1,000.

Johannesburg Corporation have placed orders with the A E.G. Electrical Co. for 200 electric street lamps; with the Universal Electrical Mfg. Co. for 1,200 pairs of "S.P." cutouts, 1,200 sealing chambers and 600 connectors, and with the General Electric Co. for 500 Osram lamps.

The Postmaster-General's Department, Brisbane, Queensland, have accepted the tenders of the British Insulated & Helsby Cables for various quantities of lead-covered cable amounting in all to £985, the Western Electric Co. for 8,492 yds. of cable at £465, W. T. Henley's Co. for 5,280 yds. of cable at £176 per mile, and C. E. Bernays for 220 yds at £74 per mile.

Electric Transporters. Kramos Limited, of Bath, have secured a repeat order from Messrs. S. Pearson & Son, Hull, for the supply of two more of their cab-controlled mono-rail electric transporters

for handling cement for harbour construction. The transporters will travel on a single I girder along the sea front at a speed of 60 ft. per minute, and will lift 3 ton loads at 30 ft per minute and lighter loads of 10 cwt. at 100 ft. per minute. All the motions are controlled by an operator who travels in a cab provided on the transporter.

BUSINESS NOTICES

The Ebonestos Mfg. Co. notify that, owing to increased demand for their moulded Ebonestos insulators, they have moved their works and offices to 127, Pomeroy-street, Old Kent-road, London, S.E., where they have doubled accommodation, enabling them to instal a new set of high-pressure hydraulic presses and to make other improvements which will help to give greater efficiency to their material. Telegraphic address remains "Ebonestos London" and the telephone number is "887 Deptford."

Messrs. G. M. Boddy & Co. state that, for the better delivery of their "Metalik" lamp and for the convenience of customers in London and the South of England, they have opened a branch in London at 15, Gray's Inn-road, W.C. The London manager is Mr. E. Slade Templeton, M.A., A.M.I.C.E. (Telephone 4814 Holborn.)

The Electrical Contractors' Association have taken larger offices at their present address, 20, Bucklersbury, E.C. In future the offices will be at No. 582 (fourth floor). Telegraphic address and telephone number remain the same.

Sale by Auction.—Messrs. Horne & Co., 8, Delahay-street, Storey's-gate, Westminster, S.W., will sell by public auction at the Royal Arsenal, Woolwich, on Tuesday, July 21, at 11 a.m., unserviceable and obsolete stores, including quantities of iron, steel, brass, copper, gunmetal, mixed metals, lead, zinc, aluminium, phosphor bronze, &c., electric cable, telegraph instruments, lamps (electric ship signalling, &c.), machinery, lathes, cut-outs and contact keys, &c. May be viewed at the Royal Arsenal, Woolwich, on the Friday and Monday previous to and on morning of sale. Catalogues at the War Office, Whitehall; Ordnance Office, Tower; and Ordnance Office, Royal Arsenal, Woolwich. Further particulars are given in an advertisement.

For Sale by Private Treaty.—Messrs. Wheatley Kirk, Price & Co have for sale by private treaty valuable freehold works at Dagenham, Essex, formerly in the occupation of the Morris Aiming Tube & Ammunition Co. (Ltd.), and distant about ½ mile from Dagenham station of the L.T. & S. Railway, about 11 miles from the city of London, and with ample space for extensions. Particulars of the equipment of the works include up-to-date electric lighting and power plant, telephone installation throughout, heating apparatus, and, in fact, everything necessary to enable the purchaser to start work immediately on acquisition. Plans and particulars can be obtained from Messrs. Wheatley Kirk, Price & Co., 46, Watling-street, London, E.C.; Albert-square, Manchester; and 26, Collingwood-street, Newcastle-on-Tyne.

Factory Sites for Sale.—Messrs. W. Brown & Co. will sell by auction at the George Hotel, Aylesbury, on July 29, 3½ acres of well placed land adjoining the siding yard of the joint railway station of the Great Central, Metropolitan and Great Western Railways at Aylesbury, Bucks (40 miles north-west of London), with a good family residence and a frontage to two streets; also four lots of building land close to the joint station, suitable for works or business premises. The land is freehold and there are no restrictions as to user. Plans and particulars from the auctioneers, Tring, Herts. (Tel. 11) and Aylesbury, Bucks (Tel. 36). See also an advertisement.

Patent Development.—The owners of patent No. 15,801 of 1901, relating to holders for electric incandescent lamps, are desirous of arranging either for the granting of licences to work upon royalty or to dispose of their rights. Particulars from Messrs. Allison Bros., 52, Chancery-lane, London, W.C.

The proprietors of Furmidge's English patent No. 25,723 of 1901 for "Improvements in Automobile Springs" are desirous of selling the patent, or of granting licences to British manufacturers. Full information from Messrs. W. P. Thompson & Co., chartered patent agents, 6, Lord-street, Liverpool. See an advertisement.

Partner Wanted.—A partner is wanted in a small electrical manufacturing business, to bring in at least £2,000 for developing several patents. See an advertisement.

CATALOGUES, &c.

"*Installation News.*"—The June issue of the "Installation News" contains some useful information on the subject of lighting a small house, while a general article "Conduit Wiring Practice" is continued.

Arc Works, Chelmsford.—Messrs. Crompton & Co. send us a booklet which contains numerous illustrations of their shops at Chelmsford, and also of typical examples of their principal products in the shop of dynamo electric machinery, switchgear, projectors, tramway plant, &c.

Show Card.—Makers of lamps are naturally wedded to show cards. Dealers, contractors and others find these the most suitable method of directing attention to the latest types of lamps, because they can be conveniently placed in windows or hung up in showrooms. Siemens Bros. Dynamo Works are issuing an attractive show card, a reproduction of which we give herewith. The large

letters stand out boldly in white on a sepia shaded ground and the panelled lettering is in green on a white ground with white border. Electrical contractors should apply early for this card to avoid disappointment.

Stirling Boilers.—The Stirling Boiler Co., 25, Victoria-street, London, S.W., send us a tiny brochure, which generally directs attention to the good points of the Stirling boiler as a steam raising unit. The book is stamped out to represent an outline of the boiler itself.

Sun Fans.—The Sun Electrical Co., Charing Cross-road, London, W.C., have issued a new fan list which includes a number of new types. We refer interested readers to the company for a copy of this publication and also to the last issue of our INDUSTRIAL SUPPLEMENT in which we give some details.

Alexander Wright's Specialities.—Two publications reach us from Alexander Wright & Co., Westminster Palace-gardens, London, S.W., one dealing with the Simmance-Abady CO_2 recorder and the other with a line of patent tape pressure recorders which are suitable for use in boiler houses, engine rooms, &c. We understand that copies of these publications will be forwarded to interested engineers.

Transformers.—The British Electric Transformer Co. are issuing a four-paged pamphlet on the Berry patent auto-transformers for use with metallic filament lamps. Approximately 500,000 H.P. of Berry transformers have been supplied during the past 10 years in sizes up to 1,500 H.P. and for voltages up to 40,000.

Telephones.—The International Electric Co., 55, Redcross-street, E.C., are issuing a comprehensive catalogue of telephone and bell material, which should be in the hands of every electrical contractor and wiring electrician. It deals fully with domestic telephones and bells and a number of special instruments for long distance working.

Imports.—The following are official values of electrical machinery, material, and apparatus imported into this country (*a*) during June, 1908, and (*b*) during the current year from Jan. 1 to June 30, with the increases or decreases compared with the corresponding periods of 1907:—

Electrical machinery (*a*) £42,189 (decrease £6,193); (*b*) £327,009 (increase £33,551); telegraph and telephone cables (*a*) £7,048 (decrease £1,104), (*b*) £64,511 (decrease £85,563); telegraph and telephone apparatus (*a*) £11,176 (decrease £12,648), (*b*) £99,627 (decrease £30,647); other electrical wires and cables, rubber insulated (*a*) £5,799 (increase £2,206), (*b*) £39,251 (decrease £5,754); with other insulations (*a*) £5,438 (decrease £712), (*b*) £57,033 (increase £16,138). The following were not separately enumerated last year: Carbons (*a*) £12,788, (*b*) £85,771; glow lamps (*a*) £21,787, (*b*) £124,222; arc lamps and electric searchlights (*a*) £280, (*b*) £1,843; parts of arc lamps and searchlights (other than carbons) (*a*) £3,559, (*b*) £25,914; primary and secondary batteries (*a*) £3,337, (*b*) £24,648. Total of electrical goods and apparatus, other than machinery and telegraph and telephone wire (*a*) £80,476 (decrease £4,804), (*b*) £582,676 (decrease £49,556).

Exports.—The exports of electrical machinery, material, &c. (*a*) during June, 1908, and (*b*) during the current year from Jan. 1 to June 30, and the increases or decreases compared with the corresponding periods of 1907, are as follows:—

Electrical machinery (*a*) £85,549 (increase £13,692), (*b*) £641,942 (increase £189,009); telegraph and telephone cables (*a*) £13,068 (decrease £251,769), (*b*) £237,259 (decrease £316,911); telegraph and telephone apparatus (*a*) £11,796 (decrease £16,050), (*b*) £79,992 (decrease £6,015); other electrical wires and cables, rubber insulated (*a*) £18,147 (decrease £1,577), (*b*) £137,630 (increase £4,460); with other insulations (*a*) £21,585 (increase £2,544), (*b*) £134,531 (increase £20,878). The

following were not separately enumerated last year: Carbons (a) £678, (b) £3,853; glow lamps (a) £5,308, (b) £24,781; arc lamps and searchlights (a) £985 (b) £10,653; parts of arc lamps and searchlights (other than carbons) (a) £1,926, (b) £8,201; primary and secondary batteries (a) £9,521, (b) £31,909. Total of electrical goods and apparatus, other than machinery and telegraph and telephone wire (a) £108,163 (decrease £256,824), (b) £841,985 (decrease £290,981).

BANKRUPTCIES, LIQUIDATIONS, &c.

Claims against the Allan Electrical Synd. (Ltd.) (in liquidation) are to be sent by Aug. 4 to Mr. H. G. Ash, 3, London Wall-buildings, London, E.C.

Reed's Electrical Co. (Ltd.) is being wound up voluntarily. Mr. D. S. Fripp, 90, Cannon-street, London, E.C., is liquidator.

The Chipping Norton Electric Light & Power Co. (Ltd.) is being wound up voluntarily. Mr. A. Harlow, 8, Maitland Park-road, London, N.W., is liquidator.

The Buenos Ayres & Belgrano Electric Tramways Co. (Ltd.) is being wound up voluntarily. Mr. J. B. Concanon, 28, Austin-friars, E.C., and Mr. H. S. M. Woodrow, 52, Moorgate-street, E.C., London, are liquidators.

PATENT RECORD.

APPLICATIONS FOR PATENTS.

NOTE.—*The undermentioned Applications (except those marked †) are not open to public inspection until after acceptance of Complete Specifications. Those marked † are open for inspection 12 months after the date attached to them, if they have not been published previously in the ordinary course. Names within parentheses are those of communicators of inventions. When Complete Specification accompanies application, an asterisk is affixed.*

February 25, 1908.

4,181 LASSEN. Electric motor-car with single steering-wheel. (Date applied for, 2/3/07.)*†
4,188 LAKEMAN. Coupling for wires or cables.
4,191 FLINT. Mechanical tilting sand-gear for electrical tramcars.
4,193 LYON. Controllers for electric motors.
4,212 BAGGETT. Arc lamps.
4,219 YOUNG. Antiseptic attachment for mouthpieces of telephones.
4,246 BRADBURN. Telephone apparatus.*
4,257 BOSCH. Electrical ignition devices for internal combustion engines. (Application for addition to No. 4137/08. Date applied for, 6/11/07.)*†
4,267 LEHMANN. Motors.
4,274 O'KEENAN. Apparatus for compensating friction of brushes or other parts in motor meters or other apparatus. (Date applied for, 1/3/07.)*†
4,286 TARDIEU. Suspension device for microphones. (Date applied for, 16/11/07. Comprised in No. 25,448, 16/11/07.)*

February 26, 1908.

4,292 CUTTRISS. Rectifiers for alternating currents.
4,297 JONES. Resistances.
4,316 SLATER. Trolley heads.
4,318 MACDONALD. Switch.
4,325 DEARLE. Brake mechanism for tramway or like vehicles.
4,348 DAVIS. Conductors for use with installations of electric light. (Application for addition to 12,711/07.)
4,349 MORPHY. Switches.
4,350 MORPHY. Locking incandescent lamps in their holders.
4,357 POSTANS. Magneto sparking plugs for internal combustion engines.
4,361 MORCOM & MORRIS. Transformers, choking coils and like contrivances.
4,364 SVEINBJORNSSON. Generation of electricity on railway trains, boats and the like.*
4,368 SYKES. Electrical operation or control of railway points.*
4,372 FELTEN & GUILLEAUME LAHMEYERWERKE A.G. Regulation pressure of electric machines. (Date applied for, 27/2/07.)*†
4,391 CHILD. Electric photophone for production of photophonographs or use as a telephone transmitter; also means of reproducing sound from photographs thus obtained.

February 27, 1908.

4,394 BOWEN. Revolving table to carry any size printing frame for printing with electric arc.
4,410 GIBBS. Producing metallic articles and combined metallic and non-metallic articles by electro deposition.
4,421 ORLING. Transmission of a series of electric impulses along land lines or cables.
4,429 HANWAY. Thermo-electric light controller.
4,432 MASCHINENFABRIK OERLIKON. Single phase commutator motors. (Application for addition to 28,968/04. Date applied for, 9/3/07.)*†
4,443 SIEMENS-SCHUCKERT WERKE G.M.B.H. Starting and working of three-phase motors from a single phase supply. (Application for addition to 1,243/07. Date applied for, 28/6/07.)*†
4,444 DOWSING. Electrical radiators.*
4,461 MICHAUD & DELASSON. Manufacturing filaments for illuminating and heating purposes. (Date applied for, 10/6/07.)*†
4,464 SIEMENS BROS. & CO. (Siemens & Halske A.-G., Germany.) Manufacture of coils of large section for electromagnetic apparatus.*
4,472 SCHNEIDAU. Electric wall plugs.
4,475 SCHULTZ. Automatic circuit-breakers.
4,477 DIEPPE & KNORR. Switches.
4,479 LINDEMANN & LINDEMANN. Röntgen tubes and the like.

February 28, 1908.

4,509 PIDD. Guides for pulleys of trolley.
4,550 HILL & MANN. Electrically igniting gas burners or lamps.
4,560 DAMASKINOS. Automatic telegraph instruments.
4,568 TAYLOR & BROOM. Arc lamps.*

February 29, 1908.

4,571 FISHER. Automatically protecting human life, and electrical machines in mines and the like.
4,589 AITKEN. Telephone switchboard cords.
4,590 AITKEN. Telephone instruments.
4,597 HOPE. Switches and fuses for starting three-phase electrical motors and the like.
4,602 WEHRSEN. Discs for influence or static induction and condenser machines.*
4,608 SUTER. Holders for electric lamps.
4,617 MACKENZIE. (Ford, U.S.) Electrical igniting apparatus.*
4,621 FRIEDHEIM. Manufacture of heat interchangers by an electrolytic process. (Date applied for, 4/3/07.)*†
4,635 AYLES. Electrically operated horns and trumpets.
4,637 WAGNER. Electrically driven trackless train. (Date applied for, 16/3/07.)*†
4,644 B.T.-H. CO. (G.E. Co., U.S.) Reduction of metallic compounds and furnaces therefor.
4,646 PRINGLE. Brakes for tramways and railways. (Application for addition to 15,943/06.)

March 2, 1908.

4,657 RUZICKA. Electrical resistances.*
4,666 WINN. Electric current leakage indicator.
4,668 HOLMAN. Arc lamps.
4,683 RIDGWAY, RIDGWAY & BRUNT. Terminal connections.
4,689 UPWARD. Electric clock systems.
4,692 SIEMENS SCHUCKERTWERKE G.m.b.H. Brush holders. (Date applied for, 2/3/07.)*†
4,696 CURTIS, MACKLEY & ADAMS MFG. CO. Electric locking and interlocking indicating push-button switch for use with push-button electric lifts.
4,717 RICHARDSON. Electric signalling apparatus for railways.
4,739 GARDE. Grids for electrodes of secondary batteries.
4,744 FRIEDHEIM. Electrolytic deposition of metal on hollow articles. (Application for addition to 7,563/07. Date applied for, 4/3/07.)*†
4,757 GRAHAM. Electric bells.*
4,760 LAKE. (Elektrische Glühlampenfabrik Watt, Scharf, Loti & Latzko, Austria.) Manufacture of a conducting connection for use in incandescent lamps.*
4,762 ALLGEMEINE ELEKTRICITATS GESELLSCHAFT. Electrodes for arc lamps. (Date applied for, 1/3/07.)*†

March 3, 1908.

4,774 IDE. Key switch lamp holder.
4,799 CROMPTON & CO. & CROMPTON. Controllers for electric motors.
4,819 RAWLINGS. Fixings for electric fittings.
4,843 SCHELLER. Apparatus for receiving undamped electric oscillations. (Date applied for, 4/3/07.)*†
4,844 SCHELLER. Apparatus for plotting resonance curves for determining the damping and frequency of electric oscillations. (Date applied for, 4/3/07.)*†
4,852 DOINIKOFF. Alternating current commutator dynamo-electric machines.*
4,857 B.T.-H. CO. & PARK. Track brakes for tramways and railways.
4,867 ONE YEAR ELECTRIC CLOCK CO., GRUNDKE & LAZARUS. Automatic electric winding devices for clocks. (Date applied for, 4/3/07.)*†

March 4, 1908.

4,883 BATTY & BATTY. Liquid magnetic compasses.
4,884 BROWN. Electrical block signalling system for railways. (Application for addition to, 10,687/07.)
4,891 BRIGHT. Electromagnetic slides and shutters for theatre lighting.
4,895 GIBBS. Electro deposition of metals.
4,909 BUTTERWORTH & VEEVERS. Switches for use in flash signalling.
4,922 STEARN & TOPHAM. Electric lamps and their circuits.
4,932 TRUDE. Automatically firing guns on ships by means of electricity.
4,940 D'VARAD & ADRIENNE MEISLINGER MESZLENYI. Process for producing positive storage battery plates.
4,947 NOODT. Producing insulating bodies. (Date applied for, 16/4/07.)*†
4,950 PROTT. Regulating dynamo electric generators and motors.*
4,956 PLANCHON. Incandescent bodies for electric lamps.*
4,957 DAVY. Enclosed arc lamps.
4,962 ATKINSON & GARSIDE. Electric controllers or switches.
4,964 SIEMENS BROS. & CO. & FERREIRA. Electrically controlled railway points and signals.*

March 5, 1908.

4,977 JONES. Arc lamps.
4,987 BARRY & FARRAND. Devices for indicating and recording electric currents.
4,993 RAWCLIFFE. Brakes for railway and tramway vehicles.
4,995 JONES. Resistances.
5,004 HEATHER. Electric winding engines.
5,015 HARRISON. (Electric Railway Improvement Co., U.S.) Bonding rails.*
5,016 HARRISON. (Electric Railway Improvement Co., U.S.) Apparatus for bonding rails.*
5,017 HARRISON. (Electric Railway Improvement Co., U.S.) Electrodes for electric welding, soldering or brazing.*
5,025 MOSER. Covering or protecting underground electric cables.
5,026 TOMLINS & HILL. Disinfecting device for mouthpieces of telephones.
5,029 JOHNSON & PHILLIPS & PATERSON. Arc lamps.
5,040 PLANCHON. Metallic filaments for electric lamps. (Date applied for, 9/11/07.)*†
5,042 BEECH. Printing and sight reading telegraph apparatus.
5,054 NEALE & POWELL. Electric clocks.*

March 6, 1908.

5,064 ROWLANDS. Batteries.
5,078 GREENWOOD. Electric lamps for motor cycles and the like.
5,080 AITKEN. Telephone instruments.*
5,089 SAVART & GRAINDORGE. Electric tremblers. (Date applied for, 31/10/07.)*†
5,097 BRISTOL. Portable accumulators.
5,099 LUNDBERG, LUNDBERG & LUNDBERG. Switches.*
5,137 HARRISON & BRITISH INSULATED & HELSBY CABLES. Telegraph, telephone circuits and the like.

March 7, 1908.

5,158 ALBION MOTOR CAR CO. & MURRAY. Low-tension electric ignition apparatus.*
5,170 PHILLIPS. Electric auto-musical instruments.
5,172 CHADBURN'S (SHIP) TELEGRAPH CO. & GRANT. Ships' "telltale" telegraphic apparatus.
5,176 INGLE. Electric cash check register.
5,191 BELLISS & MORCOM, JUDE & MORCOM. Turbines. (Date applied for. Comprised in application 11,580, 17/5/07.)
5,199 GRAY. Cables.
5,212 JUNGNER. Electrodes.*
5,214 JUNGNER. Depolarising galvanic batteries.*
5,223 JUNGNER. Galvanic apparatus.*
5,225 ALLGEMEINE ELEKTRICITÄTS GES. Electrodes for arc lamps. (Date applied for, 5/7/07).*†

SPECIFICATIONS PUBLISHED.

1906 SPECIFICATIONS.

19,378A BOUNEVIALLE. Electrical signalling apparatus for use on and with railway locomotive engines and the like. (Date applied for, 28/3/07.)
29,647 MERK. Automatic telephone exchange systems. (Rights not granted.)

1907 SPECIFICATIONS.

1,373 PARK & MASON. Electric lighting of vehicles.
2,383 MITCHELL. Electric contact make-and-break devices.
2,587 HOWARD. Arc lamps.
2,588 ALBRECHT. Dynamo-electric transmission gear for motor road vehicles. (Date applied for, 1/2/06.)
4,709 FESSENDEN. Signalling by electromagnetic waves.
4,710 FESSENDEN. Transmission of energy by electromagnetic waves.
4,910 DASSOMVILLE. Electrolytic apparatus for bleaching and scouring vegetable and animal fibres and fabric.
5,133 LEITNER. Compound-wound electric motors.
5,170 PARSONS. Steam turbine.
5,187 CARBONNELLE. Electro-mechanical distance transmission of half-tone illustrations, portraits and other photographs, &c.
5,339 LEITNER. Quick acting "make and break" switches.
5,402 SUCHOSTAWER. Electric traction on the surface contact system.
5,508 LAMME. Alternating current motors of the commutator type. (Date applied for, 2/8/06.)
5,522 HAWLEY (LTD.) & JONES. Electromagnetic separator drum for grain and similar conveyors.
5,538 DE FERRANTI. Turbine blades.
5,564 MERSHON. Concatenated control of alternating current motors.
5,564A MERSHON. Concatenated control of alternating current motors. (Date applied for, 7/3/07.)
5,630 WARD. Switches applicable to internal-combustion engines.
5,652 FYNN. Alternate current motors also capable of use as generators.
5,671 B.T.-H. Co. & HOPPS. Control of electric vehicles.
5,733 GOLBY. (Soc. Alsacienne de Constructions, Mecaniques.) High efficiency alternating current polyphase commutator motor.
5,741 B.T.-H. Co. (G.E. Co., U.S.) Commutating poles for dynamo-electric machines.
5,749 GRIFFITHS & BEDELL. Cable for electric traction on the stud contact system.
5,853 SKINACKER & PLISNIER. Wireless telephony.
5,925 TRIQUET. Primary cell.
6,006 BOWDEN, ROBINSON & JACKS. Prepayment mechanism for meters.
6,064 BRECKNELL, MUNRO, & ROGERS (LTD.) & MUNRO. Bow trolleys or collectors.
6,083 MORRIS & LISTER. Electromagnets.
6,224 HANDCOCK, DYKES & SMITH. Protective fuses for electrical circuits.
6,279 KITSEE. Telegraphy.
6,288 METCALFE. Trembler coils and contact breakers.
6,409 SIR W. G. ARMSTRONG, WHITWORTH & CO. & HONNER. Electric lighting of vehicles.
6,417 TORRENS. Electrical ignition apparatus.
6,649 B.T.-H. Co. (G.E. Co., U.S.) Compensated dynamo-electric machines of the commutator type.
6,847 JOHNSON-LUNDELL ELECTRIC TRACTION CO. (Lundell.) Dynamo-electric machines.
6,854 SCHATTNER & AMBERTON. Electro-magnetic switches.
6,906 KEITH & TUSON. Alternating current series commutator motors.
6,920 FULLER & FULLER. Apparatus for magneto-electric ignition.
6,943 DAVY. Arc lamps.
6,992 NOTARIANNI. Electric railway signalling apparatus.
7,181 B.T.-H. Co. (G.E. Co., U.S.) Electric motor control systems for towing and the like systems.
7,737 R. WAYGOOD & CO. & BONE. Electric lifts or hoists.
7,933 ARCHIBALD. Electric transmission of power from a prime mover for automobiles and other purposes.
8,151 RAWLINGS & SMITH. Adjustably supporting incandescent lamps, and shades or reflectors therefor.
8,764 B.T.-H. Co. (G.E. Co., U.S.) Controlling devices for electric motors.
8,881 PARSONS. Inter-communication telephone systems.
9,010 RITCHIE. Telautographs.
9,029 BORGNET. Electrolytic apparatus and galvanic batteries.
9,652 WATSON. Switches.
9,683 STORER. Voltage regulators.
9,962 B.T.-H. Co. (G.E. Co., U.S.) Electrically-operated signals.
10,091A SUTCLIFFE. Telegraph apparatus. (Date applied for, 1/5/07.)
10,152 SIEMENS & HALSKE A.-G. Conversation counters in telephone exchanges. (Date applied for, 3/5/06.)
10,440 BROWNE. Microphones for telephones.
11,166 HIGHFIELD. Generating high tension direct currents.
11,523 KNEEN & KING. Tramway conduit points.

COMPANIES' MEETINGS AND REPORTS.

CHILI TELEPHONE CO. (LTD.)—The report for the year to March 31 states that the aggregate number of subscribers at all centres at the end of the year was 7,666, compared with 7,115 at the beginning, a gain of 551. Gross revenue in Chili from all sources was $1,469,611, against $1,169,488, increase $300,123. Expenditure in Chili was $744,121, against $648,549, increase $95,572. Net income in Chili from all sources was $725,489, against $520,938, increase $204,551. The average rate of exchange for the year was 11·21d., compared with 14·01d. Converted into sterling at these rates, the figures for 1907-8 were £33,883, against £30,414. The liquid assets and liabilities in Chili on March 31 were valued at 8¾d. (the current rate of exchange), compared with 12¾d. in 1907. The whole of the outstanding 6 per cent. debentures, amounting to £12,000, were redeemed on Sept. 30 last. The balance to credit of revenue account, including £2,727 from previous year, is £33,817, of which £13,440 has been carried to reserve. An interim dividend of 3s. per share (tax free) has been paid, and the directors now recommend a final dividend of 5s. per share (tax free), leaving £2,777 to be carried forward. The total mileage of lines on March 31 was 13,496 miles 275 yds., against 12,678 miles 746 yds. in 1907.

ELECTRICAL POWER STORAGE CO. (LTD.)—The report of the directors for the year ended May 31 last states that the profit for the year, including £786. 11s. 2d. brought forward, is £4,860. 14s. 9d., and the directors recommend payment of a dividend of 5 per cent. on the ordinary shares, absorbing £4,491. 8s., leaving £369. 6s. 9d. to be carried forward. The buildings, plant, tools, &c., have been maintained in thorough repair and condition at a cost of £3,046. 9s. 6d., provided out of revenue. The debentures, amounting to £28,400, which appeared in the last balance-sheet, have been redeemed, and have been replaced to the extent of £10,000 (part of an authorised issue of £30,000), thus reducing the outstanding debentures by £18,400. Owing to the fluctuations in the price of lead and other raw materials, together with the general depression in trade, the volume of business has somewhat decreased as compared with the previous year.

GREENWOOD & BATLEY (LTD.)—The chairman (Mr. A. Greenwood) stated at the meeting last week that the amount of work turned out had considerably increased, and although prices had not been high, and cost of materials and labour had been fully maintained, if not increased, their profits were almost double those of the previous year, and they were enabled to make an increased allowance for depreciation, £5,000 compared with £4,000. During the year they had spent an increased sum in the renewal of their plant, and also upon maintenance. There was undoubtedly a great falling off in the engineering business generally. As to the outlook their engineering and tool departments (including their special tool branches) were slack. The electrical department was showing some falling off, but they were fairly well employed. The textile machinery department was still well employed, but there was a marked falling off in orders. The business outlook was discouraging, but they anticipated a reduction in cost of material.

JAMES KEITH & BLACKMAN (LTD.)—The report for the year to March 31 recommends a dividend of 5½ per cent. on the preference shares for the year, and 5 per cent. (tax free) on the ordinary shares. £1,000 is to be written off patents and goodwill, £1,854 to extinguish expenditure on patterns for new specialities, and to carry forward £3,066.

NEW COMPANIES, MORTGAGES AND CHARGES.

NEW COMPANIES.

BROWN-MACKENZIE SIGNAL CO. (LTD.) (3,335.)—Reg. in Dublin July 3, capital £1,000 in £1 shares, to acquire certain British patents for improvements in electric signalling on railways, and also any patent granted in any other country with respect to same. Private company. First directors, G. H. Brown, W. R. McMurray and H. Brown, jun. Reg. office, 1, Marcus Ward-street, Belfast.

CHIPPING NORTON & DISTRICT ELECTRIC LIGHT & POWER CO. (LTD.) (98,562).—Reg. June 29, capital £10,000 in £5 shares (1,000 preference) to acquire undertaking and assets of Chipping Norton Electric Light & Power Co. (Ltd.) and to carry on the business of an electric light and power company in all its branches. Reg. office, The Power Station, Chipping Norton, Oxon.

A. C. COSSOR (LTD.) (98,652.)—Reg. July 2, capital £3,500 in £1 shares, to take over the business of a scientific and electrical instrument maker, manufacturer of incandescent electric lamps, electrical apparatus, vacuum tubes, mercury pumps, McLeod gauges, X-ray tubes and apparatus and electro-medical apparatus, experimental and electrical glass blower, &c., carried on by A. C. Cossor. Private company with only two subscribers. First directors, A. C. Cossor (chairman), W. R. Bullimore (manager), and Mrs. A. Cossor. Reg. office: 54, Farringdon-road, London, E.C.

ELECTRIC TAXICAB CO. (LTD.) (98,665.)—Reg. July 3, capital £300,000 in £1 shares, to carry on in London and elsewhere the business of proprietors of motor cabs, cars, carriages and vehicles (particularly electric cabs), garage proprietors, electricians, electrical engineers, &c. First directors, Rt. Hon. Lord Westbury, Sir David S. Goldsmid-Stern-Salmomons, Bt., Sir Bache Cunard, Bt., H. Willmott, W. M. Rolph, C. L. Samson and T. G. Chambers. Reg office, Dashwood House, New Broad-street, London, E.C.

ERNEST SCOTT & CO. (LTD.) (98,667.)—Reg. July 3, capital £30,000 in £1 shares, to acquire the business carried on as Ernest Style & Co., and to carry on the business of mechanical and electrical engineers, machinery manufacturers, &c. First directors, E. Scott (chairman and manager) and others to be appointed by him. Reg. by Hillearys, 5, Fenchurch Buildings, London, E.C.

HYDRO ELECTRICAL GEAR CO. (LTD.) (96,608.)—Reg. June 30, capital £6,000 in 5,000 participating cumulative preference shares of £1 each and 20,000 deferred ordinary shares of 1s. each, to adopt an agreement with Col. Boddam, and to carry on the business of lift manufacturers, engineers, builders of machinery and electrical apparatus, &c. First directors, Viscount Molesworth, C. E. Peczenik and R. P. Hornby. Reg. office, 11, Pancras-lane, London, E.C.

RUGBY LAMP CO. (LTD.) (98,691.)—Reg. July 4, capital £10,000 in £1 shares, to adopt an agreement with B. H. C. Fox and T. Hunter, for the acquisition of a piece of freehold land in Rugby, and to carry on the business of manufacturers of and dealers in arc, incandescent and other electric lamps, lighting appliances, &c. Private company with three subscribers.

SYNDICATE LAMP CO. (LTD.) (98,588).—Reg. June 29, capital £2,000 in £1 shares, to adopt an agreement with the Metallfadenlampenwerk, Berlin G.m.b.H., and to carry on the business of manufacturers of and dealers in filament or other lamps, electricians, engineers, suppliers of electricity, &c. Reg. office, 36, Spring-gardens, Manchester.

MORTGAGES AND CHARGES.

CAMPBELL & ISHERWOOD (LTD.)—£400 5 per cent. debentures, created and dated June 17, 1908, charged on company's undertaking and property, present and future, including uncalled capital, have been registered. No trustees.

CITY NOTES.

MEMORANDA July 9.—Bank rate 2½ per cent. (since May 28, 1908). Price of silver, 24⅜d. per oz. Consols 87 — 87⅛ for money and 87¼—87⅜ account. Consols Pay Day, Aug. 6; Stock and Shares Continuation Days, July 15 and 28; Ticket Days, July 14 and 29; Pay Days, July 16 and 30. Mining Share carry over Day, July 10.

Prices of Metals (London).—*Copper*, cash, 57¼—58¼; three months, 58—58¾. *Lead*, English, 13¾—13½; foreign, 13—13⅛. *Spelter*, foreign, 18—18¼. *Tin*, English, 122—123; foreign, cash, 131¾—132¼, three months, 133¾—133¼. *Iron*, Cleveland, cash, 51/1—51/4; three months, [illegible]—51/10.

AMERICAN TELEPHONE & TELEGRAPH CO.—The board have declared a dividend of 2 per cent. for the past quarter.

BRITISH ALUMINIUM CO. (LTD.)—During the week this company invited applications for £700,000 5 per cent. mortgage debenture stock at par.

BRUSH ELECTRICAL ENGINEERING CO. (LTD.)—At meetings of the shareholders on Tuesday, resolutions were confirmed converting the present shares of £1. 6s. 8d. into £1 shares.

BUENOS AYRES NEW TRAMWAYS CO. (LTD.)—The accounts for the 18 months to March 31 show, after providing for interest, &c., a credit balance of £31,238. From this has been deducted the debit balance of £29,806, leaving a credit balance of £1,432.

CITY OF LONDON ELECTRIC LIGHTING CO. (LTD.)—The directors have declared the following dividends on account of the distribution for the year ending Dec. 31, 1908. Preference shares: 6s. per share (at the full rate of 6 per cent. per annum for the half-year ended June 30). Ordinary shares: 5s. per share (at the rate of 5 per cent. per annum for the half-year ended June 30). The dividends will be less tax and will be payable on and after Aug. 1. The transfer books and register of members will be closed from 17th to 31st inst. inclusive.

COMPANIES TO BE STRUCK OFF REGISTER.—The following will be removed from the Register of Joint Stock Companies unless cause to the contrary is shown before Oct. 3: Anti-Friction Roller Bearing Synd., Electrical Appliances Synd., Electrical Productions, Electro-Smelting Co., Helios Electrical Construction Co., Irish Electric Railways Co., Miller Signal Synd. for India, North-West London Electric Supply Co., Querette (Parent) Co., Uddingston District Electric Lighting Co.

CONSOLIDATED ELECTRICAL CO. (LTD.)—A dividend of 3½ per cent. is announced on the ordinary capital for the year ended March 31, the same as last year.

DOULTON & CO. (LTD.)—The directors have decided in future to transmit the interim and final dividends on the five per cent. preference shares on Sept. 30 and March 31 respectively, instead of June 30 and Dec. 31 as heretofore. They propose to pay on Sept. 30 next a further interim dividend for three months of the current year of £1. 5s. per cent., leaving only the final three months' dividend to Dec. 31, 1908, which will be payable on March 31, 1909.

DUBLIN UNITED TRAMWAYS CO. (LTD.)—Subject to audit the directors recommend dividends for the half-year ended June 30 at the rate of 6 per cent. per annum on the preference shares, and 6 per cent. per annum (tax free) on the ordinary shares, and are carrying forward £6,494. 12s. 8d., in addition to £4,749. 8s. 4d. unexpended of the sum provided last half-year for reconstruction and maintenance.

ELECTRIC TAXICAB CO. (LTD.)—During the week this company has invited subscriptions for the whole of its capital of £300,000.

GREAT NORTHERN TELEGRAPH CO.—The board of this company have declared an interim dividend of 5s. per share (less tax) for the past half-year.

HASTINGS & DISTRICT ELECTRIC TRAMWAYS CO. (LTD.)—The directors do not feel justified in making any payment on account of preference dividend.

LA CAPITAL TRACTION & ELECTRIC CO. (LTD.)—The directors have declared a dividend of 3½ per cent. on the ordinary shares for the 15 months to March 31.

MARCONI INTERNATIONAL MARINE COMMUNICATION (LTD.)—The "Financial Times" states that the balance-sheet of this company at June 30, 1907, shows the following:—Debit: Issued capital, £204,056; debentures, £20,000; creditors, £23,269—total, £247,325. Credit: Plant, apparatus, &c., £13,163; office furniture, £1,093; consideration for licence and rights, £105,115; contract with Lloyd's Corporation, £977; shares in associated companies, £23,715; debtors, £4,397; cash, £34; balance of expenditure over receipts from incorporation of company to date, £98,831—total, £247,325.

NORTH MELBOURNE ELECTRIC TRAMWAYS & LIGHTING CO. (LTD.)—The accounts from Oct. 11, 1906, to Sept. 30, 1907, after providing for debenture interest, show a debit balance of £8,897.

OKONITE CO. (LTD.)—The directors have declared an interim dividend at the rate of 8 per cent. (4s. per share), less tax, on the ordinary shares for the past quarter.

ROYCE LIMITED.—The trading profit for the year ended March 31 was £5,726. After providing for interest, for debit (£1,873) brought forward, and applying £2,622 to extinguish the arrears on the debenture sinking fund, £165 remains to carry forward.

STOCK EXCHANGE NOTICES.—The Stock Exchange committee have appointed July 14 a special settling day in and have granted a quotation to a further issue of £100,000 preferred ordinary stock of the *British Columbia Electric Railway Co. (Ltd.)*, and have also granted quotations to scrip, partly paid, for $1,325,000 30 year 5 per cent. gold bonds of the *Kaministiquia Power Co. (Ltd.)*; £460,000 4½ per cent. sterling debentures in lieu of scrip now quoted of the *Montreal Street Railway Co.* and a further issue of 10,000 £5 fully paid 6 per cent. cumulative preference shares of the *[illegible]* *Supply Co. (Ltd.)*. The committee have been asked to allow 59,357 £1 fully paid ordinary shares of the *[illegible]* *Ltd.)* to be quoted.

TELEGRAPH CONSTRUCTION & MAINTENANCE CO. (LTD.)—An interim dividend of 15s. per share has been declared.

UNITED RIVER PLATE TELEPHONE CO. (LTD.)—The directors recommend a final dividend of 3 per cent. on the ordinary shares, making 6 per cent. for the year (tax free).

ELECTRIC TRAMWAY AND RAILWAY TRAFFIC RECEIPTS.

Line	Week ended.	Amount.	Inc. or Dec. (a)	Aggregate: No. of weeks.	Aggregate: Amount.	Aggregate: Inc. or Dec. (a)
		£	£		£	£
Aberdeen Corporation	July 1	1,597	+ 26	5	6,777	− 153
Airdrie	June 26	231	+ 1	25	5,626	+ 56
Anglo-Argentine	July 1	17,605	+ 1,103	26	479,932	+ 51,697
Ayr Corporation	,, 4	378	+ 26	7	2,287	− 5
Baker St. & Waterloo Ry.	,, 4	2,970	+ 185	1	2,970	+ 185
Barnsley	June 26	175	+ 23	25	4,357	+ 262
Barrow	,, 26	274	− 17	25	5,832	− 70
Bath Electric Trams, Ltd.	July 1	856	+ 18	26	17,810	− 1,391
Birkenhead Corporation	,, 5	1,219	+ 139	1	1,219	+ 139
Birmingham Corporation	,, 4	6,461	+ 405	14	87,878	+ 4,585
Birmingham & Mid.	June 19	761	− 60	24	19,807	+ 922
Blackburn Corporation	July 1	1,269	+ 209	14	16,578	+ 998
Blackpool Corporation	,, 2	1,831	+ 422	§13	13,240	+ 1,083
Blackpool and Fleetwood	,, 4	1,380	+ 495	1	1,380	+ 495
Bolton Corporation	,, 5	2,693	+ 399	14	33,455	+ 1,878
Bombay	June 11	R37,671	+ R8,727	23	R837,642	+ R166,252
Bournemouth Corporation	July 1	1,624	+ 33	13	21,521	− 654
Bradford Corporation	,, 4	5,005	+ 101	14	65,878	+ 1,131
Brighton Corporation	,, 5	1,018	+ 81	14	12,176	+ 266
Bristol Trams & Carriage	,, 3	5,600	+ 478	32	126,092	− 1,562
Buenos Ayres & Belgrano	,, 1	3,664	+ 507	25	98,675	+ 1,116
Burnley Corporation	,, 4	1,420	+ 68	14	18,100	+ 795
Burton Corporation	,, 5	286	− 5	14	3,751	− 213
Bury Corporation	June 28	1,247	+ 95	‡13	15,677	+ 1,619
Calcutta Tramways Co.	July 4	R16,450	− R1,302	1	R46,450	− R1,302
Camborne-Redruth	...	...	...	...	...	...
Cardiff Corporation	...	...	...	...	...	...
Cavehill	June 26	140	+ 69	25	2,123	+ 242
Central London Railway	July 4	7,003	+ 1,167	1	7,003	+ 1,167
Charing C., Euston & H'stead	,, 4	3,380	+ 720	1	3,380	+ 720
Chatham & Dist. Lt. Rys.	,, 2	928	− 7	§26	18,889	+ 621
City & South London Rly	,, 5	3,101	− 161	1	3,104	− 161
City of Birmingham	June 26	2,789	− 64	25	69,806	+ 343
Colchester Corporation	,, 30	212	− 6	...	...	...
Cork Electric Trams Co.	July 2	[illegible]	− 25	§26	11,490	− 412
Croydon Corporation	,, 3	1,607	+ 127	14	20,161	+ 293
Devonport & Dist. Trams	June 26	551	+ 65	25	11,233	+ 75
Dover Corporation	...	...	...	...	...	...
Dublin & Lucan Railway	July 3	121	..	26	3,033	+ 220
Dublin United	,, 3	6,632	− 281	1	6,632	− 281
Dudley-Stourbridge	June 26	840	− 4	25	20,024	− 1,056
Dundee Corporation	July 1	1,292	+ 116	‡7	8,371	+ 730
East Ham Council	,, 4	891	− 52	14	12,465	− 588
Falkirk and District	,, 1	297	− 6	.	...	...
Gateshead & Dist. Trams	June 26	1,236	− 8	25	25,173	+ 188
Glasgow Corporation	July 4	18,716	+ 1,510	5	89,457	+ 3,280
Glossop	...	...	...	...	...	...
Gravesend—Northfleet	June 26	231	− 25	25	5,061	− 739
Great Northern & City Rly.	July 4	1,471	− 277	1	1,471	− 277
Gt. Northern, Piccadilly, &c	,, 4	5,250	+ 810	1	5,250	+ 810
Greenock & Port Glasgow	June 26	643	− 112	25	12,762	− 3,420
Hartlepool Tramways	,, 26	272	− 45	25	5,607	− 1,105
Hastings Elec. Trams Co.	July 2	1,153	+ 116	1	1,153	− 208
Hong Kong	,, 4	$7,805	− $208	1	$7,806	− $208
Huddersfield Corpn.	,, 4	1,681	+ 148	13	21,247	+ 795
Hull Corporation	,, 4	2,406	− 71	14	33 087	− 251
Ilford District Council	,, 4	510	− 8	†14	6,242	− 372
Ilkeston District Council	,, 1	148	+ 6	13	1,876	+ 41
Ipswich Corporation	,, 4	466	+ 19	14	5,366	− 11
Isle of Thanet Co.	,, 4	916	+ 25	40	14,363	− 314
Jarrow	June 26	150	+ 19	25	2,606	− 353
Keighley Corporation	,, 30	143	+ 18	‡52	8,422	+ 401
Kidderminster & District	,, 26	135	− 20	25	2,534	− 138
Kilmarnock Corporation	July 4	157	+ 3	7	1,117	− 89
Lanarkshire Trams Co.	June 30	1,152	...	26	33,387	+ 4,197
Lancashire United	July 1	1,802	+ 496	26	33,830	+ 2,029
Leamington	June 26	197	+ 40	25	3,848	+ 174
Leeds Corporation	,, 27	6,919	+ 364	13	83,680	+ 1,736
Leicester Corporation	July 4	2,344	+ 151	1	2,344	+ 151
Lincoln Corporation	,, 4	114	− 4	14	1,662	− 64
Liverpool Corporation	June 27	11,129	− 167	26	272,452	− 2,033
Liverpool Overhead Rly.	July 5	1,493	− 118	1	1,493	− 118
*London County Council	June 27	37,393	+ 5,797	†13	434,967	+ 46,043
London United	July 4	8,098	+ 678	26	167,079	+ 4,243
Lowestoft	,, 4	228	− 2	40	6,602	+ 159
Maidstone Corporation	,, 4	206	...	14	2,678	...
Manchester Corporation	,, 4	16,433	+ 1,497	14	209,747	+ 10,735
Mersey Railway	,, 4	1,804	− 78	1	1,804	+ 1,484
Merthyr	June 26	201	− 6	25	5,228	+ 70
Metropolitan Dist. Railway	July 4	9,153	+ 821	1	9,153	+ 821
Metropolitan Elec. Trams	June 26	6,594	+ 1,480	25	135,765	+ 27,382
Middleton	25	409	+ 49	25	8,812	+ 280
Nelson Corporation	July 4	150	+ 25	¶13	1,992	− 91
Newcastle-on-Tyne Corp.	,, 4	5,233	+ 1,423	14	55,525	− 3,433
Newport (Mon.)	,, 4	735	+ 66	14	9,491	− 795
Northampton Corporation	,, 3	499	+ 39	¶13	6,388	+ 388
Oldham, Ashton & Hyde	June 26	588	− 23	25	14,855	− 20
Oldham Corporation	July 5	2,030	+ 143	15	29,498	+ 819
Perth (N.B.) Corporation	,, 1	161	− 6	8	1,054	− 47
Perth (W.A.) Elec. Trams	,, 3	1,373	+ 70	¶27	37,669	− 869
Peterborough	June 26	127	+ 10	25	2,926	+ 49
Portsmouth Corporation	July 4	2,362	+ 290	14	27,444	+ 414
Potteries	June 26	1,659	− 223	25	45,691	− 310
Rotherham Corporation	July 2	629	+ 30	§13	8,258	+ 198
Rothesay	June 24	390	+ 115	25	2,928	− 63
Salford Corpn.	July 6	5,012	+ 322	14	67,055	+ 870
Sheerness	June 24	65	+ 6	25	1,327	+ 1
Sheffield Corporation	July 5	5,706	+ 139	†15	82,794	+ 236
Singapore Trams	,, 4	$8,900	− $301	1	$890	− $301
South Metropolitan	June 26	948	+ 134	25	19,080	+ 591
South Staffs	,, 25	858	− 9	25	22,010	− 218
Southend Corporation	July 1	488	+ 47	14	5,227	+ 358
Southport Tramways	June 26	322	− 4	25	6,378	− 331
Stalybridge, Hyde, &c., Jt. Bd.	July 4	868	+ 102	†14	10,953	+ 68
Sunderland Corporation	...	...	...	...	...	...
Sunderland and District	,, 1	515	+ 5	35	16,227	+ 1,404
Swansea Trams	June 25	998	+ 93	25	22,539	+ 1,691
Swindon Corporation	July 1	150	− 17	...	...	...
Taunton	June 25	38	− 4	25	986	− 39
Tynemouth and District	,, 26	560	+ 70	25	4,683	− 261
Tyneside Trams Co.	July 1	729	+ 40	27	10,958	− 1,351
Wallasey District Council	,, 4	1,008	+ 153	†14	12,316	+ 771
Walsall Corpn.	,, 4	558	+ 16	27	14,158	+ 1,3[illegible]0
Warrington Corpn.	,, 2	40[illegible]	− 32	13	5,059	− 49
West Ham Corporation	June 25	2,[illegible]	− 55	13	29,114	− 1,734
Weston-super-Mare	,, 24	199	+ 29	25	1,837	− 57
Wolverhampton Co.	,, 26	424	− 31	25	11,381	− 218
Wolverhampton Corpn.	July 1	858	+ 5	4	3,790	+ 443
*Worcester	June 26	308	+ 10	25	6,580	+ 20
Wrexham	,, 26	108	− 7	25	2,182	+ 3
Yorkshire W.R. Trams	July 5	1,222	+ 67	27	31,837	...
Yorkshire Woollen District.	June 26	942	− 34	25	22,691	− 980

(a) These comparisons are with the corresponding period last year. § Plus 2 days. ¶ Plus 3 days. * Partly electrical. † Minus 3 days. ‡ Minus 2 days.

ELECTRICAL COMPANIES' SHARE LIST.

Share	Last Dividend	Name.	Price Wed., July 8.	Rate % Yielded. £ s. d.	Dividend Due.	Business Week to July 8. Highest.	Lowest.
		ELECTRICITY SUPPLY.					
10	9 0	Bournemouth & Poole Elec. Sup. Ord.	10½–11	6 7 0	Mar, Sept,	..	..
10	4 6	Do. 4½ per Cent. Cum. Pref.	9¾–10⅜	4 7 0	Feb, Aug	–	–
10	6 0	Do. 6 per Cent. Cum. Second Pref.	10⅜–10⅞	5 11 6	Feb, Aug	..	..
St.	4½%	† Do. 4½ per Cent. Deb. Stock (red.)	100 –108	4 7 6	Jan, July	..	..
5	3 6	Bromley (Kent) El. Lt. & Power Shares	4½–5	5 10 0	April, Oct	..	..
St.	4½%	Do. Do. 1st Debs.	94 –97	4 12 9	May, Nov	..	..
5	5 6	Brompton & Kensington Elec. Sup. Ord.	7 –8	6 6 6	March....	..	..
5	3 6	Do. 7 per Cent. Pref.	6¾–7¾	4 10 0	Mar, Sept	..	..
St.	4%	Central Elec. Sup. Co. 4% Guar. Db. Stock	98 –101	4 0 0	June, Dec	99	..
5	2/6	Charing Cross (W. End & City) El. Sup. Co.	3¾–4¼	5 17 6	Feb, Aug	..	..
5	2/3	Do. 4½ per Cent. Pref.	4 –4½	5 0 0	Feb, Aug	4⅛	..
St.	4%	Do. 4 per Cent. Deb. Stock (red.)	95 –98	4 2 0	Jan, July	96½	..
5	2/3	† Do. City Undertaking 4½% Cm. Pref.	3⅞–4⅛	5 11 0	Jan, July	–	..
5	2/6	Chelsea Electric Supply Ord.	3 –3½	6 8 9	March ..	3¾	3[illegible]
St.	4½%	*† Do. 4½ per Cent. Deb. Stock (red.)	99 –102	4 8 0	June, Dec	..	..
10	7/0	City of London Electric Lighting Ord.	9½ –10½	5 16 6	Feb, Aug	..	..
10	6/0	Do. 6 per Cent. Cum. Pref.	12 –13	4 12 0	Jan, July	12[illegible]	12¼
St.	5%	† Do. 5 per Cent. Deb. Stock (red.)	122 –125	4 0 0	June, Dec	..	..
St.	4½%	† Do. 4½ per Cent. 2nd Deb. Stock (red.)	100 –103	4 7 0	Jan, July	..	..
5	2%	County of Durham Elec. P.D. Ord.	2¾–3	3 9 7	April, Oct	..	..
5	5%	Do. 5 per Cent. non Cum. Pref.	3⅞–4⅛	6 5 0	April, Oct	..	–
10	6/0	County of London Elec. Supply Ord.	7¾–8¼	6 1 0	Feb, Aug	..	..
10	6 0	Do. 6 per Cent. Cum. Pref.	10⅜–10⅞	5 10 6	Mar, Sept	10[illegible]	10¾
St.	4½%	† Do. 4½% Deb. Stock (red.)	105 –108	4 3 6	Jan, July	..	..
St.	4½%	Do. Second Deb. Stock	98 –101	4 9 9	May, Nov	99½	98½
5	3 6	Folkestone Electricity Supply Co. Ord.	4¾–5¼	5 7 0	April, Oct	..	–
5	2 6	Do. 5 per Cent. Cum. Pref.	5 –5½	4 11 0	Mar, Sept	..	..
St.	4½%	Do. 4½ 1st Deb. Stock (red)	96 –99	4 11 0	Feb, Aug	..	..
5	4/6	Hove Electric Lighting Ord.	6 –6½	6 11 0	April, Oct	..	..
5	5/0	Kensington & Knightsbridge Ord.	8 –9	5 11 0	Feb, Aug	..	..
5	6%	Do. 6 per Cent. 1st Pref.	6 –6½	4 12 0	Jan, July	..	–
St.	4%	Do. 4 per Cent. Deb. Stock (red.)	96 –99	4 1 0	..	..	..
St.	4%	Kensingtn. & Kngtbg. Co. & Notting Hill Co. (Joint Station) 4% Deb. Stock (red.)	97 –101	3 19 0	April, Oct	..	..
St.	4½%	Kent Elec. Power Co.	88 –92	4 18 3	Jan, July	..	–
3	1/6	London Electric Supply Ord.	⅞–1¼	5 8 0	Mar, Sept	..	..
5	3/0	Do. 6 per Cent. Pref.	4½–5	6 0 0	Mar, Sept	4[illegible]	4[illegible]
St.	4%	Do. 4 per Cent. 1st Mort. Deb.	89 –92	4 7 0	Jan, July	..	..
5	3/6	Metropolitan Electric Sup. Ord.	4⅞–5⅛	6 6 6	April, Oct	..	..
5	2/3	† Do. 4½ per Cent. Cum. Pref.	4⅝–4⅞	4 12 6	Jan, July	4[illegible]	4⅜
St.	4½%	† Do. 4½ per Cent. Deb. Stock 1st Mort.	105 –109	4 1 6	June, Dec	..	..
St.	3½%	† Do. 3½ per Cent. Mrt. Deb. Stock (red.)	84 –89	3 19 0	Jan, July	..	..
100	4½%	† Midland Elec. Corp. for P.D. 1st Mort. Db.	94 –97	4 12 6	June, Dec	..	–
10	4%	Newcastle & Dist. Elec. Ltg. Ord.	7¾–8¼	5 0 0	Feb, Aug	–	–
100	4½%	† Do. 4½ per Cent. Deb.	94 –96	4 14 9	Jan, July	..	..
5	8%	Newcastle Elec. Supply Ord.	5⅝–5¾	7 0 10	Feb, Aug	..	..
5	5%	Do. 5 per Cent. non Cum. Pref.	5¼–5⅜	4 14 1	Feb, Aug	..	..
100	4%	† Do. 4 per Cent. Mort. Deb. red. 1907.	95 –97	4 3 4	Jan, July	..	..
1	3%	Northern Counties Elec. Sup.	—	..	Mar, Aug	–	..
100	4½%	† Do. 4½ per Cent. Deb.	93 –95	4 15 9	Jan, July	..	..
10	6/0	† Notting Hill Electric Ord.	12 –13	5 8 0	March ..	..	..
5	4/6	Oxford Electric Ord.	5¾–6¼	5 12 0	March ..	..	..
St.	4%	Do. 4 per Cent. Deb. Stock	95 –99	4 1 0	Jan, July	..	..
5	5/0	St. James' & Pall Mall Elec. Ord.	7½–8½	5 18 0	Feb, Aug	..	..
5	3/6	Do. 7 per Cent. Pref.	6½–7¼	4 16 6	Feb, Aug	..	..
St.	3½%	Do. 3½ per Cent. Deb. Stock (red.)	83 –88	4 2 0	Jan, July	..	..
5	..	Smithfield Markets Electric Sup. Ord.	¼–¾	..	Feb	87	86
St.	4%	Do. 4 per Cent. Deb. Stock	70 –74	5 8 0	Feb, Aug	..	..
5	4/0	South London Electric Supply Ord.	2¾–[illegible]	5 19 0	April	..	..
1	0/6	South Metrop'n Elec. Lt. & Power Ord.	⅜–⅝	4 0 0	..	..	..
1	0/8⅖	Do. 7 per Cent. Cum. Pref.	1 –1¼	5 12 0	Feb, Aug	..	..
St.	4½%	Do. 4½ 1st Db. Stk. Red.	99 –102	4 8 0	April, Oct	..	..
5	2/6	Urban Electric Supply Ord.	1 –2	12 10 0	April, Oct	–	..
5	2/6	Do. 5 per Cent. Cum. Pref.	1⅞–2¼	10 12 0	April, Oct	..	..
St.	4½%	Do. 4½ per Cent. 1st Mort. Deb.	87 –90	5 0 0	April, Oct	..	..
5	5 0	Westminster Elec. Sup. Ord.	7¾–8¾	5 14 0	Mar, Sept	8¼	..
5	2/3	† Do. 4½ per Cent. Cum. Pref.	4⅞–5⅜	4 4 0	Jan, July	[illegible]	..
		ELECTRIC RAILWAYS, TRAMWAYS, &c.					
St.	4%	Baker St. & Waterloo 4% Perp. Db. St.	90 –92	4 7 0	Jan, July	91¾	[illegible]
1	.	Bath Elec. Trams Pref. Ord.	¼–½	8 0 0	April	..	–
1	0/6	† Do. 5 per Cent. Cum. Pref.	⅝–⅞	5 14 0	Jan, July	[illegible]	..
St.	4½%	Do. 4½ 1st Mort. Deb. Stock (red.)	84 –89	5 0 0	April, Oct	..	..
St.	4½%	† B'ham & Midland Trams 4½ 1st Db. Stk.	91 –94	4 17 0	Jan, July	..	..
10	9%	Bristol Tramways & Carriage Ord.	10½–11	7 12 8	Feb, Aug	..	..
10	4%	† Do. Cum. Pref. (fully paid)	8 –8½	4 14 2	..	..	..
St.	4%	† Do. 4 per Cent. Debs.	93 –98	4 2 0	Feb, Aug	..	..
10	..	British Electric Traction Ord.	1⅜–1⅞	..	June, Dec	1⅝	1⅝
10	1/5⅓	† Do. 6 per Cent. Cum. Pref.	4¼–4¾	..	Feb, Aug	4[illegible]	4[illegible]
St.	5%	Do. 5 per Cent. Perpetual Debs.	94 –97	.	April, Oct	96½	95½
St.	4½%	Do. 4½ per Cent. 2nd Deb. Stock	76 –78	5 15 0	May, Nov	77	76
St.	3%	Central London Ordinary Stock	75 –78	3 17 0	Feb, Aug	75½	..
St.	4%	Do. 4 per Cent. Pref. Stock	90 –92	4 7 0	Feb, Aug	90	..
St.	2%	Do. Deferred Stock	55 –58	3 6 0	Feb	56½	..
100	4%	Do. 4 per Cent. Debs.	103 –106	3 15 6	Jan, July	104[illegible]	104
St.	4%	† Charing X, Euston & Hmpstd Per Db. Stk.	80 –83	4 16 0	Jan, July	..	..
5	2/6	City of Birmingham Trams. 5% Cm. Pref.	4¼–4¾	5 5 0	April, Oct	..	..
100	4%	Do. 4 per Cent. 1st Mort. Debs.	97 –100	4 0 0	April, Oct	..	..
St.	1½%	City & South London Rly. Con. Ord.	38 –40	5 0 0	Feb, Aug	39½	38¼
St.	5%	Do. 5 per Cent. Perp. Pref. (1891)	113 –116	4 6 0	Feb, Aug	..	..
St.	5%	Do. (1896)	112 –115	4 7 0	Feb, Aug	..	..
St.	5%	Do. (1901)	110 –113	4 8 6	Feb, Aug	..	..
St.	5%	Do. (1903)	104 –107	4 13 6	Feb, Aug	105¾	105
St.	4%	Do. 4 per Cent. Perpetual Debs.	100 –103	3 17 6	May, Nov	..	..
10	7/0	Dublin United Trams. Ord	12¼–13¼	4 10 6	Feb, Aug	..	..
10	6/0	Do. 6 per Cent. Pref.	12½–13½	4 9 0	Feb, Aug	..	..
10	..	Gt. Northern & City Rly. Pref. Ord. (4%)	¾–1¼	..	Feb, Aug	..	..
10	4/0	G. Northern, Piccadilly & Brompton Ord.	6½–7	5 13 0	Feb, Aug	5½	5¾
St.	4%	† Do. 4 per Cent. Deb. Stock	88 –90	4 9 0	Jan, July	89	88
5	4/0	Hastings & Dist. Elec. Trams. 6% Cm. Pf.	3½–3¾	8 0 0	Mar, Sept	..	..
St.	4½%	Do. 4½ Db. St.	93 –96	4 13 9	April, Oct	..	..
10	9%	‡ Imperial Tramways Ord.	10½ –11½	7 17 0	Mar, Sept	..	..
10	6%	†‡ Do. 6 per Cent. Pref.	9½–10	6 0 0	Mar, Sept	..	..
St.	4½%	†‡ Do. 4½ per Cent. Debs.	91 –92	4 18 0	Jan, July	..	..
5	..	I. of Thanet E. T. & Lt. 5 per Cent. Pref.	⅞–1⅜	.	Mar, Sept	..	–
St.	4%	† Do. 4 per Cent. Deb. Stock	56 –61	6 11 0	Jan, July	..	–
10	6/0	Lanarkshire Tramways	9⅞–10⅜	5 9 0	Feb, Aug	..	..
St.	5%	† Lancs. Utd. Trams 5% Prior Lien Db. St.	88 –91	5 10 0	Jan, July	..	..
10	..	Liverpool Overhead Railway Ord.	1⅜–1½	..	Feb, Aug	..	..
10	5%	Do. 5 per Cent. Pref.	5¾–6¼	8 0 0	Feb, Aug	..	–
St.	4%	Do. 4 per Cent. Deb.	86 –88	4 10 0	Jan, July	..	..
10	5/0	† London United Trams. 5% Cum. Pref.	7 –8	6 5 0	Jan, July	7½	7¼
St.	4%	† Do. 4 per Cent. 1st Mort. Deb. Stock	79 –84	4 15 0	Jan, July	..	..
St.	..	Mersey Con. Ord. Stock	1 – 3	–	Feb, Aug.	..	..
St.	..	Do. 3 per Cent. Perp. Pref.	3 – 6	–	..	..	..
1	..	Metropolitan Elec. Tramways Def.	[illegible]	.	April.. .	..	..
1	0/6	Do. 5 per Cent. Cum. Pref.	[illegible]	6 3 6	Feb, Aug	..	..
St	4½	† Do. 4½ per Cent. Deb. Stock	9[illegible] – 95	4 12 0	Jan, July	..	.
St.	½%	Metropolitan Railway Consolidated	37½–38½	1 6 0	Feb, Aug	39½	37⅞
St.	2½%	Do. Surplus Lands Stocks	68 –70	3 [illegible] 0	Feb, Aug	69¾	69
St.	3½	Do. 3½ per Cent. Preference	86 –89	3 19 9	Feb, Aug	88½	83
St.	3½	Do. 3½ per Cent. "A" Preference	76 –79	4 8 6	Feb, Aug	75½	..
St.	3½%	Do. 3½ per Cent. Convertible Pref.	73 –76	4 12 0	Feb, Aug	73½	..
St.	3½%	Do. 3½ per Cent. Debenture Stock	91 –94	3 14 6	Jan, July	..	..
St	3½%	Do. 3½ per Cent. "A" Ditto	89 –92	3 16 0	Jan, July	91	..

* In calculating the yield allowance has been made for accrued interest but *not* for redemption

† Ex Dividend

ELECTRICAL COMPANIES' SHARE LIST.—*Continued.*

Share	Last Divi-dend	Name	Price Wed., July 8	Rate % Yield-ed £ s. d.	Dividend Due	Business Week to July 8 High-est	Low-est
		ELECTRIC RAILWAYS & TRAMWAYS—*Continued.*					
St.	..	Metropolitan District Railway Ord.	12 —13	..	Feb, Aug	12½	12
St.	..	Do. Extension Pref. (5 per Cent.)	21 —26	..	Feb, Aug	22	21½
St.	3½	Do. Assented Ext. Pref. (Int. Guar. by Und. Elec. Rlys. Co. of London, Ltd.)	44 — 48	7 6 0	Feb, Aug	..	..
St.	3%	† Do. 3 per Cent. Consolid. Rent-charge	70 —75	4 0 0	Jan, July	74½	..
St.	4%	† Do. 4 per Cent. Midland Rent-charge	98 —102	3 18 0	Jan, July	..	..
St.	1½	Do. Guar. Stock 4 per Cent.	44 — 49	3 11 0	Mar, Sept	45½	44½
St.	6%	† Do. 6 per Cent. Perp. Deb. Stock	117 —122	4 13 6	Jan, July	..	..
St.	4	† Do. 4 per Cent. Ditto	71 —76	5 5 0	Jan, July	72	..
5	..	New Gen. Trust. 6 per Cent. Cum. Pref	½—¾	..	May	..	..
1	0/9?	Potteries Electric Traction Ord.	½—¾	8 0 0	April, Oct	..	..
1	0/6	Do. 5 per Cent. Cum. Pref.	⅜—½	6 13 0	Feb, Aug	..	..
St.	4½%	Do. 4½ per Cent. Deb. Stock	93 —96	4 14 6	May, Nov	..	..
1	0/7½	S. Met. Elec. Trams. & Ltg. 6% Cm. Pref.	⅞—1	6 0 0	Feb, Aug	..	..
St.	4%	† Do. 4 per Cent. Deb. Stock	75 —79	5 1 0	Jan, July	..	..
100	5%	† Sunderland Dist. Elec. Trms. 5% 1st Mt. Db	74 —79	6 11 0	Jan, July	74½	74
..	5%	Underground Elec. Rys. Co. of London	40 — 44	11 8 0	June, Dec	42½	41½
5	..	Yorkshire (W.R.) Elec. Trams. Ord.	⅞—1⅛	—	March ..	..	..
5	..	Do. 6 per Cent. Cum. Pref.	3⅛—3⅝	..	..	..	..
St.	4½	† Do. 4½ per Cent. 1st Debs.	82 —85	5 5 6	Jan, July	..	..
		ELECTRIC MANUFACTURING, &c.					
1	..	Aron Electricity Meter Ord.	⅛—¼	..	..	..	..
1	1 1½	Do. 6% Cum. Pf. ex on a/c arrears)	⅞—1	7 13 7	April, Oct	..	..
1	2/4½	Babcock & Wilcox Ord.	3½—4½	4 17 6	April, Oct	4	3½
1	0/7½	Do. Pref.	1⅛—1¼	3 16 9	..	..	..
5	6/0	British Insulated & Helsby Cables Ord.	6 —6½	7 14 0	July, Feb	6	..
5	3/0	Do. 6 per Cent. Pref.	6 —6¼	4 12 0	Jan, July	6⅛	..
St.	4½%	† Do. 4½ per Cent. 1st Mort. Deb. (red.)	100 —103	4 7 6	Jan, July	..	..
St.	4½%	British Thoms'n Houst'n 4½% 1st Mt. Db.	93 —98	4 12 0	Mar, Sept	..	..
5	..	British Westinghouse 6 per Cent. Pref.	1⅛—1¼	..	Feb, Aug	..	..
St.	4%	† Do. 4 per Cent. Mort. Deb. Stock	45 — 48	8 8 0	Jan, July	..	..
2	..	Brush Electrical Engineering	¼	—	March ..	..	..
2	..	Do. 6 per Cent. Pref. non-Cum.	⅛—¼	..	Mar, Sept	..	..
St.	4½%	Do. 4½ per Cent. Perp. 1st Deb. Stock	70 —75	6 0 0	Mar, Sept	..	..
St.	4½%	† Do. Perpetual 2nd Deb. Stock	53 —58	7 14 0	Jan, July	..	..
5	16/0	Callender's Cable Con. Ord.	9½—10½	7 1 0	Jan, July	9½	..
5	2/6	† Do. 5 per Cent. Cum. Pref.	5¼—5½	4 7 0	Jan, July	..	..
St.	4½%	† Do. 4½ per Cent. 1st Mort Debs. (red.)	105 —107	4 4 0	Nov, May	..	..
1	1/0	Castner-Kellner Alkali Co.	1¼—1⅜	9 18 0	May, Nov	1⅜	..
St.	4½%	Do. 4½ per Cent. 1st Mort. Deb. (red.)	101 —104	4 6 6	Feb, Aug	..	..
1	0 9?	† Chadburn's (Ship) Telegraph Ord.	1⅛—1⅜	8 8 0	March ..	..	..
1	0/7½	Do. 6 per Cent. Cum. Pref.	1 —1⅛	5 6 6	April, Oct	..	..
1	0/8?	Consolidated Electrical Co.	¼—½	7 0 0	August ..	..	..
1	1/0	Consolidated Signal Co.	1⅝—1⅞	4 12 0	April, Oct	..	..
1	0/7½	Do. 6 per Cent. Cum. Pref.	⅞—1	6 0 0	April, Oct	..	..
1	3/0	* Crompton & Co. (Nos. 1 to 85,000)	1⅝—1⅞	8 1 6	Jan, July	..	..
100	5%	† Do. 5 per Cent. 1st Mort. Debs. (red.)	90 —93	5 7 0	Jan, July	..	..
1	0/7½	Davis & Timmins	⅞—1⅛	..	Mar, Sept	..	..
5	2/0	Dick, Kerr & Co. Ord.	1⅛—1⅜	7 11 0	Sept	..	..
5	0/7½	Do. 6 per Cent. Cum. Pref.	1 —1⅛	4 16 0	Sept	1	..
St.	4½%	† Do. 4½ per Cent. Deb. Stock	99 —102	4 8 6	Jan, July	..	..
5	2/6	Edison & Swan United ("A" Sh.) (£3 pd.	⅛—¼	..	Feb, Aug	..	..
5	4/2	Do. (£5 paid)	1½—2½	5 0 0	Feb, Aug	..	..
St.	4%	† Do. 4 per Cent. Mort. Deb. Stock (rd.)	76 — 79	5 1 0	June, Dec	..	..
St.	5%	Do. 5 per Cent. 2nd Deb. Stock	85 —87	5 15 0	Mar, Sept	..	..
5	..	Edmundson's Elec. Corp. Ord.	⅛—⅜	..	Jan, July	..	..
5	..	Do. 6 per Cent. Cum. Pref.	⅞—1	..	May, Nov	..	..
St.	4½%	Do. 4½ per cent. 1st Mort. Deb. (red.)	63 — 73	6 2 9	Jan, July	68	..
5	..	Electric Construction Co.	⅛—⅜	..	Jan, July	..	..
5	..	Do. 7 per Cent. Cum. Pref.	1¼—1½	..	July	..	..
St.	4%	Do. 4 per Cent. Perp. 1st Mort. Debs.	61 —64	6 5 0	Jan, July	..	..
10	5/0	General Electric (1900) 5% Cum. Pref.	7½—8	6 5 0	June, Dec	..	..
St.	4%	Do. 4 per Cent. 1st Mort. Debs.	87 —90	4 9 0	Mar, Sept	..	..
5	10/0	Henley's Telegraph Works Ord.	10½—11½	6 10 0	Feb, Aug	10⅞	..
5	2/3	Do. 4½ per Cent. Pref.	5 —5½	4 2 0	Feb, Aug	..	..
St.	4½%	Do. 4½ per Cent. 1st Mort. Deb. Stock	105 —107	4 4 0	Mar, Sept	..	..
10	15/0	India Rubber, Gutta Percha, &c., Wrks.	15½—16½	6 2 0	Feb, Aug	16	..
100	4%	Do. 4 per Cent. Debs. (red.)	98 —100	4 0 0	April, Oct	98½	98
1	..	National Elec. Construction Co.	⅛—¼	..	April	..	..
1	0/6?	Richardsons, Westgarth & Co., Ltd. Ord.	⅝—⅞	7 2 0	Nov	..	..
1	0/7½	Do. 6 per Cent. Cum. Pref.	⅞—1	6 17 0	May, Nov	..	..
St.	4½%	† Do. 4½ per Cent. Perp. Deb. Stock	87 —90	5 0 0	Jan, July	..	..
1	..	Simplex Conduits Ord.	1⅛	..	..	..	..
5	..	Do. 6 per Cent. Cum. Pref.	5⅛	..	..	..	..
12	30/0	Telegraph Construction & Maintenance	31 — 33	6 8 0	Mar, July	32½	31½
100	4%	† Do. 4 per Cent. Deb. Bonds (1909)	100 —102	3 18 0	Jan, July	..	..
1	2/0	Vickers Sons & Maxim, Ltd., Ord.	1½—1⅝	8 5 0	..	1⅝	1½
1	1/6	Do. 5 per Cent. non-Cum. Preference	1 —1⅛	4 9 0	..	1⅛	1⅛
St.	5%	Do. 5 per Cent. non-Cum. Preferred	102 —106	4 14 6	..	..	..
St.	4%	Do. 4 per Cent. 1st Mort. Db. Sk. red.	102 —104	3 16 6	June, Dec	103	..
100	4½%	Do. 4½ per Cent. 2nd Mort. Deb. red.	104 —106	4 5 0	June, Dec	105	104
100	15/0	Do. 5 per Cent. 3rd Mort. Debs. Perp.	101 —103	..	..	102½	101½
1	1/0	J. G. White & Co. 6 per Cent. Cm. Pref.	7½—8½	7 1 0	..	..	..
1	1/0	Wolseley & Robinson Ord.	⅞—1⅛	4 0 0	Apr, Oct	..	..
5	3/0	Do. 6 per Cent. Cum. Pref.	3½—3⅞	8 0 0	Apr, Oct	3⅝	..
100	4%	Do. 4 per Cent. 1st Mort. Debs.	72 —76	5 5 6	May, Nov	72	..
		TELEGRAPHS.					
10	..	Amazon Telegraph	2 — 3	—	June, Dec	..	—
100	5%	† Do. 5 per Cent. Debs. (red.)	85 —88	5 13 6	June, Dec	..	..
St	16/0	Anglo-American	[illegible] 61	5 12 6	F,My,Ag,N	58½	..
St	3/0	Do. Preferred	102½—103	5 15 6	F,My,Ag,N	103	102½
St	1/	Do. Deferred	1¼—1½	6 4 0	F,My,Ag,N	1⅜	1⅜
St	4%	[illegible] Cable 4 per Cent. Deb. Stk.	83 — 86	4 15 0	Jn,Ap,Jy,O	85½	84
[illegible]	[illegible]	Cuba Submarine Ord.	7½ — 8½	7 0 0	Feb, Aug	..	..
10	[illegible]	Do. 10 per Cent. Pref.	16½ 16½	6 19 0	Feb, Aug	..	..
[illegible]	[illegible]	[illegible] Ord	3 — 3½	6 4 0	April, Oct	..	..
[illegible]	[illegible]	Do. 10 per Cent. Cum. Pref.	8 — 9	6 11 0	April, Oct	..	..
[illegible]	4½	Do. 4½ per Cent. Deb.	100 — 103	4 7 6	Jan, July	..	..
[illegible]	4 0	[illegible] United States Cable	13½ 14	6 10 6	Ja,Ap,Jy,O	14	13½
10	4½?	[illegible] Cable 4½% Rg. Db. (rd.	98 — 100	4 10 0	June, Dec	..	..
St	[illegible]	Eastern Company	135 — 136	5 3 0	Ja,Ap,Jy,O	136	135½
St	[illegible]	Do. 3½ per Cent. Pref. Stock	81½—82	4 1 0	Ja,Ap,Jy,O	81	..
St	[illegible]	Do. 4 per Cent. Mort. Deb. Stk. (red.)	101 —103	3 17 6	May, Nov	101½	101½
10	[illegible]	Eastern Extension	12½— 13½	5 16 0	Ja,Ap,Jy,O	13	13
St	1/	Do. 4 per Cent. Deb. Stock	101 — 104	3 18 0	Feb, Aug	102	..
10	1/	Eastern & S. Africa Mort. Deb. 1900	101 —103	3 17 0	Feb, Aug	101	..
[illegible]	[illegible]	[illegible]	[illegible]	3 15 0	Mar, Nov	..	..
[illegible]	[illegible]	[illegible]	57 — 59	6 16 0	Jan, July	..	..
[illegible]	[illegible]	[illegible]	98 —100	4 1 0	June, Dec	..	..
[illegible]	[illegible]	[illegible]	14 — 17	5 19 0	May, Nov	..	..
100	81	[illegible]	69 — 79	5 11 0	Ja,Ap,Jy,O	..	..
1	81	[illegible]	69 — 79	5 11 0	Ja,Ap,Jy,O	..	..
1	..	[illegible]	[illegible]	..	April ..	..	..
[illegible]	[illegible]	[illegible]	[illegible] 101	4 0 0	June, Dec	..	—
[illegible]	[illegible]	[illegible]	1 — 1	4 5 0	May	..	..
[illegible]	[illegible]	[illegible]	[illegible]	..	Jan, July	..	..
10	[illegible]	[illegible]	[illegible]	..	May, Nov	..	..
[illegible]	[illegible]	[illegible] Pref	[illegible]	7 1 0	May, Nov	..	..
[illegible]	[illegible]	[illegible]	1 — 1½	..	May, Nov	..	..
[illegible]	[illegible]	[illegible]	[illegible]	4 18 0	Jan, July	..	..
[illegible]	[illegible]	[illegible]	1 — 1½	4 3 0	Mr,Je,S,D	1	1
[illegible]	4	[illegible] Stock (red.)	[illegible] — 102½	3 1 0	June, Dec	..	..
..	4	[illegible]	1 — 2	1 1 6	..	..	80

Share	Last Divi-dend	Name	Price Wed., July 8	Rate % Yield-ed £ s. d.	Dividend Due	Business Week to July 8 High-est	Low-est
		TELEPHONES.					
100	2$	Amer. Telephn. & Telegh. Cap. St.	120 —124	6 12 6	..	..	..
..	4%	† Do. Coll. Trust $1,000 4 per Cent. Bds	89 —92	4 7 0	Jan, July	..	—
St.	5%	Anglo-Portug'se Tel. 5% 1st Mt. Db. Stk.	99 —102	4 18 0	Mar, Sept	..	—
5	3 0	Chili Telephone	7½—7⅞	5 2 0	August ..	..	—
1	0/7½	Monte Video Telephone Ord.	1⅛—1¼	6 12 0	Nov	1	..
1	0/6	Do. 5 per Cent. Pref.	⅞—1	5 3 0	May, Nov	..	..
St.	6%	National Co. Pref. Stock	109 —111	5 9 0	Feb, Aug	110	109½
St.	6%	Do. Def. Stock	115 —117	5 2 6	Feb, Aug	116½	113
10	6/0	Do. 6 per Cent. Cum. 1st Pref.	10⅞—12⅜	4 16 0	Feb, Aug	..	..
10	6/0	Do. 6 per Cent. Cum. 2nd Pref.	10⅞—12⅜	4 16 0	Feb, Aug	..	..
5	2/6	Do. 5 per Cent. non-Cum. 3rd Pref.	5⅛—5⅜	4 9 0	Feb, Aug	5¼	5¼
St.	3½%	*† Do. Deb. Stock 3½ per Cent. (red.)	98 —100	3 10 0	June, Dec	98¾	..
St	4%	† Do. 4 per Cent. Deb. Stock (red.)	100½—102½	3 17 6	Jan, July	102	100½
1	1/0	Oriental	1⅛—1¼	5 9 0	April, Oct	..	..
1	0 7½	Do. 6 per Cent. Cum. Pref.	1⅛—1¼	4 16 0	April, Oct	—	..
St.	4%	† Do. 4 per Cent. Red. Deb. Stock	88 —91	4 8 0	Jan, July	..	..
St.	4½%	† Telephone Co. of Egypt 4½% Db. Stk. (red.)	97 —100	4 10 0	Jan, July	..	..
5	3/9	United River Plate	6½—7	5 14 0	July	6⅞	6⅞
5	2/6	† Do. 5 per Cent. Cum. Pref.	5 —5⅛	4 11 0	June, Dec	..	..
St.	4½%	† Do. 4½ Deb. St. Red.	99 —101	4 9 0	Jan, July	..	..
		FINANCIAL, INVESTMENT, &c.					
5	3/0	† Elec. & Gen. Investment 6% Cum. Pref.	3½—4	7 10 0	Jan, July	..	..
10	2/0	Globe Telegraph & Trust	10½—11	5 1 6	SpDcMrJu	10⅞	10½
10	3/0	Do. 6 per Cent. Pref.	13⅝—14⅛	4 5 0	SpDcMrJu	13⅞	13⅝
10	6%	Submarine Cables Trust (Cert.)	127 —130	4 12 0	April, Oct	..	..
		COLONIAL AND FOREIGN ELECTRIC RAILWAYS, TRAMWAYS, &c.					
5	3/0	† Anglo-Argentine 6% Cum. 1st Pref.	6⅝—6⅞	4 14 0	April, Oct	6⅞	6⅞
5	5 0	Do. 10% Non-cum. 2nd Pref.	8¾—8⅞	5 15 0	Jan, July	8⅞	8⅞
St.	6%	† Do. Permanent 6% Deb. Stock	138 —143	4 5 0	June, Dec	141	..
St.	5%	† Auckland Elec. Trams. 5% Deb. (red.)	103 —106	4 14 3	Jan, July	..	..
5	4 0	Brisbane Electric Trams. Invest. Ord.	4⅜—4⅝	4 8 0	May	4½	4½
5	2 6	Do. 5 per Cent. Cum. Pref.	4⅞—5⅛	4 17 6	May, Nov	5	..
St.	4½%	† Do. 4½ per Cent. Db. Prov. Certs.	98 —102	4 8 0	Jan, July	101	100
St.	8%	British Columbia El. Ry. Df. Ord.	124 —129	6 4 0	Mar, Sept	..	..
St.	65.0	Do. Pref. Ord. Stock	108 —112	5 6 0	May, Nov	..	..
St.	5%	Do. 5% Cum. Perp. Pref. Stock	107 —111	4 10 0	Jan, July	107½	107
40	4½%	Do. 4½ per Cent. 1st Mort. Debs.	99 —102	4 8 0	April, Oct	..	..
100	4½%	Do. Vancouver Power Debs.	101 —104	4 6 6	Jan, July	..	..
St.	4½%	Do. 4½% Perp Con. Deb. St.	99 — 102	4 3 0	..	101½	100½
St.	6%	† Buenos Ayres Elec. Trams (1901) Ltd. Deb. St.	93 —97	5 2 6	Ja, Jul ..	..	..
5	..	Buenos Ayres Grand National Ord.	2¼—2¾	..	..	2½	2½
5	2/6	Do. 5 per Cent. Cum. Pref.	3⅞—4⅜	..	Feb, Aug	4	4
100	5½%	† Do. 5½ per Cent. Pref. Debs.	99 —103	5 7 6	Jan, July	..	..
100	6%	Do. 6 per Cent. 1st Deb. Bonds.	100 —104	5 14 6	April, Oct	..	..
St.	5%	Buenos Ayres Lacroze Trams 1st Mt. Db.	93 —96	5 4 0	Mar, Sept	93½	..
St.	6%	Buenos Ayres Port & City Tram. 1st Mt. Deb. Stock £75 Paid	64 —68	6 12 0	Feb, Aug	..	..
5	2/6	Calcutta Tramways (1 to 137,610)	5⅛ 5⅝	4 15 0	Mar, Sept	..	..
100	2/6	† Do. 5 per Cent. Cum. Pref.	5 —5⅜	4 13 0	Jan, July	..	..
1	4½%	† Do. 4½% 1st Deb. Stock (red.)	101 —104	4 6 6	Jan, July	..	..
St	..	Cape Electric Tram Shares	⅛—¼	..	..	..	—
5	1/3	City of Buenos Ayres Trams Co. (1904) Sh.	5⅛—5⅜	4 5 0	F,My,A,N	5½	5
St.	4%	† Do. 4 per Cent. Deb. Stock	97 —101	3 19 0	June, Dec	..	..
..	5%	Colombo Tr. & Ltg. 5% 1st Mt. Db.	89 —92	5 7 6	May, Nov	..	—
100	5%	Electric Traction Co. of Hong Kong 5 per Cent. 1st Mort. Debs.	85 —90	5 10 0	June, Dec	..	..
1	5%	Havana Elec. Ry. Con. Mt. 5% $1,000 50 year Coup. Bds.	82 —87	5 14 6	Feb, Aug	..	..
1	..	Kalgoorlie Elec. Trams Sh.	⅛—¼	..	..	..	..
100	5%	Do. 5 per Cent. "A" Deb. Stock	86 —89	5 12 0	Jan, July	..	—
5	6%	Do. 6 per Cent. "B" Ditto	69 — 73	8 4 0	Jan, July	..	..
5	1/0	Lisbon Elec. Trams. Ord.	1 —1⅛	4 0 0	July	..	..
100	0/7½	† Do. 6 per Cent. Cum. Pref.	1 —1⅛	4 16 0	Jan, July	..	..
St.	6%	† Do. 6 per Cent. Reg. Mort. Debs	92 —97	6 3 0	Jan, July	..	..
St.	5%	† Madras Elec. Trams. 5% Deb. Stk.	93 —96	5 4 0	Jan, July	..	..
	5%	Manila Elec. Ry. $1,000 Gold Bonds	86 —90	5 11 8	Feb, Aug	..	..
100	$1	Mexico Trams Co. Com. St.	102 104	3 17 0	..	103½	101½
500	5	Do. Gen. Con. 1st Mort. 5 Gold Bds.	91½—92½	5 8 3	..	91½	91½
St.	4½	Montreal St. Ry. Sterling 4½ per Cent. Debs. (1922)	102 —104	4 6 6	Feb, Aug	101½	101½
1	1/0	Perth Elec. Trams Ord	⅞—1	8 0 0	May	..	..
St.	5%	† Do. 1st Mt. Db. Stock	101 —104	4 16 0	Jan, July	..	—
5	3/0	† Rangoon Elec. Trams. & Supply Co. 6 Cum. Pf.	5⅛—5⅜	5 6 6	..	..	..
St.	4½	† Do. 4½% 1st Mort. Deb. Stk.	96 —98	4 12 0	..	..	..
..	$5½	† Sao Paulo Tramway, Light & Power Co. $100 Stock.	131 —136	6 12 6	..	..	..
..	5%	Do. 5 per Cent. 1st Mt. $500 Db.	93 — 98	5 2 0	June, Dec	97	..
100	4½%	Toronto Ry. Co. 1st Mt. 4½% Ster. Bonds	98 —100	4 10 0	Feb, Aug	..	..
		COLONIAL AND FOREIGN ELECTRICITY SUPPLY &c.					
5	3 0	Adelaide Elec. S'ply Co. 6% Cu. Pr.	4⅞—5⅛	5 11 0	Mar, Sept	..	..
10	5/2?	Bombay E. S. & T. Co. Cum. Pf.	10½—10¾	5 11 6	..	10½	..
St.	4½	† Do. 4½ per Cent. Deb. Stk. (red.)	92 — 94	4 16 0	Jan, July	93½	93
1	1/9	Calcutta Elec. Supply Ord.	1⅛—1¼	5 17 0	April, Oct	..	..
100	7.2	[illegible] Elec. Co. Com. St.	87½—89	7 16 6	..	88	..
100	5%	[illegible] Electrolytic Alkali Co. (of U.S.A.) 1st Mort. Stl. Debs.	92 — 97	5 2 6	Jan, July	..	..
100	5	Elect. Development Co. of Ontario	83 — 88	5 16 0	..	..	..
5	..	Elec. Ltg. & Trac. Co. of Aust. 6 per Cent. Cum. Pref.	2 —2⅜	..	Feb, Aug	..	..
St	6	† Do. 6 per Cent. Deb Stock	82 — 86	5 16 0	Jan, July	..	..
St.	6	† Elec. Supply Co. of Victoria 5 per Cent. 1st Mort. Deb. St.	90 — 93	5 7 6	Jan, July	..	..
St.	6	Indian Elec. Sup. & Trac. Co. Constn Pref. St. Rd.	10 —20	10 0 0	Jan, July	..	..
1	..	Kalgoorlie Elec. Power & Ltg. Ord.	⅛—¼	..	..	..	..
1	0/7½	Do. 6 per Cent. Cum. Pref	⅞—1	8 0 0	April, Oct	..	..
St.	6	Madras E. S. Corp. 6 per Cent. Constn Deb. St.	86 — 90	6 11 0	April, Oct	..	..
100	5	† Mexican Elec. Light Co. 5% 1st Mort. Gold Bond	81 —82	6 2 0	..	82½	81½
St	$1	† Mexican Lt. & Power Co. Cap St	56¾—57⅞	..	..	65	57½
100	5	Do. 5% 1st Mort. Gold Bonds.	87½—88½	5 10 0	..	88½	88
..	..	Montreal Lt. Ht. & Power Co. Cap. St.	96 — 99	6 1 0	F,My,A,N	98½	97½
1	1	Royal Eastern Electricity Co. Ord	⅞—1	6 0 0	April	..	..
1	1	Do. 6 per Cent. Cum. Pref.	⅞—1	6 0 0	May	..	..
St.	1	Do. 4 per Cent. 1st Deb. Stock	94 —97	5 7 0	Jan, July	96	..
6	7/0	Rosario Elec. Co. (Ltd.) (1 to 20,000)	4⅞—5⅛	6 17 0	April, Oct	4⅞	..
100	$1	Shawinigan Water & Power Co. Cap. St.	71 — 73	6 10 0	..	..	..
..	..	† Do. 4½ per Cent. Bds.	100 —102½	4 18 0	Jan, July	101	100½
..	7 7/0	Victoria Falls Power Co. Pref.	4	—	Jan, July	..	..

* In calculating the yield on such shares, provision is made for accrued interest but *not* for redemption. † Ex dividend. ‡ The London Stock Exchange Committee have declined to quote these

// THE ELECTRICIAN:

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CONTENTS OF THE CURRENT NUMBER.

NOTES.

The Mining Exhibition.

THE coincidence of our Mining Issue with the opening of the Mining Exhibition at Olympia is in every respect a happy one. Visitors to the Exhibition who have looked through the pages of our last issue will find in the exhibits practical confirmation of the case which we endeavoured to put forward for the uses of electrical energy in mining and colliery operations. Although the purely electrical exhibits are not numerous, nevertheless almost every stand contains some piece of machinery or apparatus driven by electric motors. In many instances the design of the machine has been adapted specially for the accommodation of an electric motor. The polyphase motor seems to predominate for most underground purposes, and its robust construction fits it admirably for the extremely variable and unquestionably arduous duties imposed upon it. Electric coal cutters, for instance, may look merely fascinating, if not elegant, machines when exposed for inspection on an exhibitor's stand, but under working conditions they afford the very highest form of testimonial for electric driving, and one which can probably be furnished by no other industry. In the hands of unskilled labour, spasmodically started and stopped, subjected to heavy overloads, run in a far from cool atmosphere and amid grimy and dusty surroundings, they must perform their allotted task while giving a minimum of trouble and affording a maximum operating economy. The promoters of the Exhibition and the exhibitors themselves have provided an excellent advertisement for electric power, and one which has that desirable effect which, when publicity is afforded a thoroughly genuine subject, is cumulative in every sense of the word.

FROM our inquiries among mining machinery manufacturers we gather that the advantages of electric power are appreciated by them, and they welcome the opportunity of giving it prominence, if only in an incidental way in connection with their products. The Exhibition affords mining engineers and colliery managers an opportunity of inspecting a primary battery miner's lamp, for which, what appears at first sight, extravagant claims are made. Without attempting to pass an opinion at this early stage, we may, nevertheless, be permitted to remark that a lamp of this class is very desirable for miners' use, and if satisfactory it would fill a distinct want in mining illumination, but it is by no means the first of its kind. The Exhibition has now been running a week, and will remain open until the end of the month. During the interim we are sure that its comprehensive collection of mining plant and machinery will be inspected with profit and interest by all those directly concerned in this important industry who can make the trip to Olympia. The organiser of the Exhibition, Mr. H. GREVILLE MONTGOMERY, M.P., is to be complimented on the result of his endeavours to concentrate attention upon the mining industry, and to consolidate the interests of mining engineers.

Positive Electrons.

WE translate in another column what the younger BECQUEREL says concerning his alleged isolation of the positive electron, a discovery which, if corroborated, is of very considerable importance to electrical science. The existence of positive as well as negative electrons has been suspected ever since the discovery of the latter, but although some facts indicated the existence of such electrons within the atom, nobody has hitherto claimed to have obtained them in a beam by themselves, as we do obtain the negative electrons in a beam of cathode or

β-rays. J. Becquerel himself deduced the existence of positive electrons from some magneto-optic phenomena observed in rare earth minerals like tysonite or xenotime. Lilienfeld, in Germany, appeared at one time to furnish a corroboration, and another support, unknown, apparently, to the author, was furnished by Wood and Hackett from their observations on sodium vapour. That these converging lines of evidence should eventually lead up to the isolation of the long-expected positive electron is not surprising. But although the author's experiments appear to have been carefully prepared and carried out, they cannot be said to be quite satisfactory. In the first place one might expect almost anything from the complicated arrangement of two anodes and two cathodes described. We are told that when a cathode beam plays upon a beam of canal rays, positive electrons are split off the positively charged atoms which are known to constitute canal rays. But one would think such interfering beams would be more likely to result in neutral atoms, and, in any case, it must be difficult to establish satisfactorily the identity of any beam, whether original or resultant. The case would be altered for the better if the positive electrons could be prevailed upon to emerge from the tube into the open air. If they have really the small mass of electrons, they should easily penetrate Lenard's aluminium window. But that they have such a small mass is precisely what Becquerel's experiment fails to show. It only proves that the ratio e/m, sometimes called the "specific charge," is extraordinarily high in this new species of positively charged particles. This would just as well be accounted for by some atoms losing, say, a couple of thousand negative electrons each, as by the liberation of "positive electrons." We shall await M. Becquerel's detailed account with some interest. He will not find it easy to get his "new constituent of matter" generally recognised.

The Supply of Metal Lamps.

At the recent Electric Light Convention at Chicago the tungsten lamp appears to have been the prominent topic for discussion, and we notice that in one of the Papers presented the author gives the replies received to an inquiry sent out to 501 central stations in regard to the general effect of these lamps. The great majority of the engineers at these stations consider that the new lamps will prove beneficial to the electric lighting industry; in fact, our contemporary, the *Electrical World*, describes the tone of the replies as jubilant. It is also interesting to notice the statement by the author that the production of metal lamps for the year 1908 will not reach more than $2\frac{1}{2}$ per cent. of the incandescent lamp demand of the previous year, and that it will be several years before a sufficient number of metal lamps can be obtained to displace carbon lamps to a serious extent. Our contemporary, however disagrees with this view, and believes that the great economies offered by such lamps will enable a high price to be paid for them, so that their manufacture should prove very profitable. As the supply of these lamps is being controlled in America by the central station engineers, metal lamps will probably be introduced at a slow rate, so that electricity supply authorities will have plenty of opportunity for counteracting the consequent diminished consumption of energy by obtaining new consumers.

Sir William Preece.—We are pleased to be able to report the continued excellent progress towards convalescence of Sir William Preece after his operation. Sir William is now in Wales regaining his usual vigour.

Personal.—According to the *Elektrotechnische Zeitschrift*, Herr Robert Dahlander, chief engineer of the Swedish Government Railways, has resigned this position and taken up the post of manager of the municipal gas and electricity works at Stockholm.

Society of Engineers and the Civil and Mechanical Engineers' Society.—A scheme for the amalgamation of these two societies has been approved by the respective councils, and the terms of the amalgamation will be shortly submitted to the members of both societies. It is confidently believed that the amalgamation will receive the cordial support of all members, and will result in a large accession to the membership.

Wireless Telephony.—It is stated that French naval officers and engineers are making experiments in wireless telephone working between the Eiffel Tower (Paris) and the battleship "Vérité," which is conveying M. Fallières on his trip to Scandinavia. The results so far attained are reported to be extremely promising. It is said that Lee de Forest instruments are used in these experiments, the same as those employed by the American Pacific Squadron in some recent experiments.

The Post Office Electrical Engineers' Journal.—We have received the July issue of this journal, in which by far the most interesting feature is an article by Major W. A. J. O'Meara on "Education and Training of Telegraph Engineers in France." The discussion of how other people do things is always fascinating and shows up our own shortcomings in the pleasantest possible way. An article by Messrs. C. C. Vyle and E. V. Smart deals with "The Motor-Driven Wheatstone Transmitter," while Mr. A. G. Lea writes on "The Design of Telephone and Telegraph Cables." Other contributions are by Messrs. G. W. Hook, E. Gommersall, W. Noble, J. W. Turner, C. Harris, and J. Zenneck. There are a number of Institution Notes dealing with matters interesting to Post Office Engineers.

Mixed Pressure Turbines.—In our Mining Issue last week we stated that Messrs. Willans & Robinson introduced the mixed type of turbine to meet the special conditions existing at collieries. In doing so we did not wish to imply that Prof. Rateau, to whose ingenuity we believe the steam accumulator is due, had nothing to do with this innovation. We think we are right in saying that Prof. Rateau took out patents in this connection as far back as 1901, and has had several turbines of this kind running on the Continent during the last four years. But we believe that we are also right in saying that Messrs. Willans & Robinson were the first to bring forward commercially the mixed turbine in one cylinder, as supplied to the Tredegar Co., this idea being subsequently adopted by other makers.

Large Gas Engines.—The success which attended the visit, organised last autumn by the Key Engineering Co., to inspect large gas engines under construction and installed in German works has led that company to organise a further visit, which has taken place this week, the party having left for the Continent last Monday and being due back in London to-morrow evening. We understand that the works visited include the Heinitz Government mines installation, Messrs. Ehrhardt & Sehmer's works, Messrs. Thyssen's works and the Bruckhausen Iron & Steel Works. The names of those who are taking part in this tour are: Sir John Turney (Nottingham), Councillors Clarke (Nottingham), Ellaway (Birmingham) and Freeman (Birmingham), and Messrs. P. R. Allen (Runcorn), L. Andrews (London), R. A. Chattock (Birmingham), A. C. Cramb (Croydon), W. J. Crampton (London), E. W. Cowan (London), J. Dalrymple (Glasgow), J. Ferguson (Glasgow), W. W. Lackie (Glasgow), A. H. Lymn (London), H. B. Mathews (London), R. B. Slacke (Manchester), H. Talbot (Nottingham) and S. J. Watson (Bury).

Cable Interruptions.

	Date of Interruption.
Cayenne–Salinas	May 12, 1908
Las Palmas–Arrecife	May 18, 1908
Kwandang–Manado	July 9, 1908

Accumulators for Peak Loads.—In our Correspondence columns Mr. A. M. Taylor corrects an impression that the accumulators referred to in his I.M.E.A. Paper, which we published last week, were estimated on a one-hour rating; apparently a three-hour rating was adopted, so that the batteries suggested would be good for all probable overloads up to 100 per cent., and would thus be able to meet conditions due to fog. We would point out, however, that the price of £15 per kilowatt, including accessories and buildings, although true for a one-hour rating, appears to be too low for a three-hour rating.

Gin Electric Furnace for Smelting Zinc.—The *Engineering and Mining Journal* describes a furnace for this purpose recently patented in France. It is of the induction type, the primary circuit consisting of windings of copper wire, and the secondary circuit of a bath of molten iron contained in two distillation chambers, which communicate by a channel also filled with molten iron. The insulated copper wire is protected from radiated heat by water-cooled plates, between which and the windings are channels through which cold air is passed. The mixture of zinc ore and carbon is charged mechanically into the distillation chambers. Molten zinc condenses in the first condensation chambers, which are at a temperature of 500°C. to 700°C. Further condensation is effected in a second set of chambers, and the vapours then deposit zinc dust in further chambers before they pass into the chimney. At the end of the distillation, the zinc is run out of the condensation chambers by tilting the furnace, and the residues in the distillation chambers are rabbled off, without interrupting the heating. The lining of the furnace consists of bricks made of dolomite and magnesia.

Double Cantilever Crane for Railway Use.—A large crane has recently been erected by Messrs. C. & A. Musker, of Liverpool, for the Lancashire & Yorkshire Railway Co. at their North Mersey and Alexandra Dock goods station. This crane has a lifting capacity of 10 tons over a span of 172 ft. and a crane travel of about 540 yds., thus covering the greater portion of the company's immense timber ground, and giving greater facilities to the traders. The total length of the crane is 188 ft. and the total height 63 ft., and it will stack timber to a height of 30 ft. The operator travels with the crab, thus having the load always in view, a matter of importance when working amongst timber stacks; consequently all the controllers for working the motors are placed in the crab cage. The crane legs are placed sufficiently wide apart to allow a log of timber 40 ft. long to pass right through from one side of the yard to the other without requiring to be twisted. The crane will travel up and down the yard at a speed of 400 ft. per minute, and the crab will travel across the crane at speeds up to 600 ft. per minute, and a weight of 10 tons can be hoisted at 90 ft. per minute.

Wireless Telegraph Notes.—The French papers have recently contained particulars of the prospectus of the Compagnie Française de Télégraphie San Fil et d'Applications Électriques, inviting subscriptions to an issue of capital made by the company, which, according to the *Journal*, has attained "a significant success by securing by a coup a monopoly of wireless telegraphic communications in the Straits of Gibraltar, the Spanish Government having (it is stated) granted the company a concession to establish 24 stations on the Spanish coasts and on the Balearic and Canary Islands." Last year (continues the *Journal*) the same company established stations at Tangier, Casablanca, Rabat and Mogador, and now claims that, since it can operate on the two continents separated by the Straits of Gibraltar, it has wireless control of the most important part of the world. The first station is (continues our contemporary) to be established at Cadiz and will be indirect communication with the Canary Islands. Barcelona and Vigo are to follow, these four stations to be working by January next. Twenty more stations are, it is stated, to be in operation by September, 1909. The moving spirit of the French company, which is affiliated to a Spanish company with offices in Madrid, is M. Victor Popp, whose name is well-known in connection with many French electrical enterprises. M. Popp is the promoter of both the French and the Spanish companies, and is president and director-general of each. Neither the prospectus to which we have referred nor our Paris contemporary states whether the company or the Spanish Government will operate the 24 stations or any of them, and it may be pointed out in regard to the suggested establishment of wireless communication between Cadiz and the Canary Islands that the Spanish Government have quite recently signed a contract for the making and laying of a submarine telegraph cable between these two points. This contract has, we believe, been secured by an English firm, and the order is in process of execution. The total capital of the French Wireless Company is Fr.1,255,000. Our Paris contemporary is also not quite accurate in regard to the statement that the Spanish company is operating in Morocco. There is an affiliated company, called the Compagnie Marocaine des Télégraphes, with head offices at Tangier, and this company is responsible for the operation of the stations in Morocco. The system of wireless which is worked by these various companies is the "Telefunken." The list of subscriptions for the French issue closed on Wednesday.

Reuter announces that wireless telegraphic communication was established on July 9th between Lima and Iquitos (Peru).

Experiments are being made in regard to the installation of a system of wireless telegraphy on the Channel Islands boats of the Great Western Railway Co. The "Reindeer" has been fitted up with apparatus from which very satisfactory results are said to have been obtained.

Orders have been issued by the Admiralty directing that wireless telegraph offices on board ships which are exposed to the blast of heavy guns are to have their doors made of 10 lb. steel plating without windows.

The Tramways and Light Railways Association.—The annual congress was resumed on Friday last at the Franco-British Exhibition, when Mr. A. L. C. Fell presided and delivered an address, in which he said that he hoped the Exhibition would be such a success that some of the buildings would be again used next year, a portion being set aside for a tramway exhibit worthy of the industry. In this connection he gave some comparative figures showing the great development of tramways during the last 30 years. The remainder of his address was mostly concerned with matters pertaining to the Association. In the course of his remarks he mentioned that unfortunately it had been impossible to prepare the report on "Brakes" in time for the congress, but he hoped it would be submitted to the Board of Trade before the end of the recess. As indicating the large amount of work comprised in the preparation of this report, he mentioned that 41 committee meetings had been held. The Municipal Tramways Association had also been investigating this question, and he felt that the report on "Brakes" ought to have been a joint report by the two tramway associations, since there was no question of policy involved. The Association were also about to appoint a committee to investigate the matter of "rail corrugation." Prof. Carus-Wilson then gave a lecture on "Rail Corrugation," of which we hope to give an abstract in our next issue. This lecture was discussed by a few provincial members who will be unable to be present at the meeting which is to be held on Friday, July 24th, at 4 p.m., at the offices of the Association, 35, Parliament-street, S.W.; on that occasion the model shown by Prof. Carus-Wilson at the congress will again be on view for half an hour before the meeting, as we understand that several members have expressed a desire to inspect it. Last Friday evening an informal dinner of the Association was held in the Exhibition.

ARRANGEMENTS FOR THE WEEK.

SATURDAY, July 18th.

Institute of Marine Engineers.

7 p.m. Meeting in the Congress Hall, Franco-British Exhibition. Paper by W. P. Durtnall on "The Generation and Electrical Transmission of Power for Main Propulsion and Speed Regulation."

FRIDAY, July 24th.

The Tramways and Light Railways Association.

4 p.m. Meeting at 35, Parliament-street, Westminster. "Rail Corrugation," by Prof. Carus-Wilson. Adjourned discussion.

ELECTRIC TRACTION ON RAILWAYS.*

VI.—GENERAL COMPARISON OF CONTINUOUS AND ALTERNATING-CURRENT TRACTION.

BY PHILIP DAWSON.

(*Continued from page 439.*)

Summary.—The author, having described the chief points in connection with continuous current, three-phase and single-phase systems of railway electrification, now makes a comparison between them, giving in the form of tables particulars of various typical equipments.

We will now consider another point, and one which for heavy electric railway traction is of particular importance, especially if the question of long distance traction should ever arise, and that is the continuous output of which traction motors are capable, and, after having examined this question for the continuous and single-phase motor, institute a comparison between the results obtained.

For this purpose certain tables have been compiled :—Table XII. gives a comparison between the one hour rating and continuous rating of direct-current traction motors, from which it will be seen that for large railway motors the hour rating is from 2½ to 3 times the continuous rating.

Table XIII. gives a comparison between the hour and continuous rating for single-phase motors, from which it will be seen that the hour rating is only from 1½ to 3 times the continuous capacity, and Table XIV. a comparison between one and three hours' rating with a temperature rise of 75°C. In this connection it is interesting to remember that in connection with the design of larger single-phase traction motors artificial or forced ventilation has come into use to a considerable extent. The limit in the output of a given size of machine is entirely a thermal question, and it is not therefore surprising that forced cooling should have been resorted to. Indeed, some manufacturers apparently intend to use this method throughout, and in this connection it is interesting to note that the single phase equipments supplied by Messrs. Siemens Schuckert to

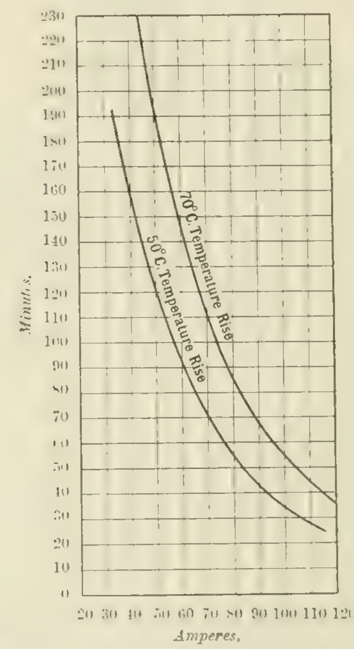


FIG. 53.—TEMPERATURE CURVE, OERLIKON MOTOR, TYPE T.M. 14. 900 VOLTS.

the Midland Railway for their experimental line at Heysham have forced cooling, effected by means of a motor driven fan fitted in the motor car. The increased output which can thus be produced is clearly shown from the figures given in Table XV. These tables go to show that the ratio of continuous output to hour rating is greater in the case of single-

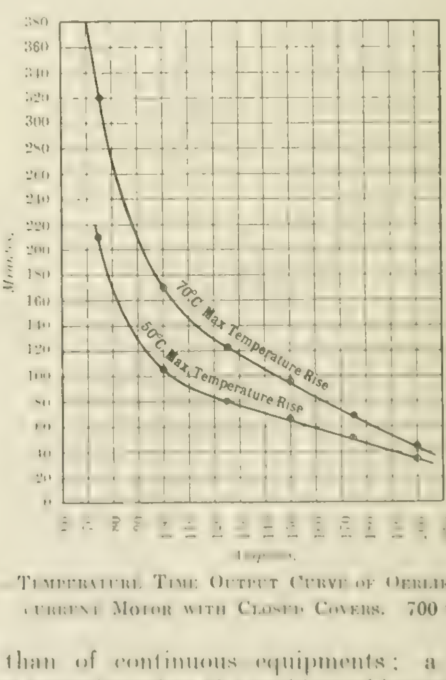


FIG. 54.—TEMPERATURE TIME OUTPUT CURVE OF OERLIKON CONTINUOUS-CURRENT MOTOR WITH CLOSED COVERS. 700 VOLTS.

phase than of continuous equipments: a point which deserves attention when the problem of heavy railway electrification is approached.

The comparative outputs per given periods for different classes of continuous and single phase motors are clearly illustrated in the following diagrams. Fig. 53 gives the thermal characteristic curve for a continuous current trac-

Table XII.—*Comparison between Hour and Continuous Rating of some Continuous-current Motors.*

Types of Motor.	One Hour Rating in H.P.	Continuous Capacity in H.P.	Ratio of continuous to one hour rating.
G.E. 60.	22	9	41·0 per cent.
Oerlikon T.M. 22 ...	180	65	36·0 ,,
Oerlikon T.M. 14 ...	120	41·5	34·7 ,,
G.E. 58	35	10	28·6 ,,
G.E. 66	115	40	34·8 ,,

Table XIII.—*Comparison between Hour Rating and Continuous Rating of some Single-phase Motors.*

—	Hour rating in H.P.	Continuous output rating in H.P.	Ratio of continuous to one hour.
A.E.G. WE 51 motor...	115	60	52 per cent.
A.E.G. locomotive* gear driven	350	250	71·5 ,,
Westinghouse.....................	150	55	36·8 ,,
American *a.c.* motor as per W. Sprague	125	64	51 ,,

* Forced ventilation.

Table XIV.—*Comparison between One and Three Hours' Rating with Temperature Rise of 75 C. (d.c. motors).*

Type of Motor.	Load for 1 hour Rise 75 C.	3 hour Run with Temp. Rise 75 C	Commercial rating 1 hour run. 70 C rise.
G. E. 69	240 H.P.	150 H.P.	200 H.P.
G. E. 76	170 H.P.	100 H.P.	150 H.P.

Table XV.—*Comparison of Output based on one hour rating with closed cover with natural and forced ventilation of some Siemens Schuckert Single phase Motors.*

Natural ventilation.	Forced ventilation.	Increased output in percentage.
175 H.P.	210 H.P.	20
225 H.P.	225 H.P.	17·8
320 H.P.	370 H.P.	15·7

tion motor built by the Oerlikon Company, and operating at the pressure of 900 volts. Fig. 54 gives two curves of a similar nature corresponding respectively to a temperature rise of 50 and 70 degrees Centigrade for a 700 volt continuous-current motor, and Fig. 55 gives the time in which

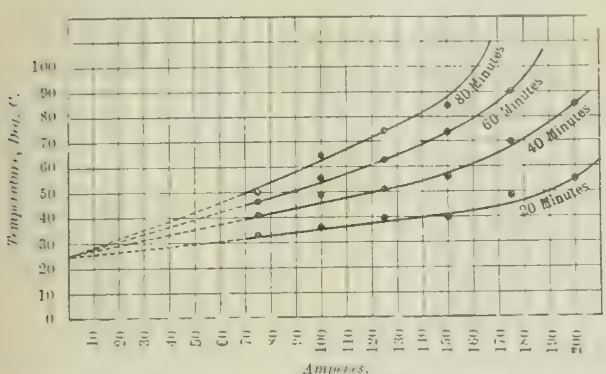


Fig. 55.—Oerlikon Type T.M. 22 Continuous-current 200 h.p. 700 volt Motor.

Temperature curves with closed motor covers.

for any given rate of increase of load the temperature rises. Fig. 56 gives the thermal capacity of a G.E. 58 railway motor, and Figs. 57 and 58 show the relation between output and time for a given temperature rise, and refer to standard continuous-current American tramway motors,

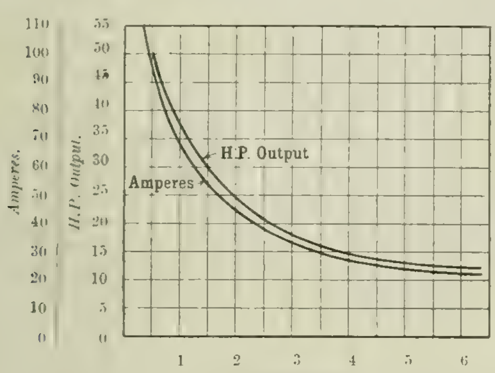


Fig. 56.—G.E. 58 Railway Motor.

Four-turn armature, 500 volts. Thermal characteristic curves.

whilst Fig. 59 is the result of a large number of tests carried out by the Author on a standard single-phase traction motor.

In conclusion a few remarks on the three systems of motors at present in use for operating railways, may not be out of place.

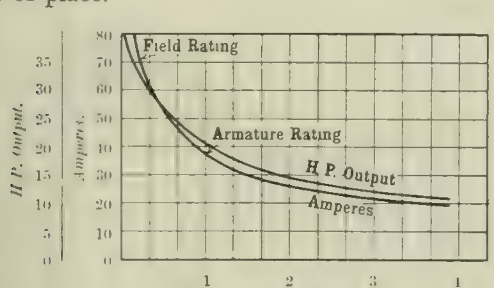


Fig. 57.—G.E. 60 Railway Motor.

Six-turn armature, 500 volts, 30 in. wheels, gear ratio 4·78. Thermal characteristic curves.

Temperature characteristics of continuous-current traction motor for temperature rise of 75°C.

The continuous-current motor as at present designed, may eventually work at pressures of from 2,000 to 4,000 volts, but it would seem mprobable that higher line pressures of from 6,000 to 15,000 or even 20,000 volts, which are the pressures that will be necessary in connection with main railway electrification can ever be worked with direct current motors. A continuous-current equipment, including all regulating gear, is lighter than the equivalent single-phase equipment.

The efficiency *qua* motor of a continuous-current machine is slightly in excess of that of a corresponding single-phase motor. The speed regulation of single-phase motors is more economical than is possible with direct-current machines. As regards commutation there is little to choose between the two types of machines, although the single-phase motor

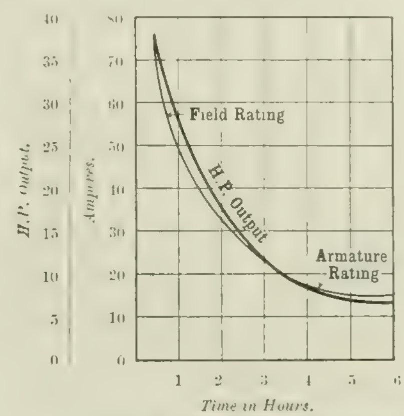


Fig. 58.—Four-turn Armature.

500 volts thermal characteristic curves. Curve showing time in hours during which motor will deliver any given B.H.P. through its gearing or pass given current with a temperature rise not exceeding 75°C.

Temperature characteristics of continuous-current traction motor for temperature rise of 75°C.

requires a greater number of brushes and commutator segments than are needed with the corresponding direct-current machine.

The cost of manufacture of a single-phase motor is greater than that of the direct-current motor. For equal output under equal conditions of design and operation the dimensions of a direct-current machine are smaller than those of the corresponding single-phase machine.

The maximum line voltage, owing to the necessity of using two working conductors and the difficulties of insulation at points and crossings, is in the neighbourhood of 3,000

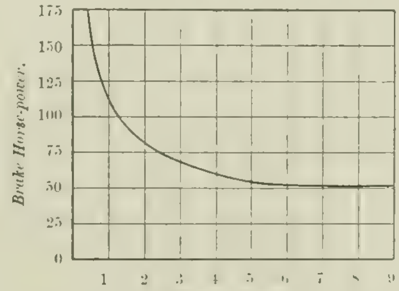


Fig. 59.—Single-phase 25~ Traction Motor.

Horse-power-hour curve for temperature rise of 75°C. with open covers, shop test.

volts for three-phase motors. Speed regulation is much more difficult and much less economical with three-phase than with either direct-current or single-phase motors. Under these circumstances it could appear as if for British conditions, as far as conversion of existing steam roads or parts thereof to electric traction is concerned, the only two systems to be considered are the high-pressure continuous machine and the single-phase motor; and as regards which is the most suitable no general rules can be laid down, the local conditions that obtain in each case deciding as to which system should be installed.

(To be continued.)

TRAMWAYS OF THE WORLD.*

BY SIR CLIFTON ROBINSON.

The author first gives a brief historical *résumé* of the early days of tramway enterprise, and it is interesting to note his advocacy at that time of cable traction in preference to horse and steam haulage. He describes the inauguration of the first cable tramway in this country—that at Highgate Hill in 1884—and the construction on the same system of the lines at Los Angeles, California, in which he took a leading part.

Excellent as the cable system was in practice, it had its drawbacks in the way of large capital expenditure, extensive road excavation, and the movement of dead-load mechanism in the conduits under the street. Where the traffic was of reasonable magnitude, the extremely low working expenses more than offset the capital cost, but the latter rendered it impracticable for suburban and outlying districts. There was also a limit to the length of cable which could be profitably utilised, so that for a large system power houses had to be multiplied indefinitely. Some method combining greater flexibility and power of expansion was needed, and traction engineers longingly turned their eyes in the direction of electricity. Sir W. Siemens exhibited the first electric railway model at Berlin in 1879, and the first line for public traffic was opened at Lichtenfelde, in Belgium, in 1881. Edison and S. D. Field constructed a short electric railway at the Chicago Exhibition of 1883, and in the same year Magnus Volk laid down a short electric line on the beach at Brighton. The inauguration of the Giant's Causeway electric tramway took place also in 1883; the initial electric conduit tramway was opened at Blackpool in 1884, and the Bessbrook and Newry line a year later. In America the idea of the overhead trolley-wire method of transmission on tramways was being vigorously developed, and, after many failures and much discouragement, this system attained its first substantial recognition at Richmond, Virginia, in 1886, and a year later secured a more pronounced success at Boston, Mass.

British Electric Tramways.—In Jan., 1893, the first electric overhead trolley line in Great Britain was opened at Roundhay Park, Leeds. The poles and overhead construction were pronounced hideous, but the speed and ease with which the cars moved proved a revelation. This demonstration was quickly followed by the conversion of the South Staffordshire steam tramways, but hardly had these lines got under way when the æstheticism of a section of the British public was up in arms at the outrage thus perpetrated, and, as all sorts of danger were imagined, parliamentary inquiry, involving tedious delay, was instituted. The outcome was the promulgation in 1894 of Board of Trade Regulations for the protection of existing interests, and those rules, remodelled from time to time, are still in force. They have no doubt increased the construction cost, but on the whole have encouraged a type of installation and equipment unsurpassed if not unequalled in the world.

About this time the famous decision was given by the House of Lords that the price to be paid by a local authority in exercising its powers of purchase under sec. 43 of the Tramways Act was the cost of construction minus an allowance for depreciation dependent upon the condition in which the tramways were when acquired. Something of the kind had been feared, and tramway companies had become chary of investing capital in electrification. When the House of Lords' judgment encouraged a rush of local authorities to enter upon schemes of tramway ownership, all hope of raising capital by private enterprise for the adoption of the new method of traction had to be practically abandoned. A few of the stronger and more progressive companies, in enjoyment of considerable terms of unexpired tenure, and strong in the faith that was in them, came to terms with the local authorities and succeeded in pressing forward the realisation of electric traction.

Encouraged by his American experiences, the author returned to this country and entered upon an energetic advocacy of electric traction, the results of which are seen in the many tramways with which his name is connected. He describes his struggle from 1894 to 1901 in establishing the London United Tramways, and gives particulars of some of the other undertakings with which he is personally associated.

The London County Council tramways require separate mention. Owing to the extensive adoption of the conduit system a large capital expenditure has been necessary, and to this must be added the price of the old horse tramways taken over from the companies. At present the total cost represents over £60,000 per route mile of tramway, and about half the mileage consists of horse lines still to be electrified. When all these have been converted the cost per mile over the completed system will be considerably higher. Although the lines are operated through what is probably the most congested districts in the world, and the cars carry about a million passengers per day, there is only a modest surplus for the reserve fund after paying working expenses and the enormous annual capital charges. It is only fair, however, that two features common to other similar undertakings should be referred to. First, the horse lines, partly owing to dislocation of traffic during reconstruction, are operated at a loss, and this, it may be assumed, will improve concurrently with the work of electrification. Second, the debt charges are not equated as in other towns. The result is that, instead of a uniform charge over the whole period of the currency of the loans, interest and redemption on the whole sum borrowed is paid from the first, and the amount of interest paid per annum diminishes every year as the capital is paid off. Thus, even though matters were not to improve, the financial position should get better every year provided adequate amounts are set aside as a reserve for depreciation and allowed to accumulate, a matter which, as we know, is at the moment seriously exercising the minds of all concerned.

The London County Council have recently departed from their strict adherence to the underground conduit and have now adopted the overhead trolley system, so the author may be pardoned if he sees in this recantation a vindication of his views. There appears no prospect of extensive development of the conduit, or of any surface contact systems, save in places where from æsthetic considerations, real or affected, overhead wires are prohibited, and the author's judgment is that the electric trolley still holds the field.

The Light Railways Act of 1896 must be mentioned. To a considerable extent it has been taken advantage of for the construction of electric tramways, and the procedure is quicker and somewhat cheaper than that of proceeding by bill. The veto of the local authorities has not to be encountered, but against this an existing railway company may veto a proposal on the ground of competition, and a light railway order will not be granted for a line which would be wholly within the area of one local authority. The act is gradually becoming a dead letter, and no great increase in the number of applications under it can be hoped for till it has been amended.

The greatest stumbling block in the way of tramway promotion is the power of veto vested in local authorities by the Standing Orders of Parliament. Many efforts have been made to induce Parliament to remove or at least mitigate an evil that has had an immense influence in retarding the progress of street locomotion in this country. Great hopes were entertained that good results might follow the recommendation of the Royal Commission on London Traffic in 1904, that the veto should be modified if not altogether abrogated. Although Imperial Parliament has not made any definite pronouncement, our labours in pressing this very necessary reform have not been altogether in vain, and the first step was made this session in connection with the project for linking up our West London, Middlesex and Surrey lines across King Edward VII. Bridge, when the Committee of both Houses unanimously disallowed the veto of the two County Councils, and permitted the bill to proceed.

Great hopes were based on the announcement by the Royal Commission: "We have come to the conclusion that the appointment of a permanent body to deal with questions of London locomotion is expedient." A carefully selected tribunal, impartial and working on broad lines, would, the author is convinced, be able to concentrate and consecrate to the best service of London the energy, experience and brains that are now expending themselves on partial and fragmentary projects. There is no question in his mind but that until the great problem of the traffic of the metropolis is handled in some such way as is suggested it will continue to be a reproach that, in spite of all our individual efforts, we lag far behind many of the other great capital cities of the world.

Mention is made in the address of the B.O.T. tramway returns, the figures of which are proof of continued expansion and prosperity. As regards engineering improvements, the greatest advance of recent years is probably in track construction. The following details of the most recent form of permanent-way construction on the London United Tramways may be interesting as conforming with the best standard in modern tramway practice.

The foundation is a bed of Portland cement concrete not less than 6 in. in depth, in which are embedded cross sleepers of old girder rail inverted and bolted solidly to the girder track rails. These sleepers are placed at intervals of 9 ft. and extend for 9 in. outside the gauge line. In addition to the fishplates, each joint is provided with a girder sole plate consisting of a ½ in. flat plate 10 in. by 20 in. riveted to a 24 in. length of 6 in. girder joist, which is embedded in the concrete. The girder sole plate is bolted to the flanges of the running rail and forms a very solid and effective support. The result of the experience with this arrangement has been entirely satisfactory. On all extensions constructed during the past three years the rails of the British standard No. 8 size and specification, have been used, having a weight of 100 lb. per lineal yard straight track with a depth of 6¾ in. and a width of base of 7 in. Practically the whole of this tramway area is paved with Australian Jarra blocks 9 in. long, 3 in. wide and 4½ in. deep, and close jointed, laid on a floating of sand and Portland cement. All points and crossings are of manganese steel, and every possible means is adopted of making the permanent way substantial and

* Abstract of an address delivered on July 9th before the Tramways and Light Railways Association.

durable, to obviate as far as possible an unduly heavy drain on revenue in maintenance and repairs. The cost of construction per mile of double track amounts to £13,000.

In regard to British tramways generally, there appears to be no reason why, skilfully managed and conservatively financed, they should not enjoy an indefinite period of financial prosperity. There are three points that handicap us in comparison with other countries: (1) Our tramway cars are not permitted to travel fast enough, the average speed being less than 10 miles an hour. (2) The double-deck tramway car in general use causes much delay, particularly at stopping points. The adoption of this type of car is consequent upon the regulation enforced by the authorities that no car shall be licensed to carry any passenger for whom a seat is not provided. (3) Traffic could be handled more successfully on special occasions were the present licensing restrictions regarding passengers removed or amended. It is undoubtedly the fact that there is nc other country in the world where such onerous conditions are imposed upon the operation of electric tramways, and we are faced by the alternative that either we are right and all the rest of the world is wrong, or we are lagging behind the more progressive nations. In Tokyo, with an electric tramway mileage approximating to that of the London United, 1,000 cars a day are run at an average speed of 20 miles an hour, and the passengers carried number some 300 millions a year, or nearly six times the number carried over the lines of the London United.

Municipal control of tramways, although benefiting from the command of cheap capital, has done little for the solution of scientific or traffic problems.

The United States.—The growth of electric traction was here amazing, as may be gathered from the fact that in the early nineties nearly every town with a population of over 10,000 had its electric tramway. The reasons may be summed up as follows:—Bad roads, cheap and easy grants of franchises and concessions for long or indefinite periods, lack of legislative checks on cheap (and sometimes at first crude) forms of construction, alertness of the people to grasp new ideas and opportunities, a general desire for rapid transit, enormous manufacturing interests, the activity and insistence of promoters and speculators, and the political doctrine of individual freedom and equality. Much of the work, of course, had to be done over again, and a better permanent way, better overhead construction, and better power stations provided.

There is little prospect of tramways being worked by municipalities in America. In New York the city authorities have constructed the whole of the latest underground electric railways and then leased the line to the operating company. The people who have anything to lose have a wholesome distrust of local authorities, and too often there seems to have been ample cause for it. There have been prolonged struggles over the municipalising of the tramways in Chicago and Cleveland, and the proposals so far do not seem to go further than that the public should own the undertakings and lease on terms to a company under municipal control.

It should be clearly understood that the only reason why the conduit system is employed in New York and Washington is that overhead wires for any purpose whatever are prohibited by the Legislature. In Chicago, San Francisco and elsewhere the overhead trolley has been largely substituted for the cable system. A considerable proportion of the American tramways are less prosperous financially than ours, but, so far as engineering and traffic management are concerned, the present-day American administrator deserves unbounded praise for his enterprise and almost consuming energy, and the various departments appear to be most elaborately and efficiently organised.

British Colonies.—The author has not paid special attention to Canada, but the style of construction there is similar to that in the United States. The population is relatively small, and the number of undertakings in 1906 was only 48. Electric power is almost exclusively used. The total length of lines, measured as single track, was 1,150 miles, and growth is rapid, as in the preceding year the length was only 956 miles. The number of cars was 2,920, against 2,697. Australia has no extensive systems of mechanical tramways outside Melbourne and Sydney, the former, worked by a company under arrangement with a joint board of municipalities, is cable system, and the latter, mostly electric, is worked by a Department of the State. Tramways in other towns are electric, except, in Adelaide, where a large horse system has been taken over by the local authorities, and is now being extended and electrified. In New Zealand there are only a few tramway systems, mostly electric. South African tramways are suffering from the trade depression there.

The author was much struck during his recent journey with the development of electric tramways in Tokyo, Yokonama, Shanghai, Hong Kong, Singapore, Colombo, &c. These follow western models; indeed, most of them have been built and equipped by British engineers. In Japan, however, they are run by native officials; but in China Europeans are in administrative command, as in those towns in India, where tramways have been installed.

Europe.—A prominent feature on the Continent is the use of alternating current instead of continuous. The great variety of local conditions in different European countries, and of nationalities and customs, is reflected in the variety of equipments. As a rule, the operation is in the hands of companies.

Conclusion.—Too often in this country have we lagged behind in the race with other countries, not from any backwardness in our capitalists, inferiority in our engineers, or lack of enterprise in our business men, but because we have been bound by legislative restrictions and innate conservatism. But in the past public opinion and Parliament have been forced to accede to changes which have been proved beneficial in young, adventurous and go-ahead countries and colonies. In such cases we have profited by the experience and mistakes of those who led the way, and as a result we have produced apparatus and plant superior to that of any other country. This will be the case again in the near future in connection with inter-urban tramways and light railways. The author is looking for the substitution of the electric for the steam locomotive on railways. Meanwhile, let us still impress on Parliament that, while the improvement and development of the means of generating, transmitting and distributing electrical energy have made rapid, cheap and cleanly transport possible, the legislation affecting it remains a relic of the horse age. But, having done so much despite discouragement, let us not despair of doing more.

ELECTRIC SIGNALLING AT THE NEW VICTORIA STATION, LONDON.

The rebuilding of the passenger station of the London, Brighton & South Coast Railway Co. at Victoria, London, has been in progress for about eight years, and the work, which has entailed the solution of some important engineering problems, is now approaching completion. The station is one of the busiest of London's great railway termini, and both main line and local trains converge upon it. It is in connection with the rebuilding of the station and the rearrangement of the traffic that the length of line between Victoria and London Bridge is to be operated on the single-phase alternate-current system (see *The Electrician*, Vol. LIX., p. 888). The management is evidently in practical sympathy with electrical developments, judging by its enterprise in connection with the traction scheme referred to, and also in the matter of its signalling arrangements. It is with the latter that we propose to deal in the present article. We may mention at this juncture that the extension of the traffic facilities at Victoria has not only affected the immediate vicinity of the station proper, but also the entire stretch of permanent way between Victoria and Battersea Park. This has been widened by the addition of three extra running roads up to the south side of Grosvenor Bridge over the Thames, and beyond by two additional roads. The bridge across the Thames has been widened, and other important engineering works undertaken. The cost of the entire scheme when finished will probably reach the sum of £1,500,000. This will serve to indicate that in the matter of cost the signalling arrangements do not rank with the more imposing works, though their importance in the control of the traffic is infinitely greater.

All the signalling between Victoria and Battersea Park is carried out on what is known as the Sykes Electro-Mechanical system, so called because the distinct operations of signal and point movement are performed respectively by means of electrical and manual energy. All signals are actuated electrically by "slides" in the operating frame, and the points are moved by mechanical levers which are interlocked in the ordinary way. The use of slides saves a considerable amount of space in the frame and also labour in operation. In conjunction with this installation is the lock-and-block system, the distinctive feature of which, apart from those of signal operation, is the interlocking of the block instruments with the signal slides and point levers. The ordinary block telegraph instrument, common to most railway systems, is dispensed with, and its place is taken

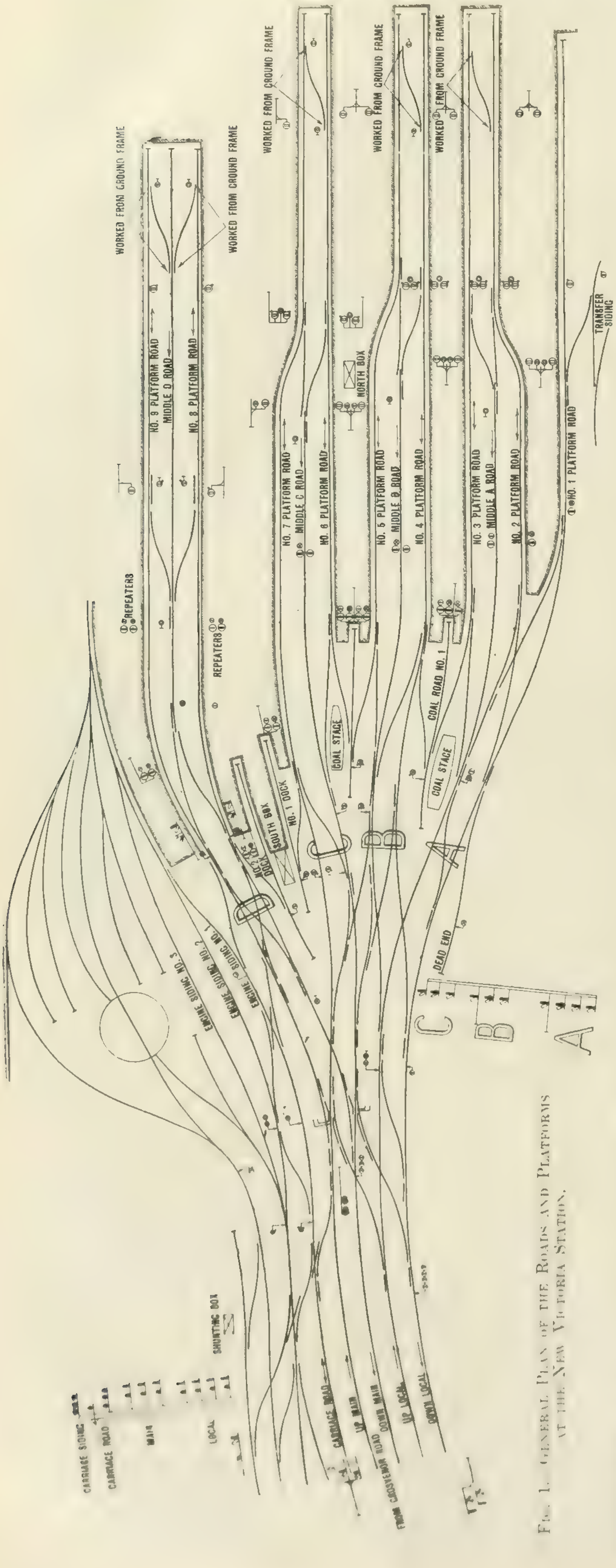


Fig. 1.—General Plan of the Roads and Platforms at the New Victoria Station.

by indicating and locking devices which prevent the release of sectional signals in one box without what we may call "electrical permission" from the signalmen in other boxes. The connections are, in fact, so arranged that each signalman has electrical control of the release of the signals on each side of him, and unless he closes the releasing circuit of the particular signals controlled they cannot be pulled off by the man in the next box. The act of giving the release signal, or "plunging," as it is termed, locks the push switch by which the signal has just been sent, and prevents the signalman sending forward another train until the preceding one has passed over a "treadle" or rail switch, which again releases the plunger of that particular section.

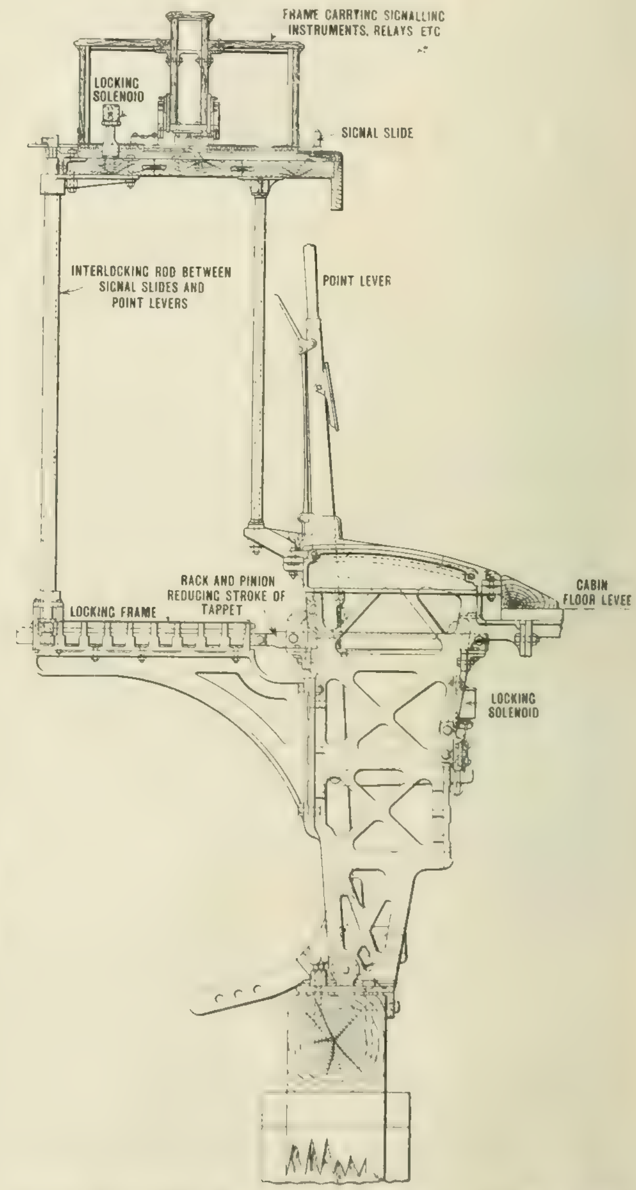


Fig. 2.—End View of Signal Slide and Point Lever Frame as Installed at Victoria Station.

A plan of the roads at Victoria station is shown in Fig. 1, which indicates the positions of the boxes, signals, points, &c. The largest cabin is that known as the South Box, measuring 60 ft. by 14 ft. and containing 106 mechanical levers for point operation and 163 electrical signal slides. Fig. 2 illustrates an end view of the locking frame used at this station. The mechanical levers, which are 7 ft. 6 in. long from the centre to the top of handle, and have a draft of 2 ft. 6 in., are placed at 5¼ in. centres and the electrical slides, which are above these levers, about 5 ft. from floor level, at 2⅝ in. centres.

The signal slide frame is formed of wood panels, which can be lowered from the front to give access to the slides and block instruments which, together with the signal keys or

"plungers," train indicators and signal repeaters, form a part of this frame and give it a compact appearance. The slides, as their name implies, move in a horizontal plane and are pulled out or pushed in as may be required, the draft being 2 in. In both positions they are check locked by a small electromagnet, the plunger of which is arranged to obstruct the path of the slide. The slide handle is provided with a depression switch, which is in series with the lock and may be used under certain conditions to remove the lock by closing the circuit of the lock magnet. These conditions are governed by the trains, which make or break the lock circuit at a "locking" bar operated by the flanges of the train wheels. Similarly, certain of the point levers are provided with an electrical lock, which consists of a magnet in circuit with an electrical depression bar placed at the points, and so arranged that, while an engine or train is standing on the bar, the lever

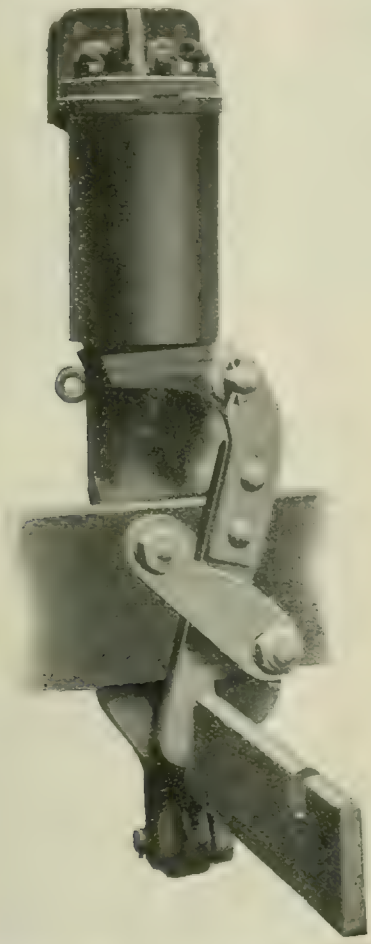


FIG. 3.—DETAILS OF CHECK LOCK MAGNET AND LOCKING BARS FOR POINT LEVERS.

cannot be pulled over. In such cases, a current-saving device is provided in the form of a foot plunger fitted in the floor of the cabin opposite the lever, and only by depressing this plunger can the lock magnet circuit be closed and the lever freed to operate the points. A detail of one of the locking magnets for the point levers is shown in Fig. 3.

All interlocking between electrical slides is done on the shelf above the frame, and all interlocking between slides and levers is done in the troughs below the floor line. The interlocking is of the "tappet" type, the mechanical tappets being worked from an escapement gear, which reduces the stroke on the tappet to 2 in., at the same time keeping the tappet 3 ft. 5 in. from the fulcrum of the lever, thus forming a dead lock. This is shown in Fig. 4. The electrical tappet is actuated from the slide by a vertical rocking shaft, and, the stroke of the tappets being 2 in. and the centres of the troughs $2\frac{7}{8}$ in. conflicting notches are avoided. Seven locking bars may be placed in each trough, and the locks are all loose, not riveted on to the bars.

Although ordinary mechanical-facing point locks are in use at Victoria, some of the facing points are locked by a mechanical bolt working in conjunction with an electrical depression bar which works somewhat as follows: Assume that the bar is not depressed by an engine or train, a contact is made at the

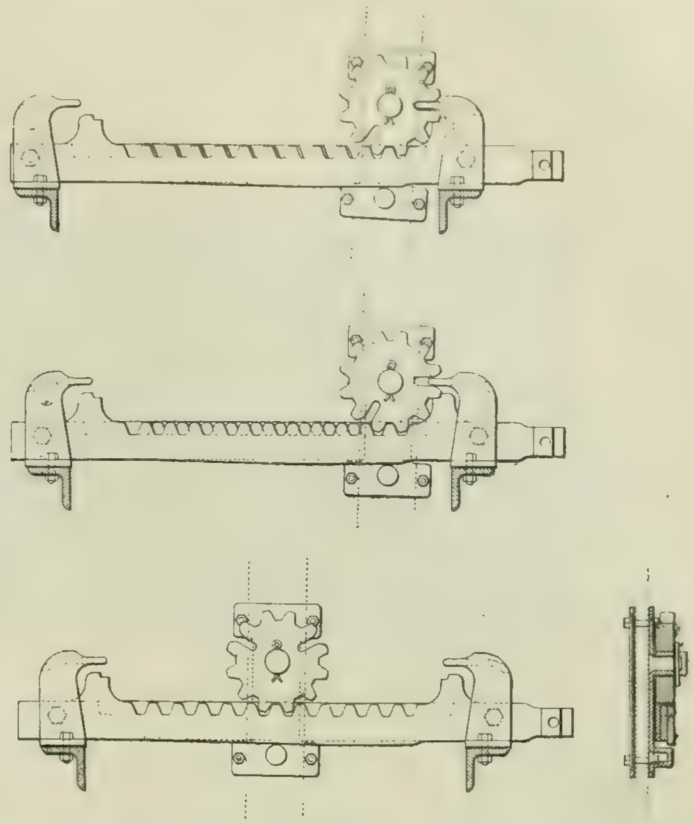


FIG. 4.—DETAILS OF ESCAPEMENT GEAR ON SYKES POINT LEVER TO REDUCE LENGTH OF EFFECTIVE STROKE TO 2 IN.

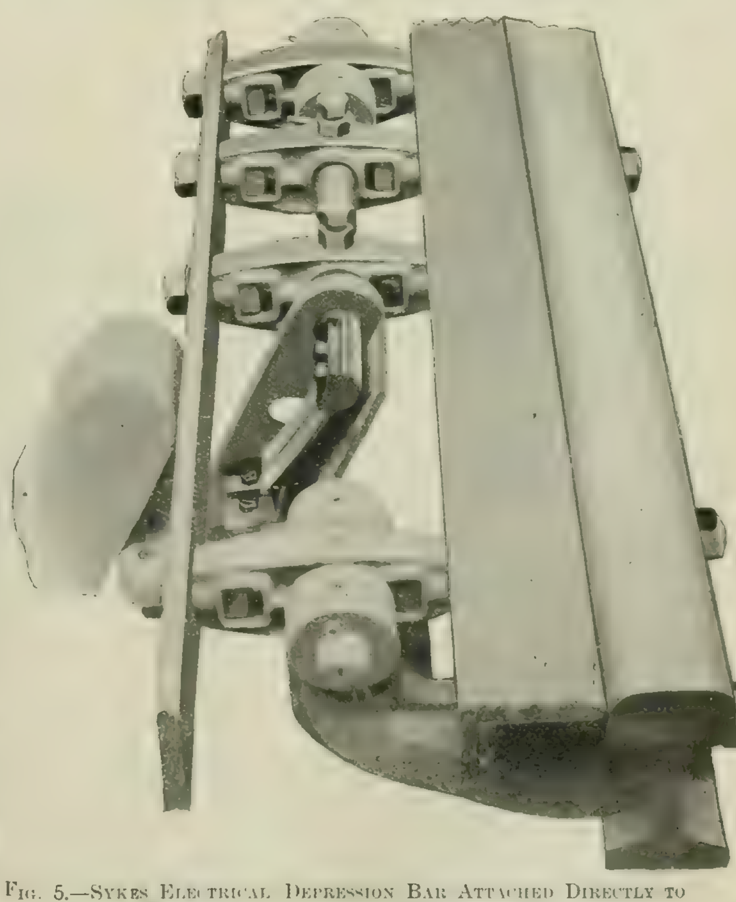


FIG. 5.—SYKES ELECTRICAL DEPRESSION BAR ATTACHED DIRECTLY TO RUNNING RAIL, AS USED IN PLATFORM BAYS.

bar which allows a current to flow through foot plungers, fixed in the footboard opposite the bolt levers in the cabin, and through an electrical lock on the levers, so that if the foot

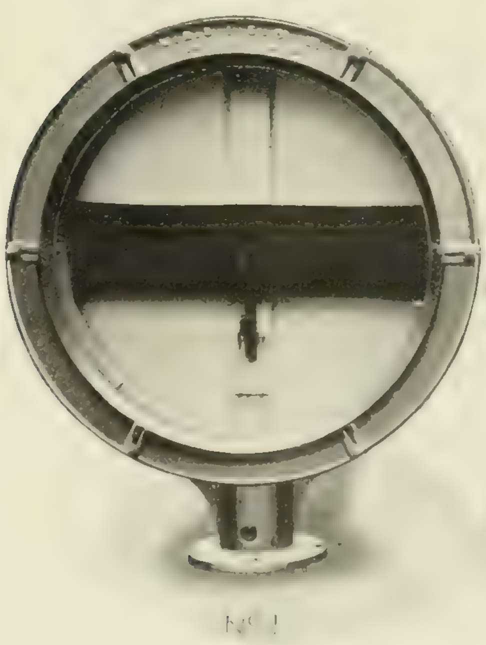
plunger is depressed the lock is withdrawn, thus allowing the bolt to be drawn and the points moved. If a train is standing on the electrical bar the circuit is broken down and both the bolt and point levers are held in the frame. These electrical bars are 42 ft. in length, and some of them are made up of two pieces for convenience of working. It may here be mentioned that all the electrical depression bars are of the usual Sykes pattern, but they are carried on the rail itself and not on the sleeper. A view of a portion of one of these bars is shown in Fig. 5.

Fig. 6.—Sykes Rail Contact or Treadle Used to Release Block Instrument by the Passage of a Train.

The electrical bar contacts are spring tongues attached to an insulated block fixed to the hinge pin which moves with the bar. The contacts bridged by these tongues are fixed to the bearing supporting the hinge pin from the sleeper level. The main bearings of the bar are substantial brackets which are secured directly to the rail itself. In Fig. 6 an electrical treadle is illustrated, this being also attached directly to the rail. It consists of a girder bolted at each end to the rail and provided with a hole in the web near its centre. Through this hole projects a pin secured at one end to the rail and fitted at its free extremity with a knife-edged projection which bears on the end of a long lever. This lever is linked up to a small sealed box which is normally tilted slightly when the lever is at rest. When a train passes over the rail the pin passing through the girder web is depressed and through the lever the box is tilted, and as it contains mercury, this is set in motion completing a "wave" the circuit across two fixed contacts. This treadle is used in the platform bays at Victoria.

The banner signals are placed in a circular enclosed case as shown in Fig. 7, which illustrates a group of signals of various sizes. The semaphore is of light wire framing covered with a suitable red fabric. This is pivoted in the centre on a spindle which carries an S shaped armature placed within the field of a double-limbed electromagnet. The shape of the armature ensures its movement (with the semaphore) on the passage of a small current through the electromagnet. The heavier signals used in the approaches to the station, and which are of the ordinary semaphore pattern, are operated by a small motor attached, in a suitable housing, at the base of the signal post or located conveniently on the bridge when several signals are mounted together. The signal motor equipment is depicted in Fig. 8, in which two outfits, one open and one closed, are shown. The motor itself is quite diminutive, and takes only 2·7 amperes at 60 volts. This is arranged to drive the operating wheel through a worm, and by this the signal is drawn down to the "off" position. When this is reached a pair of contacts are closed and a small electromagnet is energised and attracts an armature, which draws a pin against a stop, thereby holding down the signal arm; the motor meantime is stopped. When the holding magnet is de-energised the signal arm is free to go to danger by the falling of its controlling weight, the holding off current being 0·1 ampere at 60 volts.

Two point motors are employed at Victoria, and the equipment of one of these is shown by the drawing in Fig. 9. The



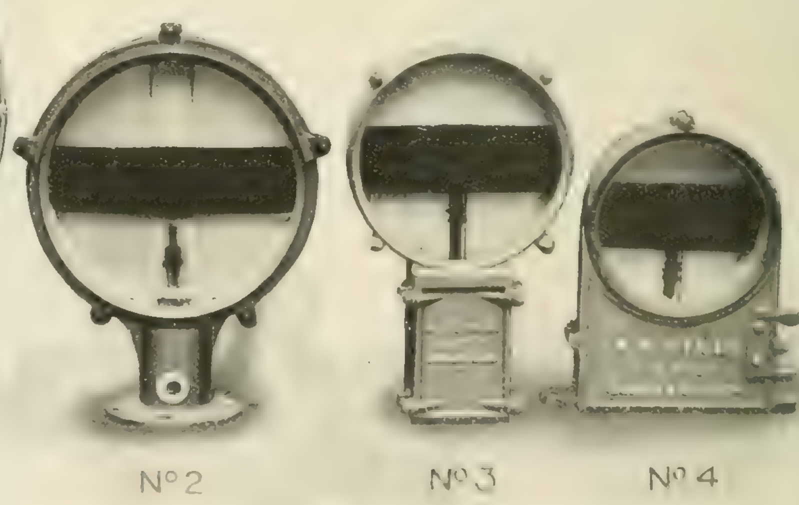


Fig. 7.—Group of Sykes Banner Signals Operated by Electromagnets.

motor is fitted with a pinion engaging with a spur wheel on the shaft of which is a worm from which the main drive to the point lever is taken. The gears run normally in air, being lubricated with hard grease from time to time. The motor is rated at ½ H.P., and runs at 2,000 revs. per min. The points are moved over in 3 seconds from the putting over of the point lever. A special spring coupling is fitted between the worm wheel and the point lever to relieve the motor of the shock of finally closing the points.

The diagram in Fig. 10 shows the connections between the signal slides and the signals at Victoria station. The current passes direct from the contact springs of the signal slides to the signal motors, afterwards passing through the point and bolt detectors to return. In the case of the distant signals, the current first passes through contacts on the inner and outer homes, so that it is electrically impossible for the distant signal to come off with the homes at danger, supposing the interlocking failed. The platform bars control the distant arm at the entrance to Nos. 8 and 9 platforms, so that if these bars are depressed by a train standing in the platform the distant arm is held at danger. The home arm, however, can be lowered if the bars in the south section are not depressed. These bars are also used for removing the slot on the South Box shunting signals into the platform roads, so that if the platform road is occupied the South Box may lower his shunt to allow an engine to proceed to his train independently of the North Box; at the same time the semaphore arms are electrically locked. The other platform roads are similarly locked.

Battersea Park is an ordinary double-line junction, which is interlocked with the block instruments in such a way that when a branch train is standing at the platform it is only possible to accept another train from the rear by reversing the junction points, the points becoming locked in that position when once the train has been accepted.

The block instrument is similar to that which is used for Sykes' lock-and-block on mechanical frames, but is adapted for locking the electrical slides which work the signals in the electro-mechanical system.

It consists of a pair of coils, the poles of which are magnetised by the induced magnetism of a permanent magnet placed above. The armature, when held up by the coils, allow a blade to drop into a slot in an ordinary V lock engaging in the slide, at the same time a flag attached to the top of the blade shows the word "Locked" in red through an opening in the dial of the instrument. The magnets are not sufficiently strong to pull the armature up, but are only intended to hold the armature when it is pushed up by means of the slide being pulled.

The instrument controlling the starting signals leading into the next station are freed by means of a plunger in the box in advance. This plunger joins up a battery, which in passing current through the coils of the instrument neutralises the effect of the permanent magnet, allowing the armature to fall away, thus releasing the signal slide. The slide is now pulled to lower the starting signal and by so doing the instrument becomes again locked. A switch is also operated which cuts off the plunging line and joins up the treadle line in readiness for the train to release the instrument by passing over the treadle; the long notch, however, allows the signal to be placed

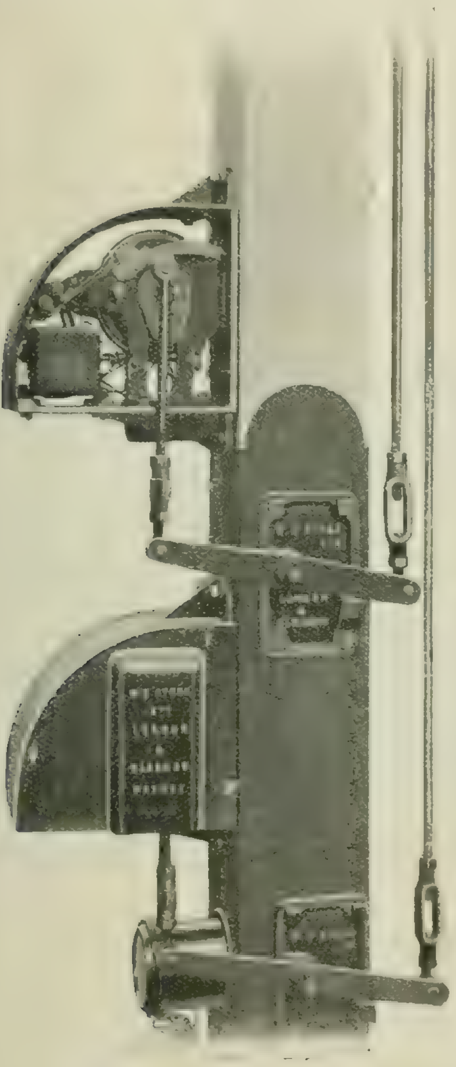


FIG. 8.—SYKES SIGNAL MOTORS, SHOWN OPEN AND CLOSED.
The upper motor works the home and the lower motor the distant signal arms.

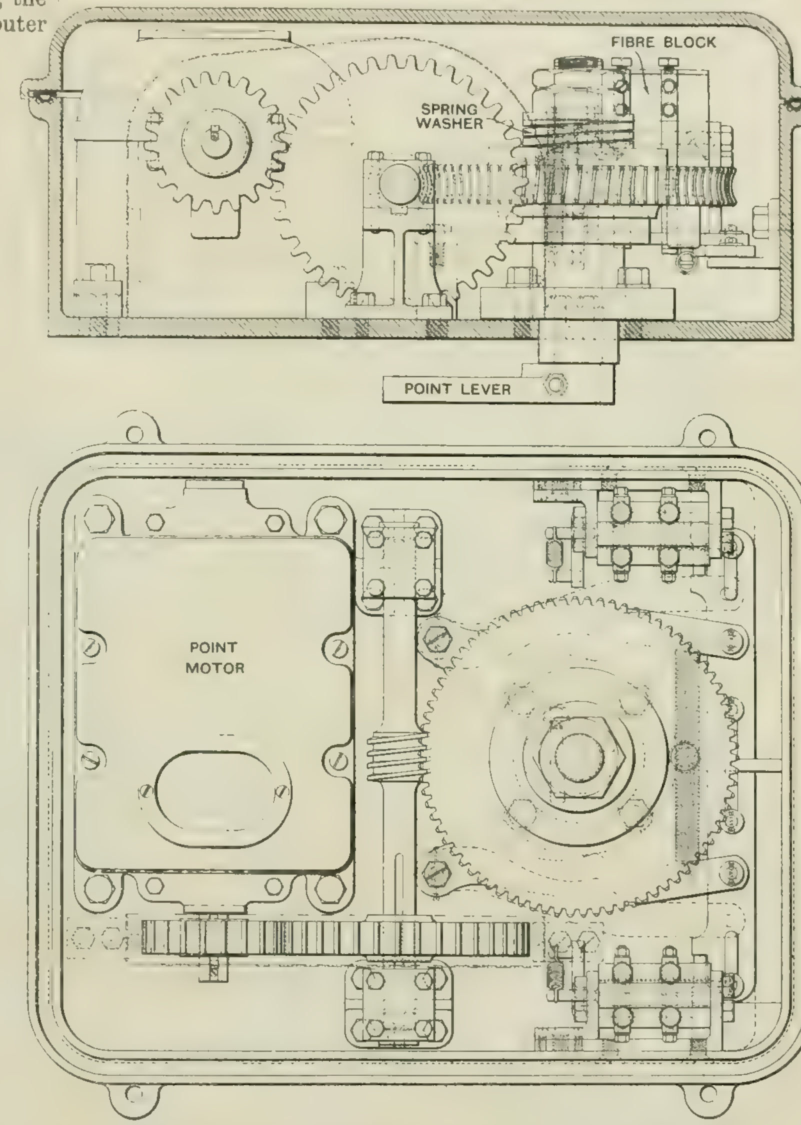


FIG. 9.—DETAILS OF SYKES POINT MOTOR EQUIPMENT AS INSTALLED IN THE PLATFORM BAYS AT VICTORIA NEW STATION.

at danger in a case of emergency, but the slide cannot be placed fully normal.

The plunger P at this cabin, which is shown in the diagram (Fig. 11) has to be turned either to the right or left in order to plunge. It is also prevented from turning by the electrical locks B, B. A switch hook S is placed so that it may be placed over the plunger to act as a reminder to the signalman not to plunge if it should be necessary. This hook also cuts off the battery at K, which controls the block arm in the rear box, so that the signalman there knows that the man in advance is not in a position to accept a train. Suppose a down branch train is offered by the man in the rear, he must first have Nos, 1, 4, 8 and 9 points in their normal position, and should No. 25 have been used previously, No. 26 would have to have been used to reset the relay on No. 25. Current now passes from the battery through the contacts on the point levers, contact and lock on plunger, relay on 25 and back to battery. This allows him to turn the plunger to the left and plunge, another battery is now joined up, sending a releasing current to Battersea Pier to release the starting signal. When the hand is removed, the plunger assumes its normal position and becomes locked, allowing the blade to drop and displaying "Train on" through an opening in the dial of the instrument, at the same time the two pairs of contacts C, C, above the indicating flag are broken, thus cutting off the block arm battery, and consequently throwing the indicating arm in the rear box to danger. Nos. 25 and 26 signal slides are now pulled, becoming backlocked in their turn. The train is now offered to Wandsworth-road, and, when plunged for by the signalman there, takes the lock off No. 28 slide and throws the block arm to danger. No. 28 signal may now be pulled off, and that also becomes back-locked. The train now passes over the first treadle, thus freeing No. 25 slide, allowing the signal to be put to normal, the action of replacing the slide re-sets the plunger, so that a second train may be accepted; but No. 25 slide is locked up, and the relay, having been lifted when No. 25 was first pulled, breaks the circuit on the left-hand plunger coil lock, so that the man is compelled to reverse the position of No. 4 junction points, and set them for the straight road before being able to turn his plunger to the right in order to plunge. The release of No. 25 slide is effected by a pneumatic contact on No. 26 slide, which is only operated by the slide being replaced to normal; the first action of pulling the slide does not affect it. Then, again, this contact is only momentary, so that it does not in the least matter how long the slide remains in the mid position. It follows that No. 26 can only be replaced by the train actuating the treadle in advance, and, once having done so, it becomes locked until 28 is used and replaced. No. 26 also resets the relay on 25, thus allowing the branch plunger to be used once again.

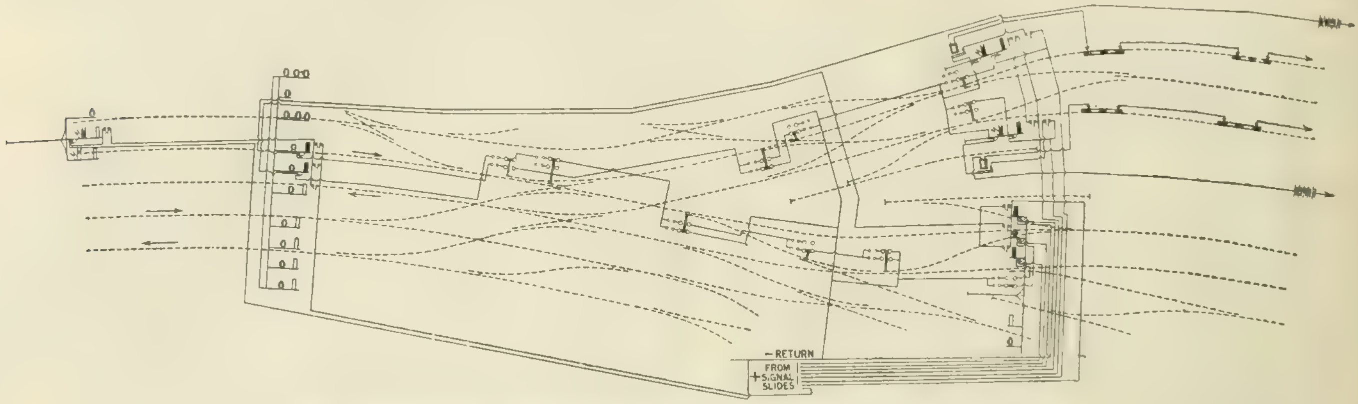


FIG. 10.—CONNECTION DIAGRAM OF SIGNAL CIRCUITS AT VICTORIA NEW STATION.

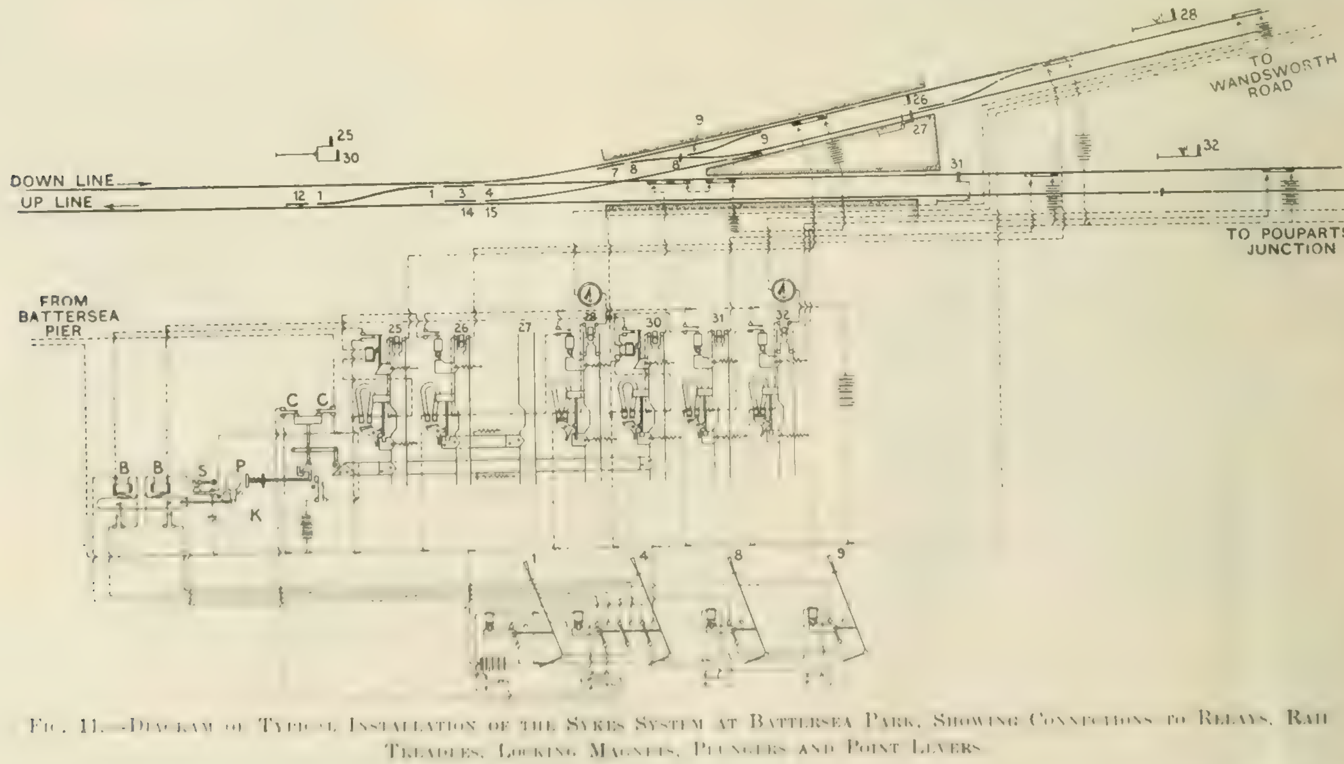


FIG. 11.—DIAGRAM OF TYPICAL INSTALLATION OF THE SYKES SYSTEM AT BATTERSEA PARK, SHOWING CONNECTIONS TO RELAYS, RAIL TREADLES, LOCKING MAGNETS, PLUNGERS AND POINT LEVERS.

The Victoria signalling scheme, which requires only a small amount of energy for the operation of the signals and other apparatus, constitutes the largest installation of the lock-and-block system yet introduced by the W. R. Sykes Interlocking

Signal Co. From a railway engineer's point of view they present many features which we feel are of importance in the safe handling of the traffic at such complicated termini as Victoria. The ingenious combination of electrical and mechanical devices to furnish a complete check on the signalman, and at the same time make the setting of roads and signals dependent upon the movements of the trains themselves, is something of which railway men should feel proud, particularly as it appears to solve many problems impossible of solution by purely mechanical means.

Our thanks are due to Mr. C. L. Morgan, engineer to the London, Brighton & South Coast Railway, for his courtesy in allowing us to inspect the various parts of the installation, and to the W. R. Sykes Interlocking Signal Co. for placing information at our disposal.

ELECTRICITY IN AGRICULTURE.*

BY SIR OLIVER LODGE.

Some 30 years ago Prof. Lemström sought to elucidate the aurora borealis by trying to imitate its appearance by electrical experiments.† For this purpose he produced high-tension discharges of various kinds, and sent them through vacuum tubes until he got an appearance very like those of the northern lights. Some of these experiments he conducted in his greenhouse, and he noticed incidentally that the plants seemed to thrive under the treatment, and that the electrification thus produced in their neighbourhood appeared to do them good. He also noticed as remarkable the flourishing development of plants in arctic regions where the sunlight was very weak, and he attributed part of this growth to the influence of electric discharges. He says that when the plants in the North of Norway, Spitzbergen and Finnish Lapland have resisted the frequently destructive night frosts they show a degree of development which greatly surpasses that of plants in more southern regions, where the climatic conditions are more advantageous.

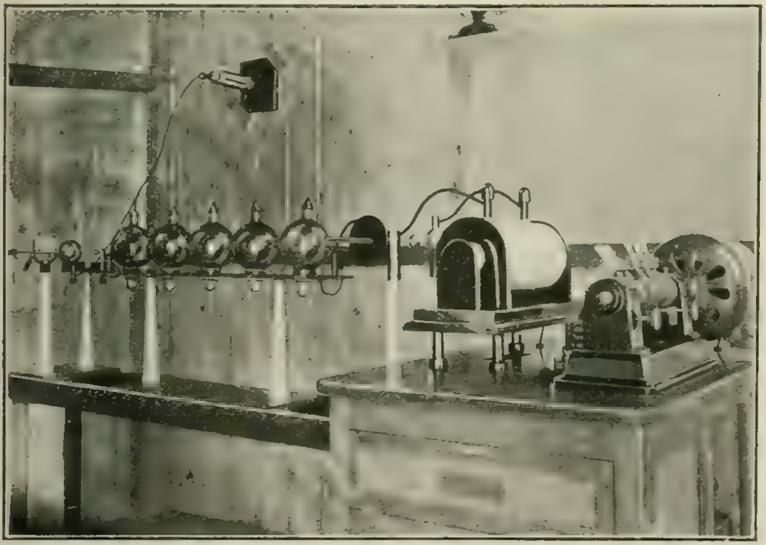


FIG. 1.—INSIDE THE TRANSFORMER SHED, SHOWING SIR OLIVER LODGE'S INDUCTIVE BREAK, SPECIAL INDUCTION COIL AND HIGH-TENSION VALVES.
This apparatus supplies continuous current at 100,000 volts.

He pursued the matter by careful observation, and he concluded that the needle-like shape of the leaves in fir trees, and the beard on the ears of most cereals, have the discharge of electricity as their function, and finds that they do act in this way.

This observation and these experiments of Prof. Lemström were not, indeed, the beginning of the application of electricity to plant growth, because pioneer attempts had been made long before, but it was the beginning of a thorough and scientific treatment of the problem. Attempts of a different kind had also been made. Plates had been sunk in the ground, and a current passed between them among the roots of plants; but whatever effect is thus caused is of a totally different kind to that excited by high-tension electricity supplied to the air above them. Both in a manner are natural processes. There are natural earth currents, and these must flow among the roots of plants, though whether they produce an appreciable effect may be doubted.

There is a natural atmospheric electrification, and this must be playing an important part in many phenomena. Atmospheric electrification is responsible for the formation of rain and hail. During fine weather the electricity in the air is usually of one sign: mainly positive. When wet weather sets in, the electricity in the air usually changes sign, becoming negative. The whole subject is a large one; a great deal is known about it, and vastly more remains to be known; but meanwhile it can hardly be doubted that the electrification of the air has some effect on growing plants. For it is found that, under the influence of sunshine, electrified plants can give off electricity into the air from the leaves; and the fact that the air is electrified relatively to the soil requires that the plants shall be electrified too, so that in all probability they are in a constant state of slow electrical discharge, which becomes more rapid when the sun is up. In what way this discharge of electricity from their growing tips and hair and surface generally really acts must be studied and reported on by physiological botanists; but it is natural to suppose that it cannot be without influence, and reasonable to think that that influence must be beneficial—a hypothesis which direct experiment confirms.

Possibly, in some sunny countries the effect is excessive, and might, with advantage, be moderated; but in this climate it turns out that artificial supply of electricity does increase the rapidity and assist the amount of growth. At any rate, the experiments of Lemström, which were repeated and extended by others, clearly pointed in that direction. So when, after some preliminary experiments at Bitton, Mr. J. E. Newman, of Gloucester, acting in conjunction with Mr. R. Bomford, of Salford Priors, determined to try the phenomenon on a really large scale, and came to me to see if I could help them electrically, and enable them to maintain a continuous high-tension discharge for hours together each day over 10 or 11 acres by means of power furnished by an oil engine and dynamo, I very willingly assented, and set my son, Mr. Lionel Lodge, upon the work.

The method adopted is to stretch over the field to be treated a number of wires on poles, something like low telegraph wires, but high enough for loaded waggons and all the usual farming operations to go on underneath the wires without let or hindrance. The wires are quite thin, and are supported by a few posts in long parallel spans, about 30 ft. apart. They are supported on the posts by elaborate high-tension insulators, and they extend over all the acreage under experiment, a control plot of similar land under similar conditions being, of course, left without any wires. The system of conductors is then connected at one post with a generator supplying positive electricity at a potential of something like 100,000 volts, and with sufficient power to maintain a constant supply of electricity at this kind of potential.

Leakage immediately begins, and the charge fizzes off from the wires with a sound which is sometimes audible, and with a glow which is visible in the dark. Anyone walking about below the wires can sometimes feel the effect on the hair of the head, as of a cobweb on the face. They are then feeling the stimulating action of the electrification.

The electrification is maintained for some hours each day, but is shut off at night; it is probably only necessary to supply it during the early morning hours in summer time, and in spring time or in cold, cloudy weather for the whole day, or during the time of the plant's greatest activity. But at what stages of the growth of a plant the stimulus is most effective has still to be made out.

However, in the case of wheat, both the ear and the straw is valuable, and the electrification is accordingly applied for a time each day during the whole period of growth until stooling begins.

The power required to generate the electricity is very small, for although the potential is high the quality is insignificant, and the energy is accordingly comparatively trivial.

The electricity can be generated in more than one way. It can be generated by the revolving glass plates of a static influence machine, usually known in this country as a Wimshurst machine, or it can be generated by transforming up to high tension, and rectifying to one direction, the current from the generator after transformation. The first is in many respects the simplest, and was used in the early and small scale experiments, but it can hardly be regarded as an engineering method adapted to continuous or rough use.

The latter is the one which in the trials now to be described we have adopted.

* In abstract.

† "Electricity in Agriculture and Horticulture." By Prof. S. Lemström (London: *The Electrician* Offices, 1, 2 and 3, Salisbury-court, Fleet-street, and all booksellers.) 3s. 6d. net.

The power is generated by a two-horse oil engine driving a small dynamo in an outhouse of the farm. Thence the current is taken by ordinary overhead wires to the field, where the wires enter a suitable weather-tight hut, which contains the transforming and rectifying apparatus. The only moving part here is the "break," and if the original dynamo had been an alternator, even this might be dispensed with. The transformer is a large induction coil specially made to stand continuous use, and its current is then rectified by means of vacuum valves in accordance with a patented device of my own.

The negative electricity is conveyed direct to earth, while high-tension electricity, all of positive sign, is led by a specially insulated conductor out of the shed to the nearest post of the overhead insulated wires, which are thereby maintained at continuous high-positive potential.

The results obtained in 1906 were an increase of 40 per cent. in Canadian (Red Fife) wheat and 30 per cent. in English (White Queen) wheat. The corresponding increase in 1907 for Red Fife wheat was 29 per cent.

In 1906 the electrical plant was run for 621¾ hours on 90 days at an average electrical pressure corresponding to a ⅝ in. spark. In 1907 it was run for 1,014 hours on 115 days at an average pressure corresponding to a ½ in. spark.

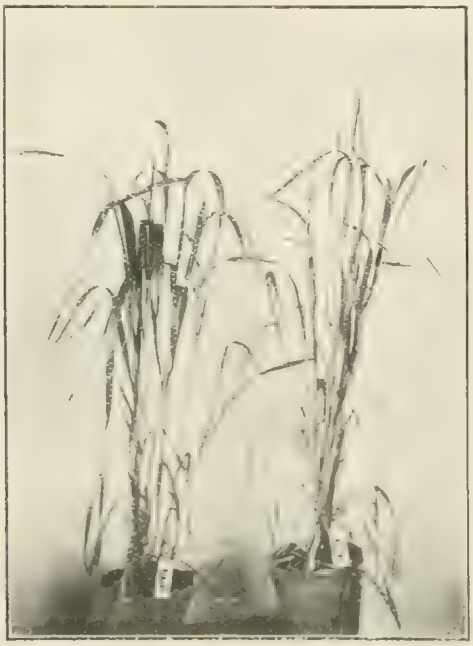


Fig. 2 Comparison of Electrified Wheat (E) with Wheat Grown in the Control Field (C).

An average plant is taken in each case; note the broader leaves and darker colour of the electrified wheat. The wheat was put into pots for convenience in photographing.

The complete arrangements for generation of the high-tension currents are as follows:—Direct current, about 3 amps. at 220 volts, is generated by a dynamo driven by an oil engine of about 2 H.P. The current passes from the dynamo through the primary of a large induction coil with a make-and-break contact interposed in the circuit. From the secondary of the coil the high-tension current was passed through the rectifiers, and then the one pole connected to the system of overhead wires, the other pole being earthed.

The overhead system of wires covered about 19½ acres of ground. The wires were mounted on insulators placed upon larch poles, some 15 ft. high, which were placed in rows, the rows being separated by a distance of 102 yds., and the poles in a row being 71 yds. apart. Stout telegraph wire carried the current down each row, while thin galvanised-iron wires, placed some 12 yds. apart, were stretched between the rows, and acted as the discharge wires. In this way 22 poles were sufficient to support the wire over the 19 acres. Roughly, only one pole per acre is required; therefore, the inconvenience is practically nil. The height at which the wires are taken allows a loaded waggon to go beneath. Owing to the flexible suspension, risk of breakage to the wires is negligible.

The acreage was spread over two different fields, in one field of which some 11 acres of wheat were under treatment, in the other 6 acres of barley, and a ½ acre plot planted with potatoes, mangolds, &c. The wheat field was of 18½ acres extent, the remaining 7 acres were sown with English (White Queen) wheat, 1½ acres, and Canadian (Red Fife) on 5½ acres. In the electrified part Canadian wheat occupied 2½ acres, English wheat 9 acres. In the wheat difference was noticeable at an early stage, the young blades on the electrified part being, in the opinion of many observers, of a darker green.

The crop was judged as considerably heavier by several practical observers, and the straw was, on an average, from 4 in. to 8 in. higher. Both experimental and control plots came into ear at about the same time, but the Canadian wheat under treatment was ready for cutting some three or four days before the control area. Besides the increased yield of 39 and 29 per cent. respectively as previously stated, the electrified wheat sold at prices some 7½ per cent. higher, several millers in baking tests finding that it produced a better baking flour.

No theoretical conclusions can be drawn from the increase by electrical treatment owing to the uncertainty existing as to what factors determine the strength of wheat, but it is interesting to note that greater strength is usually accompanied by increase in percentage of total nitrogen. The experiments are being repeated upon wheat during the present season, and strawberries are also under treatment once more.

Strawberries showed a 35 per cent. increase. Earlier ripening was also observed.

Those interested in these experiments are much indebted to the enthusiastic co-operation of Mr. Bomford.

ON THE ABSORPTION OF SHORT ELECTRIC WAVES BY AIR AT DIFFERENT PRESSURES.*

BY J. E. IVES AND R. E. CLYDE GOWDY.

It has been known for some time past that wireless telegraph messages can be sent farther at night than in the day. One of the explanations of this fact which have been advanced is that the sunlight ionises the air, and that this ionisation causes an absorption of part of the energy of an electric wave. It was suggested by Prof. L. T. More that this problem could be reduced to a laboratory experiment by sending short electric waves through air enclosed in a glass tube at different pressures and under different conditions of ionisation, and determining what absorption of the energy of the wave, if any, occurred under these differing conditions.

This experiment has, in part, been carried out by the authors during the past year. The electric waves were generated by an oscillator of a modified Righi type, consisting of two small cylinders of platinum, each 25 mm. long and 2·5 mm. in diameter, sealed into glass tubes. The spark between them took place in kerosene oil. The resonator wasof the Klemencic type, consisting of two brass cylinders each 31 mm. long and 2·5 mm. in diameter, connected together by a thermo electric junction made of fine iron and constantan wires. A Duddell thermo-galvanometer was used to detect the thermo electric current. Between the oscillator and the resonator was placed a glass tube, 44·5 cm. long and 10 cm. in diameter, having pieces of plate glass sealed upon its ends. This tube was airtight, and the air in it could be rarefied by means of a Geryk pump. The oscillator and resonator were each about 2 cm. from an end of the tube. Behind each of them was placed a parabolic cylindrical mirror made of zinc. The electric waves generated by the oscillator thus travelled through the rarefied air in the glass tube, produced electrical oscillations in the resonator at the other end of it and caused a deflection of the galvanometer. Any increase in the absorptive power of the air in the tube due to its rarefaction was shown by a decrease in the deflection, and vice versa.

The following results have thus far been obtained: For pressures ranging from atmospheric pressure to about 0·5 mm. of mercury, there are two pressures which give maxima of absorption and at least one pressure which gives a minimum of absorption. One of the pressures which give maxima of absorption is near the zero of pressure, and the other lies between 40 cm. and 60 cm. of mercury. The pressure of minimum absorption lies between 25 cm. and 35 cm. of mercury. At the pressures which give maxima of absorption the absorption is greater than at atmospheric pressure, while at the pressure of minimum absorption the absorption is less than at atmospheric pressure. Near the zero of pressure the absorption decreases rapidly. The percentage absorption—namely, the ratio of the energy absorbed at any pressure to that transmitted at atmospheric pressure expressed in per cent.—is a small quantity, varying between +7 and −7 per cent. for the whole tube. This gives a percentage absorption per centimetre of length of the tube varying between +0·15 and −0·15 per cent.

* Abstract of a Paper read before the American Physical Society. From the *Physical Review*.

ON THE NATURE OF CHARGES OF POSITIVE ELECTRICITY AND ON THE EXISTENCE OF POSITIVE ELECTRONS.*

BY JEAN BECQUEREL.

We know that the charged radiations of negative electricity (cathode rays, β-rays) are formed by a flux of corpuscles called electrons, whose mass, 2,000 times smaller than that of the hydrogen atom, appears to be of an electromagnetic nature, and which may be regarded as intermediary between the ether and ponderable matter.

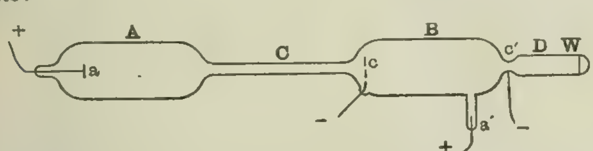
On the other hand, the actually known positive radiations (α-rays, canal rays, anode rays) are constituted, not by electrons comparable to the negative particles, but by ions possessing a mass at least equal to the material atom of hydrogen.

The existence of positive electrons appears hardly to be admitted at present. Many physicists think that the positive charges of atoms result from a lack of negative electrons, and do not accept a second constituent of matter. Yet some physicists, finding difficulties in the way of accounting for the properties of metals by means of negative electrons only, have introduced the hypothesis of positive electrons, although hitherto no fact has revealed their real existence. The absolute lack of data on this important question at present retards the progress of our knowledge of the constitution of matter.

The study of magneto-optic phenomena in the rare earths, pursued for two years along the whole scale of temperature, furnished, for the first time an experimental basis for the hypothesis of positive electrons.†

Then Lilienfeld‡ obtained, with discharges in rarefied gases, phenomena which he attributes to positive electrons; but Bestelmeyer and Marsh,§ with a similar arrangement, could only find negative electrons and positive ions. The question has remained in suspense, Lilienfeld having, so far as I know, never since either confirmed or disowned his first experiments.

Having been led, by a long series of researches, to the conviction that the atoms enclose positive electrons, I have endeavoured to get them in the *free* state, and have performed the following experiments:—



A Crookes tube is formed of two cylindrical portions, A and B (*see* diagram), 3·5 cm. in diameter and 13 cm. in length, joined by a narrow tube, C, 6 mm. in diameter and 15 cm. long. The anode a is in the tube A, and the (aluminium) cathode c is in B. This cathode is perforated in front of the constriction C in such a manner as to allow canal rays to penetrate into B. The discharges are produced by an induction coil or an eight-plate influence machine.

If the wall of B is touched by an earthed conductor, or by the hand, a secondary cathode is formed on that wall (a well-known phenomenon), and an orange patch, due to a cathode beam, appears on it.

If the pressure is low enough ($\frac{1}{300}$ mm. at the most) to make the dark space exceed the dimensions of the tube, then on bringing the hand near the wall without touching it, the secondary cathode rays are seen to be repelled to the opposite wall, whereas a whitish patch is formed in front of the hand, and is attracted to the latter, and follows its movements. By trial the size of this patch may be reduced to 1 or 2 sq. cm. On approaching a magnet whose lines of force are normal to the plane passing through the axis of the tube and the centre of the patch, this is seen *to be displaced with extreme sensitiveness.* It is easy to make sure that whatever may be the direction in which the corpuscles forming the beam are travelling, the patch must undergo a general displacement whose sense indicates the charge of these corpuscles. Thus we find that we are in the presence of positive corpuscles whose great deflectibility is, on a first view, *at least equal to that of cathode rays* which have traversed in the opposite direction the same fall of potential in the neighbourhood of the patch which represents a secondary cathode

I endeavoured to make these corpuscles leave the tube B by attracting them by means of a secondary cathode c' formed by wire-netting, or by a small ring placed at the entrance of a supplementary tube D. I also added a second anode a' which increases th intensity of cathode radiation in B.

Then a beam issues from c' which colours the gas (air, oxygen, or hydrogen) blue and forms on the glass a patch of orange, or on a willemite screen a greenish-yellow patch. This beam behaves like a canal ray insensible to a magnetic field so long as the cathode rays do not reach the regions close to c'. But when the pressure is low enough, it suffices to approach to c', a small magnet, to make the beam *deviate strongly* in the sense corresponding to positive charges coming from the secondary cathode c'. If the field is increased, the patch on the wall of D moves towards c, which shows that the beam *comes* from c', a fact which I have also verified by means of phosphorescent screens.

The action of the field takes place only in the immediate neighbourhood of the secondary cathode c'; the beam observed in the gas is only the prolongation of a deflected beam.

The following experiment shows that the deflection is only produced in the interior or in the immediate vicinity of the cathode beam. A narrow inclined cathode beam is formed, which does not fall upon c'. If a magnet is brought near c', so as to further displace the cathode beam, no deviation of the positive ray is seen. On reversing the field a feeble deviation of this ray is seen, and at the moment when the border of the cathode beam arrives near c' a great deviation of the positive beam is observed. Finally, this deviation diminishes as soon as the cathode beam has passed c'.

These phenomena have been studied with several tubes ably constructed by M. Matout. Each tube presents peculiarities which will be described in a more detailed publication.

It is, therefore, possible to produce a flux of positive electricity having a magnetic deflectibility comparable to that of cathode rays.

The only interpretation which seems to me at all likely is that the beam, in the region where it can be deflected, is not formed of ions, but of *positive electrons*, comparable to the negative electrons, or at least possessing a ratio of charge to mass of the same order of magnitude.

This *new constituent of matter* appears under the influence which cathode particles exert upon canal rays, for the simultaneous presence of both these radiations is indispensable in the preceding experiments. Without a comparatively dense atmosphere of cathode particles, necessary to split them off the material atoms, the positive electrons have probably a very small free path, and are at once re-attached to matter, or, perhaps, contribute to form a new kind of matter.

* Translated from *Comptes Rendus*, No 25, June 22, 1908.

† Jean Becquerel, *Comptes Rendus*, March 26, 1906, &c. *Le Radium*, February, March, September, November, 1907, January, 1908. Jean Becquerel and H. Kamerlingh Onnes, Kon. akad., Amsterdam, February 29, 1908.

‡ *Verh. der Deutschen Phys. Gesellsch.*, November 16, 1906, and March 22, 1907.

§ *Ibid.*, December 13, 1907.

TRAMWAY RAIL JOINTS.*

BY A. H. GIBBINGS.

Summary.—The author describes some of the modern forms of rail joints for tramway track and the methods which have been adopted to make the joints as nearly as possible like the rest of the rail as regards running.

Fishplates.—In regard to rail design, the author first illustrates the type of rail in use 15 years ago and the modern form. In the former the angle which the bearing portion of the fishplate makes with the web of the rail is 45 deg., and with the flange of the rail the angle is 45 deg. In the modern section these angles are respectively 6 deg.—that is, just sufficiently out of the parallel to admit of properly and efficiently tightening up. He shows that the strain on the bolts due to wedging action in the first case is more than 10 times that in the second case. As it is absolutely essential that a tramway joint when once screwed up should remain tight, it follows that the rail should be so designed as to relieve the bolts as far as possible of any tensional efforts tending to loosen the fishplates. Experience proves that in all cases joints have a tendency to become loose and "spring" through the continual passing over of the cars, and however slight this springing may be at first it is rapidly increased by every car passing over the joint. Hence, when the joint is badly worn it appears that the only remedy is to cut out and renew either the joint or the concrete beneath it, or both. This becomes a very expensive operation and necessitates removal of setts and paving. It follows, therefore, that fishplates should not be required to take a vertical thrust. The function of fishplates should be confined to jointing the web and the vertical thrust should be taken by some other means.

The principal types of rail joints are comprised under one or other of the following classes: (*a*) Sole plates, (*b*) welded joints, (*c*) anchors, (*d*) comb nations, (*e*) adjustable joints. In order that the latest practical experience might be brought to bear upon this subject, the writer submitted a list of enquiries to several tramway managers, and their replies are embodied below.

Sole Plates.—The original and simplest method of taking the vertical thrust at the joint was by means of sole plates and fishplates. Sole plates are now in use at Hull and Darwen. In the

* Abstract of a Paper read on July 9th at the Annual Congress of the Tramways and Light Railways Association.

case of Hull, the rail ends are cut to an angle of 45 deg. in plan, and the rails are laid on continuous creosoted sleepers. At Darwen they are apparently being discarded in favour of other types. In neither case has any account been kept of the cost of renewals.

Welded Joints.—The principal welds are the "Falk," the "Thermit," and the electric. One or other of these welds is in use in many towns, including Glasgow, Leeds, Southampton, Nottingham, Liverpool, Brighton, Darwen and West Ham. The replies from Brighton and Darwen are both favourable to the welded joint, but it does not appear that welds have been extensively used in those towns. In addition to these places there are, of course, many others where the welded joint has been adopted. The advantages which are claimed for the welded joint may be summed up in the statement that it should constitute a continuous rail both as regards wear and tear and electrical conductivity. There can be no doubt that when two rail-ends are thus fastened together with a close joint the result will appear theoretically and practically perfect. As a matter of fact, however, the rail-ends in some portion of the rail and rail head always remain severed, and this occurs principally near the running surface or point where the real wear takes place. In other words, the weld is the least effective and satisfactory at the point where it is most required.

The difficulties of making a satisfactory practical weld are many and obvious. The difference in the chemical composition of the two metals in the case of the "Falk" and "Thermit" welds and the great cost of the electric weld may be cited by way of illustration. All three processes also tend to alter the temper and nature of the rail-ends and so produce a new fault while remedying an old one. The opinion at Glasgow is that the welded joint is the most satisfactory from every point of view, except in the case of renewals; at Leeds and Southampton a similar opinion is expressed, but at West Ham no comment is made. It must be noted that in each of these instances the experience with these joints has been only for about three years. At Nottingham the city surveyor puts the life of a welded joint at about three years, as at the end of that time fractures begin to occur and renewals are necessary. It seems to be the practice there, when a renewal is required, to cut out the weld for a distance of about 18 in. on each side of the joint and then to insert a new piece of rail, thus getting two joints in place of one. In Liverpool the same difficulty of fractures has arisen.

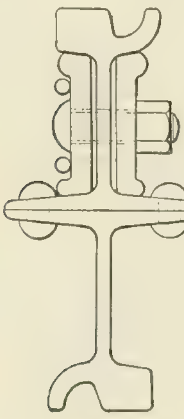


FIG. 1.

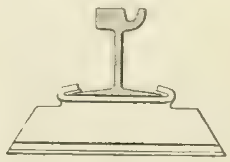


FIG. 2.

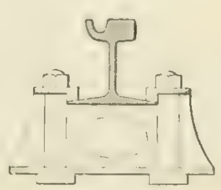


FIG. 3.

The foregoing remarks apply to new track welds and it seems to be the general experience that the process is not well adapted to old track. The important question, therefore, with regard to this method is what is going to be the result in a few years when large renewals become imperative. The solution is not an easy one to suggest at the moment, but putting all practical difficulties aside, the inference is that the cost will be heavy. One of the striking features of the replies received from tramway engineers is the statement, in nearly every case, that no separate accounts are kept of the cost of renewals or repairs to joints.

Anchors.—Among the more prominent types of anchors in use in this country are the following: (1) The "Cooper" anchor (Fig. 1); (2) the "Winby" anchor (Fig. 2); (3) the "Kirkland" anchor chair (Fig. 3); (4) the "Bull Dog" anchor (Ames-Crosta) (Fig. 4); (5) the "Positive" rail anchor (Walker and Grant) (Fig. 5). The anchor joint, in one form or another, appears to have appealed to a great number of engineers, and may be found in use on the majority of tramway undertakings. Anchors are preferred or are used in Burnley, Huddersfield, Bournemouth, Wolverhampton, Birmingham and Darwen. In all cases of anchors at joints the ordinary type of fishplate is used, the function of the anchor being merely to prevent springing of the rail ends. The success of this method of jointing depends absolutely on the stability of the concrete in which the anchor is buried, the nature of the soil beneath the concrete, and getting a true alignment on the running surface, without grinding. From the insufficiency of one or both of these conditions many anchors have failed. As the dropping of water will wear away stone, so the continual hammering and pounding of the cars loosens the anchors and breaks the concrete.

On the London County Council tramways the joint adopted, known as the girder joint, is constructed as follows (Fig. 6)—viz., a piece of steel H joint, 30 in. long by 5 in. wide and 8 in. deep, weighing 30 lb. per foot, and a steel plate 30 in. long by 12 in. wide by ½ in. thick, are fastened to the rail by 2¼ in. by ⅞ in. hook bolts. The attachment is made by the hooks of the bolts fitting into slots made in the top of the flange of the joist and fastened through holes in the plate and bottom flange of the rail, and the nuts are screwed down to a bevel washer. The bolts are made of mild steel, and are threaded for a length of 1½ in. from the nut. The writer does not know what has been the experience with these anchors, but the conditions of track bed and traffic determine their value as with other anchors.

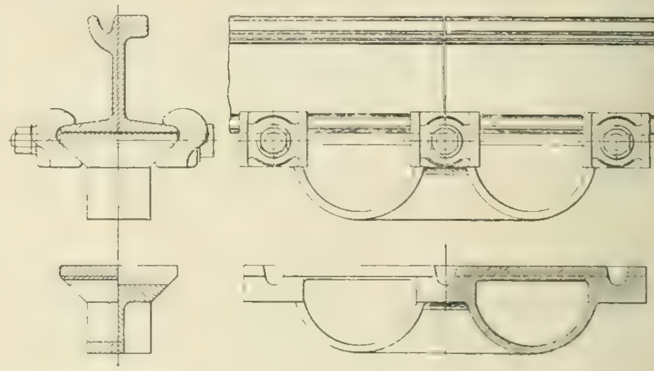


FIG. 4.

The experience at Burnley is interesting, and tends to bear out entirely the dependence on the condition of the soil and concrete. It is there claimed to maintain a good joint, but that hammering develops after two or three years, when the rail has to be ground. It is further stated to be bad for the rolling stock and that rigid foundations and hammered joints break the car axles.

With regard to anchor joints generally, it is found here again that their application has been confined to new track work. The expense of excavation and fixing to old track is too great, to say nothing of the problematical satisfactoriness. It would also involve grinding down the surface of the rail, and that, in addition to being expensive, is never satisfactory.

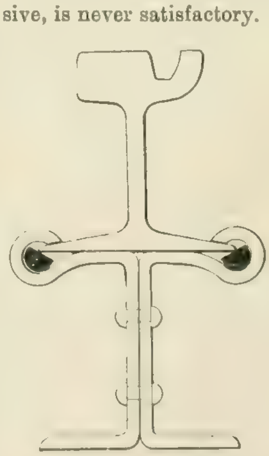


FIG. 5.

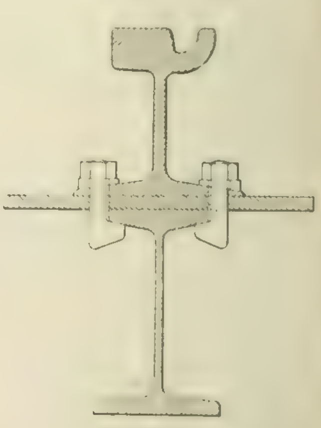


FIG. 6.

Combinations.—A combination joint consists of a device in which an attempt is made to distribute the forces and counteract the effects of the hammering and pounding. Several types have already been tried with considerable success, among which reference is made to the following: (1) The continuous rail joint; (2) Booth's continuous rail joint; (3) the "Atlas" joint; (4) the "Dicker" joint. Those are shown in Figs. 7, 8, 9 and 10 respectively, and are well known.

Forged Rail-ends.—Several years ago an attempt was made to forge out the fishplate and rail-end in one, by means of a portable hydraulic press and furnace. The rail-end was formed in such a manner that the joint faces were at an angle of about 80 deg. with the rail edge. The idea was never successful in practice for several reasons. First, the cost was prohibitive; and, second, the rails were much shortened in the process. The re-heating also had the effect of softening and injuriously affecting the steel.

Adjustable Joint.—This device differs in almost every particular from those which have been here mentioned. It consists of two plates of rolled mild steel, one being superimposed on the other. In the upper plate are two steel screws, having gas threads, and on each screw is a combined protection and lock nut. The apparatus is shown in cross section with the rail in Fig. 11. The arrangement is simple, and by slightly turning the screws the upper plate is raised, thereby raising the rail-ends and "supporting" the joint. Any

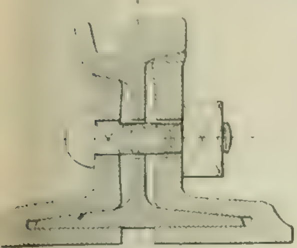


Fig. 7.

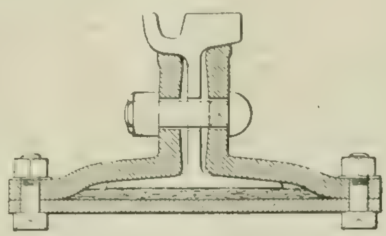


Fig. 8.

subsequent depression due to the rolling load or any other cause is readily adjusted by the use of a box spanner without any disturbance of the paving. Hence the joint can always be maintained as satisfactory as the rest of the rail. In adopting this type for new tracks, the heavy fishplates can be dispensed with, and shorter mild steel plates substituted.

In the case of old track or repairs, the disturbance of the paving setts in fixing is reduced to a minimum. The heads of the rails are raised and maintained at one level, thereby giving a perfectly true

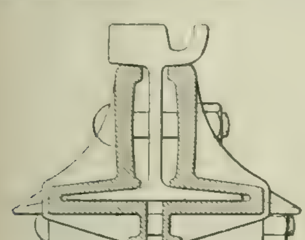


Fig. 9

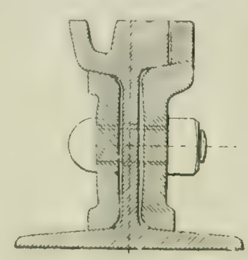


Fig. 10.

joint, thus preventing the lifting of the setts or paving. Where the rail-ends differ slightly in depth the fault can be remedied by placing a "skim" or liner of the required thickness on the supporting plate under the flange. This liner must be placed close to the end of the rail, so as to place the weight on the centre of the bolt. It will be observed that this joint support provides for the natural and inevitable expansion and contraction of the rails.

In order to obtain the absolute and correct adjustment of the support when first put in, and after the concrete has set, several cars should be allowed to pass over the joint, and observation made of

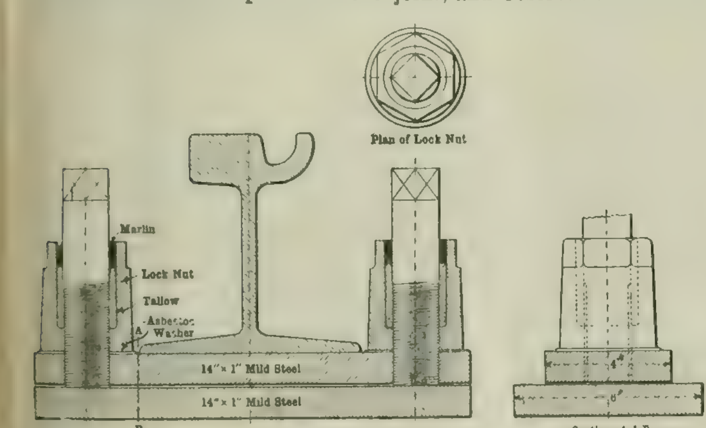


Fig. 11.

any slight knock or spring which may exist; the screws are then given a slight turn, say a quarter turn at a time, until it is certain that no sound whatever can be detected as the cars pass over. The lock nuts are then tightened, and the joint is complete. The lock nuts are hollow, and the space around the screws is filled in with melted tallow. These supports have been put down on several systems during the last three years.

Bonding.—In considering this part of the subject, the devices may be divided into two classes—viz. (*a*) those in which the fishplates are retained, and (*b*) welded joints. In the first case, no matter whether the type is an "anchor" or a "combination," no claim is made for increased conductivity to the extent of doing away with the bond altogether. The point is whether a short or long bond has to be employed, and whether, and in what manner, it can be protected. It is in this aspect that the relationship is important, as it affects both the first and subsequent costs.

The universal practice is to use two bonds per joint in order to obviate the "gathering" of the current, and it is admitted that the best position for them is one at the top of the web and the other at the bottom. It is, of course, not always convenient to adopt that arrangement, owing to the design of the fishplates, and it is much to be regretted that in some cases the better form of fishplates has been sacrificed on account of the bond difficulty. This difficulty has been rendered more complex (and disastrous, so far as the efficiency of the joint is concerned) by the desire to have "concealed" bonds. Briefly, it may be stated that with the "Anchor" joint the short bond and the concealed bond may be used without seriously affecting the efficiency of the lateral support; with the "combination," or continuous rail joint, the only alternative is to use a long and unprotected bond, thus rendering that method still more expensive. With regard to welded joints, the copper bond is not required, although, of course, in the case of a fracture, the mechanical and electrical features are both destroyed.

Conclusions.—In the first place, theoretical calculation shows, and practical experience proves, that the usual type of fishplate is unsatisfactory. Attempts have been made to get over this defect in design by making them longer. One engineer suggests 3 ft. The trouble is not overcome by that means, but by limiting their function to supporting the rails laterally. Whether it is necessary to use fishplates or not, there can be no question but that each device strives to fulfil the conditions of a perfect joint. It would be invidious to attempt to criticise further the several forms of tramway rail joints in view of the practical experience which the writer has cited.

It is another matter, however, as to what are the requirements which a perfect (speaking relatively) joint should meet, and these may be summarised as follows: (1) The joint should be rigid laterally, with no tendency or wedging action for bolts to work loose. (2) The vertical thrust should be taken as unyielding as the rest of the rail. (3) Where the least sign of yielding or "knocking" occurs it should be possible to remedy it forthwith, *in situ*. (4) It should not be possible to detect when the cars are going over a joint, and hence the running-surface alignment should be perfect. (5) The maintenance should be a minimum. (6) It should permit free expansion and contraction of rails.

TOTALLY-ENCLOSED MOTORS WITH FORCED VENTILATION.

It frequently happens that electric motors are required to work in extremely dusty or damp places, or in factories where the production of acid-bearing steam or gases is unavoidable. The motors may be rendered suitable to operate under these unfavourable con-

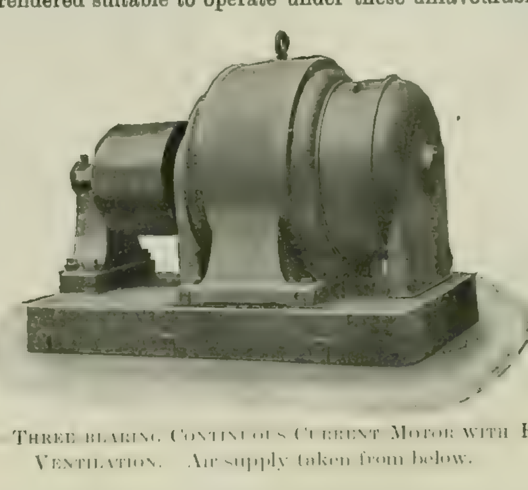


Fig. 1. Three-bearing Continuous Current Motor with Forced Ventilation. Air supply taken from below.

ditions by protecting them to a greater or less degree, and they then fall under the heading of partially or totally-enclosed machines. As a natural result of this protection a motor for any required output must be considerably larger and correspondingly more costly than an open-type machine.

To overcome this objection to the employment of electric motors in places where such conditions prevail, the Felten & Guilleaume-Lahmeyerwerke A.-G. has developed a system for the employment of forced ventilation with totally-enclosed motors, with the result that they may be rated as equivalent to open-type machines, and

will develop an equal output. The motor frame is completely enclosed, with the exception of two openings, one at the pulley end and the other at the commutator or slip-ring end. The former serves for the ingress and the latter for the egress of the air, which is forced through the machine by a fan mounted on the armature shaft. Each of these openings is in connection with a conduit, in order that the circulating air shall not communicate with the atmosphere of the room in which the motor is at work, but be drawn from a pure source outside the building. It is, of course, an essential condition for the employment of these motors that a supply of clean and cold air is available without the provision of an excessive length of conduit. The air supply and exhaust connections to the motor may be made either from above or below, the junction pieces cast or screwed to the end brackets being arranged accordingly. In order to give the machines sufficient stability they are mounted on base plates, in which there are openings connecting the air conduits with the motor housing, assuming that the air supply is taken from below (Fig. 1). With a belt drive the machine with this base plate is mounted on slide rails, which are so constructed that the connection between the motor and the underground channels is always air-tight. When the air supply is derived from above (Fig. 2), the

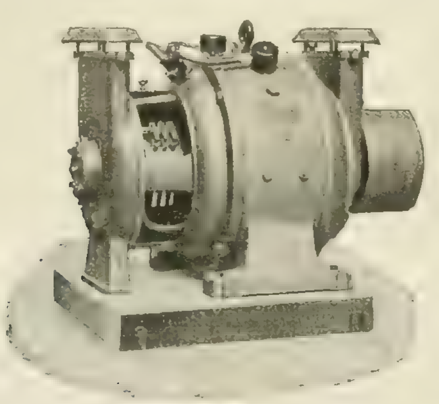


FIG. 2.—CONTINUOUS CURRENT MOTOR WITH FORCED VENTILATION. Air supply from above.

bracket at the slip ring or commutator end of the motor is supported by a foot resting on an extension of the base plate. If such a machine be mounted on slide rails the air connections must be made with flexible tubing.

Motors with forced ventilation may be employed also without special conduits leading to the open air in cases where the object of protecting them is to prevent access to their working parts by unauthorised persons, or to render them proof against dripping water in places not otherwise excessively damp. The air openings in the motor housing are then usually directed upwards and capped by a small hood. Machines built in this way have an advantage over the usual type of ventilated protected or drip-proof motors inasmuch as their ventilation is considerably superior, and their output for a given size correspondingly higher. The end brackets of motors of the forced ventilated type are concentric with the shell, and they may consequently be turned through 90 deg. or 180 deg. in order to fasten the machines to a wall or ceiling.

THE TESTING OF HIGH-TENSION CABLES.*

BY C. FELDMANN AND J. HERZOG.

Summary.—The advantages of grading the insulation of cables is discussed, and an example is taken in support of this view. With regard to the testing of cables, prolonged application of excessive voltages is considered to be harmful, for any faults should be discovered in quite a short time. Some interesting phenomena, obtained when overhead lines are subjected to very high tensions, are also described.

The potential gradient of a cable having a single sheath of homogenous insulating material falls from the metallic conductor of radius r to the earthed lead casing of radius R. The gradient, then for any radius ρ is given by

$$-\frac{dv}{d\rho} = \frac{V}{\rho \log R/r},$$

where V is the potential of the conductor above earth.

If a cable is insulated with materials in successive layers whose specific inductive capacities are inversely proportional to their distance from the core, the gradient is of the same slope throughout, and the cable is, for the same strength, both thinner and more flexible. O'Gorman, in 1901, proposed altering the graduation of the voltage gradient by suitable choice of successive layers in regard to specific conductivity and specific inductive capacity. It is possible, by various additions and mixtures, to alter the dielectric constant K without affecting the breaking-down voltage. Cables of this kind have been designed by Jona, and some shown at the Milan Exhibition did not break down until a voltage of between 200,000 and 210,000 had been reached. These cables, which consisted of 19 wires, each 3·6 mm. in diameter, were insulated with different layers of indiarubber to a thickness of 15 mm., the outer diameter of the cable being about 48 mm.

The authors then give mathematical reasons for the adoption of these methods of insulation, and show that the stress on the insulation is greater when stranded wires are used than when a single wire of the same section is employed. On small cables single wires should, therefore, be used, while on large cables the strands should be surrounded by a lead covering. In both cases the gradient is from 25 to 40 per cent. less than with ordinary stranded conductors. In order that the cables shall not be too rigid, armouring is dispensed with, special protective methods being, however, sometimes used.

Three cables laid across the lake of Garda, connecting the power station at Ponale with Roverto, transmit 600 kw. at 13,000 volts. The copper core is made of 19 strands and is 75 sq. mm. in cross section. It is covered with lead and then is insulated with indiarubber 5·5 mm. thick. There is, further, a gutta-percha covering 1·2 mm. thick, which is completely watertight, and as an insulated supplement to the lead covering gives the cable a higher breaking-down voltage combined with greater flexibility. The conductor insulated in this manner is then overwound with jute and armoured with 18 3 mm. steel wires. Three of these single-core cables form one feeder. The overwinding of the single steel wires with manilla hemp increases the reluctance of the armouring and decreases the excessive self-induction of the cable due to the armouring to the same value as the ohmic losses. After the jute spinning had been removed from both ends for a distance of 1·2 metres the cable withstood 100,000 volts without breakdown. When this point was reached the spark discharges from the armouring to the core became so great that the voltage could not be further raised. This is due to the fact that each unit length of core and earthed lead sheath forms a condenser. All these condensers are connected in parallel. The voltage increases from the edges of the lead covering to the free end, and the discharge takes place at the spot where the voltage breaks down the air. The arrangement due to Nagel of separating the successive insulating coverings by metal bands is recommended as it gives an equal potential gradient even on high-voltage tests.

The questions now arise, up to what working voltage can present-day high-tension cables be used and at what voltages should they be tested. Until 1900 12,000 volts was thought to be a limiting working voltage, but the A.E.G. has recently laid a 60 km. section to work at 20,000 volts, which after laying withstood the stringent Board of Trade test of 40,000 volts for an hour. The experience obtained with the transmission from Sainte-Croix to St. Paul in the United States is interesting. Two three-core cables 5 km. long and working at 22,000 volts, are directly connected to an overhead network 40 km. long. In one case each conductor is insulated with indiarubber 5·5 mm. thick, there being also a common covering of the same material 4 mm. thick. In the other case, paper insulation is used, the thicknesses being 6·5 mm. and 3 mm. respectively. Both cables have stood the test of four years' working.

The Cie. Energie Electrique du Littoral Méditerrané placed at de Marchena's disposal an overhead network so that he could carry out tests on three different kinds of cable. They were all three-core conductors, the copper section being 25 mm.; in the first each core was overwound with one ¼ mm. of paper, then followed insulation 7 mm. thick. The sector-shaped conductors were then twisted together with a lay of 1 m., further insulation being added up to 7 mm., and a lead covering pressed on. The diameter of the cable over the lead was 85 mm. The second cable had only 7 mm. of impregnated paper over each core and no common covering. Its outer diameter was only 65 mm. The third cable was still thinner; it had a covering 5 mm. thick over each cable and a common sheath 4 mm. thick. Before erection the cables were tested for one hour with 60,000 volts between two cores, and for one minute with 80,000 volts. They were also tested for one hour with 36,000 volts between the cores and lead, and for one minute with 50,000 volts. After laying, a test at 26,000 volts between cores and lead was made for one hour. De Marchena considers that for voltages between 5,000 and 20,000 volts cables should be tested at the factory at three or four times, and after laying at twice the working voltage. But he emphasises the fact that under certain circumstances such an excessive strain, if applied for a long time, may weaken or injure the insulation without actually breaking down the cable. It may thus be possible, on account of the length of the test and high value of the voltage, to lay a prematurely weakened and aged cable. From a practical standpoint it does not appear suitable to delude oneself into a state of false security by specifying a high voltage test, say, two or three times the working voltages for an hour. The insulat-

* Abstracted from the *Elektrotechnische Zeitschrift* [illegible] Vol. XLVI., p. 822 et seq.

ing materials usually employed break down at voltages between 12,000 and 20,000 per mm. Indiarubber and gutta-percha give between 15,000 and 20,000 volts per mm., and impregnated paper between 10,000 and 15,000 volts per mm. Stresses over 10,000 per mm. are, when lasting for a minute, permissible for the discovery of faults, but when applied for an hour may cause damage. A permanent strain will be given at voltages of from 4,000 to 5,000 per mm. to the layers in direct connection with the conductor.

Tests on short lengths of cable do not give correct results for the breaking down voltage on longer lengths. It is well known to cable manufacturers that short lengths behave in a relatively more favourable manner than do long lengths. Dr. H. Kath explained, according to the laws of probability, the uncertain and contradictory results obtained on breaking down tests. A cable with n layers of insulating material, with a faulty piece of area, δ on a unit of area, and, therefore, a serviceable surface of area $(1-\delta)$ has a mean breaking-down voltage of $n(1-\delta)$V, where V is the highest breaking-down voltage for a homogenous material. The shorter the test pieces the less probability that faulty places will not coincide.

If during the cable testing aerial wires are used as leads, attention must be paid at high voltages to the cable ends and to the behaviour of the overhead conductors. If tests are made in the dark on wires between 0·12 mm. and 0·15 mm. in diameter, placed on insulators about $1\frac{1}{2}$ metres above the ground, the ends being connected to a transformer whose other pole is connected to another separate and insulated line, a bluish discharge is noticed from a 0·12 mm. wire at 12,000 volts, from a 4 mm. wire at 80,000 volts, from a 12 mm. wire at 185,000 volts, while from a 15 mm. no discharge is noted at 196,000 volts. Tests of this description were made by Jona at the Milan Exhibition, and the whistling, buzzing noise made by the wire was quite distinct. Streams of light came from all parts of the line and insulators, while the electrostatic field was so strong that vacuum tubes not containing electrodes lighted up when placed in the immediate neighbourhood of the line. At 290,000 volts an arc which was set up by an insulator breaking down fired one of the supporting masts. The insulators were warranted for 60,000 volts and were tested at 160,000 volts.

BATTERY-BOOSTER PLANTS ON VARYING LOADS.

The problem of how best to deal with a widely varying load is one upon which it is not easy to generalise. The circumstances surrounding each individual case require careful investigation, for not only have the variations of the load to be considered, but the time element is often the determining factor. Where the fluctuations rapidly follow each other, are comparatively small in extent, and do not exceed the overload capacity of the generating plant, it is sometimes sufficient to meet the conditions with an over-compounded steam generator. If, however, on any system of power distribution there are connected a number of motors dealing intermittently with a comparatively heavy load, the installation of a battery and booster would offer the following advantages :—

1. The saving of a considerable amount in the first cost of the generating plant.
2. Constant operation of the generating plant at a steady load.
3. Saving in feeders.

FIG. 1. BATTERY OF 240 CHLORIDE ACCUMULATORS, 840 AMPERE-HOUR CAPACITY.

A case in point is the North Wall electricity works of the Dublin Port and Docks Board, where the Chloride Electrical Storage Co., of Clifton Junction, Manchester, have recently completed the installation of a battery-booster plant. The generating plant consists of three 200 kw. Parsons turbo generators. In parallel with the 'bus bars are 240 Chloride cells, capable of giving 420 amperes for one hour, and in series with the battery is a Highfield automatic reversible booster. The battery is illustated in Fig. 1 and the booster in Fig. 2.

The load will eventually consist of motors taking 60 H.P. for driving the workshops, two motors for hauling on the slip way taking 150 H.P., a 100 ton crane with 60 H.P. motor, 10 dock cranes, 10 railway capstans with 25 H.P. motors, and the equivalent of 600

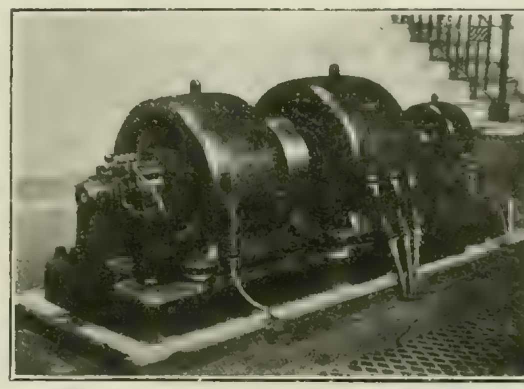


FIG. 2.—HIGHFIELD AUTOMATIC REVERSIBLE BOOSTER.

60 watt lamps for lighting purposes. It will be seen that the load will be of a very variable nature, and one which is not likely at any time to average itself out, but will be subject to very heavy peaks. The lighting is on the three-wire system, a balancer being run in conjunction with it. The power and lighting load are both supplied from the same 'bus bars, the battery and booster furnishing the difference between the mean generator load and the minimum requirements of the line load, thereby maintaining a constant load on the generators and a steady voltage on the 'bus bars. With a battery in series with a really sensitive reversible booster, the 'bus bar voltage can be kept constant within 1 per cent. of the mean, if the discharge from the battery does not exceed the one-hour rate.

The Chloride Company have also installed a battery-booster plant on a tramway system, to which are also connected some motors in a shipyard driving hydraulic pumps and air compressors, a class of load which is highly conducive to heavy peaks in the amount of energy required, the current ranging rapidly from 0 to 1,000 amperes. The tramway peaks amount to about 300 amperes above the mean generator load, yet with the two loads on the same generator the 'bus bar voltage curve is practically a straight line and the generator amperes only very occasionally vary more than 50 amperes.

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With "THE ELECTRICIAN" for Sept. 14, 1906, was issued the first of a series of "Industrial Supplements," to be published from time to time with "THE ELECTRICIAN." The twenty-fifth issue of the Supplement will be issued (Gratis) with "THE ELECTRICIAN" for July 24.

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TECHNICAL EDUCATION STATISTICS.

As the merits of technical education are now so well recognised, and as technical education is generally considered a necessary preliminary to the engineering profession, it is interesting to note, from the report of the Council of the City and Guilds of London Institute, any variation in the number of students passing annually through the courses connected with this Institute. In some respects activity in the student world is a barometer to the well-being of the electrical industry, though, unfortunately, it is a barometer which acts with considerable lag, being necessarily a reflection of what has taken place in the industrial world rather than an indication of what is to come. From the present report we notice that, although the total number of students at the Central Technical College continues to increase, the number of those taking the electrical engineering course is decidedly on the wane. On the other hand, the course dealing with civil and mechanical engineering is increasingly popular, and the number of students in the chemical departments is more or less steady. Thus, whereas in the session 1904-5, 160 students were occupied in the electrical engineering department of the Central Technical College, compared with 145 who were taking the civil and mechanical engineering courses, the figures for the session 1905-6 were 135 and 192 respectively, whilst in the session 1906-7 the electrical engineering students had further diminished in number to 126, whilst those taking the purely engineering courses had risen to 226.

These figures are deserving of more attention than is usually the case with statistics, for there had been a steady

increase in the civil and mechanical engineering department during the past 22 sessions from 14 to 226 students, and an equally steady increase in the electrical department from 13 students in 1885-6 to a maximum of 160 in 1904-5, compared with 126 in 1906-7 as mentioned above. This decrease is not peculiar to the Central Technical College, but is also evident at the Finsbury Technical College, where the maximum number of 110 electrical engineering students was reached in the two sessions 1901-2 and 1902-3, whereas in 1906-7 the total was only 87.

On the other hand, in the department of general technology, which is concerned with much evening class work throughout the country, and with the examinations which are held yearly by the Institute, not only has the number of students steadily increased but the number of those in electrical subjects was much about the same in 1906-7 as it was in 1905-6. We may, therefore, conclude that there is a steady desire on the part of those who are already engaged in the profession to improve their knowledge by means of work at evening classes, though there is evidently a distinct falling off in the annual number who have the hardihood to embark in the electrical industry. The large output of students during the last few years has not been beneficial. Now that the profession is well overstocked, parents are beginning to realise that electricity is not necessarily "the thing" of the immediate future. We do not doubt that much remains for electricity to do and that there are better days in store, but, nevertheless, it is well that it should be realised at the present time that electricity does not provide unlimited scope or opportunities for all who desire to take up this attractive, but by no means remunerative, profession.

ON SOME METHODS OF MEASURING CAPACITY WITH ALTERNATING CURRENTS OF COMPLEX WAVE FORM.

BY ROBERT BEATTIE, D.Sc.

Summary.—After pointing out the error in the "direct" method of measuring capacity by alternating current, caused by the presence of higher harmonics in the E.M.F. wave, the author describes how this may be overcome by using a non-inductive "swamping" resistance or a "swamping" choking coil, thus rendering the E.M.F. across the condenser terminals approximately sinusoidal. The other methods of measuring capacity here described involve comparison with a known capacity or with a known inductance, and the use of Dr. Sumpner's iron-cored wattmeter.

The so-called "direct" or "ammeter and voltmeter" method of determining capacity by alternating currents consists in measuring the effective value I of the current flowing into the condenser under test and the effective value E of the E.M.F. across its terminals. The required capacity is then given by the formula

$$C = \frac{I}{E\omega}, \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (1)$$

where ω denotes 2π times the frequency of supply. Only when the applied E.M.F. is simple periodic does this method give entirely reliable results, however. Even with an E.M.F. differing but slightly from simple periodic, comparatively large errors may be expected, and if the experiment be made by connecting the condenser to ordinary supply mains, the E.M.F. wave form of which is often very irregular in character, the results obtained by applying the above formula may have little apparent relation to the true capacity.

The cause of this discrepancy is found in the higher harmonics present in every irregular E.M.F. wave. As a result of the existence of these, the condenser current produced by an E.M.F. of complex form is always greater than that produced by a sinusoidal E.M.F. of the same effective value. Hence when the E.M.F. wave form is complex, the value of the capacity obtained by using equation (1) is invariably greater than the true capacity. A correcting factor has therefore to be applied, the value of which has been shown by H. F. Weber (*Wied. Ann.*, LXIII., p. 366, 1897) to be

$$\sqrt{\frac{E_1^2 + E_3^2 + E_5^2 + \ldots\ldots}{E_1^2 + 9E_3^2 + 25E_5^2 + \ldots}}, \quad . \quad . \quad . \quad . \quad . \quad (2)$$

where E_1, E_3, E_5, &c., denote the values of the simple periodic components into which the E.M.F. wave can be resolved.

As an example of the kind of error to be expected, let it be assumed that the harmonics in the E.M.F. across the condenser terminals decrease in amplitude according to some regular law as their order increases. For instance, let it be supposed that $E_3 = \frac{1}{3}E_1$, $E_5 = \frac{1}{5}E_1$, &c., so that if the fundamental be represented by 1 the successive harmonics are $\frac{1}{3}$, $\frac{1}{5}$, $\frac{1}{7}$, &c. The value of the correcting factor is then

$$\sqrt{\frac{1 + \frac{1}{9} + \frac{1}{25} + \frac{1}{49} + \&c.}{1 + 1 + 1 + 1 + \&c.}}$$

This decreases without limit as the number of harmonics increases. With harmonics up to the 5th only present, its value is 0·62; with harmonics up to the 7th only, 0·54; and so on. The correction to be applied is thus seen to be large, and the necessity for applying it takes away from the simplicity which the direct method would otherwise possess. The difficulty can in great measure be overcome by the use of certain expedients, however.

Use of Swamping Resistance.—Of these expedients the simplest is to insert a non-inductive "swamping" resistance in series with the condenser under test. The effect of this is to render the E.M.F. across the condenser terminals approximately simple periodic, even though the supply E.M.F. may have a very irregular wave form. To secure this result, however, it is necessary that the value R of the swamping resistance should be numerically large compared with the value $1/C\omega$ of the reactance of the condenser. (Here and subsequently when reactance, whether of a choker or a condenser, is mentioned without qualification, it is the reactance corresponding to the frequency of the fundamental that is referred to.) It will suffice if R is greater than $5/C\omega$ for example. In that case the magnitude of the current flowing into the condenser is, for all practical purposes controlled almost entirely by the resistance. Thus, if E_1, E_3, E_5, &c., be the components of the supply E.M.F., the currents produced by them will be E_1/R, E_3/R, E_5/R, &c., and the corresponding voltages set up by these currents flowing into the condenser will be $E_1/C\omega R$, $E_3/3C\omega R$, $E_5/5C\omega R$, &c. Hence if, for the sake of illustration, we assume, as before, that the components of the supply E.M.F. in ascending order are 1, $\frac{1}{3}$, $\frac{1}{5}$, &c., the components of the E.M.F. across the condenser terminals will be 1, $(\frac{1}{3})^2$, $(\frac{1}{5})^3$, &c. The higher harmonics are thus greatly diminished relatively to the fundamental, and in consequence the correcting factor now becomes

$$\sqrt{\frac{1 + \frac{1}{81} + \frac{1}{625} + \&c.}{1 + \frac{1}{9} + \frac{1}{25} + \&c.}}.$$

When there are a large number of harmonics present this works out as 0·911, so that the error committed by leaving out the correcting factor altogether would amount to only 9 per cent.

This, however, is for the rather extreme case in which the harmonics in the supply E.M.F. are exceptionally large and numerous. Under ordinary practical conditions where the higher harmonics in the supply are likely to be less in magnitude and fewer in number than has been assumed, it may be taken that the use of a swamping resistance of the order of magnitude named, or even less, will permit the capacity to be deduced by equation (1) from measurements of the condenser current and the condenser E.M.F. correct to within a few per cent.; and for many requirements this is a sufficient degree of accuracy.

Use of Swamping Inductance.—Should any doubt exist in a given case as to the adequacy of a swamping resistance, a swamping choker (which must be ironless) may be used in its place. This is much more effective, and may be relied upon to render the E.M.F. across the condenser terminals approxi-

mately sinusoidal even with a very distorted supply E.M.F. wave.

Let it be assumed, for the moment, that the reactance $L\omega$ of the swamping choker employed is numerically large compared with the reactance $1/C\omega$ of the condenser, and that its ohmic resistance is negligible. The components of the current flowing into the condenser can then be written $E_1/L\omega$, $E_3/3L\omega$, $E_5/5L\omega$, &c. The corresponding components of the condenser E.M.F. are, therefore, $E_1/CL\omega^2$, $E_3/9CL\omega^2$, $E_5/25CL\omega^2$, &c. Taking, as before, the components of the supply E.M.F. as 1, $\frac{1}{3}$, $\frac{1}{5}$, &c., those of the condenser terminal E.M.F. are 1, $(\frac{1}{3})^3$, $(\frac{1}{5})^3$, &c. Thus while the use of a swamping resistance reduces the higher harmonics in the condenser E.M.F. to small quantities of the first order (compared with those in the supply E.M.F., that is), the use of a swamping inductance reduces them to small quantities of the second order. The correcting factor—viz.,

$$\sqrt{\frac{1 + (\frac{1}{3})^6 + (\frac{1}{5})^6 + \&c.}{1 + (\frac{1}{3})^2 + (\frac{1}{5})^2 + \&c.}},$$

is accordingly much more nearly equal to unity, being, in fact, 0·993 when a large number of harmonics are present. In other words, the condenser E.M.F. is now so nearly sinusoidal that the error committed by employing formula (1) only amounts to 7 parts in 1,000.

With the view of affording a comparison between the effects of an inductance and a resistance, it has been supposed, in the above, that the swamping inductance used is high. This is not at all necessary, however. As is well known, the best results are obtained with a choker adjusted to have a reactance numerically equal to that of the condenser. In this way the fundamental is brought into resonance, and it is under these conditions that the choker acts most efficiency in swamping the higher harmonics. A choker of even less inductance than this may be employed, however, if an accuracy of 1 per cent. only is aimed at. The reader can easily satisfy himself that, with a supply voltage of the assumed wave-form, a choker with a reactance equal to half that of the condenser is sufficient to obtain this degree of accuracy. But in the ordinary course of things one would naturally select a choker having a reactance several times that of the condenser as giving all desired accuracy without incurring the risk of resonance with the fundamental.

Comparison with a Known Capacity.—Manifestly with alternating currents of any wave-form the capacity of a condenser can always be determined by comparison with a standard condenser. It is only necessary to place the two in parallel across the supply mains and measure the currents taken by each; the ratio of these currents is then equal to the ratio of the capacities whatever the wave-form may be. Or, again, the condensers may be placed in series, when the inverse ratio of the E.M.F.s across their terminals gives the ratio of their capacities.

Comparison with a Known Inductance.—The simple devices just described are not, of course, novel, and are probably familiar to everyone who has had to make measurements of capacity on commercial alternating current circuits; but that results independent of wave-form can be obtained by comparing a capacity with an inductance is, perhaps, less generally known. As far back as 1898, however, Rowland described (*Phil. Mag.*, Vol. XLV., p. 66) a large number of alternating current methods in which a capacity is placed in circuit with one coil of a dynamometer wattmeter, and an inductance in circuit with the other, the currents in the two coils being then brought to exact quadrature by means of non inductive resistances and (though Rowland did not point this out) some of these zero methods are independent both of wave form and of frequency (cf. Lagnana, *Science Abstracts*, Vol. XI., Abstract No. 268).

Deflectional methods, as distinct from zero methods like those of Rowland, may also be employed for comparing a capacity with an inductance and give results which are independent of wave form. Such methods have occasionally been used by the writer (in common with many others doubtless) for some considerable time past, but no account of their general theory has, so far, appeared.

The comparison of a capacity with an inductance by a deflectional method can be carried out in a variety of ways, the inductance being placed either in series or in parallel with the capacity. Consider first the case of an ironless choker of inductance L and negligible resistance placed in series with a condenser of capacity C across alternating current mains. Let I_n be the nth harmonic in the current wave taken as a type. Then the E.M.F. set up by this harmonic across the choker terminals is $I_n Ln\omega$, and that set up across the condenser terminals $I_n/Cn\omega$. Calling ϕ_n the phase difference between these two E.M.F.s (equal, in the assumed circumstances, to 180 deg.) we have

$$\frac{1}{T}\int_0^T e_1 e_2\, dt = \sum I_n Ln\omega \cdot \frac{I_n}{Cn\omega} \cdot \cos\phi_n = -\frac{L}{C}\sum I_n^2 = -\frac{L}{C}I^2,$$

where e_1 and e_2 denote the instantaneous values of the E.M.F.s across the choker and the condenser respectively; T is the

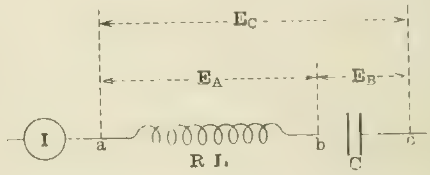

FIG. 1.

periodic time, and I is the effective value of the current, it being understood that the summation indicated by Σ extends to all the existing harmonics in the current wave.

In the same way by considering the case of a resistanceless choker connected in parallel with a condenser across supply mains at a voltage E, we have the nth harmonic E_n in the E.M.F. wave creating a current, $E_n/Ln\omega$, in the choker, and a current, $E_n Cn\omega$ in the condenser.

Accordingly

$$\frac{1}{T}\int_0^T i_1 i_2\, dt = \sum \frac{E_n}{Ln\omega} \cdot E_n Cn\omega \cdot \cos\phi_n = -\frac{C}{L}\sum E_n^2 = -\frac{C}{L}E^2,$$

where i_1 and i_2 are the instantaneous values of the currents in the choker and the condenser, and ϕ_n is the phase difference (equal to 180 deg.) between the nth harmonic in the condenser current and the nth harmonic in the choker current.

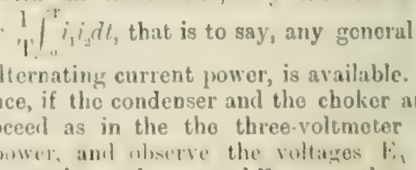

FIG. 2.

These general relations show that, for the comparison of a capacity with an inductance, any method of measuring $\frac{1}{T}\int_0^T e_1 e_2\, dt$ or $\frac{1}{T}\int_0^T i_1 i_2\, dt$, that is to say, any general method of measuring alternating current power, is available.

For instance, if the condenser and the choker are in series, we may proceed as in the the three-voltmeter method of measuring power, and observe the voltages E_A across the choker, E_B across the condenser, and E_C across the two together (Fig. 1). Then

$$\frac{1}{T}\int_0^T e_1 e_2\, dt = \frac{E_C^2 - E_A^2 - E_B^2}{2} = -\frac{L}{C}I^2,$$

and, therefore,

$$C = 2L \cdot \frac{I^2}{E_A^2 + E_B^2 - E_C^2} \quad . \quad . \quad . \quad . \quad . \quad (3)$$

Or we might employ electrometer, &c., methods, the appropriate formulæ for which the reader can readily work out for himself.

In like manner, with the choker and the condenser in parallel, we have a choice of several methods. We may elect to proceed as in the three-ammeter method of measuring power, for example, and observe the currents I_A and I_B in the

choker and condenser branches, as well as the total current I_C (Fig. 2). Then

$$\frac{1}{T}\int_0^T i_1 i_2\,dt = \frac{I_C^2 - I_A^2 - I_B^2}{2} = -\frac{C}{L}E^2,$$

or
$$C = \frac{L}{2}\cdot\frac{I_A^2 + I_B^2 - I_C^2}{E^2}. \quad . \quad . \quad . \quad . \quad . \quad (4)$$

If we prefer to use a dynamometer wattmeter connected up as in Fig. 3, we have

$$\frac{1}{T}\int_0^T i_1 i_2\,dt = KW = \frac{C}{L}E^2,$$

or
$$C = L\frac{KW}{E^2}, \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (5)$$

where W is the wattmeter reading and K is an instrument constant.*

Recently Dr. Sumpner has shown how his iron-cored wattmeter may be used for capacity measurements. The shunt-excited electromagnet of this instrument creates a field of exactly the same character (as regards the relative magnitude and phase of its constituent harmonics) as that produced by the coil of an ordinary dynamometer wattmeter having in series with it an external inductance as just described. Hence, when the moving coil of a Sumpner wattmeter is connected to the supply mains through a condenser the deflection of the instrument is directly proportional to the capacity and to the square of the voltage in accordance with equation (5).

It remains to point out certain noteworthy features of these methods. If, with the condenser in series with the choker, we attribute a resistance R to the latter, the E.M.F.s set up across

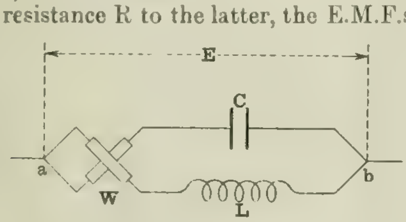

FIG. 3.

the choker and the condenser by an nth harmonic I_n in the the current are $I_n\sqrt{R^2 + L^2n^2\omega^2}$ and $I_n/Cn\omega$ respectively. Hence

$$\frac{1}{T}\int_0^T e_1e_2\,dt = \sum I_n\sqrt{R^2 + L^2n^2\omega^2}\cdot\frac{I_n}{Cn\omega}\cdot\cos\phi_n$$

where ϕ_n is now equal to $\left(90 + \tan^{-1}\frac{Ln\omega}{R}\right)$. Accordingly

$$\cos\phi_n = -\frac{Ln\omega}{\sqrt{R^2 + L^2n^2\omega^2}},$$

and therefore
$$\frac{1}{T}\int_0^T e_1e_2\,dt = -\frac{L}{C}I^2$$

as before. Deflectional methods of measuring capacity by comparison with a series-connected choker are therefore independent of the resistance of the choker. For this to hold good, however, the condenser must be free from appreciable leakage.

It is of more importance to observe that, with the choker in parallel with the condenser, deflectional methods give results which are independent of leakage in the condenser. Leakage in the condenser is equivalent to so much resistance R connected as a shunt across its terminals. An nth harmonic, E_n, in the applied E.M.F. then creates a current $E_n/Ln\omega$ in the choker branch and a current $E_n\sqrt{C^2n^2\omega^2R^2+1}/R$ in the condenser branch. Thus

$$\frac{1}{T}\int_0^T i_1 i_2\,dt = \sum\frac{E_n}{Ln\omega}\cdot\frac{E_n\sqrt{C^2n^2\omega^2R^2+1}}{R}\cdot\cos\phi_n.$$

Here ϕ_n is equal to $(90 + \tan^{-1} Cn\omega R)$ so that

$$\cos\phi_n = -\frac{Cn\omega R}{\sqrt{C^2n^2\omega^2R^2+1}}.$$

Consequently
$$\frac{1}{T}\int_0^T i_1 i_2\,dt = -\frac{C}{L}E^2,$$

into which the condenser leakage does not enter. But this only holds good provided the comparison choker is devoid of appreciable resistance.

The following numbers, the results of experiments on a condenser of 5·04 mfd. capacity will serve to show what degree of reliance can be placed on the foregoing methods.

The condenser was first connected directly to a small alternator and the current, as well as the E.M.F. across the condenser terminals, noted at a frequency of 60. The value of the capacity deduced from these observations by formula (1) was found to be 11·8 mfd. The wave-form, on open circuit, of the particular alternator used is shown in Fig. 4, curve I., but the conditions during the test were such as to bring one of the higher harmonics into partial resonance, so that the E.M.F. wave-form actually applied to the condenser terminals was of a more irregular character. The result is typical of the kind of error that may be expected when capacity measurements are made with alternating currents of complex wave-form without taking special precautions.

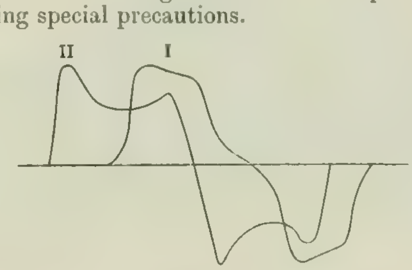

FIG. 4.

Analysis of these Curves gave the following results :—

Components	1st.	3rd.	5th.	7th.	9th.	11th
Curve I.	100	13·8	13·8	2·3	5·0	1·0
Curve II.	100	42·0	16·[illegible]	3·6	2·4	1·8

The same experiment was next repeated under identically the same conditions, except that a swamping resistance of 1,000 ohms was introduced in series with the condenser. The value obtained for the capacity was in this case 5·15 mfd., which is in excess of the true capacity by 2 per cent. This is exactly what would be predicted from the known harmonics in the applied E.M.F. Nor would anything have been gained by using a higher swamping resistance. Even if an infinite resistance had been used the error would still have amounted to 1·7 per cent.

An exactly similar experiment made at a frequency of 100, but with a swamping inductance of 1·3 henry in place of the resistance of 1,000 ohms, gave a value of 5·05 mfd. for the capacity. The discrepancy here is small and well within the limits of experimental error. With a choker of the stated inductance and with sufficiently accurate instruments there was nothing to prevent an accuracy of at least one part in 1,000 being obtained.

Numerous measurements of the capacity of the condenser were also made by the three voltmeter method, the conditions being varied within wide limits in order to test its reliability. Thus experiments were made with both the E.M.F. wave-forms shown in Fig. 4. In addition the frequency was varied from 30 to 100, and the inductance of the choker likewise altered with the view of distorting the current wave-form as much as possible. The mean of many experiments gave 5·05 mfd. for the capacity; and in no single instance was the difference from this mean more than could be accounted for by experimental error.

Working with different wave-forms and frequencies, equally satisfactory results were obtained with the three-ammeter method and with the wattmeter method. In these methods, as already explained, it is necessary to use a choker whose resistance is small compared with its reactance. In the ex-

* The expressions (4) and (5) are rigorously true only when the ohmic resistance of the comparison choker is negligible. It is necessary, therefore, to determine what error is introduced by a small amount of resistance such as cannot be avoided in an actual choker. On recalculating (4) and (5) with the resistance R of the choker taken into account it will be found that in both expressions E^2 should be replaced by $\sum E_n^2\cdot\frac{L^2n^2\omega^2}{R^2+L^2n^2\omega^2}$. When the choker possesses appreciable resistance the results obtained by (4) and (5) are thus too small, and the ratio $E^2/\sum E_n^2\cdot\frac{L^2n^2\omega^2}{R^2+L^2n^2\omega^2}$ represents the correcting factor which ought to be applied. When the fundamental is the predominant component of the E.M.F. wave, the value of this correcting factor is seen to be approximately $1+\frac{R^2}{L^2\omega^2}$. In no case, whatever the wave-form may be, can it exceed this. Thus if $R=\frac{1}{10}L\omega$ the error in using (4) or (5) will be less than 1 per cent; and if $R=\frac{1}{20}L\omega$ less than one-quarter of 1 per cent.

periments the reactance varied with the frequency but was, on the average, about 20 times the resistance. The attainable accuracy was thus one-quarter of 1 per cent. The actual values obtained for the capacity were 5·03 mfd. by the three-ammeter method and 5·04 mfd. by the wattmeter method, these numbers being the means of many individual results, none of which differed from the mean by as much as 1 per cent.

CORRESPONDENCE.

A.C. ACCUMULATOR SUB-STATIONS.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: Supplementing the notes sent you, I beg leave to enclose a few additional remarks.

Mr. Raphael's remarks, as published to-day, are most interesting to me, for it is quite evident that he (and I fancy also Mr. Wilmshurst and Mr. Watson) had gathered from the Paper that I was figuring upon getting the kilowatt capacity on which I had based my capital costs on a one-hour basis, whereas I had done nothing of the kind. The kilowatt capacities alluded to in Figs. 10, 12, 13 and 14 of my Paper are based on a *three-hour* rating; hence, the 15,000 kw. battery of Fig. 10 *could* do 30,000 kw. for one hour (the 100 per cent. overload capacity alluded to), which, however, since there are 19,000 kw. of steam plant, and the peak load only 30,000 kw., it would never be called on to do, unless the steam plant totally failed.

It is unfortunate that Mr. Wilmshurst pitched upon my Fig. 1 for his comparison with Derby, and I greatly regret having misled him, as this is a purely hypothetical curve, and none of my deductions are based upon it, but upon Fig. 9, which is the load curve of a large commercial town having a good motor load. I fancy that a careful comparison of the *area* of the upper half of the Derby curve with my Fig. 9 will show Mr. Wilmshurst that there is no very material difference; anyway, I can assure him that by reducing the battery kilowatt capacity at Derby to, say, 40 per cent. of the peak (instead of 50 per cent.) the figures of my Paper for the saving per kilowatt will still hold. I can also assure him that an increment of 5 to 10 or even 15 per cent. in the annual load factor is of *far* less importance than a corresponding difference in the area of the mid-winter peak, for reasons which I will give in my reply to the *Journal*.

I have analysed dozens of load curves, and may say that, fogs excepted, the estimates given in my Paper will hold for towns having large power and tramway loads, such as Manchester, Liverpool, Birmingham, &c., provided that only some 30 per cent. of the peak is taken up by the cells. In such towns the fog load rarely exceeds 66 per cent. of the peak load, on account of the less amount of lighting; consequently, the steam plant is capable of meeting it with very little, if any, assistance from the batteries, and these will thus be no bigger than those considered in my estimates; but if he will refer to my Fig. 9 he will find there a fog load of nearly 10 hours' duration—probably rarely exceeded even in London—and may be somewhat incredulous when I assert that the estimates of the saving (per kilowatt) given in my Paper would apply even here, provided that the battery was only put in to deal with, say, 25 per cent. of the peak. While on this question, I may point out that, if the batteries are put in for 50 per cent. of the peak, a "fog load" *averaging* 75 per cent. of the mid-winter peak over 7 to 8 hours can be dealt with by the combined plant, without *any* extra expenditure on battery power. I know of no towns outside of London where this demand is exceeded, and think the above will show that I have carefully considered the question of "fog" loads, and not, as some critics appear to think, ignored it.

I would add that my Paper dealt *almost entirely* with alternating current sub-stations combined with direct-current distribution from same, but that even at Sheffield and Leeds the cost would be a long way below that of steam plant (*pace* Mr. Wilmshurst).

I herewith enclose Table X., which is a condensed (corrected) financial summary of my estimates.—I am, &c.,

Birmingham, July 9. A. M. TAYLOR.

MARCONI'S SYSTEM OF WIRELESS TELEGRAPHY.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: In anything that I originally said it was my intention merely to convey that I did not consider the duplex-automatic system applicable in practice to wireless telegraphy in the same way that it was to cables. And I think so still; for it must be remembered that Mr. Raymond Barker is speaking of a particular system of wireless telegraphy—not that which was being dealt with by the *Morning Post*, or which has throughout headed this correspondence. As I spoke originally of the duplex-automatic system in connection with cables, I continued to do so in connection with radio-telegraphy, though fully appreciating Mr. Raymond-Barker's point that there is no difficulty about radio-automatic working.

Mr. Raymond-Barker and myself have now reached much about the same position—*i.e.*, that "cable-working with its present very high standard of efficiency daily developing fresh possibilities . . . . fresh actualities in high and constant speed-rates, remains paramount and practically untouched."

The only difference between us is that he considers the recent statements in the lay press in regard to wireless telegraphy supplanting cable telegraphy have had a serious influence on cable shares, and I was inclined to differ from this view to some extent. But this is, of course, purely a matter of opinion, in which Mr. Raymond-Barker is—as I have already said—quite likely to be right and I wrong.—I am, &c.,

Westminster, July 14. CHARLES BRIGHT.

Table X.

—	Steam, 1907-8	Steam, 1912-13	Accumulators, 1912-13.	
Coal, oil, wages (running costs)	£15,000	£38,200	(No coal savings credited to cells) ...	£38,200
" " " (fixed charges)	15,980	30,280	15,980 + 2,000 (sub-station wages)	17,980
	30,980	68,480		56,180
Repairs	8,350	19,150	8,350 + 4,000 (mains)	12,350
Management, &c.	8,350	14,600	8,350 + 1,500 (office)	9,850
	47,680	102,230		78,380
Rates and taxes	8,350	16,900	8,350 + 2,650	11,000
	56,030	119,130		89,380
Accumulator maintenance			9 % £225,000 (cells)	20,250
Extra wages			Wages	1,000
Working expenses	56,030	119,130		110,630
Reserve fund (depreciation, &c.)	12,000	35,300	12,000 + 3,000 (mains) =	15,000
Interest and sinking fund	73,440 (43,920 + 29,520 G.S. & F. Mains)	120,400 (77,840 + 42,560 G.S. & F. Mains)	73,440 + 13,040 (new mains)	86,480
			3 % of £225,000 (cells)	6,750
Total expenses	£141,470	£274,830		£218,860

NOTE.—£21[illegible] 13,150 5,500 £213,860 7,350 excess F.C. £211,010 (Fig. 6 in *The Electrician*).
£73,440 + (17,500 × £1·8) + 13,040 = £117,980 instead of £120,400.

A HYDROGEN PEROXIDE CELL.*

BY H. T. BARNES AND G. W. SHEARER.

Two Papers have been presented before the American Electrochemical Society by one of the authors in conjunction with H. M. Tory and G. H. Cole, in which the results of experiments on the effect of dissolved gases in water on metal surfaces have been given. In the second Paper a cell was described which consisted of electrodes of aluminium and magnesium in a solution of aluminium sulphate, to which some hydrogen peroxide was added. Aluminium behaves in a peculiar manner in contact with dissolved air, or oxygen, and becomes electro negative to a similar aluminium electrode in water free from dissolved air. Magnesium does not show this effect: hence a cell with the two metals for electrodes has a comparatively large E.M.F. developed when dissolved air or oxygen is introduced. The effect is considerably increased by adding hydrogen peroxide. Acting on the suggestion of Prof. Bancroft, tests were applied to the water in which clean aluminium had stood for a few hours, and a measurable quantity of hydrogen peroxide was detected. This was developed from the action of the dissolved oxygen on the aluminium, probably according to the following reaction, also suggested by Bancroft:—

$$2Al + 6H_2O + 6O = Al_2(OH)_6 + 3H_2O_2.$$

The amount of yield of the peroxide was considerably increased in several ways. Without dissolved air no trace of peroxide was observed. The generation of the hydrogen peroxide explains the abnormally E.M.F. developed between two metals so close together in the electrochemical series.

* Abstract of a Paper read before the American Physical Society. From the *Physical Review*.

THE MINING EXHIBITION, OLYMPIA, LONDON.

On Saturday last what is the fourth of a series of colliery and mining Exhibitions was opened by the Right Hon. Lord Strathcona at Olympia. Following as it does so quickly on the publication of our special Mining Issue we find that the pages of that number in a great measure have gone over much of the ground covered by a number of the electrical exhibits at this Exhibition. Still the show is none the less interesting from an electrical point of view, while engineers generally cannot fail to be struck with the important part machinery now plays both in the winning of coal and the obtaining of precious stones and metals from the earth's crust. The electrical industry is not fully represented at the Exhibition, but this discrepancy is probably accounted for by the exhibits in the Machinery Hall at the Franco-British Exhibition and the forthcoming Electrical Exhibition at Manchester. We do not, however, lose sight of the fact that most of the haulage gears, coal cutters, drills, boring bars, creepers, conveyors, &c., which go to make up the machinery complement of the average mine are adapted for electric driving. Consequently one can notice electrically-operated machinery on almost every stand. From an electrical point of view there is nothing particularly new presented among the exhibits, but there are signs of standardisation amongst motors and controlling gear which cannot fail to assist materially in the greater employment of electrical energy in mines.

FIG. 1. "FLOAT" ELECTRIC MINER'S LAMP IN INVERTED POSITION FOR EXTINGUISHING LIGHT.

Strange though it may seem, the electric miner's lamp, with its simplicity and general portability, does not enjoy the vogue which these features should secure for it. The first cost may have something to do with this, but we do not think it is the main reason. The primary battery lamp is the ideal for work of this class, because it places the individual lighting, from the miner's point of view, as independent of the electric power supply, as does his present oil lamp. Messrs. BERRY, SKINNER & Co. are showing a type of primary battery safety miner's lamp which has created something of a sensation at the Exhibition. This lamp, known as the "Float," receives its energy from a couple of primary cells contained in a metal case. These cells have zinc and carbon plates, but the electrolyte is a special preparation the composition of which is not divulged. No switch is required for controlling the lamp, as the operation of turning the case upside down, as shown in Fig. 1, suffices to extinguish the lamp by removing the electrodes out of the electrolyte. The primary batteries, which are hermetically sealed, thus allowing no fumes to escape, are seen on the right-hand side of Fig. 2, in which the constituent parts of the complete lamp are shown. It will be noticed that the contacts of the cells consist of metal discs which rest on one another when the cells are in position in the containing case.

The lamp will burn for 12 hours without recharging, and at the end of that period, if the cell is allowed to rest for about four hours, a further two hours light can be obtained. The process of recharging is extremely simple, occupying only one minute and consisting of replacing the electrolyte by fresh solution. The cost of burning is thus said to work out at only ¼d. per hour. Among the many advantages which are claimed for this lamp we may mention that there are no wires, connections or switches to get out of order, that the ignition of gas is impossible, the lamp is of only light weight—viz., 3¾ lb. when charged, and in the case of an accident below ground, resulting in one man or a party of men being cut off for several days, it is possible to reserve the light or eke it out for several days, which, of course, would be impossible with oil lamps. It is also a by no means insignificant advantage that the electrolyte is almost neutral—*i.e.*, only very slightly acid—so that it can be easily stored and freely handled.

In another form of portable lamp shown on this stand, an extension lamp was supplied, the flexible being fitted with a two-pronged plug. This latter also serves as a switch connecting up in circuit

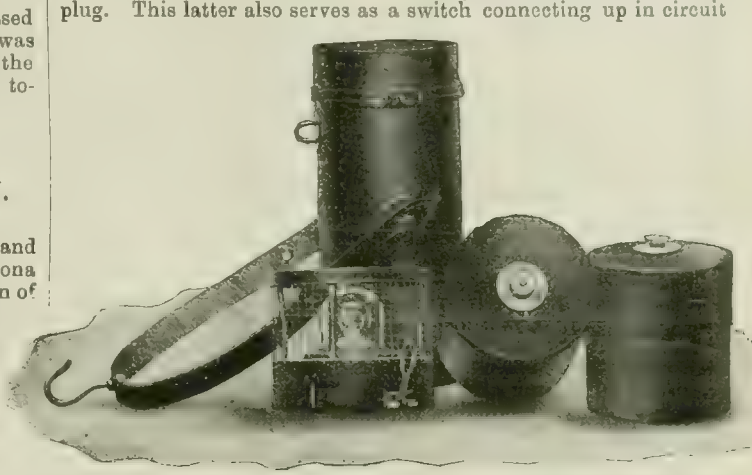

FIG. 2. COMPONENT PARTS OF THE "FLOAT" ELECTRIC MINER'S LAMP.

one or two lamps according to the depth it was inserted in the socket; whilst by inverting the complete lamp in the manner described above, the current was completely cut off, the electrolyte being removed from contact with the electrodes. An interesting selection of Messrs. Berry, Skinner & Co.'s well-known iron-clad switches, to which we have frequently referred in recent issues, are also exhibited on this stand.

Turning to the general machinery we find the problem of mining ventilation closely identified with the electric motor. Messrs. DAVIDSON & Co. are showing a large single inlet mine fan 49 in. diameter, driven by a Mather & Platt 20 H.P. direct-current 220 volt motor. This fan is shown running, and it has a capacity of 26,000 cubic ft. per minute, against 3 in. w.g. when running at a speed of 420 revs. per min. The makers claim that this fan in comparison with the ordinary Guibal type economises foundation space, and consequently takes considerably less power for the amount of air moved. An interesting model graphically illustrates this, the Sirocco fan with motor being placed between reproductions of the two Guibal fans which it successfully displaced in a colliery in the Durham district. A 35 in. diameter fan is also illustrated, this having a capacity of from 13,000 to 51,000 cubic ft. of air per minute. The good qualities of the "Sirocco" fan as a blower are also practically demonstrated on this stand. Messrs. HEENAN & FROUDE have divided their exhibit into two portions, which are joined together by an arch bridging the main gangway. A large electrically-driven fan is the outstanding feature of the exhibit. This is arranged for belt-drive, and has a capacity of 40,000 cubic ft. of air per minute when running at 340 revs. per min. The same type of fan is suitable for direct coupling to an electric motor. Several other fans of the "Heenan" and "Schiele" pattern are shown on this stand. Messrs. ANDREW BARCLAY have a large electrically-driven drum fan in operation, and we understand that a number of these are running in well known collieries, giving a combined efficiency on fan and engine of 73 per cent. The CAPELL FAN CO. have a small exhibit, comprising a small mine fan and a model of a patented system of duplicate mine fans.

Electric haulage gears, pumping plants and small electric winders are well represented on the stand of Messrs. E. SCOTT & MOUNTAIN, which adjoins the main entrance. A feature of the exhibit is a large vertical sinking pump, coupled direct to a 40 H.P. direct current

500 volt motor. The pump is driven at 1,530 revs. per min. and has a capacity of 260 gallons per minute against a 300 ft. head. The delivery water passes through a liner round the motor carcase, keeping the machine cool while the pump is running. The weight of the entire equipment is taken on wire ropes which pass round two pulleys, one on each side of the motor body. A 5 H.P. to 10 H.P. portable main rope haulage gear is shown, the motor on this being controlled by a special mining reversing controller with quick make and break on every contact. A controller of this pattern was described in the Mining Issue of *The Electrician*, p. 54, last week. Messrs. MAVOR & COULSON, in addition to showing a number of their well-known "Pickquick" coal cutters, are exhibiting a special underground carriage conveyor designed for taking coal from the working face to the haulage road, in seams up to about 3 ft. thick. A couple of sections, with end pieces, of this controller have been laid down in the Exhibition, and are shown actually in operation. The carriage is fitted with automatic end discharge, which comes into operation when the conveyor reaches the haulage road. The standard length is about 40 ft., and this will hold something like 35 cwt. of coal. When the conveyor has been loaded up at the face it is drawn down to the haulage road and immediately it arrives there a suitable gear is thrown into action which starts the conveyor discharging. This carriage is conveyed backwards and forwards by an electrically-driven haulage gear.

As a purely electrical exhibit that of Messrs. DICK, KERR & Co. is the largest in the Exhibition. The company's standard alternating current and direct current motors are exhibited in various sizes, the main parts being dissembled to facilitate inspection. Foolproof motor starting gear has also been erected on the stand, and is shown in operation, and mining engineers will no doubt appreciate the extreme simplicity and certainty of the design of this apparatus. A push button must be depressed with one hand and a hand wheel turned with the other to start up the motor, and it is impossible to switch in the main circuit-breaker attached to the starter without returning the starter arm to the off position. At one end of the stand is a large electric capstan, which is fitted with a 25 H.P. crane rated motor driving the bole from a worm and worm wheel. The motor operates on a 440 volt circuit, and runs normally at 620 revs. per min., the rate of travel of the capstan rope being about 220 ft. per minute. The starter is interesting in that a single circuit-breaker is employed, and this is operated from a pedal protruding through the removable cover of the iron box containing the driving mechanism. The subsequent acceleration of the motor after the closing of the circuit-breaker is effected by solenoid switches, which cut the resistance of the motor out quite independently of the man in charge. These solenoid switches do not break any circuit, as they remain in until the main circuit-breaker comes out, and do not close before the main circuit-breaker is put in. This arrangement is highly satisfactory, because gears of this class are apt to get into the hands of unskilled men, who always fail to appreciate the importance of starting a motor gradually. The company also shows on its stand examples of high-voltage switches and auto starters for alternating current motors. The latter we described in *The Electrician* of February 14, 1908. The GRONDAL KJELLIN Co., amongst a comprehensive exhibit of ore concentrating and briquetting methods, show an electric steel furnace of the Kjellin type, and also samples and photographs of electric steel made in furnaces of this class. Messrs. GWYNNES have a small exhibit showing their "invincible" centrifugal pump, which is made for high lift work and direct connection to electric motors. The exhibit includes a 3 in. pump of 180 gallons per minute capacity, a 5 in. pump delivering 550 gallons of water per minute, and "invincible" portable direct-acting pumping engines, with a 7 in. pump having a capacity of 1,000 gallons per minute. The firm make a feature of a manganese steel-lined pump for handling tailings, slimes, or for doing coal washing work.

The heavy steam engine is represented by Messrs. BROWETT, LINDLEY & Co. who show one of their latest standard enclosed forced-lubrication three-crank triple-expansion engines for driving a 350 kw. generator. The speed of this set is 375 revs. per min., and the engine may be worked at from 150 lb to 180 lb. steam pressure. It is also capable of giving 25 per cent. overload. This engine has been so often described that we do not need to refer to it in detail. We may, however, remark that it is used in many colliery installations, and has proved its reliability under the usual severe conditions of working which obtain in mining practice. Despite the fact that electrical energy is obtainable from companies supplying in bulk large coal bearing districts it is frequently considered desirable to put down independent steam plant, and judging by the interest taken in Messrs. Browett, Lindley's exhibit there are colliery engineers who still believe in generating their own electrical energy wherever they can conveniently and economically arrange to do so.

The HART ACCUMULATOR Co. is just to the left of the main entrance, their exhibit making up an extensive show of batteries of all kinds. Mining engineers will doubtless be interested in the portable patterns in wood lead lined boxes, which are suitable, among other things, for portable lamps, telephones, &c. The plates are arranged to stand rough usage and the boxes have special lids which prevent the spilling of the electrolyte. A feature is made among the large cells shown of the "Hexite" sheet separator, a device which, it is stated, prevents internal short-circuits, the material being an insulator and placed on each side of the positive plates. Fig. 3 illustrates the separator in position.

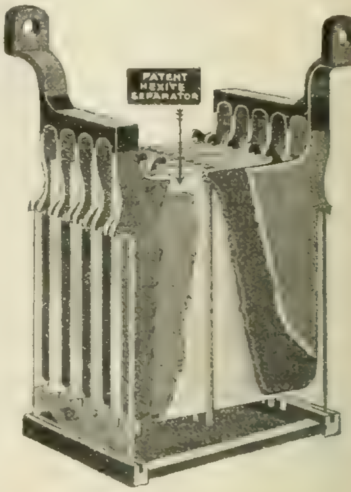

FIG. 3.—HART ACCUMULATOR SHOWING SEPARATOR.

Among other exhibits of electrical interest we may mention Messrs. Peter Brotherhood, the Cambridge Scientific Instrument Co., Clarke, Steavenson & Co., Diamond Coal Cutter Co., Erith's Engineering Co., Fraser & Chalmers, Haniel & Lueg, Austin Hopkinson, R. H. Longbotham & Co., Reavell & Co., Stewarts and Lloyds, Stirling Boiler Co., Sybry Searls & Co. Our readers will find most of these referred to in our Mining Issue of last week. In our INDUSTRIAL SUPPLEMENT next week we shall deal more fully with the general electrical exhibits at Olympia

THE B.T.H. TUNGSTEN LAMP.

There is no doubt that one of the predominant features, if not the predominant feature, in the electrical engineering history of the last few years is the greater interest shown in all questions relating to artificial illumination. The introduction of the flame arc and metallic filament lamp have done much towards altering former conditions, and the discussions to which these new inventions have given rise have been instructive both from a scientific and human point of view.


A 110 VOLT 50 WATT B.T.H. TUNGSTEN LAMP

In our issue of May 1st we gave a brief account of the recent progress made in the manufacture of metallic filament lamps, and concluded with the statement that further developments might shortly be expected. This pseudo-prophecy has been fulfilled, as the British Thomson-Houston Co. have just placed a new tungsten lamp on the market. This lamp is said to be the result of much exhaustive experiment, as the company wished to be satisfied that it was in the same class with their other products as regards both quality and reliability.

We illustrate one of these new lamps in the accompanying figure. It is intended for burning on 110 volt circuits, gives about 40 c.p. and consumes 50 watts. Its dimensions are 6¼ in. long by 2¾ in. in diameter. These lamps are also being made suitable for use on 25 volt and 50 volt circuits in conjunction with auto transformers. Such lamps may be substituted for the ordinary 16 c.p. carbon lamp without any alteration in the fitting being necessary. The 25 volt lamp is supplied in two sizes, consuming 12.5 and 20 watts, and having candle powers of 10 and 16 respectively. The 50 volt lamp is only supplied in the latter of these sizes.

The question of series burning has not been overlooked by the B.T.-H. Co. The 100 volt lamps suitable for series burning are marked with a series number, and no lamp having series numbers more than one point apart should be burned together. Thus, lamps numbered 47 may be burned with lamps numbered 46 or 48, or, in exceptional cases, with 45 or 49, but with no others

A specially interesting feature in these lamps is that of candle-power. The Teutonic origin of many metallic filament lamps has led to the free use of the Hefner standard in stating their candle-power, and confusion is sometimes the result. We are asked to state, in connection with the B.T.-H. lamp, that not only is it wholly manufactured in Rugby, but that it is rated in terms of the British standard candle. Another important feature is that users and sellers are indemnified by the B.T.-H. against all claims for infringement of British patents regarding tungsten lamps.

REPORT TO THE BOARD OF TRADE ON THE FIRE ON THE LANCASHIRE & YORKSHIRE RAILWAY.

Mr. A. P. Trotter's report to the Board of Trade on the fire which occurred on April 30th in a trailer coach running on the Liverpool and Southport branch of the Lancashire & Yorkshire Railway has now been issued. It will be remembered that no one was injured in connection with the occurrence, and fortunately no panic took place. The cause of the fire is stated to be a "short circuit" from a positive cable to the framework of the carriage, and a secondary fire spread along the inflammable woodwork of the carriage. In the report Mr. Trotter remarks :—

If I had been asked to make a critical comparison between the wiring of this carriage and those of the London lines and of the North-Eastern Railway lines before I examined this accident, I should have said that (1) the "bunching"—that is to say, the running of several cables side by side in a common trough or casing, (2) the cutting away of the uralite (for what it is worth) and the exposure of bare wood at the upward turn, (3) the number of bunched cables and wires between the panel and the end of the carriage, compare unfavourably with the practice elsewhere of running each cable in a separate iron pipe, these pipes in the case of the North-Eastern Railway being carefully arranged not to cross each other (for what that may be worth) and all carefully "earthed" to the frame. On the London railways, owing to the insulation of the negative conductor rail, bonding the iron pipes to the frame does not constitute an "earth." The wood work of the Underground Railway Co. of London is treated with chemicals which render it (not incombustible but) non-inflammable. Consideration of the whole circumstances, however, shows that while there is a somewhat greater risk here of a short-circuit, and that the use of materials not treated with non-inflammable composition allowed the secondary fire to spread through the carriage, the most serious matter was the persistence of the electric supply, and the details of the wiring are comparatively unimportant.

I recommend that bell wiring should be kept separate from power wiring and from wiring for lighting. When cables are run in iron piping, moisture sometimes condenses in them and may accumulate in considerable quantities. It has been suggested that drain holes should be provided. While these would prevent any accumulation of water, they would leave the cables subjected to damp air in wet weather or under the conditions, whatever those may be, of condensation or sweating. I recommend that when cables are run in iron pipes, they should be sealed by wooden ferrules, parallel inside, slightly tapered outside, split in two or perhaps three parts, and driven well into the pipes. Jarrah wood while not very hard is not easily inflammable. Uralite, while capable of standing the temperature of ordinary red heat, will melt when close to an arc, and is not an insulator. It is quite incapable of resisting the primary fire of an accident of this kind. If iron pipes are not used, perhaps the best bed for cable is a certain asbestos composition which will stand an electric arc better than any substance that I have seen. It may be obtained in moulded blocks, grooved to fit the separate cables, and moulded blocks may be obtained for bends. It would not be strong enough to stand tapered ferrules at the ends, but being made in halves it cannot be regarded as forming water-tight channels.

I do not attach much importance to so-called non-inflammable or fire-resisting properties of the insulation of cables. The protection of cables against external fire is not an important consideration in electric railways. Fires break out from short-circuits and the copper wires themselves inevitably become red hot and melt. The restriction of the mischief either in space or in time is the important matter ; the sacrifice of a few feet of cable is of no importance. The important thing is that the fault should burn itself out quickly, without setting fire to the carriage, and with the production of as little smoke as possible.

In this case, the arc was more severe than, I think, any that I have known in London. This is no doubt because it was a dead short from positive to negative. It is estimated that it lasted not more than two or three minutes. Its intensity was shown by the considerable amount of iron which was melted. A stout knee, a diagonal and the headstock were fused. Several pounds of iron were melted from these. Although the Board of Trade has urged, and with notable success, the use of non-inflammable materials in the construction of carriages used in the tube railways, and while similar materials are used in the other underground railways, it has not been considered necessary to press this upon such open railways as the Liverpool and Southport.

In regard to the persistence of the electric current after it had been automatically cut off, Mr. Trotter remarks :—

It is not improbable that a current of 2,000 to 8,000 amperes, insufficient to open the breakers, did most of the mischief of the primary fire, and the apparently simultaneous opening of the breakers and the explosive opening of the one at the battery sub-station, indicate that at a certain stage it quickly increased and largely exceeded 9,000 amperes. During the two minutes after the breakers were replaced the fire started again and reached the same point, again opening the breakers. Inspection of the result shows that a heavy current must have passed for some time. Had the sub-station attendants, after the current had been cut off by the opening of the automatic circuit-breakers, guessed that there was something wrong, and kept them open, it is probable that the fire would not have spread, and it certainly would have been less severe and easily controlled. But circuit-breakers frequently open, and it is the practice on this line to put them back at once, on the supposition that they have come out in consequence of a momentary overload.

Meanwhile the driver of the train put his short-circuiting bar across the rails and prevented any further supply. These short-circuiting bars afford a simple and effectual protection, which is not so easily applicable to a line when the negative conductor rail is insulated. Although the short circuit is as sudden and heavy as it can be, no damage is done to the converters, but the circuit-breakers come out violently. The fire was then subdued by chemical extincteurs, and the train started again after a total delay of only 18 to 20 minutes. It is clearly desirable that in all electric railways automatic circuit-breakers should be arranged completely to cut off current from any section on which an accident is happening.

The current fed to a line may be of three kinds—first, the ordinary working current used by the motors ; second, general leakage current, and third, current due to such an accident as this. To these may be added the current used for lighting the trains, but this is perhaps insignificant. It would be an advantage if attendants at sub-stations could discriminate between these currents. It might be worth while trying if a telephone working on an induced circuit in shunt to such a length of conductor as is available in a sub-station would indicate (1) a hum due to the motors, (2) comparative silence due to leakage, or lighting, disturbed perhaps by the sliding of the shoes, (3) a possibly characteristic roar due to an arc.

It appears to me that while attention may be given with advantage to details of wiring and to gradual alteration of the carriages, most careful consideration is immediately necessary as to the arrangement of the circuit-breakers, their time-limits and length of line controlled by each, and to the procedure to be adopted by sub-station attendants in replacing them.

Shoe fuses appear to be of minor importance. They must be so rated that two can easily take the maximum starting current of a train.

Recommendations.

1. In construction of new rolling stock, and in alterations and repair of the present stock, care should be taken to protect cables, not only against water under ordinary conditions of weather, but under conditions of high wind or driving snow.

2. The lay-out of feeders, circuit-breakers and section switches should be arranged with the view of limiting for each section the current distributed to that section, with a reasonable margin in excess of the maximum requirements of that section, and the sections should be, where possible, of such a size that one train only is likely to start on it.

A New Lamp Base.—In the United States it would seem that supply engineers suffer from the more or less occasional disappearance from their sockets of lamps used for street lighting purposes. With the advent of expensive lamps like the tantalum and tungsten, the necessity of fixing lamps in public places, so that they cannot be stolen from the sockets is being more urgently felt. Even with the comparatively cheap carbon filament lamp, some concerns lose yearly many lamps by theft. Several socket devices have been brought out to prevent lamp stealing, but the problem has been attacked in a new way in a patent recently applied for by W. I. Weber and W. R. Bonham, who propose using a lamp base of somewhat novel design. This lamp base has a brass shell, which is arranged in such a way that it can revolve freely on an inner brass shell, this inner brass shell being cemented to the lamp base in the usual manner. A small set screw is provided, which is screwed down tight to hold the shell so that the lamp can be screwed into the socket. After the lamp is in the socket the set screw is removed, and the lamp will then revolve freely without unscrewing. To remove the lamp the set screw must be put back. This screw is provided with a left-handed thread.

BRUCE PEEBLES & CO. (LTD.) (In Liquidation).

The duly notified meetings of debenture holders, creditors, preference and ordinary shareholders of this company (in liquidation) were held in Edinburgh on Friday last to consider the scheme of arrangement submitted by the liquidators.

At the *Debenture-holders'* meeting Mr. J. A. ROBERTSON-DURHAM presided, and explained that he had been appointed by the Court chairman of all the four meetings, and had been directed to report the result to the Court. Proxies received by the liquidators up to date showed the following results: Creditors with £158,472 in favour of the scheme and only £2,810 against; debenture holders £27,700 in favour and only £500 against; ordinary shareholders with £106,510 in favour and only £5,075 against; and preference shareholders with £29,305 in favour and £4,700 against.

Mr. J. WILSON, Edinburgh, moved: "That the scheme of arrangement between the company's creditors and the members and the company, dated June 15, 1908, be approved and adopted, and that the joint liquidators be and hereby are requested to take or concur in taking the necessary steps for obtaining confirmation by the Court of Session to the said scheme."

The motion was carried by 3 votes to 1, and Mr. A. W. Tait and Mr. A. B. Anderson were nominated as representatives of the debenture holders on the new board.

The *Creditors'* meeting was next held, and Mr. T. CALLENDER moved in favour of the scheme.

Mr. GYAROS, of Budapest (for Mr. L. Hubert, representing Messrs. Ganz & Co.), said it was essential to the proper consideration of the scheme that approximately the debts of the old company should be ascertained, as he considered that upon that amount hinged the prospects of the new company. He moved as an amendment: "In respect that it is necessary for the proper consideration of the proposed scheme of arrangement that the creditors should have fuller information as to the assets and liabilities of Bruce Peebles & Co. (Ltd.), in liquidation, this meeting be adjourned sine die until such information be supplied and time accorded the creditors to consider it."

Mr. GEORGE SCHULTZ, London, seconded the amendment, and said it seemed rather absurd for a large body of business men to be called together to consider a scheme of which they had only the assurance of one or two gentlemen in a private kind of way as to its value. He thought it was desirable to adjourn the meeting until they had received assurances from the members of the committee appointed by the shareholders that they had investigated the figures and could recommend the scheme.

A CREDITOR asked if the debentures were held up for 10 years, and that the preference shares at 12s. 6d. in the £1 would obtain in time a Stock Exchange quotation, or must they take it that the 7s. 6d. in the £1 was not realisable under 10 years, and that 12s. 6d. in the £1 was interminable.

Mr. WILSON TAIT, joint liquidator, said he believed the directors would be acting in the interests of the concern if they applied for a Stock Exchange quotation in Edinburgh, but it was quite open that shares changed hands which were not quoted, and there would be, if not a formal, at least an informal market on the Edinburgh Exchange for these securities.

A CREDITOR asked if there were any security for these debentures. Could it not be arranged that they should have 2nd debentures? There were floating assets, and he understood that the 1st debenture holders had no lien whatever upon the floating assets. It seemed to him a very strong point whether there should be some security given to the creditors for these debentures. As to the time of repayment, he understood that the first intention was that there should be some early day specified. The meeting had a right to expect that there would have been some report presented as to the position of the liquidation at this moment. Mr. Tait had said they had had a very full report in March last, but that was five months old. A great deal had happened since then to affect the assets.

The CHAIRMAN said there was no security for the debentures offered to the creditors. The liquidators had submitted a balance-sheet made up from the books as at Feb. 14, the date of the liquidation. They had done their best to carry on the business, and they had been very successful. They had got a large number of orders for a company in liquidation, and had kept the thing going at a small loss. Although the books showed creditors for £170,000, the claims came to £310,000. To submit a "balance-sheet" at the present time would only mislead.

Mr. [illegible] (Glasgow) said it was folly at this time for the general body of creditors to go against the committee's report.

The CHAIRMAN said, with reference to the amendment, he was advised they could not adjourn that meeting. They were met, by order of the Court, to vote upon this scheme, for or against.

On a vote the Chairman said there were only three against the scheme: Messrs. Ganz & Co., creditors for £14,500; the General Electric Co., £[illegible], and Morrison & Gibb, £213.

At the *Preference Shareholders'* meeting, Mr. [illegible] (London) said the shareholders were asked to put up a good many thousand pounds in order to carry on the business, but what possibility was there that the business would pay? Everyone knew the chronic state in which the heavy manufacturing electrical business was to-day. Had the liquidators any talisman which would enable the company to compete with international concerns, which were taking business at any price they could get, and make a profit?

The CHAIRMAN pleaded ignorance of the electrical business. He could not tell them whether the company would succeed or not, but he put before them a scheme which had been approved by a committee of gentlemen competent to judge. These gentlemen reported unanimously recommending the shareholders to go in for the scheme.

After further discussion, the Chairman announced that shareholders to the extent of £37,300 had voted in favour of and £7,500 against the scheme. Abstentions amounted to £3,800, exclusive of shareholders unrepresented at the meeting.

At the meeting of the *Ordinary Shareholders* no questions were asked and there was no discussion. The Chairman announced that 925 shares were in favour of the scheme and 30 against.

The proceedings then terminated.

PARLIAMENTARY INTELLIGENCE.

FIRE ON THE LIVERPOOL-SOUTHPORT RAILWAY.

On Wednesday, in the House of Commons, Mr. CROSS asked the President of the Board of Trade if his attention had been directed to the report made by Mr. A. P. Trotter relating to his inquiry into the recent fire in an electric carriage on the Liverpool and Southport Railway, and, having in view the liability to such fires inseparable from all electrically-driven railway carriages, what regulations had been made for the protection of the public from the consequences which might ensue, and whether a copy of such regulations had been ordered to be publicly exhibited at the stations of all such railways?

Mr. W. CHURCHILL said the Board of Trade had made special requirements with regard to the construction of tube railways, with the object of guarding against fire. These, however, related to the material, ventilation, installation, lighting, and such matters, and the knowledge of them by passengers, would not, he thought, add to the passengers' safety. Hydrants and fire hose were fixed on every platform, and there were fire extinguishers in every carriage. Copies of Mr. Trotter's report had been sent to all railway companies which had adopted electric traction.

Mr. A. P. Trotter's report is given on p. 537.

CENTRAL IRELAND ELECTRIC POWER BILL.

This bill which was recently passed by the House of Commons, having been approved by a Committee of that House, after re-committal, came before a Committee of the House of Lords, presided over by Lord Donoughmore, this week.

The bill is to authorise the incorporation of a company to generate electrical energy by gas power produced by means of peat. The original proposal to supply current in Dublin, Pembroke and Rathmines has been dropped.

Mr. Freeman, K.C., with Mr. Jeans, appeared for the promoters; and Sir Ralph Littler, K.C., with Mr. Paddon, appeared for the Alliance & Dublin Gas Consumers' Co., who opposed, alleging that the bill would create unfair competition.

On Tuesday, Capt. H. R. SANKEY, one of the promoters and joint consulting engineer for the scheme, substantially repeated the evidence he gave before the House of Commons' Committees.

Sir RALPH LITTLER said that if the area served by the gas company, which included Blackrock, was cut out of the bill, as Dublin, Rathmines and Rathgar had been, his opposition would be withdrawn.

Capt. SANKEY said the cost of an underground scheme would be prohibitive. The charges for carriage of by-products from Robertstown by canal to Dublin would be very light. They had entered into an agreement to supply Blackrock if they got their powers.

Mr. ARNOLD LUPTON, M.P., said he had examined some of the peat from the Bog of Allen, and could testify to the feasibility of the scheme. If the bill passed a commercial future might be anticipated from the utilisation of the peat. He had never known a bill projected in respect of which so many agreements for the supply of power had been secured before Parliament sanctioned the proposal. He and his friends were prepared to provide capital for the undertaking. There was no reason for the gas company's fears. Gas had been more prosperous since the introduction of electricity.

Mr. CROSSLEY, M.P., Chairman of Crossley Brothers (Ltd.), Manchester, and original director of the Manchester Ship Canal, said his works had been driven by gas engines for 25 years. They had tried gas produced by Irish peat containing from 50 to 60 per cent. of moisture and found it very good.

Mr. JOHN [illegible], the other joint engineer for the scheme, stated that the area was 847 sq. miles. Arrangements had been made for overhead transmission. The works they proposed to set up would give them 15,000 H.P. for 50 years on a 30 per cent. load factor. He thought manufacturers would crowd round them as they did around Niagara.

Cross-examined by Sir RALPH LITTLER: It was necessary to come into the Gas Co.'s area to supply a projected tramway from Donnybrook to Bray. The income from the supply of power to the Dublin and Lucan tramways would be about £1,000, and probably the same amount in the case of the Dublin and Blessington. If the Board of Trade refused permission to set up high-tension overhead wires to Blackrock they would have to be placed underground.

Re-examined: Rathdown Guardians and the owner of the property on which the garden city was to be erected had applied for a supply.

In reply to Lord [illegible]: He was prepared to put into the concern every sovereign he could scrape together.

On Wednesday Mr. L. WICKHAM, chairman of Blackrock Council, expressed the opinion that the bulk supply would be of advantage to the district, and the Council had agreed to take a supply from the company if the bill passed.

Mr. F. Heron, clerk to Blackrock Council, also supported the bill.

Mr. T. Clarke, chairman of Rathdown Guardians, said the board had approved the bill. Oil lamps were at present used in the union buildings.

Mr. W. F. Cotton, manager of the Alliance & Dublin Gas Consumers' Co., said the company had had powers since 1866 to supply electric light and for eight years did supply it, but ceased to supply because the demand did not justify the expenditure of laying underground mains.

Mr. Stephen Sellon condemned the scheme as commercially unsound.

Yesterday (Thursday) the Committee were engaged in considering various clauses of the bill.

LOCAL AUTHORITY TRAMWAY ACCOUNTS.

In the House of Commons on Monday,

Sir J. Benn asked the President of the L.G. Board if his attention had been directed to Messrs. Peat & Pixley's report on the L.C.C. tramway accounts, and whether he proposed to instruct the Government auditor of the accounts of the L.C.C. or any other local authority owning tramways to amend their accounts in the direction indicated?

Mr. John Burns replied that he did not think it necessary to take any action.

In reply to a request by Sir J. Benn that the Chancellor of the Exchequer would state the amount paid to date as income tax on the profits of the L.C.C. tramways, and an inquiry whether, in view of the recent audit made by Messrs. Peat & Pixley of the tramway accounts, it was proposed to return all or part of the income tax,

Mr. Hobhouse said it would be contrary to the express condition of the Income Tax Acts to furnish information with regard to any particular assessment. He did not suppose the Exchequer would propose to return, in consequence of this audit, any money which has been paid in regard to the tramways profits of the L.C.C.

Telegraph Construction Bill.—On Thursday last this bill, which grants the right to the Postmaster-General to erect telegraph lines on land near public roads, without consent of the occupier, and other powers, was passed by Standing Orders Committee of the House of Commons, after the addition of a clause protecting public recreation grounds.

Patents and Designs Bill.—On Friday last this bill was considered in Committee, reported without amendment, and the House of Commons agreed to the third reading after a statement by the Attorney-General that the bill was introduced merely to make good a draftsman's mistake in the act passed last year consolidating the Patents Acts. The result of the mistake was to deprive litigants of the right of appeal in cases where the patentee was alleged not to be the first inventor, where the invention was alleged not to be new, where there was alleged to be no subject matter for a patent, and in a whole group of important cases of that character as to which the Government never intended to restrict the right of appeal.

Miscellaneous Bills.—In the House of Lords on Monday the London and District Electricity Supply Bill was read a third time. On the same day the London County Council (Tramways and Improvements) and the South Wales Electrical Power Distribution Bills were considered and ordered for third reading in the House of Commons.

LEGAL INTELLIGENCE.

S.E. & C. Railway Joint Committee v. National Telephone Co. (Ltd.)

This case came before the Court of Appeal (the Master of the Rolls and Lords Justices Farwell and Kennedy) on defendants' appeal from a judgment of Mr. Justice Warrington. Plaintiffs claimed a declaration that defendants were not at liberty to construct and were not now at liberty to use or maintain any pipes, cable or telephone works in, upon or over a bridge which crossed plaintiffs' railway at Tonbridge Station except upon payment of an annual rent of £30 and with the consent of the plaintiffs. Defendants contended that they were authorised by their statutory provisions to carry their cable across the bridge without plaintiffs' consent, and that, therefore, as the agreement was without consideration. Mr. Justice Warrington decided against defendants' view.

After hearing the arguments of Mr. Roskill, K.C., and Mr. Gaine on behalf of the appellants their lordships (without calling upon Counsel for the respondents) dismissed the appeal, with costs.

Fusion Fumes.

A case of a peculiar character was heard at the Manchester Assizes on Monday by Mr. Justice Bucknill and a common jury. Mrs. Leah Ellison sued Manchester Corporation for damages for the death of her husband.

Mr. Ambrose Jones, for plaintiff, said the husband formerly carried on business in Great Ducie-street as a pawnbroker and jeweller. On March 16 Dr. Becker was called in and found that Mr. Ellison's heart was slightly dilated. About 2:30 the next morning the members of the family were aroused by fumes which originated from the fusing of a Corporation electric cable. Deceased got out of bed, but fell unconscious. He was removed to the Infirmary, and although he walked home after treatment, he subsequently died at Southport on April 1.

His Lordship made a suggestion to counsel, and it was ultimately announced that the Corporation had agreed to pay £125 and costs. In discharging the jury the Judge said the Corporation had acted very fairly.

Defective Manhole Covers.

At Kent Assizes on Saturday Alfred Wood, painter, Canterbury, sought to recover damages from Dover Corporation for personal injuries sustained through alleged negligence of the Corporation servants. Plaintiff, while cycling into Dover, was thrown from his machine owing to its striking the projecting cover of an electric box or manhole belonging to the Corporation. The roadway was under the control of and maintained by Kent County Council, and the road round the box had been worn away to the extent of 1¼ in. The point which the judge had to decide was whether the Corporation could be held liable for the altered condition of the roadway, and he held that they were not liable, and gave judgment for defendants, with costs.

Municipal Tramways and the Public Authorities Protection Act.—At Manchester Assizes on Thursday last, Mr. Justice Bucknill said he was obliged to non-suit a plaintiff (Mrs. Moss), who claimed compensation for injuries sustained whilst attempting to board a Salford Corporation tramcar, because the action was not entered within the six months allowed by the Public Authorities Protection Act. He could not agree that the limitation would not hold good because the plaintiff had not recovered from her injuries during the six months. It was, he admitted, very hard on the plaintiff, and he stayed execution as to costs for a fortnight.

Unauthorised Bulk Supply.—Brentford (Middlesex) magistrates recently heard a summons taken out by Ealing Council against the proprietors of the Ealing Hippodrome for "illegally supplying current to Liptons Limited for lighting a restaurant attached to the Hippodrome." The current thus supplied was part of the supply given to the Hippodrome by the Council, and it was argued that this placed the Council in the position of supplying electricity in bulk, for which they had no authority. The Bench held that a technical offence had been committed, but dismissed the summons under the Probation of Offenders Act on payment of £2. 2s. costs.

MUNICIPAL, FOREIGN & GENERAL NOTES.

APPOINTMENTS VACANT AND FILLED.

Foreman electrical instrument maker is required, well acquainted with modern requirements and rapid production of work. See advertisement.

Well connected engineers are wanted as district agents for steam plant suitable for electrical work. See an advertisement.

An assistant lecturer in physics is required for Portsmouth Municipal College. Additional qualifications in electrical engineering will be a recommendation. Salary, £125 rising to £150 per annum. Particulars from the Secretary, Municipal College, Portsmouth, to whom applications by July 24. See also an advertisement.

Cleveland & Durham Power (Ltd.) have vacancies for two junior switchboard attendants. Applications to the Secretary, Hinton's-buildings, Middlesbrough.

Mr. J. Shaw, M.I.C.E., M.I.E.E., resident engineer to the Mersey Railway Co., has been appointed general manager of the company, and the general offices are to be transferred from James-street, Liverpool, to the Central Station, Birkenhead. The traffic manager (Mr. R. Bowman Smith) has decided to resign.

Mr. T. W. Sampson (Barnsley) has been appointed instructor in electricity and practical wiring at Barnsley Technical Schools.

Mr. Edmund L. Hill has been appointed manager of the Manchester branch office of Siemens Bros. Dynamo Works, in succession to Mr. Philip C. Pope, who is taking up a position with John Musgrave & Sons, Bolton.

EDUCATIONAL NOTICES

City and Guilds of London Institute.—The courses of instruction at the Institute's Central Technical College, Exhibition-road, are for students not under 16 years of age and those at the Institute's Technical College, Finsbury, for students not under 14 years of age. Entrance examination to both Colleges are held in September and the sessions commence in October. Particulars of the entrance examinations, scholarships, fees and courses of study may be obtained from the respective Colleges or from the head offices of the Institute, Gresham College, Basinghall-street, London, E.C. The Central Technical College is for higher technical instruction for day students preparing to become civil, mechanical and elec-

trical engineers, chemical and other manufacturers and teachers. The college is a school of the University of London and also forms the engineering section of the Imperial College of Science and Technology. The Finsbury Technical College is for instruction for day students preparing to enter engineering and chemical industries and for evening students.

Heriot Watt College, Edinburgh.—At this college there is theoretical and practical training for mechanical, electrical and mining engineers, technical chemists, &c. The training for engineers consists of three years in the college and a three years' apprenticeship on the "sandwich" system in a local engineering works. The total cost, including apprenticeship premium and fees at college, is from £120 to £200. There are complete courses of instruction, extending over four years, for students studying for the fellowship of the Institute of Chemistry. The classes are recognised by the University of Edinburgh as qualifying for science degrees. Full information may be obtained from the Principal, Mr. A. P. Laurie, M.A., D,Sc.

We have received the syllabus of the day classes of the above college, which gives further particulars (with fees, &c.) of the courses of instruction at the college, including information as to the "sandwich system" of training engineers.

Arrangements have been made with several of the leading firms of engineers in Edinburgh and elsewhere, for the college students to begin their apprenticeship at the end of the second winter session, returning to the college the following winter to complete their third winter course. Students holding the Heriot-Watt College diploma have their apprenticeship reduced by one year, and in some cases either reduced premiums are charged to the college students or the premiums will be entirely dispensed with. The result of the arrangement is that, if a student on entering the college puts down his name as an apprentice with one of the firms, he can obtain his entire training, theoretical and practical, as an electrical or mechanical engineer in from five to six years. New mechanical engineering laboratories have just been completed at the college.

University College of North Wales.—A systematic course of instruction in electrical measurement and practical electricity is given at this college for students proposing to enter the electrical engineering profession. The physical laboratory is well equipped, and the course commences in October next. Prospectuses, &c., from the secretary, Mr. J. E. Lloyd, M.A.

University College, Nottingham.—Prospectuses of the engineering department (mechanical and electrical B.Sc. degree, mining diploma and ordinary courses) of this college can be obtained from the Registrar. The session begins Oct. 5.

Argentina.—La Plata Senate has approved the bill for the conversion of La Plata tramways to electric traction.

The town of Campana is to be provided with electricity supply for public and private purposes.

Australasia.—Prahran Council have agreed to enter into a seven years' contract to supply to the Electric Lighting & Traction Co. of Australia (Melbourne) surplus electrical energy generated by steam from their refuse destructor at ½d. per unit.

Broughty Ferry.—It has been decided to reduce the prices of current for lighting from 6d. to 5½d. and for power from 4d. to 3d. A small credit balance resulted from last year's working of the electricity department.

Bulgaria.—A company with a capital of £140,000 is being promoted at Brussels to supply electricity in Sofia.

Camberley.—The Council have resolved to ask the Board of Trade to rescind the Camberley Electric Lighting Order on the ground that the Camberley Electric Supply Co. has not provided a supply of energy in accordance with the terms of the order.

Chester.—Mr. H. Ross Hooper held an inquiry on Wednesday into the application of the Corporation to borrow £30,500 for the electricity undertaking, and a further £1,500 for wiring consumers' premises. It was stated that the profits of the undertaking since its inception were £17,773. The Inspector said he thought it was proposed to put in a very large machine, considering the power consumed. With regard to the free wiring, Corporations all over the country were giving this up.

Coventry.—Lengthy reports have recently been prepared by the manager of the electrical department (Mr. Joseph E. Jeckell) and the auditor (Mr. E. T. Peirson) on the financial position of the electricity undertaking.

Mr. Jeckell, in his report, points out the conditions under and the terms for which loans for electric lighting are sanctioned and the operation of the sinking and reserve funds. It is pointed out that many of the loans on the undertaking will be extinguished in 20 years. For the first 10 years £1,000 per annum will be required to replace plant which will be worn out in the natural course in that time. During the succeeding 10 years £3,000 per annum will be required if the L.G. Board do not grant re-borrowing powers to replace plant worn out in the natural course before the equated loan in which it is included has been extinguished—that is to say, £40,000 in the next 20 years. If that amount be set aside as reserve the undertaking would be in an absolutely sound financial condition. Particulars are given of superseded plant, &c., and appended to the report are schedules giving details of the plant superseded, the existing plant, with its estimated life, depreciation, &c. Summarising these schedules the position at Coventry is as follows:—

	£	s.	d.
Amount of accounts to be transferred from capital to revenue........................	10.411	0	9
Plant superseded	16,579	17	4
	26,990	18	1
Deduct amount at present in sinking fund applicable to these items, £7,835. 0s. 8d.; estimated present worth of superseded plant, £100; sales of plant, £1,789. 12s. 11d.; arc lamps already renewed out of revenue, £206; amount found for year ending, 1906, £2,886. 9s. 9d.; for 1907, £2,451. 13s. 10d................	15,268	17	2
Leaving to be found for obsolete or superseded plant ...	11,722	0	11

There may be required, as explained in this report, during the next 20 years for plant worn out in the ordinary course before the equated loan in which it is included is extinguished, £40,000.

In Mr. Peirson's report it is stated that the sinking fund is adequate to meet requirements in respect of wasting assets, and that the only points remaining to be considered were (*a*) the provision for renewals required before the expiry of the loan periods, and (*b*) the risk of obsolescence or of serious breakdown. Mr. Jeckell states in his report that there is little likelihood of this contingency coming to pass, but Mr. Peirson thinks the committee would be wise to make moderate provision, and suggests that a fair and reasonable provision for these items would be £2,500 per annum for the next six years, or £15,000 in all.

Customs Duties.—Under the import tariff authorised by the Tariff Act, 1908 (amending the tariffs of the Bahama Islands), telephones and "machines run by any power whatever" are duty free.

East Ham.—The Council have received permission to borrow £9,560 for the conversion of Romford-road tramways to electric traction.

Edinburgh.—The recommendation of the Electric Lighting committee that the price of electrical energy be reduced by ½d. (mentioned in our last issue) was adopted by the Council by 24 votes to 11. The convener of the committee (Mr. A. Murray) said they believed that, even after the reduction, they would have a surplus of about £5,000 on the current year's working.

Electric Lighting Companies' Audits.—Bermondsey (London) Council has decided to lodge a protest against the action of the Board of Trade in accepting audits made by companies' own auditors.

Electric Lighting Notices.—The following have given notice of intention to apply for provisional orders:—

Southampton Corporation (for South Stoneham rural district), Bovey Light & Power Co. (for Bovey Tracey and district); Chipping Norton Electric Light & Power Co. (for Chipping Norton); Coast Development Co. (for Walton-on-the-Naze); Folkestone Electricity Supply Co. (for Ashford); Foote & Milne (for Isle of Thanet rural district, New Romney and Southgate); Haywards Heath & District Electric Supply Co. (for Haywards Heath); Heswall District Power Co. (for Neston); Hindhead & District Electric Supply Co. (for Chiddingfold, Haslemere, Thursley and Witley); Marlborough Electric Supply Co. (for Marlborough); Marshead, Preece & Mountain (for Otley); South Metropolitan Electric Light & Power Co. (for Dartford rural district); United Electric Light & Traction Co. (for Feltham, Hampton Wick, Hemel Hempstead and Romford).

Electricity in Coal Mining.—Bardykes Colliery, Lanarkshire, which has just been re-opened by the Summerlee Iron Co., is equipped with electrically-driven tipplers, screeners, washer (capable of treating 700 tons a day) and centrifugal pump (to raise 900 gallons per minute).

Feltham (Middlesex).—Mr. M. Taylor has been retained to advise the Council as to the cost of a combined scheme for public electric lighting and for the drainage of the district by electrically-driven pumps.

Gravesend.—The Council last week adopted the recommendation of the Electricity committee "that the deficit on the Northfleet undertaking, arising from capital expenditure for which the L.G. Board refuse borrowing powers, should be wiped off by five equal yearly instalments, and that for the purpose of meeting the first instalment there should be paid to the relief of rates out of the net profit of £435. 19s. 8d. on the past year such sum as might be necessary."

Heywood.—At a conference last week representatives of Heywood Corporation placed before representatives of Bury and Rochdale Corporations a request for a revision of the terms upon which Bury and Rochdale jointly work the Heywood tramways in conjunction with their own systems, and attention was called to the fact that Heywood was losing money on the tramways while the most profitable lines in Bury and Rochdale were those connected with the Heywood system. The Councils' engineers are to consider and advise.

India.—"Indian Industries and Power" states that the Bombay, Baroda & Central India Railway Co. have decided to establish a separate electrical department, with Mr. R. E. Pigott (the present telegraph superintendent) as electrical engineer.

Kew Bridge Tramways.—At Richmond Town Council meeting on Tuesday, it was reported that Sir Clifton Robinson had asked the Tramways committee to recommend the Council to sanction the adoption of the overhead trolley system (with poles on one side of the road) for the tramway in Kew-road and over Kew Bridge. The committee have the matter under "further consideration."

Light Railways.—The Board of Trade have confirmed the Portmadoc, Beddgelert and South Snowdon Railway (Light Railway) Order, 1908, and the Portmadoc, Beddgelert and South Snowdon Railway (Light Railway Extension at Carnarvon) Order, 1908.

Liverpool.—The City Council on Wednesday decided to run first-class tramcars on the Garston-Pierhead route, at about double ordinary fares.

London County Council.—At Tuesday's sitting it was agreed to erect a sub-station at Camden Town in connection with the electrification of the tramways in that district, at a cost of £5,100.

Euston to Holloway Tramway.—The Council adopted the report of the Highways committee recommending the electrification of the tramways from Euston-road to Holloway-road at an estimated cost of £118,560. The extension of the existing contract with Hadfield's Steel Foundry Co. for special track work and of the Frodingham Iron & Steel Co. for slot rails and conductor tees at 5s. per ton reduction on existing prices was agreed.

Nine Elms-lane Tramway.—The Highways committee recommended the reconstruction of the tramways from Nine Elms-lane to Falcon-road for electric traction at a cost of about £89,370.—Postponed.

Aldgate to Bow Tramway.—The same committee recommended the expenditure of £3,372 for the provision of magnet equipments for the cars to be used on the tramways reconstructed for the "G.B." surface contact system.—Postponed.

London County Council Tramways.—The new electric route from Finsbury Park to Smithfield (along St. John-street, connecting with the lines from Islington to Highgate and Finsbury Park) was opened last week.

London Electric Supply Bills.—A conference of representatives of Metropolitan Borough Councils at Shoreditch Town Hall last week decided to oppose, by petition, the London & District Electricity Supply and London Electric Supply Bills.

Manchester Exhibition.—Arrangements have been made with the builder by the Committee at the last meeting held in Manchester on 7th inst. to effect certain alterations in connection with the exhibition building, in order that further space may be provided for intending exhibitors, the number of allotments already dealt with having, we are informed, necessitated some such provision.

Motor Traffic and the Road Union.—The Road Union has been formed "for securing effective control of motor traffic, and the protection of public roads and all who use them, and the owners and occupiers of roadside property, from the damage, danger, nuisance and annoyance caused by the improper use of motor-cars or any other vehicles." Offices, 47, Victoria-street, London, S.W.

Naval Electricians.—The Admiralty announce that applications for entry in electricians' rating will be received from able-bodied young men (21 to 28 years) of very good character, who are thoroughly efficient fitters and turners or instrument makers, with at least five years' practical experience. The educational examination includes vulgar and decimal fractions and simple interest, and there is also a practical examination in fitting and turning or instrument making. The pay (besides provisions) is on entry 38s. 6d. a week; after three years' approved service, 40s. 3d.; after seven years, 42s.; after 12 years, 45s. 6d.; on promotion to chief electrician, second class, 49s.; chief electrician, first class (after six years' service in the preceding rating), 52s. 6d. Electricians, on completion of eight years' approved service (of which five must be at sea), are eligible after examination for advancement, as vacancies occur, to the rating of chief electrician.

Non-Statutory Electricity Supply.—At a meeting of the sub-committees of the Convention of Royal Burghs at Edinburgh on Friday last, the town clerks of Partick and Dundee, with the agent to the convention, were appointed to attend any meetings or representations to Parliament in connection with the movement to call attention to the dangers of the proposed supply and sale of electricity by private companies by means of wayleaves obtained from railway and canal companies.

Obituary.—We regret to announce the death on Sunday of Sir Henry Reader-Lack, late Comptroller-General of the Patent Office, and who since 1876 has been associated with the Office of Patents, Designs and Trade Marks. Sir Reader-Lack was knighted in 1891, and retired from the Patent Office in 1897. He was 76 years of age.

Orrell (Lancs.)—The Council, who have lighted Orrell-road electrically under their 1903 provisional order, but have not given supply to private consumers, have decided to let their order lapse. The Council have gone into the question of taking supply in bulk and supplying to private consumers, but the expense is considered too heavy.

Poplar.—The salary of the borough electrical engineer (Mr. J. H. Bowden) has been increased from £500 to £600 per annum.

Presentations.—Mr. J. R. Groves has been presented with a gold watch by members of the New England Club, Peterborough, on the occasion of his leaving his position as manager of Peterborough tramways.

Mr. C. C. Hawkins, chief of the electrical department at W. H. Allen, Son & Co.'s Bedford Works, received from the directors a Georgian silver tea service and salver.

The staff of the Manchester branch of Siemens Bros. Dynamo Works on Friday last presented Mr. Philip C. Pope with a gold watch on the occasion of his resigning his position as manager of the branch office. Mr. Edmund L. Hill (Mr. Pope's successor) made the presentation.

Rossendale.—Rawtenstall have entered into an agreement for the purchase of the system of the Rossendale Steam Tramway Co., which they intend to convert to electric traction.

Sheffield.—Some time ago the Electric Light committee proposed to spend £250,000 on the extension of the electricity undertaking, but the Finance consultative committee withheld consent until a sub-committee had been appointed with authority to obtain expert advice as to the present condition of the undertaking, both financially and commercially. Sir Alexander Kennedy was called in to prepare a report on the matter.

His report has recently been presented, and the Electric Light committee state that of the £299,323. 17s. 3d. paid to the old electric lighting company £143,685. 18s. 10d., or 53 per cent., was unrepresented by tangible assets and could only be looked upon as goodwill and premium for compulsory purchase. This capital outlay also included £51,554 in respect of obsolete and obsolescent plant taken over from the old company at cost price (less about £10,000, the then value of plant which had since become obsolete), and after taking into account other items the sub-committee are of opinion that at least £202,996 is not now represented by productive capital. They are of opinion that it is desirable to divide the capital account so as to distinguish this sum from the productive capital of the undertaking. The renewal fund now stands at £5,879, leaving an unappropriated balance of £16,329. The sub-committee are of opinion that a further £10,000 should be transferred from this balance to the renewals fund, and that £5,000 per annum should, for the next five years, be taken from the working profits of the undertaking and placed to the renewals fund. It is also desirable that a reserve fund should be created, to accumulate until it reaches 10 per cent. of the capital. The sub-committee think there will not be any loss on the working, but for many years to come it will be unable to afford any relief to the rates. They are of opinion that it is necessary that the Electric Light committee should have "legitimate" borrowing powers so as to enable them to carry on the undertaking legitimately.

Sir Alex. Kennedy's report is a well-reasoned document, and goes fully into the question of removing the plant and works at Sheaf-street to the more modern station at Neepsend. On full consideration, Sir Alexander considers the disadvantages of such a course outweigh the advantages. On the question of a reduction in the charge for power supply, Sir Alexander recommends that no such reduction should be made, on the ground that the charge made at Sheffield for this supply (which *averages* under 1d. per unit) is exceedingly low. Referring to the question of works cost per unit, Sir Alexander says: "It is no more than fair to Mr. Fedden (your engineer) to say at once that an average cost of under 0·6d. per unit sold to consumers is, under all the circumstances of the case, a very good one."

At the Council meeting last week it was decided to extend the tramways through Psalter-lane to Banner Cross, instead of to Ecclesall Church, as originally proposed.

During the discussion on a resolution to adopt the Tramway committee's minutes an amendment giving the right to tramway employés to appeal to the committee against decisions of the general manager of the tramways (Mr. A. R. Fearnley) in cases of dismissal of men or their reduction in rank was carried by 27 votes to 25.

The proposal of the Watch committee to instal Gamewell fire alarms has been adopted.

Southwark (London).—At the Council meeting last week a motion by Mr. Scriven that a committee be appointed to ascertain on what terms the electrical undertaking could be sold or leased was adjourned.

Steel Manufacturers' Combine.—The "Iron and Steel Trades' Journal" states that the International Steel Trust, composed chiefly of American, German, Belgian and Russian concerns, has been completed. For the present all steel supplied by the firms participating will be made abroad, whilst the trust will be represented by agents in the United Kingdom, who will be instructed to make a strong bid for much of the home steel trade at lower prices than British steel manufacturers are now asking.

Swindon.—The Council have applied for a loan of £1,800 for arc lighting extensions.

Third-Party Risks.—Dundee Tramways committee have decided to be their own insurers against tramway third party risks, and will allocate £1,000 per annum for that purpose.

Tramway Inspector as Conductor.—Edward Marshall, an inspector of Leyton Council's tramways, was recently summoned for acting as a conductor without having a licence in force, and Mr. Frederick Schofield, manager of the tramways, was also summoned for knowingly allowing Marshall to act as a conductor.

The police said that on the afternoon of June 9 Marshall was seen acting as a conductor at Woodford New-road Leyton He was not wearing the badge, and admitted he had no conductor's licence in force

Mr. R. Vincent contended that the summons should be dismissed, because there was a custom that if a driver or conductor was taken ill on the road an unlicensed man could take his place for not more than 24 hours. Marshall had a driver's licence but not a conductor's.

The Bench decided that, licensed men not being available, the 24 hours' custom held good. The summonses were dismissed.

Telephone Tuberculosis.—The Postmaster-General at a meeting of the Postal Medical Officers' Association ridiculed the alarmist statement recently made by Dr. Allen that serious danger of disease lurks in the telephone mouthpiece "Long ago," said the P.M G., "we instituted inquiries on the subject, and took every precaution to safeguard the public and to make the telephones practically safe to users."

Trackless Trolley Trial.—The deputation from Dundee which visited the Continent to inquire into the trackless trolley system of traction recommend Dundee Corporation to make an experiment with the system at Clepington-road, with a view to the ultimate formation of a circular route to connect up the tramways.

Verband der Elektrotechnischen Installationsfirmen in Deutschland.—The sixth ordinary meeting of the Union of German Electrical Installation Contractors was held at Munich from June 21 to 24. The president, Herr Montanus, of Frankfort, was re-elected. In addition to the German members some Swiss and Austrian firms were represented at the meeting.

The report read by the president advised members not to be over-anxious with regard to State ownership of electricity works. The business of installation firms had distinctly improved since the municipalities had owned such works and there might be a similar result from State ownership. The receipts of the Union for the past year were £2 333 and there was £1,477 in hand. The business done by the buying branch of the Union amounted to £50,000, having increased threefold when compared with the previous year.

One member asked that a branch of the buying department of the Union should be established in each of the large towns, which would relieve the installation engineer from the necessity of keeping a stock of material and fittings and thus enable him to charge lower prices.

Walsall.—The Electricity committee has provisionally approved of an agreement for supplying the South Staffordshire Tramways (Lessee) Co. with electric current for working the leased tramways. The price (subject to revision every three years) is 1½d. per unit, less 10 per cent. The company is to take a minimum of 60,000 units per annum for the remainder of the term (viz., to Dec. 31, 1921) and the Council is to bear the cost (estimated at £300) of laying cables.

The L.G. Board have sanctioned the borrowing of £3,000 for electricity supply purposes.

Wolverhampton.—The Council on Monday approved a proposal to light the Tettenhall-road and the adjoining area at a cost of about £740.

Workhouse Lighting.—The borough electrical engineer (Mr. A. J. Fuller) has prepared a report showing that Fulham Guardians would effect a saving by taking current from the borough council instead of extending their own generating plant.

Worthing—The Council have received sanction to loans of £510 for public lighting, £250 for meters, and £900 for condensing plant.

"Telegraph" Flower Show.—The Postmaster General last week opened the first flower show held by the staff of the Central Telegraph Office (London) Amateur Gardening Association, and congratulated the exhibitors on their success. The flowers are to be sent to the hospitals.

Outings—The annual outing of the staff and employes of Marylebone Electricity department took place on July 4. The party travelled to Margate where (the resident engineer, Mr. F. A. Wilkinson, presiding) 69 sat down to dinner.

On Saturday, 4th inst., Simplex Conduits (Ltd.) held their annual works outing at Matlock Bath, some 200 employés and the various departmental and branch managers being present. The success of the outing was due to the excellent organisation and arrangements of the joint secretaries and their committee.

A special train was made from Birmingham, the usual sports being completed before luncheon. After lunch the prizes were presented by Mrs. Sheppard, wife of the works manager, and the party broke up for excursions on the river and to Haddon Hall and other places of note in the district, the return to Birmingham concluding an enjoyable function. A challenge cup (presented by Mr. L. M. Waterhouse) was eventually secured by the Birmingham "office" team.

The employés of Ferranti Limited had their annual outing on Saturday last at Scarborough. The dinner was presided over by the managing director (Mr. A. B. Anderson), and a vote of thanks to the directors for their contribution towards the outing was passed.

The Chairman, replying, said the directors wished they could do more to encourage that sort of gathering, but in these hard times it was difficult. In his opinion the cause of the hard times was foreign competition. He had spoken of hard times for the industry generally, but he was glad to be able to say something on the other side for their own company. During the course of his connection with Ferranti Limited (some 16 or 17 years) there had never been less cause for anxiety than there was to-day. The company was now employing about the same number of men as when it had an engine and dynamo shop, in addition to the switch and meter works.

The annual outing of the Sun Electrical Co. took place on Saturday in the form of an up-river trip to Hurley. The electric launch "Rosalind" left Maidenhead Bridge at 10:15 a.m., luncheon being taken at Marlow.

After the toast of "The King," Mr. A. G. Beaver, the manager, proposed "The Sun Electrical Co. (Ltd.)," and referred to the increasing prosperity of the company. He thanked the staff for their loyal co-operation. He expressed particular satisfaction with the success which had attended the introduction of the "Kalkos" system of tubing, and predicted a great future for it. Tea was taken at Hurley. The weather proved kind, considering the unsettled conditions, and the trip was thoroughly enjoyed.

The first annual outing of the staff of Gillingham electricity department took place last week. Mr. H. A. Ryan (chief assistant engineer) proposed the health of the chief engineer (Mr. A. D. Chalmers), and Mr. Chalmers, in reply, said the staff had backed him up well, and although things were not going as well as was possible he hoped a better result would be achieved in future.

Sports.—The second annual sports of the Robertson Social and Athletic Club was held at Mill Hill Park on Saturday, and proved both successful and enjoyable.

The chief event (a relay race between the staffs of the Robertson Lamp Co. and the General Electric Co. for a handsome silver cup presented by the president of the club, Mr. C. Wilson, to be competed for annually) was keenly contested, and won by the G.E.C. team. The female members of the company's staff of workers took an active part in the sports and some spirited contests resulted. The hon. secretary of the meeting was Mr. G. H. Freeman; the M.C. for dancing, Mr. F. Pluck; the concert directors, Messrs. G. H. Freeman, E. Dobson and P. Pring, and the pianist Miss F. Griffin, and all are to be heartily congratulated upon the successful organisation and execution of the programme Mrs. C. Wilson distributed the numerous prizes.

The General Electric Co.'s employés at Salford held their 12th annual sports on Saturday. Amongst the prizes were the cup presented by Mr. H. Bevis for the 220 yds. handicap and the Hirst cup for the ½ mile flat race, and an interesting feature was the fire brigade competition for teams of four men, won by C team, who fixed a stand pipe and got a delivery of water on a spot 60 yds. away in 30 seconds. Mrs. H. Bevis distributed the prizes.

ELECTRICITY SUPPLY AND TRAMWAY ACCOUNTS.

Dudley—The accounts of the electricity department for the year ended March 31 show capital expenditure £86,809, increase of £5,398 on the year.

Total income was £12,807. Expenses came to £6,830, leaving gross profit £5,977. Interest absorbed £2,253, repayment of loans £2,846 and bank charges £542, leaving net profit £336. 2,022,207 units were sold, including 422,333 for lighting, 413,727 for motors, 1,050,910 supplied to tramways company and 135,237 to public lamps. The total maximum supply demanded was 850 kw. for traction and 723 kw. for lighting. The total connections (including traction) are 69,885 equivalent 8 c.p., and there are 752 h.p. of electric motors. Total works costs were 0·644d. per unit, against 0·657d. in 1907, and the total revenue costs 0·810d., against 0·856d.

Eastbourne.—For the year ended March 31 the total receipts of the electricity department were £23,891. 10s.

Total expenses came to £12,103 16s. 6d., leaving gross profit £12,506 19s. 5d. After paying dividends on stock, sinking fund contribution, bank interest, &c., there was a net profit of £2,214 4s. 4d., out of which £1,500 was placed to depreciation and reserve, the balance being transferred to profit appropriation account, bringing the latter to £8,078. 16s. 4d. On the recommendation of the borough accountant a further £2,000 has been placed to depreciation and reserve, leaving a working balance of £6,078 16s. 4d. There are 2,128 consumers, with the equivalent of 99,243 8 c.p. lamps connected, against 1,175 consumers and 90,306 8 c.p. lamps last year. 1,253,385 units were sold, including 933,355 for private lighting (increase 9 per cent.) and 14,505 for power (increase 17 per cent.). Works costs were 1·57d. per unit, against 1·45d., and the total costs 2·11 against 1·93, and showing an increase of 0·16 per unit sold.

The borough electrical engineer (Mr. J. K. Brydges) states that

good progress is being made in the use of electric motors for driving all kinds of machinery. A total of 280 H.P. of motors is now connected to the mains, which is considered satisfactory in a non-industrial sea-side town. Increasing use has been made of the show room and inquiry office by consumers and the general public.

Gillingham.—At the Council meeting last week a deficit on the electric light undertaking of £1,000 was reported. A L.G. Board inquiry is about to be held, and the discussion of the affairs of the department has therefore been adjourned.

Glasgow.—The Corporation on Thursday last adopted the accounts of the tramways department.

Mr. J. McFarlane stated that the revenue had increased only about £20,000, and it was clear that the days of expansion of revenue were over. Expenditure was £11,000 more than in the previous year. Wages were up £4,000 and uniforms showed £2,000 increase, but that was a biennial item. Gross depreciation in connection with the sinking fund was £2,000 less than last year. The number of passengers per mile was 11, the average of all the systems in the United Kingdom. There were about 5 miles of double-track extensions in hand. Capital expenditure was £3,150,000, but the indebtedness had been reduced to £1,350,000, or £550,000 less than five years ago.

An amendment moved by Bailie Russell, that the committee consider and report upon the advisability of placing £50,000 out of the tramway profits to the common good, was carried.

King's Lynn.—After paying all expenses, including interest and sinking fund, there was a net profit of £563 on the past year's working of the electricity department.

Manchester.—The accounts of the Corporation's electricity department for the year ended March last show total capital expenditure to that date £2,442,599, an increase on the year of £104,226, the latter figure including machinery and switchboards for Stuart-street station £26,909 and for Dickinson-street station £6,231, distributing stations (including land, buildings, machinery, &c.) £19,350, mains £41,597, meters £2,411 and motors £5,720.

The year's income was £384,602, including private lighting supplies £171,153 (against £171,199 in previous year), power and heating £67,114 (£40,871), traction £140,513 (£130,002), street lighting £851 (£815), meter rental £400 (£391), motor rental £3,471 (£2,635) and warehouse rental £983 (£502). Total expenses were £179,358 (£144,800). £40,000 has been placed to renewals suspense account (as in previous year) and the gross profit was £165,244 (£161,745). Interest required £68,855 (£65,958), sinking fund £70,939 (£64,045), instalment of loan repaid to Public Works Loan Commissioners £6,330 (£5,474) and part of interest on investment in India Stock transferred to reserve fund £184 (£1,096), leaving net profit £19,513, of which £1,998 has been appropriated for extension of works, £10,000 to relief of rates and £7,545 carried to reserve. Units generated were 82,752,989 (against 63,056,914), supplied to private consumers 33,826,430 (22,686,508), public lamps 98,818 (91,938) and traction 29,511,840 (24,786,457). The maximum supply demanded was 18,233 kw. (15,376 kw.) for lighting and power, 10,288 kw. (9,804 kw.) for traction and 28,521 kw. (25,180 kw.) combined. On Dec. 25 the flat rate for lighting was reduced from 4½d. to 3¾d. per unit, and the price to long hour consumers from £7 per kw. and 1¾d. to £7 and 1½d., these reductions representing £18,896 per annum on present sales.

Messrs. Bruce Peebles have completed the installation of three 1,500 kw. motor converters at Dickinson-street, and the 6,000 kw. Willans-Siemens three-phase turbo-alternator (with Richardson-Westgarth condensing plant) have also been successfully installed at Stuart-street, where extensions of h.t. switchgear have been carried out by Ferranti Limited. A number of distributing stations have been put down on consumers' premises, and this branch of work has shown a very striking increase. Nearly 20 miles of new mains have been laid, the total now being 338 miles 1,084 yds.

Newport (Mon.)—The report of the Electricity and Tramways committee for the year ended March states that the net profit on the tramways was £2,632, compared with £2,243 last year. The report shows an improvement on last year in the electricity department, the loss being reduced by over £1,200. Revenue was £30,426 and gross profit £15,036.

Plymouth.—The Council have adopted the accounts of the electricity undertaking. The Mayor stated that £1,300 was being contributed towards the rates. The gross profit was £11,300 odd, equal to 7½ per cent. on the capital. The increase in revenue was £1,596.

Stalybridge, Hyde, Mossley and Dukinfield.—The accounts of the tramways and electricity board formed by the Councils of these towns show, for the year ended March last on tramways account capital expenditure £18,791 (total £276,968).

Revenue was £39,976 (6·832d. per car mile), against £38,805 (6·548d.). Working expenses were £33,742 (5·767d. per car-mile), against £31,939 (5·389d.). Gross profit was £5,233 (1·065d.). To meet interest, sinking fund and bank charges and £8,199 deficit at March, 1907, £24,814 is required, so that after taking into account £2,050 raised under precept by each of the four local authorities there is a deficit of £10,381, against £8,199. 10,285,973 (9,780,464) passengers were carried and 1,404,434 (1,422,122) car-miles run. Total average units used per car-mile were 1·669 (1·568).

The electricity undertaking accounts show capital expenditure £208,694 (increase £26,146). Revenue was £26,674 (including tramways supply £9,762). Total expenses were £14,494 (0·453d. per unit), against £8,848 (0·671d.). Gross profit was £12,181, against £5,550 Sinking fund required £4,616, against £4,154, and interest and bank charges £7,283, against £6,862. The deficit was £463, against £5,466. 8,897,769 (4,160,093) units were generated, 5,396,862 (928,832) sold to private consumers and 2,341,120 (2,229,944) supplied to tramways.

The Board have received sanction to a loan of £25,000 for the electricity department.

Wolverhampton.—The accounts of the Corporation tramways department for the year ended March show capital expenditure £256,591.

Revenue was £41,432 (10·929d. per mile run), against £43,823 (10·886d.) in previous year (after paying £2,846 of traffics to Wolverhampton & District Tramways, Ltd.). Total expenditure (after deducting £1,110 paid by same company for working expenses) was £26,461 (6·509d.), against £24,537 (6·095d.). After providing £4,416 (1·086d.) for renewals, against £5,301 (1·317d.), there was a balance of £13,555 (3·334d.) carried to net revenue, against £13,985 (3·474d.). The net profit, after meeting sinking fund, dividends, interest and income tax, was £2,316 (0·557d.), against £2,718 (0·675d.). Out of this had to be met a loss of £234 (£281) on motor omnibus account; which is, moreover, not called upon to bear any proportion of general management charges, &c. 9,440,369 passengers were carried, 975,714 car-miles run and 1,563,072 units used for traction and car lighting (equal 1·602 units per car-mile). Revenue per car-mile was 10·929d., the average fare per mile 0·896d, and the average fare per passenger 1·108d. There are 20 miles (equivalent) single track open and the average number of cars used per day is 30.

IMPORTANT NOTICE.

Extra Copies of "The Electrician" Special Mining Issue (July 10th, 1908), are now obtainable, price 1/- nett (post free U K., 1/2; abroad 1/6).

TRADE NOTES AND NOTICES.

TENDERS INVITED.

The Governors of Canterbury College, *Christchurch* (N.Z.) invite tenders for supply of (*a*) a 20 H.P. experimental Pelton wheel, with direct-driven dynamo, (*b*) an 8½ H.P. experimental low-fall turbine, and (*c*) a Venturi water meter. Specifications from the High Commissioner for New Zealand, 13, Victoria-street, Westminster, S.W. Offers to the Board of Governors, Canterbury College, Christchurch (N.Z.), by noon Sept. 24. See also an advertisement.

Hull Corporation require tenders for a 900 kw. 500 to 550 volt d.c. generator, with Belliss high-speed engine. Specification, &c., from the City Engineer, Town Hall, Hull. Tenders to the Chairman of the Tramways committee by noon of Monday, July 27. See also an advertisement.

London County Council want tenders by 11 a.m., July 21, for road work and platelaying for reconstruction or construction for for electric traction of (1) existing tramways from Euston to Holloway, (2) and from Loughborough Junction to Norwood, (3) new tramway from Hammersmith Broadway to Putney. Specifications, &c., from the Chief Engineer.

London County Council also require tenders by 11 a.m., July 21, for supply of six electrically propelled stores transport vehicles. Forms of tender, &c., from the County Hall.

The management of *Manchester* Electrical Exhibition want tenders for the wiring of the exhibition buildings. Plans, &c., from the manager's offices, 2, Queen Anne's-gate, Westminster, S.W.

Manchester Tramways committee want tenders by 10 a.m. July 28 for special track work. Specification, &c., from Mr. J. M. M'Elroy.

York Corporation want tenders by July 27 for two years' supply of carbon brushes, carbons, meters, motors, motor starters, incandescent lamps and electrical accessories. Particulars from the City Electrical Engineer.

Dewsbury Corporation want tenders by mid-day Aug. 3 for storage battery, reversible booster and switchgear and tramway cables. Specifications from the Borough Electrical Engineer.

Ipswich Corporation want tenders by noon July 22 for supply of rubber-insulated wires, paper-insulated lead-covered cables and bare copper trolley wire and serand. Specifications from Mr. Frank Ayton.

The committee of *Rainhill* County Asylum want tenders by July 23 for supply of an electrically-driven plunger pump. Specifications, &c., from the Clerk and Steward.

Ilford Education committee want tenders by noon July 20 for electric lighting, &c., at Uphall School. Forms of tender, &c., from Mr. C. J. Dawson, 11, Cranbrook-road, Ilford.

Eccles Education committee want tenders by noon July 25 for the electric lighting of the new Clarendon-road school. Specification, &c., from Mr. H. Lord, 42, Deansgate, Manchester.

Stepney (London) Council want tenders by 5 p.m. July 28 for erection of iron and steel h.t. generating station on Blyth's Wharf, Limehouse. Specification, &c., from the Borough Engineer.

Halifax Tramways committee want tenders by July 30 for supply of 250 tons of steel girder tram rails. Specifications, &c., from the Borough Engineer.

York Electricity committee want tenders by July 20 for 12 months' supply of coal.

Portsmouth Tramways committee want tenders by 10 a.m. July 20 for supply of steam coal. Specification, &c., from Mr. V. G. Lironi.

The Department of Posts and Telegraphs, 10, Carretas, *Madrid*, want tenders by July 28 for supply of 8,000 metres (8,800 yds.) of aerial and subterranean telegraph cable. Deposit equal to 5 per cent. of value of tender required. The "Madrid Gazette" for June 28, containing copy of form of tender, can be seen at 73, Basinghall-street, London, E.C.

The Municipal Corporation of *Freetown* (Sierra Leone) require tenders for lighting the municipal buildings and streets by electricity. Tenders to Town Clerk by Aug. 22.

Antwerp Municipal Council want tenders by July 27 for the electric lighting of the New Royers lock, Antwerp. Tenders to M. le Bourgmestre de la Ville d'Anvers. Copy of specification at 73, Basinghall street, London, E.C.

TENDERS RECEIVED AND ACCEPTED.

Stepney Council have accepted the following tenders for annual supplies (the amounts being the value of the estimated total annual requirements).

Reason Mfg. Co. for meters up to 10 amperes, £175. Seven tenders received, varying from £175 to £375.

Ferranti Limited (provisionally accepted) for meters above 10 amperes, £528 10s. Five tenders received, varying from £528 10s. to £532 5s. 6d., besides one from the Electrical Co., which did not quote above 50 amperes, and several others which did not comply with the specification.

Reason Mfg. Co. (provisionally accepted) for demand indicators, £559 11s. 6d. Three tenders received, from £[illegible] 1s. to £1,266, but the lowest, from Engineering Instruments, it was stated, did not comply with specification, and the highest (General Electric Co.) was for combined meter and demand indicator.

Sloan Electrical Co. (provisionally accepted) for carbons, £766 17s. 2d. Seven tenders received from £722 7s. 2d. to £1,113 17s. 3d., besides two informal tenders. Johnson & Phillips sent in the lowest tender, but some of the white arc carbons for which they quoted were of a type which the borough electrical engineer has not tested. The Sloan Co. have a contract now running with the Council.

Venner & Co. (provisionally accepted) for time switches £533 6s. 8d. One other tender received, £209 10s.

Stepney Electricity committee have decided to purchase 73 magazine flame lamps from the Gilbert Arc Lamp Co. at £8. 10s. each, subject to slight modifications in the lamps. The following were the tenders received for switches and cutouts (combined):—

Universal Electrical Mfg. Co. (provisionally accepted), £1 3s. 3d. each; New Century Arc Light Co., £1 5s. 3d.; Gilbert Arc Lamp Co., £1. 10s.; ditto (alternative tender for the company's switch and cut-out), £1. 5s.; Spagnoletti (Ltd.), £1. 18s.; Edison & Swan Co., £2. 2s. 6d.; A. P. Lundberg & Sons, £2. 19s.

Walsall Electricity committee have accepted the tenders of S. Boston & Son for coal, the Chloride Electrical Storage Co. for cleaning battery, Jones & Horsfield for covering steam pipes (£40), Callender's Co. for feeder cable, Bell Punch & Printing Co for hire of ticket punches at 12s. each per annum, Baker & Co. for 60 car wheel tyres at £16. 2s. 6d. per ton, and Worthington & Co. for line material (£22. 17s.)

Bristol Corporation have accepted the tenders of the British Thomson-Houston Co., for e.h.t. and l.t. switchgear for Avonmouth sub-station, at £2,255; Frank Chown, for concrete gallery for power distribution board, Avonbank, £112; Harrison & Colmer, for extension of switchboard gallery, Avonbank, £312; Geipel & Co., for 12 months' supply of arc lamp carbons, £318.

Poplar (London) Council received the following tenders for an additional water-tube boiler:—

Stirling Boiler Co. (*acc.*)...	**£2,225**	Clarke, Chapman & Co. ...	**£2,573**
Babcock & Wilcox	2,750	Davies Patent Boiler.........	2,100
Turner Bros.	2,605		

14 tenders were received by Poplar Council for construction of new sub-station buildings at Millwall, in brick, ferro-concrete or corrugated iron, alternatively. The amounts varied from £395 to £1,424, and the tender of Nicholls & Reynolds (which provides for steel frame and hollow concrete block walls) has been accepted at £737.

Cumberland County Council have placed contracts with F. B. Hellon & Co. for electric lighting at Whitehaven Schools at £284 and H. G. Riddell for a lightning conductor for the same schools at £19. 16s. 6d.

Hornsey Council have accepted tenders by Herbert Clark, Rickett Smith & Co. and Charrington, Sells, Dale & Co. for coal for the electricity works.

Carlisle Education committee have accepted the tender of R. M. Hill & Sons for the electric lighting of the girls' new secondary school at £209.

The tender of W. Cory & Son has been selected by L.C.C. for supply of 100,000 tons of coal for Greenwich generating station, at 11s. a ton.

For the carrying out of a heating and ventilating system at the central car depot the offer of the Standard Engineering Co. of £1,474 has been accepted by London County Coucil.

Malvern Council have accepted the tender of the Electric Construction Co. for a combined 50 kw. steam alternator with Belliss engine.

The D.P. Battery Co. have received an order for the renewal of the central station battery (consisting of 120 cells of their W.L. 9 type) at Cottesloe (W. Australia).

Stalybridge, &c., Tramways and Electricity Board have accepted the tenders of J. P. Hall & Co. for feed pumps and of Tangyes Limited and the British Westinghouse Co. for motor-driven pumps.

Ashton-under-Lyne Council have accepted the tender of the British Insulated & Helsby Cables for 1,000 yds. of pilot cable.

Epsom Council have accepted the tender of Dorset & Co. for fixing telephones at the pumping and fire stations at the waterworks.

Maidenhead Council have accepted the tender of Callender's Co. for cable at £471.

Underwood Bros. have secured the contract for the reconstruction of the Rawtenstall tramways for electric traction.

London County Council have accepted the tender of Spagnoletti Limited, at £2,212, for switchgear for Greenwich generating station.

The Postmaster General's Department, Perth, W. Australia, have accepted the tenders of Splatt, Wall & Co. for dry cells and of Mills & Co. for four-way and six-way conduits.

BUSINESS NOTICES.

Mr. C. H. Wordingham notifies that in future his address will be Beechgrove, Ridgeway road, Redhill, Surrey (telephone Redhill 153), where all communications should be directed.

The Bergmann Electricitäts-Werke, of Berlin, has decided to add an electric traction branch to the company's business, and an agreement has been entered into with the Westinghouse interest by which the Westinghouse patents, &c., can be utilised by the Bergmann company.

Edwd. Geipel and Alex. Arr Pyman, electrical engineers and contractors, West Hartlepool, have dissolved partnership. Debts by Mr. Geipel, who continues as Geipel & Pyman.

The telephone number of the Sphere Engineering Works of Arc Lamps (Ltd.) is 258 St. Albans.

Sales by Auction.—By order of the trustee (Mr. A. F. Whinney) in the bankruptcy of W. G. Temple, Messrs. Fuller, Horsey, Sons & Cassell will sell by auction, in lots, at the Mart, Tokenhouse-yard, London, E.C., on Tuesday, July 28, the entire contents of the works, 8 to 10, Kentish Town road, London, N.W., including capstan and screw-cutting lathes, milling, drilling and shaping machines, gas engine, motor, shafting, pulleys, loose tools, office furniture, &c., also the stock, stores and work in progress, comprising brass rod and tubing, vacuum machines, general stores, scrap metal, &c. Catalogues from Mr. A. F. Whinney (Messrs. Whinney, Smith & Whinney, C.A.), 32, Old Jewry, London, E.C., and of the Auctioneers, 11, Billiter-square, London, E.C. See also an advertisement.

Messrs. Fuller, Horsey, Sons & Cassell (having disposed of the property) are instructed by the Marconi Wireless Telegraph Co. (Ltd.) to sell by auction on Thursday, July 30, in lots, on the premises, Tyssen-street, Dalston Junction, London, surplus plant and machinery, including capstan, repetition and other lathes, Sigourney drilling machines, slotting machine, power stamping press, screw presses, emery grinders, nickel plating plant, gas engine, dynamo, six 220 volt c.c. motors up to 20 H.P., 4½ H.P. petrol engine, electric light installation, &c. Catalogues from the Auctioneers, 11, Billiter-square, London, E.C. See also an advertisement.

Plant for Sale.—A Macintosh & Seymour tandem compound engine and a 150 kw. d.c. B.T.H. dynamo coupled direct are offered for sale by the Dublin United Tramways Co. (1896) (Ltd.) Particulars from the secretary, 9, Upper Sackville-street, Dublin. See an advertisement.

Messrs. Drake & Gorham, 47, Spring-gardens, Manchester, advertise for sale two suction gas producers, two engines and dynamos (20 H.P. and 25 H.P.), switchboard, &c., and accumulator for 200 volt circuit. Can be seen working at the residence of the Earl of Ellesmere, Worsley Old Hall, near Manchester.

Two 350 H.P. compound Willans engines and alternators, a Westgarth air pump, and a single ram Cameron pump are advertised for sale.

Patent Development.—The owners of patent No. 10,219 of 1900, relating to "Improvements in Electric Energy Meters," desire to arrange for granting licences thereunder. Particulars from Messrs. Lloyd, Wise & Co., 46, Lincoln's Inn Fields, London, W.C.

The "Journal."—Part 190 of the "Journal of the Institution of Electrical Engineers" is now ready, price 5s. Particulars of contents are given in an advertisement.

Thomas Parker (Ltd.)—Dated Wolverhampton, July 14, 1908, the following circular is issued:—

Dear Sirs: Owing to the increasing demand for Rees Roturbo pumping and other machinery, for which Thomas Parker (Ltd.) holds the sole manufacturing right for Great Britain and Ireland, the present working capital of the company has been found to be inadequate for the increased business. Consequently a new company is being formed entitled the Rees Roturbo Mfg. Co. (Ltd.), which will take over the whole of the assets and liabilities of Thomas Parker (Ltd.), and carry on the business as a going concern.

The directors of Thomas Parker (Ltd.) intended originally to transfer the business under the powers given them in the memorandum and articles of association of the company, and at a meeting of shareholders in April this scheme was passed unanimously. Owing, however, to a judgment given in the High Court immediately after this meeting the directors were advised that it would be necessary to proceed by a voluntary liquidation and a transfer by the liquidator under the 161st section of the Companies Acts of 1862.

The necessary meetings of shareholders have now been held, and the scheme has been passed, and the company is now in voluntary liquidation for the purpose of carrying out the scheme, in full accordance with the advice of counsel. In the meantime the business will go on as usual.—THOMAS PARKER (LTD.) (F. Walton, Secretary).

Fire—A fire occurred at Saracen-buildings, Snow-hill, London, E.C., on Tuesday. We are informed that the cause of the fire was the accidental ignition by a blow lamp of some methylated spirit which was capsized on the premises of the A.C. Electrical Co. The damage on this company's premises amounts to between £450 and £500, and is covered by insurance. There will be no interference with the company's business, temporary premises having been secured at 41, Snow-hill.

CATALOGUES, &c.

Portable Voltmeters.—Messrs. Elliott Bros., Century Works, Lewisham, London, S.E., are now in a position to supply portable indicating and recording voltmeters for a.c. and d.c. circuits that comply with all the requirements of the Board of Trade and the local authorities for measuring the supply voltage on consumers' premises. Messrs. Elliott's instruments have been approved for this purpose.

Cowan Switchgear and Switches.—Messrs. Cowans Limited, having completely reconstructed their works at Springfield-lane, Salford, which were destroyed by fire on Jan. 21 last, have issued a circular stating that they are now able to accept orders for prompt delivery of manufactures of first class workmanship and finish. The circular contains artistic illustrations consisting of views of part of the switch shops of the new works and of one of the five sets of e.h.t and h.t. switchgear supplied to the Franco-British Exhibition, which were all put into full service at the opening of the Exhibition, notwithstanding the destruction of the work done upon them at the time of the fire. Inquiries can now be sent to the works, Springfield-lane, Salford, Manchester; or to 4, Queen Victoria-street, London, E.C.

BANKRUPTCIES, LIQUIDATIONS, &c.

A meeting of creditors of T. Arthur Evans, electrical and mechanical engineer, Heathfield-street, Swansea, was held on Thursday last. Gross liabilities £2,699, of which £1,696 is expected to rank. Assets £68. Failure attributed to speculation in a colliery undertaking. O.R acts.

An application for the discharge of Paul J. Mallmann, consulting engineer, 65 and 66, Wool Exchange, London, E.C., will be heard on July 31 at Bankruptcy-buildings, London, W.C.

First meetings of the creditors and contributories of the Kevan Electric Co. (Ltd.) will be held on July 28 at 33, Carey-street, London, W.C.

PATENT RECORD.

APPLICATIONS FOR PATENTS.

NOTE.—*The undermentioned Applications (except those marked †) are not open to public inspection until after acceptance of Complete Specifications. Those marked † are open for inspection 12 months after the date attached to them, if they have not been published previously in the ordinary course. Names within parentheses are those of communicators of inventions. When Complete Specification accompanies application, an asterisk is affixed.*

March 9, 1908.

5,231 VERITYS LIMITED & WALKER. Arc lamps.
5,271 BUTTERWORTH. Automatic electric fire and heat alarm. (Date applied for, 23/10/07.)*†
5,279 ALI-COHEN. Insulating impregnating and protective materials.*
5,297 BLEECK. Primary batteries.*
5,306 ARON. Alternating current motors.*
5,311 THOMPSON. (Gesellschaft für drahtlose Telegraphie m.b.H., Germany.) Apparatus for producing electrical oscillations.*
5,317 COWPER-COLES. Electrolytically etching or depositing metals upon metallic surfaces.*
5,318 SWAN. Incandescent lamp sockets. (Date applied for, 15/5/07.)*†
5,331 FIELD & FERRANTI LIMITED. Reverse current or reverse power devices.

March 10, 1908.

5,342 CALLERAN. High-pressure reversible turbine.
5,372 BEIN. Reflectors for lamps, electric and the like.
5,380 STEVENS. Insulators.
5,387 BLOXAM. (Siemens & Halske A.-G., Germany.) Incandescent lamps.*
5,390 STRUBLE. Lightning arresters.*
5,415 B.T.-H. Co. (G.E. Co., U.S.) Incandescing or heating bodies of zirconium for incandescent lamps, heaters, &c.
5,416 B.T.-H. Co. (G.E. Co., U.S.) Filaments for incandescent lamps.
5,422 COLEMAN. Holders for shades or globes of electric fittings,
5,425 CLOUDSLEY. Telephony.

March 11, 1908.

5,440 CRAIG. Portable motor-generators and their application for charging cells and other purposes.
5,444 VARELA. Electro-automatic sounding apparatus.*
5,457 WANDRUM. Brakes for tramway cars.
5,466 WESTWOOD. Safety trolley head.
5,467 MUCKERSIE & M'CALLUM. Guards for tramway cars and the like.
5,489 SYKES, SYKES, jun., & COOKE. Electrical control of railway traffic.*
5,497 REUTHE & AMALGAMATED RADIO-TELEGRAPH Co. Radio-telegraphy. (Date applied for, 18/6/07.)*†
5,502 GOODWIN & BURGESS. Generation of ozone.
5,510 B.T.-H. Co. (G.E. Co., U.S.) Braking systems using electric motors as generators.

March 12, 1908.

5,529 FOX. Mechanism for operating the controllers on electric cranes.
5,549 COOPER. Apparatus for controlling electric circuits.
5,560 STEARN & TOPHAM. Incandescent lamps.
5,569 HUNSLET ELECTRICAL POTTERY CO. & LINES. Securing metal contact blocks or terminals to the bases of wall plugs, ceiling roses, &c.
5,590 HERD & ESPLEN. Apparatus for registering telephonic calls.
5,596 KENT, LACELL & SILICA SYND. Mercury or metallic vapour electric lamps.
5,610 ALLGEMEINE ELEKTRICITÄTS GES. Incandescent lamps. (Date applied for, 14/3/07.)*†
5,611 B.T.-H. Co. (G.E. Co., U.S.) Electric motor controllers.

March 13, 1908.

5,628 MYERS & GEDGE. Control and transmission of electric energy.
5,634 HAMPSON & CHECKOGRAM (1908). Devices for mechanically and electrically actuating counters.
5,640 MAVOR & COULSON & MAVOR. Electric motor-driven apparatus.
5,655 PIPER. Electricity meters.
5,679 B.T.-H. Co. (G.E. Co., U.S.) Alternating current compensators or transforming devices.*
5,680 B.T.-H. Co. (G.E. Co., U.S.) Reduction of metal compounds and apparatus therefor.
5,685 CHRISTIAN. Current-collecting devices for electric railway vehicles.
5,691 SCHUECH & HIMMEL. Dynamo-electric machines for the production of continuous and alternating currents.*

March 14, 1908.

5,708 SHOWELL & HARRIS. Adjustably carrying shades for electric and gas lamps.
5,719 SCOTT. Swing out electric lamp carriers.
5,728 FAIRBURN-HART. (Electrelle Co., U.S.) Apparatus for playing musical instruments.*
5,748 GOVER, ZOEPHEL & BARHAM. Electric lamp connections.
5,781 PARTRIDGE & DAWSON. Electrical conductors.
5,783 HOWELL. Incandescent lamps. (Date applied for, 16/3/07.)*†

March 16, 1908.

5,829 JONES. Arc lamps.
5,856 GIN. Electric process of singeing textile fabrics. (Date applied for, 14/3/07.)*†
5,859 TAYLOR. Alternating electric current relays. (Date applied for, 18/4/07.)*
5,860 ANNACKER. Electric transformer switches.
5,879 GERHARDT. Automatic switch. (Date applied for, 18/3/07.)*†

SPECIFICATIONS PUBLISHED.

1907 SPECIFICATIONS.

14,935 TORDA & TORDA. Distribution of currents in the three and more wire systems.
15,810 PFANSTIEHL. Sectional induction coils.
16,087 MACKENZIE. (Lorenz.) Telephone alarm with attuned call.
16,952 KJELLBERG. Electric welding or soldering.
17,097 ALLGEMEINE ELEKTRICITATS GES. Switch mechanism for electric vehicles. (Date applied for, 26/7/06.)
18,681 SIEMENS BROS. DYNAMO WORKS & HOLMES. Arc lamps chiefly for search-light projectors.
18,843 GUDGEON. Switch or commutator for railway signalling.
19,340 SIEMENS & HALSKE A.-G. Signalling telegraphs. (Date applied for, 17/12/06.)
19,558 SIEMENS BROS. & CO. (Siemens & Halske A.-G.). Electrical locking apparatus for railway signalling.
20,600 HEITMANN & YOUNG. Wedges for closing the core slots of dynamo-electric machines. (Date applied for, 18/10/06.)
20,949 SIEMENS BROS. DYNAMO WORKS. (Siemens Schuckertwerke Ges.) Control of electric vehicles and other apparatus.
21,467 ELEKTRIZITATS A. G. VORM. SCHUCKERT & CO. Maximum demand indicators for electric supply meters. (Date applied for, 3/10/06.)
22,833 CONRAD. Armature windings for dynamo-electric machines. (Date applied for, 3/11/06.)
23,416 FERY. Electrically-controlled pendulums. (Date applied for, 1/3/07.)
24,751 SIEMENS SCHUCKERTWERKE GES. Commutators for dynamo-electric machinery. (Date applied for, 12/11/06.)
24,874 RICHARDSON. Conductors.
24,923 DUGASZ, KALDOR, & SZENDE. Method and apparatus for telephonic communication between railway trains and stations.
25,118 ARCIONI. Alternating current wattmeters of the thermal type.
25,404 ALLGEMEINE ELEKTRICITATS GES. Rotary pumps and compressors. (Date applied for, 16/11/06.)

1908 SPECIFICATIONS.

796 AUBERT & AUBERT. Electric apparatus for igniting and extinguishing lamps.
11,582 FLEMING. Apparatus for wireless telegraphy.
11,594 ALLGEMEINE ELEKTRICITATS GES. Control of electric motors for driving rolling mills. (Date applied for, 21/5/06.)
11,814 SCOTT. Circuit breakers.
12,529 MARCHI. Inductive telegraphy and telephony. (Date applied for, 30/5/06.)
13,196 B.T.-H. Co. (G.E. Co., U.S.) Insulators.
13,739 B.T.-H. Co. (G.E. Co., U.S.) Electric reactances and the like.
14,203 B.T.-H. Co. (G.E. Co., U.S.) Dynamo-electric machines.
14,876 NOEGGERATH. Dynamo-electric machines. (Date applied for, 30/6/06.)
15,441 CONRAD. Voltage regulation for electric distribution. (Date applied for, 9/7/06.)
15,505 HOLMQUIST. Folding electric light bath cabinet.
15,656 DALES & DALES. Automatically operated station indicators for electric railways.
15,773 POWELL & MOORE. Double sounders for telegraphic purposes.
15,907 WARWICK MACHINERY CO. (G.E. Co., U.S.) Bucket wheels for turbines.
16,336 TORRANCE. Electrical systems of distribution. (Date applied for, 25/7/06.)
16,366 MAYO & HOLLIDAY. Starters for motors. (Date applied for, 11/2/07.)
16,710 BRUCE, PEEBLES & CO. & LA COUR. Dynamo electric machines.
17,539 GILSTRAP. Elevated electric railways. (Date applied for, 31/7/06.)
17,690 STONE. Space telegraphy. (Date applied for, 3/8/06.)
17,695 STONE. Space telegraphy. (Date applied for, 3/8/06.)
17,769 MORRIS. Lightning conductors.
17,832 SAWYER. Trolley wheels for electric traction.
18,242 SCHÖPPE. Electric fire-alarm system.

COMPANIES' MEETINGS AND REPORTS.

Electrical Power Storage Co. (Ltd.)

The nineteenth ordinary general meeting was held yesterday, Mr. FREDK. GREEN in the chair.

The SECRETARY (Mr. Malcolm Leggett) having read the notice calling the meeting, and the auditors' certificate, as appended to the balance-sheet,

The CHAIRMAN said: Gentlemen, I regret to have to inform you that our Chairman, Sir Irving Courtenay, is unwell. We hope, as we believe, that it is nothing serious. We think that he has possibly been working a little too hard, and certainly he has been giving a good deal of time to the affairs of this Company. He has asked me to make the following statement:—The balance-sheet shows, after payment of debenture interest, a net profit of £4,074. 3s. 7d., which, with £786. 11s. 2d. brought forward, makes £4,860. 14s. 9d. The directors recommend a dividend of 5 per cent., leaving £369. 6s. 9d. to be carried forward. We have spent on maintenance, renewals and repair of plant and buildings £3,046. 9s. 6d., and have added new plant to the value of £3,836. 18s. 10d. This is largely represented by gas engines and suction gas plant, the use of which we have only had for a few months, but we anticipate considerable reductions in cost will follow. We have not thought it necessary to further reduce the amount standing under the heading patents, goodwill, &c., as this item has been liberally dealt with in that direction during the last few years. The new debentures issued amount to only £10,000. You will remember that the old debentures (£28,400) were paid off in June, 1907.

The business during the year has, unfortunately, shown a considerable falling off when compared with that of the previous 12 months, and it is noticeable that this change has all occurred since November last, when the money panic took place. Up to that date we were ahead of the previous year in output, and it really seems as if the stagnation in business might be directly traced to this cause; but the most disturbing element is the absence generally throughout the year of large contracts, which are considerably less in numbers and far less in monetary value than those of former years. This is not in any way due to our having received a less proportion of the work, but simply owing to the fact that there has not been the work in the market for anyone to obtain. This scarcity of orders has brought about a keenness of competition amongst the firms competing which can only be described as suicidal, and it is from this cause that we have not only had to face a diminution in business, but, although we have been paying more for lead than we have ever paid during the company's existence, the prices that we have been obtaining have not been on the whole as good as those of the preceding period. During the last few weeks, however, there has been a slight revival. Among the largest batteries supplied are those for the following Corporations: Newport, Mon.; Arbroath, Birmingham (three batteries), Cambuslang, Aberdeen, Holyhead, Marylebone.

Our chief engineer, Mr. Butler, and the Company's staff are giving considerable attention to batteries for use in self-propelled vehicles, and while we are keeping the question of electric 'bus propulsion well before us, we do not intend to enter into this business until we see our way to do so on commercial and remunerative terms. With these remarks I move the adoption of the report and accounts, and the payment of the dividend therein recommended.

Sir JAMES PENDER, Bart., seconded the resolution, which was carried unanimously.

The retiring director (Sir James Pender) and the retiring auditors were then re-elected, and the proceedings terminated.

Chili Telephone Co. (Ltd.)

The nineteenth ordinary general meeting was held yesterday, under the presidency of Mr. GEORGE KEITH.

The SECRETARY (Mr. Edmund Petley) having read the notice calling the meeting and the auditors' certificate,

The CHAIRMAN said: Gentlemen, business in Chili has been very active during the year under review, and we have now a favourable report and statement of accounts to present. The result of the year's business I think, is very satisfactory considering the acute financial crisis and the labour troubles through which the country has been passing during the past year. In general our business has prospered even at a greater rate than it has been doing in the past, and is now larger than it was before the earthquake disaster of 1906. The currency revenue shows a very satisfactory increase, but its gold value falls considerably short of being proportional to the increase of business, in consequence of its collection being made throughout the year in a depreciating currency. The Chilian paper dollar fell from 12½d. to 8d. during the year. The expenditure has also increased and works out at about 50 per cent. of the revenue, or at about the same ratio as it did before the set back caused by the earthquake. This shows that the business has practically resumed its normal working conditions. The net income from Chili, when converted into sterling, comes out at £33,883, showing an increase for the year of £3,469. Interest and

transfer fees give £748, and the total income amounts to £34,631. After deducting the London expenses, debenture interest and income tax, and adding £2,727 brought forward from last year's account, there is an available balance of £33,817, out of which an interim dividend of £6,600 was paid in January and £13,440 has been carried to reserve. The directors now recommend the payment of a final dividend of £11,000, making 8 per cent. for the year (tax free) leaving £2,777 to be carried forward. Our reserve now stands at £113,000, an increase for the year of £10,000. Capital expenditure shows an increase of £1,604. Our investments still show at present market prices a depreciation of about £700. The company's property is being improved and extended. Amongst other extensions a double line of copper has just been completed to the south, joining up Santiago with the Talca district, and several new offices have been opened. Altogether 817 miles of new wire have been equipped and added during the year to the total mileage. A commencement has also been made to replace the Santiago overhead lines in the central portion of the city by underground cables. I now move the adoption of the report and accounts.

Mr. FRANK JONES seconded the motion, which was carried unanimously, as were resolutions approving the final dividend of 5s per share, re-electing the retiring director (the Hon. H. T. Allsopp) and the retiring auditors, and a hearty vote of thanks to the chairman and directors.

BOMBAY ELECTRIC SUPPLY & TRAMWAYS CO. (LTD.)—The directors' report for the year ended Dec. 31 last states that the total revenue amounted to £127,920. Deducting all expenses, there remains £29,338, and £1,364 brought forward, making £30,701. Allowing for the preference dividend paid to Aug. 15 last (£16,757) and for the preference dividend accrued to Dec. 31 last (£11,007) there remains to be carried forward £2,937.

Tramway traffic receipts from horse and electric traction were £105,503, compared with £101,031 in 1906, when the system was worked entirely by horses. Working expenses in Bombay were £61,112, compared with £56,955 for the previous year. The work of reconstructing the tramways to electric traction has, of course, seriously interfered with and disorganised the company's traffic, but the results so far confirm the expectation that a substantial increase in the profits may be looked for now that the electrification of the entire system has been completed. The first portion of the reconstructed tramways was opened for traffic by electric traction in May, 1907. At Dec. 31 last 13·32 route miles were being worked by electric traction, including 2·69 miles of the authorised extensions. From May 18 last the entire system (20·69 route miles) has been worked electrically.

From electricity supply the gross receipts for the year were £21,566, compared with £8,436 for the previous year. Working expenses were £19,347, compared with £10,076. The credit balance of £2,021 compares with a debit balance of £1,640 for the previous year. On Jan. 1 there were 588 (against 330) consumers connected with 84,648 (58,849) equivalent 8 c.p. lamps, 3,560 (2,110) punkahs and 377 (219) B.H.P. of motors. By April 1 last the figures had further increased to 641 consumers, 100,000 8 c.p. lamps, 4,000 punkahs and 474 B.H.P. connected. The units sold in 1907 (exclusive of tramways supply) were 1,233,671, against 531,731. Capital expenditure during the year amounted to £334,659, making the total £1,547,061. The company has joined the British Electrical Federation.

CITY & SOUTH LONDON RAILWAY CO.—It is stated that the accounts for the half-year to June 30 show a balance, after providing for debenture stock interest, payment of the dividend on the 5 per cent. preference stocks, 1891, 1896 1901 and 1903, and transfer to renewal fund of £1,500, sufficient to allow the payment of a dividend on the consolidated ordinary stock at the rate of 1½ per cent. per annum, carrying forward £1,868. The dividend for the corresponding period last year was at the rate of 2½ per cent., carrying forward £1,857.

CONSOLIDATED ELECTRICAL CO. (LTD.)—At the meeting on Monday Mr. H. Allen, who presided, reviewed the company's position, and referred to the sale of the company's Coventry and Canonbury (London) businesses. As to the latter, he said the Consolidated Supply Co., to which the Canonbury Works and business were handed over a few years ago, had, after a plucky struggle on the part of the managing director, at length gone under. The Supply Co. was unable to continue the struggle without further assistance on the company's part, and that assistance the board did not feel justified in giving in view of the pledges they had repeatedly given the shareholders. The same applied to the Private Wire Co. The board would not, however, have been justified in lightly abandoning two concerns in which the company inherited such a relatively large stake without first giving them a fair chance. But they had been tried and found wanting, and the company had done with them. He thought the shareholders would not be sorry to feel that they had shaken off the Canonbury incubus at last. What they would save from the wreckage it was too early yet to say. If any shareholder knew of a buyer or of a tenant for the works they would be pleased to hear from him. The Private Wire Co. had never loomed very large in their accounts, and was a source of much less worry. It was impossible for small and impecunious concerns to compete successfully with powerful competitors like the National Telephone Co. and the Post Office. Three or four years ago the disappearance of the Canonbury and Private Wire businesses would have caused them grave concern, but they were now able to face the loss of them with comparative equanimity.

On the other side of the picture the Anglo-Portuguese Telephone Co., which was their mainstay, continued its career of increasing prosperity. Even in the face of the somewhat trying times through which Portugal was now passing, that company felt justified in increasing its dividend from 7½ to 8 per cent. The directors recommended payment of a dividend of 3½ per cent. on the ordinary shares (the same dividend as last year), and the report was adopted.

DIRECT UNITED STATES CABLE CO. (LTD.)—The directors have resolved to recommend a final dividend of 4s. per share, together with a bonus of 1s. per share (both tax free), and payable on and after 31st inst. making, with the three interim dividends already paid, a total distribution of 4¼ per cent. for the year ended June 30 last. After placing £5,000 to reserve about £2,812 is carried forward. The transfer books will be closed from July 16 to 28 inclusive.

ELECTRIC CONSTRUCTION CO. (LTD.)—The annual report of the directors states that the amount of work in progress is considerably greater than at this time last year, including large power installations for India and the Midlands, in addition to machines of all sizes for home and abroad. The industry, however, is still suffering severely from over production, and a small margin of profit only is obtainable. The net profit for the year (after paying £10,250 for debenture interest, and crediting £5,000 as formerly to depreciation) is £5,932. 6s. 9d. £208. 13s. 4d. was brought forward, making £6,141. 0s. 1d., of which the directors recommend £4,394. 12s. be appropriated in payment of the preference dividend for the year ended May 31, 1907, and carrying forward £1,746. 8s. 1d. In view of the volume and character of the work in progress, the directors hope to declare about the end of December a dividend on the preference shares for the year ended May 31 last.

FELTEN & GUILLEAUME-LAHMEYERWERKE A.G. (MULHEIM-ON-RHINE)—The receipts for the year ended December last were £772,237 (against £750,141 in previous year) and the net profit £308,204 (£338,000). A dividend of 10 per cent. (against 11 per cent.) has been declared, and £21,760 (£21,077) carried forward.

LANCASHIRE POWER CONSTRUCTION CO. (LTD.)—At the meeting on Tuesday Mr. T. O. Callender, who presided, said there had been great delay in getting the company to work. When they had erected their station and had laid their mains they met with opposition from the local authorities which it had taken about two years to overcome. They had now agreements to supply in bulk to three authorities and 12 others had transferred their provisional orders to the company. The boom in trade which Lancashire had experienced had also been against them, for mill owners would not temporarily reduce their productive capacity by changing over to electric power. The present receipts of the company were sufficient to pay station expenses, and with an increase in the number of customers substantial profits could be earned. The report was adopted, and at a subsequent extraordinary general meeting Mr. H. F. Parshall was appointed chairman of the company, and provision for raising fresh capital, set out in the directors' report recently issued, was approved.

NATIONAL TELEPHONE CO. (LTD.)—The report of the directors for the half-year ended June 30 states that the income accrued in respect of the business of the half-year amounted to £1,452,825. 19s. 2d., compared with £1,315,038. 9s. 5d. for the corresponding period of 1907, an increase of £137,787. 9s. 9d. Working expenses were £832,638. 6s. 9d., compared with £749,760. 5s. 4d, increase £82,878. 1s. 5d. The net result (after deducting the Post Office royalties amounting to £139,546. 11s. 6d.) was a profit balance of £480,641. 0s. 11d., compared with £439,979. 13s. 9d. for the corresponding period of 1907, an increase of £40,661. 7s. 2d. Rentals carried forward for unexpired terms of running contracts amount to £1,314,591. 8s. 11d, compared with £1,210,117. 0s. 6d., an increase of £104,474. 8s. 5d. Out of the available balance (£369,426. 19s. 10d.) the board recommend payment for the half-year of a dividend at the rate of 6 per cent. per annum on the first and second preference shares, 5 per cent. per annum on the third preference shares, 6 per cent. per annum on the preferred stock, and 6 per cent. per annum on the deferred stock (less tax in all cases). £140,000 is to be transferred to reserve and £10,676. 19s 10d. carried forward. £496,583. 14s. 9d. has been expended on capital account during the half-year in the erection of 16,761 additional exchange and private stations, and in the construction of underground works.

ROYCE LIMITED.—The accounts for the year ended March 31 show a trading profit of £5,726. After providing for debenture interest, extinguishing a debit balance of £1,873 and applying £2,622 to make up the arrears on the debenture sinking fund, £165 remains to carry forward.

UNITED RIVER PLATE TELEPHONE CO. (LTD.)—The directors' report for the year ended March 31 last states that the gross receipts in sterling in the River Plate were £250,750. 7s. 2d., against £216,204. 4s. 4d. for last year. Deducting expenses in Argentina and London, debenture interest, preference dividend and interim ordinary dividend, and adding interest on investments, &c., there was a profit of £77,739. 10s. 8d., added to £4,070. 0s. 1d. brought forward, making £81,809. 10s. 9d. The introduction of the common battery system has necessitated the replacement of part of the overhead by underground plant, and also other changes. The cost of this work will be carried to a special replacement account as the work proceeds and be gradually written off. After applying £25,000 to reduction of this special replacement account and meeting cost of paying off old debenture stock and the issue of new, the directors recommend a final dividend of 5 per cent. on the ordinary shares, making 8 per cent. for the year (tax free). £4,904. 3s. 4d. is carried forward. The new issue of ordinary shares has been completed, and the whole amount subscribed.

YORKSHIRE ELECTRIC POWER CO.—A special meeting of the shareholders was held at Leeds on Thursday last. The chairman (Mr. A. G. Lupton) said that to meet arrangements made with customers in Brigbouse the company now required £45,000, and the directors had come to the conclusion that the most advantageous method of raising money was on a second mortgage of the undertaking ranking directly after a

sum of £4,000 owing to the bank. The directors asked the shareholders to provide the money, to be repayable at the end of five years if desired by the lender, with the option to the company of repaying it any time after two years, with six months' notice; repayment to be made at the rate of £105 per £100 subscribed, and interest, payable half-yearly, at the rate of 6 per cent. per annum. A motion to the effect set out was carried unanimously.

NEW COMPANIES, STATUTORY RETURNS, MORTGAGES AND CHARGES.

NEW COMPANIES.

MALTA TRAMWAYS (LTD.) (98,766.)—Reg. July 9, capital of £140,000 in £1 shares, to acquire the tramway undertaking and passenger lift carried on in Malta by Macartney McElroy & Co. (Ltd.), to construct and equip tramways, railways, lifts, waterways and other means of communication and transit in Malta or elsewhere, and to carry on the business of carriers of passengers and goods, railway, tramway and lift proprietors, generators, accumulators and distributors of electricity, &c. Minimum cash subscription 100 shares. First directors, J. F. Macartney, J. A. McElroy and F. H. Carter. Reg. office, Caxton House, Westminster, S.W.

MALLINSON BROS. (1908.) (LTD) (98,793.)—Reg. July 11, capita £500 in £1 shares, to carry on the business of mechanical and electrical engineers and manufacturers of dynamos, motors, carriages vehicles and engines, and to acquire the business of Mallinson Bros., carried on at Mytholm Foundry, Hipperholme, Yorks. First directors, J. and W. Mallinson.

NORFOLK ELECTRICAL CO. (LTD.) (98,700.)—Reg. July 6, capital £2,000 in £1 shares, to acquire the business carried on in Birmingham as the Norfolk Electrical Co., and to carry on the business of dealers in electrical goods and appliances connected with the application of electricity for lighting, heating, motive power or otherwise, &c. Private company. First directors, G. W. Holt and J. A. Dale, one share each. Reg. office, Norfolk House, Cannon-street, Birmingham.

PREMIER ELECTRIC CONTROL (LTD.) (98,772.)—Reg. July 9, capital £7,000 in £1 shares, to acquire the business carried on at 11, Red Lion-street, Clerkenwell, E.C., as E. P. Allam & Co., to adopt an agreement with L. I. Robinson and A. E. Ralph, and to carry on the business of manufacturers of electrical controlling gear and motor starters and regulators, electrical engineers and contractors, electricians, &c. Private company. First directors, L. I. Robinson and A. E. Ralph. Reg. office, 11, Red Lion-street, Clerkenwell, E.C.

RAILLESS ELECTRIC TRACTION CO. (LTD.) (98,728)—Reg. on July 7, capital £5,000 in 4,750 shares of £1 each, and 5,000 shares of 1s. each, to adopt agreement with M. Schiemann and F. Momber, and to carry on the business of engineers, electricians, suppliers of electricity for light, heat, motive power or otherwise, manufacturers of and dealers in electrical apparatus, &c. First directors, T. G. Gribble, H. O. Foster, F. D. Fox and B. D. Fox.

STATUTORY RETURNS.

D. P. BATTERY CO. (LTD.)—The return to June 7 gives capital as £10,000 in shares of £1 each, all of which have been taken up and paid for in full. Mortgages and charges £12,000.

HARTLEPOOL ELECTRIC TRAMWAYS CO. (LTD.)—Return to April 17 gives capital as £100,000 in £10 shares, all taken up and paid for in full. Mortgages and charges, £50,000.

SOUTH LONDON ELECTRIC SUPPLY CORPN. (LTD.)—Return to April 21 gives capital as £260,000 in £4 shares, all taken up and paid for in full. Mortgages and charges, nil.

MORTGAGES AND CHARGES.

ARMSTRONG, POWER & CO. (LTD.)—Notice of appointment of E. James, 1A, Frederick's place, London, E.C., as receiver, on Jan. 8, 1908, under powers contained in debenture dated Oct. 30, 1907, has been filed.

BLACKPOOL, ST. ANNE'S & LYTHAM TRAMWAYS CO. (LTD.) (59,184).—A notice of the appointment of G. Nicholson, C.A., of 24, North John-street, Liverpool, and E. Riding, of 30, Birley-street, Blackpool, as receivers and managers, on Dec. 31, 1904, under powers contained in an instrument dated Nov. 19, 1903, securing £150,000 debenture stock, has been filed pursuant to Section 11 (2) of the Companies' Act, 1907.

BRITANNIA ELECTRIC LAMP WORKS (1905) (LTD.)—Notice of appointment of J. J. B. Cross, 65, Lanzer-road, Hornsey, as receiver and manager, by order of court dated May 1, 1908, has been filed.

D. P. BATTERY CO. (LTD.)—A statement of the total amount outstanding on July 1 in respect of mortgages and charges created prior to that date and not required to be registered under sec. 14 of the Companies' Act, 1900, has been filed pursuant to sec. 12 of the Companies' Act, 1907. Particulars: Debentures bearing various dates in 1899, securing in all £4,500.

DOLTER ELECTRIC TRACTION (LTD.)—A notice of the appointment of E. H. Fletcher, of 14, George-street, London, E.C., as receiver and manager, by order of court, dated May 16, 1908, has been filed.

FLEETWOOD & DISTRICT ELECTRIC LIGHT & POWER SYND. (LTD.)—Notice of the appointment of W. Cash, 90, Cannon-street, London, E.C., as receiver, by order of court dated March 13, 1908, has been filed.

FRANK SUTER & CO. (LTD.)—Notice of the appointment of C. H. Mourney, 21, Coleman-street, London, E.C., as receiver or manager, on April 16, 1904, by Harriet Rodway, under powers contained in debentures dated June 27, 1906, has been filed.

JOHNSTONE, BENJAMIN & CO. (LTD.)—Notice of appointment of B. Norton, 9, Old Jewry-chambers, London, E.C., as receiver and manager, by order of court dated Nov. 22, 1907, has been filed.

LIONEL ROBINSON & CO. (LTD.)—Notice of appointment of J. Page, 21, Ironmonger-lane, London, E.C., as receiver, on Jan. 11, 1907, by Linklater & Co. (for debenture holders), under powers contained in first mortgage debentures, has been filed.

MADEIRA ELECTRIC LIGHTING CO. (LTD.)—A notice of the appointment of J. E. Whitham, C.A., of Barum House, Harrison-road, Halifax, as receiver and manager, by order of Court dated Jan. 17, 1902, has been filed pursuant to Section 11 (2) of the Companies' Act, 1907.

MAXIM ELECTRICAL CO. (LTD.)—Notice of appointment of J. Poynter, Maxim Works, Shernhall-street, Walthamstow, and G. Stirling, same address, as receivers, on March 12, 1908, by C. Bright, under powers contained in debentures, has been filed.

PHOENIX ELECTRIC HEATING CO. (LTD.) (London).—A notice of the appointment of S. A. Sillem, of 18, Cheyne-court, Chelsea, as receiver and manager, on June 15, 1908, by F. A. Donnison, W. Sillem, and the said S. A. Sillem, under powers contained in debentures dated Sept. 27 and Oct. 11, 1907, has been filed pursuant to Section 11 (2) of the Companies' Act, 1907.

ROGER DAWSON (LTD.)—A statement of the total amount outstanding on July 1 in respect of mortgages and charges created prior to that date and not required to be registered under sec. 14 of the Companies' Act, 1900, has been filed, pursuant to sec. 12 of the Companies' Act, 1907. Particulars: Mortgage on leasehold premises No. 1, Berners-street, W., dated June 18, 1908, securing £7,500 and further advances up to £9,500.

ROWLAND BARNETT & CO. (LTD.)—A notice of the appointment of J. W. Pace, of Emerson-chambers, Newcastle-on-Tyne, as receiver, by order of court dated March 20, 1908, has been filed.

SYNDICATE OF ELECTRICAL ENGINEERS (LTD.)—A statement of the total amount outstanding on July 1 in respect of mortgages and charges created prior to that date and not required to be registered under sec. 14 of the Companies' Act, 1900, has been filed pursuant to sec. 12 of the Companies' Act, 1907. Particulars: Mortgage on leasehold land and premises in Southampton-row, dated Sept. 28, 1905, securing £13,800.

CITY NOTES.

MEMORANDA (July 16).—Bank rate $2\frac{1}{2}$ per cent. (since May 28, 1908) Price of silver, $24\frac{9}{16}$d. per oz. Consols $87\frac{3}{4}$—$87\frac{7}{8}$ for money and $87\frac{13}{16}$—$87\frac{15}{16}$ account. Consols Pay Day, Aug. 6; Stock and Shares Continuation Days, July 28 and Aug. 11; Ticket Days, July 29 and Aug. 12; Pay Days, July 30 and Aug. 13; Mining Share carry-over Day, July 27.

PRICES OF METALS (London).—*Copper*, cash, $57\frac{11}{16}$—$57\frac{15}{16}$; three months, $58\frac{5}{16}$—$58\frac{9}{16}$. *Lead*, English, $13\frac{1}{4}$—$13\frac{1}{2}$; foreign, $12\frac{7}{8}$—$13\frac{1}{8}$. *Spelter*, foreign, 19—$19\frac{1}{2}$. *Tin*, foreign, cash, $133\frac{3}{4}$—$134\frac{1}{4}$, three months, $134\frac{7}{8}$—$135\frac{3}{8}$. *Iron*, Cleveland, cash, 50/$4\frac{1}{2}$—50/$5\frac{1}{2}$; three months, 49/$3\frac{1}{2}$—49/4.

COMPANIES STRUCK OFF REGISTER.—The New Electric Light Synd. (registered Dec. 12, 1895) was removed from the Register of Joint Stock Companies on June 10.

The following will be struck off the Register unless cause is shown to the contrary within three months:—

Carbon (Foreign Patents) Synd., Cox Thermo Electric Co., "Holophane," Patent Universal Smoke Condenser Co., Simplex Electric Tramway Conduit Synd., Standard Dynamo & Motor Mfg. Co., United Electric Wire & Telegraph Works.

EASTERN EXTENSION AUSTRALASIA & CHINA TELEGRAPH CO. (LTD.) Notice is given that the 4 per cent. mortgage debenture stock register will be closed from 23th to 31st inst., both days inclusive.

MEXICO TRAMWAYS CO.—A dividend at the rate of 4 per cent. has been declared for the three months ended June 30.

NEWCASTLE-UPON-TYNE ELECTRIC SUPPLY CO. (LTD.)—The directors have declared an interim dividend of $2\frac{1}{2}$ per cent., less tax, on the ordinary shares for the past half-year.

SIEMENS BROS. & CO. (LTD.)—The report of the directors for 1907 recommends a dividend of 4 per cent. (4s. per share) for the year. £3,500 has been written off value of shares held and £1,116 is carried forward.

STOCK EXCHANGE NOTICES.—The Stock Exchange committee have been asked to appoint a special settling day in and grant a quotation to a further issue of 20,000 £5, fully paid, "A" 6 per cent. cumulative preference shares of the *British Aluminium Co. (Ltd.)*, and also to grant quotations to £150,000 5 per cent. debentures of the *Durham Collieries Electric Power Co. (Ltd.)*; $1,500,000 $100, fully paid, 7 per cent. cumulative convertible preference shares of the *Mexican Light & Power (Co.)* and 67,200 £5 ordinary and 70,000 £5 6 per cent. cumulative preference shares of the *United Electric Tramways of Montevideo (Ltd.)*.

TELEGRAPH CONSTRUCTION & MAINTENANCE CO. (LTD.)—The transfer books of this company will be closed from 13th to 21st inst. inclusive, preparatory to payment of an interim dividend of 12s. per share.

ELECTRIC TRAMWAY AND RAILWAY TRAFFIC RECEIPTS.

Line	Week ended.	Amount.	Inc. or Dec. (a)	Aggregate No. of weeks.	Aggregate Amount.	Aggregate Inc. or Dec. (a)
		£	£		£	£
Aberdeen Corporation	July 8	1,462	- 23	6	8,240	- 175
Airdrie	,, 3	248	+ 18	26	5,575	+ 73
Anglo-Argentine	,, 8	23,214	+ 2,926	27	601,821	+ 55,739
Ayr Corporation	,, 11	339	- 105	8	2,627	- 111
Baker St. & Waterloo Ry.	,, 11	3,099	+ 495	2	6,050	+ 680
Barnsley	,, 3	184	+ 26	26	4,511	+ 288
Barrow	,, 3	310	+ 11	26	6,142	- 59
Bath Electric Trams, Ltd.	,, 8	869	+ 87	27	18,479	- 1,304
Birkenhead Corporation	,, 12	1,080	- 83	2	2,299	+ 56
Birmingham Corporation	,, 11	6,500	+ 415	15	94,379	+ 5,000
Birmingham & Mid.	June 26	813	- 21	25	20,619	+ 901
Blackburn Corporation	July 8	1,147	+ 63	15	17,726	+ 1,064
Blackpool Corporation	,, 9	1,692	+ 112	§14	14,932	+ 1,267
Blackpool and Fleetwood	,, 11	880	- 63	2	2,260	+ 432
Bolton Corporation	,, 12	2,180	- 106	15	35,636	- 1,772
Bombay	June 18	R34,717	+ R10,727	24	R872,359	+ R176,980
Bournemouth Corporation	July 8	1,634	- 139	14	23,155	- 793
Bradford Corporation	,, 11	4,693	+ 19	15	70,571	+ 1,180
Brighton Corporation	,, 12	934	- 63	15	13,110	+ 203
Bristol Trams & Carriage	,, 10	7,721	+ 2,263	33	133,813	+ 701
Burnley Corporation	,, 11	1,231	+ 65	15	19,331	+ 800
Burton Corporation	,, 12	287	- 9	15	4,038	- 252
Bury Corporation	,, 5	1,322	+ 189	‡11	16,995	+ 1,835
Calcutta Tramways Co.	,, 11	R14,100	- R2,916	2	R90,610	- R1,248
Camborne-Redruth	,, 11	128	- 3	28	3,482	+ 209
Cardiff Corporation	,, 11	2,265	- 1,834	15	32,593	- 572
Cavehill	,, 3	119	+ 39	26	2,272	+ 281
Central London Railway	,, 11	7,225	+ 1,572	2	14,228	+ 2,739
Charing C., Euston & H'stead	,, 11	3,305	+ 620	2	6,685	+ 1,340
Chatham & Dist. Lt. Rys.	,, 9	824	+ 31	§27	19,713	+ 653
City & South London Rly.	,, 12	3,183	+ 2	2	6,287	- 159
City of Birmingham	,, 3	2,408	+ 46	26	72,714	+ 383
Colchester Corporation	,, 8	240	+ 20	1	249	+ 20
Cork Electric Trams Co.	,, 9	575	+ 21	27	12,065	- 391
Croydon Corporation	,, 10	1,473	- 33	15	21,634	+ 260
Devonport & Dist. Trams	,, 3	495	+ 29	26	11,728	+ 104
Dover Corporation	,, 11	370	+ 51	15	3,287	- 135
Dublin & Lucan Railway	,, 10	148	+ 4	¶1	201	- 19
Dublin United	,, 10	5,837	- 1,931	¶1	8,376	- 1,365
Dudley-Stourbridge	,, 3	889	+ 15	26	22,899	- 203
Dundee Corporation	,, 8	1,218	+ 87	‡8	9,590	+ 815
East Ham Council	,, 11	952	- 14	15	12,829	- 573
Exeter Corporation	,, 10	336	+ 1	15	4,624	- 92
Falkirk and District	,, 8	233	- 11	1	233	- 11
Gateshead & Dist. Trams	,, 3	1,090	+ 115	26	26,264	+ 302
Glasgow Corporation	,, 11	16,561	- 929	6	106,018	+ 1,899
Glossop	...	...	...	...	...	...
Gravesend—Northfleet	,, 3	261	+ 1	26	5,322	- 738
Great Northern & City Rly.	,, 11	1,427	- 265	2	2,898	- 542
Gt. Northern, Piccadilly, &c	,, 11	5,420	+ 1,015	2	10,670	+ 1,825
Greenock & Port Glasgow	,, 3	798	- 41	26	13,560	- 3,462
Hartlepool Tramways	,, 3	286	- 55	26	5,893	- 1,159
Hastings Elec. Trams Co.	,, 9	1,115	- 59	2	2,268	- 267
Huddersfield Corpn.	,, 11	1,569	- 35	15	21,486	+ 842
Hull Corporation	,, 11	2,489	+ 103	15	35,576	- 142
Ilkeston District Council	,, 8	145	+ 9	14	2,012	+ 51
Ipswich Corporation	,, 11	434	- 20	15	5,800	- 25
Isle of Thanet Co.	,, 11	1,059	+ 65	41	15,422	- 249
Jarrow	,, 3	124	- 15	26	2,731	- 368
Keighley Corporation	,, 9	162	+ 1	1	213	+ 12
Kidderminster & District	,, 3	141	+ 6	26	2,676	- 132
Kilmarnock Corporation	,, 11	146	- 14	8	1,263	- 103
Lanarkshire Trams Co.	,, 9	1,296	+ 48	27	34,978	+ 3,986
Lancashire United	,, 8	1,400	+ 91	27	35,231	+ 2,130
Leamington	,, 3	208	+ 41	26	4,056	+ 216
Leeds Corporation	,, 4	7,652	+ 692	14	91,332	+ 2,851
Leicester Corporation	,, 11	2,313	+ 100	2	4,657	+ 251
Leith Corporation	,, 4	604	+ 11	§7	4,003	- 26
Lincoln Corporation	,, 11	121	+ 3	15	1,783	- 60
Liverpool Corporation	,, 4	11,707	+ 565	27	284,159	- 1,467
Liverpool Overhead Rly.	,, 12	1,411	- 195	2	2,904	- 313
London County Council	,, 4	37,188	+ 4,978	†14	472,155	+ 51,021
London United	,, 11	7,678	- 224	27	174,757	+ 4,019
Lowestoft	,, 11	241	- 9	41	6,844	+ 150
Maidstone Corporation	,, 11	219	...	15	2,597	...
Manchester Corporation	,, 11	15,521	+ 212	15	225,268	+ 10,870
Mersey Railway	,, 11	1,831	- 128	2	3,635	- 206
Merthyr	,, 3	210	- 6	26	5,438	+ 63
Metropolitan Dist. Railway	,, 11	9,356	+ 1,151	2	18,509	+ 1,972
Metropolitan Elec. Trams	,, 3	6,864	+ 2,014	26	142,629	+ 29,397
Middleton	,, 3	500	+ 135	26	9,311	+ 415
Nelson Corporation	,, 11	129	- 18	¶14	2,121	- 109
Newcastle-on-Tyne Corp.	,, 11	3,724	- 337	15	59,249	- 3,770
Newport (Mon.)	,, 11	685	+ 24	15	10,176	- 771
Northampton Corporation	,, 10	502	+ 67	¶11	6,890	+ 452
Oldham, Ashton & Hyde	,, 3	636	+ 50	26	15,491	+ 30
Oldham Corporation	,, 12	1,849	- 108	16	31,347	+ 111
Perth (N.B.) Corporation	,, 8	180	+ 2	8	1,234	- 45
Perth (W.A.) Elec. Trams	,, 10	1,396	+ 105	¶28	39,065	- 746
Peterborough	,, 3	160	+ 27	26	3,086	+ 76
Portsmouth Corporation	,, 11	2,142	- 128	15	29,587	+ 288
Potteries	,, 3	1,994	- 51	26	47,685	- 361
Preston Corporation	,, 8	776	- 23	1	776	- 23
Rotherham Corporation	,, 9	599	- 1	§14	8,858	+ 198
Rothesay	,, 3	480	+ 98	26	3,118	+ 35
Salford Corporation	,, 13	4,682	- 155	15	71,737	+ 715
Sheerness	,, 1	70	- 3	26	1,397	- 2
Sheffield Corporation	,, 12	5,563	+ 27	†16	88,357	+ 263
Singapore Trams	,, 11	$9,303	+ $27	2	$18,299	- $274
South Metropolitan	,, 3	979	+ 132	26	20,068	+ 723
South Staffs	,, 3	889	+ 15	26	22,899	- 203
Southend Corporation	,, 8	508	+ 60	15	5,736	+ 418
Southport Tramways	,, 3	441	+ 81	28	6,822	- 157
Stalybridge, Hyde, &c., Jt. Bd.	,, 11	741	- 48	†15	11,694	+ 19
Sunderland Corporation	,, 12	1,223	- 296	15	17,514	- 3,792
Sunderland and District	,, 8	521	+ 38	36	16,748	+ 1,442
Swansea Trams	,, 3	1,058	+ 126	26	23,597	+ 1,816
Swindon Corporation	...	...	...	...	...	...
Taunton	,, 3	44	- 2	26	1,030	- 10
Tynemouth and District	,, 3	329	+ 2	26	5,012	- 259
Tyneside Trams Co.	,, 8	428	+ 15	28	11,366	- 1,336
Wallasey District Council	,, 11	935	+ 25	†15	13,251	+ 795
Walsall Corpn.	,, 11	550	+ 19	28	14,707	+ 1,368
Warrington Corpn.	,, 9	436	+ 54	14	5,195	- 22
West Ham Corporation	,, 9	2,210	- 150	15	33,723	- 1,808
Weston-super-Mare	,, 1	261	+ 61	26	2,038	- 45
Wolverhampton Co.	,, 3	462	- 15	26	11,846	- 253
Wolverhampton Corpn.	,, 8	303	- 4	5	4,693	+ 435
Worcester	,, 3	349	+ 20	26	6,923	+ 46
*Wrexham	,, 3	116	+ 16	26	2,598	+ 19
Yorkshire W.R. Trams	,, 12	1,862	+ 442	28	33,483	...
Yorkshire Woollen District	,, 3	1,025	+ 105	26	23,716	- 875

(a) The comparisons are with the corresponding period last year. § Plus 2 days. ¶ Plus 3 days. * Partly electrical. † Minus 3 days. ‡ Minus 2 days.

ELECTRICAL COMPANIES' SHARE LIST.

Share	Last Dividend	Name.	Price Wed., July 15.	Rate % Yielded. £ s. d.	Dividend Due.	Business Week to July 15 Highest.	Lowest.
		ELECTRICITY SUPPLY.					
10	9/0	Bournemouth & Poole Elec. Sup. Ord.	10½ -11	6 7 0	Mar, Sept,	..	..
10	4 6	Do. 4½ per Cent. Cum. Pref.	9½ -10½	4 7 0	Feb, Aug	..	—
10	6 0	Do. 6 per Cent. Cum. Second Pref.	10½ -11½	5 11 6	Feb, Aug	..	..
St.	4½	Do. 4½ per Cent. Deb. Stock (red.)	100 -103	4 7 6	Jan, July	..	..
5	3 6	Bromley (Kent) El. Lt. & Power Shares	4½ -5	5 10 0	April, Oct	..	..
St.	4½	Do. Do. 1st Debs.	94 -97	4 12 9	May, Nov	..	..
5	5 6	Brompton & Kensington Elec. Sup. Ord.	7 -8	6 6 6	March....	..	..
5	3 6	Do. 7 per Cent. Pref.	6¾ -7¼	4 10 0	Mar, Sept	..	..
St.	4%	Central Elec. Sup. Co. 4% Guar. Db. Stock	98 -101	4 0 0	June, Dec	..	..
5	2 6	Charing Cross (W. End & City) El. Sup. Co.	3¾ -4¼	5 17 6	Feb, Aug	4	..
5	2/3	Do. 4½ per Cent. Pref.	4 -4½	5 0 0	Feb, Aug	4½	..
St.	4%	Do. 4 per Cent. Deb. Stock (red.)	94 -97	4 2 6	Jan, July	..	..
5	2 3	Do. City Undertaking 4½% Cm. Pref.	3¾ -4¼	5 11 0	Jan, July	3¾	..
5	2/6	Chelsea Electric Supply Ord.	3 -3½	6 8 9	March ..	..	..
St.	4½%	* Do. 4½ per Cent. Deb. Stock (red.)	100 -103	4 7 6	June, Dec	..	..
10	7 0	City of London Electric Lighting Ord.	9½ -10½	6 16 6	Feb, Aug	..	..
10	6/0	Do. 6 per Cent. Cum. Pref.	12 -13	4 12 0	Jan, July	12[illegible]	12⅞
St.	5%	Do. 5 per Cent. Deb. Stock (red.)	122 -125	4 0 0	June, Dec	..	..
St.	4½%	Do. 4½ per Cent. 2nd Deb. Stock (red.)	101 -104	4 6 6	Jan, July	103	..
5	2%	County of Durham Elec. P.D. Ord.	2¾ -3	3 9 7	April, Oct	..	..
5	5%	Do. 5 per Cent. non Cum. Pref.	3⅞ -4⅛	6 5 0	April, Oct	..	..
10	6 0	County of London Elec. Supply Ord.	7¾ -8¼	6 1 0	Feb, Aug	..	..
10	6 0	Do. 6 per Cent. Cum. Pref.	10¾ -10¾	5 10 6	Mar, Sept	10[illegible]	..
St.	4½%	Do. 4½% Deb. Stock (red.)	105 -108	4 3 6	Jan, July	..	..
St.	4½	Do. Second Deb. Stock	98 -101	4 9 9	May, Nov	..	..
5	3 6	Folkestone Electricity Supply Co. Ord.	4¾ -5¼	5 7 0	April, Oct	..	..
5	2 6	Do. 5 per Cent. Cum. Pref.	5 -5½	4 11 0	Mar, Sept	..	..
St.	4½%	Do. 4½ 1st Deb. Stock (red)	97 -100	4 10 0	Feb, Aug	..	..
5	4 6	Hove Electric Lighting Ord.	6 -6½	6 11 0	April, Oct	6[illegible]	..
5	5 0	Kensington & Knightsbridge Ord.	8 -9	5 11 0	Feb, Aug	..	..
5	6%	Do. 6 per Cent. 1st Pref.	6 -6½	4 12 0	Jan, July	..	—
St.	4%	Do. 4 per Cent. Deb. Stock (red.)	96 -99	4 1 0	..	..	..
St.	4%	Kensingtn. & Kngtbg. Co. & Notting Hill Co. (Joint Station) 4% Deb. Stock (red.)	97 -101	3 19 0	April, Oct	..	..
St.	4½%	†Kent Elec. Power Co.	86 -90	5 0 0	Jan, July	..	..
3	1/6	London Electric Supply Ord.	⅞ -1⅛	5 8 0	Mar, Sept	..	..
5	3 0	Do. 6 per Cent. Pref.	4½ -5	6 0 0	Mar, Sept	..	—
St.	4%	Do. 4 per Cent. 1st Mort. Deb.	89 -92	4 7 0	Jan, July	..	..
5	3 6	Metropolitan Electric Sup. Ord.	4⅝ -5⅛	6 6 6	April, Oct	4½	..
5	2 3	Do. 4½ per Cent. Cum. Pref.	4⅜ -4⅞	4 12 6	Jan, July	..	..
St.	4½%	Do. 4½ per Cent. Deb. Stock 1st Mort.	105 -109	4 1 6	June, Dec	..	..
St.	3½%	Do. 3½ per Cent. Mrt. Deb. Stock (red.)	84 -89	3 19 0	Jan, July	88	..
100	4½	†Midland Elec. Corp. for P.D. 1st Mort. Db.	94 -97	4 12 6	June, Dec	..	—
10	4%	Newcastle & Dist. Elec. Ltg. Ord.	7¾ -8¼	5 0 0	Feb, Aug	—	—
100	4½%	Do. 4½ per Cent. Deb.	94 -96	4 14 9	Jan, July	..	..
5	8%	Newcastle Elec. Supply Ord.	5⅝ -5¾	7 0 10	Feb, Aug	..	..
5	5%	Do. 5 per Cent. non Cum. Pref.	5½ -5⅝	4 14 1	Feb, Aug	..	..
100	4%	Do. 4 per Cent. Mort. Deb. red. 1907.	95 -97	4 3 4	Jan, July	..	..
1	3%	Northern Counties Elec. Sup.	—	..	Mar, Aug	—	..
100	4½%	Do. 4½ per Cent. Deb.	93 -95	4 15 9	Jan, July	..	..
10	6 0	Notting Hill Electric Ord.	12 -13	5 8 0	March ..	..	..
5	4 6	Oxford Electric Ord.	6¾ -6¼	5 12 0	March ..	5[illegible]	5[illegible]
St.	4%	† Do. 4 per Cent. Deb. Stock	94 -97	4 2 6	Jan, July	..	..
5	5 0	St. James' & Pall Mall Elec. Ord.	7½ -8½	5 18 0	Feb, Aug	..	..
5	3 6	Do. 7 per Cent. Pref.	6½ -7½	4 16 6	Feb, Aug	..	..
St.	3½%	Do. 3½ per Cent. Deb. Stock (red.)	85 -90	3 18 0	Jan, July	..	..
5	..	Smithfield Markets Electric Sup. Ord.	¼ -¾	..	Feb	..	..
St.	4%	Do. 4 per Cent. Deb. Stock	70 -74	5 8 0	Feb, Aug	..	..
5	4/0	South London Electric Supply Ord.	2⅝ -2⅞	5 19 0	April	..	..
1	0/6	South Metrop'n Elec. Lt. & Power Ord.	⅜ -⅝	4 0 0	..	..	..
1	0 8⅔	Do. 7 per Cent. Cum. Pref.	1 -1¼	5 12 0	Feb, Aug	1⅛	..
St.	4½%	Do. 4½ 1st Db. Stk. Red.	99 -102	4 8 0	April, Oct	..	..
5	2 6	Urban Electric Supply Ord.	1 -2	12 10 0	April, Oct	—	..
5	2 6	Do. 5 per Cent. Cum. Pref.	1⅞ -2⅜	10 12 0	April, Oct	..	..
St.	4½%	Do. 4½ per Cent. 1st Mort. Deb.	87 -90	5 0 0	April, Oct	..	..
5	5/0	Westminster Elec. Sup. Ord.	7¾ -8¾	5 14 0	Mar, Sept	..	..
5	2/3	Do. 4½ per Cent. Cum. Pref.	4⅞ -5⅜	4 4 0	Jan, July	[illegible]	..
		ELECTRIC RAILWAYS, TRAMWAYS, &c.					
St.	4%	†Baker St. & Waterloo 4% Perp. Db. St.	89 -91	4 8 0	Jan, July	..	—
1	..	Bath Elec. Trams Pref. Ord.	¼ -½	8 0 0	April	..	—
1	0/6	Do. 5 per Cent. Cum. Pref.	⅝ -⅞	5 14 0	Jan, July	..	..
St.	4½%	Do. 4½ 1st Mort. Deb. Stock (red.)	84 -89	5 0 0	April, Oct	..	..
St.	4½%	B'ham & Midland Trams 4½ 1st Db. Stk.	91 -94	4 17 0	Jan, July	..	..
10	9%	Bristol Tramways & Carriage Ord.	10½ -11	7 12 8	Feb, Aug	..	..
10	4%	Do. Cum. Pref. (fully paid)	8¼ -8¾	4 10 0	..	..	..
St.	4%	Do. 4 per Cent. Debs.	96 -98	4 2 0	Feb, Aug	..	..
10	..	British Electric Traction Ord.	1⅜ -1⅝	..	June, Dec	..	..
10	1/5⅓	Do. 6 per Cent. Cum. Pref.	4½ -4¾	..	Feb, Aug	..	..
St.	5%	Do. 5 per Cent. Perpetual Debs.	95 -98	..	April, Oct	96½	95¾
St.	4½%	Do. 4½ per Cent. 2nd Deb. Stock	76 -78	5 15 0	May, Nov	..	..
St.	3%	Central London Ordinary Stock	70 -73	4 2 0	Feb, Aug	74½	70¾
St.	4%	Do. 4 per Cent. Pref. Stock	88 -90	4 9 0	Feb, Aug	90	88
St.	2%	Do. Deferred Stock	53 -56	3 11 3	Feb	55	53
100	4%	† Do. 4 per Cent. Debs.	101 -104	3 17 0	Jan, July	104½	..
St.	4%	Charing X, Euston & Hmpstd Per. Db. Stk.	80 -83	4 16 0	Jan, July	82½	82¼
5	2/6	City of Birmingham Trams. 5% Cm. Pref.	4¼ -4¾	5 5 0	April, Oct	..	..
100	4%	Do. 4 per Cent. 1st Mort. Debs.	97 -100	4 0 0	April, Oct	..	..
St.	1¾%	City & South London Rly. Con. Ord.	34 -36	4 17 0	Feb, Aug	39	31
St.	5%	Do. 5 per Cent. Perp. Pref. (1891)	113 -116	4 6 0	Feb, Aug	116	115¾
St.	5%	Do. (1896)	112 -115	4 7 0	Feb, Aug	114¾	..
St.	5%	Do. (1901)	110 -113	4 8 6	Feb, Aug	111	..
St.	5	Do. (1903)	104 -107	4 13 6	Feb, Aug	..	..
St.	4%	Do. 4 per Cent. Perpetual Debs.	100 -103	3 17 6	May, Nov	..	..
10	7/0	Dublin United Trams. Ord	12½ -13½	4 10 6	Feb, Aug	..	..
10	6/0	Do. 6 per Cent. Pref.	12½ -13½	4 9 0	Feb, Aug	..	..
10	..	Gt. Northern & City Rly. Pref. Ord. (4%)	¾ -1¼	..	Feb, Aug	..	..
10	4/0	G. Northern, Piccadilly & Brompton Ord.	7 -7½	5 10 0	Feb, Aug	7⅝	..
St.	4%	Do. 4 per Cent. Deb. Stock	90 -92	4 7 0	Jan, July	91¼	89⅞
5	4/0	Hastings & Dist. Elec. Trams. 6% Cm. Pf.	3½ -3¾	8 0 0	Mar, Sept	..	..
St.	4½%	Do. 4½ Db. St.	93 -96	4 13 9	April, Oct	..	..
10	9%	‡Imperial Tramways Ord.	10½ -11½	7 17 0	Mar, Sept	..	..
10	6%	‡Do. 6 per Cent. Pref.	9½ -10	6 0 0	Mar, Sept	..	..
St.	4½%	‡Do. 4½ per Cent. Debs.	90 -92	4 18 0	Jan, July	..	..
5	..	I. of Thanet E. T. & Lt. 5 per Cent. Pref.	⅞ -1⅜	..	Mar, Sept	..	..
St.	4%	Do. 4 per Cent. Deb. Stock	59 -61	6 11 0	Jan, July	..	—
10	6/0	Lanarkshire Tramways	9½ -10½	5 9 0	Feb, Aug	..	..
St.	5%	Lancs. Utd. Trams 5% Prior Lien Db. St.	91 -93	5 7 6	Jan, July	91	..
10	..	Liverpool Overhead Railway Ord.	1½ -1¾	..	Feb, Aug	..	..
10	5%	Do. 5 per Cent. Pref.	5¾ -6¼	8 0 0	Feb, Aug	..	..
St.	4%	Do. 4 per Cent. Deb.	81 -85	4 13 0	Jan, July	..	..
10	5/0	London United Trams. 5% Cum. Pref.	7 -8	6 5 0	Jan, July	7½	..
St.	4%	Do. 4 per Cent. 1st Mort. Deb. Stock	79 -84	4 15 0	Jan, July	78¾	78½
St.	—	Mersey Con. Ord. Stock	1 -3	—	Feb, Aug.	..	..
St.	..	Do. 3 per Cent. Perp. Pref.	8 -6	—	..	..	..
1	..	Metropolitan Elec. Tramways Def.	½ -¾	—	April.. .	..	..
1	0/6	Do. 5 per Cent. Cum. Pref.	1⅛ -1⅜	6 3 6	Feb, Aug	[illegible]	[illegible]
St.	4½%	Do. 4½ per Cent. Deb. Stock	93 -96	4 13 9	Jan, July	91	93½
St.	½%	Metropolitan Railway Consolidated	38½ -39½	1 4 0	Feb, Aug	39¼	37
St.	2¼%	Do. Surplus Lands Stock	68 -70	3 10 0	Feb, Aug	69½	68
St.	3½	Do. 3½ per Cent. Preference	86 -89	3 19 9	Feb, Aug	87½	86¾
St.	3½	Do. 3½ per Cent. "A" Preference	76 -79	4 5 6	Feb, Aug	77½	76½
St.	3½%	Do. 3½ per Cent. Convertible Pref.	73 -76	4 12 0	Feb, Aug	73¼	..
St.	3½	† Do. 3½ per Cent. Debenture Stock	90 -93	3 15 3	Jan, July	..	..
St.	3½	† Do. 3½ per Cent. "A" Ditto	88 -91	3 17 0	Jan, July	89	..

* In calculating the yield allowance has been made for accrued interest but *not* for redemption
† Ex Dividend

ELECTRICAL COMPANIES' SHARE LIST.—*Continued.*

ELECTRIC RAILWAYS & TRAMWAYS—*Continued.*

Share.	Last Dividend	Name.	Price Wed., July 15.	Rate % Yielded. £ s. d.	Dividend Due.	Business Week to July 15. Highest.	Lowest.
St.	..	Metropolitan District Railway Ord.	11½—12½	..	Feb, Aug	12¼	11½
St.	..	Do. Extension Pref (5 per Cent.)	21 —26	..	Feb, Aug	..	—
St.	3½%	Do. Asserted Ext. Pref. (Int. Guar. by Und. Elec. Rlys. Co. of London, Ltd.)	44 —48	7 6 0	Feb, Aug	..	..
St	3%	Do. 3 per Cent. Consoltd. Rent-charge	73 —76	3 19 0	Jan, July	75	73
St.	4%	Do. 4 per Cent. Midland Rent-charge	98 —102	3 18 0	Jan, July	99	..
St.	1¾%	Do. Guar. Stock 4 per Cent.	44 —49	3 11 0	Mar, Sept	..	..
St	6%	Do. 6 per Cent. Perp. Deb. Stock	115 —120	5 0 0	Jan, July	120	116¼
St.	4%	Do. 4 per Cent. Ditto	71 —76	5 5 0	Jan, July	71¼	..
5	..	New Gen. Tract. 6 per Cent. Cum. Pref.	¼—¾	..	May	..	—
1	0/9⅜	Potteries Electric Traction Ord.	¼—½	8 0 0	April, Oct	..	—
1	0/6	Do. 5 per Cent. Cum. Pref.	⅝—¾	6 13 0	Feb, Aug	⅝	..
St.	4½%	Do. 4½ per Cent. Deb. Stock	93 —96	4 14 6	May, Nov	..	..
1	0 7½	S. Met. Elec. Trams. & Ltg. 6% Cm. Pref.	¾—1	6 0 0	Feb, Aug	—	..
St.	4%	Do. 4 per Cent. Deb. Stock	76 —80	5 0 0	Jan, July	..	..
100	5%	Sunderland Dist. Elec. Trms. 5% 1st Mt. Db.	75 —85	5 17 0	Jan, July	..	..
..	5%	Underground Elec. Rys. Co. of London	40 —44	11 8 0	June, Dec	42	41⅞
5	..	Yorkshire (W.R.) Elec. Trams. Ord.	⅞—1⅛	—	March ..	..	..
5	..	Do. 6 per Cent. Cum. Pref.	3⅛—3⅝	—	..	..	..
St.	4½	Do. 4½ per Cent. 1st Debs.	83 —86	5 5 0	Jan, July	84	..

ELECTRIC MANUFACTURING, &c.

Share.	Last Dividend	Name.	Price Wed., July 15.	Rate % Yielded. £ s. d.	Dividend Due.	Highest.	Lowest.
1	..	Aron Electricity Meter Ord.	[illegible]	..	..	..	..
1	1 4½	Do. 6% Cum. Pf. (ex on a/c arrears)	[illegible]	7 13 7	April, Oct	..	..
1	2/4½	Babcock & Wilcox Ord	3 [illegible]—4 [illegible]	4 17 6	April, Oct	3 [illegible]	3⅞
1	0/7⅛	Do. Pref.	1 7/16—1 9/16	3 16 9	..	..	..
5	6/0	British Insulated & Helsby Cables Ord.	6 —6½	7 14 0	July, Feb	..	..
5	3/0	Do. 6 per Cent. Pref.	6 —6½	4 12 0	Jan, July	..	..
St.	4½	Do. 4½ per Cent. 1st Mort. Deb. (red.)	100 —103	4 7 6	Jan, July	10 ¾	101¼
St.	4½	British Thoms'n-Houst'n 4½% 1st Mt. Db.	93 —98	4 12 0	Mar, Sept	..	..
5	..	British Westinghouse 6 per Cent. Pref.	7/16—11/16	..	Feb, Aug	—	..
St.	4%	Do. 4 per Cent. Mort. Deb. Stock	43 —48	8 8 0	Jan, July	45	44
2	..	Brush Electrical Engineering	½	—	March ..	..	..
2	..	Do. 6 per Cent. Pref. non-Cum.	3/16—7/16	..	Mar, Sept	..	..
St.	4½%	Do. 4½ per Cent. Perp. 1st Deb. Stock	70 —75	6 0 0	Mar, Sept	..	—
St.	4½%	* Do. Perpetual 2nd Deb. Stock	53 —58	7 14 0	Jan, July	..	..
5	10 0	Callender's Cable Con. Ord.	9½—10½	7 1 0	Jan, July	..	..
5	2/6	Do. 5 per Cent. Cum. Pref.	5¼—5¾	4 7 0	Jan, July	..	..
St.	4½%	Do. 4½ per Cent. 1st Mort Debs. (red.)	105 —107	4 4 0	Nov, May	..	..
1	1/0	Castner-Kellner Alkali Co.	1 [illegible]—1 7/16	9 1 0	May, Nov	1⅜	1 [illegible]
St.	4½%	Do. 4½ per Cent. 1st Mort. Deb. (red.)	102 —105	4 5 6	Feb, Aug	..	..
1	0 9⅜	Chadburn's (Ship) Telegraph Ord.	1 1/16—1 3/16	8 8 0	March ..	..	..
1	0/7½	Do. 6 per Cent. Cum. Pref.	1 —1⅛	5 6 6	April, Oct	..	..
1	0/8¾	†Consolidated Electrical Co.	⅜—½	7 0 0	August ...	..	..
1	1/0	Consolidated Signal Co.	1 5/16—1 9/16	8 17 9	April, Oct	1 [illegible]	..
1	0/7½	Do. 6 per Cent. Cum. Pref.	[illegible]—31/32	6 4 0	April, Oct	..	..
3	3/0	* Crompton & Co. (Nos. 1 to 85,000)	1⅜—1⅝	8 1 6	Jan, July	1 [illegible]	..
100	5%	Do. 5 per Cent. 1st Mort. Debs. (red.)	90 —93	5 7 0	Jan, July	..	..
1	0/7½	Davis & Timmins	⅞—1⅛	..	Mar, Sept	..	..
5	2/0	Dick, Kerr & Co. Ord.	1⅛—1⅜	7 11 0	Sept	..	..
5	0/7½	Do. 6 per Cent. Cum. Pref.	1 —1¼	4 16 0	Sept	1 [illegible]	..
St.	4½%	Do. 4½ per Cent. Deb. Stock	99 —102	4 8 6	Jan, July	..	—
5	2/6	Edison & Swan United ("A" Sh.) (£3 pd.)	½—¾	..	Feb, Aug	⅝	..
5	4/2	Do. (£5 paid)	1½—2½	5 0 0	Feb, Aug	..	—
St	4%	Do. 4 per Cent. Mort. Deb. Stock (rd.)	76 79	5 [illegible] 6	June, Dec	..	..
St.	5%	Do. 5 per Cent. 2nd Deb. Stock	85 —87	5 15 0	Mar, Sept	—	..
5	..	Edmundson's Elec. Corp. Ord.	⅛—⅜	..	Jan, July	..	..
5	..	Do. 6 per Cent. Cum. Pref.	½—1	..	May, Nov	..	..
St.	4½%	† Do. 4½ per cent. 1st Mort. Deb. (red.)	61 —71	6 6 6	Jan, July	..	..
2	..	Electric Construction Co.	¼—½	..	Jan, July	..	..
2	..	Do. 7 per Cent. Cum. Pref.	1½—2	..	July	..	..
St.	4%	† Do. 4 per Cent. Perp. 1st Mort. Debs.	64 —69	5 16 0	Jan, July	..	..
10	5/0	General Electric (1900) 5% Cum. Pref.	7½—8	6 5 0	June, Dec	..	..
St.	4%	Do. 4 per Cent. 1st Mort. Debs.	87 —90	4 9 0	Mar, Sept	..	—
5	10/0	Henley's Telegraph Works Ord.	10½—11½	6 10 0	Feb, Aug	..	..
5	2/3	Do. 4½ per Cent. Pref.	5 —5½	4 2 0	Feb, Aug	5 1/16	..
St	4½%	Do. 4½ per Cent. 1st Mort. Deb. Stock	105 —107	4 4 0	Mar, Sept	..	..
10	15/0	†India Rubber, Gutta Percha, &c., Wrks.	15½—16½	6 2 0	Feb, Aug	16½	16
100	4%	Do. 4 per Cent. Debs. (red.)	98 —100	4 0 0	April, Oct	98	
1	..	National Elec. Construction Co.	⅛—⅜	..	April	..	..
1	0/9⅜	Richardsons, Westgarth & Co., Ltd. Ord.	7/16—9/16	7 2 0	Nov	..	..
1	0/7½	Do. 6 per Cent. Cum. Pref.	¾—⅞	6 17 0	May, Nov	..	..
St	4½%	Do. 4½ per Cent. Perp. Deb. Stock	87 —90	5 0 0	Jan, July	..	..
1	..	Simplex Conduits Ord.	1½	..	..	—	—
5	..	Do. 6 per Cent. Cum. Pref.	5½	—	..	..	—
12	12/0	†Telegraph Construction & Maintenance	31 —33	6 8 0	Mar, July	32	31
100	4%	Do. 4 per Cent. Deb. Bonds (1909)	100 —102	3 18 0	Jan, July	..	..
1	2/0	Vickers, Sons & Maxim, Ltd., Ord.	1 11/16—1 13/16	8 5 6	..	1¾	1 11/16
1	0/6	Do. 5 per Cent. non-Cum. Preference	1 —1⅛	4 9 0	..	1⅛	1 3/32
St.	5%	Do. 5 per Cent. non-Cum. Preferred	102 —106	4 14 6	..	..	..
St.	4%	Do. 4 per Cent. 1st Mort. Db. Sk. (red)	102 —104	3 16 6	June, Dec	..	..
100	4½%	Do. 4½ per Cent. 2nd Mort. Deb. (red.)	104 —106	4 5 0	June, Dec	105½	104½
100	15/6	Do. 5 per Cent. 3rd Mort. Debs. Scrip.	102 —104	..	..	103	102⅞
1	10/0	J. G. White & Co. 6% Cm. Pref. xd & bonus	7 —8	7 10 0	..	..	..
5	1/0	Willans & Robinson Ord.	¾—1¼	4 0 0	Apr, Oct	..	..
5	3/0	Do. 6 per Cent. Cum. Pref.	3¼—3¾	8 0 0	Apr, Oct	..	..
100	4%	Do. 4 per Cent. 1st Mort. Debs.	72 —76	5 5 6	May, Nov	..	..

TELEGRAPHS.

Share.	Last Dividend	Name.	Price Wed., July 15.	Rate % Yielded. £ s. d.	Dividend Due.	Highest.	Lowest.
10	..	Amazon Telegraph	2 —3	—	June, Dec	..	—
100	5%	Do. 5 per Cent. Debs. (red.)	86 —89	5 12 0	June, Dec	88½	..
St.	15/0	Anglo-American	58 —61	5 12 6	F,My,Ag,N	..	..
St	30 0	Do. Preferred	102½—103½	5 15 6	F,My,Ag,N	103¼	102
St.	1%	Do. Deferred	15½—16½	6 4 0	F,My,Ag,N	16 1/16	15 1/16
St.	4%	Commercial Cable 4 per Cent. Deb. Stk.	83 —86	4 13 0	Ja,Ap,Jy,O	85⅝	..
10	6 0	Cuba Submarine Ord.	7½—8½	7 0 0	Feb, Aug	..	..
10	10/0	Do. Preference 10 per Cent.	16½—16¾	5 19 0	Feb, Aug	..	..
5	2/0	Direct Spanish Ord.	3 —3½	6 4 0	April, Oct	..	..
5	5/0	Do. 10 per Cent. Cum. Pref.	8 —9	5 11 0	April, Oct	8 [illegible]	..
St.	4½%	Do. 4½ per Cent. Deb.	100 —103%	4 7 6	Jan, July	.	..
20	4 0	Direct United States Cable	13½—14	6 10 6	Ja,Ap,Jy,O		..
100	4½%	Direct West India Cable 4½% Rg. Db. (rd.)	98 —100	4 10 0	June, Dec	..	..
St	[illegible]	†Eastern Ordinary	132 —135	5 4 0	Ja,Ap,Jy,O	135	132¾
St	17 [illegible]	Do. 3½ per Cent. Pref. Stock	83½—86½	4 2 0	Ja,Ap,Jy,O	86½	84¾
St	4%	Do. 4 per Cent. Mort. Deb. Stk. (red.)	101 —103	3 17 6	May, Nov	102½	100⅞
10	2/6	†Eastern Extension	12¾—13¼	5 6 0	Ja,Ap,Jy,O	13⅛	12 [illegible]
St	4%	Do. 4 per Cent. Deb. Stock	101½—102½	3 18 0	Feb, Aug	102	101¾
100	4%	Eastern & S. African 4% Mort. Deb. 1900	100 —102	3 18 6	Feb, Aug	102	..
25	4%	Do. 4% Mauritius Sub. Debs. (red.)	100 —102½	3 18 6	May, Nov	..	..
10	[illegible]	G. N. (of Copenhagen), with Coupon 74	27 —29	6 15 0	Jan, July	28¼	..
100	4½	Halifax & Bermuda 4½% 1st Mt. Db. (red.)	98 —100	4 19 0	June, Dec	..	..
25	[illegible]	Indo-European	56 —59	5 1[illegible] 0	May, Nov	58	55½
100	$1	Mackay Companies Common	64 —68	5 17 0	Ja,Ap,Jy,O	..	.
100	$1	Do. Preference	60 —70	5 11 0	Ja,Ap,Jy,O	..	..
1		Marconi Wireless Teleg. Co.	[illegible]	..	April	[illegible]	..
100	4	Pacific & European Tel. 4% Guar. Dbs. red.)	97 —100	4 0 0	June, Dec	..	—
[illegible]	[illegible]	West Coast of America	1 [illegible]—1 [illegible]	4 5 0	May	.	..
100	4	Do. 4 per Cent. Debs.	98 —101	3 19 0	Jan, July	..	..
10		West India & Panama	[illegible]—⅜	..	May, Nov	..	..
10	6/0	Do. 6 per Cent. 1st Pref.	8 —8½	7 1 0	May, Nov	8 [illegible]	8¼
10	[illegible]	Do. 6 per Cent. 2nd Pref. ex coupon [illegible]	8¼—9¼	..	May, Nov	..	..
100	5	Do. 5 per Cent. Debs.	99 —102	4 18 0	Jan, July	..	..
10	[illegible]	Western Telegraph	13¾—14½	4 19 0	Mr,Jn,O,D	14	13 [illegible]
St	4%	Do. 4 per Cent. Deb. Stock (red.)	99½—100½	3 18 6	June, Dec	99½	..
..	4	Western Telegraph $1,000 4% Bonds	[illegible]	4 1[illegible] 6	..	..	..

TELEPHONES.

Share.	Last Dividend	Name.	Price Wed., July 15	Rate % Yielded. £ s. d.	Dividend Due.	Highest.	Lowest.
100	2$	†Amer. Telephn. & Telegh. Cap. St.	116 —120	6 13 6	..	..	..
..	4%	Do. Coll. Trust $1,000 4 per Cent. Bds	89 —92	4 7 0	Jan, July	..	—
St.	5%	Anglo-Portug'se Tel. 5% 1st Mt. Db. Stk.	99 —102	4 18 0	Mar, Sept	..	—
5	3 0	Chili Telephone	7½—7¾	5 2 0	August ..	7½	..
1	0/7⅛	Monte Video Telephone Ord.	[illegible]—1 1/16	6 12 0	Nov	1	..
1	0/6	Do. 5 per Cent. Pref.	[illegible]—1 [illegible]	5 6 0	May, Nov	⅞	..
St.	6%	National Co. Pref. Stock	109 —111	5 9 0	Feb, Aug	110½	109½
St.	6%	Do. Def. Stock	115½—117½	5 2 0	Feb, Aug	117	115½
10	6/0	Do. 6 per Cent. Cum. 1st Pref.	10½—12½	4 16 0	Feb, Aug	.	..
10	6/0	Do. 6 per Cent. Cum. 2nd Pref.	10½—12½	4 16 0	Feb, Aug	..	..
5	2/6	Do. 5 per Cent. non-Cum. 3rd Pref.	5 7/16—5 11/16	4 7 6	Feb, Aug	5 [illegible]	5 [illegible]
St.	3½%	* Do. Deb. Stock 3½ per Cent. (red.)	97½—99½	3 10 6	June, Dec	98½	97½
St.	4%	Do. 4 per Cent. Deb. Stock (red.)	100½—102½	3 17 6	Jan, July	101¾	101⅛
1	1/0	Oriental	1 3/16—1 5/16	5 6 8	April, Oct	..	..
1	0/7½	Do. 6 per Cent. Cum. Pref.	1⅛—1¼	4 16 0	April, Oct	—	..
St.	4%	Do. 4 per Cent. Red. Deb. Stock	88 —91	4 8 0	Jan, July	..	..
St.	4½%	Telephone Co. of Egypt 4½% Db. Stk. (red.)	98 —101	4 11 0	Jan, July	..	—
5	3/0	United River Plate	6½—7	5 14 0	July	..	..
5	2/6	Do. 5 per Cent. Cum. Pref.	5 —5½	4 11 0	June, Dec	..	..
St.	4½%	Do. 4½ Deb. St. Red.	99 —101	4 9 0	Jan, July	100¼	—

FINANCIAL, INVESTMENT, &c.

Share.	Last Dividend	Name.	Price Wed., July 15	Rate % Yielded. £ s. d.	Dividend Due.	Highest.	Lowest.
5	8/0	Elec. & Gen. Investment 6% Cum. Pref.	3½—4	7 10 0	Jan, July	3¾	..
10	5/9	†Globe Telegraph & Trust	10¼—10¾	5 11 0	Sp Dc Mr Ju	10¾	10⅝
10	3/0	Do. 6 per Cent. Pref.	14⅛—14⅝	4 0 6	Sp Dc Mr Ju	14⅛	13⅞
10	6%	Submarine Cables Trust (Cert.)	127 —130	4 12 0	April, Oct	..	—

COLONIAL AND FOREIGN ELECTRIC RAILWAYS, TRAMWAYS, &c.

Share.	Last Dividend	Name.	Price Wed., July 15	Rate % Yielded. £ s. d.	Dividend Due.	Highest.	Lowest.
5	3/0	Anglo-Argentine 6% Cum. 1st Pref.	6⅛—6⅜	4 14 0	April, Oct	6 [illegible]	.
5	5/0	Do. 10% Non-cum. 2nd Pref.	8 7/16—8 11/16	5 15 0	Jan, July	8 11/16	8½
St.	6%	Do. Permanent 6% Deb. Stock	139 —144	4 3 3	June, Dec	148	..
St.	5%	Auckland Elec. Trams. 5% Deb. (red.)	103 —106	4 14 3	Jan, July	103½	..
5	4 0	Brisbane Electric Trams. Invest. Ord.	4⅜—4⅝	4 8 0	May	4½	..
5	2/6	Do. 5 per Cent. Cum. Pref.	4⅞—5⅛	4 17 6	May, Nov	..	..
St.	4½%	Do. 4½ per Cent. Db. Prov. Certs.	98 —102	4 8 0	Jan, July	100½	.
St.	8%	British Columbia El. Ry. Df. Ord.	124 —129	6 4 0	Mar, Sept	..	..
St.	65 0	Do. Pref. Ord. Stock	108 —112	5 6 6	May, Nov	111	..
St.	5%	† Do. 5% Cum. Perp. Pref. Stock	104 —108	4 12 6	Jan, July	..	.
40	4½%	Do. 4½ per Cent. 1st Mort. Debs.	99 —102	4 8 0	April, Oct	..	—
100	4½%	† Do. Vancouver Power Debs.	100 —103	4 7 6	Jan, July	..	—
St.	4½%	Do. 4½% Perp. Con. Deb. St.	100 - 103	4 2 6	—	102½	101½
St.	5%	Buenos Ayres Elec. Trams (1901) Ltd. Deb. St.	93 —97	5 2 6	Ja, Jul ..	..	..
5	..	Buenos Ayres Grand National Ord.	2⅛—2⅜	..	..	..	..
5	2/6	Do. 5 per Cent. Cum. Pref.	3⅞—4⅛	..	Feb, Aug	4⅛	4
100	5½%	Do. 5½ per Cent. Pref. Debs.	99 —103	5 7 6	Jan, July	..	..
100	6%	Do. 6 per Cent. 1st Deb. Bonds.	100 —104	5 14 6	April, Oct	..	..
St.	5%	Buenos Ayres Lacroze Trams 1st Mt. Db.	93 —96	5 4 0	Mar, Sept	..	..
St.	6%	Buenos Ayres Port & City Tram. 1st Mt. Deb. Stock £75 Paid	64 —68	6 12 0	Feb, Aug	..	..
5	2/6	Calcutta Tramways (1 to 137,610)	5½—6	5 0 0	Mar, Sept	5¾	6
100	2/6	Do. 5 per Cent. Cum. Pref.	5 —5⅜	4 13 0	Jan, July	..	..
1	4½%	Do. 4½% 1st Deb. Stock (red.)	101 —104	4 6 6	Jan, July	..	..
St	..	Cape Electric Tram Shares	3/16—7/16	..	..	..	—
5	1/3	City of Buenos Ayres Trams Co. (1904) Sh.	5⅜—5⅝	4 5 0	F,My,A,N	.	4½
St.	4%	Do. 4 per Cent. Deb. Stock	97 —101	3 19 0	June, Dec	..	..
	5%	Colombo Tr. & Ltg. 5% 1st Mt. Db.	88 —91	5 10 0	May, Nov	..	—
100	5%	Electric Traction Co. of Hong Kong 5 per Cent. 1st Mort. Debs.	85 —90	5 10 0	June, Dec	..	..
1	5%	†Havana Elec. Ry. Con. Mt. 5% $1,000 50 year Coup. Bds.	80 —85	5 9 6	Feb, Aug	85	..
1	..	Kalgoorlie Elec. Trams Sh.	[illegible]	..	..	..	.
100	5%	Do. 5 per Cent. "A" Deb. Stock	85 —89	5 12 0	Jan, July	..	—
5	6%	Do. 6 per Cent. "B" Ditto	69 —73	8 4 0	Jan, July	..	
5	1/0	Lisbon Elec. Trams. Ord.	1 —1¼	4 0 0	July	..	..
100	0/7½	Do. 6 per Cent. Cum. Pref.	1 —1¼	4 16 0	Jan, July	..	—
St.	5%	Do. 5 per Cent. Reg. Mort. Debs	92 —97	5 3 0	Jan, July	..	..
St.	5%	Madras Elec. Trams. 5% Deb. Stk.	93 —96	5 4 0	Jan, July	..	..
.	5%	Manila Elec. Ry. $1,000 Gold Bonds	86 —90	5 11 3	Feb, Aug	.	.
100	$1	Mexico Trams Co. Com. St.	104—106	8 15 3	..	105½	103½
500	5%	Do. Gen. Con. 1st Mort. 5% Gold Bds.	91½—92½	5 8 3	..	91½	91½
St.	4½%	Montreal St. Ry. Sterling 4½ per Cent. Debs. (1922)	102 —104	4 6 6	Feb, Aug	102½	102¼
1	1/0	Perth Elec. Trams Ord	[illegible]—11/16	7 5 6	May	..	..
St.	5%	Do. 1st Mt. Db. Stock	101 —104	4 16 0	Jan, July	102	—
5	3/0	Rangoon Elec. Trams & Supply Co. 6 Cum. Pf.	5⅛—5⅜	5 6 6	..	..	—
St.	4½	Do. 4½% 1st Mort. Deb. Stk.	96 —98	4 12 0	..	97½	97½
..	$1¼	Sao Paulo Tramway, Light & Power Co. $100 Stock	132 —137	6 1 6	..	134½	
	5%	Do. 5 per Cent. 1st Mt. $500 Db.	93 —98	5 2 0	June, Dec	[illegible]	94
100	4½%	Toronto Ry. Co. 1st Mt. 4½% Ster. Bonds	98 —100	4 11 0	Feb, Aug	99½	..

COLONIAL AND FOREIGN ELECTRICITY SUPPLY &c.

Share.	Last Dividend	Name.	Price Wed., July 15	Rate % Yielded. £ s. d.	Dividend Due.	Highest.	Lowest.
5	8.0	Adelaide Elec. S'ply Co. 6% Cu. Pr.	4¾—5¼	6 14 0	Mar, Sept	..	..
10	5/2½	Bombay E. S. & T. 6% Cm. Pf.	1 [illegible]—10¼	5 11 6	..	..	.
St.	4½	Do. 4½ per Cent. Deb. Stk. (red.)	92 —94	4 16 0	Jan, July	93½	92
5	4/9	Calcutta Elec. Supply Ord.	5¾—6¼	5 17 0	April, Oct	[illegible]	.
100	7/2	Canadian Gen. Elec. Co. Com. St.	87½—8[illegible]	7 18 6	..	89	88½
100	5%	Castner Electrolytic Alkali Co. (of U.S.A.) 1st Mort. Stl. Debs.	92 —97	5 2 6	Jan, July		
500	5%	Elect. Development Co. of Ontario	83 —85%	5 16 0	..	83	.
5	..	Elec. Ltg. & Trac. Co. of Aust. 6 per Cent. Cum. Pref.	2 —2½	..	Feb, Aug	..	..
St.	5%	Do. 5 per Cent. Deb. Stock	83 —87	5 15 0	Jan, July	..	..
St.	5%	Elec. Supply Co. of Victoria 5 per Cent. 1st Mort. Deb. St.	90 —93	5 7 6	Jan, July	.	
St.	6%	Indian Elec. Sup. & Trac. Co. Constn Deb. St. Rd.	45 —55	10 18 0	Jan, July		
10	0/3	Kalgoorlie Elec. Power & Ltg. Ord.	[illegible]	..	..	.	
1	0/7½	Do. 6 per Cent. Cum. Pref.	⅜—⅝	8 0 0	April, Oct	..	..
St.	6%	Madras E. S. Corp. 6 per Cent. Constn Deb. St.	85 —90	6 11 0	April, Oct	..	..
500	5%	Mexican Elec. Light Co. 5% 1st Mort. Gold Bonds	81 —82	6 2 0	..	81½	81
St.	$1	Mexican Lt. & Power Co. Cap. St.	58½—[illegible]	..	..	[illegible]	58½
500	5%	Do. 5% 1st Mort. Gold Bnds	8[illegible]—89½	5 9 0	..	89 [illegible]	88½
100	6/2	Montreal Lt. Ht. & Power Co. Cap. St.	96 —99	6 1 0	F,My,A,N	.	
1	1/0	River Plate Electricity Co. Ord.	⅞—1	6 0 0	April ..	[illegible]	..
1	1 2½	Do. 6 per Cent. non-Cum. Pref.	.. 1	6 0 0	May	[illegible]	..
St	6%	Do. 6 per Cent. Deb. Stock	95 —97	6 [illegible] 6	Jan, July	96½	..
5	3/0	Rosario Elec. Co. 6% Pref. (1-20,000)	4⅞—5⅛	5 17 6	April, Oct	4	4⅞
100	$1	†Shawinigan Water & Power Co. Cap. St.	68 —70	5 14 0	..	71	..
..	5%	Do. 5 per Cent. Bds.	99 —101%	4 19 0	Jan, July	101½	100½
..	6d	†Victoria Falls Power Co. Pref.	[illegible]	—	Jan, July	[illegible]	—

* In calculating the yield allowance has been made for accrued interest but not for redemption. † Ex dividend. ‡ The London Stock Exchange Committee have declined to quote these

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CONTENTS OF THE CURRENT NUMBER.

NOTES.

Prepayment Meters.

Much of the business of gas companies is with prepayment customers, and facts appear to confirm the statement that a most profitable connection has been built up with this class of consumer in most cities and large towns. Central station engineers have often essayed to encourage this method of supply, but the cost of the meter, considering the scheme generally, has been one of the main difficulties. On the other hand, the prepayment system is the only really satisfactory solution of the problem of the small consumer, assuming that a meter is to be retained. The capital cost of a service to such consumers individually can, under exceptional circumstances, be reduced to a limit of £5, this sum including a meter, which would come to at least half the total expenditure. Probably this outlay will not be recovered in less than two years by the revenue derivable from the consumer; consequently the investment is a somewhat unprofitable one. A really cheap shilling-in-the-slot meter should alter this complexion of affairs. In another column we describe a form of meter, which, though only suitable for continuous current circuits, should, by reason of its simple construction and extremely low cost, give the station engineer an opportunity of working up quite a good prepayment business. The commercial station manager should bear in mind the S.P.Q.R. trader who makes a comfortable living out of small sales. The prepayment consumer is to be welcomed rather than despised, and this fact must be made full use of in conjunction with a reliable, simple and cheap prepayment mechanism such as that dealt with elsewhere appears to be. The prepayment systems obviates bad debts. Middle-class folk also, are not above installing a "pay as you go" meter, and the records of gas supply confirm this. Now that we have metal filament lamps arresting, rather than increasing, the load on electricity works, some steps must be taken to encourage profitable or, at any rate, paying consumers to come on the mains. Without posing in the least as scaremongers we may recommend station engineers, with and without commercial instinct, to review the prepayment situation in the light of the cheap meter. They should be able to make considerable capital out of the reduction in price of the meter to a figure which is probably less than half that previously obtaining.

Symbols in Engineering Literature.

Elsewhere in our present issue we publish a communication from Mr. Miles Walker with regard to the use of symbols in scientific literature. The subject is one that has received a good deal of attention recently, and more than one society has had it under consideration. The International Electrotechnical Commission more particularly must be looked to for an acceptable solution of the trouble, and it is at the request of a sub-committee of this Commission that Mr. Miles Walker writes. Few of us can have failed to realise the difference, according to the style of notation used, between one book and another, as far as ease of reading is concerned, when formulæ are under discussion. Most of us will remember that we hailed with delight the new style of Euclid, in which signs for "therefore," "angle" and "triangle" were introduced, thereby making the reading of geometrical problems far more easy than it had been hitherto. Equally, there would, no doubt, be a good deal of gratification if ordinary engineering and electrical formulæ could be written in such a way as to tell automatically their own tale. The bad effect of our present want of method is apparent enough even in English books, but it is more particularly when we turn to books in other languages that we find reading to be so laborious, because letters different from those to which we are accustomed are used by the authors. For example, it is troublesome to remember that resistance is represented by w in German instead of by r.

As Mr. WALKER points out, symbols are useful in two cases. They may be used as a species of shorthand in the text, or they may be used with a more definite meaning in formulæ. The first use is not so important as the second, though undoubtedly convenient. On the other hand, we think that symbols in formulæ are very important, because so much information can be supplied in a condensed form, and anything which enables us to obtain this information more quickly will be an advantage. Letters of the alphabet are convenient in a limited way, but, unfortunately, there are not enough of them, and initial letters are liable to vary from one language to another. For this reason it is suggested that a set of entirely new symbols should be evolved. We think that this might meet the case, provided that the symbols are not too numerous and are sufficiently suggestive. A dozen symbols would be useful, whereas three dozen would become confusing and might render the reading of books more difficult instead of more easy, because the reader would not be sufficiently familiar with all the symbols. In such matters it is necessary to bear in mind the requirements of the average reader, not of the specialist. It is also important to consider the whole question from the printer's point of view as well as from the reader's standpoint. If symbols are introduced they should be of such a form that they can be made easily by the printer. This point (an important one) may very possibly be overlooked, and therefore we hope to return to it in another issue. We shall also be glad to have the views of our readers on the subject generally, for a question of this kind cannot be decided satisfactorily without discussion.

Large German Gas Engines.

MR. LEONARD ANDREWS has again completed a successful Continental trip with a party of British power-station engineers, inspecting large gas-dynamo installations in German steel and iron works. While we regard the introduction of the large gas engine into electricity works in this country as a possibility of the next few years, we cannot overlook the fact that the steam turbine is a powerful competitor, and is likely to remain so for some long time to come. The enterprise of German engineers in developing the large horizontal gas engine is extremely laudatory, and for the sake of the time, energy and capital expended we trust that it may prove profitable to them. We are inclined, however, to entertain doubts of any ultimate success with this class of engine in electricity works—that is, public supply stations in this country. The opinion of the majority of municipal engineers appears to favour the high-speed generating unit, and confirmation of this may be found in the vast number of high-speed engines in use in British electricity works to-day. The high-speed steam engine is essentially a British product, and contrasts in a striking manner with Continental practice, which favours horizontal slow and medium speed units. In these circumstances we look to the engine builders of this country to develop the multi-cylinder high-speed vertical gas engine as an ultimate competitor of the steam turbine. British research may then lead to the gas turbine as a rival to the steam turbine. None the less, we do not lose sight of the fact that there is a field here for the blast furnace and coke oven gas engine, and the experience of German engineers, which is mainly confined to this field, will be both useful and profitable to British iron and steel makers. We think that Mr. ANDREWS' efforts in directing attention to the reliability and efficiency of the large gas engine are highly commendable, and will assist materially in making station engineers think seriously about an important problem. The future of electricity supply in these islands is undoubtedly certain of identification with the large internal combustion engine, and the sooner the difficulties in the way of the production of suitable prime movers of a capacity comparable with that of the steam turbine are tackled by British engine makers the better. We are ourselves confident that in the immediate future some effort worthy of our engineering reputation will be made. Until that is done we are practically tied to the steam turbine for public electric service.

University of London : University College.—Mr. H. M. Hobart, B.Sc., M.Inst.C.E., has been appointed to the newly created Lectureship in Electrical Design.

Academie des Sciences.—Dr. Bouchard has been elected president of this Society in succession to M. H. Becquerel. M. Becquerel was recently appointed permanent secretary of the Academy.

New Submarine Cable.—The c.s. "Faraday," belonging to Messrs. Siemens Bros. & Co., is engaged in laying a submarine telegraph cable between Varna (Bulgaria) and Sevastopol (Russia). The "Faraday" left London on July, 1st and the work is now practically finished.

Wireless Telephony.—It is stated that the U.S. Postal Department has issued an order charging fraud against the Oakland Trans-continental Aerial Telephone & Power Co., Oakland, Cal., which has been advertising that it owns an invention whereby it is possible to "talk round the world without wires or cables."

The Corps of Electrical Engineers.—Orders have been given for the 2nd London Divisional Engineers, the 3rd and 4th London Field companies R.E. and the 2nd London Divisional Telegraph company R.E. to train at Herne Bay from August 2nd to 16th.

Among the territorial units recognised by the Army Council in the list just issued by them are the London Wireless Telegraph company, London Cable Telegraph company and London Air Line Telegraph company.

Single-Phase Electric Traction on the Midland Railway.—In the course of our description of this system we mentioned (*The Electrician*, June 19, p. 371) that the Westinghouse car was capable of starting a train weighing 163 tons out of Lancaster station. To avoid misapprehension we ought to say that any of the cars may be called upon to do this work in the ordinary course of events, and that the Siemens cars as well as the Westinghouse car do so as a regular thing. The current taken to start out of Lancaster station is over 1,000 amperes per motor, but the commutation is perfectly satisfactory.

Exhaust Turbines in Mining Work.—*Die Turbine* describes an installation of this kind at the Grube Konig at Saarbrucken. The exhaust steam from three winding engines is passed through an oil separator and then through a Rateau collector, $10\frac{1}{4}$ ft. in diameter and 25 ft. long. The turbine is of the Zoelly type, with an output of 800 H.P. when running at 1,500 revs. per min. A surface condenser is also provided. The steam consumption of the turbine at full load with a steam pressure of 0·23 atmosphere and 90·6 per cent. vacuum was 27·8 lb. per horse-power hour.

Cable Interruptions.	Date of Interruption.
Cayenne–Salinas	May 12, 1908
Las Palmas–Arrecife	May 18, 1908
Kwandang–Manado	July [illegible], 1908
Kotonou–Grand Bassam	July 20, 1908

University of London.—At a meeting of the Senate on Wednesday last Prof H. A. Miers, D.Sc., F.R.S., Professor of Mineralogy in the University of Oxford, was appointed Principal of this University in succession to Sir Arthur Rücker.

The Imperial College of Science and Technology was admitted as a school of the University in the faculties of science and engineering.

The degree of Doctor of Science was conferred on Mr. S. W. J. Smith for a thesis on "The Thermo-magnetic Analysis of Meteoric and Artificial Nickel-Iron Alloys."

The Liquefaction of Helium.—In our issue of March 13th we announced the solidification of this gas by Prof. Kamerlingh Onnes, of Leyden. Subsequent investigation, however, showed that this result was premature, as the helium was not quite pure. Prof. Onnes is now able to announce the liquefaction of helium, a result which was obtained on July 10 and telegraphed to Sir James Dewar. He, however, desired that publication should be delayed for a few days until the result had been checked, and thus the facts were announced in *The Times* of the 20th. Prof. Onnes shows that the boiling point of helium is 4·3 deg. abs. and the gas is not solid when exhausted to 10 mm. of mercury—at which pressure the temperature must have been about 3 deg. abs.

Illumination and the Eye.—At a recent meeting of the Illuminating Engineering Society, at Chicago, Dr. H. Gradle read a Paper on this interesting subject. He dealt mainly with the effect of varying degrees of illumination on the eye and showed that what the eye considers good illumination is, within certain limits, largely a matter of comparison or contrast. The eye can work comfortably within great ranges of illumination, but after being exposed to very high illumination, such as sunlight, considerable time is required to adapt it to see clearly where the illumination is less. In the discussion it was brought out that the eye in normal daylight receives a certain amount of light from every direction. If we change these conditions with artificial light, it is most trying to the eyes. For example, a person when sitting in a comparatively dark place and looking toward a place more brilliantly lighted with exposed lamps suffers great eye fatigue. A practical example of this was afforded by the accidental extinguishing of the lamps at one end of the meeting room during the meeting, thus causing considerable eye discomfort to those sitting in the dark end of the room looking towards the lighted end.

Fire on the City & South London Railway.—On Thursday evening last a small fire occurred on the down road of this company's system near Moorgate-street station. Fortunately it led to no casualties, either through burns or fright, and with the assistance of the Fire Brigade it was soon got under. These facts, however, did not prevent a certain section of the Press from attributing the outbreak to most extraordinary, and even supernatural, causes. As was to be expected, the dangerous "fluid," electricity, was again made the scapegoat, and various weird theories were advanced in support of this view. Thinking, however, that some quite simple reason might be at the bottom of this accident, one of our representatives paid a visit to Mr. McMahon, chief engineer of the City & South London Railway, to elicit his views on the subject. As a result of this visit it may be stated (indeed, the fact has already come out at the Board of Trade enquiry) that the fire was not primarily due to electrical causes. It may have been caused by the ignition, spontaneous or otherwise, of some waste or by other external reasons, such as cigarette ends or matches. This is borne out by the fact that at first and until the cables had become ignited, there was no "popping," such as might be expected from an electrical fire. Further, the news that a fire was in progress was known at the Stockwell station, by telephone, some minutes before any circuit-breakers came out. The reports as to the damage were much exaggerated and traffic could have been resumed in quite a short time but for the fact that it was considered better to have everything in order first. It is in no way desired by any electrical engineer to avoid the just responsibility of a proper electrical fire, but the ascription of every fire to this cause is a matter which rather rankles. We are, therefore, glad to be able to dispose of another *canard.*

Electricity Supply in Germany.—As is their annual custom, the *Elektrotechnische Zeitschrift* has published statistics relating to this subject, from which it appears that there are now 1,530 stations in operation. The lighting load amounts to 576,284 kw. and that for power to 524,577 kw., a total of 1,000,561 kw., or an average of 650 kw. per station. The capacity of the stations amounts to 858,841 kw.; 64 stations have a capacity exceeding 2,000 kw. The following table gives details as to the supply and capacity of the stations :—

Nature of current.	No.	Power in KW. Machines.	Accumulators.	Total.
Continuous	1,217	178,169	64,853	243,022
Single and two phase	41	26,201	115	26,316
Three phase	129	151,123	1,536	152,659
Single phase and three phase	2	973	14	989
Continuous and single phase	19	13,828	2,838	16,666
Continuous and three phase	116	334,492	58,146	392,638
Continuous, single phase and three phase	2	25,963	588	26.551
Unknown	4	...	...	...
Total	1,530	730,749	128,090	858,841

Of the above stations, 1,025 belong to the State or to municipal authorities, 501 to private owners, and details as to four are unknown.

Wireless Telegraph Notes.—Reuter's agency announces that the Bulgarian Government are negotiating for the establishment of a Marconi wireless telegraph station at Varna.

The North-West lightship (stationed 26 miles off Liverpool) is to be equipped with Marconi apparatus in communication with the lighthouse at Bidston Hill, on the Wirral side of the Mersey. The Mersey Dock and Harbour Board are providing this communication.

The United Wireless Telegraph Co. has opened a station for commercial messages at Friday Harbour, Washington (U.S.A.).

It is announced that wireless communication has been established across the Pacific, intimation having been received from Honolulu of the receipt of a message from Rear-Admiral Sperry's flagship "Connecticut" at San Francisco, this message being relayed by the "Yankton," on her way to Honolulu in connection with the establishment of wireless communication between the different vessels of the U.S. Pacific fleet.

According to the Paris *Figaro* the French War Department are putting the new central wireless station on the Champ de Mars underground, and according to our contemporary it is the hope of the chief engineers of this enterprise to be able to establish communication with New York.

A correspondent of the Paris *Eclair* states that a group of French Catholics offered to instal in the Vatican a wireless telegraph station, enabling the Holy See to communicate with Catholics all over the world without using the Italian stations. The Pope, although delighted with the offer, has been obliged to refuse, as a single wireless telegraph station would not suffice. Corresponding stations would be necessary, and, as the Marconi Company cannot guarantee complete secrecy of communication, special stations would have to be established for the Holy See.

The Great Eastern Railway Co. have decided to fit their steamers with wireless telegraph apparatus. Two of the boats on the Hook of Holland service, the turbine steamer "Copenhagen" and the twin-screw "Dresden," have already been equipped.

It is announced that "flying top-masts," or top-gallants are being generally fitted in the Japanese fleet for wireless telegraphy as in the British Navy.

ARRANGEMENTS FOR THE WEEK.

FRIDAY, July 24th (to-day).

THE TRAMWAYS AND LIGHT RAILWAYS ASSOCIATION.

4 p.m. Meeting at 35, Parliament-street, Westminster. Discussion on Prof. C. A. Carus-Wilson's Paper on "Rail Corrugation."

ELECTRIC TRACTION ON RAILWAYS.*

VII.—AXLES.

BY PHILIP DAWSON.

(*Continued from page 515.*)

Summary.—In this article the author considers the important question of axles, and gives details of present practice, after which an outline is given of the calculations involved in axle design.

The calculation of axles has, as regards electric traction, only recently received careful attention. The entirely theoretical determination of axles is practically impossible, for only experience in conjunction with theory can enable satisfactory results to be arrived at. The introduction of electric traction has introduced a new factor into the calculations, that due to torsion, which must be taken into consideration when deciding on the dimensions to be given to motor-car axles; this factor is of great importance, particularly in those cases where heavy weights and considerable rates of acceleration have to be dealt with.

But there are other factors besides the dimensions which enter into consideration when axles have to be designed, the neglect of which has frequently brought about serious troubles with axles which, considering their dimensions, should have given every satisfaction. The length and the diameter of the axle in the journals depends largely on the weights which the axle has to carry, on the length of the axle as well as on the diameter of the road wheels. For reasons of weight, axles are rarely made of the same diameter throughout, and the greatest care must be exercised that the change from one size to another is gradually effected, as abrupt changes in dimensions are sure to cause breakage.

Before going more exhaustively into the theoretical determination of motor car axles, it may be of interest to consider what practice has so far shown to give satisfactory results in electric railway working. The subject in question has been thoroughly considered in the United States of America by the Central Electric Railway Association, who have fixed upon the types reproduced in Fig. 1 according to the various weights they have to carry. Fig. 1 is interesting, summarising as it does the results obtained in American practice.

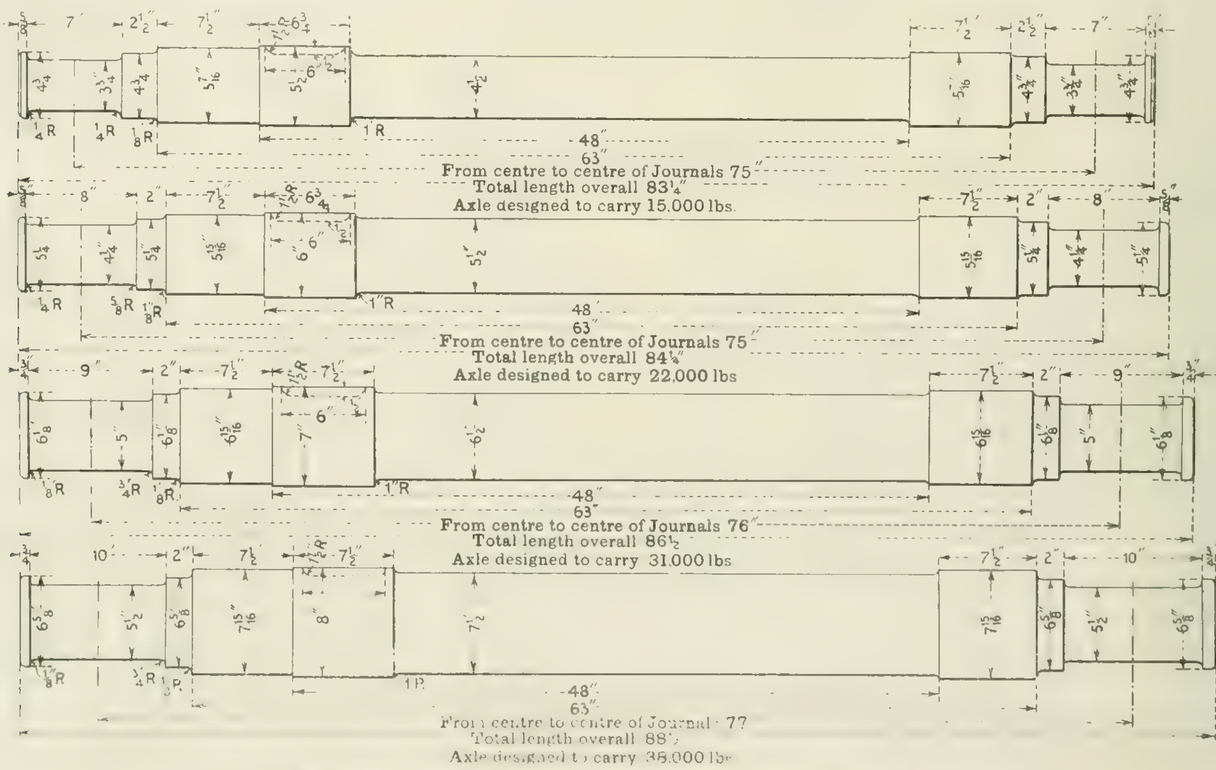

FIG. 1. PROPOSED STANDARD MOTOR AXLES. CENTRAL ELECTRIC RAILWAY ASSOCIATION.

The stresses to which axles are subjected, may be summarised as follows :—

(1) The weight to be carried by the axle.

(2) The pressure against the flanges of the wheels in curves

(3) The pressure of the brake blocks, when single blocks.

(4) The backward thrust of the axles due to braking.

(5) The unequal travel of the wheels in curves.

(6) Stress due to the thrust of the motor gearing and torsion.

It will be observed, as regards the above conditions, that practically they can be divided into three classes, namely, those which depend upon the dead weights carried, those which depend upon the effects of braking, and those which are effected by the action of electric motor-driven axles depending on the action of the motor.

As regards the question of dead weights, the effect of these on the axles will be very different when separated from them by springs, and when directly applied to them, and the stresses where the weight is not carried by, or through, springs will be many times greater than the actual weight applied.

As regards the stresses due to the application of the brakes, these are practically limited by the coefficient of friction which exists between the rail and wheel, and the same holds good of the torsional effects due to the action of the motor on the axles.

In the case of trail cars all the weight is spring borne, whereas in the case of motor-car axles not only will the axles have torsional stresses imposed upon them by the motor, but they will also have to bear a certain portion of the weight of the motor without the interposition of any springs.

For the above reasons, it will at once be seen that motor-car axles have to be designed on a much more liberal basis than trail car axles, even if the same weights were involved in both cases. But, besides the above reasons, there is another which deserves attention, and which is due to the fact that motor-driven axles usually require keyways to be cut in them for fixing the gears. The actual reduction, in consequence, may be small, but the sharp corners required by the keyways are a source of weakness, as experience has shown, in that cracks are very prone to start at keyways, therefore special caution is required in proportioning motor-driven axles, and in designing the keyways in such a manner as to reduce liability, as far as possible, of cracking, referred to above.

Besides the above cause of stresses in axles there are others which must be taken into consideration, such as the effects of the shocks of the flanges of the wheels against the rails when these suddenly enter a curve, or at points and crossings, and as it is impossible to calculate them theoretically they can only be assumed or allowed for in the calculations, which should be made when motor axles are designed.

The following Table I. gives some data of axles for electric traction. The several stresses to which motor-car axles are subjected, and the restricted space available, has resulted in the most careful study being made in order to ascertain what steels are the most suitable, and in this connection the following data may prove of interest :—

Sample Specifications of Special Nickel Steel for Axle Purposes and Results obtained by the Author. Chemical Composition.

Sample.	1.	2.
Carbon	0·37 per cent.	0·3 to 0·35 per cent.
Silicon	0·52 ,,	0·15 to 0·25 ,,
Manganese	0·455 ,,	0·9 to 1·0 ,,
Phosphorus	0·026 ,,	0·015 to 0·02 ,,
Nickel	3·89 ,,	3·0 to 3·5 ,,
Sulphur	0·01 ,,	

Result of Tests.

Tensile strength in tons per sq. in.	40·74	46·9
Elastic limit in tons per sq. in.	29·72	33·5
Ratio	73·2 per cent.	71·4
Elongation on 2 in.	28·9 per cent.	
Contraction on 2 in.	65·77	16 to 20 %
Contraction on 4 in.		58 %

The steels mentioned above are now commercially manufactured. They are, however, expensive, involving amongst other things double refining and special treatment. In the case of steel No. 1 and 2 it will be remarked that great care has been taken to eliminate the phosphorus. As regards No. 1 it will be observed that there is a very large percentage of silicon. This has been added and is not present as an impurity. The object of the silicon is to hold the carbon in solution, and this not only makes the steel more homogenous but also more elastic. One of the most important properties to be obtained is that the steel shall be able to stand a considerable and protracted vibration without changing its structure and producing liability to fracture This property is more important than any of the other mechanical properties, and a test has now been devised by which it can to a certain extent, be measured by comparison with other known steels. It is generally known under the name of the alternating stress test, and is taken as follows : A piece of steel of a given diameter and length is fixed in a revolving chuck, the revolutions of which are counted by a recorder. A blow of a given weight is given at intervals of a certain number of seconds. This blow is frequently given by means of a spring acting on a striker actuated by a cam worked automatically by the lathe. This tool is constructed in such a way that the steel is subjected to this alternating stress under exactly similar conditions in all cases.

The difference in behaviour of steel under this test will be seen by the fact that steel No. 1 stood 63,470 blows before breaking, whereas ordinary steel such as is used for structural purposes wil only stand 2,000 blows.

The ratio of elasti limit to the breaking stress and the high percentage of extension and reduction of area all confirm the quality of this steel as regards its ability to withstand shocks and varying stresses. If steel of this description be used it would not be improved by heat treatment, in consequence of the high percentage of silicon and manganese. After treatment it would become too hard to be machined, and would have to be annealed.

Besides the two very special steels which have been mentioned above, and which are classed under the generic name of nickel steel, there are many others in general use. With nickel steel some difficulty was experienced at the start in getting the nickel uniformly distributed, with the result that the steel produced has not always been reliable. But special care in manufacture has enabled satisfactory results to be obtained, and there are firms to-day whose nickel steel is beyond suspicion.

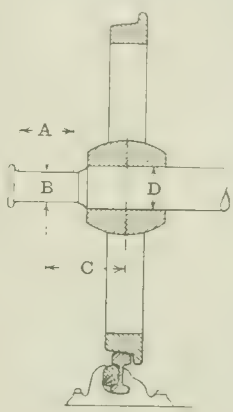

Fig. 2.

Steel for axles must be manufactured by the Siemens-Martin process. If nickel steel is used it must be borne in mind that it does not run well in gun-metal bearings ; and a good deal of care will be required before settling on the bearing metal to be used if the steel contains more than 2 per cent. of nickel.

The steel specified below lends itself particularly to heat treatment, a method which has proved invaluable in motor-car manufacture. The results of such treatment of suitable steel increases the tensile strength about 20 per cent., and the elastic limit about 30 per cent., and what is more important still it increases the resistance to decrystalisation under varying stresses practically ten times :—

—	1.	2.	3.
Carbon	0·36 per cent.	0·37 per cent.	0·43 per cent.
Silicon	0·15 ,,	0·06 ,,	0·065 ,,
Sulphur	0·01 ,,	0·02 ,,	0·05 ,,
Phosphorus	0·02 ,,	0·01 ,,	0·05 ,,
Manganese	0·82 ,,	0·51 ,,	0·94 ,,
After Heat Treatment.			
Elongation	26 per cent.	27 per cent.	21.3 per cent.
Contraction	52·6 ,,	40 ,,	44·7 ,,

As regards the tests to which axles should be submitted, there are various accepted standards in railway work, but the following is a good example of the sort of requirements which should be made. The steel should be manufactured from Swedish iron, made by the Siemens-Martin open-heater process. A percentage of the finished axles should be tested to destruction with a falling weight of one ton. For axles six circles in diameter 10 blows falling 35 ft. with bearings 5 ft. apart.

A few remarks as regards the standard steam railway specifications may be useful as a basis of comparison.

Thus the Great Western Railway specifies the use of steel having a tensile strength of at least 35 tons to the square inch, with an elongation of 25 per cent. The standard

Table I.—*Data Regarding Some Standard Axles.* (*See Fig. 2.*)

	Load on Journal in lbs.	A in inches.	B in inches.	C in inches.	D in inches.
Central London motor car axle	7.800	8	4·625	8	5·75
Manhattan Elevated motor-car axle	6.800	8	4·25	8·5	5·5
American Street Ry. Assoc. 40 ton motor-car	9.400	9	5	10·125	6·375
50 ton motor-car	12.000	9·25	5·5	8·5	6·5
L. B. & S. C. Ry.	14.800	10	5½	10·188	7·813
Interborough.NewYork		9	5		7·75
Berliner Vorortbahn ...	10.000	6·69	3·74	9·56	6·29

practice in Germany is to use Siemens-Martin steel having a tensile strength of 39 tons per square inch, whilst in America the Manhattan Elevated Co. require a tensile strength of only 26·6 tons per square inch, with an elongation of 22 per cent. in a length of eight inches.

ERRATUM.—We regret that several decimal points in Table X. of Mr. Dawson's article, appearing on page 437 of *The Electrician* of July 3rd, became displaced. The figures should read 30·5 to 45·5, 24·6 to 60·7 and 32·6 to 65.—ED. *E.*

(*To be continued.*)

DIVERSITY FACTORS.

BY F. FERNIE.

The diversity factor among a number of consumers is defined as the ratio of the sum of all the consumers' maximum demands to the maximum demand on the station. The writer thinks a more enlightening way of putting it is: The diversity factor is that number by which the sum of the consumer's maximum loads must be divided in order that this sum may equal the maximum observed load on the station.

The cost to the station of supplying any one consumer is, according to the "maximum demand" system,

$$C = \frac{ak}{D} + b + xR, \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (1)$$

where a = that part of the capital charges per kilowatt which depends on station maximum demand,

k = maximum demand of consumer,

D = general diversity factor,

b = that part of capital charges per consumer which depends on the number of consumers,

x = number of units used,

R = running cost per unit.

If k_1, k_2, k_3 ... are the consumers' maximum demands, D must be such that $\Sigma k / D = K$, K the maximum demand on the station. Thus if Σk = 2,000 kw. and K = 1,000, then D = 2,000/1,000 = 2.

Supposing every consumer were charged on the basis of equation (1). If D = 2 the assumption is that every consumer affects the station maximum load by the half of his individual maximum load—that is, that at the time of maximum load on the station every consumer has switched on one half of his maximum demand.

It is very certain, however, that at the time of maximum load on the station some consumers will be making no demand, some perhaps half their maximum, and some their full maximum, with all intermediate demands.

It has been stated several times recently that those supply authorities who sell energy at 1d. per unit and less must be selling it at under cost price, and it seems probable that these statements are made from a consideration of an equation similar to (1). If, however, the matter be looked at in rather a different way, these low rates can be shown to be quite sound.

Suppose, instead of considering individual consumers, one considers groups of consumers, each group consisting of a similar class of consumer, having approximately similar load factors. Each group must consist of a similar class of consumer—that is, a shop must not be in the same group with a private house, although their load factors may be the same.

Consumers of a similar class having approximately similar load factors can be supplied at a similar cost per unit, and for any station there is a certain (rather indefinite) consumer's load factor above which the cost per unit alters very slowly—that is, if cost per unit (calculated from (1)) be plotted against consumer's load factor, the rate of change of the curve will be found to be very quick for low load factors, but gets slower and slower as the load factor increases, always approaching but never quite reaching the value R. Hence a group of high load factor consumers may vary a good deal amongst themselves and still be charged at a uniform rate per unit without any great error.

The consumers being then split up into groups, the question arises as to what is the correct rate per unit for each group. This must depend on the maximum demand made by the group on the station. The maximum demand of any group depends on the "class diversity factor" of the group—*i.e.*, on the diversity factor existing amongst the members composing the group. This diversity factor will have a very different value for different groups. Thus the maximum demand of any group $= \Sigma k/d$, where k_1, k_2, k_3 ... are the maximum demands of the individuals in the group, and d is the class diversity factor of the group.

The cost of supplying any group per annum is then

$$C = \frac{a \, . \, \frac{\Sigma k}{d}}{D_1} + bn + xR, \quad . \quad . \quad . \quad . \quad (2)$$

where n = number of consumers in the group,

x = number of units used by the group per annum.

D_1 is not the general diversity factor, but a third kind, the group diversity factor. This is a number such that $\Sigma \frac{\Sigma k}{d}$ divided by it is equal to K, the maximum load on the station. D_1 is only equal to unity when the maximum demands ($\Sigma k / d$) of all the groups coincide in point of time. The meaning of D_1 is at once apparent if the groups are regarded as individual consumers.

It is the widely varying values of d, the class diversity factors, that make possible the low rates per unit for some groups.

Suppose the consumers are divided into three groups, then the following table shows the number of kilowatts of station maximum demand for which each group would be responsible, according as the first term of equation (2) is $\Sigma k / D$ or $\Sigma k / d \, . \, D_1$ (K = 400 kw.):

Group.	Σk.	d.	$\Sigma k / d \, . \, D_1$.	$\Sigma k / D$.
1	200 kw.	4·0	37 about	80
2	300 kw.	2·0	115 ..	120
3	500 kw.	1·5	250 ..	200
			400	400

$$\Sigma \frac{\Sigma k}{d} = \frac{200}{4} + \frac{300}{2} + \frac{500}{1 \cdot 5} = 533,$$

$$\therefore \quad D_1 = 533/400 = 1 \cdot 33,$$

$$\Sigma k = 200 + 300 + 500 = 1{,}000,$$

$$\therefore \quad D = 1{,}000/400 = 2 \cdot 5.$$

It will be seen from the above that a group with a class diversity of 4 has to pay less than half the standing charges, by the method which takes into account the class diversity factor, than by the method which only takes into account the general diversity factor. Whereas a group with a class diversity factor of 1·5 has, in the example above, to pay more by the former method than by the latter. The first method charges a consumer on the basis of his group load factor, and the second on his individual load factor.

The cost per unit for any group of consumers is then

$$\text{Cost per unit} = \left(\frac{a \frac{\Sigma k}{d} \, . \, D_1 + bn}{x} \right) + R. \quad . \quad . \quad . \quad . \quad . \quad (3)$$

The term bn should, of course, not really be in the equation at all, but should represent a fixed charge, equal to b, for each consumer, which may take the form of a meter rent. This charge is here assumed to be the same for each consumer, but is, in reality, widely different for different consumers.

In attempting to fix a scale of charges for different groups according to (3) some figures have, of course, to be estimated. However, with some experience, the estimates may be made fairly closely. Neglecting D_1 for the moment, one has to estimate $\Sigma k/d$ for each group. This may be partly done by inserting a maximum demand indicator on the premises of certain typical consumers, and assuming that the ratio thus obtained of $\frac{\text{maximum demand in kilowatts}}{\text{kilowatts installed}}$ is true for the whole group. The total kilowatts installed by any group are of course known, so that Σk may be estimated.

The values of d are not difficult to guess at for many classes, but assuming that Σk is correctly estimated for any group, d may often be calculated. This may be done by taking advantage of the fact that different feeders often feed a particular class of consumer only. If it is possible to isolate each feeder district from the rest of the network, which can be done on most modern three-wire networks, the result may be made more certain. Indeed, by comparing feeder load curves, drawn out for 24 hours, for dark and light days, and warm and cold days, the value of $\Sigma k/d$ can be arrived at for nearly every class of consumer. Then if either Σk or d has been estimated, the value of the other can be calculated.

An example may make this clear. Suppose a certain feeder supplies a purely residential district. If the feeder district be isolated about the time of maximum load (on this feeder), the feeder ammeter reading will give the value of $\Sigma k/d$. For instance, on a three-wire system, suppose the positive feeder reading is 200 amperes and the negative 220 amperes, and the voltage of supply is 500. Then $210 \times 500/1{,}000 = \Sigma k/d$ in kilowatts = 105 kw. If it has been found that two or three typical consumers (in this district) have a maximum demand equal to one-third of the kilowatts installed in their premises, then Σk = one-third total kilowatts installed. Suppose this equals 150 kw., then $d = 150/105 = 1{\cdot}4$ (about).

The value of d thus obtained may now be used for all similar consumers, who fall into the same class, on other feeders. There are several ways of roughly checking this result, because there are occasions on many feeders when two or more classes of consumers will be making their maximum demand at the same time, so that the sum of the values of $\Sigma k/d$ for the portion of each class on that feeder should be equal to the observed load on the feeder. Again, the value of $\Sigma k/d$ for industrial power consumers is probably represented by the station load on a fine warm day, perhaps about 11 a.m. Σk will for this class be nearly equal to the total kilowatts installed by the class, but the value of d will be (comparatively) very high.

For public houses the value of d is probably nearly unity. Σk may be roughly estimated by observing the sudden fall of the station load at 11 p.m. (with some deductions), supposing the public house closing time to be 11 p.m.

Whilst the quantities Σk and d for each class may be separately estimated, from different feeders, the results can be checked by the station load curves. For instance, the load on a station at 10 p.m. in winter may be made up of private houses, public houses, places of entertainment, late closing shops and public lighting, whilst at 6 p.m. it may be made up of all these plus early closing shops; at 5 p.m. it may be the same as at 6 p.m. plus business offices and minus places of entertainment. Hence, from one load curve, the offices and early closing shops may be estimated. It should be possible, by drawing the load curves for each group and adding them together, to build up the station load curve. $\Sigma k/d$ being then obtained for each group $\Sigma \frac{\Sigma k}{d \cdot D_1}$ must equal K, the maximum demand on the station; hence D_1 is calculated directly.

The estimated revenue from a scale of charges, based on these calculations, must then be checked against the estimated expenditure.

The following table represents some possible groups, with a suggested value of d for each, and a possible scale of charges :—

Group.	d.	Cost per unit.
Early closing shops	1·0	8d.
Offices, banks, &c.	1·1	7d.
Later closing shops (depending on declared hour of closing)	...	3d. to 6d.
Private houses (rental above £35 and below £150	1·3	3d.
„ „ (rental above £150)	1·4 or more	2¼d.
„ „ (with 15% or more power, heating, &c., installed)	1·5	2d.*
Basements and special	1·6	1½d.
Private houses (rent below £35)	1·3	2½d.
Power consumers	5·0	1d. or less
"Intermittent" power consumers (lifts, barbers, butchers, &c.)	10 or 15	1d.
Theatres	1·0	3d.
Churches (with motor organ, week day use only considered)	1·6	2d.
Tramways	15·0 (?)	½d. or less

* Combined charge.

The following table gives some average consumer's load factors collected from different sources, all for comparatively small installations, less than 25 H.P.

Consumer.	L.F. $\frac{\text{units per annum}}{\text{max. demand} \times 8{,}760}$ 100.
Private house (lighting alone)	15 to 20 per cent.
Elevators (power)	·4 „
Butchers and bakers (power) (one motor)	3·25 to 5 „
Printers (power) (more than one motor)	8 to 10 „
Joiners (power) (more than one motor)	9 „
Engineers' shops (power) (more than 1 motor)	12 „
Laundries (power) (one or more motors)	12 „
Cloth workers (power) (one or more motors)	12 „
Organ motors (power) (one motor)	3·5 „
Stable motors (power) (one motor)	3·5 „
Shops (lighting) (one hour average daily use of light)	5 „
Shops (lighting) (two hours average daily use of light)	9 „

All consumers might have the option of a separate rate for power and lighting. There should also be the option of a "time switch" rate for power consumers. The charge per unit depends, of course, on the average individual load factor as well as the diversity factor; thus the load factor of intermittent power consumers is very poor, but the class diversity factor is very high. The load factor of a group takes account of the class diversity factor, and of the individual load factors.

Thus group load factor per cent.

$$= \frac{\text{Number of units consumed by group per annum}}{\Sigma k/d \text{ in kilowatts} \times 8{,}760} \times 100.$$

This load factor is equal to the average of the consumers' load factors composing the group only when the class diversity factor equals unity.

There is probably nothing a consumer grumbles at so much as the special wiring involved, if he takes advantage of a special power rate, and it seems probable that a combined rate for power and lighting for private house consumers would largely encourage the use of power devices amongst this class. There is a largely undeveloped field in the sale of motor-driven boot cleaning, knife polishing and dish-washing, &c., plant. One small motor could easily be arranged to drive a number of such machines. Some modern flats are sold with these machines ready installed, fitted with an electric drive.

Motor-driven Ink-Eraser.—*Engineering News* gives an account of an apparatus for ink erasing which is said to be specially suitable for use in large drawing offices of manufacturing concerns where many and extensive changes on tracings are necessary, as the erasing then becomes irksome work, and the time consumed excessive. A small $\frac{1}{8}$ H.P. motor drives the eraser through a flexible shaft. Good results are obtained by using a soft wheel and feeding powdered pumice stone to the tracing. The adoption of this apparatus should add another item to the list of what can be done with a pennyworth of electricity.

THE SHAPE OF THE CURRENT CURVES IN THREE-PHASE MOTORS AND THE SEPARATION OF THE LOSSES.*

BY DR. K. SIMONS AND K. VOLLMER.

Summary.—By means of the oscillograph several phenomena occurring in electric machinery can be conveniently studied. The present Paper is intended to clear up in this way certain unsettled points with regard to the losses in three-phase motors, thereby avoiding the aid of mathematics, which would become too complicated.

The Rotary Field.—A pure ideal rotary field can only exist when all the three alternating fields—displaced both in time and space from one another by 120 deg.—distribute themselves sinusoidally over the armature circumference, and also vary in magnitude as a sine-wave function of the time.

For this the following conditions are necessary:—

1. The exciting alternating currents must be sinusoidal.
2. The induction must vary directly with the ampere-turns.
3. The conductors of each phase must be sinusoidally distributed over each pole.

Since the last two conditions can never be fulfilled, even in motors with closed slots, the resultant rotary field can never be a pure one. On the other hand, the induction in each stator tooth varies according to a sine wave if the first two conditions are satisfied, since then the same number of turns always act on every tooth.

For an ideal rotary field, the mathematical expression for the flux in a stator tooth would be

$$N_z \sin(\omega t - p\alpha_z),$$

where N_z = maximum flux per tooth,

p = number of pole-pairs,

α_z = angle between the centre line of tooth and any desired direction.

Even with a sinusoidal current and the induction varying directly as the current, the above expression—in consequence of the non-sinusoidal distribution of the conductors—must be written

$$(N_z \pm \delta N) \sin(\omega t - p\alpha_z \pm \delta\alpha).$$

Hence, with an open-rotor winding, we can suppose the field in each rotor tooth to be made up of two parts, the one part corresponding to the ideal field, the other being superposed on this.

The E.M.F. induced at Synchronism in a Rotor with Closed Slots.—If the rotor is driven at synchronism, an E.M.F. will be induced in its winding, even with closed slots, since the flux embraced by a coil varies. Suppose the deviation of the actual rotary field from the ideal to be due in one case to a change in its intensity, and in another to a change in its angular velocity, as given by the above mathematical expression for the flux in a tooth, then the E.M.F. induced in a rotor phase will vary according to the position of the coil relative to the synchronous rotary field. When the centre of the coil coincides with the centre of the field, variations in the intensity of the flux will exert their maximum effect, whilst changes in its velocity will have very little effect in this position.

Conversely, when the centre of a coil lies in a zero point of the field, a change in magnitude of the latter can induce no E.M.F. whatever in the former, since the total number of lines of force embraced is always zero in this position. On the other hand, any change in velocity of the flux will have a large effect, since one part of the maximum induction enters the coil on the one side and leaves on the other.

The E.M.F. induced at Synchronism in a Rotor with Open Slots.—The variation of flux due to the open slots can cause such large E.M.F.s to be induced as to almost nullify the above effects with closed slots, whilst the current curve will show ripples corresponding to the number of teeth. (Curves were taken to illustrate the above.)

Curve Shapes of Stator and Rotor Current.—Provided the ohmic drop is negligible, the variation of the flux interlinked with each stator coil remains constant, but its distribution will vary owing to the reaction of the rotor currents. A current flows in the rotor at synchronism, however, even with closed slots, and its effect on the variation of the stator current curve must also be taken into account. Moreover, since the E.M.F. and current in the rotor depend on the position of the rotor coils relatively to the rotary field, the stator current curve at synchronism will vary according to this relative position, so that we have thus a means of telling when the rotor is running at synchronism by means of the oscillograph, for only in this case can the stator current show a steady curve.

On load, the variation in the primary current curve becomes more rapid on account of the slip, whilst the curve at the same time increases in magnitude and displaces itself with respect to the pressure curve in order to counterbalance the normal rotor current; moreover, from these curves, the slip can be directly measured.

The Losses in Three-Phase Motors and their Determination.—We must now see how the above effects influence the losses. The latter are as follows:—

1. Iron losses in the stator core.
2. Iron losses in rotor corresponding to the pure rotary field—*i.e.*, corresponding to the slip.
3. Iron losses in the rotor teeth corresponding to alternating field of higher frequency.
4. Additional tooth losses in motors with open slots, these losses being proportional to the speed of the rotor.
5. Copper losses.

To investigate this, the method due to Lehmann and worked out by Bragstad and Bache-Wiig, was used. The motor was driven with the rotor open by a continuous-current motor, and the power taken by the latter noted, first when the stator was unexcited, then with the stator excited at normal pressure and frequency; in the latter case the stator input was also measured. At synchronism, the curve is discontinuous, since a part of the energy passes over from the stator to the driving motor. This changing over is due to the hysteresis torque set up by the rotor core. At synchronism, fixed poles must form themselves on the rotor. Since now the presence of hysteresis causes the iron to resist any change in its magnetic condition, the rotor must be displaced forwards or backwards through a definite angle with respect to the field; this is accomplished by the development of a torque in the rotor until the latter begins to slip.

To investigate whether—in the case of a short-circuited rotor—the currents in the rotor at synchronism cause an additional loss, the power consumed was measured, and the following results were obtained:—

1. The total consumption of power was somewhat smaller when the rotor winding was closed than when open.
2. The power at synchronism yielded either by the stator or driving motor (as desired) was much greater when the rotor was closed than when open.

We thus see that the current harmonics in the rotor reduce the deviation of the field from the ideal rotary field, and the copper losses set up in the rotor thereby are more than compensated in the above case by the reduced eddy current losses. On the other hand, the break in the curve of consumed watts is considerably augmented by closing the rotor.

Lastly, a summary is given of the various methods for determining the several losses, together with a criticism of the same.

1. Measurement of the power consumed at no-load and falling pressure, deduction of copper losses, extrapolation to zero pressure at which only the friction losses remain.

The friction loss is obtained correctly, but only under the assumption that no magnetic pull is present, since at zero pressure the iron losses and hysteresis torque become zero.

2. Measurement of the power at very small slips. Assumption of straight-line curve for the power transmitted to the rotor as function of the slip and extrapolation to zero slip. The power thus obtained should represent the friction (Benischke).

This method cannot be used for motors with ball bearings and closed slots, since the curve is not quite a straight line in the region of synchronism.

3. Measurement of power when motor is running light and again immediately after the rotor circuit is opened. The difference should give the friction losses, whilst the power measured with the rotor open equals the stator iron losses.

In this case the friction losses are too small by an amount equal to half the break at synchronism, whilst the stator losses are too large by this amount.

4. Running-down method with excited and with unexcited stator. In this case the rotor circuit is broken, and the losses determined by the graphical method due to Bragstad and La Cour.

Since, even with opened rotor, a torque is exerted on the latter, the losses are somewhat too small, as was also found by Bragstad and La Cour.

5. Use of an auxiliary motor. The input of an auxiliary motor is measured first when the induction motor is driven light at synchronism, then with the rotor excited by continuous current. From the former measurement the friction losses are obtained from the latter, the iron losses.

Additional frictional losses due to magnetic pull are measured here along with the iron losses, otherwise the stator losses and additional tooth losses are given correctly. The increased rotor losses are not found.

6. Use of auxiliary motor, but exciting stator with alternating current whilst rotor is left open. The powers taken by the auxiliary motor and by the stator are measured at various speeds above and below synchronism.

This method gives the most accurate results, but we must not take the break at synchronism as double the hysteresis loss at rest.*

7. The iron losses measured with the rotor at rest and the rotor winding open are taken as constant.

This assumption only holds occasionally for motors with open slots, for motors with closed slots it is always too large.

* Abstracted from the *Elektrotechnische Zeitschrift.*

* As given by Bache-Wiig.

LARGE GERMAN GAS ENGINES.

Our readers will recall the account we gave last year of the visit of a number of British engineers who formed a party conducted by Mr. Leonard Andrews, of the Key Engineering Co., to Germany, with the object of inspecting a number of large gas engines. Last week a similar trip was brought to a successful conclusion, the party including a number of well-known engineers whose names we

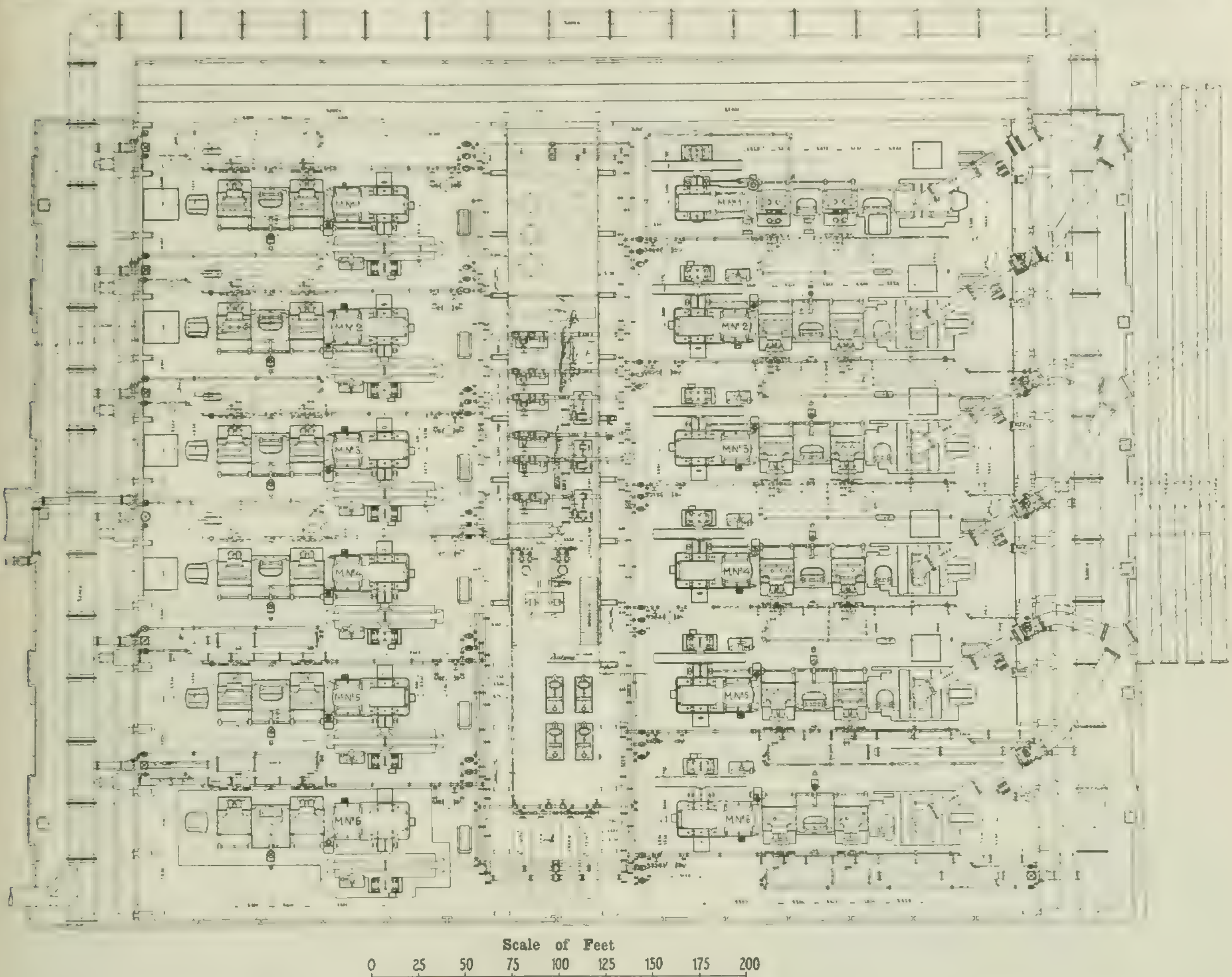

Fig. 1.—Plan of Gas Engine Power Station containing 24,000 h.p. of Plant.

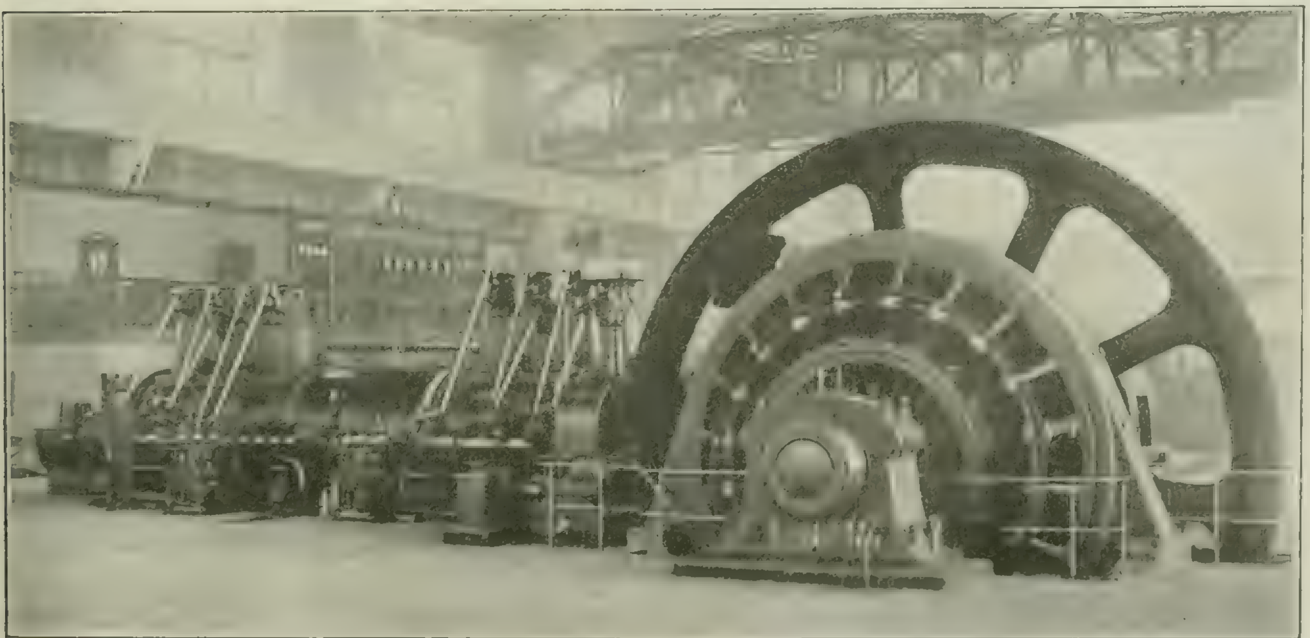

Fig. 2.—C.C. Generator coupled Direct to 2,000 h.p. Horizontal Tandem Blast Furnace Gas Engine.

published in our last issue. The programme was somewhat the same as last year, but, instead of visiting the Hoesch steel works near Dusseldorf, the party was taken to the works of Messrs. Thyssen & Co., Mulheim. This company has a world-wide reputation and has devoted much time to the large gas engine. In addition to a large plant in its own steel works in the Rheinish Provinces, they have built and supplied many engines for other companies. The Thyssen engine is similar in principle to that of Ehrhardt & Sehmer and there are only minor points of difference in the design and construction adopted by the respective firms; there is, at any rate, sufficient similarity in the engines to justify the two companies entering into an arrangement for bringing both patterns into line. This circumstance added considerably to the interest of the party in going over Messrs. Thyssen's workshops and steel foundries. The main foundry is 3?0 ft long by 30 ft. wide and is served two large electric cranes of 30 tons capacity.

In the large machine shops several 3,000 H.P. two-cylinder single tandem engines were seen in course of construction, these being the largest engines yet built The bedplate weighs 62½ tons in a single casting, and the crankshaft is slightly over 2 ft. in diameter. A large lathe taking work up to 33 ft. diameter was a conspicuous tool in the machine shop, also a facing machine, some 80 ft. in length, on which four distinct operations were proceeding simultaneously.

The Bruckhausen Iron and Steel Works which are owned by Messrs. Thyssen & Co., were also visited, these containing one of the largest gas engine installations in Germany. A plan of the main station is shown in Fig. 1. The equipment at present comprises four 2,000 H.P. gas engines driving 1,500 kw. alternating current generators and four similar units driving blowers coupled direct to the tail shafts of the engines. The plan also shows four additional (two dynamo and two blowing) units of the same output, which are now in process of installation. The blowing engines are run at 45 revs. per min. and the gas dynamos at 94 revs. per min. Three-phase current at 5,500 volts 50 periods is supplied by the generators. We are informed that one of the engines was down for repairs the cast iron liner having dragged out of position by an overheated piston, the water supply to the latter having failed. The use of liners is a feature of the Thyssen design, and contrasts with the practice of Ehrhardt & Sehmer, who cast the entire cylinder in one piece. We may also remark that the mixing valve is of special construction, the air supply being controlled by a sliding piston and regulated by an axial movement of the piston rod, thereby opening and closing the ports. The gas admission is controlled by a double beat mushroom valve, and the exhaust valves are of a special acid and heat-proof bronze, being also water cooled. In the Ehrhardt & Sehmer engine the exhaust valves are of cast iron and are water cooled. The whole of the plant in this interesting station is run in parallel and is also coupled with five other stations in the neighbourhood, these having a capacity of 16,000, 10,000, 8,000, 5,000 and 3,000 H.P. respectively. No trouble has been experienced running these plants in parallel, except when trunk main circuits are opened and closed, when abnormal pressure rises occur, causes the spark gaps to go over. A view of a 2,000 H.P. gas engine d c. generator is shown in Fig. 2.

The plants at Homécourt and Heinitz were also visited again, the installation at the latter place being now increased by some four additional two cycle single-tandem engines of 1,200 H.P. each and one 600 H.P., all of Messrs. Ehrhardt Sehmer's make. Two further engines of 3,000 H.P. are on order. This plant supplies three-phase current to the adjoining steel works and the districts of Neunkirchen and Saarbrücken, the rate charged being about 5 pfg. per unit. The entire installation operates from coke oven gas.

The party was liberally entertained by Messrs. Ehrhardt & Sehmer and Thyssen & Co. during the trip, and the proceedings were brought to a close by an informal, but none the less pleasurable, presentation to Messrs. Andrews and Slacke, by the engineers of the party, of a set of smokers' accessories.

THE ELECTRICAL TESTING INSTRUMENTS OF MESSRS. SIEMENS BROS. & CO.

The development of the D'Arsonval type of moving-coil galvanometer during recent years has led to a more extensive use, as well as a complete remodelling, of most electrical measuring instruments. As is well known, electrical instruments in which the moving part, consisting usually of iron, depends on gravity for its control, have many disadvantages and are by no means so reliable as those in which the current carrying coil is the moving member and is controlled by a spring. A few years ago, such instruments were mostly considered as laboratory instruments only, but now that they are obtainable in a handy portable form an extensive demand has arisen which is almost certain to be maintained as the many advantages of reading measurements *in situ* are realised.

The electrical measuring instruments supplied by Messrs. Siemens Bros. & Co. are already widely known, but the firm are now developing this department of their business, and judging by instruments we have inspected, these are likely to take a prominent position in this branch of the electrical industry. We have recently received from Messrs. Siemens a copy of their new Catalogue No. 506 on testing instruments and accessories. This is undoubtedly one of the most complete and interesting catalogues of electrical instruments which it has been our pleasure to notice, and we have also had the opportunity of examining all the instruments to which we refer in the following description.

The first instruments of which particulars are given in the catalogue are millivoltmeters and ammeters. These instruments, which are of the well-known Weston pattern, are supplied for various requirements with an internal resistance of 1, 2, 10 or 100 ohms, and the current range at the maximum scale deflection is from 0·015 ampere to 3,000 amperes, according to the shunt used, whilst the pressure range is from 0·15 volt up to 1,500 volts. The instruments are either supplied with separate shunts and series resistances, or in a self-contained pattern. Where pressure and current readings are to be taken simultaneously, a combined instrument with two independent movements and four pressure and four current ranges is recommended. The current range can be extended by the use of separate shunts. The series resistances, for use when the instruments are employed as voltmeters, are wound on slate, thus ensuring a most satisfactory insulation; the material for the shunts is manganin, and the shunts for the different instruments are not made interchangeable, so that errors cannot arise from the use of a wrong shunt. Fig. 1 gives some idea of the convenient form of these shunts.

With a view to supplying an instrument not only of the highest accuracy, but also independent of temperature variations, the 10 ohm instrument (Fig. 2) has recenlty been developed. By a special combination of resistances, made of materials having different temperature coefficients, it has been possible to design an

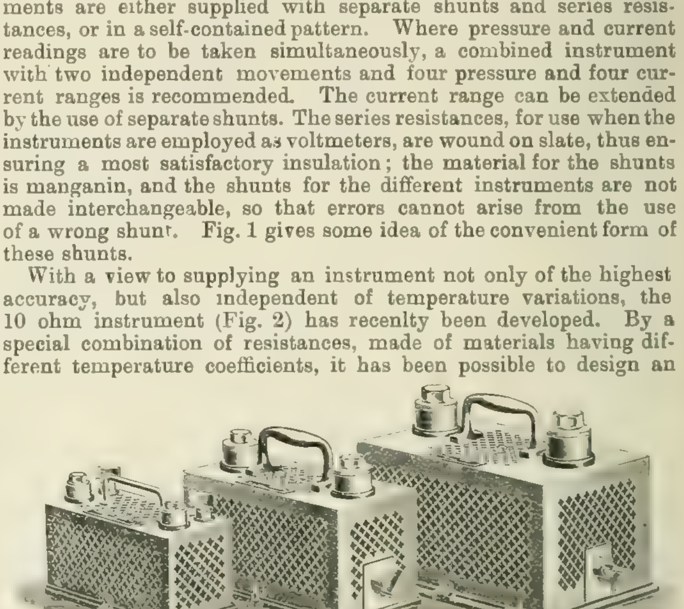

FIG. 1.—300, 750 AND 1,500 AMP. SHUNTS FOR MILLI-VOLT AND AMPEREMETERS.

instrument which is practically unaffected by any ordinary temperature variations. In connection with this instrument a combined shunt (*see* Fig. 3) can be supplied instead of the ordinary type of shunt; this permits of seven different current ranges for the instrument and of passing from one range to the other without breaking the circuit, a feature which will be appreciated for many investigations, such as researches on hysteresis loops. The multiplier is read off in an opening in the case of the circular type shunt, whilst an index indicates the corresponding permissible maximum current for the respective range.

One of the most useful and compact instruments is the universal galvanometer shown in Fig. 4. This instrument is a combination of the 1 ohm moving-coil millivolt and amperemeter just described with a Wheatstone bridge, and is suitable for measuring resistances (including insulation resistances and faults), currents and pressures. All the advantages of the 1 ohm instrument are embodied, and it requires no special setting up, nor is it necessary to lock the movement during transit. The readings are not affected by external magnetic disturbances and the excellent damping permits of rapid readings. The diagrams for the various uses of the instrument are also engraved on the top.

The moving coil of the galvanometer consists of a winding supported on a copper frame carried on jewelled pivots and moving in a strong permanent magnetic field. The motion is strongly damped by eddy currents produced in this frame. The controlling force is provided by two springs which also serve to conduct the current to the windings on the copper frame. The position of the moving-coil is indicated by means of a pointer passing over a mirror inside the scale, in order to enable readings to be taken without parallax error. The bridge wire is carried on a slate disc below the galvanometer. An incision of 60 deg. is made in the edge of this disc and a metal plate is mounted on each side. The ends of the bridge wire are soldered to these plates, the wire being stretched round the edge of the slate disc in a half-round groove. A scale is engraved on the top edge of the slate disc, on which the position of the moving contact is read. The product of this reading and the particular multiplier in use gives the value of the unknown resistance. The movable contact itself consists of a small platinum roller carried on a movable arm, which is also fitted with an index moving over the scale.

The resistances of comparison are made of insulated manganin wire and are wound non-inductively. The ends of these resistances are connected to suitable metal blocks provided with the usual conical plugs. Five terminals, which are intended for connecting up the wires between the instrument, battery, unknown

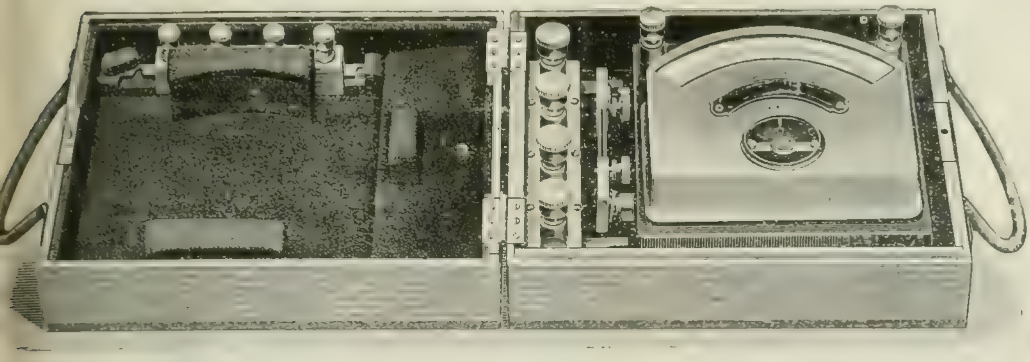

FIG. 2.—AMMETER WITH SHUNTS UP TO 150 AMPERES.
Scale 1:5.

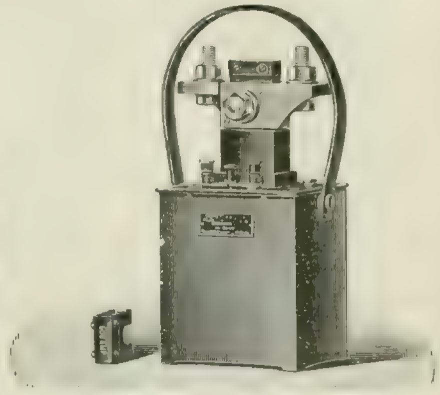

FIG. 5.—CURRENT TRANSFORMER WITH TWO RANGES. Scale 1:10.

resistances, &c., are mounted on a projection of ebonite on the front of the instrument. The terminal marked V is connected with the instrument by the depression of a key, which puts the battery on to the galvanometer when required. A connecting strip is supplied with the instrument, by means of which shunts may

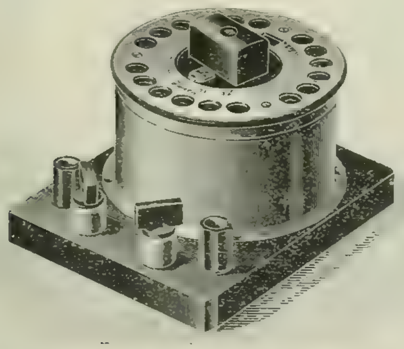

FIG. 3.—FEUSSNER'S SEVEN-WAY COMBINED SHUNT.
Scale 1:5.

be attached as used with the millivolt and amperemeters. As the plug between terminals III. and IV. must be withdrawn if a measurement is made with such a shunt, the connecting strip is so designed that it can only be attached when the plug is withdrawn.

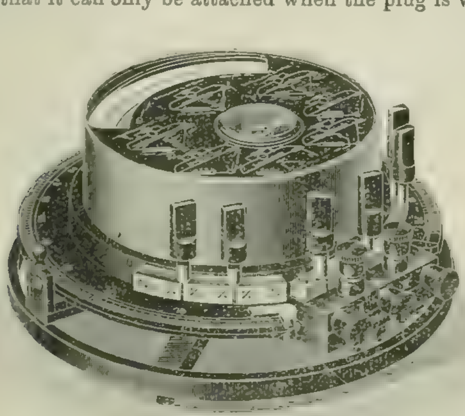

FIG. 4.—MOVING COIL UNIVERSAL GALVANOMETER.
Scale 1:5.

When used for measuring resistances, in order to obtain the greatest accuracy for widely different ranges, five standards of comparison are provided, the values of which are selected so as to give simple multipliers for the reading on the bridge wire—namely, the multipliers 1/10, 1, 10, 100 and 1,000; resistances ranging from 0·002 ohm up to 30,000 ohms can thus be measured direct with the aid of one or two dry cells, whilst resistances above this value and up to 1 megohm can be measured by using the galvanometer as an ammeter.

For measuring pressures the galvanometer is employed as a direct-reading voltmeter up to 0·15 volt; for higher pressures up to 150 volts the standards of comparison for the Wheatstone Bridge previously referred to are employed as series resistances; for further increase of range separate series resistances are utilised, whilst for measuring currents the galvanometer is employed as a direct reading ammeter up to 0·15 ampere, and for higher ranges up to 3,000 amperes the shunts previously described have to be used.

The next instrument which attracted our attention was a wattmeter for measuring the power in three-phase circuits with unequally loaded branches. This instrument, which is illustrated in Fig. 6, operates on the dynamometer principle and gives a direct reading of the output. The pointer is rendered practically dead-beat by means of a patent air-damping device. The readings are accurate, irrespective of the frequency and wave form of the currents, of the phase displacement or of the length of time the instrument is in circuit. The connections are so arranged that the mutual interference of the

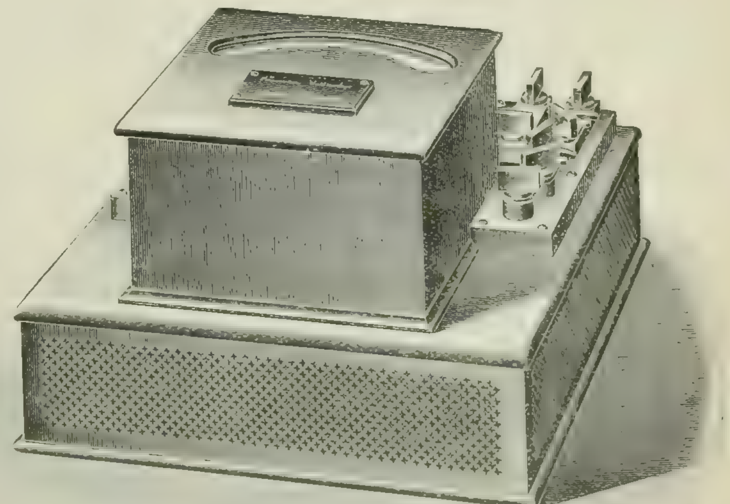

FIG. 6.—DIRECT READING WATTMETER FOR THREE-PHASE CIRCUITS WITH UNEQUALLY LOADED BRANCHES.
Scale 1:5.

two wattmeter movements constituting the instrument is completely neutralised. The instrument is provided with two current ranges up to 200 amperes and three pressure ranges up to 750 volts. Should it be desired to exceed these values, or not to subject the windings to high-tension currents, a special wattmeter must be employed in combination with two current transformers and two pressure transformers for single-phase currents.

For measuring high-tension currents complete safety can be secured by employing current transformers. For careful laboratory measurements, however, these usually have not provided sufficient accuracy, but in the type which is being supplied by Messrs. Siemens this difficulty has been overcome by stamping the plates forming the yoke out of a single sheet of iron. In this way an air-gap of even infinitesimal dimensions is obviated, with the result that the ratio between the primary and secondary currents is

constant under the widest limits of load, so that very accurate readings can be obtained over a wide range. These current transformers are supplied either for one range or with variable primary winding for several ranges, but with fixed secondary winding for 5 amperes. They are insulated for working pressures up to 12,000 volts and, in the case of currents above 500 amperes, up to 6,000 volts. The insulation is tested with twice the working pressure. The earthing of one of the secondary terminals as well as of the transformer case is permissible and, in fact, advisable. The ratio of transformation is constant between 10 per cent. and 100 per cent. of the rated load and is independent of the wave form and of the frequency between 25 and 100 periods; for lower frequencies special calibration is necessary. As there is a comparatively high P.D. at the secondary terminals, namely, 4 volts, more than one instrument (*e.g.*, wattmeters and ammeters) can be connected to the transformer. It is important to remember that the secondary circuit should be closed through the measuring instruments or the short-circuiting terminal whenever the primary circuit is closed. We illustrate in Fig. 6 a convenient form of such a current transformer with two ranges up to 600 and 1,200 amperes. The plug by which the change in the range is made will be noticed lying at the left-hand side of the transformer case.

Somewhat of a novelty is the portable current transformer shown in Fig. 7. As will be noticed in the illustration, it is for use with single conductors carrying alternating currents, and such current can be measured without removing the insulation from the conductor. The two halves of the iron core are unscrewed and clamped over the

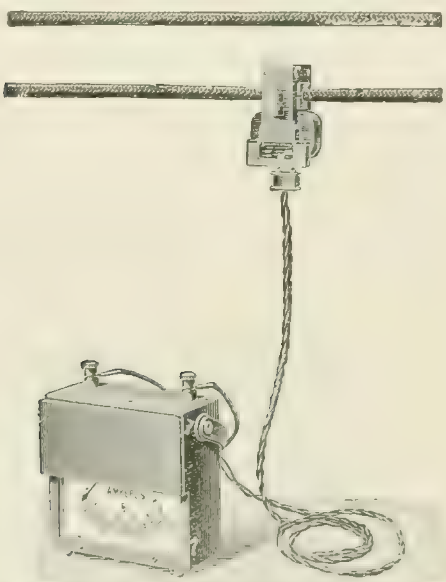

Fig. 7.—Portable Current Transformer for Single Conductors. Scale 1:10.

conductor, which, of course, for pressures up to 500 volts, may be uninsulated, though at higher pressures the conductor requires to be insulated from the transformer. The ammeter shown and the transformer are calibrated together and can be employed for frequencies varying 10 per cent. from the standard. It will be noticed that a plug is employed for connecting the ammeter leads to the transformer, and this plug is provided with a short-circuiting device, which automatically protects the transformer when the leads are disconnected.

The chief features of the highly-sensitive moving coil mirror galvanometer illustrated in Fig. 8 are its substantial design, which permits of easy transport of the instrument without any danger of the suspension strip breaking, and the ease with which the coil carriage can be removed. As seen in Fig. 8, the coil carriage can readily be changed, so that different windings can be employed for various values of current and pressure, the same base and magnets being used. Each instrument is provided with three terminals, so that it can be used with or without series resistances. The latter, which are arranged in the coil carriage, are so designed that when the galvanometer is short-circuited it is nearly dead beat. The ballistic pattern is fitted with a magnetic shunt, which permits of obtaining the aperiodic limit for any given external circuit resistance, a feature which is of extreme importance when a large number of observations have to be made, since it is thus possible to reduce to a minimum the time for the return of the moving coil to the zero position for any given external circuit. A special shunt resistance has been designed for use with these ballistic galvanometers, which ensures the total resistance of the circuit being kept unchanged, whilst the multiplier for the instrument can be varied; hence the damping of the galvanometer is unaffected by the multiplier.

An extremely handy vertical scale outfit (Fig. 9) can be supplied for use with these mirror galvanometers. This scale takes up practically no room, and permits of the instrument being mounted on the wall several yards above the floor if necessary; several instruments can be fitted with this outfit without taking up more floor space than one where the usual horizontal scale of oufits are employed.

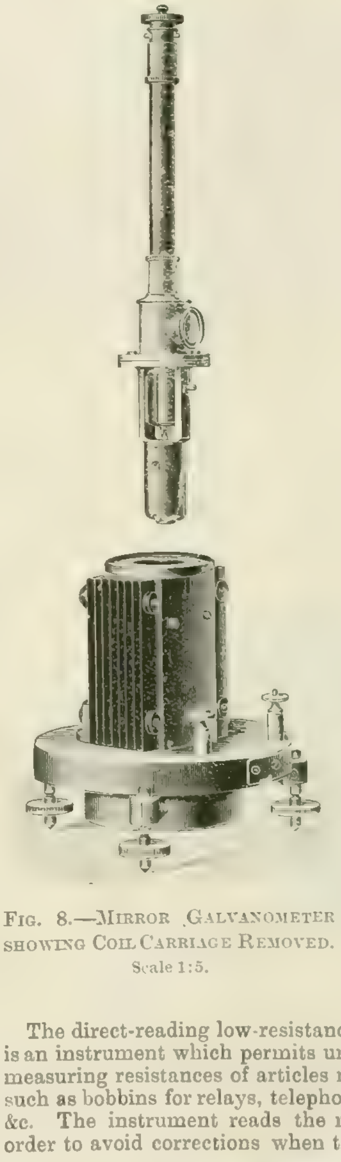

Fig. 8.—Mirror Galvanometer showing Coil Carriage Removed. Scale 1:5.

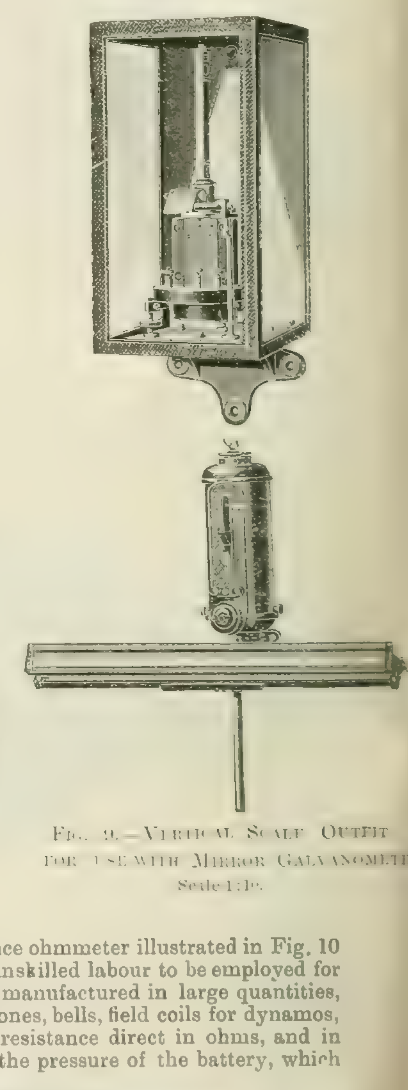

Fig. 9.—Vertical Scale Outfit for Use with Mirror Galvanometer. Scale 1:10.

The direct-reading low-resistance ohmmeter illustrated in Fig. 10 is an instrument which permits unskilled labour to be employed for measuring resistances of articles manufactured in large quantities, such as bobbins for relays, telephones, bells, field coils for dynamos, &c. The instrument reads the resistance direct in ohms, and in order to avoid corrections when the pressure of the battery, which

Fig. 10.—Direct-Reading Ohmmeter for Shop Use.

is used together with the instrument, varies, a magnetic shunt is fitted, which compensates for variation of pressure. There should be a considerable demand for an instrument of this character, since its operation is rendered so simple that it is admirably adopted for shop use.

An apparatus for measuring the resistance of tramway rail joints is of an unusually portable character (*see* Fig. 11). This is due to the fact that no batteries are required, the principle of the Siemens arrangement being to compare the pressure drop across a joint against that in a given length of rail. For this purpose it is, of course, necessary to take the measurement whilst current is flowing

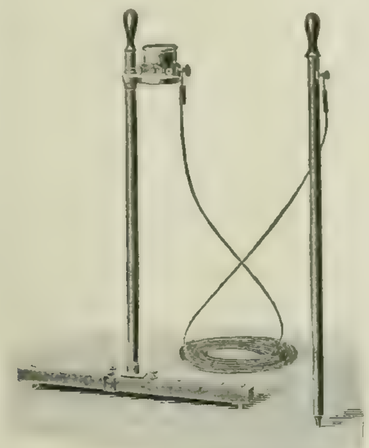

FIG. 11. RAIL JOINT TESTER.
Scale 1:20.

in the rail. It will be noticed that three contacts are employed, two of them being fixed, whilst the third is at the end of a rod, a sensitive differential galvanometer indicating whether the drop of pressure across the joint is greater or less than that in the given length of rail.

The form of potentiometer supplied by Messrs. Siemens Bros. & Co., which is known as the "Raps" potentiometer (Fig. 12), although

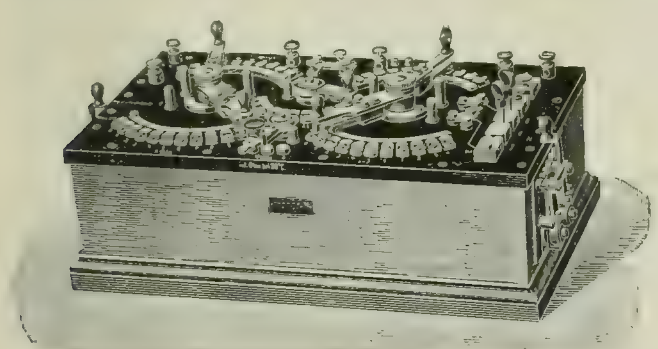

FIG. 12.—POTENTIOMETER (RAPS PATTERN).
Scale 1:8.

not widely known in this country, has been employed for many years on the Continent. It is designed for very accurate pressure and current measurements, with two ranges for pressure—namely, 0·00001 to 10 volts—and, in connection with switch resistances, for 1 to 1,600 volts. Current measurements are made by taking the P.D. at the terminals of standard resistances.

(To be concluded.)

RAIL CORRUGATION.*

BY PROF. C. A. CARUS-WILSON.

It will not be necessary for me to spend time this morning in giving any general account of rail corrugation; the phenomenon is unfortunately only too well known to all those interested in tramways. I will therefore begin by asking you to consider certain facts which may throw light on the vexed question as to how corrugations are formed.

You have no doubt observed that corrugations on grooved rails are very often accompanied by a cutting of the check of the rail immediately opposite. This is especially noticeable on curves, where the centrifugal force has made the inner flange bear against the inner check, the corrugations being on the outer rail. But the same kind of check cutting is found on the straight, where the car has been bearing over on one side or the other, the corrugations appearing on the rail immediately opposite the one whose check is cut. Speaking generally, it may be said that, with some exceptions, to which I will allude later on, corrugation is accompanied by a cutting of the check of the opposite rail. When wheels and rails are new there is a clearance, generally of about ¼ in., between the flange and the check on both sides, as shown in Fig. 1, which represents the normal position of the flange in the groove on each side when new. Any side pressure on straight or curve is then taken by the throat of the flange bearing on the head of the rail. The flange cannot come in contact with the check until considerable wear has taken place. Fig. 2, taken from a cast of an actual tyre, shows how the flange bears against the check when the flange has worn sufficiently. Such instances of check-cut tyres are very common. I do not now propose to pursue the important inquiry as to how this wear is brought about, as this would involve a discussion of the whole problem of wheel wear; but taking the fact that check cutting generally accompanies corrugation, to consider the question as to the possible connection between the two. The answer to this question

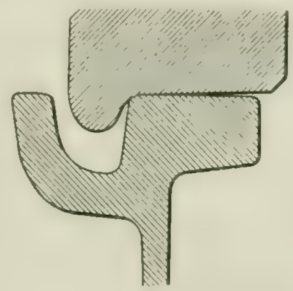

FIG. 1.

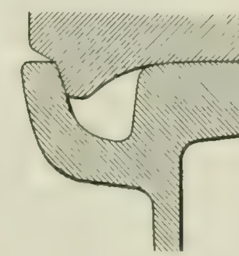

FIG. 2.

depends upon the solution of a very much wider question—namely, when a wheel rolls upon a rail how is the motion affected by the grinding of the flange against the head of the rail? With a view to investigating this matter, I have constructed a model in which the action may be conveniently examined.

Fig. 3 illustrates the model, which consists of a four-wheel truck with brass wheels $2\frac{1}{2}$ in. diameter, whose centres are $4\frac{1}{4}$ in. apart. There is an equaliser suspension by which a weight, hung from a central support, is distributed equally over the four wheels. One wheel on each axle is keyed to the shaft, the other being a loose wheel held in place by a sleeve. The left of these loose wheels in the figure has its sleeve slotted to correspond with a slot in the end of the axle; into this slot can be placed a plate or coupler which at the same time fits into a stud in the rim of the wheel. When the coupler is fixed in position the wheel is thus coupled to the axle.

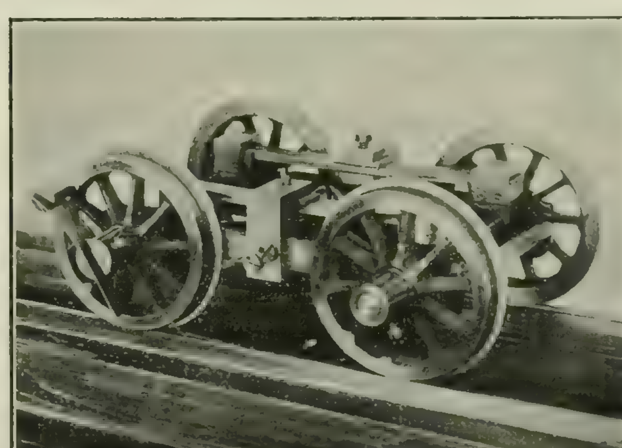

FIG. 3.—PROF. CARUS WILSON'S MODEL FOR SHOWING RAIL CORRUGATION.

Different couplers may be used, some being rigid and some of the nature of a stiff spring, as shown in the figure. There is a mark on the rim of the coupled wheel which may be set opposite to any required point on the rail. The track consists of brass rails $\frac{3}{16}$ in. wide and 3 ft. long, set to a gauge of $3\frac{9}{16}$ in., with a space between them to admit of the passage of the suspension for the weight. The truck is first loaded with a weight of 14 lb., a rigid coupler inserted in the loose wheel, and the mark set opposite a point A at the right-hand end of the track. The truck is then gently pushed from behind and made to travel over the track until the wheel has made three complete revolutions, and the mark has met the rail at a point B. The distance AB then represents a pure roll equal to three times the circumference of the wheel. The truck is taken back, and

* Lecture delivered before the Congress of the Tramways and Light Railways Association.

the mark placed opposite point A as before. If the flange of the coupled wheel is now pressed hard against the rail while the truck is made to travel forwards, it is found that the mark will meet the rail at a point C, which lies beyond point B, the distance BC being about 2 per cent. of AC. Owing to the side pressure the flange bites the rail on a line of contact whose diameter is greater than that of the tread of the wheel; the wheel tends to run on this line of contact, and the tread is forced to skid on the head of the rail in consequence. The result is that the motion is a combined roll and skid, the distance AB representing roll, and BC representing skid. The skidding, however, is continuous, and for any part of AC covered, say, $\frac{1}{100}$ in., the same proportion—namely, 2 per cent. is skid. The two wheels being rigid on one side, both skid an equal amount. It thus appears that when the flange is forced against the side of the rail the wheels are made to skid a certain percentage of the distance travelled. Having ascertained this fact, the next step was to find out whether any such skidding took place on an actual tramway track. For this purpose I conducted a series of tests at Croydon on a car kindly placed at my disposal by Mr. T. B. Goodyer, general manager of the Croydon Corporation tramways.

The car selected for the tests was a four-wheel double-deck car with Mountain & Gibson truck equipped with two Westinghouse No. 200 motors, weighing, with five passengers, 7·8 tons. The truck had a wheel base of 6 ft., with British Griffin chilled iron wheels. A bicycle gear wheel with 68 teeth was fixed on one of the axles and connected by a chain drive to a spur wheel with 14 teeth secured on the floor of the car. A Harding speed counter was attached to the spur wheel by which the revolutions of the axle could be measured. The circumference of each wheel on this axle was measured with a steel tape, and checked by calipering; the result being exactly 95¾ in. in each case, the two wheels having the same diameter. A section of straight and nearly level track was chosen on the road between Croydon and Purley. There are here two lines of rails, badly corrugated for the greater part of the distance. The track is of standard gauge with macadam sides, and the rails, weighing 95 lb. per yard, are laid on a 6 in. bed of concrete. Two trolley poles about ½ mile apart were selected, and the distance between them chained and found to be 2,597 ft. If this distance were covered by simple rolling, the counter would make 1,581 revolutions. The method of test was as follows: One observer was told off to take charge of the counter, a second to take the time, and a third to call the start and the stop. The car was started up some distance behind the first pole, which it passed at full speed; at the moment of passing the third observer gave the signal; the time was taken and the counter inserted in the spur wheel. The car covered the distance at constant speed without slowing down; on passing the second pole at a given signal the time was taken and the counter withdrawn. The car was then brought to rest beyond the second pole and was changed over to the up-track, when the same process was repeated in the reverse direction. The slight difference of level resulted in the up-journey being made at a rather higher speed than the down-journey. Two trips were made each way with the track very dry, and two trips each way after a heavy rain storm, the track being then very wet but not greasy. The results are given in the following table:—

	Condition of track.	Mean counter revs.	Skid in counter revs.	Skid in of distance covered.	Mean speed miles per hour.
Down trip	Dry	1,516	65	4·1	11·2
,,	Wet	1,535	46	2·9	11·1
Up trip ...	Dry	1,522	59	3·7	14·4
,, ...	Wet	1,547	34	2·1	14·0

From these experiments it appeared that when a car travels along a tramway track the wheels skid upon the head of the rails in the same way as they do in the model.

It remained to be seen in what way the skidding, which had been shown to take place, could produce corrugation. For this purpose further experiments were made on the model. In order to get a definite amount of skid that should be independent of possible variations in the side pressure exerted, a metal fillet, shown in place in Fig. 3, was inserted against one of the rails in such a way as to lift the keyed wheels off the rail and force them to roll on the outside of their flanges. The diameter of the outside of the flange is about 9 per cent. greater than that of the tread, and a pure roll on the flange would correspond with the distance AD on the rail, where BD is about 9 per cent of AB which represents three complete revolutions on the tread. If the loose wheel is now fitted with a rigid coupler, the motion of the coupled wheel will be a roll and a skid, and of the keyed wheel a roll and a slip, the proportion of skid to slip depending upon the relative co-efficients of friction, but the sum of the two always being equal to BD or 9 per cent. of AB. With a total weight of 42 lb., that is, 10·5 lb. on each wheel, the coupled wheel skids about 8 per cent. The skidding remains quite uniform and continuous as before. If the coupler is removed from the notch and placed on one side of the stud, the loose wheel is at liberty to roll freely on the rail, and the coupler tends to draw away from the stud under the action of a definite force. This force can be made apparent if the rigid coupler is replaced by a spring coupler fixed in the notch. Whichever way the truck is pushed the spring is bent, indicating a tendency to twist the coupled wheel relatively to the axle. The angle through which the spring is bent represents the torsion required to overcome the adhesion between the tread of the wheel and the rail. From these experiments it is evident that when the flange of a car wheel grinds against the rail in such a way as to cause skidding, the axle will be twisted until the torsion is sufficient to make the tread of the mate wheel skid on the rail, the elastic twist of the axle representing the bending of the spring in the model. So far, however the skidding is quite continuous, and there is no indication of any intermittent action such as could produce corrugation. But the experiments with the model have been carried out under conditions differing in one very important respect from those of ac ual practice. The rails have been quite clean. It remains to be seen what is the effect of making the rail surface rough as it is in practice. For this purpose a little sand may be sprinkled over the surface of the rail. If the truck is now pushed along the track an entirely new effect is produced; the coupled wheel, instead of moving uniformly as before, now advances with a series of jerks at regular intervals.

The action is as follows: When the torque on the spring has increased to a certain amount the force of adhesion is overcome and the wheel skids, tu ning meanwhile about its own axis, so that the whole force of the skid is concentrated over a limited area on the rail surface. In skidding the wheel grinds through the grit on the surface of the rail and comes into contact with clean metal; there is thus a large and sudden reduction in the coefficient of friction and the wheel flies back under the influence of the spring through a considerable angle. The result is that the subsequent motion of the wheel upon the rail will be a pure roll while the spring is being again deflected. When the limit of adhesion is reached the wheel again skids and the process is repeated, the motion thus consisting of alternate rolling and skidding. The addition of the grit has made the skid intermittent, whereas formerly it was continuous. When the surface of the rail is clean there is no sudden breaking down of the adhesion which is required to make the skid intermittent. This effect is not due to the increased torsion on the spring consequent on the increase in the coefficient of friction; for the same torsion can be obtained with a clean rail by increasing the weight, when the skid remains continuous.

So long as the rail is clean the motion is thus continuous and uniform. In order to produce intermittent action it is e sential that the rail surface should have been roughened by the application of some hard and gritty material. In tramway practice such material is furnished by dust, and especially by the sand which is put on the rails. According to my observations, the presence of sharp grit on the rail surface is a prime factor in the production of corrugation. Numerous instances might be quoted where corrugations are worst in places where the rails are liable to be continually covered with sharp gritty dust. Thus, in the case of the Brussels tramways the worst corrugated section in the whole city is on the Boulevard de Waterloo, where the tram lines are flanked from end to end by a sand-covered avenue. This may also explain why the tram lines in one town, say, for example, Norwich, are badly corrugated, while at another, say Coventry, where the track, the rails and the rolling stock are identical in character, there is little or no corrugation, the difference being due to the quantity of dry flint dust that is blown over the Norwich tracks by the prevailing east winds.

The experiments on the model afford an explanation of the connection between check cutting and corrugation. The flange of one of the two wheels on an axle grinds against the rail on a line of contact having a diameter greater than that of the tread, causing both wheels to skid. The skidding on the one side, where the flange is grinding, will be uniform, but on the other side, owing to the twist of the axle, the skidding will be intermittent, provided the rail surface be sufficiently rough, and the motion will be an alternate rolling and skidding This explains why, as a rule, corrugations appear on one rail only; both wheels are skidding, but owing to the twist of the axle one skids uniformly and the other intermittently, the intermittent skidding taking place on the rail opposite to that where the flange is grinding. Observation shows that the rail opposite the corrugated rail is generally scored uniformly, though often with a slight wavy appearance which is caused by the sudden release of the twist on the axle affecting the motion of the non corrugating wheel. The distance apart of the marks on the rail, or the pitch of the corrugations, necessarily depends on the action above described. When the coefficient of adhesion, the weight on the wheel and the dimensions of the axle are fixed, the limiting amount of twist measured, say, in fractions of an inch at the rim of the wheel, is also fixed. Now the skid is a definite per cent. of the distance travelled, say, per cent., and when corrugation takes place the skid between any two marks is accumulated in the twist of the axle, hence x per cent. of the pitch must equal the limiting twist on the axle. Thus, if the skid is 2 per cent. and the limiting

twist 0·02 in., the pitch would have to be 1 in. It is necessary, therefore, to ascertain whether this relation holds good in practice. With the car used in the Croydon tests the weight on each wheel was 4,370 lb., the diameter of the axle $3\frac{3}{4}$ in., and the distance between wheel hubs 48 in. Taking the modulus of transverse elasticity for the axle at 14×10^6, and the coefficient of friction at 0·4,* the twist measured at the rim of a wheel 31 in. diameter will be 0·073 in. For a skid of 3 per cent. the pitch of the corrugations would, therefore, have to be 2·4 in. On the Croydon tramways the pitch of the corrugations on the straight varies from $2\frac{1}{4}$ in. to $2\frac{3}{4}$ in. During the process of corrugation the axle is subject to torsional vibration, and in order that the skidding may continue to take place intermittently the twisting force must be applied rythmically with a time interval equal to the period of vibration of the axle. Hence, the time occupied in covering the distance between two successive skids will be a constant quantity for any given wheels and axle. It follows, therefore, that the pitch of the corrugations will depend not only upon the skid, but also upon the speed of the car. Thus, if the mean speed is 12 miles an hour for corrugations having a pitch of $2\frac{1}{2}$ in., when the speed is 24 miles an hour the pitch would be 5 in. This increase of pitch with speed has been noticed by many observers. It would seem then that the pitch is determined in the first place by its relation to the per cent. skid and the limiting twist on the axle, and in the second place by the speed, and that corrugation cannot take place unless the two sets of conditions are to some extent in agreement. Thus in the case just quoted, the skid at 24 miles an hour must be half that at 12 miles an hour—that is, if the skid is halved the speed must be doubled.

This may explain why, on tramways in this country, corrugations rarely appear unless accompanied by check cutting on the opposite rail. Until such check cutting takes place the side pressure is taken by the throat of the flange bearing against the head of the rail, the line of contact being only slightly below the tread of the wheel. Under these conditions the skid is small, not exceeding 1 or $1\frac{1}{2}$ per cent. Taking the relation of pitch to skid, as calculated for the Croydon car, this amount of skid would correspond with corrugations having a pitch of from 5 in. to 7 in., involving a speed of from 24 to 36 miles an hour, or two or three times our normal speed. Hence the speeds on tramways in this country are too low to give corrugations except where the skid is large, as happens when there is check cutting. Similar conditions obtain more or less on the Continent. Where the speeds are higher, as on American tramways and on steam railways, corrugations may, and do, appear with the small per cent. of skidding that is caused by the ordinary side pressure of the flange on the rail. The side pressure of the flange on the rail that is necessary for the production of corrugations is caused on the straight, by irregularities of gauge and level which make the car lunge from side to side and bear over against one rail or the other. This accounts for the irregular distribution of corrugations along the track, first on one side, then on the other, in long or short stretches with smooth parts in between. The tendency of a car to lunge from side to side in the manner described neutralises the tendency of the car to ride down on the lower side on a double track in spite of the usual camber, and corrugations are found quite as frequently on the inside as on the outside rail on a double track on the straight. The irregularities of gauge and level, due in the first instance to faulty construction, are augmented by the wear and vibration to which the track is subjected. This is one reason why corrugations generally take time to develop. On a curve there is always a definite force, due to centrifugal action, tending to press the flanges outwards. If the curve is of large radius the speed will be practically the same as on the straight, and the conditions under which corrugations may be produced will be similar, except that the pressure is constant and always in one direction. When flanges and rails are new the pressure is between the outer flange and the outer rail, but the skidding thus caused is small, and not enough to produce corrugations at ordinary speeds. After sufficient wear has taken place to bring the inside flange against the check of the inner rail corrugation will begin on the outer rail. For this reason, on any tramway system, corrugation will generally first begin on large radius curves, the corrugations appearing on the outer rail accompanied by cutting of the check of the inner rail. The difference of length between the inner and the outer rail on a curve gives rise to a skidding or slipping, quite apart from that due to the grinding of the flange on the rail. With curves of large radius this difference is small, and does not greatly affect the conditions of corrugation. With curves of small radius the difference produces a skidding or slipping which is large compared with that produced by flange grinding, and the conditions of corrugation become very complex. Speaking generally, however, it may be said that the speeds on small radius curves are, as a rule, too low to admit of corrugations being formed. The pitch of the corrugations on a curve is generally less than on the straight. Thus, in the case of a car which produces corrugations on the straight having a pitch of 2·4 in. with 3 per cent. skid, on a curve of 500 ft. radius the skid on the outer rail due to the difference in the length of the inner and outer rails will be about 0·9 per cent., making a total of 3·9 per cent. Now, the pitch is inversely proportional to the per cent. skid, so that the pitch of the corrugations on the curve should be about 1·9 in. Observation shows that the pitch on curves is reduced about in this proportion.

The appearance of corrugations on the grooveless girder rail used in Philadelphia and other American cities presents some interesting features in connection with what has been said as to side-flange pressure. A full report on this subject was presented by Mr. H. B. Nichols, engineer to the Philadelphia Rapid Transit Co., at the 1907 Convention of the American Street Railway Engineering Association (*see* Tramways and Light Railways Association *Circular* for April, 1907). A section of the rail and tyre used in Philadelphia is reproduced in Fig. 4. The rail shown is a 93 lb. girder rail, $8\frac{3}{4}$ in. deep with a $\frac{3}{8}$ in. web. Careful observation showed that when the normal traffic was passing over this rail at a point on the straight where corrugations had appeared the head of the rail was forced outwards, due to a bending of the web, by as much as $\frac{3}{32}$ in. The web was then stiffened by the addition of fishplates, after which the corrugations disappeared. Subsequently this rail was replaced by another rail weighing 137 lb. with a $\frac{1}{2}$ in. web, after which corrugations appeared only in a few places. Finally this rail was replaced by a rail weighing 141 lb. with a $\frac{9}{16}$ in. web, after which there was no

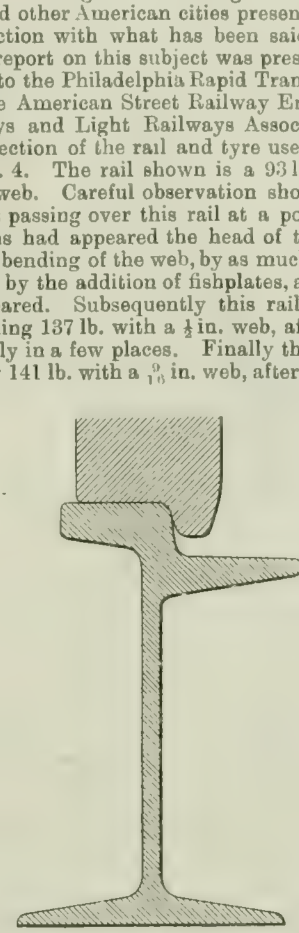

Fig. 4

trouble from corrugations. It has been suggested that the corrugations in this case were due to vibrations in the rail, which were stopped by the stiffening of the web, but I would submit tho following as a more probable explanation. A side deflection of $\frac{3}{32}$ in. corresponds to vertical depression of 0·03 in. at the outside of the tread of the wheel. That is to say, the side pressure caused by the lungeing of the car lifted the wheel about $\frac{1}{32}$ in. off its tread, and threw almost the whole weight on the throat of the flange, causing the wheel to ride on a line of contact about $\frac{1}{4}$ in. below the head of the rail, that is, on a diameter about $1\frac{1}{2}$ per cent. greater than that of the tread, thus producing corrugations in accordance with the principles already stated. A simple calculation will show that when the web has been thickened to $\frac{9}{16}$ in., the lift off the tread for an equal side pressure has been reduced to 0·009 in.; and the tendency of the wheel to ride on a larger diameter than the tread has been practically eliminated.

(To be concluded).

* The most complete tests made to determine the coefficient of adhesion for a wheel on a rail under varying conditions are those made by Capt. Galton and published in the *Proceedings* of the Institution of Mechanical Engineers, 1878-1879. The results there recorded indicate that the limiting or static coefficient of adhesion immediately previous to skidding exceeded 0·38 for a clean dry rail and rose still higher on the application of sand. The value 0·4 is here taken as the limiting coefficient of adhesion.

Single-Phase Electric Traction in Switzerland.—It is announced that the Bernese Alps Railway Co. have set aside £400,000 for the immediate conversion of the Spiez Frutigen line to electric traction. Single-phase current at 15,000 volts at a frequency of 15 will be used. The necessary energy will be supplied from the Kander and Hagnek works, in which special turbo-generators are to be installed.

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"THE ELECTRICIAN" INDUSTRIAL SUPPLEMENT.

With "THE ELECTRICIAN" for Sept. 14, 1906, was issued the first of a series of "Industrial Supplements," to be published from time to time with "THE ELECTRICIAN." The twenty-fifth issue of the Supplement is issued (Gratis) with the current number of "THE ELECTRICIAN."

The "INDUSTRIAL SUPPLEMENT" is a comprehensive record of developments in Electrical Plant, Machinery, Apparatus, Accessories, Sundries and Materials, and of their proved suitability for various Industrial purposes.

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The "INDUSTRIAL SUPPLEMENT" is holed for filing or hanging, and filing covers can be supplied for holding 6 or 12 issues.

SINGLE-CLASS TRAMWAY CARS.

We are so accustomed in this country to tramcars of a single class that the idea of introducing a first-class car, as is now being done by the Liverpool Corporation, appears almost novel. On the Continent such cars are not unknown, and generally take the form of a car divided into first and second-class compartments. Anyone who is well acquainted with the Continent knows that in certain districts such arrangements are distinctly desirable. In this country there is, fortunately, not the same need for them. In Liverpool, however, the Corporation have formed the opinion that there would be a demand for such a service. In regard to this decision Sir CLIFTON ROBINSON and others have expressed the view that such a policy is unnecessary and undesirable, simply because such cars are not general and no request seems to be made for them. This standpoint, however, is scarcely one from which the case can be judged fairly. People often do not ask for what is eminently desirable, simply because they do not realise its advantages. For example, there has been no demand for first-class omnibuses, but in London, at the present time, such vehicles are being run along certain routes, the charge being 6d. per passenger for any distance. We do not know to what extent they are successful, but we believe them to be fairly well patronised, because the route chosen is one on which such facilities are appreciated. There are, obviously, some routes on the London County Council system on which any such innovation would not be an advantage; on the other hand, we can quite believe that when the system is further extended there may be routes on which it would be appreciated,

though for the moment we doubt if any such change is called for, because the tramways do not pass through the best parts of London.

It has sometimes been remarked that first-class cars have been tried in which the inside was the first class and the outside the second class, but that in fine weather everyone desired to go on top. This is very likely to happen in certain conditions of the weather, though not so much so if the cars have top covers. Nevertheless, there would often be a difficulty in restricting the accommodation of the second class in order to provide for first-class passengers on crowded routes. We, therefore, think that a car divided into two classes would not be successful in this country, and that the point will be met more easily by having first-class single-deck cars, these cars being reserved exclusively for first-class passengers and being run at stated intervals. Provided that a definite time table can be adhered to, such a service of cars might be well patronised and they need only be run at such times of the day as the necessity for their use would be felt. For example, we can imagine that many people living in the south of London would appreciate a "theatre service" of first-class cars.

In discussing a question of this kind London is not a very good example of a typical case, because the tramways do not pass through the best neighbourhoods. If they ran through Oxford-street, Regent-street and the good residential thoroughfares surrounding the parks the case would be different. For this reason there is a better outlook for first-class motor omnibuses than for first-class tramcars. In many provincial towns, however, it is otherwise; good residential parts may be sandwiched between docks or factories and poorer suburban parts, and in such cases the first-class car might meet a want. But obviously there would be no point in running such a service through dock thoroughfares, and every particular route would have to be considered on its merits.

SYMBOLS FOR PHYSICAL QUANTITIES.

Summary.—In the following communication Mr. Miles Walker considers the question of symbols in scientific literature, a subject that is engaging the attention of the International Electrotechnical Commission. The suggestion is made that a number of new symbols should be adopted, distinct from letters of various alphabets, and the author asks for criticism to enable the Commission to solve some of the difficulties.

It is very desirable to have a notation for the representation of physical quantities in scientific books and periodicals which shall be the same in all languages.

The subject is under the consideration of the International Electrotechnical Commission with a view to international agreement, and committees in the different countries (in England under the chairmanship of Lord Rayleigh, O.M.) are discussing this particular subject. They are dealing more especially with symbols for electrical and magnetic quantities, but the system might with advantage be extended to embrace all important quantities in physical science, especially as the subject is receiving the attention of most technical societies with a view to some action being taken in the matter.

There are, however, two great difficulties which arise when we try to fix upon a standard notation.

The first is the difficulty of persuading a number of writers and readers who have become accustomed to a certain symbol for a certain quantity to change it in favour of an equally large number of writers and readers who have become accustomed to another symbol. For instance, in France and Germany the letter "I" commonly represents the strength of an electric current, while in England and America "C" is more commonly used.

In the second place, there are not enough letters in the two or three alphabets at our disposal to give a distinct symbol to each quantity, without resorting to the combination of more than one letter to form a single symbol. There is a great objection to this combination of letters, because the use of sub-script letters and numbers is required for distinguishing between particular quantities of the same general kind. If, for instance, C represents current, C_a might conveniently represent armature current and C_1 the current in circuit No. 1. It would, therefore, not be good to take C_a to represent capacity, or any other quantity other than an electric current.

There is, moreover, an objection to using letters at all to represent quantities in a universal notation, because, unless initial letters are used, there is no connection in the mind between the letter and the quantity, and the symbol is difficult to remember. We cannot always use initials, because the initial letters differ in different languages. For instance, in England "R" commonly stands for resistance, while in Germany it is more convenient to use "W" for widerstand. Moreover, the same initial occurs for a great number of different quantities. For instance, "R" might stand for resistance, reluctance, reactance, radius, &c.

One way of avoiding the above difficulties would be to create a number of new symbols which could be printed by means of type like ordinary letters, and which would represent each physical quantity in a distinctive manner.

The question, however, arises as to whether a number of entirely new symbols would be acceptable to writers, readers and printers alike, and the Sub-committee on Symbols appointed by the British section of the Commission has requested the writer to place his views publicly before the profession, with a view of obtaining suggestions and criticisms as to the feasibility of such a scheme from as wide a circle as possible.

In choosing a symbol, we would try to make a very simple picture of something that reminds us of the quantity in question. For instance, ǃ might represent temperature. If we were told that this simple outline of a thermometer represents temperature, we would have no difficulty in remembering it. Similarly / might represent force, and the various "forces" might be derived from it; for instance, ϟ electromotive force (conventional representation of lightning), and ∩ magnetomotive force.

It is not my purpose here to say what would actually be the best form of symbol for each quantity, but it is not a difficult matter to devise very simple characters which can be written quickly, easily and with sufficient accuracy, and which can at the same time assist the memory to connect them with the quantity for which they stand.

What would the printers say to the new type? The author has taken up this matter with a very large publishing firm, and is assured by their chief expert that 200 or 300 new type would be a small matter to a modern printer, who is already accustomed to deal with many hundreds of different founts, each of which contains from 30 to 120 different symbols. He estimates that a printer in a large way of business has at his command as many as 60,000 distinct types, differing from each other either in letter, size, body or face. The addition of 200 or 300 more would be a drop in the ocean. The size of the new type could be standardised for most purposes, and it would only be in some special case that another size would be called for.

The setting up of the formulæ with the standard size of type would be simpler than with the present system, in which sub-script letters are often unnecessarily introduced. One symbol under the present system sometimes consists of four or five letters.

If it be admitted that the introduction of new symbols is advisable, the question arises, What shall the new symbols represent exactly? Shall the sign ǃ (temp.) represent temperature in any units, or shall it represent the number of degrees of temperature, measured by some scale agreed upon, and embodied in the definition of the symbol? If the

system of units employed be not prescribed, fewer symbols would be required, and the general writer, who now says vaguely "Let T equal the temperature," would find the symbol sufficient for his purpose. But, from the reader's point of view, there is much to say in favour of a symbol which will embody in its definition a standard system of units. Any formula expressed in such symbols would be completely self-contained, and would be an exact statement of a physical fact. Until the units employed in any formula are known the formula expresses only half its meaning. Perhaps some slight addition to the symbol, or even to the whole formula, might be used to indicate that the standard system of units is employed. Without that addition the symbol would have a general meaning. For instance, ⌋ might equal temperature, while ⌋ might indicate the degrees Centigrade above the absolute zero. The name of the type might be the name of the physical units which it represents; for instance, for ⁄ we might read "volts."

If writers, printers and readers, who have any definite views as to the best method of devising a system of symbols, would communicate with the technical press, or with the author, they might assist in solving the many difficulties which arise in connection with this matter.

The Cottage, MILES WALKER.
Leicester-road, Hale, Altrincham.

ELECTRIC LIGHTING IN THE CITY OF LONDON.

A title such as heads this article is likely to lead the reader to suppose that a well-known controversial subject is once

MODEL OF PROPOSED ARC LAMP STANDARD FOR USE IN THE CITY OF LONDON.

again to be re-opened in these columns. This is not the case, for we are about to deal with an interesting matter subsidiary to this important subject.

Given as an axiom that electric lighting is the best for the City streets—as regards this we are sure all readers of *The Electrician* are in agreement—the question remains: How are the lamps to be fixed so that a maximum illumination can be obtained from any one source? We have already seen, in Cannon-street, the adoption of overhead suspension, and this system has not been unsuccessful in this crowded thoroughfare. But there are cases, especially where the road is at all wide, where the employment of standards offers certain advantages.

There is no reason, however—though ordinary London practice would have us suppose otherwise—for such standards to be inartistic. This point was indeed raised by Mr. A. A. Voysey in his recent report on the City lighting. The real artist we know, or at any rate are told, can make the most humdrum things artistic, a remark which applies with great force to the ordinary lamp post.

In the accompanying illustration we show a model of a lamp standard, which has been designed for use in the City. It is made by Messrs. Elsley, of Great Titchfield-street, London, and is a good example both of the designer's and the iron founder's art. Unfortunately, some of the detail is not evident in the illustration. Such a post cannot by the most captious be considered inartistic, and we shall await with interest its erection in the streets of London.

ELECTRICAL EXHIBITS AT THE FRANCO-BRITISH EXHIBITION.—II.*

The exhibit of Messrs. W. H. ALLEN, SON & Co. gives an excellent idea of the various types of machinery manufactured by this company at their works in Bedford. Their well-known high-speed enclosed, forced lubrication, engines are well represented by two examples—one a three-cylinder compound engine, and the other a two-cylinder. The former is capable of developing 450 B.H.P. when running at a speed of 400 revs. per min., and has one high-pressure cylinder 16 in. in diameter and two low-pressure cylinders each 18 in. in diameter, with a stroke of 10 in. Our readers are familiar with the main features of the construction of these engines, and therefore we shall not describe them further.

Messrs. Allen's condensing equipment is well represented by two of their standard "Allen-Edwards" three-throw air pumps. The larger has been constructed for a condenser of 10,000 sq. ft., and has three barrels exactly similar with a diameter of 18 in. and a stroke of 14 in., the crankshaft to run at 135 revs. per min. This is arranged for driving by means of a motor developing 19 B.H.P. and running at 575 revs. per min. The air pumps deliver the condensed water into a small surge tank situated in the lower part of the air-pump casing. This water is withdrawn by means of a single-acting force pump having a plunger 7 in. in diameter and a stroke of 10 in., and capable of delivering against a head of 10 ft. This pump is driven from an outside disc crank on the end of the air-pump crankshaft. The air-pump buckets are of cast iron, and are fitted with solid gun-metal rings. The barrels are of solid gun-metal, as also are the valve plates, the valves being of the "Kinghorn" metallic type resting on accurately faced seatings. The force pump is also fitted with gun-metal plunger and liners, and the air-pump casing is fitted with the usual accessories, such as snifting valves, drain cocks and relief valves. The large tube plate shown on this stand is one of those constructed for the condenser just referred to, there being no less than 3,751 holes drilled, counter-sunk and tapped in this plate. The diameter of the tube plate is 7 ft. 4 in. and the thickness 1½ in. This will give some idea of the necessity which the makers have found for the development of drilling and tapping machinery in their works to enable them to produce this high class of workmanship at a moderate cost.

An interesting exhibit is Messrs. Allen's four-stage turbine pump (Fig. 1) which is direct-coupled to a continuous current motor, and is shown running drawing water from a cast iron tank below the pump and motor and delivering through a throttle and nozzle, a pressure gauge being situated behind the throttle showing the head upon the pump. This pump has branches 4 in. in diameter, and is capable of delivering 100 to 120 gallons of water per minute against a head of 200 ft. to 250 ft. when running at 1,700 revs. per min. The pump casing is of cast iron and the spindle of high-grade nickel steel completely encased with gun-metal sleeves. The four discs are of bronze, and likewise the fixed guide blades in the casing of the pump. The spindle is carried in bearings of the self oiling type, arranged external to the pump casing, and at one end is provided with a small collar thrust bearing, which is automatically lubricated and cooled, and which takes up any slight unbalanced end thrust which may occur during running. The glands through which the spindle enters the casing are of special design owing to the high speed of rotation, that at the suction end being water sealed, the

* The previous article appeared in our issue of July 3, p. 455.

water being drawn from the discharge side of the pump. The drive is transmitted to the pump spindle through a flexible coupling, and great care has been taken in the design of these pumps that the critical speeds of the pump spindle shall lie sufficiently above the normal speed of working to give freedom from vibration in running, and the employment of a flexible coupling ensures that these critical speeds shall not be modified by the connection with the electric motor. The smooth working, the small space required and the fewness of the working parts of this class of machinery ought at once to commend it to all who are seeking suitable pumping machinery, especially for high lifts. The electric motor is of Messrs. Allen's high-speed continuous current type, and is specially designed for this class of work. Great care has been taken in the mechanical design to ensure durability and good running over long periods without attention. The motor is fitted with a pair of commutating poles situated in two of the interpolar spaces, thus giving excellent commutation under all conditions of load with the brushes fixed in the neutral position.

The combination is set into operation by means of one of Messrs. Allen's drum tramway type controllers. The arrangements are such that the motor is accelerated to its normal speed in passing the first four steps, and any subsequent regulation of speed which may be required, is obtained by inserting resistance into the shunt of the motor, in the last five positions of the controller barrel. A feature of the controller is its compactness, as well as the accessibility of its various parts, and the entire absence of the use of solder. The connections are so arranged that the circuit of the motor is broken on both poles in the controller, the main switch being fitted with easily renewable carbon tips.

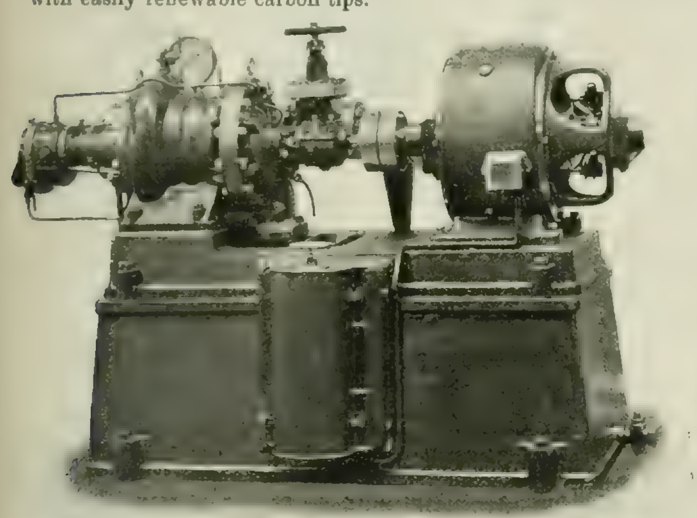


Fig. 1.—Allen's Turbine Pump.

A three-stage turbine pump is also shown, having a discharge branch 7 in. in diameter. This pump is of an exceedingly economical construction, and has internally the same general features of design as those just described in the case of the smaller pump.

Many visitors to the exhibition will have heard that Messrs. Allen have taken up the manufacture of paraffin oil engines, and it will be remembered that we described these in our issue of May 1. This type is represented by a small two-crank compound oil engine and dynamo, the engine having two cylinders 4 in. in diameter, with a stroke of 5¼ in., and being capable of giving 5 B.H.P. when running at a speed of 800 revs. per min., whilst the output of the dynamo is 2·75 kw. at 100 volts. We understand that this engine runs with any standard oil, consuming about 0·8 lb. per brake horse power hour, whilst in the larger sizes, which are made up to 100 H.P., the oil consumption is reduced to 0·6 lb. per brake horse power hour. An interesting point in connection with these engines is the ease of starting since all the levers are marked for starting and running positions, and the whole operation can be performed in about seven minutes.

Messrs. Crossley Bros. have a representative exhibit of gas and oil engines, part of which form a working exhibit in connection with a suction gas plant. This suction gas plant operates with anthracite fuel, and supplies gas to the four cylinder vertical engine shown as a working exhibit. The engine shaft is extended and has mounted upon it a 125 kw. 220 volt continuous current dynamo built by the General Electric Co., running at 250 revs. per min. The whole forms a very compact plant. The starting of the vertical gas engine is effected by means of compressed air contained in three steel receivers. These receivers are charged with air obtained from a small gas engine and compressor, an operation only necessary occasionally, as the loss of compressed air is not more than from 5 lb. to 10 lb. on each occasion of starting. This vertical engine is fitted with forced lubrication supplied from two valveless oil pumps within the engine base plate, the oil being filtered before passing to the various bearings. In addition to working the engine with suction gas, an arrangement is also made for working from the public gas mains, and the operation of changing over from one kind of gas to the other may be performed whilst the engine is running. This important feature is made possible by means of the Crossley patent governing valve, with which the engine is fitted.

Fig. 2.—Westminster Engineering Co.'s Enclosed Arc Lamp.

Another gas engine shown is of the vertical high-speed class, and develops 5½ B.H.P. when running at 700 revs. per min. The engine is coupled direct to a dynamo, and the combination is mounted on a substantial cast-iron bed plate. This type of engine is supplied with either one, two, three or four cylinders to work on either town gas, producer gas, petrol, petroleum, benzol or alcohol, and to be used either for stationary, marine, portable or electric lighting purposes. It is intended especially for use when either a limited space is available, or where a high speed or a light weight only is required.

Two of the firm's horizontal oil engines are also shown, type "HH" giving 1 B.H.P. at 400 revs. per min., and type "OON" giving 8 B.H.P. at 260 revs. per min. The last-mentioned engine represents a class which is rapidly gaining favour, owing to its ability to work without alteration with either the ordinary petroleum lamp oils or with crude oils. No lamp is used except for starting purposes.

The Westminster Engineering Co. are exhibiting samples of their enclosed type arc lamps of the brake feed type as used on the Central London Railway, Great Western Railway, Metropolitan Railway at Baker-street and South Kensington, by the G.P.O., &c., also a small arc lamp taking a current of 3½ amperes, and particularly suitable for lighting small shops, corridors, waiting rooms, &c. An interesting section of the exhibit is a number of photographic arc lamps, the speciality being a large lamp burning singly on a 500 volt continuous-current circuit. The arc is about 6 in. long and the actinic power of the light is very great. Two similar lamps were used by the *Daily Mail* on the occasion of the visit of the French President and King Edward to the Exhibition. One of the photographic lamps is mounted on a tripod stand so that it can be moved about the studio to suit the requirements of the photographer. A half-size model of a very handy printing frame with arc lamp

Fig. 3.—Westminster Engineering Co.'s Limit Switch.

and light shade on the top is shown. A lamp and frame such as this enables the photographer to do the whole of his printing quite irrespective of the state of the weather; in fact, it is often found that photographers who get used to printing by artificial light are inclined to give up day-light altogether, the exposures being so much more easily managed by artificial light. We illustrate one of this firms standard enclosed lamps in Fig. 2.

This firm also show their new pattern limit switches (*see* Fig. 3). The idea of the switch is for use in places where for one reason or

another, it can take the place of a meter; for instance, in large blocks of flats or offices it is found convenient by the supply company to put one large meter at the point of entrance of the supply, and a limit switch to each tenant of a flat or offices. The tenant is then charged so much per annum for current, his maximum not to exceed a specified amount. If this maximum is by accident exceeded, the limit switch operates by opening and closing the circuit, so causing the light of the lamps to fluctuate violently until the current is reduced to the normal value. A particular point about this switch is that it is shunted by a resistance so that the circuit when broken through the switch is diverted through the resistance; the lamps are thus not wholly extinguished but dimmed. The company claim that this is the only limit switch of any use where metallic filament lamps are used, as, owing to the large starting current of this type of lamp, if the circuit were broken and the lamps extinguished the switch would continue to work until nearly all the lamps were switched off.

Messrs. W. Geipel & Co. have a stand on which are shown their "Liconite" cables, which we described in our issue of May 29th. A length of cable is shown under test at 50,000 volts.

Messrs. Berry, Skinner & Co. have a stand on which they are showing their well-known switches. These also are in use throughout the Exhibition, and were described in our issue of May 22.

The Linolite Co. exhibit their "Tubolite," which is coming into use for shop window illumination, where, although not attracting attention by any glare, it serves to illuminate the goods displayed to the best advantage. Our readers are already familiar with this device, and therefore we will only draw attention to the notice on the stand informing visitors that the cost of illumination by means of the "Tubolite" works out at ½d. per yard per hour with current supplied at 3d. per unit, and that over 13 miles of these tubes are in use.

Some interesting novelties in the way of fittings are shown by Messrs. J. Dugdill & Co, of Failsworth. The most striking of these is probably the extensible switch pendant, the ceiling rose being of unusually large size and containing a spring reel for winding up or feeding out the flexible cord as the position of the pendant is raised or lowered. The ceiling rose also contains an automatic double-pole switch, which is "closed" when the pendant is being lowered and "opens" as soon as the pendant is raised to any extent. An advantage of this fitting is that in the case of the flexible cord breaking the switch automatically cuts off current. Other fittings shown are telescopic tube pendants, wall brackets with wide range of adjustment, bench standards, &c., all fitted with automatic switches as described above.

An interesting exhibit of machine tools is shown on the stand of Messrs. A. Herbert, of Coventry. The latest pattern of hexagon turret lathe is shown in operation. This machine, which we illustrate in Fig. 4, possesses the advantage of not requiring a variable speed motor, as 16 speeds are provided by simple adjustment in the lathe itself. This lathe is of special interest, as it is designed for producing direct from the bar, screws, studs, spindles, lock nuts, pulleys, &c., and it is claimed that the speed at which the work may be produced cannot be approached by any other machine. Thus the lathe shown in operation at the Exhibition turns a bolt 8 in. over all length and 1 in. diameter, 3 in. of its length being screwed, from a 2 in. diameter steel bar in three minutes. It is capable of taking work up to 30 in. in length and can reduce a steel bar from 2 in. to 1 in. in diameter at the rate of 6 in. per minute, the operation being performed with one cut.

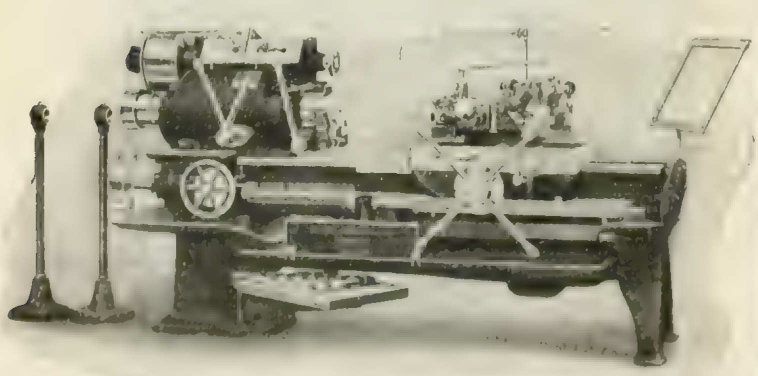


Fig. 4.—Herbert & Co.'s Standard Lathe.

Another interesting machine on this stand, and one which is shown for the first time, is a ball-bearing drill, in which all the bearings are fitted with balls, so that friction is reduced to such an extent that a [illegible] in. drill may be put through a cast iron plate 1 in. thick in five seconds, this, of course, being a remarkable speed for performing such work.

The Imperial Lighting Co. have a stand adjacent to the model house of the London electricity supply companies, and are exhibiting their "Fairyland" strip. This has been very extensively used in connection with the illumination of the Exhibition buildings, and was described and illustrated, in connection therewith, in our issue of May 15, so that further reference is unnecessary.

There are few places where the electric drive is seen to more advantage than in the portable drill. It is true these machines possess formidable rivals in the form of compressed air drills, and these latter had the further advantage of being first in the field But this opposition is being gradually overcome, and in the near future we shall hope to see the electric drill predominant.

Among the firms who make a speciality of this class of work are Messrs. Electromotors of Manchester. As seen in Fig. 5, their

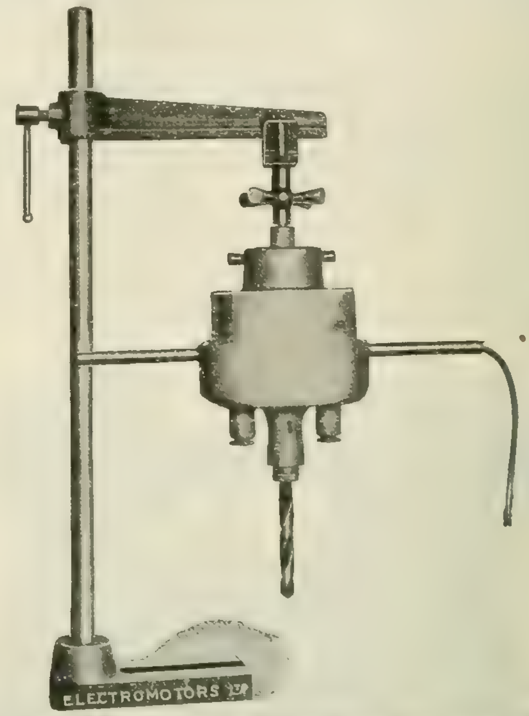


Fig. 5.—An "Electromotors" Self Contained Drill with Straight-arm Drilling Pillar.

drills are of sound construction, and possess the decided advantage of being British manufacture throughout. They are in general provided with aluminium cases for the sake of lightness. They are liberally rated for the specified duty, and where provided with gear wheels, these are cut from steel blanks. It is claimed that the working parts are quite accessible, and the motors can be designed for any voltage, though the standard is 250 volts.

The drill illustrated is a good example of Messrs. Electromotors products; it is shown fitted to a straight-arm drilling pillar.

Another interesting arrangement consists in fitting the motor equipped with a swivelling-gear on a truck, whence it is connected to the drilling head by a flexible shaft. The motor and truck wheels can be locked in any position. The shafts consist of steel wire spirals wound in opposite directions, protected with an outer metal sheath. The motor spindle is provided with a universal joint, and in larger sizes an enclosed gear box is fitted. The drill heads are provided with ball bearings suitable for rough usage, and all the working parts are enclosed. They can be supplied with ordinary drill pillar, or with spoon-shaped arm. A pot magnet type has also been standardised for attaching to blank plates. A grip attachment is included to prevent the drill head dropping when the drill goes through.

CORRESPONDENCE.

ACCUMULATORS FOR PEAK LOADS.

TO THE EDITOR OF THE ELECTRICIAN.

Sir: It is with much reluctance that I again trespass upon the hospitality of your columns, but it is to correct a mistake of some considerable importance, and one that tells very adversely against batteries, and this must be my excuse.

The comment of practically everyone who has hitherto criticised my Paper has been that the use of cells is doomed to discontinuance directly any station acquires a decent load factor.

In the case of the large majority of our municipal systems it would be most unsafe to predict that the load factor will exceed 30 per cent. in the course of the next 10 years. If, then, it can be shown that, as far as *fixed* charges are concerned, the battery can compete with steam additions, even where there is a good load factor, the only question remaining is whether, in the matter of running expenses, this saving is not wiped out by the inefficient battery.

An analysis of the Neptune Bank mid-winter peak for 1903 (*see* Merz's Paper, April, 1904), shows that, by putting in a battery on a three-hour rating, it would be practicable to take up 40 per cent. of the peak. The capital cost would be £15 per kilowatt and the annual fixed charges £2·4 per kilowatt of maximum demand per annum, as against £4·6 per kilowatt with reciprocating engines, or, say, £4·2 per kilowatt with turbines (*see* Fig. 14 of my Paper, corrected by adding £0·45 per kilowatt to the battery curve, as already explained at Nottingham). It may here be remarked that it is the high value of other fixed charges than capital costs which tells against steam, as my Fig. 11 was intended to illustrate.

The running charges will also be less (although the load factor at Neptune Bank must have been quite 30 per cent.), because the battery enables certain engine and boiler units to be shut down altogether, on account of the all-night load being so much less than the day load.

The diagram given with my Paper (Fig. 8) shows a net saving of some 4,750 tons of coal per annum for a station which is mostly a lighting station. On a station with a large power load this would no doubt be considerably reduced, but there would certainly still be a saving, even where steam turbines were employed, on account of the reduced number of boilers under commission.

Surely there are many municipal stations that have yet to beat the power load possessed by Neptune Bank in 1903-4; or is "Lightning's" column of load factors not to be trusted?

Is it too much to hope that the above simple example, which anybody can check for themselves, will at least cause engineers to consider whether the continuance of the use of batteries does so entirely depend on the obtaining of a power load; and whether the all night load, and the sizes of steam units employed, do not have something to say in the matter?—I am, &c.,

Birmingham, July 7. A. M. TAYLOR.

RAIL CORRUGATION.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: In reference to Prof. Carus-Wilson's lecture, of which I have seen a very brief report, might not an incipient irregularity in rail surface be attributable to periodic fluctuations in current between tyres and rail? Everyone knows that particles of grit can settle on tramway rails, entailing sparking, visible by daylight, and, of course, the interruptions produced by such particles of grit [this not commented on in the said report] could generate, as we may easily conceive, oscillations in the electric source, comparable to the alternating oscillations of a charged Leyden battery, or (on small scale) to a Hertz resonator.

It need scarcely be remarked that these surgings (electric), in spite of their cause being irregular, would, of course, be regular, and could be coincident with period of passage of ripple marks on rails at a particular rate of running of car. Evidently we observe that the effect could thus be greatly accentuated, and the electrical wave-period also adjustable (if induced by varying speeds of the car) to higher or lower harmonics of electric resonance; while a ripple mark once initiated would obviously of itself be a secondary factor in determining the wave period.—I am, &c.,

Gross Flottbek, Altona, Germany, July 15.

S. TOLVER PRESTON.

EXPERIMENTS ON A DIRECTIVE SYSTEM OF WIRELESS TELEGRAPHY.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: On pp. 460 and 461 of your issue of July 3rd I notice a communication by Messrs. Bellini and Tosi on the subject of directive wireless telegraphy. This short abstract does not indicate how far the authors have taken into account earlier work or how far such work is touched upon in the Paper. But when Mr. Tosi (in answer to Dr. Fleming) stated, with regard to my researches, described in *The Electrician* for May 25 and June 1, 1906, that "the method had not succeeded . . ." it is quite clear that he had no knowledge of the contents of that article when he passed this opinion. May I draw Mr. Tosi's attention to my article in the *Jahrbuch der drahtlosen Telegraphie* (1907, No. 1) and the literature mentioned therein, which gives an historical account of the researches undertaken.—I am, &c.,

Strassburg, Elsass, July 11. F. BRAUN.

TRAMWAY RAIL POINTS.

The discussion on Mr. A. H. Gibbings' Paper (abstracted on p. 525 of last issue) on this subject brings out a great many points of interest to tramway engineers. We have, therefore, in what follows, summarised the principal criticisms offered and the amendments proposed to his statements.

DISCUSSION.

Mr. A. H. GIBBINGS in amplification of his Paper, which was taken as read, corrected the statement in which the life of a welded joint was placed at about three years. The bulk of his Paper was written two years ago, and details might require bringing up-to-date. He drew attention to a device known as a patent mechanical joint which consisted of fish plates with ordinary holes in them, and in the web of the rail. A safety bolt was used having a right-handed thread, and an eccentric which nearly fitted the circular hole in the rail web. If the two eccentrics were brought forward the joint was closed, and a practically continuous rail obtained. The tendency of the ordinary running stresses was to tighten the joint.

Mr. J. R. SALTER (Lancashire United Tramways) thought that the most important consideration, *viz.* that of paving had been omitted from the Paper. Rigidity in tramway permanent way was only required for keeping the rails level with the paving, and conditions would be infinitely better if a flexible track could be obtained. He used wooden sleepers on his system, and the running was perfect, though the paving suffered. He referred to the adjustable joint described in the Paper (*The Electrician*, Vol. LXI., p. 527, and Fig. 11), which was intended to take up small substances in the rail which work in, and which would leave a gap between the two plates. This gap would certainly accumulate water with consequent destruction of the paving. With regard to the first desideratum (*see The Electrician*, July 17, p. 527), it was assumed that the fish plates had a wedging action, when the web was omitted. But to omit the web was impossible, and it was necessary to increase the depth of the fish plate to get support under the head and rib of the rail.

Mr. J. B. HAMILTON (Leeds City Tramways) thought that a concrete foundation was an absolute necessity in public thoroughfares, but to get a reasonable life out of rails laid in this manner with ordinary fish or sole plates was impossible. The welded joint had been tried in Leeds, but it was useless unless anchoring was also employed. He called attention to the inverted rail anchor, which had been most satisfactory.

Mr. BANISTER (Norwich Electric Trams) had found the "Falk" joint very satisfactory, but the cost of making repairs was prohibitive. About four years ago the "Thermit" joint had been adopted and with it, it was as cheap to make one joint as to make fifty. The great advantage of a welded rail was the excellent rail return obtained. The joints described by Mr. Gibbings required machine shop labour, and the ordinary platelayer could not deal with them satisfactorily. He believed the claim f r the adjustable joint was that it could be easily tightened, but in doing this, if the weather were wet, the paving would suffer. He thought with Mr. Salter that the paving was the essential thing.

Mr. STUTZ ("Thermit," Ltd.) did not consider the "Falk" joint to be a proper weld. The molten iron was poured round the joints, and there was some adhesion, but he did not think the rails were actually fused together.

Mr. E. BENEDICT was surprised at the author's statement that tramways had profited by the experience of railways. To him it seemed they had gone in a diametrically opposite direction. The difficulty lay in the paving and in the drainage, without which no railway track could last any time. He thought difficulty would be experienced in using longitudinal sleepers, and asked for some details as to cost. There was the difficulty of packing them and keeping them in line. A certain amount of elasticity could be obtained by the use of compressed felt.

Mr. H. M. SAYERS referred to No. 2 of the desiderata at the end of the Paper. He thought this should read, "the vertical rigidity of the joint should be uniform with that of the rest of the rail." The question was one of rigid or elastic track. Rigidity was to a certain extent compulsory, but he did not think it detrimental either to the track or the vehicles. The track should be equally rigid or equally elastic at all points. If this was not the case wave motion would be set up leading to hammering of joints. Joints were not so stiff vertically as the rest of the rail, and there was necessarily a certain amount of give. This was got over by the use of anchor plates, though to fit these the concrete was sometimes cut away and the joint rested on the sub-soil. Again,

the screw mechanisms always present in mechanical joints could not be properly maintained when buried in concrete. The welded joint seemed to fulfil the requirements best, though the rail was softened and most joints had less rigidity than the rest of the rail, as the railhead was not welded. He thought improvements should be sought along the line of the welded joint.

Mr. J. WELLING (L.C.C. Tramways) thought the more rigid the foundation the better the results. Longitudinal sleepers were much affected by the wet, with "hammering" as the result. The lateral pressure was also great, large stresses being set up at the joint fastenings. This can be prevented by the use of a stiffer vertical web. "Knocking" is also set up by an imperfect fitting of the soleplate. The joints used by the L.C.C. were "Cooper Anchor" joints, and rivets were used instead of bolts, thus making repairs easier. The experience of the L.C.C. with anchor joints had been different from that of the author, and they only cost one half the amount of unanchored joints in maintenance. The most frequent cause of bad joints was the difference in section of adjacent rail ends, and good fitting of the fish plates was an important matter.

Mr. S. SELLON thought the whole question was one of paving, and he was rather hopeless that a solution would be found. Directly repairs were started difficulties began. He was against the introduction of an elaborate system of anchor joints. The question was one of expense, and every tramway should be designed for the special conditions under which it had to work.

The CHAIRMAN (Sir Clifton Robinson) agreed that there was no universal method for constructing tramways. They had gradually come to believe in a more rigid roadbed. The better bonded the rails, the better the foundation, and the heavier the rail the better would be the working. The greatest strain on the revenue was repairs. He thought that the whole trend was in the direction of a solid roadway.

Mr. GIBBINGS (in reply) briefly thanked the members for their remarks, but preferred to reply in writing.

ANNUAL REPORT OF THE ELECTRICAL INSPECTOR OF FACTORIES.

We give below an abstract of the report by Mr. G. S. Ram, H.M. Electrical Inspector of Factories, which has just been issued. After referring to the general progress of electrical power, as shown by *The Electrician* tables of electricity supply undertakings, the report proceeds as follows :—

TABLE I.—ACCIDENTS AT ELECTRICAL GENERATING STATIONS AND SUB-STATIONS OF ELECTRICITY SUPPLY COMPANIES AND LOCAL AUTHORITIES, 1907

Description.	Non-fatal.		Fatal.	
Non-electrical.				
At engines, pumps and generators	29		..	
At boilers and steam plant	61		.. 2	
At coal handling plant	17		.. —	
Falls	53		.. 4	
Struck by falling bodies	29		.. —	
Miscellaneous	57	246	.. 1	—7
Electrical.				
At switchboards when engaged in ordinary routine work, mostly due to faulty design of apparatus	10		.. —	
Cleaning, repairing, &c., at "live" switchboards	13		.. 1	
Cleaning, repairing, or other handling of switchboards supposed to have been made "dead":				
(a) Skilled persons	1		.. —	
(b) Unskilled persons	—		.. —	
Adjusting brushes	9		.. —	
Miscellaneous	15	—48	.. 1	—2

In private electrical stations there were 23 non-fatal accidents and 1 fatal accident of a non-electrical kind; also 3 fatal and 1 non-fatal accidents due to electrical causes. The electrical accidents show a slight increase over those of last year. One of them was due to the oil becoming ignited in a large oil type fuse. The accidents in factories and engineering works other than electrical generating stations are classified in Table II. Here the non-fatal accidents have increased from 191 last year to 253, the number of fatal accidents remaining the same. There is little, if anything, new in the circumstances of the accidents, but particular reference is made to the following cases.

One accident was due to the absence of any protection whatever on a three-phase medium pressure motor starting switch. Owing to the nature of the industry the floor near the switch was always wet, and the arrangement was little better than a trap.

Another accident exemplified the danger of alternating current at low pressures. It occurred in an engineering works. A man was engaged at a saw bench where hot metal was being cut up by a circular saw. The saw was driven directly by a three-phase motor working at 350 volts per phase and, therefore, probably, only 200 volts above earth. After cutting a piece of metal the man while still holding it with tongs on the saw bench, told his assistant to switch off the current. Immediately the switch was pulled off, the man at the saw received a shock and was killed. The saw bench had become electrically charged through a trailing breakage at the switch. A spring at the switch broke and made contact with the metal cover. This cover was connected by a wire to the lead covering of the cable leading to the motor and which rested on the motor frame. Another

* [illegible]

TABLE II.—REPORTED ELECTRICAL ACCIDENTS IN FACTORIES, ENGINEERING WORKS, &C., OTHER THAN ELECTRICAL GENERATING STATIONS AND SUB-STATIONS, 1907.

Description.	Non-fatal.	Fatal.
Arcing of switches	17	.. —
Arcing of fuses	26	.. —
Arcing at fuses, when replacing fuse wires	24	.. —
Unprotected conductors, switches, terminals, fuses, &c.	29	.. 3
Faulty apparatus (other than switches)	55	.. 2
Working on live conductors:—		
(a) Skilled persons	24	.. —
(b) Unskilled persons	20	.. 1*
Flashing at motor brushes when adjusting	3	.. —
Electric travelling cranes:—		
(a) Unprotected electrical apparatus in driving-cage	6	.. —
(b) Faulty apparatus	8	.. —
(c) Carelessness	7	.. —
Miscellaneous accidents in testing electrical apparatus in course of manufacture	23	.. 1
Miscellaneous	16—258	.. 1†—8

wire connected the lead covering of the cable to a bolt passing through a piece of wood in such a way that when screwed up the end of the bolt was forced against a metal column of the building, which it was supposed would form an efficient earth connection. The earth connection proved useless, probably because the bolt had not penetrated the coating of paint on the column. It is, however, doubtful if iron columns standing in concrete blocks afford a sufficient earth. Cases have occurred of an iron framework of this kind becoming electrically charged and persons receiving shocks therefrom.

The danger in the use of hand lamps as ordinarily constructed is seldom realised, and can so easily be guarded against that it is proposed to refer to the matter at length. The danger arises from the construction of the lamp being such that any metal work used is very liable to become electrically charged. If, therefore, a person holding such a lamp happens to be standing on metal floor plates or on damp ground or is otherwise in connection with earth, he may get a shock, and in all probability he will be unable to release his hold of the lamp and a fatal result will ensue. In each of three particular cases the current was alternating and at low pressure. Each lamp had an insulating handle, but this did not prevent a fatal accident. Two of the lamps had each a brass tube passing through the handle. One end of the brass tube was screwed into the lamp-holder and the other end into a ferrule which served to hold the insulating handle in position and provided an attachment for the metal hook, by means of which the lamp might be hung up. In each of these lamps if there occured any defect by which any part of the metal work could make contact with the conductors, the whole of the metal work becomes live. Although a person may be grasping the wood handle in the proper way he is liable to touch the brass ferrule at one end or the gallery of the protecting cage at the other. If he is at the same time standing on "earth," he will get a shock which may prevent him dropping the lamp; in fact, he will probably grasp it all the tighter, although the actual point of contact between his hand and the charged metal at one end or other of the handle may be very small. The third lamp was similar, but had no brass tube passing through the handle. The handle, however, was not large, and a man holding it was liable to have his thumb upon the brass socket into which the handle fits. This socket terminated in a short brass tube which screwed into the lamp-holder, and was consequently in metallic connection with the lamp-holder, the gallery and cage. Should these parts become live through any defect, the person holding the lamp may again be unable to release his hold. In the case of each of these lamps the metal work became live when the persons holding them were in connection with earth and were consequently unable to let go and were killed. Examination of the lamps shows the following defects by reason of which the metal parts became "live." In one of them the flexible wires pass from the lamp-holder through the brass tube inside the handle and out at a hole in the side of the brass ferrule. The edge of this hole is bushed with insulating material, but the edge of the end of the brass tube inside the ferrule is not so bushed and has a sharp edge. The insulating covering to the flexible wires appears to have been cut through at this point, thus causing the whole of the metal work to become live, and hence the accident. In the second case the flexible wires pass out through the end of the brass ferrule, and this, of course, is again a weak spot, the covering of the wires being liable to be injured at this point. This, however, does not appear to have been the cause of the metal work becoming live in this case. There is another defect which is indicated in Fig. 1. The lamp-holder is screwed on to the end of the brass tube which passes through the handle, the flexible wires passing through this brass tube to the terminals fixed in the porcelain block in the holder. The fit of the threads in the holder and the brass tube is very easy, and the holder cannot be firmly fixed unless it is screwed on the brass tube, or rather the brass tube is screwed into the holder as far as it will go. This, until the flexible wires are in position, means that the brass tube is screwed in so far that it becomes jammed against the porcelain block. The holes in the porcelain block into which the ends of the flexible wires are threaded are somewhat wider apart than the diameter of the brass tube. Consequently, when the flexible wires are put in place, the brass tube is screwed hard up against them, nipping them between its sharp edge and the porcelain block. As there is no grip upon the

* Fall following shock. † Due to a practical joke.

flexible wires elsewhere within the handle and as the lamp may be frequently carried about by means of the wires, the whole weight will be taken by the latter at the point where they are nipped. Under such conditions it is practically a foregone conclusion that the insulation, even if it should escape damage in the first instance, will be cut through after the lamp has been in use for a short time. In the third case the same defect occurs.

The two most important points to be borne in mind in the design of a lamp for use in dangerous places—*i.e.*, where the user is in connection with earth, are (1) that there shall be no metallic connection between the lamp holder and any other metal part of the fitting, and (2) that the flexible wires in passing from the lamp-holder shall not be taken through a metal tube or be otherwise touching any metal part of the fitting. Fig. 2 shows a very simple and inexpensive type of lamp, of which a number are in use. The body is made from a piece of oak, about 3½ in. in diameter at one end and turned down to form a handle. The flexible wires pass through a hole down the centre to the lamp-holder and are clamped near the end of the handle, so that no strain can be put upon the connection in the lamp holder, which is of the

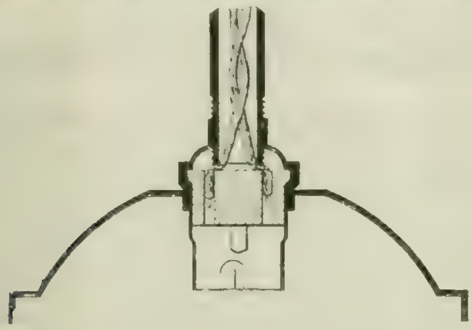


FIG. 1.

"batten" type, and is screwed to the flat disc end. The wire cage is attached by screws to the outside of the disc. There is no metallic connection between the lamp-holder and the wire cage, and there is no other metal used in the construction of the fitting except the hook at the end of the handle used for the purpose of hanging up the lamp. This hook should, however, be replaced by a leather or other non-metallic loop, as with constant use it might injure the insulating covering of the flexible wires where it rubs against them just beyond the end of the handle. With this slight alteration this lamp would be entirely free from the defects described above. As a result of the remarks on this subject in the last report, another design has been produced. In this case again the body of the lamp is of wood. The lamp holder, which is of the "cord-grip" type, is fixed in a vulcanite ring or cylinder which is extended so as to form a guard or sheath completely surrounding it. The wire cage is attached to a metal ring, which is screwed to the outside of the wood base. There is no possibility of any metallic contact between the cage and the lamp-holder. The lamp-holder is supported in such a way as to give a large insulating

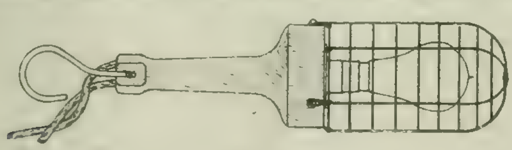


FIG 2.

surface between it and the metal cage-ring in view of preventing leakage by a film of moisture if the lamp is used in a damp situation. The only weak spot appears to be in the metal hook, which, however, can, without any difficulty, be replaced by a leather or other non-conducting loop.

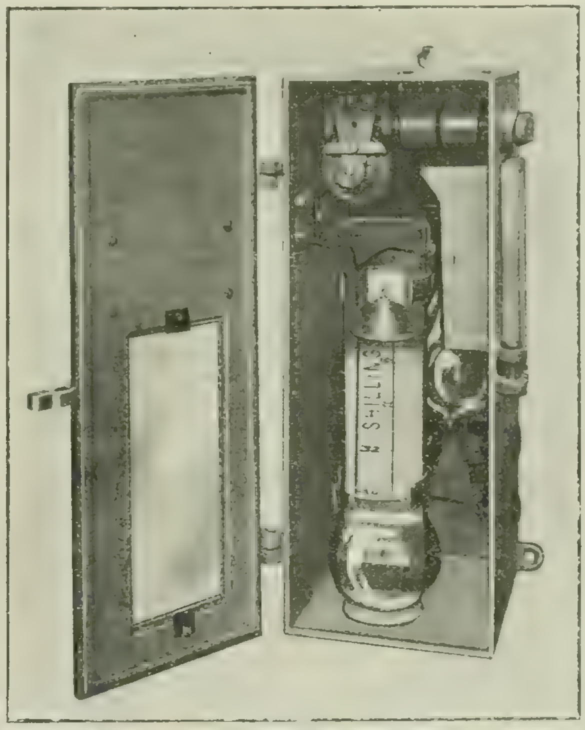
In conclusion, a number of defects are summarised which have been dealt with in previous reports. In some cases accidents have occurred from want of divisions or screens to shut off live conductors from those which are dead. Neglect of this precaution sometimes means that a labourer who is cleaning switches and conductors will work along until he finally comes upon live conductors without realising the danger.

No table is given this year of all the fatal accidents, as this is liable to be incomplete. As far as it is possible to gather information, there appear to have been nine fatalities in mines, seven on electric railways and tramways and one on the premises of an authorised electric supply undertaking. The danger of electric shock at low pressures is still not sufficiently realised, and during the past six years there have been three fatalities from continuous current and 22 from alternating current at 250 volts or less, and 11 in addition from three-phase systems not exceeding 440 volts per phase.

Tramways in the City of London.—In connection with the widening of Bishopsgate street Without, the Improvements committee of London County Council have intimated to the City Corporation that as the latter will not oppose the proposed construction of a tramway from the City boundary to Middlesex-street, they are prepared to recommend the Council to contribute half the net cost (£314,000) of widening the thoroughfare to 70 ft.

AN ELECTROLYTIC PREPAYMENT METER.

The electricity supply manager has always looked with favour on the prepayment meter, but his enthusiasm for the "pay as he goes" consumer has been checked by the cost of the apparatus required to collect the nimble "bob," and record its value in electrical energy by simple means. The slot meter must be of a reasonable price no matter what its claims to the notice of the station engineer. The cost of laying a service to a customer of the class accustomed to a prepayment system is often out of all proportion to the prospective return on the capital outlay. An inexpensive slot meter may also be expected to be of simple construction. The Electrical Apparatus Co., Caxton House, Westminster, London, S.W., has introduced such a meter, and confidently anticipates a response from those suppliers of electrical energy who can avail themselves of the opportunity which it presents. The meter is electrolytic in principle, and is, therefore, restricted to direct current circuits. Its general construction is shown in the adjoining illustration. It comprises a glass cell containing caustic soda into which a fixed and a moving electrode of nickel are placed. The former extends down one side of the cell, and is attached at the bottom to a second strip of nickel which faces it. The connecting link, however, is an insulating one of ebonite, and the second strip acts as a shunt to the moving electrode which is free to pass up and down the tube between the two



ELECTROLYTIC PREPAYMENT METER SHOWING CELL, ELECTRODES AND COIN OPERATED MECHANISM.

strips. This moving electrode is attached to a thin wire which passes round an insulated pulley pivoted in a bearing which is fixed near the top of the meter. This pulley is worm-geared to a horizontal spindle which is fitted with a cylindrical block having a transverse slot in it. This block is faced by a similar slotted block attached to a spring-controlled spindle extending outside the case and terminating in a short lever. Directly above the slots in the blocks referred to is a coin slot in the case through which the prepayment "fee," in shillings, is passed. The coin serves to temporarily connect the two spindles and the half-turn of the lever necessary to free the coin, causes the electrode to descend by a definite amount into the liquid. Further shillings inserted at the same time wind the electrode lower into the caustic soda. The action of the current passing is to electrolyse the water which is decomposed and gradually falls in the tube, the rate being directly proportional to the current passing. When the level falls below the centre electrode the circuit is not broken but is maintained across the cell by the second strip of nickel already referred to, and in the shunt circuit is an incandescent lamp in series with the installation. The effect of this is to lower the line voltage and dim the consumers' lights. Warning is thus given that further payment is necessary. As soon as another coin is inserted the lowering of the electrode cuts out the shunted lamp and restores the voltage of the main circuit. At the back of the cell is a scale marked off in shillings, and this, together with the moving electrode, can be seen

through a glass panel in the front of the meter. The same panel serves to emit a portion of the light from the shunted lamp inside the meter, so that should the customer be inserting coins at night the meter can be seen without the need for any other light.

The instrument is made in one size only, its capacity being 5 amperes, while it is suitable for all standard voltages. The "till" of the meter will hold 40s., and when the solution in the cell is decomposed it is easily replenished, the tube being withdrawn slightly from the meter for this purpose. The drop in the meter is about 4 volts. The whole construction is substantial and there are few parts to get out of order. The list price of the meter is 30s., subject, a figure which should ensure an immediate and steady demand.

LEGAL INTELLIGENCE.

D. Santoni & Co. (1906) Ltd. v. Farringdon Engineering Co.

Judge Edge, at Clerkenwell (London) County Court on Thursday last, concluded the hearing of a claim by D. Santoni & Co. (1906), Ltd., against the Farringdon Engineering Co., of Clerkenwell, for £45. 16s. 10d. for 314 armatures supplied.

On June 29 (as reported in our issue of July 3) the case was adjourned for the production of the original sample to which the armatures were made.

Richard Chadwick, rolling stock superintendent of Birkenhead tramways, said he made a trial with the coils. 33 were wound on the armature, but as soon as the controller was put on the first parallel notch the coils short-circuited. He wound another and yet another set of 33 coils, and the results were the same. He found the short-circuiting in nearly every case was between turn and turn of the coil. Afterwards the coils were returned to defendant company. They had no trouble with a previous consignment of coils.

In cross-examination Witness said the cars were running satisfactorily with coils of the same shape as those in dispute. There was no undue force used in getting the coils into the armature.

In reply to the Judge, Witness said it was his opinion that the wire, taken from an old dynamo in use for 15 years, was not suitable for tramway traction. The different temperatures of so many years would have the effect of making the wire brittle and perishing the insulation.

After further evidence of a similar nature, his Honour said he was satisfied the reasons given by the defence were very likely ones for rendering the coils defective. Birkenhead Corporation were entitled to have an article delivered to them that was reasonably fit for their purpose, but in his opinion the coils supplied by plaintiffs were not reasonably fit for the purpose of tramway traction. His judgment must be for defendants, with costs.

Koehler v. General Electric Co.

At the Birmingham County Court last week plaintiff (Mr. George H. Koehler) sued defendants for £100, alleged to be due to him as a bonus.

Mr. Joy (for plaintiff) said that, prior to 1906, his client was living in New York, and earning £900 a year. In 1906 he was engaged as works manager by the General Electric Co. at £700 per annum and a bonus to be fixed at the discretion of the directors. The first year he received his salary and subsequently a bonus of £100. In July, 1907, plaintiff represented to Mr. Railing, resident director of defendants, that he had been receiving £900 a year in New York, and could not, in justice to himself and his family, remain in England for less. It was then (plaintiff alleged) verbally agreed that, although the salary should not be altered in the books, he should receive bonuses bringing up the total to £900 for the ensuing year. In May he resigned, but, according to his agreement, should have continued with the company for three months. Although he was willing to remain he was told that it was unnecessary, and that the company would pay him the three months' salar . On May 12 he received a cheque for three months at the rate of £700 per annum, and afterwards he was given a further cheque for £100 as a bonus. This, he alleged, left a balance unpaid of £100.

Cross-examined by Mr. Hurst (for defendants), plaintiff denied that the original agreement made the bonus payable at the discretion of the directors. It was only the amount of the bonus which was to remain at their discretion for the first year.

Mr. Max Railing said plaintiff was engaged at £700, and, in the discretion of the directors, a bonus for the first year. The only alteration at the subsequent interview was that the bonus for the second year was fixed at £100, a total income of £800 being thus guaranteed. He denied that plaintiff told him he was earning £900 in New York before being engaged by the General Electric Co.

Judgment reserved.

Thomas Parker Ltd. : Clark v the Company. On Friday last Mr. Justice Joyce appointed the chairman of the company, Mr. C. T. Marler, receiver and manager in a debenture holder's action. Counsel for Mr. Clark said the capital was £75,000 and the debenture issue £45,000, his client holding £1,000 worth of debentures. The company had passed a resolution for voluntary winding up with the object of reconstruction, and plaintiff wanted the receiver and manager in possession during the reconstruction. The debentures fell due July 15. The Judge appointed the receiver and manager until Oct. 31, and gave him leave to act at once.

Underground Electric Railways Co. of London (Ltd.)—On Thursday last week Mr. Justice Swinfen Eady granted a petition by this company for the confirmation of its scheme for the conversion of its profit-sharing security notes into new obligations. Counsel for the company said it was formed in 1902 with a share capital of £5,000,000, of which £4,800,000 was paid. It had constructed the Baker Street & Waterloo Railway tube, the Great Northern, Piccadilly & Brompton Tube, and the Charing Cross, Euston & Hampstead Tube, and had electrified the Metropolitan District Railway. For the purpose of supplying electrical power to these four companies it had erected the power station at Lots-road, Chelsea, at a cost of nearly £1,400,000. The company also had a considerable interest in the London United Tramways. In addition to its share capital the company had issued £7,000,000 profit-sharing secured notes, £775,000 power house debentures and £300,000 secured temporary loans (outstanding). A scheme had been approved by the whole of the holders of the £7,000,000 profit-sharing notes except £28,000.

His lordship said his view was that, taken as a whole, the scheme was fair and reasonable, and probably the best that could be devised in the interests of all parties concerned. He therefore affirmed the scheme.

PARLIAMENTARY INTELLIGENCE.

POSTAL TELEGRAPHS AND TELEPHONES.

In the House of Commons last week, on the vote of £11,821,530 for salaries and expenses of the Post Office (including telegraphs and telephones), the Postmaster-General said that while the rev nue had been fairly elastic during the last two and a half years, and had been increasing by from £1,000,000 to £2,000,000 a year, the expenditure had unfortunately risen by a larger amount owing to the ordinary automatic increase from the increased amount of matter which went through the Post Office. Buildings were increasing, and as they anticipated taking over the telephone system in a few years, that would add to expenditure as their own telephone system had already done; and in addition to the ordinary increase in the rates of pay of the staff, in the last two or three years expenditure had been increased to meet recommendations of the Hobhouse Committee very materially, and the ultimate result would be no less than £1,000,000 a year. They found that the telephone system, which was cutting materially into the telegraph system, was doing something to diminish the number of letters. He need not dwell on the disastrous history of their telegraph system. It was over-capitalised to start with; then came the reduction to 6d. telegrams, and now it was carried on at a very great annual loss to the Exchequer. The only remedy suggested was the introduction of 3d. telegrams, but the result of that would only be to double the loss. They were determined, looking to the experience of the telegraph system, that the telephone system should remain on a paying basis. It was quite clear that it ought to be on a business basis. Various proposals had been made for modifying rates. The matter was still under discussion, and he was glad that the Post Office, in this respect and in other respects, of late had got into more intimate touch with the chambers of commerce and others who were interested in those matters, so that they could be discussed from the point of view of the public. Complaints were made that the telephone system was not always quite as effective as it ought to be, and that sometimes more calls were charged for than had been made. The complaints made as regards the Post Office system were necessarily much less than those made against the National Telephone system, because the Post Office system was much the better system of the two. He would like to point out to those who complained of overcharges that, as a matter of fact, they could not be overcharged. Their experience was, so far as the automatic check was concerned, that if there was a balance of incorrect calls, it was rather in favour of the customer than of the office. The impression that there had been overcharges was greatly due to the fact that people were not always aware how much their telephones were used. The underground telegraph work was making progress. They had spent about £1,250,000 on it—about £230,000 this year—and it was gradually spreading throughout the country. The question of underground telegraphs was not merely a local one. Every mile made of the underground telegraph, which saved the wires from storms, especially where added in connection with submarine telegraphs, was equally advantageous to any particular town, whether it was added close to it or nearer to a submarine cable. Therefore it was not merely a question of a particular expenditure in a particular locality, but of the best system under which it could be expanded. As regarded overhead telegraphs, the House had read a third time a bill which would assist him in obtaining wayleaves from obstructive individuals. In regard to the question of wireless telegraphy, the Convention of last year had now been ratified by the Government for all the Colonies with the exception of Newfoundland, which was peculiarly situated, and the Orange River Colony, which had no sea board, and had been ratified by all the great Powers with the exception of the United States. The United States, he had no doubt, would ratify the Convention later; they knew that in principle they were in favour of the Convention. He was glad to say that the relations between the Post Office and the great Marconi Company, which until lately were of a somewhat unfriendly character, were now of the most friendly kind, and that they had accepted and adopted the principle of the Convention—the principle of intercommunication. He was sure they were wise in doing so; the result would be largely to extend their operations. He should like to say, looking to the telegraph system and telephone systems in the past and their experience in the matter of buying them out, that they did not desire in regard to wireless telegraphy to put themselves in

the same position. They were not going to allow any monopoly in regard to a particular system. Last year they started two experimental stations. They were now working commercial stations which would enable them at any moment, if they desired to do so for postal purposes, to extend their operations without having to buy up companies and monopolies.

CENTRAL IRELAND ELECTRIC POWER BILL.

On Thursday last Lord Donoughmore's Committee of the House of Lords resumed the consideration of this bill.

Sir R. LITTLER (for the Alliance and Dublin Gas Consumers' Co.) said the bill had been so truncated that the Gas Company were now the only opponents, and they did not object if only the area served by the Gas Company was struck out of the scheme, and the promoters confined their attention to the Bog of Allan. He contended that this was not a bill for the supply of power, but merely for the purpose of obtaining the bye-product of sulphate of ammonia. Let the promoters harness the bog, and stay there, instead of launching a wild cat scheme.

The CHAIRMAN announced that the Committee had decided to pass the preamble.

Mr. PATTEN asked for the insertion of a clause providing for compensat ion being paid to the Gas Company in case of injury to their mains.

Mr. FREEMAN, K.C. (for the promoters) assented and the proceedings terminated.

MILE END TRAMWAYS.

In the House of Commons on Wednesday Mr. B. S. STRAUS asked the President of the Board of Trade whether, on July 15, a horse was electrified by a live stud in the Mile End-road, London, and severely burned on the flank and forelegs.

Mr. W. CHURCHILL said the Board of Trade were informed by London County Council that on the date named a horse came in contact with a stud which was electrically charged, and sustained some slight injuries. The use of the surface system of traction on the tramway had been sanctioned as an experiment for a period of six months from June 23, and he was informed that the Board of Trade had no power to withdraw this permission within that period.

London United Tramways Bill.—This bill was passed by a Committee of the House of Lords on Tuesday. It gives the company power to carry a tramway over Kew Bridge, and so to connect the systems of the company on each side of the water. The company have agreed to pay the County Councils of Middlesex and Surrey £1,000 yearly for the use of the bridge. The Councils ask ed that the company should be required to construct the tramway on the conduit, or some system other than the overhead system, and there was a further claim that the authorities should have the control of the tramway on the bridge. The Committee declined to allow a clause to be inserted giving control to the Councils, but allowed the Councils a locus before the Board of Trade in regard to the question whether the system adopted should be surface contact, overhead or conduit.

Keighley Corporation Bill.—This bill, which confers additional powers on the Corporation in regard to electricity supply, came before a Committee of the House of Commons on Tuesday. In regard to the clause which dealt with consumers who failed to pay for gas or electricity supplied to them, the chairman thought that because a man did not pay his gas bill his supply of electricity, if he had one, should not be cut off. The representative of the L.G. Board pointed out that in the Burnley bill a similar clause was struck out.

Mr. HARPER (for the Corporation) mentioned that last year in the Brighouse bill a clause was allowed giving power to cut off the supply of electricity in case of non-payment.

The CHAIRMAN said that clause was not specially considered on that occasion. The Committee felt that the Corporation should not have power to cut off both gas and electricity when a consumer was only in arrears for one. He advised Mr. Harper to submit an amended clause.

MUNICIPAL, FOREIGN & GENERAL NOTES.

APPOINTMENTS VACANT AND FILLED.

Foreman electrical instrument maker is required, well acquainted with modern requirements and rapid production of work. See advertisement.

Well connected engineers are wanted as district agents for steam plant suitable for electrical work. See an advertisement.

A junior assistant is required for the electrical laboratory in Hadfield's Steel Foundry, Sheffield. See advertisement.

A junior invoicing clerk is required in the lamps department of an old-established electrical firm. See advertisement.

An assistant lecturer and demonstrator in physics and electrical engineering and a demonstrator in chemistry are wanted for Huddersfield Municipal Technical College. Salaries £120 and £80, respectively.

An electrical tester is wanted at Gibraltar Dockyard. Pay 62s. 6d. to 65s. 6d. per week. Applications to Electrical Engineer, H.M. Dockyard, Portsmouth, by July 30.

The Governors of the Royal Holloway College, Englefield Green, Surrey, invite applications by July 31 for the position of chief of the physics department.

Mr. Wm. Corin, consulting electrical engineer to Launceston (Tasmania) Corporation, has been appointed electrical engineer to the Department of Public Works, Sydney (N.S.W.), at a salary of £750 per annum.

EDUCATIONAL NOTICES

University of Manchester (Engineering Department).—A prospectus of the lecture, laboratory and drawing courses in engineering, and the course in physics (including electrical engineering), mathematics and chemistry, qualifying for the degrees in engineering and the engineering certificate, is now ready and may be obtained fr om the Registrar. The new and enlarged engineering laboratory will be opened early in the session.

King's College (London).—The session 1908 9 commences on Sept. 30. In addition to the ordinary day courses in the faculty of engineering and applied science, there are evening classes in mechanical and electrical engineering, architecture and building construction, drawing mathematics, physics and other science subjects. There is a large staff of lecturers and demonstrators, and prospectuses, &c., from the secretary, Mr. Walter Smith, Strand, W.C.

Northampton Polytechnic Institute (London).—The full day courses in the theory and practice of mechanical and electrical engineering will commence on Monday, Oct. 5. Entrance examination on Sept. 30 and Oct. 1. The courses include periods spent in commercial workshops and extend over four years; they also prepare for the degree of B.Sc. in Engineering at the University of London. Three entrance scholarships of the value of £52 each will be offered for competition at the entrance examinations in September. In the technical optics department there are full and part time day courses. Full particulars as to fees, &c., can be obtained at the Institute or on application to the Principal, Dr. R. Mullineux Walmsley.

Camp Lighting.—Woking Electric Supply Co. are supplying current for lighting in the N.R.A. offices and the umbrella tent at Bisley Camp. 73 lamps have been installed in the N.R.A. offices by H. Quartermaine, of Woking.

Dundee.—The Tramways committee have considered the question of introducing the trackless trolley system.

The city electrical engineer (Mr. H. RICHARDSON) stated that the cars the deputation to the Continent had seen in operation would not be suitable in Dundee except on a level road, and if the system were to be inaugurated in different portions of the city new cars with brakes would have to be built.

The committee decided that before anything was done the sub-committee which recently visited the Continent should submit a complete report.

Exhibition.—An international rubber and allied trades' exhibition will be held in September at the Royal Horticultural Hall, Westminster, London. The official opening will take place on Sept. 21.

Farnworth.—An inquiry was held here recently into the application of the Council for permission to borrow £7,000 for electric lighting extensions.

The electrical engineer (Mr. R. B. LEACH) said the demand for electrical energy was increasing at a constant and steady rate. He found they could purchase current in bulk from the Lancashire Electric Power Co. at a rate cheaper than they could generate it for themselves. Dr. E. Hopkinson, of Manchester, had reported favourably on the Council's scheme. They proposed to take three-phase current at 10,000 volts and convert it to 500, 400 and 250 volts as required. The proposed expenditure included £1,281 for new engine house, stores, &c., £2,500 for transforming plant, £450 for switchboards, £300 for battery extension, £700 for new services, £100 contingencies, £1,281 spent in anticipation and £385 for floating expenditure.

Finchley.—The salary of the electrical engineer (Mr. E. Calvert) has been increased from £450 to £475 per annum.

Fire on the City & S. London Railway.—Lieut.-Col. Yorke and Mr. A. P. Trotter held an inquiry on Monday at the offices of the company in Moorgate-street, London, into the circumstances attending a fire which occurred on the line on 16th inst.

P. KELLY, lift machinery attendant, stated that shortly before 6 p.m. he saw what appeared to be a small fire at the points on the down road. The under sides of two sleepers were on fire. He threw some sand on the place, but this seemed to have little effect, so he informed the stationmaster, who also applied sand. Finding that little could be done, the stationmaster returned to the platform to see that every one left the train then in the station and ascended to the street. The flame ran in the direction of the cables. There seemed to be a small explosion on the other side of the down road. A little later he returned, but could see nothing but smoke.

F. C. NICHOLS, linesman, said as he approached the fire with some sand the cable blew out. He advised the stationmaster to switch off the current.

Col. YORKE: Was the smoke collecting in the station?—Yes, when I came out of the tunnel the second time. The air current was towards the station.

Mr. P. KNOWLES, stationmaster, said, standing on the platform, he saw a fire about 40 yds. away in the tunnel in the direction of the

Bank station. He took sand to the spot and found the sleepers on fire underneath. The main cable then became ignited. He saw Kelly switch off the current from the section. Although there was smoke in the station, the 120 passengers were not nervous, but left the station in the usual way. Most of them were carried up by the three lifts which were running. The fire brigade arrived about 6:15, and by that time smoke was beginning to show itself in the street above.

Mr. A. P. Trotter read a number of newspaper extracts, and questioned witness as to their accuracy. Witness, in reply, denied that passengers made a hurried exit, driven out by the noxious fumes, or that ladies were screaming.

Mr. Trotter: Supposing a train were on the up line from the Bank and were stopped in the tunnel on account of this fire—supposing the signal were against it to prevent it from entering the station, it would stay in the tunnel?—It would stay there until I could fetch it in. If the officials had any intimation of a fire they would at once block both roads. If a train had already started from the Bank there would be the "outer" and the "inner" home signal to stop it. If a train were held up in the tunnel and the smoke were driven in that direction it would, if unable to "clear back," be in a serious position. But passengers could alight from either end of the train, and could walk back to the Bank station assisted by the officials. It was possible to back a train along the line, but it was an unusual thing to do.

By Mr. T. C. Jenkin (manager of the company): In case of a train stopping between the Bank and Moorgate-street and unable to go into the latter station in consequence of fire, the driver would communicate by telephone either with Moorgate-street or the Bank station. He would at once tell them to instruct the guards to take the passengers on to the Bank, the electric lights would be switched on from the Bank and from Moorgate-street, and they would go through lighted tunnels without risk to themselves.

Mr. P. V. McMahon (chief engineer to the company) said the lights would be switched on half-way from the Bank and from Moorgate-street half-way. If any unusual delay occurred in the arrival of a train from the next station, say four minutes, the lights in the tunnel would be at once switched on by the signal man. He could not ascribe any cause for the fire. About four or five minutes elapsed between the discovery of the fire and the shutting off of the current to make the line "dead."

A. E. Limberick, driver in charge of a train which left Old-street station at 5:47 p.m. said when he arrived at Moorgate-street he saw "a little fire," but it was practically subdued. So far as he could see three men were throwing sand on it. He sometimes saw evidences of little fires on the line, and reported them to the stationmaster at the next station. If he were held up in the tunnel by a fire he would connect his telephone with the telephone line in the tunnel and warn the signalman in both directions. Several years ago, owing to a locomotive breakdown, he had had to get the passengers to walk back. They seldom had such breakdowns now.

Mr. McMahon said at rare intervals pieces of cotton waste had been found on fire in the tunnels. He did not know how they became ignited, because the quantity would not be large enough to start a fire by spontaneous combustion. Sometimes a small light occurred at the base of the insulator near the sleeper. The remedy was to send a man to brush away any accumulation of carbon.

Mr. Trotter: Have you any theories to suggest as to the cause of this fire?—From the evidence I am convinced it was not of electrical origin. Whenever large repairs have been undertaken of late wood was replaced by slate slabs where that was possible. He did not think the cables were the cause of the fire.

Mr. Trotter said that when he visited the tunnel after the fire he found four sleepers badly charred on the up line. One newspaper stated that "for some distance the permanent way had been destroyed," and another alleged "that the track for over 100 yds. leading into Moorgate-street station had been destroyed."

Mr. McMahon said there was no truth whatever in these statements. Only 5 ft. or 6 ft. of permanent way on each road was damaged. So far as the permanent way was concerned running could have been resumed half an hour after the outbreak was extinguished. The smoke and smell were probably due to the coating of the cables. There was a certain amount of wood smoke. It was important to have a cable covering which was not liable to fire, and he thought that perhaps the inverts might be filled up altogether. It was absolutely untrue to state, as one newspaper had done, that the iron sides of the tunnel became red hot. At no time were the passengers in any danger. The case of a train held up in the tunnel and the smoke drifting back upon it was the only dangerous situation that could happen, but even then the passengers could be got out in the way described by a former witness. He had formed a theory that possibly the fire was caused by a spark from the shoe of the locomotive.

The inquiry was adjourned.

Glasgow Coatbridge Tramway Project.—Glasgow and Coatbridge representatives last week discussed a proposal to extend the Glasgow electric tramways to Coatbridge. It was arranged that a formal memorial should be presented to Glasgow Corporation.

Greenock.—Negotiations are proceeding between the Corporation and the Admiralty as to the supply of electrical energy to the new torpedo factory.

It has been provisionally agreed that the Admiralty will take from the Corporation the whole of the supply for power and lighting for a period of [illegible] years, and that the rates offered by the Corporation are to be reduced in the event of a general reduction of prices. The Corporation are to supply up to 200 kw., with such increase as may reasonably be demanded, provided the Admiralty give six months' notice of their requirements. It is expected that the supply will be required in about 18 months.

Hastings.—The Council have sanctioned the continued running of the tramcars on Sundays, provided that, in the event of the Corporation purchasing the undertaking, the Sunday receipts shall not enter into the valuation.

Hindley.—The Board of Trade have deferred for a year the question of the revocation of the Council's electric lighting order.

Institute of Chemistry.—Of 24 candidates who presented themselves for the intermediate examination (in London and Glasgow) the following 15 passed:—

H. L. Allen, B. S. Evans, B.Sc., C. E. C. Ferrey, H. A. Goldsbrough, L. Goodban, T. R. Greenough, B.A., D. Henville, G. Hogan, A. P. Imrie, G. E. Johnson, B.Sc., Osman Jones, H. T. Reeve, E. H. Shepherd, B.Sc., R. W. Warrick and J. Young. 20 candidates presented themselves for the final examination in the branch of mineral chemistry and 14 passed: J. Boyd, J. Brebner, M.A., B.Sc., R. Bruce, G. S. Butler, B.A., A. M. Cameron, B.Sc., W. Cameron, G. A. M. Cunningham, M. C. Fletcher, G. A. Freak, B.Sc., J. V. J. Hayman, A.C.G.I., A. Hepburn, J. W. H. Pattison, A. S. Petrie, and Miss M. M. J. Sutherland. In the branch of metallurgical chemistry, of two examined one passed: R. T. Rolfe. One candidate was examined in the branch of physical chemistry, but did not satisfy the board. Of nine candidates who presented themselves in the branch of organic chemistry, four passed: N. C. Akers, J. Kenyon, B.Sc., H. R. Norton, B.Sc., and W. F. Russell.

Institute of Metals.—The recently formed Institute of Metals is making good progress. At the first meeting of the interim council over 200 members were elected.

The next meeting of the interim council will take place in September, when it is hoped that the rules will be finally fixed and some definite steps taken to appoint a permanent secretary, with offices. A general meeting, at which Papers will be read, will probably be held in Birmingham in November. The members of the interim council are:—Sir W. H. White, K.C.B., F.R.S. (president), Engineer Vice-Admiral Oram, C.B., J. D. Bonner, G. A. Boeddicker, J. A. Bayliss, Norman C. Cookson, J. Corfield, E. E. Dendy, Dr. F. Elgar, F.R.S., Prof. Gowland, R. Kaye Gray, G. B. Hunter, J. T. Milton, G. H. Nisbett, R. Pearce, T. Hurry Riches, E. Ristori, L. Sumner, and Cecil H. Wilson. Prof. T. Turner, of Birmingham University, is treasurer.

Leigh (Essex).—The Council are considering an offer by a syndicate (for which Mr. W. Ivey is acting) to construct a light railway between Leigh and Hadleigh, and also for establishing electricity supply in Leigh.

Liverpool and District Electrical Association.—At the annual meeting on Tuesday the report and balance-sheet for the past 12 months was presented by the hon. secretary and treasurer (Mr. S. Frith) and was unanimously accepted, there being a satisfactory balance carried forward.

The election of the officers for the present year resulted as follows: Mr. H. E. O'Brien, president; Mr. J. A. Crowther and Mr. C. W. Mallins, vice-presidents. Members of Council: Messrs. H. W. Brooks, J. Greenhalgh, W. H. Hamilton, R. A. Lambert, C. I. Moore, J. Maxwell and J. J. Richardson. Mr. Samuel Frith (77, St. John's-road, Bootle), hon. sec. and treasurer; and Mr. J. T. Stanbury, assist. hon. sec. and treasurer.

London County Council.—On Tuesday a loan of £2,520 was granted to Stepney for electricity meters.

Invention.—On the recommendation of the General Purposes committee it was agreed to allow Mr. E. W. Dickinson (superintendent of the Greenwich electricity generating station) jointly with Messrs. Hopkinson & Co. to take out a patent for an improvement relating to steam valves.

Nine Elms-road to Falcon-road Tramways.—The adjourned recommendation of the Highways committee recommending capital expenditure of £89,370 for reconstructing these tramways was adopted.

G.B. Surface Contact System.—The adjourned recommendation of the same committee was submitted recommending the expenditure of £3,372 in respect of the provision of magnet equipments for the Aldgate and Bow Tramways, and that an agreement be entered into with the G. B. Surface Contact Co. in respect of the provision of such equipment.

Mr. Whittaker Thompson, chairman of the committee, made a statement to the effect that in view of reports made the committee saw no alternative but to advise the Council to cease to use the G. B. surface contact system on the Bow-road tramways. The decision had been come to on official reports showing that there had been accidents. The heavy traffic and the character of the mud in this particular road had apparently been too heavy a trial for this system, and although they did not doubt it would work successfully under more favourable circumstances they had no alternative but to recommend its abandonment on this route. This recommendation was adopted.

Lighting of Westminster Bridge.—The Highways committee reported that they considered the substitution of electric arc lamps for the existing gas lamps would be a great improvement and that a saving of £74 a year would be effected. It was agreed to invite tenders from selected firms.

L.C.C. Tramwaymen's Grievances.—The London District Council of the Tramway and Vehicle Workers' Association have passed a resolution:—

That taking into consideration the unnecessary delay of the London County Council in dealing with the programme for improved conditions of labour placed before them by the tramway employes in May, 1907,

the executive council be requested to forward an ultimatum to the London County Council that if a satisfactory reply is not received within 21 days due notice be given (as per rule) that the executive council will take a ballot of the members with a view to withholding their labour.

L.C.C. Tramways.—Stoke Newington Council decided on Tuesday to ask London County Council to promptly convert the Green Lanes Moorgate tramway route to electric traction.

Malvern. The electric lighting mains are to be extended to Malvern Wells at a cost of £600 to £800.

Mexico.—Writing on the trade of Tampico in 1907, Mr. Consul H. W. Wilson points out that it is essential in order to increase the bulk of British trading in Mexico to send out capable commercial representatives with a thorough knowledge of Spanish, and provided as far as possible with samples.

During 1907 the electric street car service of Monterey was completed, the work having been carried out by a Canadian firm of contractors.

The Saltillo municipal authorities have completed their extended electric generating station, in substitution of the smaller station formerly in use.

Naval Electricians.—It has been decided to authorise, as a temporary measure, the transfer of armourers to the rating of electrician, subject to the following special provisions:—

(1) The privilege of transfer is to be limited to chief armourers and armourers passed for chief armourers, who have shown marked mechanical ability and general efficiency. (2) Men who desire to present themselves for examination for transfer to electrician must be reported to possess sufficient ability to pass the educational and trade examination prescribed for candidates from the shore. (3) The candidates selected are subsequently to undergo a modified electrician's course on board H.M.S. "Vernon" or "Defiance," and at the conclusion of the course to pass the examination for acting electrician fourth class, as prescribed above. (4) Men who pass this examination may be transferred to the rating of acting electrician fourth class by order of the commander-in-chief, and they are to receive the pay and wear the uniform of their new rating from the date of the commander-in-chief's approval.

Nice.—Four large electric cranes were erected at this port in 1907 and early in the present year the fifth, with a lift up to 30 tons, has been provided.

Porto Rico.—The work upon the new electric railway between the capital of this most recent of United States possessions and Caguas is approaching completion.

Presentation.—On leaving Burton-on-Trent to become station superintendent at Carlisle Mr. Thompson has been presented by the staff with a number of books on electrical engineering.

Private Fire Brigades' Competition.—The annual competition of the London private fire brigades took place at the Crystal Palace on 18th inst., and the Robertson fire brigade again won the shield presented by Sir Thomas Dewar for the best drill. In the championship totals the Robertson brigade came out second out of 23 competitors.

Rawtenstall.—The Corporation have purchased the undertaking of the Rossendale Tramways Co. for £21,750, and the contracts in connection with the conversion of the system to electric traction make the total commitments to date £114,389, exclusive of cost of new cars.

Southwick.—The joint committee of Portslade, Shoreham and Southwick Councils has decided not to agree to the application of Brighton Corporation for an electric lighting order for their districts under the condition proposed by Brighton that the price of current should be left to the Corporation to decide so long as it did not exceed the Board of Trade maximum.

Spain.—The Public Works Department, Madrid, have authorised Senor J. de la Rosa y Diez to prepare plans for an electric railway from Valladolid to Toro.

Surbiton.—The Council have adopted the new schedule of charges submitted by Callender's Cable & Construction Co. (who operate the local electricity works), which show a substantial reduction in nearly every item. At the recent conference between representatives of the Council and the company and the L.G. Board inspector (Mr. Hooper), the company offered to make a uniform charge of £5 for each service, including service box and its connection to main, supply and lay service cable and all necessary excavation and temporary reinstatement. This offer has also been accepted.

Taunton.—The Council have received sanction to a loan of £1,670 for electricity supply extensions.

West Ham Tramway Route Guide.—West Ham Corporation has issued an official guide, timetable, map and handbook of its electric tramway system. The booklet contains useful information as to the routes over which the tramways run, places of interest, walks reached by the outer termini, traffic facilities, &c., and it should prove useful in encouraging both residents and visitors to make greater use of the trams. It is issued gratis. We notice that the issue of such guides by electric tramway undertakings is becoming general, the London County Council having lately issued a useful pocket companion in this class.

Outings.—The employés of the Chloride Electrical Storage Co. had their annual picnic to the Dukeries on Saturday. The weather was fine and a large gathering assembled. After breakfast a drive of some 15 miles was taken through Welbeck, Edwinstowe, Thoresby and Clumber, returning for dinner, which was presided over by the officials of the company. As last year, a badge worn by the men consisted of a white metal miniature of the company's "R" type plate suspended by red and black silk ribbon. The arrangements were admirably carried out, and the outing proved very enjoyable.

On the 18th inst. Messrs. E. P. Allam & Co. held their annual works outing at Rye House, Herts. The dinner was presided over by Mr. E. P. Allam, who, in responding to the toast of the firm, detailed the progress of the different departments.

On July 11 the second annual outing of the staff of West Ham Corporation's electricity department took place in ideal weather conditions. The party journeyed to Broxbourne, Herts., where, after dinner, a programme of athletic sports was carried out. One member of the staff, Mr. Walden, displayed great versatility by winning the 100 yds. handicap, the mile run, and the sack race. Mr. Bignell won a half-mile walking match, and Mr. Mackenzie made a top score by putting the shot (16 lb.) a distance of 31 ft. 9 in. In the tug-of-war the generating station team showed their skill and won.

ELECTRICITY SUPPLY AND TRAMWAY ACCOUNTS.

Croydon.—The electricity department report and accounts show £6,730 capital expenditure for the year ended March last, making the total £339,203.

Revenue was £66,938 and expenditure £31,133 (against £28,217), leaving (with £10,248 brought forward and other sums brought in) £46,597. The net profit on the year was £12,242 (£8,928), but against this coal bunkers and conveyor have cost £2,100. Of the balance, £5,000 has been placed to reserve, £1,512 devoted to public lighting improvement and £1,488 to distribution improvement, leaving £14,490 balance in hand. 7,005,141 (6,027,338) units were generated. 655,762 (674,173) were supplied to public lamps, 3,044,362 (2,292,047) for traction and 2,174,879 (1,970,637) to private consumers. The maximum supply demanded was 3,255 kw. (against 3,381 kw.).

The report states that this is the first time the contribution to sinking fund (£11,082) has exceeded cost of new works (£6,730). There are 2,902 (2,646) consumers, and the average price for private supply was 3·6d. (3·8d.). The efficiency of distribution was 84·03 per cent. (82·8 per cent.). The more general use of metal filament lamps has given great satisfaction, though minimising the rate of increase of units sold for lighting. The saving in some individual consumers' accounts is shown as high as 48 per cent. There has been a satisfactory increase in the quantity of current sold for power, and the time switch system of charging for same has proved satisfactory.

Capital expenditure of the tramways department was £275,717.

The total revenue was £75,064 and traffic receipts £72,211. Working expenses were £55,807, gross profit £19,258, interest and income tax £8,965, sinking fund and repayment of loan £7,388 and net profit (placed to renewals fund) £2,830. 16,277,418 passengers were carried and 1,884,137 car-miles run. The total revenue per car-mile was 9·44d. and traffic revenue 9·20d. (9·88d.). 2,247,586 units were used for all purposes (increase 428,292), costing £18,730 at 2d. per unit (increase £3,569). 1·19 (1·01) units, costing 2·38d. (2·02d.), per unit were used per car-mile. Attached to the report and accounts are (1) a route plan of the tramways and charts showing (2) cars run per week during the year, (3) weekly receipts for the year, (4) highest and lowest day's receipts and average day's receipts on each day of the week and all days of the week, and (5) weekly consumption of current per mile (and cost of same) during the year.

Hull.—The revenue of the tramways department for the year ended March last was £129,837, including traffic receipts £128,722 (10·22d. per car-mile).

Gross profit was £55,645, after paying total expenses £74,118. Power cost 0·94d. (0·76d.) per car-mile and total expenses 7·84d. (7·75d.). 3,617,096 (against 3,349,964) units of electrical energy were delivered to the tramways, and the works costs for producing same were 0·74d. (0·63d.) per unit. Interest required £13,364, sinking fund £9,659, income tax £1,404, and contribution to district fund £2,528. Net profit was £29,895, of which £20,000 is reserved for relief of 1908-9 borough rate and £9,895 carried to reserve. The passengers carried were 30,964,254, the average fare per passenger 1d., the car-miles run 3,022,844, units consumed 3,865,051. Capital expenditure is now £438,235.

Manchester.—The traffic revenue of the tramways department for the year ended March was £760,994. 3s. 11d.; parcels receipts were £1,219. 16s. 7d. and other revenue £6,858. 14s. 4d., making a total of £769,072. 14s. 10d., against £719,673. 4s. 10d. in 1906-7.

Working expenses were £600,022. 16s., leaving gross profit of £269,049. 18s. 10d. plus £2,103. 9s. 9d. for interest. Interest on capital debt was £49,035, sinking fund £41,748, rent of tramways £21,195, income tax £6,197, parliamentary expenses £4,847. Net profit was £146,893 (against £147,039), of which £87,790 has been placed to reserve, renewals and depreciation, £55,000 contributed to relief of rates £4,108 applied to street improvements, &c. The decrease in the receipts per car-mile, from 11·02d. to 10·76d., is mainly attributable to inclement weather. Working expenses increased by 0·04d. per car-

mile owing to a large increase in cost of compensations and a slight increase in cost of maintenance of permanent way. The number of cars in stock was 566. The top covers for 240 cars have been fitted in the department's own workshops, and the work of covering additional cars is being proceeded with. The committee has purchased about 6½ acres of land at Moss Side to accommodate 250 cars.

The gross capital expended at date of report was £1,776,629, against £1,725,844. The car-miles run were 16,974,955, against 15,523,459, and 151,477,138 passengers were carried (143,264,501). During the year over 7 miles of single track were opened for traffic, making the total at March 31 last 176 miles 1,337 yds.

Tunbridge Wells.—The electricity department's capital expenditure for the year ended March last was £350, making the total £81,826.

Revenue was £14,675, expenses were £8,830, leaving £5,846 to be carried to net revenue account. Interest and sinking fund required £4,704, and the balance, £1,142, added to £5,221, brought forward, enables £3,000 to be placed to reserve, £531 to suspense, and £2,831 to be carried forward. This result is regarded as satisfactory in view of the fact that 28s. 3d. per ton is still being paid for coal. 1,110,038 (1,049,110) units were generated, 246,464 (265,327) supplied to public lamps, and 653,269 (597,605) to private consumers. The maximum demand was 682 kw. (671 kw.). There are 64,126 (62,158) equivalent 8 c.p. lamps connected.

Weymouth.—The accounts of the electricity department for the year ended March show capital expenditure £46,609, increase £177.

Revenue was £5,672 and expenditure £2,727, gross profit was £2,945. Capital charges, interest, &c., came to £3,043, leaving a deficit of £98. Works costs were 1·09d. (against 1·29d.), and total costs 1·63d. (2·11d.), or including capital charges 3·68d. (4·41d.). Total revenue was 3·62d. (3·71d.). 353,415 (303,944) units were supplied for all purposes. The total connections in equivalent 33 watt lamps are 23,893 (20,235), including motors 3,336 (2,639). The maximum load was 301 kw. (269) and the load factor 13·36 (12·89) per cent.

Willesden.—The accounts of the electricity department (which takes current in bulk from the North Metropolitan Electric Power Supply Co.) for the year ended March last show capital expenditure £181,763, increase £11,826.

The year's revenue was £24,946 (against £20,229 in previous year). Expenses were £16,748, including cost of current purchased £11,750 (1·407d. per unit). Gross profit was £8,198 (£6,662), and after meeting capital charges (£7,541) the net profit was £725 (against £174 deficiency). There are 1,932 (1,703) consumers with 97,736 (83,198) equivalent 8 c.p. lamps. Motors connected aggregate 725¼ H.P. (534½ H.P.). The maximum load was 1,358 kw. (1,108 kw.). 2,004,253 (1,441,834) units were sold. The total working and general expenses were 1·902d. (2·191d.), capital charges were 0·990d. (1·112d.), and total costs 2·805 (3·303d.). Public lighting took 303,075 units, which were purchased at 0·812d. per unit.

During the year a new departure has been made by distributing alternating current (transformed down from 2,800 to 240 volts) to 250 consumers in Cricklewood.

Wolverhampton. The electricity department accounts for the year ended March show capital expenditure £218,765 (increase £34,335).

Revenue was £30,926 (against £27,525), total expenses were £15,831 (£13,073), gross profit was £14,845 (£14,302), interest and sinking fund charges were £11,797 (£10,905), and net profit £3,325 (£3,653). 5,452,731 (4,553,855) units were generated, 173,858 (151,472) supplied to public lamps, 18,840 (20,003) by contract, 2,797,983 (2,115,058) to private consumers by meter and 1,563,776 (1,580,992) for traction. The maximum load was 2,450 kw. (2,075 kw.). There are 129,559 (110,706) equivalent 32 watt lamps connected besides the public lamps. The decrease in amount of net profit is due to the fact that the greater part of the year's capital expenditure was upon extensions to the main generating station from which extension no revenue was obtained during the year dealt with in the accounts. 283 motors of an aggregate of 2,135 B.H.P. are connected to the mains (increase 586 B.H.P.). The reserve fund now stands at £11,395 and £18,888 has been repaid off capital.

TRADE NOTES AND NOTICES.

TENDERS INVITED.

By command of the *Postmaster General* tenders will be received until noon Sept. 7 for supply of telegraph poles of (*a*) home grown larch or fir and (*b*) Swedish, Norwegian, Finland or Russian red fir, delivered at one or more ports in the United Kingdom as directed. Forms of tender from the Controller of Stores (Mr. G. Morgan), 17 19, Bedford-street, London, W.C. See also an advertisement.

Hull Corporation invite tenders for supply of (1) ironwork and (2) insulator bolts and cups for the telephone department. Tenders to town clerk (Mr. E. Laverack) by 10 a.m. July 27.

Hull Corporation also require tenders for a 900 kw. 500 to 550 volt d.c. generator, with Belliss high-speed engine. Specification, &c., from the City Engineer, Town Hall, Hull. Tenders to the Chairman of the Tramways committee by noon of Monday, July 27.

[illegible] Corporation want tenders by 9 a.m. Aug. 1[illegible] for supply of steel steam pipes and c.i. circulating water pipes at the electricity works. Specification, &c., from the Borough Electrical Engineer.

IMPORTANT NOTICE.

Extra Copies of "The Electrician" Special Mining Issue (July 10th, 1908), are obtainable, price 1/- nett (post free U.K., 1/4; abroad 1/6).

Leeds Tramways committee require tenders by 4 p.m. July 27 for re-construction of two portions of tramway track. Specifications, &c., from the Tramways Office.

The Governors of Canterbury College, *Christchurch* (N.Z.) invite tenders for supply of (*a*) a 20 H.P. experimental Pelton wheel, with direct-driven dynamo, (*b*) an 8½ H.P. experimental low-fall turbine, and (*c*) a Venturi water meter. Specifications from the High Commissioner for New Zealand, 13, Victoria-street, Westminster, S.W. Offers to the Board of Governors, Canterbury College, Christchurch (N.Z.), by noon Sept. 24.

The Deputy Postmaster-General, *Brisbane*, wants tenders by mid-day Aug. 24 for ironwork, insulators, copper and covered wires and accessories. Specifications from 72, Victoria-street, London, S.W.

The Deputy Postmaster-General, *Adelaide*, requires tenders by mid-day Aug. 26 for 9 tons h.d. copper wire and 3,000 each copper tapes and binders and porcelain insulators. Specifications from 72, Victoria street, London, S.W.

TENDERS RECEIVED AND ACCEPTED.

For the manufacture and delivery of tramway feeder pillars London County Council received the following tenders:—

J. H. Tucker & Co. (*accepted*)	£1,595	6	0
Whipp & Bourne	2,597	16	6
W. T. Glover & Co.	2,445	18	3
Callender's Co.	2,117	19	9
Nalder Bros. & Thompson	1,951	17	9
Johnson & Phillips	1,911	7	11
Estler Bros.	1,901	2	0
Universal Elec. Mfg. Co.	1,[illegible]97	10	9
W. Boydell & Sons	1,[illegible]77	16	9
T. L. Scott & Co.	1,851	3	6
British Insulated & Helsby Cables £1,896. 3s. 3d., £1,841. 11s. 3d. and	1,818	16	3
Edison & Swan Co.	1,[illegible]82	5	0
Spagnoletti (Ltd.)	1,762	3	0
R. W. Blackwell & Co.	1,[illegible]13	16	9

London County Council received the following tenders for road-work and platelaying for construction of tramways from Dulwich library to Dartmouth-road, Forest Hill:—

W. Manders (*accepted*)	£27,431	10	1
W. Muirhead & Co.	31,613	6	6
J. G. White & Co.	30,277	13	6
Fry Bros.	29,992	17	2
R. W. Blackwell & Co.	28,459	8	9
Dick, Kerr & Co.	28,125	6	7
John Mowlem & Co.	28,120	0	0

Stoke Newington Electricity committee have accepted the tender of Belliss & Morcom for an engine and dynamo at £770. Browett, Lindley & Co. tendered at £758. 17s., and W. H. Allen, Son & Co. at £794.

Stoke Newington Electricity committee have also accepted the tender of J. Glover & Son at £418 for the erection of electricity station buildings; of Nalder Bros. & Thompson for switching apparatus at £185. 10s.; and of the Lancashire Dynamo & Motor Co. for a booster at the sub-station at £33. For the booster the Phœnix Dynamo & Mfg. Co. tendered at £246, Siemens Bros. Dynamo Works at £388, Laurence, Scott & Co. at £390 and Thomas Parker (Ltd.) at £427.

In connection with the conversion of the Rossendale tramways to electric traction Rawtenstall Corporation have accepted the tenders of W. T. Glover & Co. for cables, £21,920; Browett, Lindley & Co., for steam dynamos, £4,683; British Westinghouse Co., for transformers, £1,008; Yates & Thom, boilers, condensers, &c., £5,418; Dryland & Preston, for erection of generating station, £7,503; W. Underwood & Bro., reconstruction of permanent way, £39,040; British Insulated and Helsby Cables, overhead equipment, £8,853.

Hackney (London) Council have decided to continue their present arrangement with Belliss & Morcom for supply of lubricating oils. The oils supplied by Belliss & Morcom and Willcox & Co. are stated by the Electric Lighting committee to be superior to samples submitted by other tenderers.

Middlesex Tramways committee recommend the acceptance of the tender of Dick, Kerr & Co. for the construction of rather over 5 miles of tramways from High road, Finchley, to Hendon for £116,978, and that of Wimpey & Co. for the lines from Green lanes, Southgate, to Enfield (about 1¾ miles) for £40,220.

Norwich Council have accepted the tender of Babcock & Wilcox for boiler, superheater, mechanical stoker, ash elevator, hopper and

coal bunkers at £3,215 and that of E. Green & Son for an economiser (160 tubes) at £281.

Staerker & Fischer (agents for the A.E.G.) have received an order from the Mount Lyell Mining & Railway Co. for a 350 H.P. motor and electric compressor and four electric mine pumps.

Taunton Council have accepted the tender of Newtons Limited for an electric pump and gear at £28. 5s., and of W. Geipel & Co. for carbons at £2. 7s. 4d. per 1,000.

Malton Council have accepted the tender of the Northern Counties Electricity Supply Co. for public lighting for three years at £400 per annum

The tender of G. N. Haden & Sons, at £106, has been accepted for the installation of electric lighting in a portion of the West Ham and East London Hospital.

In consequence of the withdrawal of S. P. Hutton's tender the L.C.C. has accepted the tender of the Falkirk Iron Co. (£910) for cast iron insulator frames and covers.

London County Council has also accepted the tender of Spagnoletti (Ltd.) (£636) for switchgear for the central car repair depot.

Willesden Council have accepted the tender of Duncan Watson & Co. for maintaining telephones in the public offices.

Birkenhead Guardians have accepted the tender of Stafford & Co. for telephone installation at the workhouse at £87. 13s.

Worksop Waterworks Co. have accepted the tender of Thos. Flamwell & Son for an electric light installation at the waterworks.

The Fife and Kinross Lunacy Board have accepted the tender of Crompton & Co. for electric lighting plant at £252. 9s

The Municipal Tramways Trust, Adelaide (S. Australia), have accepted the tender of British Insulated & Helsby Cables for overhead equipment, feeders, &c., at £25,806.

BUSINESS NOTICES.

The new telephone number of Simplex Conduits (Ltd.) for the general manager's office, the publicity department and all matters for Mr. L. M. Waterhouse's attention is "1875 City."

Mr. Philip Souper (who has been in the service of Veritys Limited, the Alliance Electrical Co. and the British Westinghouse Co.) and Mr. John T. Callaghan (also lately in the service of the Westinghouse interests and previously with Plenty & Son and P. R. Jackson & Co.) will in future carry on business as Souper & Callaghan, buying and selling agents for all classes of machinery and engineering materials and supplies, at 46, Grosvenor-chambers, Deansgate, Manchester.

Fred Beanland and John Wm. Perkin (trading as Beanland, Perkin & Co), engineers' supply contractors, &c., School lane Works, Neville-street, Leeds, have dissolved partnership. Debts by Mr. Perkin, who will continue the business for three months (from July 16) under the name of J. W. Perkin, late Beanland, Perkin & Co.

F. W. Cross and A. A. P. D. Stone (trading as Cross & Cross), electrical engineers, &c., Pleck road, Walsall, have dissolved partnership. Debts by Mr. Stone.

Morris Hawkins (Ltd.) have removed their London offices to Hornsby House, 75D, Queen Victoria-street, E.C. The company, which will be glad to receive trade catalogues of manufacturers allied to the electrical industry, wishes it to be known that it is in no way connected with the Morris Aiming Tube & Ammunition Co., whose works at Dagenham are now for disposal.

Sale by Auction.—In the liquidation of the Kevan Electric Co. (Ltd.), Mr. John Sulley has been instructed to sell, on the premises, 136-142, Clerkenwell-road, London, E.C., on Tuesday, Wednesday and Thursday next (July 28, 29, and 30), a new and well-assorted stock of electrical fittings, electric fans, heating stoves, switches, electroliers, reflectors, lampholders, &c. Catalogues at the auctioneer's offices, 46, Cannon-street, London, E.C. See also an advertisement.

Factory Sites for Sale.—Messrs. W. Brown & Co. will sell by auction at the George Hotel, Aylesbury, on July 29, 3½ acres of well placed land adjoining the siding yard of the joint railway station of the Great Central, Metropolitan and Great Western Railways at Aylesbury, Bucks (40 miles north-west of London), with a good family residence and a frontage to two streets; also four lots of building land close to the joint station, suitable for works or business premises. The land is freehold and there are no restrictions as to user. Plans and particulars from the auctioneers, Tring, Herts. (Tel. 11) and Aylesbury, Bucks (Tel. 36). See also an advertisement.

Partner Wanted.—A partner is wanted in a small electrical manufacturing business, to bring in at least £2,000 for developing several patents. See an advertisement.

Plant for Sale.—Two 350 H.P. compound Willans engines and alternators, a Westgarth air pump, and a single ram Cameron pump are advertised for sale.

Patents Development.—The owners of Deckert's patent No. 21,849 of 1901 for "Improvement in Microphones" are prepared to sell the patent, or, alternatively, grant licences thereunder on reasonable terms. Applications to Mr. Philip M. Justice, Chartered Patent Agents, 55, Chancery-lane, London, W.C.

The proprietor of patent No. 12,681 (1902) for "Improvements relating to the Manufacture of Carbon Articles" and the proprietors of patents Nos. 15,120 (1903) and 24,277 (1903) for "Improvements in Sparking Plugs for Gas Engines" and "Improvements in the Method of and Means for Crushing and Stamping Ores," are desirous of entering into arrangements, by way of licence or otherwise, for exploiting same and ensuring their full development and practical working in this country. Communications to Messrs. Haseltine, Lake & Co., Chartered Patent Agents and Consulting Engineers, 7 and 8, Southampton buildings, Chancery-lane, London, W.C.

The proprietors of patents Nos. 11,070 (1899) and 26,820 (1906) relating to "Storage Battery Grids and Machines for making same" desire to sell the patents or to grant licences for manufacture in this country. Applications to Messrs. Harris & Mills, 23, Southampton-buildings, London, W.C.

The owner of patent No 22,807 (1899) relating to "Improved Manufacture of Lead Peroxide and its application to Electrical Storage Batteries" desires to enter into negotiations with British firms for the exploitation of the patent. Communications to Messrs. Abel & Imray, Chartered Patent Agents, Birkbeck Bank-chambers, Southampton-buildings, London, W.C.

"Indestructible" Wires and Cables.—When working standard insulated electric lines difficulties are encountered under certain conditions (for instance, exposure to air or acid fumes) and these lines do not transmit properly. Various experiments have been instituted to obtain a means of free insulation which would not be objectionable. It is claimed by the makers that "Indestructible" wire has filled this desideratum. The inventor, Mr. Hackethal (Telegraph Director of the Imperial German Post Office) found, after careful and long experiments, that a mixture of minium purum (sub-oxide of lead or red lead) and linseed oil (which, per se, is a good rust preventative) offers in its hardened condition a great resistance against atmospheric and chemical influences. It was an easy matter to utilise this feature by applying its acting quality to the insulation of wires and cables.

The makers point out that the composition appears to present an ideal protective device, and, that the success of the "Indestructible" Cable Company is entirely due to the efficiency of this prepared wire. By the use of this wire electrical networks which serve as free lines can be cheaply insulated against changing currents. This particularly applies to conductors of weak currents which for any reason touch or twist and interlace each other. In cases where the safety of an electric installation is vital (such as in fire signals and alarms, block station and electric clock installations), "Indestructible" wire will be found of great service. In the case of momentary contact with high-tension currents "Indestructible" wire gives perfect protection, and also where telephone and telegraph wires cross overhead electric tramway cables or the cables of electric power stations. As atmospheric influences and acid fumes have no action on "Indestructible" wire insulation, the latter is suitable for use in chemical works, bleaching establishments, dye works, tanneries, breweries, distilleries, oil refining factories, sugar, soap and textile factories, accumulator rooms, wet tunnels and factory centres. The influence of air, &c., so unfavourable to other materials, produces an opposite effect on "Indestructible" insulated wires, because such influence increases their hardness and mechanical durability, and therefore raises the insulation value. In tunnels experience has shown that "Indestructible" wire is of great value, and the largest existing railway tunnel (the Simplon) has been completely equipped with these cables with most satisfactory results.

CATALOGUES, &c.

"*Leuconium*" *Lamps.*—The Stearn Electric Lamp Co., 47, Victoria-street, Westminster, S.W., have issued a list giving particulars of their "Nevaout" metallic lamps for use on 100 and 200 to 500 volt circuits. The watts per English candle of these lamps are stated to be 1·25 to 1·4. Our readers will recall the fact that these lamps are made up in tubular units, the number employed depending on the voltage of the circuit. A description of the main features of these lamps was given in *The Electrician* for May 1. From the same source we have to acknowledge receipt of two attractive show cards of Stearn electric lamps, and also two booklets containing a number of useful hints to users of electric lamps in general and Stearn lamps in particular.

Boiler Tube Cleaning.—The popularity among users of steam power of the water-tube or fire-tube boiler lends interest to the cleaning apparatus which W. H. Willcox & Co., of Southwark-street, London, S.E., are putting on the market. This is known as "Ramoneur," and the makers claim that a boiler tube can be cleaned thoroughly in two seconds by the application of this device. Heated air is forced through the tube under pressure by a jet of dry steam, and the design of the nozzle is such that a swirling action is given to the air current which completely removes soot and ashes from the smoke tubes and thoroughly cleanses the water tubes. A boiler of 70–80 tubes can be cleaned by the use of this apparatus in four minutes, and a locomotive boiler of 210 tubes in

11 minutes. No brushes or mechanical swirling devices are used, so that the operation, as far as the workman is concerned, is comparatively comfortable. The actual cost of cleaning 80 tubes is stated as being [illegible]d. The "Ramoneur" cleaner is made in several patterns, one for fire-tube, another for water-tube boilers and a further type, which is suitable for both classes of boilers.

Simplex Specialities.—The ever-increasing list of Simplex electrical accessories has been added to recently by useful devices in the shape of the brass electric kettle and the improved pattern turn switch. The latter is illustrated herewith. Its principal features are its good appearance, low projection and quick independent action. The switch movement is operated by a milled knob pivoted in the centre of the porcelain base, The actual projection of the switch is $1\frac{5}{16}$ in. over all. The brass kettle of $1\frac{1}{4}$ pints capacity,

"SIMPLEX" TURN SWITCH.

"SIMPLEX" KETTLE.

is listed at a low price. This amount of water is boiled in 12 minutes by an energy consumption of 450 watts. A guarantee of 12 months is given with Simplex heating apparatus, this covering free repair of the utensil when needed for faulty material or bad workmanship. We illustrate also one of the kettles.

Electric Cranes.—The publications which are issued from time to time by builders of large cranes always make interesting reading. One just published by Vaughan & Son, Manchester, is above the usual standard. It is bound in a most attractive cover, and the printer and block maker have done full justice to the illustrations. The descriptive matter and specifications of the various types of cranes dealt with go towards making the publication a comprehensive record of electric crane design and construction. Messrs. Vaughan have been builders of cranes for the past 20 years, and their experience extends to almost every known variety up to the most modern patterns. We shall be dealing more fully with typical examples of these products in a later issue.

Pick-Quick Coal Cutters.—The monthly card issued by Mavor & Coulson, 47, King-street, Mile End, Glasgow, deals with data recording three years' working of a "Pick-quick" cutter. A diagram marked off in red shows the progress made with this machine during the time stated. The distance cut in three years is 72 lineal miles and the amount of coal 89,000 tons. The same firm have been distributing at the Mining Exhibition a special pamphlet on their underground conveyors. This interesting machine is described in "The Electrician" INDUSTRIAL SUPPLEMENT" published with this issue.

Remington Bros.' Specialities.—This firm send us three publications, which deal respectively with their lubrication devices, power transmission section 1 and power transmission section 2. The two last-mentioned give complete particulars of overhead shafting, pulley blocks, hangers and swivels, and, in fact, every conceivable device and accessory required in the mechanical transmission of power. The second publication is confined almost exclusively to belts and belt fasteners and other devices used for power transmitting material of this character.

BANKRUPTCIES, LIQUIDATIONS, &c.

The public examination of J. T. Murray, Gunterstone-road, W. Kensington, London, took place last week.

Liabilities £3,212; assets £73, apart from bad book debts £30,250. During the last few years debtor had been engaged in the formation of the Smyrna [illegible] Asia Minor, and had provided considerable sums in connection with the enterprise. His efforts resulted in the granting of [illegible] concession from the Sultan, [illegible] of the concessions for [illegible] generally [illegible]. The matter is in progress. Debtor had also been engaged in the formation of the Blackpool Garage and General Electrical Engineering Co. The first meeting of creditors [illegible] adjourned to enable the debtor to make arrangements with a view to the [illegible] of his liabilities. The examination was postponed until Oct. 23.

Alfred W. Bennett, electrical engineer, Park Cross-street, Leeds, was examined on Tuesday.

Deficiency £1,155. Debtor had accepted bills amounting to £1,000, and [illegible] by the holder to recover £248 compelled him to file his petition. Examination adjourned for a revised statement of affairs.

The estates of J. Allan Wilson, electrical engineer, Kilmarnock, were sequestrated on July 17. Meeting to elect trustee and commissioners on July 31 at the George Hotel, Kilmarnock.

The trustee (Mr. E. B. Rawlinson, Halifax Commercial Bank-chambers, Tyrrell-street, Bradford) in the bankruptcy of Albert John Harris, electrical engineer, Borough Mills, Bower-street, Bradford, has been released.

A second and final dividend ($3\frac{1}{2}$d.) is payable Aug. 5 at 191, Corporation-street, Birmingham, in the bankruptcy of W. S. & Grace E. Wright (executors of J. Wright, deceased), and H. T. Wright (trading as Wright's Heater Condenser Co), 16, Great George-street, London, S.W.

Claims against the Lancashire Electric Supply Co. (Ltd.) by Aug. 7 to Mr. John Collier, 4, Chapel Walks, Manchester.

Claims against the Cornwall Electric Power Synd. (Ltd.) are to be sent to the liquidator, Mr. J. A. Stoneham, 89 and 90, Cheapside, London, E.C., by Aug. 31.

The Electromobile Co. (Ltd.) now holds all the shares of the Electromobile Hiring Co (Ltd.), and it has been decided to amalgamate the two companies. The latter company is being wound up, with Mr. Geo. Cockerton, 7, Hertford street, Mayfair, London, W., as liquidator.

An order for the winding-up of Illuminated Signs (Ltd.), 120A, Manor-street, Clapham, London, S.W., was made at Wandsworth County Court on July 13.

A meeting to receive an account of the winding-up of F. W. Dickinson (Ltd.) will be held at 19, Bond-street, Leeds, on Aug. 28.

A meeting will be held at 1, Oxford-court, Cannon-street, London, E.C., on Aug. 21 to receive an account of the winding up of the South Western Electrical Co. (Ltd.)

A meeting will be held at 12-16, Southwark-street, London, S.E., on Aug. 17 to receive an account of the winding-up of Conduits & Fittings (Ltd.).

The Allan Electrical Synd. (Ltd.) is being wound up voluntarily. Mr. H. G. Ash, 52, Coleman-street, London, E.C., is liquidator.

A meeting to receive an account of the winding-up of Bishop's Cluster Co. (Ltd.) will be held at 14, Golden-lane, London, E.C., on Aug. 24.

Deed of Assignment.—A deed of assignment was executed on April 14 last, by Chas. W. Zobel, electrical engineer, &c., 153, Euston-road, London, N.W. Claims by Aug. 5 to Mr. S. H. Wood, 73, Basinghall-street, London, E.C.

COMPANIES' MEETINGS AND REPORTS.

Telegraph Construction & Maintenance Co. (Ltd.)

A half-yearly general meeting was held on Tuesday, Sir JAMES PENDER, Bart., presided.

The SECRETARY (Mr. C. W. Clarke) read the formal notice convening the meeting.

The CHAIRMAN said: Gentlemen, our Chairman is unfortunately prevented by illness from being here to address you to-day. We hope, however, that his illness is not very serious, but, of course, we naturally feel anxious about the health of one who has for so many years been the guiding spirit of this Company. You will remember that Mr. Shuter has practically held the reins ever since the formation of the Company 44 years ago. I think we all appreciate his long services, and feel that it has been greatly due to his wise policy in the past that the Company stands financially where it does to-day, and that it has been able to pay dividends of 15 per cent. or more without interruption for the last 38 years, showing a steady prosperity which is not surpassed by many companies in the City of London. I am sure that we all regret his absence and hope soon to see him restored to health and amongst us again. With regard to the last six months' work, I have not anything very important to report. Cable work generally has not been as active as it was last year, but of what there has been doing I think we have had our fair share. You will have seen in the newspapers lately a great deal about damage to cables by trawlers off the English and Irish coasts. This has become a very serious question, and has cost the cable companies a great deal of money for repairs and renewals. The newest cables appear to be not so often interrupted as those that have been laid for some years, so it is probable that the trawlers do not do the mischief at once, but wear the cable out by continually dragging the trawls over them. This has kept the cable steamers very busy, and we have been offered more repairing work of this sort during the last year than we have been able to undertake. We are, however, making arrangements to build another ship specially suited to the work. Our steamer "Cambria" has been fully occupied, and has established a very good record both for efficiency and economy. Although she is not one of the largest ships, she is as well able to do work in mid-ocean, and in the greatest depths, as in shallow water. She has, for instance, repaired cables this year in a depth of [illegible],000 fathoms in the Bay of Biscay during the winter months. The ship we are now about to build will be smaller than the "Cambria," and we hope she will prove even handier to compete with for cable work in moderate depths. She will be a weatherly boat, able to go anywhere and keep at sea in all seasons of the year, extremely economical to work, whilst being efficient in every detail. But it is of no use, of course, having the best of ships unless you also have able men to use them. Fortu

nately, our staff has had great experience in cable work, and their accuracy and quickness in making these repairs has often saved a great deal of expense. For instance, the last work that the "Cambria" has been employed upon, and from which she has just returned, was a break in one of the Atlantic cables, about 50 miles from the coast of Ireland. At this point the cables are very numerous, and lie close together, the one that had to be repaired being less than half a mile from another which runs parallel to it, and although many dredges had to be made in depth varying from 200 to 450 fathoms in close proximity to the other cable, no mistake was made, but the right cable was lifted and repaired without any other being touched. I think we may congratulate ourselves on this (hear, hear), and as long as we see our people doing such good and careful work, I feel sure that we shall not be wrong in providing the best possible ships for the work. I have no resolution to submit to you as no report and accounts are presented at our half-yearly meeting, but in accordance with our usual custom, I have to announce that the warrants for the interim dividend of 5 per cent. will be posted to-day. That concludes the business of the meeting.

Mr. H. CROFT: Mr. Chairman, I am sure that the shareholders will all sympathise with you and with your colleagues, as also with the family of our Chairman, in the absence of Mr. Shuter from our meeting to-day, owing, as you have told us, to that gentleman's illness. I am sure we all hope that he will shortly be restored to health. (Hear, hear.) We all quite endorse what you have stated in regard to the great debt the shareholders of this Company are under, and the great obligations they owe to Mr. Shuter for the able way in which he, in conjunction with all his colleagues, has conducted the business of this Company these many years. There is one matter to which you have not alluded in your statement. It is this. Just previous to the last half-yearly meeting, there was the announcement in the paper of the sentence upon the murderers of one of our staff. I think it occurred at the end of February. Since the last half-yearly meeting, an application was made to the Privy Council for special leave to appeal from that conviction and sentence. This appeal was rejected, and the decision will be approved by everyone who read the statement in connection with the facts relating to the murder of Mr. London by the natives. I am sure that we are all pleased to hear that you are contemplating building another steamer, and the more our fleet is increased in that way, in view of the able seamen we have and the able staff we possess, the better for us all. I hope the Company will go on progressing in the way that it has done. I am sure we are all obliged to you for the statement with which you have favoured us this morning.

The proceedings then terminated.

United River Plate Telephone Co. (Ltd.)

The 22nd ordinary general meeting took place on Tuesday, Mr. Frederick Green presiding.

The SECRETARY (Mr. David Smith) read the notice convening the meeting and the auditors' report.

The CHAIRMAN explained that Sir Irving Courtenay was unable to take the chair that day owing to being temporarily indisposed. He was much better, however, and hoped to be about again shortly. He has asked me to make to you the following statement. The result of the year's working is very satisfactory. During the year the company's business has continued to increase and extend. The extension of our underground plant has been energetically pushed forward, and the benefit of the removal of our overhead circuits is becoming more and more appreciable. Our subway system has increased by 80 squares, and we have completed the underground connection to our Belgrano exchange in one of the most important suburbs. The Libertad exchange, with about 2,000 subscribers, has been converted, all the subscribers to this important exchange now working on the common battery system, which is giving excellent results. The new common battery exchanges in Juncal and Mitre have also been installed, and the work of transferring the subscribers' lines is in hand. The Avenida district overhead distribution is being prepared for the change-over to common battery. Our operations, besides embracing the capital, are spreading widely over the province of Buenos Aires and into that of Santa Fé, both of which provinces afford an immense field of operations for the telephone business. The Rosario trunk line, uniting the two largest cities and linking up the two principal provinces in the Republic, has been completed and opened for public use, the traffic being already satisfactory. In Cordoba, too, our underground system is working well, and new lines are being constantly added. In Bahia Blanca, the city which is making the most rapid progress of any in the province of Buenos Aires, we have obtained, after several years' effort, a satisfactory concession to put our plant underground. While no new provincial exchanges have been opened during the year with direct connection to Buenos Aires, preparations have been actively carried out for the opening up at an early date several important districts, including the important towns of General Paz (Ranchos), General Belgrano, and Lobos. The first-named has been joined up since our financial year closed. We have obtained concessions for Marcos Paz and Las Heras and Dolores, one of the principal towns. In accordance with a law recently sanctioned by Congress, all telephone companies joining the capital to a province or joining two provinces together will in the future come solely under the control of the National Government, and the old controversy about territorial jurisdiction has been satisfactorily settled, so far, at least, as our business is concerned. All trunk lines joining any partido of the provinces of Buenos Aires or Santa Fé are now under the jurisdiction of the National Government, to which application must be made in respect of any future extensions desired. The law referred to required that all networks and lines erected previous to its promulgation should be formally legalised and authorised by the National Government, and one of the most important matters, therefore, which have engaged our attention during the year has been the final settlement and regularising of our position with the National Government. This has now been done. Sir John Gavey has visited Argentina. He made an examination of the business and affairs of the company, and it will be a satisfaction to the shareholders to know that not only was his visit of great assistance to the local board and executive in the River Plate, but his report on what he saw and the impressions he formed were entirely favourable.

Turning to the accounts, the share capital is the same as last year. The new issue of ordinary shares recently made was fully taken up but does not come into the preesent year's accounts. The old 5 per cent. debenture stock has been replaced by the new $4\frac{1}{2}$ per cent. stock. Sundry creditors are considerably less than last year. The reserve funds stand as before. On the assets side we have spent £62,932 in capital expenditure during the year, in addition to £45,396 in substituting underground for overhead lines and in connection with the installation of the common battery system. We have put the expenditure to a special replacement account, and as the work proceeds we shall make further additions to this account, and, at the same time, write it off gradually against revenue. The appropriation account shows we have already written off £25,000 of this sum, so that the actual amount is now only £20,395. 19s. 7d. Real estate has been increased by £7,579. Securities are down by £15,846, as we had to realise certain of our investments before the issue of our new debentures to meet current engagements. Stock of materials is down £12,590, as part of the common battery plant in stores at the previous balance has now gone into the business. The profit and loss account shows an increase in receipts in the River Plate of nearly £35,000, while maintenance charges and general expenses are about £12,000 more than for the previous year. The increase in the net profit for the year is £18,746. These results speak for themselves. The directors recommend a final dividend of 5 per cent. on the ordinary shares, making 8 per cent. for the year tax free. I now move the adoption of the report and accounts.

Sir JOHN GAVEY, C.B., seconded the motion and said: I was thoroughly satisfied with the result of my inquiries on your behalf into the business of the company during my recent visit to the Argentine Republic. I spent a period of five weeks out there in very carefully investigating into all the matters connected with the plant, and I also made a number of other investigations into the methods of management and the methods of the working of the business of the company, going generally into all the details of the telephone system belonging to this company, and I am glad to say that I came to the conclusion that we possess in the Argentine Republic a most valuable property. You have a system which, when the replacement of the plant which is now in active progress is completed, will be quite equal to that of any other civilised country in the world, and one which will defy competition.

Col. TOTTENHAM asked what the total cost of the replacement of plant and apparatus was likely to be.

The CHAIRMAN said he could not answer at the moment, but they hoped that the work would be completed within a comparatively short time, and the directors anticipated that when that was the case they would be able to effect a considerable saving in the cost of maintenance.

The resolution was then carried unanimously.

The retiring directors (Sir Irving Courtenay and Mr. A. Le Rossignol) and the retiring auditors were re-elected.

The CHAIRMAN then moved a hearty vote of thanks to the local board and the manager and staff of the company in Argentina, and also to the staff in London.

Mr. W. TIRRELL (a shareholder) seconded and warmly supported the resolution, which was carried unanimously.

A cordial vote of thanks to the chairman and directors brought the proceedings to a close.

Electric Construction Co. (Ltd.)

The fifteenth annual general meeting was held on Monday under the presidency of Mr. Walter S. B. McLaren.

The SECRETARY (Mr. David Willock) having read the notice calling the meeting and the auditors' certificate.

The CHAIRMAN said: As I told you a year ago, we looked forward to an improvement, and we are now not only able to pay last year's preference dividend, but we have every reason to expect that within six months we shall pay the dividend for this year also. Indeed, it would have been quite possible to make the present accounts show the full dividend for the two years; but we prefer to adhere to the most rigid system of account keeping, to write off everything necessary for depreciation, to debit each year with every possible charge, and to build up the internal resources of the Company, rather than to produce an attractive balance-sheet. Despite severe depression and competition the great excellence and high quality of the Company's manufactures have met with their reward, and the works have been kept fairly well employed. Strict care and economy have been exercised, with the satisfactory result that the gross profit on manufacturing and contracting shows an increase of £9,775. 1s. 8d. upon that of the previous year. This would have been greater by approximately £1,500, which represents abnormal experimental expenditure, and which the Board decided to write off in pursuance of their former policy. As intimated at the last annual general meeting, the Board resolved to adopt other branches of engineering, and the accounts have already benefited by this departure, a considerable amount of general engineering having been obtained. The equip-

ment of large tools which the Company possesses enables it to handle work of any magnitude, and during the year the plant has been almost constantly employed. Increased cost under the head of fuel is not less than about £500. As formerly, all expenditure on new lines of machines has been written off and the whole of the factory equipment has been maintained in the most thorough manner out of revenue. In the opinion of the management the Company is better equipped at the present time for the expeditious handling of work than ever it has been.

Turning to the debit side of the profit and loss account, you will have noted an increase in general charges of £1,185. 7s. 6d. The principal changes are increases in salaries of about £400, in workmen's compensation £200, and in branch offices and agencies £500. Prior to the Workmen's Compensation Act, 1906, the Company undertook the risk itself, but in consequence of the scope of the act having been extended it was considered advisable to insure the risk, and the premium is £200 greater than the annual sum formerly put aside by the Company. It will interest you to know that since the passing of the new act the number of claims upon the Company has almost trebled. None of the claims I am glad to say have been of a serious nature. In consequence of the strenuous competition which prevails, the sales department has continued to receive the close attention of the Board, and fresh arrangements have been made for opening up new connections both at home and abroad. (Hear, hear.) The Board is satisfied of the wisdom of such a step, although it means increased expenditure.

The result of the year's working is a net profit of £5,932. 6s. 9d. compared with a loss of £1,442. 2s. 10d. for 1907, and to this profit must, of course, be added the £10,250 which goes to the payment of debenture interest, and the profit, therefore, has really been about £16,000. This result, while showing an improvement on either of the previous three years, is still unsatisfactory, and quite incommensurate with the energy and skill displayed by the members of the staff in their various vocations. The industry, however, is still suffering from overproduction, and the keenest competition prevails. Various remedies for improving the position of the industry have been discussed in the Press and, as I stated last year, we shall welcome any fair scheme of co-operation, but so long as the power of absorption is so much less than the means of production you will recognise that the problem is a difficult one. We, however, begin the new financial year under more favourable conditions than formerly, and the Directors are sanguine that by the end of December they will be in a position to declare a dividend on the preference shares for the past year, and thus get rid of that liability. Our financial position, is perfectly satisfactory. We have £16,700 in hand. We have no floating liabilities apart from trade accounts, and these are less than one-half the amount due by sundry debtors, besides our having a very substantial sum in stock-in-trade and work in progress—viz., £74,000, as compared with £52,000 at this time last year. No profit has been credited on this work, though much of it has really been earned, and it will all come into next year's accounts.

Before sitting down I should like to refer to the satisfactory relations which continue to exist between the Board and all grades of the staff and workmen. I sympathise with the ordinary shareholders in the absence of a dividend, but I feel it incumbent on me to put on record that the staff and men have also suffered by the depression which has prevailed for so long. Promotion in most cases has not been possible for some years, but notwithstanding, we have continued to receive the same willing service, and in the interests of both the shareholders and the staff, I fervently hope that some improvement will soon be apparent in the industry. The Board, being anxious to see the Territorial Army scheme a success, offered to recoup to the men who put in full compulsory drills the difference between their wages and the grant allowed by Government. 33 men have joined the force—we hope the number will be increased—and the annual donation by the Company will not exceed £12. I now move the adoption of the report and accounts.

Mr. P. E. BEACHCROFT seconded, the motion which was carried unanimously.

The retiring directors (Sir James Pender, Bart., and Sir Irving Courtenay) and the retiring auditors were then re-elected, and the proceedings terminated.

National Telephone Co. (Ltd.)

The forty-second ordinary general meeting of the company was held yesterday, Mr. George Franklin presiding.

The SECRETARY (Mr. Albert Anns), having read the notice calling the meeting and the auditors' report,

The PRESIDENT said the report and accounts were presented in the usual form, and, speaking generally, he thought he might say that the board regarded them as eminently satisfactory. The income accrued in respect of the business of the half-year ended June 30 was £1,453,325, compared with £1,315,638 for the corresponding period of 1907, an increase of £137,687—quite a record increase of revenue in any half-year the company had had. The Post Office royalties for the half-year were £139,546, compared with £125,[illegible], leaving a net income of £1,313,279, compared with £1,189,739, so that they had a net income, after deducting the Post Office royalties, larger by £123,540 than they had in the corresponding half of last year. The income arose from 453,864 stations, an increase of 16,761 over the number in the same period of the previous year. As to the disposition of their revenue, working expenses had increased from £[illegible] to £852,635, an advance of £32,878. This was not due merely to the normal growth of the business, but to one or two special items of expenditure, maintenance and renewal of lines and instruments alone absorbing £27,629 more than last year. He only mentioned this to indicate to the shareholders the determination of the board to keep up the company's plant in an efficient condition, and when they remembered that the purchase price to be paid to them in 1911 was upon the basis of plant value, the importance of that policy would, he hoped, commend itself to the shareholders. Rents, rates, taxes and insurances were up by £8,068, mainly in respect of items over which the board had no control, while administration and management charges showed an increase of £38,178—which he thought they might take to be a reflection of the growth of the business. The net result for the half-year was £480,641, compared with £439,979, being an advance of £40,661, which was increased to £41,257 by the balance of £596 brought forward. To be able to pay the full dividend of 6 per cent. per annum on the new stock as well as upon the old deferred stock, especially when they had on June 30 last nearly half a million of the new capital unproductive, was matter for gratification to the board, and not less so was the fact of their having increased the transfer to reserve fund account from £130,000 to £140,000. This reserve fund account now amounted to £2,664,960, and consisted of sums reserved from profits from time to time, its main purpose being to cover any possible shrinkage in the company's capital on the transfer of the undertaking to the Postmaster-General in 1911, bearing in mind, on the one hand, that their capital account consisted of their expenditure upon plant and upon the acquisition of various undertakings from time to time, while, on the other hand, that the company were to be paid, as they were told by the purchase agreement, on the basis of the then value of the plant, less depreciation. Some shareholders might think—indeed, he knew that some of them did think—that in making these large transfers and in building up this large reserve fund, the board were making excess provision. That might be so, but, however large their reserve fund might be, it could make no difference at all to the basis upon which the transfer of the business was to be effected, while an insufficient reserve fund might imperil the shareholders' capital, which it was the main object of the board to secure. If through caution too much was reserved, the excess remained the property of the shareholders, but if too little were reserved the then shareholders might reasonably complain of lack of provision. The directors, acting upon the best available expert advice, made these half-yearly transfers to the reserve fund in order to build up an account against which might be debited any depreciation in the company's capital when the time for transfer arrived. He had noticed during the last few days that there were certain authorities learned in finance who attempted to predict the price at which the deferred stock might be paid off after the transfer. He could only say that the board had no responsibility and saw no safe ground for such predictions. The purchase agreement provided that the company's assets were to be bought on a basis which could not be determined except as either the result of agreement or arbitration. At the moment there had been no agreement, and, so far as he knew, the result might and probably would have to be determined by arbitration. The last column of the abstract of the accounts was a very interesting one, because it showed the rentals which had been carried forward for unexpired terms, and a glance at the column showed the remarkable development in the business. The amount of the rentals carried forward had risen from £1,210,117 to £1,314,591, an increase of £104,474 in the half-year. That was not profit for this particular half year, but it consisted of income which had been received and debited, and which would come in in the current half-year or in the half-year following. The capital account showed that the amount expended was £14,042,959, which represented the amount spent on the 463,869 stations, and adding the amount spent on land and buildings, £685,309, there was a total of £14,728,269. Of this sum the shareholders and debenture holders had provided £11,221,593, leaving an excess of capital expenditure of £3,506,676. It might be asked how this money had been provided, and a reference to the balance-sheet showed that the first item on the assets side was £3,506,676, and that the stock of materials was £365,928, the latter item showing the gratifying reduction of about £30,000, compared with the figures in the previous year. There were other assets making a total of £5,157,456, which had been provided by rentals in advance £1,187,629, by credit balances £935,438, and the reserve fund account £2,664,960, leaving them with £369,426, which was appropriated as shown at the end of the accounts. At the last half-yearly meeting he referred to the evil influence which the unlimited rate of charge was exercising on the progress of the company's business, and to the substitution of a system of payment according to the use of the telephone, instead of having an annual charge, no matter how many calls the subscriber might desire to send. As he then explained, every telephone call cost money, and from the point of view of the producer of the telephone it should be paid for according to the use made of it, and not according to any fixed or annual charge. This was necessary by reason of the fact that, as the traffic grew, growth went on on all sides, and it was precisely that position which had determined the directors, in conjunction with the Postmaster-General, to adopt this system of measured charge. There were now upon that system something like 100,000 stations, and it was gratifying to note that a number of the more important municipalities of the country—notably the great municipalities of Liverpool and Belfast had, as a result of careful investigation, approved the principle. Part of the expenditure (£496,555) on capital account during the half-year had been upon a new and up-to-date common battery exchange in Gerrard street, and there they had, he thought, the last word in the science and art of telephone development. The number of the staff had increased from 17,421 to 17,[illegible], and the number of shareholders from 12,217 to 13,031. The number of their exchanges at the present time was 1,513, the number of stations, ex-

change and private, was 463,869, the present rate of effective calls per annum was 656,755,000, equivalent in messages, counting the call and the reply, to 1,313,511,000; the accrued revenue per station worked out at £6. 3s. 4d., and the average cost per message to a subscriber was 0·48d. less than ½d. per call - the average per week being 2s. 4d., and the average per day, Sundays included, 4d. He thought that his statement would be regarded as eminently satisfactory by the shareholders. He saw that the Postmaster-General, in a speech in the House of Commons last week, made a statement which might be considered to be a reflection on the company's plant. The statement was as follows:-"From time to time complaints are made to me that the telephone system is not always quite as effective as it ought to be, and that sometimes more calls are charged for than had been made. I need hardly say that the complaints made as regards the Post Office system are necessarily much less than those made against the National Telephone system, because the Post Office system is much the better system of the two." The public, however, must judge of the merits of the two systems—at least, he preferred them to be the judge. He dared hardly say what their experience was with reference to the Post Office service, but there was one fact which showed the public appreciation of the two systems. In December last the Post Office had upon their system 46,355 stations and the company had upon their system 93,020 stations; but in June last the Post Office had increased to 49,690 stations and the company had increased to 99,068 stations, so that there was an increase of 3,335 stations on the Post Office system and an increase of 6,048 on the National Telephone Co.'s system. He concluded by proposing the adoption of the report and accounts and the payment of the dividends recommended.

The VICE-PRESIDENT (Mr. Samuel Herrick Sands) seconded the motion, which was carried unanimously, after the president had replied to a few questions.

The retiring directors and auditors were reappointed, and a vote of thanks to the president, directors and staff terminated the proceedings.

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ANGLO-AMERICAN TELEGRAPH CO. (LTD.)—The report of the directors for the half-year ended June 30 states that including £2,478. 13s. 9d. brought forward, the total receipts amounted to £195,258. 11s. 6d. Traffic receipts show a decrease of £15,625, compared with the corresponding half-year of 1907. Working expenses amounted to £73,295. 18s. 1d., a decrease of £1,467. 4s. 7d. The directors have, before declaring the net profits, set apart £10,000 to renewal fund, leaving £111,962. 13s. 5d. Quarterly interim dividends of 15s. per cent. on the ordinary and £1. 10s. per cent. on the preferred stock were paid on May 1, absorbing £52,500, and second quarterly interim dividends of 15s. per cent. on the ordinary and £1. 10s. per cent. on the preferred stock, amounting to £52,500, will be paid on Aug. 1. The balance (£6,962. 13s. 5d.) will be carried forward.

BOMBAY ELECTRIC SUPPLY & TRAMWAYS CO. (LTD.)—The chairman (Sir E. Sassoon), at the meeting on Tuesday, said the tramway system was completed on May 18, and they now looked forward to increased profits. The balance from the working of the traction and electricity supply sections amounted to £43,442. 13s. 1d., and sundry and other receipts were £395. 18s. 6d, making £43,838. 11s. 7d. After deducting London administration expenses, debenture interest chargeable to revenue, &c., the available total was £30,701. 2s. 7d. Preference dividend amounted to £27,764. 7s. 5d., leaving £2,936. 15s. 2d. to be carried forward. They had at present 152 electric cars, and those were being supplemented by a further 10 in October. The electricity supply section was making rapid progress. The company had not yet been able to do much towards the supply of electrical energy to large power consumers, the demands made by the tramways and the rapid increase in general supply having ear-marked the greater portion of the plant, but in order to enable the company to deal with that important branch of the business arrangements had been made for the acquisition of a site for another power station. The additional capital outlay during the year amounted to £334,659. 6s.

BRITISH THOMSON-HOUSTON CO. (LTD.)—The directors' report for the year ended March 31 states that the buildings and machinery of the company have been maintained in first-class condition and the directors have followed their usual practice in providing for depreciation thereof. They have also provided for depreciation of patents and stock in hand, besides making reserves sufficient in their opinion to cover risks in connection with bad debts, depreciation of shares held by the company, and for other contingencies. The company has now acquired all the outstanding interests in the patents for the United Kingdom for Curtis steam turbines, excepting the marine rights. During the year the company has developed a line of low-pressure turbines, several of which have been sold. The company's business in the direction of industrial developments has been satisfactory during the year, and a number of important contracts have been closed in connection with the electrical operation of colliery plants, steel and iron works, and mills of various kinds. The quantity of electrical equipment for tramway and railway work sold in Great Britain during the year has been very small, but the company has received its fair share of this business. Several important contracts for switchboards have been obtained during the year.

Metallic Filament Lamp.—The company has made satisfactory progress in the development of metallic filament (tungsten) lamps, and has now in production several sizes of unexcelled quality. The process which is used in making the filaments is covered by patents owned solely by the company for the United Kingdom.

Finance.—Under the terms of the trust deed securing the issue of the company's debentures, the company had to pay to the trustees on Feb. 28 last, £3,339, to be applied by them in purchasing debentures in the market. Debentures of the par value of £1,160 were purchased prior to March 31 (the end of the year under review), and since the closing of the books the trustees have purchased an additional £2,400, making the total par value of debentures retired £3,560. The trading profit for the year, after deducting general and technical expenses, discounts, debenture and other interest, amounts to £28,038. 3s. 4d. The whole of this profit, with the exception of £1,394. 16s. 7d. carried to the balance-sheet, has been applied to various depreciations. The amount carried forward last year was £1,071. 15s., which, added to the above £1,394. 16s. 7d., makes the total carried forward this year £2,466. 11s. 7d. On the balance-sheet of last year, the balance of the excess cost incident to the establishment of the manufacturing business of the company amounted to £16,707. 17s. 8d. (£51,000 having been previously written off). Nothing was added to this account during the year, and the directors have decided to write off a further £6,707 17s. 8d., leaving £10,000, which will be written off from time to time until finally disposed of. The directors record with regret the resignation of Mr. W. A. McArthur as chairman and director of the company. It is not proposed to fill the vacancy on the board at present, and Mr. J. F. Nauheim has been elected to act as chairman of the company.

CITY & SOUTH LONDON RAILWAY CO.—The report of the directors for the half-year ended June 30 states that the receipts from all sources were £88,500. 14s. 10d. and the cost of working £40,964. 3s. 1d., leaving a profit of £47,536. 11s. 9d. Inclusive of the balance forward, the net revenue account shows an aggregate total of £48,656. 4s. 1d. After making provision for the debenture stock interest, rent charge, and the transfer to the renewal fund of £1,500, a balance remains available for dividend of £32,999. 12s. 5d. The directors recommend that the full dividend of 5 per cent. per annum be paid on the preference stocks 1891, 1896, 1901 and 1903, and that a dividend at the rate of 1½ per cent. be paid on the consolidated ordinary stock for the half-year, leaving £1,868. 1s. 6d. to be carried forward. The number of passengers, exclusive of season ticket holders, carried in the half-year was 10,890,535, compared with 10,048,780 in the corresponding period of 1907. The receipts for the half-year have been unfavourably affected by various causes, including the weather. The L.C.C.'s electrified tramways from Moorgate to King's Cross were opened for traffic in July, 1907, and since April 10, 1908, the Council's tramways on the south side of the Thames has been placed in direct communication with those on the north. With the exception of a sum of about £2,800, the whole of the charges for the extension to Euston, the new works at Stockwell, and the two new trains of five coaches each, ordered in July, 1907, have now been paid.

CROMPTON & CO. (LTD.)—The directors' report for the year ended March 31 states that the output from the works at Chelmsford shows a large advance over any previous year, and further economies in cost of manufacture have been effected. There is also a considerable increase in the turnover of the sales department, and some important contracts have been carried out during the year. Net profit was £31,220. 10s. (compared with £38,290. 19s. 6d. for the previous year, and £20,060. 6s. 4d. for the year to March, 1906). From this has been deducted £1,211. 13s., representing loss on old type stock, which, owing to the introduction of improved designs, it has been thought advisable to dispose of at less than cost. After providing for debenture interest, &c., there is, with the amount brought forward, an available balance of £28,215. 18s. 4d. In view of the continued keen competition and low prices, and the general depression in trade experienced during the latter part of the year, the directors are of opinion that the results of the year's working are satisfactory. They recommend a dividend of 5 per cent. for the year, £2,000 is provided for doubtful debts and contingencies, £8,000 is put to reserve (making this £28,185) and £6,103 is carried forward.

The undertakings of the Electric Supply Corpn. continue to make progress. A further £9,687 has been invested during the year in shares of the guaranteeing company, but the directors anticipate a substantial reduction in the amounts which will be required for the remaining two years, during which the guarantee has to run. Any possible loss on this head is partly covered by insurance.

CRYSELCO LTD.—We extract the following from a communication received from Cryselco Ltd.:—"In submitting the balance-sheet and accounts for the year ended May 31, 1908, the directors report that the business continues to show steady improvement, the profit for the year (including balance forward) being £6,081. 1s. 9d. The number of lamps sold shows a substantial increase. In regard to the development of the metal filament, they have reason to believe that they will be successful during the present year in placing upon the market a metal filament lamp which should satisfactorily replace the decreased demand for carbon filament lamps which is undoubtedly ensuing. Success will necessitate an increased working capital which the directors hope may be met out of revenue, but it is possible that it may be necessary to raise additional capital. The directors recommend the usual dividend at the rate of 10 per cent. for the year."

DIRECT UNITED STATES CABLE CO. (LTD.)—The directors' report for the six months ended June 30 last shows that the half-year's revenue, after deducting out-payments, amounted to £51,367. 11s. 5d. compared with £57,055. 19s. for the corresponding period of 1907, a difference of £5,688. 7s. 7d. Working and other expenses for the same period, including income tax, amounted to £24,932. 0s. 1d., leaving £26,435. 11s. 4d. as net profit, or with £6,396. 14s. 3d. brought forward and £2,299. 8s. adjustment of income tax, £35,131. 13s. 7d. For the corresponding period of 1907, working expenses and other payments amounted to £24,699. 2s. 6d. Three quarterly interim dividends of 4s. each per share,

(£36,426) have been declared and paid and a final dividend of 4s. per share is now proposed, together with a bonus of 1s. per share (making $4\frac{1}{4}$ per cent. for the year). After transferring £5,000 to reserve, the balance of £2,812. 3s. 7d. is proposed to be carried forward. Reserve has been debited with £12,853. 3s. cost of cable maintenance, and after being credited with interest on investments, profit on sale of securities, and amount transferred from revenue, now amounts to £505,196. 1s. 4d.

DUBLIN UNITED TRAMWAYS CO. (LTD.)—The report for the half-year to June 30 states that the amount available for division is £41,594. 12s. 8d. and dividends at the rate of 6 per cent. on the preference and ordinary shares are recommended. These will absorb £35,100.

EAST LONDON RAILWAY CO.—The report for the half-year ended June states that, owing to the declining receipts, the lessee companies had, since last February, given the question of the electrical working of the line exceptional attention. By their instruction Mr. C. Jones and Mr. H. W. Firth (electrical engineers respectively of the Metropolitan and the G.E. Railway Cos.) had prepared a comprehensive report as to the best system and the cost of equipping the railway for electric traction. They had also furnished estimates of the annual working costs, capital outlay on the permanent way and supply of electric current. The matter had been referred to the general managers of the lessee companies, but as yet no definite conclusion had been arrived at.

ELECTRIC & GENERAL INVESTMENT CO. (LTD.)—The report of the directors for the year ended May 31 shows that the gross profit was £7,891. 2s. 10d. Deducting all general charges and interim preference dividend, and providing for proportion of final preference dividend, there remains £568. 7s. 4d. to be carried to contingencies fund, bringing this to £67,556. 9s. 1d. Owing to unfavourable financial conditions prevailing in the electrical industry, the company's revenue has been mainly derived from income from investments and fees for acting as trustees. The trustee for the ordinary shares reserve fund proposes to distribute 6d. per share and the trustee for the founders' shares reserve fund £10 per share out of dividends received on trust investments, less tax. Warrants will be posted on 28th inst.

The report states that the carefully-considered scheme of reconstruction submitted by the directors to the shareholders on June 26, 1907, did not meet with the approval of the holders of the founders' shares, and is in abeyance for the present.

GENERAL ELECTRIC CO. (LTD.)—The directors' report for the year to March 31 shows the net trading profits and income from investments, &c., to have been £59,753. 3s. 1d., or, after deducting depreciation and debenture interest (£25,029. 19s. 10d.) £34,723. 3s. 3d. Preference dividend (£12,500) has been paid, leaving £22,223. 3s. 3d. Managing directors' and employés bonus absorbs 5 per cent. (£2,222 6s. 4d.), dividend on ordinary shares for the year £18,026. 10s., and £1,974. 6s. 11d. is placed to reserve, which, with £1,974. 6s. 11d., undivided profit of the year, now amounts to £120,343. 8s. The exceptional feature of the year has been the sudden fall of prices of raw materials, which has adversely affected the results of several departments, and has besides necessitated a considerable writing down. The factories at Salford, Witton, Birmingham and London, have been well employed, and are maintained at a high state of efficiency. The development of the Osram metal filament lamp business proceeds to the satisfaction of the directors. 1,466 further ordinary shares have been allotted during the period covered by the accounts to the directors and staff at par. During the year Mr. M. Byng tendered his resignation as a managing director, which was accepted by the board. Mr. Ernest G. Byng was appointed a director in May.

NEW COMPANIES.

BALCHIN, SCHULZ & CO. (LTD.) (98,799.)—Reg. July 13, capital £10,000 in £1 shares, to acquire businesses (1) carried on by Balchin, Schulz & Co. and (2) by Armitage & Co., and to carry on the business of electrical and mechanical engineers, founders, &c. Private company. First directors, H. A. Balchin, G. F. Schulz, C. H. Hayward, H. A. Woodman and F. Coomber (all permanent, subject to holding 200 shares each). Reg. office, Lennox House, Norfolk-street, London, W.C.

COWEYS (LTD.) (98,833.)—Reg. July 15, capital £6,000 in £1 shares, to adopt an agreement with L. E. Cowey, and to carry on the business of electrical, mechanical, manufacturing and mining engineers, &c. Reg. office, 39, Victoria-street, Westminster.

ELECTRICAL REGULATORS & ECONOMISERS (LTD.) (98,802.)—Reg. July 15, capital £2,000 in £1 shares, to acquire and turn to account certain patent rights granted or to be granted to H. S. Marten, relating to improvements in electric resistances, to make experiments in and exhibitions of applied electricity, magnetism or similar agencies, &c. Private company. Reg. office, 51, North John-street, Liverpool.

LUX CANDLE CO. (LTD.) (98,823.)—Reg. July 14, capital £2,000 in £1 shares, to carry on business as manufacturers of and dealers in electric candles, lights and stoves, electric lighting and heating apparatus, batteries, dynamos and switches, metal workers, electrical and general engineers, &c. Private company with only three subscribers. First directors, A. A. Barron and A. Hooydonk.

PARIS ACCUMULATOR CO. (LTD.) (98,825.)—Reg. July 14, capital £3,000 in £1 shares, to acquire the business of an accumulator manufacturer and assembler carried on by S. Leuchters as the Paris Accumulator Co., and to carry on the same and the business of manufacturers of and dealers in motor cars, motor cycles, &c. Private company with two subscribers—viz., S. Leuchters and W. Wainwright. First directors, S. Leuchters and W. Wainwright. Reg. office, 14, Park Cross-street, Leeds.

CITY NOTES.

MEMORANDA (July 23).—Bank rate $2\frac{1}{2}$ per cent. (since May 28, 1908) Price of silver, $24\frac{3}{16}$d. per oz. Consols $86\frac{3}{4}$—$86\frac{7}{8}$ for money and $86\frac{13}{16}$—$86\frac{15}{16}$ account. Consols Pay Day, Aug. 6; Stock and Shares Continuation Days, July 28 and Aug. 11; Ticket Days, July 29 and Aug. 12; Pay Days, July 30 and Aug. 13; Mining Share carry-over Day, July 27.

PRICES OF METALS (London).—*Copper*, cash, $58\frac{3}{8}$—$58\frac{7}{8}$; three months, $59\frac{3}{8}$—$59\frac{5}{8}$. *Lead*, English, 13—$13\frac{1}{4}$; foreign, $12\frac{7}{8}$—$13\frac{1}{8}$. *Spelter*, foreign, $19\frac{1}{4}$—$19\frac{3}{4}$. *Tin*, English, $137\frac{1}{2}$—138; foreign, cash, $137\frac{1}{4}$—$137\frac{3}{4}$, three months, $138\frac{1}{4}$—139. *Iron*, Cleveland, cash, 49/$10\frac{1}{2}$—51/1; three months, 50/$1\frac{1}{2}$—50/$2\frac{1}{2}$.

BLACKPOOL DISTRICT TRAMWAYS.—Meetings of the Blackpool, St. Annes & Lytham Tramways Co. and the Blackpool Electric Tramways (South) (Ltd.) were held on Monday at Liverpool. The meetings were private, but it is stated that the proposed agreement between the companies was sanctioned, and that a resolution was passed for winding up the Blackpool (South) Co.

BOURNEMOUTH & POOLE ELECTRICITY SUPPLY CO. (LTD.)—The directors have declared an interim ordinary dividend at the rate of 5 per cent., less tax, for the half-year ended June 30.

BRUCE PEEBLES & CO. (LTD.) (*In Liquidation.*)—The joint liquidators announce that the results of the recent meetings having been reported to the Court, the judge has pronounced an order allowing all creditors and other parties having an interest to lodge answers to the scheme of arrangement, if so advised, on or before Thursday, Aug. 13. As soon thereafter as possible, the application to the Court for approval of the scheme of arrangement will be proceeded with.

CENTRAL LONDON RAILWAY CO.—The directors have declared dividends for the half-year at the rate of 3 per cent. on the undivided ordinary stock, 4 per cent. on the preferred ordinary stock, and 2 per cent. on the deferred ordinary.

CITY OF BUENOS AYRES TRAMWAYS CO. (1904) (LTD.)—The directors have declared a dividend of 1s. 3d. per share (less tax) for the three months ended June 30.

COUNTY OF LONDON ELECTRIC SUPPLY CO. (LTD.)—The directors have declared an interim dividend on the preference shares at the rate of 6 per cent. per annum (less tax) for the half-year ended June 30, and an interim dividend on the ordinary shares for the same period at the rate of 4 per cent. per annum (less tax), both payable Aug. 1. The transfer books and register of members will be closed from 21st to 31st inst. inclusive.

METROPOLITAN RAILWAY CO.—The ordinary stock dividend for the past half-year is announced at the rate of $\frac{1}{2}$ per cent. per annum.

MONTREAL LIGHT, HEAT & POWER CO.—The directors have declared a dividend of $1\frac{1}{2}$ per cent. (at the rate of 6 per cent. per annum) for the quarter ending 31st inst.

THOMAS PARKER (LTD.)—A meeting of the creditors of this company will be held at the offices, Wednesfield-road, Wolverhampton, on 30th inst., at noon. The meeting is formal. The chairman of the company, Mr. C. T. Mander, has been appointed receiver and manager for the debenture holders, and is carrying on the business until the necessary formalities are completed and the new company formed.

ST. JAMES' & PALL MALL ELECTRIC LIGHT CO. (LTD.)—The directors have declared an interim dividend on the preference shares at the rate of 7 per cent. per annum, and on the ordinary shares at the rate of 10 per cent. per annum for the half-year ended June 30. The share transfer books will be closed from 25th inst. to Aug. 7 inclusive.

The amount of electricity sold for the half-year ended June 30 is returned at 4,802,560 units, estimated to produce £61,652, against 4,561,897 units which produced £60,441, for the corresponding period of last year.

STOCK EXCHANGE NOTICES.—The Stock Exchange committee have appointed July 29 a special settling day in and granted a quotation to a further issue of £173,800 $4\frac{1}{2}$ per cent. debenture stock of the *Metropolitan Electric Tramways (Ltd.)* and have also granted quotations to 20,000 £5 (£3 paid) 5 per cent. cumulative preference shares of the *Calcutta Electric Supply Corpn. (Ltd.* and $5,650,000 additional $500 30 year 5 per cent. first mortgage gold bonds of the *Electrical Development Co. of Ontario (Ltd.)*. The committee have been asked to grant quotations to a further issue of £100,000 sterling 5 per cent. first mortgage debenture stock of the *Buenos Ayres Lacroze Tramways Co.* and £1,000,000 5 per cent. third mortgage debentures of *Vickers, Sons & Maxim (Ltd.)*, in lieu of scrip now quoted.

VICKERS, SONS & MAXIM (LTD.)—The following interim dividends for the half-year ended June 30 will be paid: $2\frac{1}{2}$ per cent. (less tax) on the preferred 5 per cent. stock and 5 per cent. preference shares, and 1s. per share, tax free, on the ordinary shares.

WALSALL ELECTRICAL CO. (LIMITED AND REDUCED).—A petition for confirmation of a resolution reducing the capital of this company from £25,000 to £20,620 will be heard in the High Court on July 28.

ELECTRIC TRAMWAY AND RAILWAY TRAFFIC RECEIPTS.

Line	Week ended.		Amount.	Inc. or Dec. (a)	Aggregate No. of weeks.	Aggregate Amount.	Aggregate Inc. or Dec. (a)
			£	£		£	£
Aberdeen Corporation	July	15	1,339	- 6[illegible]	7	9,579	- 870
Airdrie	,,	10	21[illegible]	- 51	27	6,494	+ 42
Anglo-Argentine	,,	15	21,352	+ 2,394	28	...	...
Ayr Corporation	,,	18	456	- 521	9	3,0[illegible]4	- 636
Baker St. & Waterloo Ry.	,,	18	3,150	+ 820	3	9,210	+ 1,510
Barnsley	,,	10	180	+ 18	27	4,721	+ 305
Barrow	,,	10	268	- 49	27	6,409	- 108
Bath Electric Trams, Ltd.	,,	15	8[illegible]2	+ 7	28	19,542	- 1,29[illegible]
Birkenhead Corporation	,,	19	1,144	+ 1	3	3,443	+ 57
Birmingham Corporation	,,	18	6,365	+ 194	16	100,744	+ 5,194
Birmingham & Mid.	,,	3	862	- 45	26	21,482	+ 945
Blackburn Corporation	,,	15	1,119	- 55	16	18,845	+ 1,079
Blackpool Corporation	...		...	...	...	...	...
Blackpool and Fleetwood	,,	18	324	- 341	3	3,189	+ 92
Bolton Corporation	,,	19	2,432	- 150	16	38,068	+ 1,622
Bombay	June	25	R34,3[illegible]0	+ R6,743	25	R806,719	+ R183,723
Bournemouth Corporation	July	15	1,[illegible]04	- 229	15	24,859	- 1,022
Bradford Corporation	,,	18	4,770	- 551	16	75,341	+ 629
Brighton Corporation	,,	19	9[illegible]6	- 115	16	14,076	+ 88
Bristol Trams & Carriage	,,	16	5,579	+ 6	34	139,392	+ 7[illegible]7
Burnley Corporation	,,	18	1,451	+ 169	16	20,782	+ 1,[illegible]2[illegible]
Burton Corporation	,,	19	311	+ 105	16	4,348	- 357
Bury Corporation	,,	12	1,141	- 18	‡15	18,137	+ 1,815
Calcutta Tramways Co.	,,	18	R15,948	- R2,832	3	R136,558	- R7,080
Cardiff Corporation	...		...	...	...	...	...
Cavehill	,,	10	9[illegible]	- 60	27	2,268	+ 221
Central London Railway	,,	21	7,558	+ 2,129	3	21,786	+ 5,159
Charing C., Euston & H'stead	,,	18	3,280	+ 2,815	3	9,965	+ 2,035
Chatham & Dist. Lt. Rys.	,,	16	768	- 116	§28	20,481	+ 537
City & South London Rly.	,,	14	2,[illegible]62	- 491	3	8,989	- 6[illegible]0
City of Birmingham	,,	10	2,876	+ 3	27	75,520	+ 392
Colchester Corporation	,,	15	21[illegible]	- 29	2	468	9
Cork Electric Trams Co.	,,	15	5[illegible]	- 47	28	12,595	- 438
Croydon Corporation	,,	17	1,4[illegible]0	- 1[illegible]9	16	23,014	+ 102
Devonport & Dist. Trams	,,	10	45[illegible]	- 56	27	12,183	+ 48
Dover Corporation	,,	18	226	- 30	16	3,514	- 165
Dublin & Lucan Railway	,,	17	131	- 38	2	338	- 54
Dublin United	,,	17	5,431	- 2,688	¶12	13,811	- 4,177
Dudley-Stourbridge	,,	10	877	- 76	27	21,763	- 1,077
Dundee Corporation	,,	15	1,111	- 70	‡19	10,734	+ 794
East Ham Council	,,	18	840	- 148	16	13,669	- 739
Exeter Corporation	,,	17	322	- 60	16	4,956	- 152
Falkirk and District	,,	15	236	...	2	269	...
Gateshead & Dist. Trams	,,	11	1,024	+ 19	27	27,288	+ 321
Glasgow Corporation	,,	18	17,287	+ 1,649	7	123,305	+ 2,654
Glossop	,,	15	131	- 20	29	3,557	- 233
Gravesend-Northfleet	,,	10	234	- 42	27	5,[illegible]5[illegible]	- 7[illegible]0
Great Northern & City Rly.	,,	18	1,2[illegible]3	- 381	3	4 131	- [illegible]26
Gt. Northern, Piccadilly, &c.	,,	18	5,405	+ 1,290	3	16,075	+ 7,115
Greenock & Port Glasgow	,,	10	510	- 129	27	14,[illegible]0	- 3,5[illegible]0
Hartlepool Tramways	,,	10	257	- 63	27	6,[illegible]0	- 1,[illegible]23
Hastings Elec. Trams Co.	,,	16	1,065	- 285	3	3,333	- 552
Hong Kong	,,	15	$3,3[illegible]3	- $1,930	...	...	...
Huddersfield Corpn.	,,	18	1,5[illegible]	- 164	16	26,036	+ 678
Hull Corporation	,,	18	2,576	+ 163	16	38 153	+ 21
Ilkeston District Council	,,	15	153	- 5	15	2,175	+ 45
Ipswich Corporation	,,	18	444	- 41	16	6,244	- 70
Isle of Thanet Co.	,,	1[illegible]	957	- 231	42	16,379	- 480
Jarrow	,,	1[illegible]	107	...	27	2,838	- [illegible]69
Keighley Corporation	,,	1[illegible]	161	- 15	2	375	- 3
Kidderminster & District	,,	10	152	+ 18	27	2,828	- 114
Kilmarnock Corporation	,,	18	158	- 36	9	1,422	- 139
Lanarkshire Trams Co.	,,	16	1,226	- 6[illegible]9	28	36,204	+ 3,317
Lancashire United	,,	15	1,316	- 80	28	36,580	+ 2,077
Leamington	,,	10	194	+ 19	27	4,2[illegible]0	+ 235
Leeds Corporation	,,	18	6,759	- 272	15	107,8[illegible]7	+ 5,495
Leicester Corporation	,,	18	2,291	- 62	3	6,948	+ 189
Leith Corporation	,,	18	580	- 110	§[illegible]	5,189	- 176
Lincoln Corporation	,,	1[illegible]	115	- 8	16	1,898	- 65
Liverpool Corporation	,,	11	11,148	- 206	28	295,207	- 1,674
Liverpool Overhead Rly.	,,	19	1,478	- 497	3	4,382	- 810
London County Council	,,	11	36,841	+ 4,681	†15	508,997	+ 55,703
*London United	,,	18	6,968	- 1,541	28	181,725	+ 2,478
Lowestoft	,,	18	258	- 17	42	7,102	+ 133
Maidstone Corporation	,,	18	183	...	16	3,080	...
Manchester Corporation	,,	18	15 499	+ 657	16	240,767	+ 10,[illegible]10
Mersey Railway	,,	18	1,879	+ 158	3	5,514	- 48
Merthyr	,,	10	215	+ 2	27	5 [illegible]53	+ 65
Metropolitan Dist. Railway	,,	18	9,461	+ 1,751	3	27,973	+ 3,723
Metropolitan Elec. Trams	,,	10	6,273	+ 1,[illegible]8	27	148,902	+ 30,404
Middleton	,,	10	387	+ 5	27	9,698	+ 420
Nelson Corporation	,,	18	143	- 25	¶15	2,265	- 134
Newcastle-on-Tyne Corp.	,,	18	3,707	- 419	16	62,955	- 4,190
Newport (Mon.)	,,	18	6[illegible]9	- 61	16	10,846	- 832
Northampton Corporation	,,	17	402	- 3	¶15	7,382	+ 452
Oldham, Ashton & Hyde	,,	10	615	+ 7	27	16,105	+ 37
Oldham Corporation	,,	19	2,044	- 217	17	33,391	+ 494
Perth (N.B.) Corporation	,,	15	112	- 48	9	1,377	- 93
Perth (W.A.) Elec. Trams	,,	17	1,425	+ 45	¶20	40,[illegible]	- 700
Peterborough	,,	10	247	+ 9	27	3,333	+ 219
Portsmouth Corporation	,,	18	2 0[illegible]7	- 318	16	31,684	- 30
Potteries	,,	10	1,728	- 105	27	49,413	- 466
Preston Corporation	,,	15	777	- 18	2	1,553	- 41
Rotherham Corporation	,,	15	575	- 26	§15	9,433	+ 71
Rothesay	,,	1[illegible]	42[illegible]	- 31	27	3,817	+ 4
Salford Corporation	,,	20	1,917	- 87	16	76,684	+ 628
Sheerness	,,	8	62	- 1	27	1,459	- 2
Sheffield Corporation	,,	19	5,528	- 302	†17	93,885	- 39
Singapore Trams	,,	18	$8,[illegible]0	+ $12	3	$27,279	- $262
South Metropolitan	,,	10	874	+ 14	27	20,943	+ 737
South Staffs	,,	10	861	- 24	27	23,7[illegible]0	- 228
Southend Corporation	,,	15	514	+ 7	1[illegible]	6,250	+ 125
Southport Tramways	,,	10	3[illegible]2	- 27	27	7,184	- 277
Stalybridge, Hyde, &c., Jt. Bd.	,,	18	820	- 158	†15	12,511	- 139
Sunderland Corporation	,,	19	1,231	- 370	16	18,745	- 4,163
Sunderland and District	,,	15	463	- 82	37	17,211	+ 1,260
Swansea Trams	,,	10	1,014	+ 41	27	24,611	+ 1,8[illegible]0
Swindon Corporation	,,	15	15[illegible]	- 18	...	...	...
Taunton	,,	10	42	- 2	27	1,[illegible]72	- 42
Tynemouth and District	,,	10	2[illegible]	- 25	27	5,[illegible]00	- 2[illegible]4
Tyneside Trams Co.	,,	15	406	101	2	831	- 86
Wallasey District Council	,,	18	[illegible]	- 38	†16	11,233	+ 757
Walsall Corpn.	,,	18	5[illegible]0	- 9	29	15,257	+ 1,339
Warrington Corpn.	,,	16	378	- 9	15	5,873	- 31
West Ham Corporation	,,	16	2,158	- 322	16	25,881	- 2,231
Weston-super-Mare	,,	8	27[illegible]	+ 52	27	2,574	+ 5[illegible]
Wolverhampton Co.	,,	10	[illegible]01	- 15	27	12,[illegible]5	- 218
Wolverhampton Corpn.	,,	15	[illegible]2[illegible]	- 61	6	5,615	+ 378
Worcester	,,	10	323	+ 14	27	7,[illegible]52	+ 59
Wrexham	,,	10	1[illegible]	+ 8	27	2,704	+ 27
Yorkshire W.R. Trams	,,	19	1,241	+ 19	29	31,740	...
Yorkshire Woollen District	,,	1[illegible]	871	- [illegible]	27	24,587	- 965

(a) The comparisons are with the corresponding period last year. § Plus 2 days. ¶ Plus 3 days. * Partly electrical. † Minus 3 days. ‡ Minus 2 days.

ELECTRICAL COMPANIES' SHARE LIST

Share	Last Dividend	Name.	Price Wed., July 22.	Rate % Yield-ed. £	s.	d.	Dividend Due.	Business Week to July [illegible] Highest.	Lowest.
		ELECTRICITY SUPPLY.							
10	9 0	Bournemouth & Poole Elec. Sup. Ord.	10½–11	6	7	0	Mar, Sept	..	..
10	4 6	Do. 4½ per Cent. Cum. Pref.	9[illegible]–10[illegible]	4	7	0	Feb, Aug		–
10	6 0	Do. 6 per Cent. Cum. Second Pref.	10[illegible]–1[illegible]	5	11	[illegible]	Feb, Aug	10[illegible]	..
St.	4½%	Do. 4½ per Cent. Deb. Stock (red.)	100–103	4	7	6	Jan, July	103	..
5	3 6	Bromley (Kent) El. Lt. & Power Shares	4½–5	5	10	0	April, Oct	..	..
St.	4½%	Do. Do. 1st Debs.	94–97	4	12	9	May, Nov	.	..
5	5 6	Brompton & Kensington Elec. Sup. Ord.	7–8	6	6	6	March	.	..
5	3 6	Do. 7 per Cent. Pref.	6¾–7¾	4	10	0	Mar, Sept		..
St.	4%	Central Elec. Sup. Co. 4% Guar. Db. Stock	98–101	4	0	0	June, Dec	100	..
5	2 6	Charing Cross (W. End & City) El. Sup. Co.	3¾–4¼	5	17	6	Feb, Aug	..	..
5	2 3	Do. 4½ per Cent. Pref.	4–4[illegible]	5	0	0	Feb, Aug	..	..
St.	4%	Do. 4 per Cent. Deb. Stock (red.)	94–97	4	2	6	Jan, July	95	..
5	2 3	Do. City Undertaking 4½% Cm. Pref.	3¾–4½	5	11	0	Jan, July	..	..
5	2/6	Chelsea Electric Supply Ord.	3–3½	6	8	9	March ..	3¼	3[illegible]
St.	4½%	* Do. 4½ per Cent. Deb. Stock (red.)	100–103	4	7	6	June, Dec	..	..
10	7 0	City of London Electric Lighting Ord.	9½–10[illegible]	5	16	6	Feb, Aug	9[illegible]	9[illegible]
10	6/0	Do. 6 per Cent. Cum. Pref.	12–13	4	12	0	Jan, July	..	..
St.	5%	Do. 5 per Cent. Deb. Stock (red.)	122–125	4	0	0	June, Dec	..	..
St.	4½%	Do. 4½ per Cent. 2nd Deb. Stock (red.)	101–104	4	6	6	Jan, July	..	..
5	2%	County of Durham Elec. P.D. Ord.	2¾–3	3	9	7	April, Oct	..	..
5	5%	Do. 5 per Cent. non Cum. Pref.	3¾–4½	6	5	0	April, Oct	..	..
10	6 0	County of London Elec. Supply Ord.	7¾–8¼	6	1	0	Feb, Aug	7¾	.
10	6 0	Do. 6 per Cent. Cum. Pref.	10[illegible]–10[illegible]	5	10	6	Mar, Sept	10[illegible]	10½
St.	4½%	Do. 4½% Deb. Stock (red.)	106–109	4	1	0	Jan, July	107½	..
St.	4½%	Do. Second Deb. Stock	93–101	4	9	9	May, Nov	..	..
5	3 6	Folkestone Electricity Supply Co. Ord.	4¾–5½	5	7	0	April, Oct	..	–
5	2 6	Do. 5 per Cent. Cum. Pref.	5–5½	4	11	0	Mar, Sept	..	..
St.	4½%	Do. 4½ 1st Deb. Stock (red.)	98–101	4	9	0	Feb, Aug	..	..
5	4 6	Hove Electric Lighting Ord.	6–6½	6	11	0	April, Oct	6[illegible]	..
5	5 0	Kensington & Knightsbridge Ord.	8–9	5	11	0	Feb, Aug	..	..
5	6%	Do. 6 per Cent. 1st Pref.	6–6½	4	12	0	Jan, July	..	–
St.	4%	Do. 4 per Cent. Deb. Stock (red.)	96–99	4	1	0	..	..	..
St.	4%	Kensingtn. & Kngtbg. Co. & Notting Hill Co. (Joint Station) 4% Deb. Stock (red.)	97–101	3	19	0	April, Oct	100½	..
St.	4½%	†Kent Elec. Power Co.	86–90	5	0	0	Jan, July	..	..
3	1 6	London Electric Supply Ord.	⅞–1⅛	5	8	0	Mar, Sept	1[illegible]	..
5	3 0	Do. 6 per Cent. Pref.	4½–5	6	0	0	Mar, Sept	..	–
St.	4%	Do. 4 per Cent. 1st Mort. Deb.	89–92	4	7	0	Jan, July	..	..
5	3,6	Metropolitan Electric Sup. Ord.	4⅞–5⅛	6	6	6	April, Oct	4[illegible]	4[illegible]
5	2 3	Do. 4½ per Cent. Cum. Pref.	4[illegible]–4[illegible]	4	12	6	Jan, July	..	..
St.	4½%	Do. 4½ per Cent. Deb. Stock 1st Mort.	105–109	4	1	6	June, Dec	10[illegible]½	..
St.	3½%	Do. 3½ per Cent. Mrt. Deb. Stock (red.)	84–89	3	19	0	Jan, July	..	..
100	4½%	Midland Elec. Corp. for P.D. 1st Mort. Db.	94–97	4	12	6	June, Dec	..	–
10	4%	Newcastle & Dist. Elec. Ltg. Ord.	7½–8	5	3	2	Feb, Aug	–	–
100	4½%	Do. 4½ per Cent. Deb.	94–96	4	14	9	Jan, July	..	..
5	8%	†Newcastle Elec. Supply Ord.	5½–5¾	7	8	10	Feb, Aug	..	..
5	5%	† Do. 5 per Cent. non Cum. Pref.	5½–5¾	4	15	8	Feb, Aug	..	..
100	4%	Do. 4 per Cent. Mort. Deb. red. 1907.	95–97	4	3	4	Jan, July	..	..
1	3%	Northern Counties Elec. Sup.	—	..			Mar, Aug	–	..
100	4½%	Do. 4½ per Cent. Deb.	93–95	4	15	9	Jan, July	..	..
10	6 0	Notting Hill Electric Ord.	12–13	5	8	0	March ..	..	..
5	4 6	Oxford Electric Ord.	6¾–6¾	5	12	0	March ..	..	..
St.	4%	† Do. 4 per Cent. Deb. Stock	95–98	4	2	0	Jan, July	..	..
5	5 0	St. James' & Pall Mall Elec. Ord.	7½–8½	5	18	0	Feb, Aug	..	..
5	3 6	Do. 7 per Cent. Pref.	6½–7½	4	16	6	Feb, Aug	6¾	..
St.	3½%	Do. 3½ per Cent. Deb. Stock (red.)	85–90	3	18	0	Jan, July	..	..
5	..	Smithfield Markets Electric Sup. Ord.	½–¾	..			Feb	..	..
St.	4%	Do. 4 per Cent. Deb. Stock	70–74	5	8	0	Feb, Aug	..	..
5	4,0	South London Electric Supply Ord.	2¾–2[illegible]	5	19	0	April ...	..	..
1	0/6	South Metrop'n Elec. Lt. & Power Ord.	[illegible]–[illegible]	4	0	0	..	..	..
1	0 8¾	Do. 7 per Cent. Cum. Pref.	1–1¼	5	12	0	Feb, Aug	..	..
St.	4½%	Do. 4½ 1st Db. Stk. Red.	99–102	4	8	0	April, Oct	..	..
5	2/6	Urban Electric Supply Ord.	½–1½	16	12	0	April, Oct	–	..
5	2/6	Do. 5 per Cent. Cum. Pref.	1⅞–2[illegible]	10	12	0	April, Oct	1⅞	..
St.	4½%	Do. 4½ per Cent. 1st Mort. Deb.	82–85	5	6	0	April, Oct	..	..
5	5 0	Westminster Elec. Sup. Ord.	7¾–8¾	5	14	0	Mar, Sept	8[illegible]	8⅛
5	2/3	Do. 4½ per Cent. Cum. Pref.	4⅞–5⅜	4	4	0	Jan, July	5[illegible]	..
		ELECTRIC RAILWAYS, TRAMWAYS, &c.							
St.	4%	†Baker St. & Waterloo 4% Perp. Db. St.	90–92	4	7	0	Jan, July	..	–
1	..	Bath Elec. Trams Pref. Ord.	½–[illegible]	10	13	0	April	–	–
1	0/6	Do. 5 per Cent. Cum. Pref.	⅝–[illegible]	6	14	0	Jan, July	..	..
St.	4½%	Do. 4½ 1st Mort. Deb. Stock (red.)	85–90	5	[illegible]	0	April, Oct	..	..
St.	4½%	B'ham & Midland Trams 4½ 1st Db. Stk.	91–94	4	17	0	Jan, July	..	..
10	9%	Bristol Tramways & Carriage Ord.	11–11½	7	16	0	Feb, Aug	..	..
10	4%	Do. Cum. Pref. (fully paid)	8½–9	4	9	0	..	..	..
St.	4%	Do. 4 per Cent. Debs.	93–98	4	2	0	Feb, Aug	..	..
10	..	British Electric Traction Ord.	1¾–1[illegible]	..			June, Dec	1[illegible]	1[illegible]
10	1/5½	Do. 6 per Cent. Cum. Pref.	4¼–4¾	..			Feb, Aug	4½	4[illegible]
St.	5%	Do. 5 per Cent. Perpetual Debs.	95–98	..			April, Oct	97½	96½
St.	4½%	Do. 4½ per Cent. 2nd Deb. Stock	76–78	5	15	0	May, Nov	..	..
St.	3%	Central London Ordinary Stock	68–71	4	4	6	Feb, Aug	72	69
St.	4%	Do. 4 per Cent. Pref. Stock	88–91	4	9	0	Feb, Aug	..	..
St.	2%	Do. Deferred Stock	53–56	3	11	3	Feb	55	53½
100	4%	† Do. 4 per Cent. Debs.	101–104	3	17	0	Jan, July	..	..
St.	4%	Charing X, Euston & Hmpstd Per. Db. Stk.	81–84	4	15	0	Jan, July	82½	82¾
5	2/6	City of Birmingham Trams. 5% Cm. Pref.	4¼–4¾	5	5	0	April, Oct	..	..
100	4%	Do. 4 per Cent. 1st Mort. Debs.	97–100	4	0	0	April, Oct	..	..
St.	1¾%	City & South London Rly. Con. Ord.	33½–34½	5	1	0	Feb, Aug	34½	33
St.	5%	Do. 5 per Cent. Perp. Pref. (1891)	113–116	4	6	0	Feb, Aug	..	..
St.	5%	Do. (1896)	112–115	4	7	0	Feb, Aug	..	..
St.	5%	Do. (1901)	110–113	4	8	6	Feb, Aug	..	..
St.	5	Do. (1903)	104–107	4	13	6	Feb, Aug	..	..
St.	4%	Do. 4 per Cent. Perpetual Debs.	100–103	3	17	6	May, Nov	..	..
10	7/0	Dublin United Trams. Ord	12½–13½	4	10	6	Feb, Aug	..	..
10	6/0	Do. 6 per Cent. Pref.	12½–13½	4	9	0	Feb, Aug	..	–
10	..	Gt. Northern & City Rly. Pref. Ord. (4%)	¾–1¼	..			Feb, Aug	..	..
10	4/0	G. Northern, Piccadilly & Brompton Ord.	7–7½	5	10	0	Feb, Aug	..	..
St.	4%	Do. 4 per Cent. Deb. Stock	90–92	4	7	0	Jan, July	91[illegible]	91
5	4/0	Hastings & Dist. Elec. Trams 6% Cm. Pf.	3½–3¾	8	0	0	Mar, Sept	..	..
St.	4½%	Do. 4½ Db. St.	93–96	4	13	9	April, Oct	..	..
10	9%	‡Imperial Tramways Ord.	10½–11½	7	17	0	Mar, Sept	..	..
10	6%	‡Do. 6 per Cent. Pref.	9½–10	6	0	0	Mar, Sept	..	..
St.	4½%	‡Do. 4½ per Cent. Debs.	90–92	4	18	0	Jan, July	..	..
5	..	I. of Thanet E. T. & Lt. 5 per Cent. Pref.	⅞–1⅜	..			Mar, Sept	..	..
St.	4%	Do. 4 per Cent. Deb. Stock	59–61	6	11	0	Jan, July	..	–
10	6/0	Lanarkshire Tramways	9¾–10¼	5	9	0	Feb, Aug	10[illegible]	..
St.	5%	Lancs. Utd. Trams 5% Prior Lien Db. St.	91–93	5	7	6	Jan, July	..	..
10	..	Liverpool Overhead Railway Ord.	1¼–1[illegible]	..			Feb, Aug	..	..
10	5%	Do. 5 per Cent. Pref.	5¾–6¼	8	0	0	Feb, Aug	..	–
St.	4%	Do. 4 per Cent. Deb.	84–85	4	13	0	Jan, July	..	..
10	5,0	London United Trams. 5% Cum. Pref.	6½–7[illegible]	6	13	6	Jan, July	..	..
St.	4%	Do. 4 per Cent. 1st Mort. Deb. Stock	79–84	4	15	0	Jan, July	..	..
St.	–	Mersey Con. Ord. Stock	1–3	–			Feb, Aug.	..	–
St.	..	Do. 3 per Cent. Perp. Pref.	3–6	–			..	..	..
1	..	Metropolitan Elec. Tramways Def.	[illegible]–[illegible]	–			April..	.	..
1	0/6	Do. 5 per Cent. Cum. Pref.	[illegible]–[illegible]	6	3	6	Feb, Aug	[illegible]	[illegible]
St.	4½%	Do. 4½ per Cent. Deb. Stock	93–96	4	13	9	Jan, July	93¼	..
St.	½%	Metropolitan Railway Consolidated	3[illegible]½–36½	1	7	3	Feb, Aug	37	34½
St.	2¾%	Do. Surplus Lands Stocks	67–69	4	0	0	Feb, Aug	68[illegible]	68⅜
St.	3½	Do. 3½ per Cent. Preference	86–89	3	19	9	Feb, Aug	86½	..
St.	3½	Do. 3½ per Cent. "A" Preference	76–79	4	8	6	Feb, Aug	7[illegible]	76½
St.	3½%	Do. 3½ per Cent. Convertible Pref.	73–76	4	12	0	Feb, Aug	73½	..
St.	3½	† Do. 3½ per Cent. Debenture Stock	90–93	3	15	3	Jan, July	91½	91
St.	3½	† Do. 3½ per Cent. "A" Ditto	88–91	3	17	0	Jan, July	91½	89

* In calculating the yield allowance has been made for accrued interest but *not* for redemption.
† Ex Dividend

ELECTRICAL COMPANIES' SHARE LIST.—*Continued.*

ELECTRIC RAILWAYS & TRAMWAYS *Continued.*

Share	Last Dividend	Name	Price Wed., July 22	Rate % Yield-ed £ s. d.	Dividend Due	Business Week to July 22 Highest	Lowest
St.	..	Metropolitan District Railway Ord.	11½—12½	—	Feb, Aug	11¾	11½
St	..	Do. Extension Pref (5 per Cent.)	21 —26	..	Feb, Aug	21¼	—
St.	3½%	Do. Asserted Ext. Pref. (Int. Guar. by Und. Elec. Rlys. Co. of London, Ltd.)	46 —50	7 0 0	Feb, Aug	..	..
St.	3%	Do. 3 per Cent. Consoltd. Rent charge	73 —76	3 19 0	Jan, July	74½	74¼
St.	4%	Do. 4 per Cent. Midland Rent-charge	98 —102	3 18 0	Jan, July	101	..
St.	1¾%	Do. Guar. Stock 4 per Cent.	44 —49	3 11 0	Mar, Sept	..	..
St.	6%	Do. 6 per Cent. Perp. Deb. Stock	115 —120	5 0 0	Jan, July	115½	115
St.	4	Do. 4 per Cent. Ditto	71 —76	5 5 0	Jan, July	..	..
5	..	New Gen. Tract. 6 per Cent. Cum. Pref.	¼—¾	..	May	..	—
1	0/9⅜	Potteries Electric Traction Ord.	¼—½	8 0 0	April, Oct	..	..
1	0/6	Do. 5 per Cent. Cum. Pref.	⅝—¾	6 13 0	Feb, Aug	..	..
St.	4½%	Do. 4½ per Cent. Deb. Stock	93 —96	4 14 6	May, Nov	..	..
1	0/7½	S. Met. Elec. Trams. & Ltg. 6% Cm. Pref.	¾—1	6 0 0	Feb, Aug	¾	..
St.	4%	Do. 4 per Cent. Deb. Stock	76 —80	5 0 0	Jan, July	78½	77¾
100	5%	Sunderland Dist. Elec. Trms. 5% 1st Mt. Db.	75 —80	6 5 0	Jan, July	..	..
..	5%	Underground Elec. Rys. Co. of London...	40 —44	11 8 0	June, Dec	..	..
5	..	Yorkshire (W.R.) Elec. Trams. Ord.	⅞—1⅜	—	March ..	..	..
5	..	Do. 6 per Cent. Cum. Pref.	3⅛—3⅝	—	..	..	..
St	4½	Do. 4½ per Cent. 1st Debs.	83 —86	5 5 0	Jan, July	..	..

ELECTRIC MANUFACTURING, &c.

Share	Last Dividend	Name	Price Wed., July 22	Rate % Yield-ed £ s. d.	Dividend Due	Highest	Lowest
1	..	Aron Electricity Meter Ord.	7/16—11/16	..	..	..	..
1	1/4½	Do. 6% Cum. Pf. (ex on a/c arrears)...	[illegible]	7 13 7	April, Oct	..	..
1	2/4½	Babcock & Wilcox Ord.	3 11/16—3 15/16	4 16 3	April, Oct	3 13/16	3½
1	0/7⅛	Do. Pref.	1 7/16—1 9/16	3 16 9	..	..	..
5	6/0	British Insulated & Helsby Cables Ord.	6¼—6¾	7 4 0	July, Feb	..	..
5	3/0	Do. 6 per Cent. Pref.	6 —6½	4 12 0	Jan, July	..	..
St.	4½%	Do. 4½ per Cent. 1st Mort. Deb. (red.)	102 —105	4 5 6	Jan, July	..	..
St.	4½%	British Thoms'n Houst'n 4½% 1st Mt. Db.	93 —98	4 12 0	Mar, Sept	..	..
5	..	British Westinghouse 6 per Cent. Pref...	9/16—11/16	..	Feb, Aug	..	..
St.	4%	Do. 4 per Cent. Mort. Deb. Stock	45 —48	8 8 0	Jan, July	..	..
2	..	Brush Electrical Engineering	½	—	March ..	..	..
2	..	Do. 6 per Cent. Pref. non-Cum.	3/16—7/16	..	Mar, Sept	..	..
St.	4½%	Do. 4½ per Cent. Perp. 1st Deb. Stock	70 —75	6 0 0	Mar, Sept	..	..
St.	4½%	Do. Perpetual 2nd Deb. Stock	53 —58	7 14 0	Jan, July	..	..
5	10/0	Callender's Cable Con. Ord.	9½—10½	7 1 0	Jan, July	..	..
5	2/6	Do. 5 per Cent. Cum. Pref.	5¼—5¾	4 7 0	Jan, July	..	..
St.	4½%	Do. 4½ per Cent. 1st Mort Debs. (red.)	104½—106½	4 4 6	Nov, May	105	..
1	1/0	Castner-Kellner Alkali Co.	1⅜—1½	8 14 0	May, Nov	1[illegible]	..
St.	4½%	Do. 4½ per Cent. 1st Mort. Deb. (red.)	102 —106	4 5 6	Feb, Aug	..	..
1	0/9⅜	Chadburn's (Ship) Telegraph Ord.	1 1/16—1 3/16	8 8 0	March ..	..	..
1	0/7½	Do. 6 per Cent. Cum. Pref.	1 —1⅛	5 6 6	April, Oct	..	..
1	0/8¾	†Consolidated Electrical Co.	⅜—½	7 0 0	August ...	..	..
1	1/0	Consolidated Signal Co.	1 5/16—1 9/16	8 17 9	April, Oct	..	..
1	0/7½	Do. 6 per Cent. Cum. Pref.	[illegible]	6 4 0	April, Oct	..	..
3	3/0	*Crompton & Co. (Nos. 1 to 86,000)	1⅜—1⅝	8 1 6	Jan, July	..	..
100	5%	Do. 5 per Cent. 1st Mort. Debs. (red.)	90 —93	5 7 0	Jan, July	..	..
1	0/7½	Davis & Timmins	⅞—1⅛	..	Mar, Sept	..	..
5	2/0	Dick, Kerr & Co. Ord.	1⅛—1⅜	7 11 0	Sept	..	..
5	0/7½	Do. 6 per Cent. Cum. Pref.	1 —1¼	4 16 0	Sept	..	..
St.	4½%	Do. 4½ per Cent. Deb. Stock	99 —102	4 8 6	Jan, July	101	—
5	2/6	Edison & Swan United ("A" Sh.) (£3 pd.)	½—¾	..	Feb, Aug	..	..
5	4/2	Do. (£5 paid)	1½—2½	5 0 0	Feb, Aug	..	—
St	4%	Do. 4 per Cent. Mort. Deb. Stock (rd.)	76 79	5 [illegible] 6	June, Dec	..	..
St.	5%	Do. 5 per Cent. 2nd Deb. Stock	85 —87	5 15 0	Mar, Sept	—	..
5	..	Edmundson's Elec. Corp. Ord.	⅛—⅜	..	Jan, July	..	..
5	..	Do. 6 per Cent. Cum. Pref.	¾—1	..	May, Nov	..	..
St.	4½%	† Do. 4½ per cent. 1st Mort. Deb. (red.)	61 —71	6 6 6	Jan, July	..	..
2	..	Electric Construction Co.	¼—½	..	Jan, July	..	..
2	..	Do. 7 per Cent. Cum. Pref.	1½—2	..	July	1 13/16	1[illegible]
St.	4%	† Do. 4 per Cent. Perp. 1st Mort. Debs.	66 —71	5 13 0	Jan, July	..	..
10	5/0	General Electric (1900) 5% Cum. Pref...	7½—8	6 5 0	June, Dec	..	..
St	4%	Do. 4 per Cent. 1st Mort. Debs.	84 —87	4 12 0	Mar, Sept	85½	—
5	10/0	Henley's Telegraph Works Ord.	10½—11½	6 10 0	Feb, Aug	..	..
5	2/3	Do. 4½ per Cent. Pref.	5 —5½	4 2 0	Feb, Aug	5[illegible]	5[illegible]
St	4½%	Do. 4½ per Cent. 1st Mort. Deb. Stock	106 —108	4 3 6	Mar, Sept	..	..
10	5/0	†India Rubber, Gutta Percha, &c., Wrks.	15½—16½	6 2 0	Feb, Aug	15[illegible]	..
100	4%	Do. 4 per Cent. Debs. (red.)	98 —100	4 0 0	April, Oct	9 ¼	98
1	..	National Elec. Construction Co.	⅜—⅝	..	April......	..	..
1	0/9¾	Richardsons, Westgarth & Co., Ltd. Ord.	7/16—9/16	7 2 0	Nov	..	..
1	0/7½	Do. 6 per Cent. Cum. Pref.	¾—⅞	6 17 0	May, Nov	..	..
St	4½%	Do. 4½ per Cent. Perp. Deb. Stock	87 —90	5 0 0	Jan, July	..	..
1	..	Simplex Conduits Ord.	1½	..	..	—	—
5	..	Do. 6 per Cent. Cum. Pref.	6½	..	..	..	—
12	12/0	†Telegraph Construction & Maintenance	31 —33	6 8 0	Mar, July	31½	31
100	4%	Do. 4 per Cent. Deb. Bonds (1909)	100 —102	3 18 0	Jan, July	..	..
1	2/0	Vickers, Sons & Maxim, Ltd., Ord.	[illegible]	8 11 0	..	1 23/32	1[illegible]
1	0/6	Do. 5 per Cent. non-Cum. Preference	1 —1⅛	4 9 0	..	..	..
St.	5%	Do. 5 per Cent. non-Cum. Preferred	102 —106	4 14 6	..	..	..
St.	4%	Do. 4 per Cent. 1st Mort. Db. Sk. (red)	103 —105	3 16 0	June, Dec	104½	..
100	4½%	Do. 4½ per Cent. 2nd Mort. Deb. (red.)	104 —106	4 5 0	June, Dec	105½	105
100	15/6	Do. 5 per Cent. [illegible] Mort. Debs. Scrip.	102 —104	..	..	105¼	102
1	10/0	J. G. White & Co. 6% Cm. Pref. xd&bonus	7 —8	7 10 0	..	..	..
5	1/0	Willans & Robinson Ord.	¾—1¼	4 0 0	Apr, Oct	1[illegible]	..
5	3/0	Do. 6 per Cent. Cum. Pref.	3¼—3¾	8 0 0	Apr, Oct	3½	3¼
100	4%	Do. 4 per Cent. 1st Mort. Debs.	72 —75	5 5 6	May, Nov	75	73¼

TELEGRAPHS.

Share	Last Dividend	Name	Price Wed., July 22	Rate % Yield-ed £ s. d.	Dividend Due	Highest	Lowest
10	..	Amazon Telegraph	2 —3	—	June, Dec	..	—
100	5%	Do. 5 per Cent. Debs. (red.)	86 —89	5 12 0	June, Dec	..	..
St	16/0	Anglo American	57 —60	5 13 6	F,My,Ag,N	57	..
St	30/0	Do. Preferred	103 —104	3 15 0	F,My,Ag,N	104	103
St	1%	Do. Deferred	1[illegible]—16	6 6 0	F,My,Ag,N	16⅛	15⅞
St	4%	Commercial Cable 4 per Cent. Deb. Stk	83 —86	4 13 0	Jn,Ap,Jy,O	85¼	85⅛
10	6/0	Cuba Submarine Ord.	7½—8½	7 0 0	Feb, Aug	..	..
10	10/0	Do. Preference 10 per Cent.	15½—16½	6 1 6	Feb, Aug	..	..
5	2/0	Direct Spanish Ord.	3 —3¼	6 4 0	April, Oct	3	..
5	5/0	Do. 10 per Cent. Cum. Pref.	8 —9	5 11 0	April, Oct	..	..
St	4½%	Do. 4½ per Cent. Deb.	100%—103%	4 7 6	Jan, July	100	.
20	4/0	Direct United States Cable	13⅜—13⅞	6 11 0	Ja,Ap,Jy,O	13[illegible]	13[illegible]
100	4½%	Direct West India Cable 4½% Rg. Db. (rd.)	95 —100	4 10 0	June, Dec	..	..
St	[illegible]	Eastern Ordinary	132 —135	5 4 0	Ja,Ap,Jy,O	134½	132½
St.	17/6	† Do. 3½ per Cent. Pref. Stock	83½—87	4 2 0	Ja,Ap,Jy,O	[illegible]	[illegible]
St.	4%	Do. 4 per Cent. Mort. Deb. Stk. (red.)	101 —103	3 17 6	May, Nov	[illegible]	101½
10	2/6	†Eastern Extension	12¾—13¼	5 6 0	Ja,Ap,Jy,O	[illegible]	[illegible]
St.	4%	Do. 4 per Cent. Deb. Stock	101 —103	3 17 6	Feb, Aug	102½	101½
100	4%	Eastern & S. African 4% Mort. Deb. 1900	100 —102	3 18 6	Feb, Aug	..	..
25	4%	Do. 4% Mauritius Sub. Debs. (red.) ...	100 —102	3 18 6	May, Nov	..	..
10	[illegible]	G. N. of Copenhagen, with Coupon 74	27 —29	6 16 0	Jan, July	..	..
100	4½	Halifax & Bermuda 4½% 1st Mt. Db. (red.)	98 —100	4 12 0	June, Dec	..	..
[illegible]	[illegible]	Indo-European	59 —[illegible]	5 12 0	May, Nov	..	..
100	$1	Mackay Companies Common	68 —70	5 14 0	Ja,Ap,Jy,O	.	..
100	$1	Do. Preferred	69 —70	5 11 0	Ja,Ap,Jy,O	[illegible]	..
1		Marconi's Wireless Telegraph Co.	⅜—½	..	April	..	..
100	4%	Pacific & European Tel. 4% Guar. Dbs. (red.)	97 —100	4 0 0	June, Dec	..	—
[illegible]	1/3	West Coast of America	[illegible]	4 5 0	May	..	..
100	4%	Do. 4 per Cent. Debs.	98 —101	3 19 0	Jan, July	.	..
10		West India & Panama	[illegible]	..	May, Nov	[illegible]	
10	[illegible]	Do. 6 per Cent. 1st Pref.	[illegible]—4	7 1 0	May, Nov	[illegible]	[illegible]
10	[illegible]	Do. 6 per Cent. 2nd Pref. [illegible]	[illegible]—3½	..	May, Nov	[illegible]	.
[illegible]		Do. 5 per Cent. Debs.	[illegible]—102	4 18 0	Jan, July	..	.
10	[illegible]	Western Telegraph	[illegible]—14½	4 19 0	Mr,Jn,O,D	[illegible]	[illegible]
St	4	Do. 4 per Cent. Deb. Stock (red.)	[illegible]	3 18 6	June, Dec	[illegible]	[illegible]
..	4	Western Union Teleg. $1,000 4% Bonds	80 —85	4 14 0	..		

TELEPHONES.

Share	Last Dividend	Name	Price Wed., July 22	Rate % Yield-ed £ s. d.	Dividend Due	Highest	Lowest
100	2⅜	†Amer. Telephn. & Telegh. Cap. St.	119 —123	6 10 0	..	..	..
..	4%	Do. Coll. Trust $1,000 4 per Cent. Bds	89 —92	4 7 0	Jan, July	91	90½
St.	5%	Anglo-Portug'se Tel. 5% 1st Mt. Db. Stk.	100 —103	4 17 0	Mar, Sept	..	—
5	3/0	Chili Telephone	7¾—8¼	4 16 0	August ..	..	..
1	0/7½	Monte Video Telephone Ord.	[illegible]	6 12 0	Nov	1	..
1	0/6	Do. 5 per Cent. Pref.	[illegible]	5 6 0	May, Nov	[illegible]	..
St.	6%	National Co. Pref. Stock	109½—111½	5 7 6	Feb, Aug	111¼	110
St.	6%	Do. Def. Stock	120 —122	4 15 0	Feb, Aug	122	116⅞
10	6/0	Do. 6 per Cent. Cum. 1st Pref.	11½—12½	4 16 0	Feb, Aug	..	..
10	6/0	Do. 6 per Cent. Cum. 2nd Pref.	10 —12	5 0 0	Feb, Aug	..	..
5	2/6	Do. 5 per Cent. non-Cum. 3rd Pref.	5¾—6	4 3 4	Feb, Aug	5⅞	5[illegible]
St.	3½%	* Do. Deb. Stock 3½ per Cent. (red.)	97½—99½	3 10 6	June, Dec	99⅛	9[illegible]½
St	4%	Do 4 per Cent. Deb. Stock (red.)	100½—102½	3 17 6	Jan, July	101¼	..
1	1/0	Oriental	1[illegible]—1[illegible]	5 6 8	April, Oct	..	..
1	0/7½	Do. 6 per Cent. Cum. Pref.	1⅛—1¼	4 16 0	April, Oct	—	..
St.	4%	Do. 4 per Cent. Red. Deb. Stock	88 —91	4 8 0	Jan, July	..	..
St.	4½%	Telephone Co. of Egypt 4½% Db. Stk. (red.)	98 —101	4 11 0	Jan, July	—	..
5	3/0	United River Plate	6¾—7¼	5 10 0	July	6[illegible]	6¾
5	2/6	Do. 5 per Cent. Cum. Pref.	5 —5½	4 11 0	June, Dec	5	..
St.	4½%	Do. 4½ Deb. St. Red.	99 101	4 9 0	Jan, July	100½	..

FINANCIAL, INVESTMENT, &c.

Share	Last Dividend	Name	Price Wed., July 22	Rate % Yield-ed £ s. d.	Dividend Due	Highest	Lowest
5	8/0	Elec. & Gen. Investment 6% Cum. Pref.	3½—4	7 10 0	Jan, July	..	..
10	5/9	†Globe Telegraph & Trust	10½—10⅞	5 11 0	SpDcMrJu	10[illegible]	10½
10	3/0	† Do. 6 per Cent. Pref.	13⅝—13⅞	4 0 6	SpDcMrJu	13¾	13[illegible]
10	6%	Submarine Cables Trust (Cert.)	127 —130	4 12 0	April, Oct	127½	127

COLONIAL AND FOREIGN ELECTRIC RAILWAYS, TRAMWAYS, &c.

Share	Last Dividend	Name	Price Wed., July 22	Rate % Yield-ed £ s. d.	Dividend Due	Highest	Lowest
5	3/0	Anglo-Argentine 6% Cum. 1st Pref.	6⅛—6⅜	4 14 0	April, Oct	6¼	6¼
5	5/0	Do. 10% Non-cum. 2nd Pref.	[illegible]	5 12 0	Jan, July	8¼	8[illegible]
St.	6%	Do. Permanent 6% Deb. Stock	141 —146	4 2 0	June, Dec	142½	141
St.	5%	Auckland Elec. Trams. 5% Deb. (red.)...	103 —106	4 14 3	Jan, July	..	..
5	4/0	Brisbane Electric Trams. Invest. Ord.	[illegible]	4 8 6	May	4[illegible]	[illegible]
5	2/6	Do. 5 per Cent. Cum. Pref.	4⅞—5⅛	4 17 6	May, Nov	[illegible]	..
St.	4½%	Do. 4½ per Cent. Db. Prov. Certs.	98 —102	4 8 0	Jan, July	101	.
St.	8%	British Columbia El. Ry. Df. Ord.	124 —129	6 4 0	Mar, Sept	124½	..
St.	65/0	Do. Pref. Ord. Stock	108 —112	5 6 6	May, Nov	110⅛	109⅛
St.	5%	† Do. 5% Cum. Perp. Pref. Stock	104 —105	4 12 0	Jan, July	..	.
40	4½%	Do. 4½ per Cent. 1st Mort. Debs.	99 —102	4 8 0	April, Oct	..	—
100	4½%	† Do. Vancouver Power Debs.	100 —103	4 7 6	Jan, July	..	—
St.	4½%	Do. 4½% Perp. Con. Deb. St.	101 —104	4 1 6	—	102[illegible]	102¼
St.	5%	Buenos Ayres Elec. Trams (1901) Ltd. Deb. St.	93 —97	5 2 6	Ja, Jul ..	..	..
5	..	Buenos Ayres Grand National Ord.	2⅛—2[illegible]	..	..	2¼	..
5	2/6	Do. 5 per Cent. Cum. Pref.	3⅞—4⅛	..	Feb, Aug	4[illegible]	4
100	5½%	Do. 5½ per Cent. Pref. Debs.	99 —103	5 7 6	Jan, July	..	..
100	6%	Do. 6 per Cent. 1st Deb. Bonds.	100 —104	5 14 6	April, Oct	..	..
St.	5%	Buenos Ayres Lacroze Trams 1st Mt. Db.	93 96	5 4 0	Mar, Sept	..	..
St.	6%	Buenos Ayres Port & City Tram. 1st Mt. Deb. Stock £75 Paid	64 —68	6 12 0	Feb, Aug	..	..
5	2/6	Calcutta Tramways (1 to 137,010)	5¼—5½	5 4 0	Mar, Sept	5[illegible]	..
100	2/6	Do. 5 per Cent. Cum. Pref.	5 —5¼	4 13 0	Jan, July	..	..
1	4½%	Do. 4½% 1st Deb. Stock (red.)	101 —104	4 6 6	Jan, July	..	..
St.	..	Cape Electric Tram Shares	[illegible]—7/16	..	..	..	.
5	1/3	City of Buenos Ayres Trams Co. (1904) Sh.	5⅜—5⅝	4 5 0	F,My,A,N	5[illegible]	[illegible]
St.	4%	Do. 4 per Cent. Deb. Stock	97 —101	3 19 0	June, Dec	..	..
.	5%	Colombo Tr. & Ltg. 5% 1st Mt. Db.	88 —91	5 10 0	May, Nov	..	—
100	5%	Electric Traction Co. of Hong Kong 5 per Cent. 1st Mort. Debs.	85 —90	5 10 0	June, Dec	.	..
1	5%	†Havana Elec. Ry. Con. Mt. 5% $1,000 50 year Coup. Bds.	80 —85	5 9 6	Feb, Aug	8[illegible]	..
1	..	Kalgoorlie Elec. Trams Sh.	[illegible]	..	..	..	.
100	5%	Do. 5 per Cent. "A" Deb. Stock	80 —85	5 12 0	Jan, July	..	—
5	6%	Do. 6 per Cent. "B" Ditto	60 —73	8 4 0	Jan, July	..	..
5	1/0	Lisbon Elec. Trams. Ord.	1 —1¼	4 0 0	July	..	..
100	0/7½	Do. 6 per Cent. Cum. Pref.	1 —1¼	4 16 0	Jan, July	..	—
St.	5%	Do. 5 per Cent. Reg. Mort. Debs.	92 —97	5 3 0	Jan, July	..	..
St.	5%	Madras Elec. Trams. 5% Deb. Stk.	93 —96	5 4 0	Jan, July	..	..
.	5%	Manila Elec. Ry. $1,000 Gold Bonds	86 —90	5 11 8	Feb, Aug	.	.
100	$1	Mexico Trams Co. Com. St.	104½—106½	3 14 9	..	105½	104¼
500	5%	Do. Gen. Con. 1st Mort. 5% Gold Bds....	91¼—92¼	5 8 3	..	92	91¼
St.	4½%	Montreal St. Ry. Sterling 4½ per Cent. Debs. (1922)	102 —104	4 6 6	Feb, Aug	10[illegible]½	1[illegible]¼
1	1/0	Perth Elec. Trams Ord	[illegible]	7 5 6	May	..	..
St.	5%	Do. 1st Mt. Db. Stock	101 —104	4 16 0	Jan, July	..	—
5	3/0	Rangoon Elec. Trams & Supply Co. 6% Cum. Pf.	5⅛—5⅜	5 6 6	..	[illegible]	—
St.	4½	Do. 4½% 1st Mort. Deb. Stk.	97½—99½	4 10 6	..	..	—
..	$2½	Sao Paulo Tramway, Light & Power Co. $100 Stock	140 —144	6 5 0	..	142	136
..	5%	Do. 5 per Cent. 1st Mt. $500 Db.	97 —99	5 1 0	June, Dec	97⅛	[illegible]
100	4½%	Toronto Ry. Co. 1st Mt. 4½% Ster. Bonds	99 —101	4 9 0	Feb, Aug	99½	[illegible]

COLONIAL AND FOREIGN ELECTRICITY SUPPLY &c.

Share	Last Dividend	Name	Price Wed., July 22	Rate % Yield-ed £ s. d.	Dividend Due	Highest	Lowest
5	3/0	Adelaide Elec. S'ply Co. 6% Cu. Pr.	4¾—5¼	6 14 0	Mar, Sept	..	..
10	5/2½	Bombay E. S. & T. 6% Cm. Pf.	[illegible]—10½	5 11 6	..	10[illegible]	
St.	4½	Do. 4½ per Cent. Deb. Stk. (red.)	92 —94	4 16 0	Jan, July	93½	94
5	4/9	Calcutta Elec. Supply Ord.	5½—6¼	5 17 0	April, Oct	..	
100	7/2	Canadian Gen. Elec. Co. Com. St.	89 —91	7 15 6	..	90	89¼
100	5%	Castner Electrolytic Alkali Co. (of U.S.A.) 1st Mort. Stl. Debs	92 —97	5 2 6	Jan, July		
500	5	Elect. Development Co. of Ontario	[illegible]	6 1 0	..	..	..
5	..	Elec. Ltg. & Trac. Co. of Aust. 6 per Cent. Cum. Pref.	2 —2½	..	Feb, Aug	..	..
St.	5	Do. 5 per Cent. Deb Stock	[illegible]	5 10 0	Jan, July	..	..
St.	5%	Elec. Supply Co. of Victoria 5 per Cent. 1st Mort. Deb. St.	90 —93	5 7 6	Jan, July		..
St.	6%	Indian Elec. Sup. & Trac. Co. Constn Deb St. Rd.	[illegible]	10 18 0	Jan, July		
100	0/3	Kalgoorlie Elec. Power & Ltg. Ord.	—	..	..		
1	0/7½	Do. 6 per Cent. Cum. Pref.	[illegible]	8 0 0	April, Oct	..	..
St.	6%	Madras E. S. Corp. 6 per Cent. Constn Deb. St.	85 —90	6 11 0	April, Oct	8[illegible]	..
500	6%	Mexican Elec. Light Co. 6% 1st Mort. Gold Bonds	[illegible]	5 18 0	..	[illegible]	[illegible]
St	$1	Mexican Lt. & Power Co. Cap. St.	[illegible]	..	..	[illegible]	[illegible]
100	5%	Do. 5% 1st Mort. Gold Bnds	90 —91	5 11 0	..	[illegible]	[illegible]
10	6/2	Montreal Lt. Ht. & Power Co. Cap. St.	[illegible]	6 1 0	F,My,A,N	..	
1	1/[illegible]	River Plate Electricity Co. Ord.	—	6 0 0	April		
1	1	Do. 6 per Cent. non-Cum. Pref.		6 0 0	May		
St	6%	Do. 6 per Cent. Deb. Stock	[illegible]	[illegible]	Jan, July	[illegible]	[illegible]
5	3/0	Rosario Elec. Co. 6% Pref. (1—20,000)	[illegible]	5 17 6	April, Oct		..
100	$1	*Shawinigan Water & Power Co. Cap. St.	[illegible]	5 13 0	.	71	[illegible]
	5%	Do. 5 per Cent. Bds.	101 —104	4 17 6	Jan, July	101½	[illegible]
..	[illegible]	*Victoria Falls Power Co. Pref.	[illegible]	—	Jan, July	8	..

* In calculating the yields allowance has been made for accrued interest but *not* for redemption. † Ex dividend. ‡ The London Stock Exchange Committee have declined to quote these.

THE ELECTRICIAN:

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CONTENTS OF THE CURRENT NUMBER.

NOTES.

The "G.B." System and the L.C.C.

It is, we suppose, inevitable that every branch of municipal work should be exposed to the fierce light of political controversy. This, in theory, is an advantage. It allows a close watch to be kept on a concern which suffers by having no competitors, and is, therefore, likely to become rather stunted in its growth. That this is so is a fact well known to, and put forward by, political economists. But when the controversy becomes merely political in nature, judgment is likely to be thrown to the winds, and not only is the municipal trading concern itself involved, but other subsidiary persons are dragged in, often to their own detriment. Nobody who studies the daily Press can have failed to notice the controversy that has lately been carried on in reference to the surface contact trams in the Bow-road. It will be remembered that owing to the proximity of the Underground Railway a conduit was impossible, while the Stepney Borough Council objected to the use of the overhead system. The "G.B." surface contact system, which has been in successful operation at Lincoln since November, 1905, was, therefore, adopted, and a section of route was opened on June 25th last. The running has not been an unqualified success; in fact, it has been so inefficient that the surface contact cars have been withdrawn and horse trams substituted.

That a system which has been successfully operating in Lincoln for nearly three years should, after a few weeks' running in London, be quite incapacitated seems, in spite of the difference in traffic conditions, rather curious. As an explanation of this we mention the following points which are put forward by the "G.B." Surface Contact Co., and summed up in the statement that certain alterations have been made in their system by the Council's engineers. These alterations have practically, it is claimed, rendered operation impossible. In Lincoln the cable conduits drain into small catch pits, which are separate from each other and which can be emptied from the road. In London the conduits drain into a common sump connected with the main drain. This arrangement is said to be the cause of the gas explosions, about which so much has been heard. At turn-outs and other special work insulators have been inserted against the wish of, and in places not recommended by, the "G.B." Surface Contact Co. The cable at these points being in a state of strain has led to insulators breaking and consequent earths. The frames and covers of the access boxes are, in certain cases, said to be above the road level, so that earthing occurs from car chains coming in contact with them. The arrangement of the studs at special work is badly designed and is not suitable for the cars used. The pick-up magnets were originally designed with three cores, but the Council's engineers have, it is said, removed one of these, with the result that the pull is not sufficient to overcome the spring, and proper working cannot be obtained.

The above statements form the "G.B." Surface Contact Co.'s case. They have offered to put the electrical equipment of the track in an efficient state and to maintain it for twelve months provided the Council will fit the cars in accordance with their designs. They claim that the unsatisfactory conditions now obtaining are due to a total disregard of their advice and instructions by the Council's engineers. Although the Highways Committee recommended that the system be abandoned and the overhead system substituted, the Council finally decided that expert advice should be taken and that the experiment with

surface contacts should be continued during the recess. As to the technical points involved, we do not care to express an opinion without hearing the other side of the question, and as the L.C.C. officials are silent we must leave this part of the subject for future comment. But as a matter of general policy we think that it is a great mistake to divide responsibility between the purchaser and the contractor (through alterations effected by the former) in such a specialised matter as a surface contact system. If the London County Council have altered the designs and have disregarded the protests of the Company, the responsibility of failure falls upon the Council, and the Company should be given a free hand to put matters right before failure is finally proclaimed.

Concrete Transmission Poles.

THE cost of supports for high-voltage transmission lines is a matter of considerable importance and one which has received world-wide attention in recent years. The increase in the voltage of hydro-electric transmission schemes necessitated the abandonment of the wooden pole as well as the entire reconstruction of the insulator and its support. Steel towers and suspended insulators are now becoming the rule rather than the exception, but both are very expensive items. The steel tower, particularly, is a source of cost which may ultimately prohibit its employment, more especially as it requires to be repainted periodically and must, for this reason, be examined at stated times. Concrete suggests itself as a possible substitute for steel in this capacity, and our readers may turn with some interest to another page on which is described a machine for the manufacture of reinforced concrete poles. The process possesses the two-fold advantages of simplicity and low cost of product, while it certainly presents possibilities of development which should, if the makers' claims can be substantiated, put a different complexion on transmission line costs; that is, regarding at the moment one only of the types of product coming from the machine. Our description elsewhere contains figures (given by the pole makers) comparing the concrete pole with those of iron and wood. On inquiry, we are also informed that a concrete pole 52 ft. high erected at Lucerne was put up for £9, a slightly lower steel braced column having cost £43. In each case the load was represented by a constant 2,600 lb. wire pull. Particulars of the span are not supplied, but we understand that for the same load it would be the same in each case.

THESE figures, in so far as they concern general transmission line practice, may be accepted with some reserve, but they certainly point to a marked difference in the initial outlay required for steel towers and concrete poles respectively. The span remaining the same in both cases practically clinches the argument in favour of the concrete pole for this reason. The steel tower has been welcomed on transmission lines because it reduces the number of supporting points, and thereby tends to minimise the risk of breakdown of insulators, increasing, of course, the general reliability of the line. But steel towers have proved costly to erect and maintain; also they have no insulating factor in themselves. If a wire becomes "un-lipped" and touches the tower, an earth results at once without warning. From what we can gather, the reinforced concrete pole does not represent a "dead earth," if touched by a live wire, and sufficient warning would be given of the fault on the line before the supply would be entirely interrupted. If this claim can be substantiated in practice, and also if the reinforced concrete pole can be erected at such reduced cost there should arise a demand for this class of pole on transmission lines, both new and old. We think there can be little doubt about the life of the poles. This should considerably exceed that of wood, and of iron or steel, while it must be borne in mind that this lengthy existence is practically independent of maintenance. The introduction of these poles into transmission line practice should be closely watched by interested engineers. We may remark in conclusion that rectangular poles have been used in Canada and the United States on transmission lines, but the Siegwart process, described elsewhere, is, as far as we know, the first system introduced for the use of cylindrical poles.

London Electric Power Bills.—At the House of Commons a long discussion took place last evening (Thursday) as to the procedure to be adopted in regard to the consideration of the London Electric Power Bills. After a statement by the Prime Minister, it was decided that the London and District Electricity Supply Bill should be taken last evening, the other two bills being left over for the autumn session. Accordingly the discussion on the London and District Bill commenced at 8.15 last evening, and was proceeding when we went to press, the main opposition to the bill emanating from a number of Progressive members of the last London County Council, including Mr. Pickersgill and Mr. T. Davies. The rejection of the measure was moved by the Right Hon. Henry Chaplin, M.P. for Wimbledon. This opposition entailed considerable debate, and we must, consequently, leave our report of the proceedings to our next issue.

The Imperial College of Science and Technology.—At a meeting of the governing body of this institution, held on Friday last, it was announced that the Royal Commissioners of the Exhibition of 1851 had appropriated the whole of the remaining site of their estate at South Kensington for the purposes of the College. The rector of the College (Dr. H. T. Bovey, F.R.S.) was appointed an *ex-officio* member of the governing body and the Hon. R. J. Strutt, F.R.S., additional professor of physics.

Institution of Mechanical Engineers.—The summer meeting of this Institution was opened on Tuesday last at Bristol. The visitors were welcomed at University College by the Lord Mayor, Sheriff, Sir George White and Prof. Lloyd Morgan. Several Papers were then presented to the meeting. The new docks at Avonmouth were visited in the afternoon, and a dinner was held in the evening. We hope to deal with some of the Papers in a subsequent issue.

Speed Indicators on Tramcars.—It is announced that the Board of Trade is inquiring into a suggestion that speed indicators be fitted on tramcars. An intimation to this effect has been sent by the Board to the tramway and automobile organisations in Great Britain. The Board asks to be furnished with such information as these organisations possess regarding the trustworthiness and cost of the speed indicators now on the market. They add that for tramcar purposes it is desirable that the indicator should be reliable for speeds as low as 4 miles an hour as well as for maximum speeds.

Cable Interruptions and Repairs.

	Date of Interruption.	Date of Repair.
Cayenne – Salinas	May 12, 1908	July 24, 1908
Las Palmas – Arrecife	May 18, 1908	—
Kwandang – Manado	July 9, 1908	July 22, 1908
Kotonou – Grand Bassam	July 20, 1908	—
Jeddah – Suakim	July 27, 1908	—
Assab – Massowah	July 28, 1908	

University of Cambridge.—On Monday last Prof. Liveing, F.R.S., was the recipient of an illuminated address on his retirement from the chair of chemistry in this University, a post which he has held for nearly half a century.

Franco-British Telephone.—It is stated that the Postmaster-General has decided to put down two new telephone cables between France and England. When these cables are ready for work the charge for messages, it is further stated, is to be reduced from 8s. to 4s. 2d.

Air Pump for Incandescent Lamp Work —*Engineering News* describes a two-stage vacuum pump, capable of producing a vacuum within 0·02 in. of the barometric height, which is being used by makers of incandescent lamps. The pump is of the reciprocating piston and cylinder type with two cylinders of 12 in. diameter and 12 in. stroke. The valves are operated mechanically from eccentrics on the main shaft. The machine may be driven by belt or gearing, or is built with steam cylinders attached.

Wireless Telegraph Notes.—We are informed that a message received from Lima reports that the telegraphic connection with Iquitos (on the Amazon River) is now opened. The connection from Lima to Puerto Bermudez is effected by means of a wire telegraph line while the section from Puerto Bermudez to Iquitos, a distance of about 1,000 km., which in part consists of primeval forest is bridged by a "Telefunken" radio-telegraphic installation. The original intention of the Government of Peru to connect Iquitos by means of a wire line was given up on account of the difficulties and the cost involved. The Telefunken Company succeeded in establishing the service within two years at a cost to Peru of about 1,000,000 marks.

Associated Municipal Electrical Engineers.—The following were elected officers of this Association for the ensuing year at the annual general meeting held on Friday last: *President*—Mr. C. N. Russell (Shoreditch). *Vice-Presidents*—Messrs. G. G. Bell (Hammersmith), W. C. P. Tapper (Stepney), and W. C. Ullmann (East Ham). *Treasurer*—Mr. G. G. Bell. *Auditors*—Messrs. A. J. Fuller (Fulham) and P. E. Rycroft (Heston). *Hon. Secretary*—Mr. A. H. Shaw (Ilford). *Council*—Messrs. S. W. Baynes (St. Pancras), J. R. J. Bowden (Hackney), A. C. Cramb (Croydon), C. S. Davidson (Mortlake), A. Gay (Islington), A. C. Gilling (Epsom), C. F. McInnes (Gravesend), L. L. Robinson (Hackney), E. Sayer (Hampstead), A. H. Seabrook (West Ham), N. Staniland (Hornsey), and J. E. Tapper (Beckenham).

Electric Lighting on Trains.—A successful trial of the Rosenberg train-lighting equipment was made recently on the Austrian-Hungarian Government Railways. The car used for the test contained six compartments, each of which was equipped with two 16 c.p. tungsten lamps. The car also carried five other lamps of the same type and rating. The lamps operate at 32 volts, while the generator is designed for an E.M.F. of from 44 to 58 volts, the full-load output being 30 amperes. A storage battery capable of supplying energy to the lamps for six consecutive hours has been installed. Iron ballast resistors of the cartridge type are connected in series with the lamps when they receive energy from the generator. These resistors are mounted in the vestibules. In the vestibules are also fixed field rheostats which serve for adjusting the voltage of the generators when charging the storage battery, and an automatic reverse-current relay which prevents the battery from feeding energy to the generator when the speed is low. It is reported that the lamps give a steady light and do not flicker when the train is accelerating or retarding.

Wireless Telephony.—In our last issue we referred to the action taken by the U.S. Postal Department against the Oakland Trans-Continental Aerial Telephone & Power Co. for fraud. According to the *Western Electrician*, since the case has gone for trial in the Courts it has been shown that the action was too hasty, at least in its application to Jahnke, the wireless telephone inventor. The indictments against J. B. Allen, Dr. Bardach and M. F. Allen of the company named, who were charged with using the mails for a scheme to defraud, were dismissed on July 6th. The hearing of Prof. Albert Jahnke, the inventor of the wireless telephone advertised by the company, and W. H. Shadburne was continued the next day, following a motion for dismissal. Frank Carmody, an electrician of 15 years' experience, now employed in the Mint, testified that he had attended a demonstration of Prof. Jahnke's wireless telephone in Kansas City, Mo., in 1904, and communicated articulate speech without the aid of wires from Kansas City to a place seven miles away. Carmody said that Jahnke had the right principle, and that if a person could talk one mile he could communicate for a distance of 1,000 miles if the instrument were strong enough. The defence also proved that Jahnke had expended £2,000 of his own money in perfecting his invention, and that he had received but £120 from the Oakland Company for his services.

An Electrical Recording Target.—We are sure every one who has shot or superintended range firing, whether as a Regular or a Territorialist, has been struck by the archaic methods at present used in marking. Not only is a considerable time taken up, but in the mind of one who has missed there always lingers an idea that the marker is in league against him. To get over these difficulties many arrangements have been tried, but without any great success. The majority are exceedingly complicated, and the remedy is often worse than the disease; but we shall shortly hope to see some improvement in this matter, for Mr. S. A. M. Rose, of Melbourne, has recently patented an arrangement which is certainly very simple, and should work well in practice. The target consists essentially of a roll of paper which is wound off a drum, then passing through a frame where it is exposed to fire. At the firing position is another similar target. When the target has been pierced by the shot it is moved between a number of spring arms, which are held off by the paper. One of these arms falls through the hole made by the bullet, and completes a circuit, causing an indication to be transmitted to the firing position. At the firing position an ingenious arrangement of solenoids and linkage movements causes the position of the shot to be marked exactly on the similar target, and the target proper can be then re-set from this position. Former electrical targets suffered too much from a plethora of wires. In the Rose system only three wires are needed for an individual target, though when volleys are fired more are necessary. The general adoption of such an arrangement should add much to the peace of mind of range officers in general, for nothing is more distressing than an attempt to communicate with a marker over the ordinary range telephone.

Provisional Electric Lighting Orders, 1908.—The report by the Board of Trade respecting the applications and proceedings under the Electric Lighting Acts 1882 to 1902 during the past year was recently issued. Of the 27 applications for provisional orders received in December, 1907, 17 were made by local authorities and 10 by companies, and orders were granted except in the undermentioned cases:—

Barton-on-Irwell District Council applied for an order to enable them to transfer the powers under their 1906 order, but the Board of Trade were not satisfied as to the financial position of the company who were proposed as transferees or that the company wished to take a transfer, and the Board refused to grant the order.

Bath Rural District Electric Lighting (Amendment) Order was not proceeded with by the Council.

Broadstone Ltd. abandoned their application for Fleetwood.

In the case of the *Johnstone* Electric Lighting order, which was applied for by Strathclyde Electricity Supply Co., as the promoters failed to produce the consent of the local authority, or to satisfy the Board of Trade that consent should be dispensed with, the application was refused.

For *Oulton Broad* there were two applications for orders (by the Urban Council and by Lowestoft Corporation), but the application of the Urban Council was preferred, Lowestoft Corporation, however, succeeded in their application for further powers for their existing undertaking.

The *Lymington* (Extension) Electric Lighting Order was granted to Lymington Electric Light & Power Co., but the area of supply in the parishes of Milford and Hordle was reduced.

In the case of *Macclesfield* Electric Lighting (Amendment) Order, promoted to enable the Corporation to transfer their powers under their 1901 order to a company, the Board were not satisfied as to the financial position of the company, and the application was refused.

Woking Electric Supply Co. withdrew their application so far as it related to Staines and Egham, and the order was granted in respect of the remainder of the area.

Since the date of the last report the Board of Trade have approved deeds transferring the powers, duties and liabilities of the undertakings in the case of 19 orders. In all cases the transfers were to companies, 13 being to power companies.

ALTERNATING CURRENT COMMUTATOR MOTORS.*

BY DR. RUDOLF GOLDSCHMIDT.

Summary.—In this article the author discusses the theory o the single-phase commutator motor. The production of the field is first considered, and then the shunt and series methods of excitation, it being shown that the simple shunt is an impossible method. The characteristics of the ideal series motor are then given in some detail, after which the complications and difficulties encountered in the real motor are considered, including commutation and the circulating currents in the short-circuited coils. Finally, the various losses are considered.

INTRODUCTION.

1. Counter E.M.F. and Torque.

If a direct current armature revolves in a magnetic field and the field is an alternating one, at every moment an E.M.F. is induced in the armature, as given by the formula

$$E = z_a \times \frac{n}{60} \times N \times 10^{-8} \text{ volts}, \quad . \quad . \quad . \quad . \quad (1)$$

in which

N = total flux in C.G.S. lines.
z_a = the number of conductors all round the armature.
n = the speed in revolutions per minute.

This well-known formula in use with direct-current machines can be applied to instantaneous values of E and N with alternating current machines, since for very short intervals of time the alternating E.M.F. and alternating flux can be considered as constant.

At every moment the E.M.F. is fixed by formula (1) *; therefore, if the flux* N *is an alternating one the E.M.F., following it very closely in every respect, is also alternating.* E *is always proportional to* N, *has the same form expressed as a function of the time and the same periodicity, regardless of the speed.*

Taking the exciting current to alternate sinusoidally, and disregarding saturation for the present, N, and consequently E, will follow the same law as the current.

At the moment where N has its maximum value $N_{max.}$, we have

$$E_{max.} = z_a \times \frac{n}{60} \times N_{max.} \times 10^{-8} \text{ volts},$$

and the root mean square value

$$E = \frac{1}{\sqrt{2}} \times z_a \times \frac{n}{60} \times N_{max.} \times 10^{-8} \text{ volts}. \quad . \quad . \quad (2)$$

It is usual to introduce $N_{max.}$ into the formula for E, as the maximum of the flux density fixes the saturation of the iron and the core loss, and is limited by the flux carrying capacity cf the iron and by heating.

2. The Production of the Magnetic Field.

The general behaviour of the alternating-current commutator motor would be very much the same as that of a direct-current machine if an alternating-current magnetic field could be produced as simply and inexpensively as a direct-current field. In both cases, to drive a flux through field, air-gap and armature a certain number of ampere-turns in the field coils are required, the same with alternating and direct-current motors. There is some slight distinction necessary due to our calculations being made with the maximum flux N_{max}

Suppose that, to produce a constant flux equal to $N_{max.}$, a direct current, i_c must flow in the z field-turns. The ampere-turns being $i_c \times z_f$, then the *maximum* alternating current excitation must be equal to i_c; hence, the effective value (R.M.S.) of the exciting current, taking the curve form to be sinusoidal, is

$$i_f = \frac{1}{\sqrt{2}} \cdot i_c .$$

This difference, naturally, is only due to our using $N_{max.}$ Introducing directly the E.M.F. induced in the armature, the factor $1/\sqrt{2}$ drops out as it occurs in the formula (2) for E as well, and we can say that, *to produce in a given armature at a fixed speed a certain E.M.F. (R.M.S.), the same exciting current in the field is required, regardless of its being direct current or alternating, provided that the iron is not saturated.*

With direct and alternating current alike the current flowing through the field coils causes the same ohmic losses in its resistance and the same ohmic drop, provided the coils are otherwise the same. But the flux has ceased to be constant and the well-known effect of the alternating flux makes itself felt—*i.e.*, (1) the iron resists the variation of the lines, hysteresis and eddy-current losses being caused. *This necessitates lamination of the field iron in alternating motors.* (2) The alternating flux, passing through the field coils, induces an E.M.F. in them.

If z_f denotes the number of field turns, v the frequency in periods per second of the supply, and naturally also the frequency of flux and field current, further $N_{f\,max.}$ the amplitude of the magnetic flux, then the formula for the E.M.F. induced in the field coil is

$$E_L = 4{\cdot}44 \times z_f \times v \times N_{f\,max.} \times 10^{-8} \text{ volts}. \quad . \quad . \quad (3)$$

This is the well-known formula for the E.M.F. caused by an alternating flux passing through a number of turns, as used with all alternating apparatus.

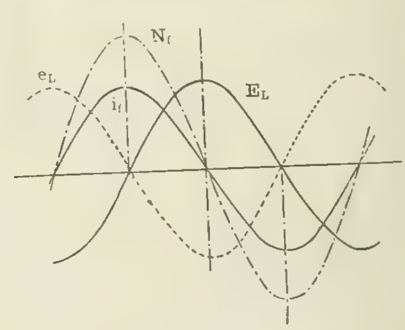


FIG. 1.

To keep up the flux $N_{f\,max.}$, we have to supply the field coil with a voltage e_L, equal and opposite in phase to E_L. Further, the magnetising current i_f is flowing; e_L and i_f are at 90 deg. phase displacement, and the product $e_L \times i_f$ does not represent any energy. The current is wattless, the same as with a choking coil. The energy stored in fields and field coils during the period of creating the flux is given back a moment later when the field disappears. Represented in a linear diagram (Fig. 1) the sine curve i_f is the field current, being in phase with the flux N_f, and, created by it, the sine wave for the induced E.M.F. E_L follows flux and current by 90 deg. To overcome E_L, the E.M.F. e_L must be equal and opposite to E_L. Fig. 2 represents the same phase relation in a vector diagram.

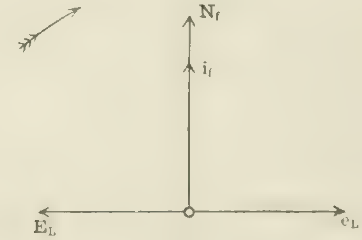


FIG. 2.

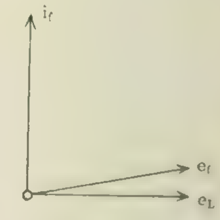


FIG. 3.

The losses in resistance and core affect this diagram only to a very small degree. They reduce the phase displacement between the terminal voltage of the field coil which we will call e_f, to distinguish it from its inductive component e_L (Fig. 3). With practical motors the cosine of the angle between e and i_f is about 0·10 to 0·15.

Though, except for the comparatively small losses, actually no power is consumed, *the wattless voltage e_L and current must be taken from the line.* $e_L \times i_f$ volt amperes must actually be produced by the generator. Calling this amount of wattless power $P_L = E_L \times i_f$, we can express it by the following formula:—

$$P_L = 4{\cdot}44 \times i_f \times z_f \times N_{f\,max.} \times v \times 10^{-8} \text{ volt amperes}, \quad (4)$$

or wattless power consumed by field = $4{\cdot}44 \times 10^{-8}$ × ampere-turns × max. flux × periodicity.

The ampere-turns required to produce $N_{f\max.}$ are proportional to $N_{f\max.}$ itself and to ther eluctance R of the magnetic path. Putting

$$\text{Ampere-turns} \times \sqrt{2} = \frac{10}{4\pi} \times R \times N_{f\max.} \; ; \text{and } N_{f\max.} = \frac{\frac{4\pi}{10} \times \text{amp.-turns} \cdot 1{\cdot}41}{R}$$

we can say

$$P_{Lf} = 2{\cdot}5 \times 10^{-8} \times N^2_{f\max.} \times R \times v,$$

or

$$P_{Lf} = 7{\cdot}8 \times \frac{(i_f \times z_f)^2}{R} \times v \times 10^{-8}$$

$$= 7{\cdot}8 \times 10^{-8} \times \frac{(\text{ampere-turns})^2}{\text{reluctance of magnetic path}} \times \text{periodicity} \qquad (5)$$

The similarity to Joule's law will be noticed. These formulæ tell us that *the wattless power to produce the magnetic field is proportional to the periodicity and the reluctance of the motor, and proportional to the square of the magnetic flux.* A small air-gap reducing the reluctance and a low periodicity are, therefore, desirable.

Our flux N_f would be identical with the flux in the armature N, except for the leakage lines. Just the same as with direct-current machinery, additional flux lines find their way through leakage paths round the field coils. The leakage co-efficient—*i.e.*, the ratio N_f/N—is about 1·1 or 1·15 or smaller, dependent on the design. Calling the leakage co-efficient c, we can write the formulæ for E_L and P_{Lf}

$$E_L = 4{\cdot}44 \times c \times z_f \times v \times N_{\max.} \times 10^{-8}. \quad . \quad . \quad . \quad (6)$$

$$P_{Lf} = 4{\cdot}44 \times c \times (i_f \times z_f) \times N_{\max.} \times v \times 10^{-8}. \quad . \quad . \quad (7)$$

The basis for these formulæ has been an arrangement as shown in Fig. 4, the field coils embracing th e whole of the

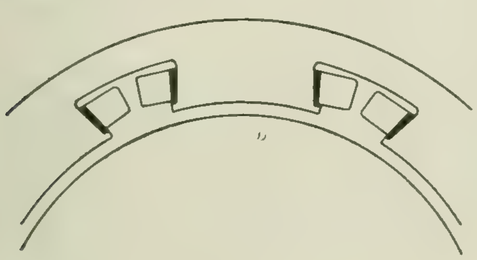


Fig. 4.

magnetic flux. If the field winding is split up into several smaller coils distributed in slots on the inner circumference of the stator, the flux passes through between the different coils; it is not clear at first sight if such an arrangement offers an advantage over that with concentrated coils—*i.e.*, if, to produce a certain flux, less wattless power is necessary in one case or the other.

A simple investigation shows that *the wattless energy necessary to produce a certain flux is smaller the more the field winding is concentrated.*

The ohmic loss in the field varies together with *the ampere-turns*, and the latter *are smaller the greater the concentration of the field winding*, this effect not being compensated for by the increase of mean length of turn.

The core losses in teeth and poles are also smaller the more the ratio $B_{\max.}/B_{av.}$ approaches unity, the latter being reached practically with a one-coil winding.

3. The Simplest Forms of Excitation: Shunt and Series Motor.

The most frequent form of a direct-current machine is the shunt motor. We might almost call it the most natural way to supply the exciting coils with their energy separately from the armature. Further, this constant-speed form of machine is most suitable for the majority of practical purposes. Let us consider the qualities of such a machine, when supplied with alternating current.

Fig. 5 shows a diagram of such a machine. The terminal voltage of the motor being the terminal voltage of the field, the exciting current i_f and the flux N_f will be displaced in phase from e by almost 90 deg. This phase relation is again borne out by diagram Fig. 6; OA is e, OC the flux N, 90 deg. behind e. The armature revolving in the flux N consequently generates the counter E.M.F. E, which, as is easily seen, is exactly in phase with flux N, and, therefore, lagging 90 deg. behind e. On the other hand E must be counterbalanced, it must be supplied as a component of the terminal voltage e, but both being in 90 deg. phase displacement, *e cannot* have a component in phase with E. We can, therefore, conclude at once *that the shunt motor in this form cannot work.* There are means by which such a shunt machine can be made to develop torque; for instance, this can be effected by bringing the phases of N with its E and e closer together. Ohmic resistance may be introduced in the field winding, thus shifting the phase of i_f, N and therewith E closer to e. At the same time self-induction must be introduced in the armature circuit, possibly by increasing the natural re-actance of the armature, so as to make the armature

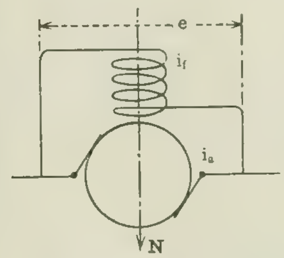


Fig. 5.—Shunt Motor.

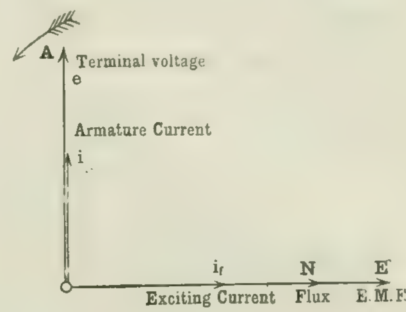


Fig. 6.

current lag behind the terminal voltage (Figs. 7 and 8). It is evident that these expedients are not practical ones; the resistance in the field coils would consume an enormous amount of energy. As stated above, the power factor of the field circuit is ordinarily about 0·10 to 0·15. To bring the flux within 45 deg. of e—*i.e.*, to produce a power factor of the field equal to 0·71, the losses in the field circuit must be about six times the ordinary losses, which means a reduction in efficiency of something like 20 to 25 per cent. In trying to make up the rest of the phase displacement between e and E—45 deg.—an E.M.F. of self-induction must be introduced in the armature circuit, just as big as the useful counter E.M.F. E itself. The power factor, therefore, will be very low indeed.

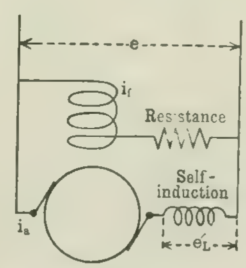


Fig. 7.—Shunt Motor with Choker and Resistance.

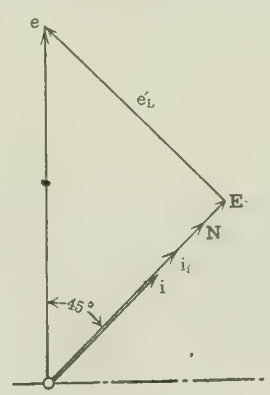


Fig. 8.

We shall see later that there are motors with "shunt" characteristics, but these are machines of a quite special construction, entirely different from that of the direct-current shunt motor.

We have come to these conclusions very quickly on the basis that the terminal voltage must have a component in phase with the counter E.M.F. to make the motor work. This supposition is the same as if we had said that the current must have a component in phase with the flux as already explained. The motor best suited for alternating-current work is a machine where flux and armature current are in phase, *i.e.*, where counter E.M.F. and terminal voltage of the armature are in phase, without it being necessary to introduce an E.M.F. of self-induction (e'_L in Fig. 8) to adjust the lack of phase coincidence. This condition is excellently fulfilled in the plain series motor. Fig. 9 shows diagrammatically such a motor. The current naturally is the same in field and armature, and

thus also the magnetic flux produced by the field coil and the current in the armature are—apart from hysteretic lag—in phase. Due to the hysteresis component of the current, and other causes which we shall consider later, some slight phase displacement between flux and current exists. For the present we will neglect this amount. Diagram Fig. 10, therefore, becomes very simple. OA is the current, in phase with it the flux OB = N, and in phase with the flux the counter E.M.F. OC = E. If we have—as we will assume for the present—no self-induction in the armature and no resistance, the terminal voltage of the armature would have only to balance E, and would present itself as a vector OD = − E. We find from diagram Fig. 2 the terminal voltage of the field e_L to be 90 deg. in advance of the current and represented by the vector OF; these E.M.Fs., − E and e_L, together equal the terminal voltage of the machine e.

We see that the difference between the series and shunt motor consists in the latter working with a wattless component of the armature current. The plain shunt motor works, therefore the better, the lower the power factor. The series motor in a way is working with the useful component of the E.M.F. and its working ability improves with the power factor.

The Series Commutator Motor.

4. The Ideal Series Motor.

Following the principle thus put forward we will treat the ideal case first and then provide the ideal machine, with all the comparatively minor difficulties and complications. Our ideal series motor is a machine without saturation, without resistance in armature and field, without core loss and difficulties in commutation, and without self-induction in the armature; the diagram Fig. 10 is that of our machine.

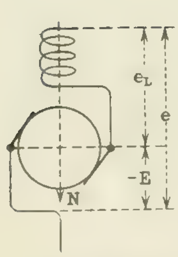


Fig. 9.—Series Motor.

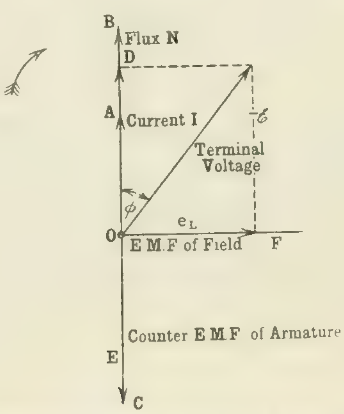


Fig. 10. —Diagram of Series Motor.

The magnetic flux has hitherto been the only interconnecting factor between armature and field, as, apart from the leakage coefficient, armature and field flux were identical. Our series machine has a second important item common to the stationary and revolving parts—*i.e.*, the current. The formula for the useful power is

$$P = E \times I = \frac{1}{\sqrt{2}} \times z_a \times \frac{n}{60} \times I \times N_{max} \times 10^{-8} \text{ watts},$$

and for the wattless power consumed in the field

$$P_{Lf} = E_L \times I = \sqrt{2} \times \pi \times I \times z_f \times v \times N_{max} \times c \times 10^{-8} \text{ volt amperes},$$

have the common factor I. Therefore the ratio

$$k = \frac{P_{Lf}}{P} = \frac{E_L}{E} = 2\pi \times c \times \frac{z_f}{z_a} \times \frac{v}{n/60}, \quad . \quad . \quad . \quad (8)$$

i.e., *the ratio between the wattless power to produce the magnetic flux to the useful power is, apart from a constant, fixed by the ratio* $\frac{\textit{field turns}}{\textit{armature conductors}}$ *and the ratio* $\frac{\textit{frequency}}{\textit{speed}}$. The lower the frequency and the higher the speed, the smaller is the wattless power which must be spent to produce the field. With a certain motor with fixed z_a, z_f, and c, k is inversely proportional to the speed. Fig. 11 shows that the ratio k has a direct bearing upon the power factor—*i.e.*, the cosine of the angle ϕ, between the phases of the voltage e and current I. $\tan\phi = k = E_L/E = e_L/E$, or the power factor $\cos\phi = 1/\sqrt{1+k^2}$.

If we wish to design a motor for a given frequency to run at a given speed, and if we further desire to obtain a certain $\cos\phi$, we can calculate the ratio of the field turns to the armature conductors by means of formula (8).

The latter may conveniently be written

$$k = \sqrt{\frac{1}{\cos^2\phi} - 1}, \quad \text{or} \quad \frac{z_f}{z_a} = \frac{n/60}{v} \times \frac{1}{c} \times \frac{1}{2\pi} \times \sqrt{\frac{1}{\cos^2\phi} - 1}$$

for a motor, for $n = 1{,}200$ revs. per min., $v = 25$ cycles per second, $c = 1\cdot12$, the following table is representative:—

$\cos\phi$	z_f/z_a	$\cos\phi$	z_f/z_a
0·30	·364	0·80	0·086
0·50	·199	·90	0·0554
0·70	·117		

It will be noted that a small ratio $\frac{\text{field-turns}}{\text{armature-turns}}$ is a condition for a good power factor. It is the same as with induction motors. In both cases the field ampere-turns must be kept low, because the exciting energy must be supplied with alternating current, and is, therefore, expensive.

To obtain a power factor of 0·70 with our ideal two pole motor the ratio of armature conductors to the field turns of a motor must be 0·117.

As the turns of the armature are one-half of the conductors and the conductors carry only one-half of the total current, we can say that to obtain the power factor of 0·70 the field ampere-turns must not be more than $11\cdot7 \times 4 = 47$ per cent. of the armature ampere-turns. The ratio $\frac{\text{field ampere-turns}}{\text{armature ampere-turns}}$ is familiar to us from the theory of direct-current machines and alternators, where it is of chief influence on the reactive drop of the voltage. With alternating-current commutator motors it fixes the inductive drop and consequently the power factor. Through these elementary considerations such an important "constant" as the ratio of turns can be fixed. It is very easy to extend our study to multi-polar machines (say, 4 poles, Fig. 12), bearing in mind that our investigation refers to one magnetic circuit comprising a pair of poles. For the sake of convenience we give the machine a parallel wound armature.

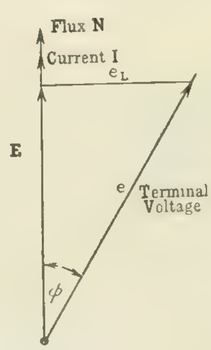


Fig. 11.

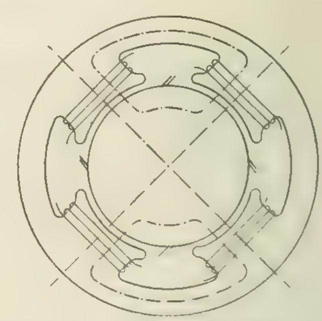


Fig. 12.—Multipolar Motor.

Giving z_a the same meaning as hitherto—*i.e.*, the total number of conductors on the circumference of the armature, we find

$$P = \frac{1}{\sqrt{2}} \times \frac{n}{60} \times z_a \times I \times N_{max} \times 10^{-8} \text{ watts},$$

the same as before. As the magnetic circuits have doubled, P_{Lf} is twice as great as before,

$$P_{Lf} = 2\,.\,\sqrt{2} \times \pi \times I \times z_f \times v \times N_{max} \times 10^{-8} \times c \text{ volt amperes}.$$

z_f must be taken as the number of conductors per pair of poles. Putting $p/2$ = number of pairs of poles, we have generally

$$P_{Lf} = p/2\,.\,\sqrt{2}\,.\,\pi \times I \times z_f \times v \times N_{max} \times 10^{-8} \times c \text{ volt amperes}.$$

The ratio k is now

$$k = \frac{P_{Lf}}{P} = \frac{p}{2} \times 2\pi \times \frac{z_f c}{z_a} \times \frac{v}{n/60},$$

and

$$\frac{z_f}{z_a} = \frac{p}{2} \times \frac{n/60}{v} \times \frac{1}{c} \times \frac{1}{2\pi} \times \sqrt{\frac{1}{\cos^2\phi} - 1}.$$

A series armature equivalent to a parallel armature with

z_a conductors would have $\frac{z_a}{p/2}$ conductors, and, therefore, with a series armature

$$k = 2\pi \times \frac{z_f}{z_a} \times \frac{v}{n/60} \times c.$$

Here k becomes independent of the number of poles.

Introducing the ampere-turns instead of the turns or conductors, we find, generally, for any armature, series or parallel,

$$k = \pi \times c \times \frac{v}{n/60} \times \frac{\text{field ampere-turns per pair of poles}}{\text{total armature ampere-turns}}. \quad (9)$$

It is often convenient to compare the field ampere-turns per pair of poles with the armature ampere-turns per pair of poles; therefore,

$$\gamma = \frac{\text{field ampere-turns}}{\text{armature ampere-turns}} \text{ per pair of poles}$$

$$= \frac{1}{1{,}900} \times \frac{n}{p \cdot v} \times \frac{1}{c} \sqrt{\frac{1}{\cos^2 \phi} - 1}. \quad (10)$$

The greater the number of poles, the higher the speed and the lower the frequency, the greater can be the ratio of $\frac{\textit{field ampere-turns}}{\textit{armature ampere-turns}}$ *to obtain a given power factor.*

A certain speed is specially significant, the synchronous speed—that is, the speed at which a synchronous motor with p poles would run.

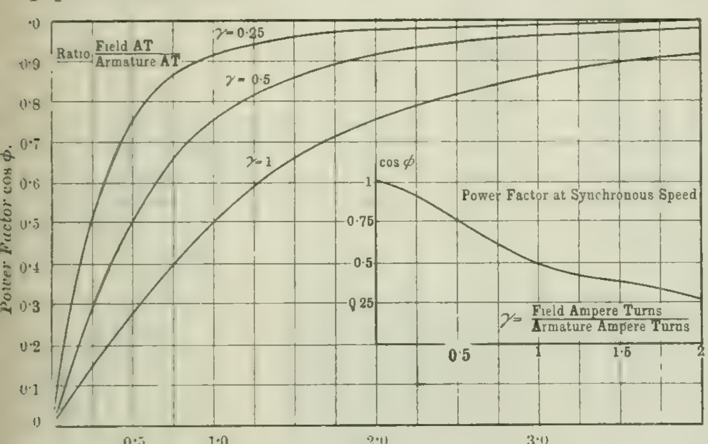


FIG. 13.

For a four-polar motor, supplied with alternating current at 25 periods, the synchronous speed would be $n_s = 750$ revs. per min.

Introducing n_s into the formula for γ we find—

$$\gamma = \frac{2}{\pi} \times \frac{n}{n_s} \times \frac{1}{c} \sqrt{\frac{1}{\cos^2 \phi} - 1}.$$

Introducing further the ratio $\beta = \frac{n}{n_s} = \frac{\text{actual speed}}{\text{synchronous speed}}$,

$$\gamma = \frac{2}{\pi} \times \beta \times \frac{1}{c} \times \sqrt{\frac{1}{\cos^2 \phi} - 1},$$

$$k = \frac{E_L}{E} = \frac{\pi}{2} \times c \times \frac{\gamma}{\beta},$$

and
$$\cos \phi = \frac{1}{\sqrt{1 + \left(\frac{\pi}{2} \cdot c \cdot \frac{\gamma}{\beta}\right)^2}}.$$

The three curves (Fig. 13) give the power factor as a function of the speed for the ratios $\gamma = \frac{\text{field ampere-turns}}{\text{armature ampere-turns}} = 0{\cdot}25, 0{\cdot}5,$ and 1. We have assumed c to be 1·1.

To obtain a power factor of 0·75 with the machine running at double the synchronous speed (say, four poles, 25 cycles, 1,500 revs. per min.), the ratio $\frac{\text{field ampere-turns}}{\text{armature ampere-turns}}$ must not exceed 1. With a direct-current machine γ is about 1, sometimes more, up to about 2, but very rarely less than 1. If we were to design the alternating-current motor on similar principles, making $\gamma = 1$, a power factor of 0·85 would be obtained at about 2·90 × synchronous speed. Assuming we have to deal with a large railway motor where the speed may be fixed at, say, 725 revs. per min., the synchronous speed must be 725/2·90 = 250 revs. per min. With 25 periods the motor must have at least 120 × 25/250 = 12 poles; with $16\frac{2}{3}$ periods, 8 poles. If we keep the air-gap small and make $\gamma = 0{\cdot}5$, the speed need only be 2·2 × synchronous speed, and the number of poles can be reduced to 8 or 6 respectively. A very large number of poles is undesirable for many reasons; among others, it increases the number of commutator bars, makes the brushes come very close together and reduces the interpolar space.

So we see that a low frequency, if possible below 25, is a condition for obtaining a good power factor. At the same time, a very small air-gap, unknown with direct-current machines, is desirable—unless artificial means are employed to improve the power factor.

Moreover, hysteresis and eddy currents effect an indirect improvement of the power factor. Both these subjects will be dealt with in detail later.

(To be continued)

KIEBITZ'S DIRECTIVE ARRANGEMENT FOR ELECTRIC WAVES.

Much attention has lately been devoted to the question of directing the waves in wireless telegraphy, and perhaps rightly so, for as the use of wireless communication extends it will

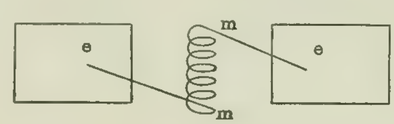


FIG. 1.

become increasingly necessary, in order to allow of a sufficient number of stations existing and working harmoniously in a given region, to provide other means for giving security from disturbance besides the ordinary safeguard of tuning.

One of the simplest ways is to arrange that the radiation does not extend equally in all directions. This is the first step; and given this condition, it has been shown, for instance, by Bellini and Tosi that quite remarkable results can be secured by simple means. But the directive quality is a *sine qua non* in such methods.

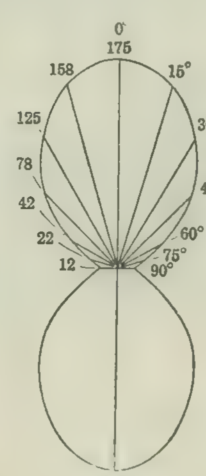


FIG. 2.

In the directive arrangements hitherto proposed use has sometimes been made of some form of compound oscillator, that is, one in which an electric or open oscillator is combined with a closed oscillator. A new arrangement on these lines has recently been patented in Germany by Dr. F. Kiebitz, and though the experimental results quoted were obtained at very short distances, the fact that sufficient data are given for an energy diagram to be plotted therefrom makes it of greater interest than a mere laboratory experiment would otherwise have. In Kiebitz's arrangement the directed electromagnetic waves are excited by giving the radiating system such a shape that although the electric and magnetic line systems generated in space have each an axis of symmetry, the two axes are in this case perpendicular or make an acute angle, while at the same time the direction of the electric force is inclined to that of the magnetic force. In this case the plane of greatest magnetic force is inclined to the plane of greatest electric force, the line bisecting the enclosed angle being the direction of greatest energy emission.

The same device can, it is said, be employed at the receiver, and then absorbs chiefly those waves which have the particular direction to which it is set. The arrangement shown in Fig. 1 consists of a solenoid whose ends *m m* are connected to two metal surfaces *e e*. When such a system is excited, inductively or otherwise (and here it is apparently meant that the excitation is inductive), its electromagnetic field which is set up consists of that of a magnetic doublet oscillating in the direction *m m*, and an electric doublet oscillating between *e e*. The electromagnetic field thus has a minimum in the plane of the paper and a maximum at right angles to this. Nothing is changed if the whole arrangement is turned in its plane through 90 deg., and one of the metal plates is replaced by the earth.

The experiments with this compound oscillator were conducted in the laboratory and in the open. The wave length employed was 22 metres and the received energy was measured thermoelectrically, and in some cases estimated by the electrolytic detector. On turning the transmitter round a vertical axis the readings at the receiver (in the laboratory) were as shown in the figures at the left side of the energy diagram shown in Fig. 2, the figures on the right-hand side indicating the angle through which the transmitter had been turned from its position of maximum energy radiation. The experimental figures given are for the upper half diagram; but owing to the symmetry of the arrangement it is obvious that the radiation on the other side is of the same form.

Similar readings were obtained at a directive receiver built up on the same lines. In the open the ratio of the energy in the 0 deg. position to that at 90 deg. was as 70:1. On giving the transmitter an inclination of 45 deg. round a horizontal axis the received energy fell off to one-third of that previously obtained. Using the electrolytic detector in other experiments at 30 metres distance and receiving distinct signals in the 0 deg. position, a rotation of the arrangement through 30 deg. sufficed to make the signals cease.

It will be seen from the foregoing that the arrangement described has very marked directive properties, but without information as to results over distances of at least several wavelengths it is imposible to judge whether some of the effect may not be due to static or other influences. Further, from the scheme as described, it does not at all follow that on substituting the earth for one plate and enlarging the scale of the transmitter the arrangement will prove as workable or an efficient radiator; these are the points which have to be made clear before one can quite believe that another practicable directive method can be said to have been produced.

A LARGE SOUTH WALES COLLIERY POWER PLANT.

An excellent example of how a number of coal pits can be supplied with electric power from a large central generating plant is furnished by the Ferndale Collieries of Messrs. D. Davis & Sons in South Wales. Here some nine collieries are fitted with electrically-driven plant and machinery and practically all operations, except winding, are carried on with the power, transmitted in some cases 4,500 yds. by overhead lines, from the station already mentioned.

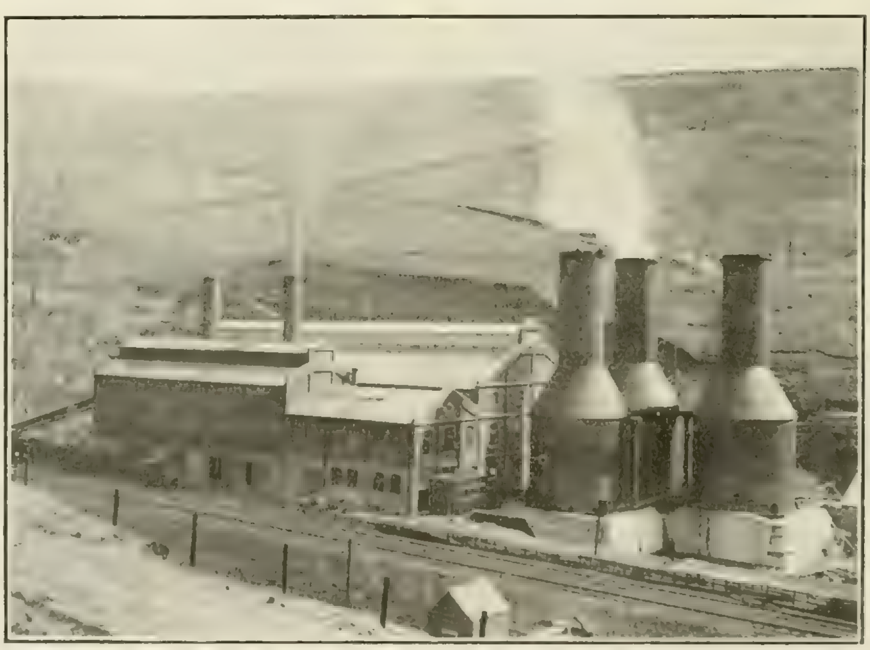


Fig. 1 View of Tylorstown Power Station.

Before describing the plant in some detail we may remark that the equipment has been undertaken on modern lines, and due regard has been had to the installation of substantial and efficient electrical machinery. Some surprise may, however, be expressed at the erection of so large a plant within the area of the South Wales Power Distribution Co. under conditions which would appear to favour bulk supply from one or two large generating stations.

The Ferndale installation is none the less interesting on this account, and its engineering features are certainly worthy of note. The central power plant at Tylorstown contains 7,500 H.P. of plant in three units of 2,500 H.P. each, the engines being horizontal medium speed type coupled direct to large flywheel alternators. They have been built by Messrs. Sulzer Bros. and the high pressure cylinders are 33½ in. diameter and the low-pressure 56 in. diameter, the stroke being 55 in. and the speed 94 revs. per min. The steam pressure is 170 lb. per square inch and the engines run with a superheat of 150 F. at the stop valve. Two jet condensers and feed-water heaters are connected to each engine, the injection water being taken from cooling tower concrete tanks through a 4 ft. main running under the basement floor. After passing through the condensers the injection water is collected in the hot well. The circulating water is raised to the cooling towers by motor-driven circulating pumps, connected to the hot well, and is delivered into the towers about 30 ft. from the base, being discharged into wooden troughs from which it is delivered to the spraying slats. There are three cooling towers, 33 ft. diameter by 83 ft. high. The general arrangement of the power station is seen in Fig. 2, while Fig. 1 is an exterior view in which the cooling towers are seen prominently on the right.

The steam-raising plant includes four Stirling water-tube boilers of the three-drum type, each having a heating surface of 6,209 sq. ft. The evaporating capacity of the boilers is 30,000 lb. of water per hour from and at 212 F. The boilers are built in pairs, and the waste gases pass to two steel stacks mounted at the back of each battery. The working pressure is 180 lb. per square inch, and steam is superheated to 525°F. by superheaters attached to each boiler.

Two stokers of the underfeed type are fitted to each boiler, these being manufactured by the Underfeed Stoker Co. The coal, with this type of stoker, is conveyed from the hopper under the fire by a reciprocating sliding bottom which runs the

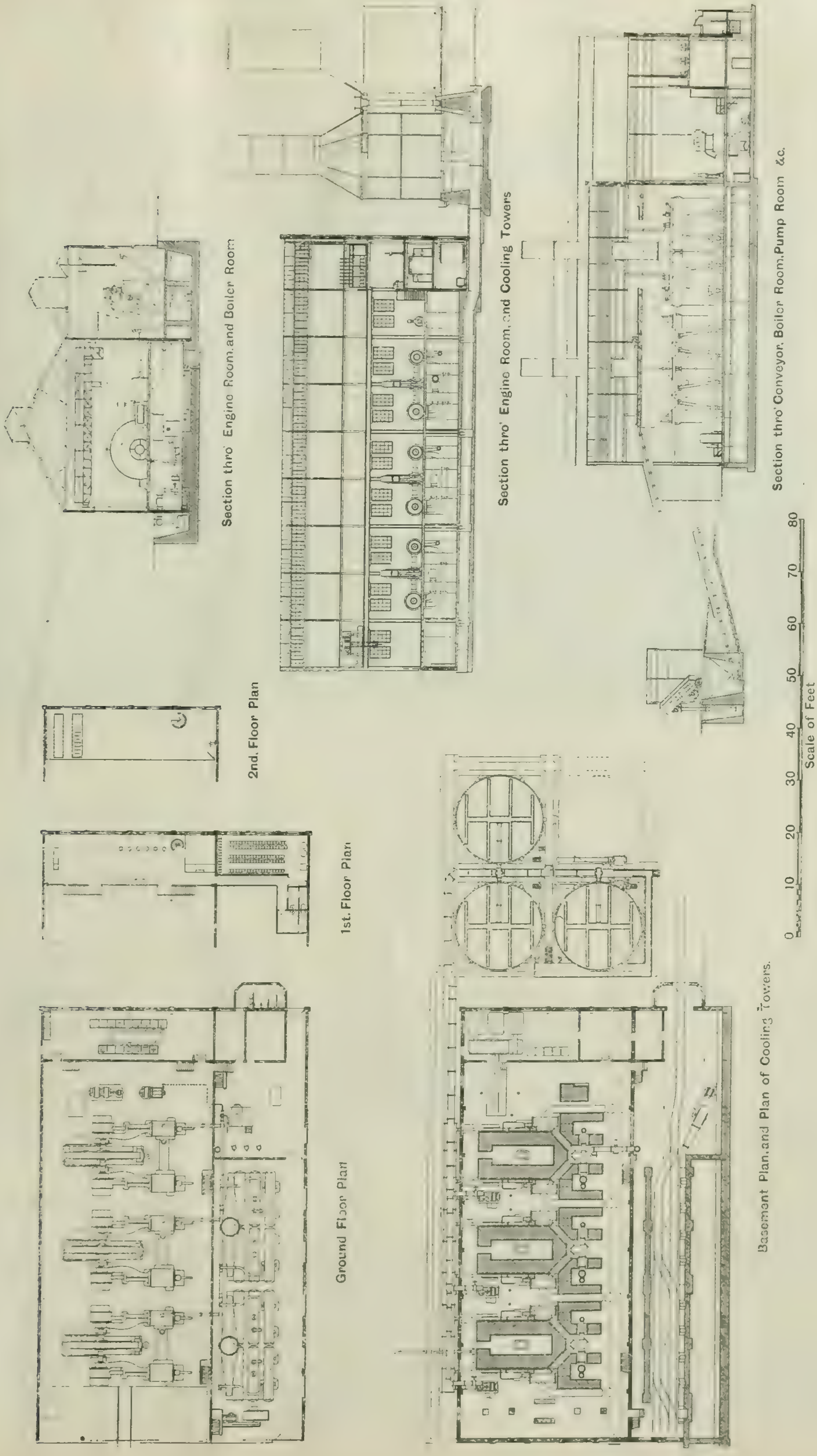


FIG. 2.—GENERAL ARRANGEMENT OF TYLORSTOWN POWER STATION.

full length of the grate trough. Moving bars distribute the coal to the sides of the furnace, where the dumping trays are situated. The coking and burning coal is by these means constantly moved from the centre of the fire to the dumping trays each side. The trays are operated by levers at the outside of the furnace, the ash and clinker being thus discharged. The coal used is "Ferndale small," which is run in on a private siding from the Taff Vale Railway. The wagons are tilted by hydraulic rams supplied with water from the feed pumps, and the coal is transported to the bunkers by a motor-driven inclined band conveyor. The bunkers have a capacity of 150 tons and the conveyor is capable of dealing with 20 tons of coal per hour.

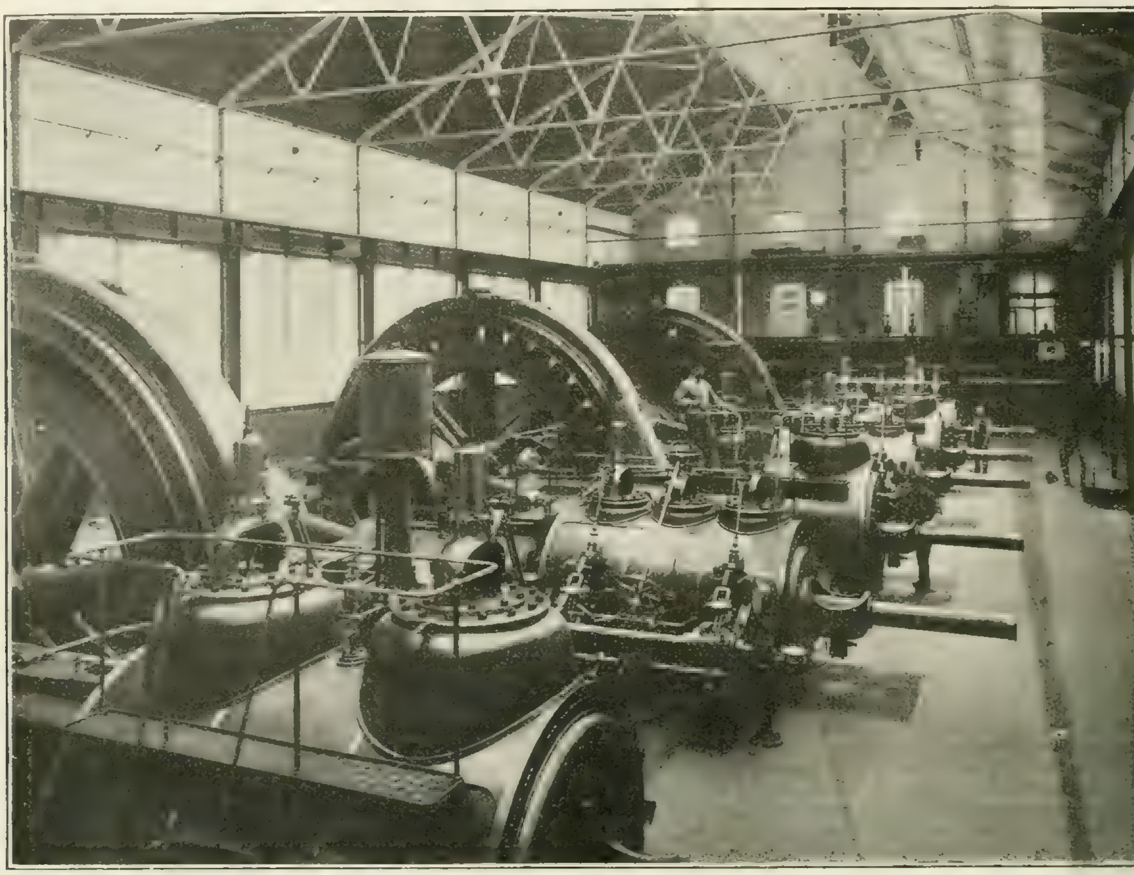


Fig. 3.—Main Generators and Engines, Tylorstown Power Station. Switch Gallery is at far end of the Room.

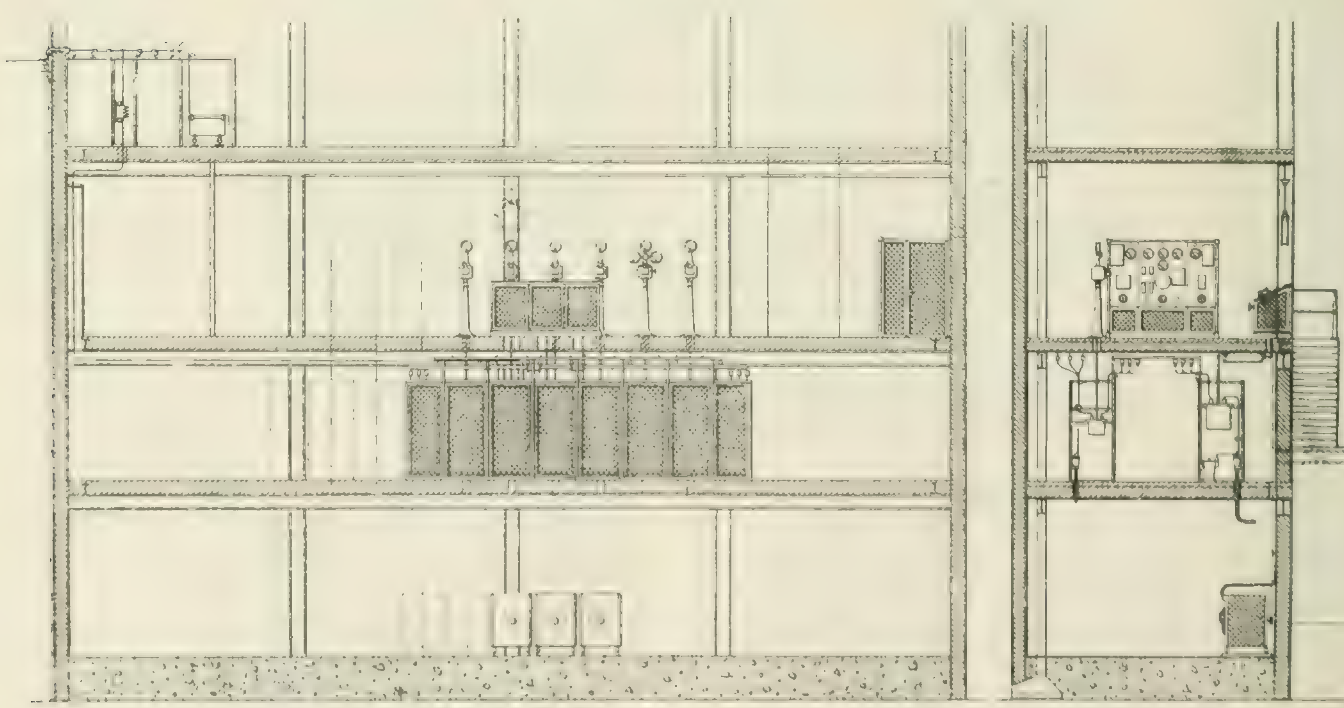


Fig. 4.—Front and End Elevations of H.T. Switchgear in Main Power Station.

The main generators are of the revolving flywheel type and

each has a capacity of 1,600 kw. at a power factor of 0·85. The voltage is 2,200 and the overload capacity is 20 per cent. for two hours and 30 per cent. for half an hour. The temperature rise is guaranteed not to exceed 45 per cent. after 10 hours' full load run. The revolving field weighs approximately 75 tons,

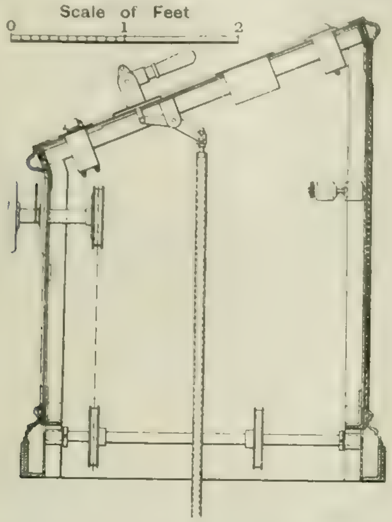


Fig. 5.—End View of Generator Control Desk showing Chain Gear for operating Rheostats

the total weight of stator and field being about 107 tons. Excitation is provided by a steam-driven set of 75 kw., a 100-120 kw. motor-generator booster unit, and a 380 a.h. 115 cell Tudor battery. The booster is fixed to one end of the shaft of the motor-generator, and the battery can also be charged from the steam unit, the generator of which is so arranged that its voltage can be increased to 290 to allow of its acting as a standby to the motor-generator. The control of the battery is arranged on a 21 contact regulating switch on the exciter board.

The switchgear is erected at the south end of the building. The main engines and generators, also switchgear, are shown in Fig. 3, which gives a full view of the engine room. The lever controlled type of gear has been installed as being best suited to the needs of the case. The gear is in two tiers, the lower containing the high tension switches and 'bus bars and the upper the generator control desk and the feeder switch columns. The generator desk faces the engine room, and behind it is the row of feeder pillars which are within easy reach of the attendant. The generator panels contain a switch lever, main ammeters and time limit overload and reverse current relays for the main oil switch. A general view of the main gear and also the generator control desk are shown in Figs. 4 and 5.

The relays are of the Ferranti pattern. The main oil switches, fixed in cells below the control gallery, are of the free-handle type with trip coils for the release of the switch from the relays on the control desk. A system of pull rods and levers connects the switch with the operating handle. The feeder pillars simply contain a switch lever and a main ammeter. The switches in this case are of the oil break type, the overload relays being contained in the switch itself and placed in the high-tension circuit. The relays of the generators are actuated from the secondaries of small transformers. The connections from the generators to the switchgear are rubber-covered cables. From the switchgear to the overhead transmission lines bare conductors on insulators are used, the voltage being 6,600. Lightning arresters of a special shunted type are connected up to these lines. In circuit with the arresters are water resistances, while choke coils of the spiral pattern are included in the extra high tension circuits. The 'bus bars are arranged on the ring system with interconnectors at each end; there are also section switches in the bars between each generator and between each feeder. The feeders are so grouped that the heavy intermittently loaded lines are placed on one side of the ring, and the light steadily-loaded cables are connected to the other half. This allows of the system being run in two independent sections, an arrangement which makes for advantageous working of the plant. In addition to the pillars controlling the outgoing feeders there is an additional pillar which governs the supply to the high voltage motors driving pumps, &c., in the generating station. The exciter board is on the same gallery as the main control board, but is placed near the wall at right angles to the latter. A feeder pillar is shown in the drawing in Fig. 7.

The energy from the station is distributed by underground cables at 2,200 volts to pits Nos. 8 and 9 near the power station, and by overhead lines to pits Nos. 6 and 7 situated about 900 yds. away.

The other pits, Nos. 1 and 5 and 2 and 4 are some 2,500 yds. and 4,500 yds. distant respectively and transmission lines serve these points at a pressure of 6,600 volts. Previous to its entry to these places, the current is transformed down to 2,200 or 440 volts, as the case may be for the various motors below

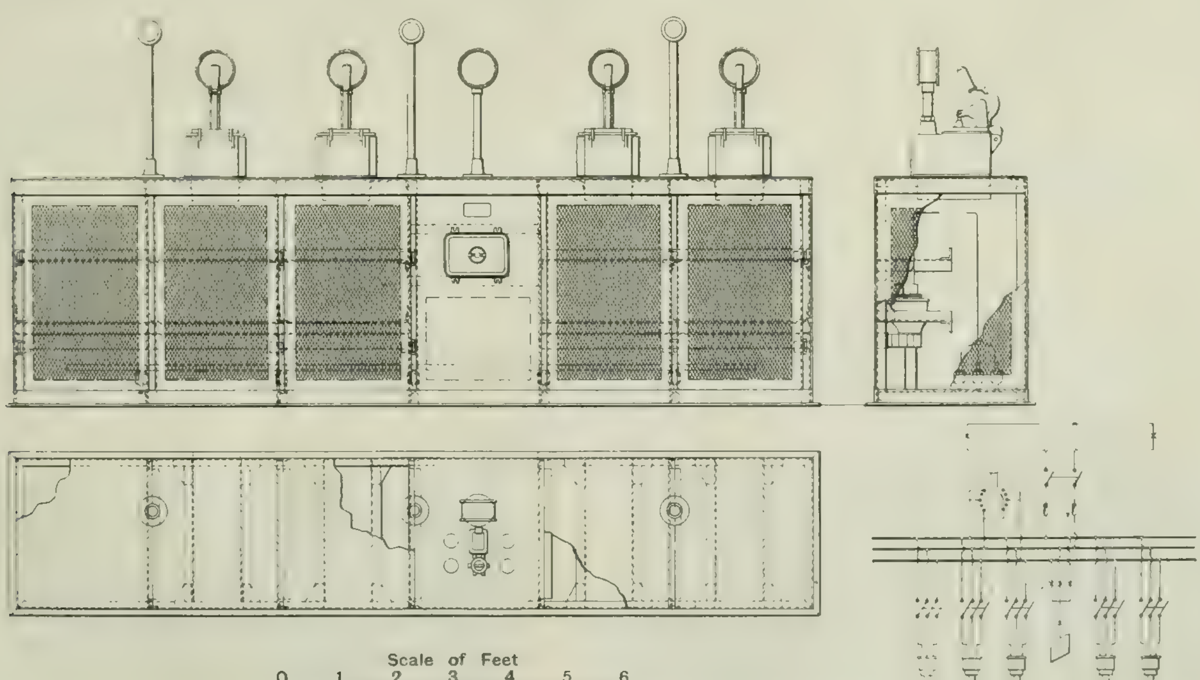


Fig. 6.—Typical Distribution Board for 440 volt Circuits

ground and on the pit bank. A typical 440 volt distribution board is illustrated in Fig. 6.

The mining plant in the various pits includes as many as 22 haulage gears, in sizes varying from 50 H.P. to 200 H.P. They

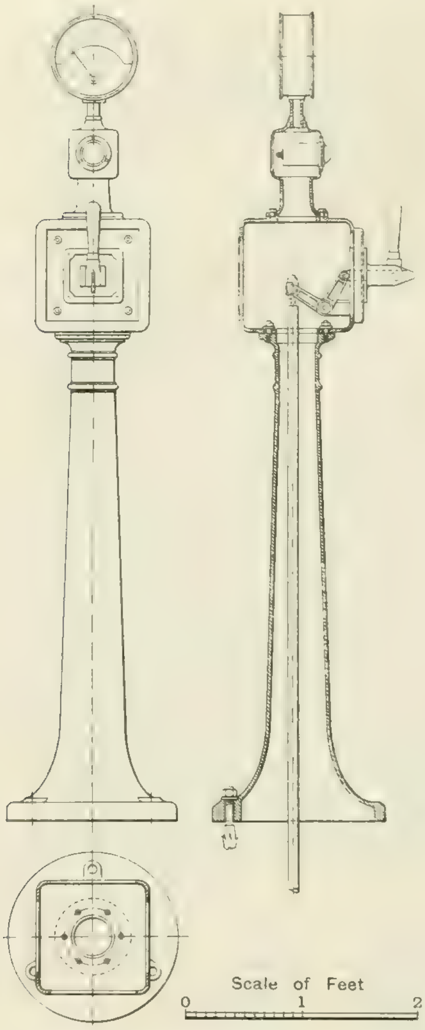


FIG. 7.—VIEWS OF FEEDER PILLAR SHOWING SWITCH HANDLE AND AMMETER.

are generally of the main and tail types, and operate at a normal speed of 6 miles per hour. Slow-speed motors, with enclosed slip rings, drive the gears mostly through single

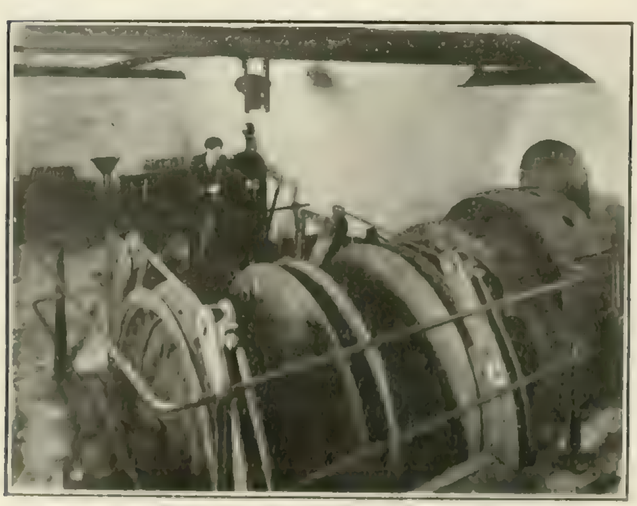


FIG. 9.—VIEW OF 200 H.P. HAULAGE GEAR IN WORKINGS.

reduction gearing, though one or two double reduction have been installed to meet the exigencies of some particular case. A feature of the gears is an oil immersed controller of the drum type, which deals with the rotor circuit resistances. These controllers are of a new design, arranged by the consulting engineer. The special attention paid to them has led to an absolute freedom from the troubles which have been complained of in some other places. A throw-over reversing switch is also used in conjunction with the controller, while the main high-tension supply is switched on and off from a special ironclad pillar, which also

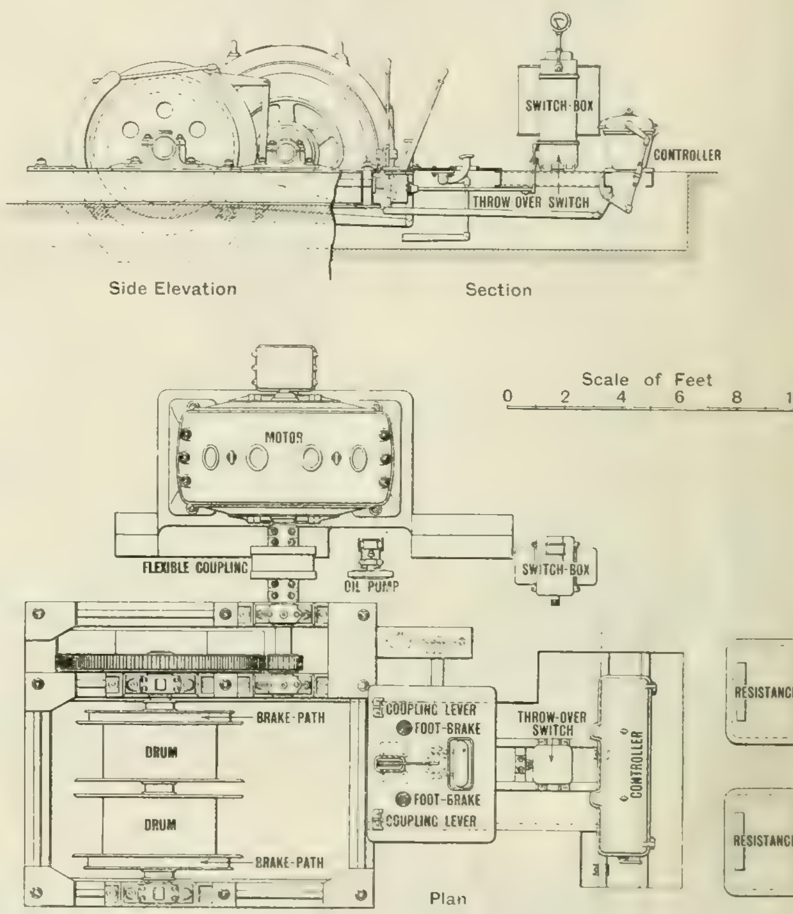


FIG. 8.—PLAN AND ELEVATION OF 200 H.P. ELECTRIC HAULAGE GEAR.

carries an ammeter. The motor is connected to the gear through a flexible coupling of the rubber block type, this pattern being suitable for reversing. The control levers, brake pedals and clutch levers are all in front of the operator,

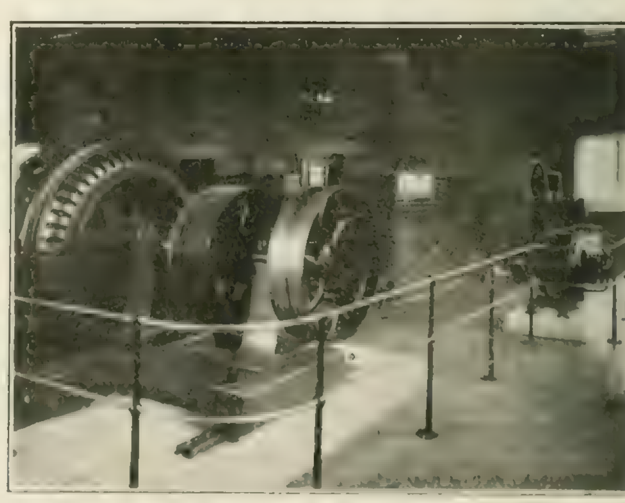


FIG. 10.—MOTOR DRIVING SIROCCO FAN.

so that they can be readily handled. The resistances for the controller are of the grid pattern oil cooled, the circulation of the oil being maintained by small rotary pump, belt-driven

off the rim of the flexible coupling. We understand that these haulages have found great favour with the men because they are so easily controlled and operate more steadily than the old steam pattern. Considerable economies have been effected over the older type and also the output has been found to increase. Figs. 8 and 9 show details of one of these 200 H.P. haulage gears, manufactured by the Uskside Eng. & Rivet Co.

All the underground pumping has been entrusted to electrically-driven pumps, some of these being of the three-throw pattern, and others of the Sulzer high lift centrifugal type.

The ventilation also is made dependent on the electric power supply. At the new pit a Sirocco fan of 300,000 cubic ft. air per min. capacity is installed. Two 2,200 volt motors, one of which is shown in Fig 10, drives this fan. One of the "Schiele" fans which has run for several years from a steam engine, and has a similar capacity, has been converted for motor driving. Two further Sirocco fans are being installed, each capable of a capacity of 125,000 cubic ft. of air per min. at 4 in. water gauge. The equipment of the new pit will also be modern in respect of the method of driving generally. Every machine in use will be driven by electric power, including the main winder, which will operate on the Ilgner system, and raise 1,800 tons of coal per day.

The contract for the general electrical equipment has been carried out by the Lahmeyer Electrical Co., to the specifications of Mr. W. H. Patchell, M.Inst.C.E., the consulting engineer. Our thanks are due to Mr. Patchell and the Lahmeyer Electrical Co. for kindly placing information at our disposal; also to Messrs. D. Davis & Sons, and their manager, Mr. David Hamish, for kindly lending us the photographs.

RAIL CORRUGATION.*

BY PROF. C. A. CARUS-WILSON.

(*Concluded from page 565.*)

Although corrugations are, in my opinion, generally caused by the grinding of the flange on the rail, this is not the only way in which they may be produced. A similar action may be set up if for any reason the wheel should be forced to run on its flange. This often happens at points and crossings, the tread of the rail being lifted clear off the rail head, when corrugations may frequently be observed on the opposite rail. The same thing happens when the rail has been badly worn and the flange actually touches the bottom of the groove. I have noticed cases of this kind, and corrugations invariably appear on the other rail immediately opposite the marks made by the flange in the groove. The most common example of flange riding, however, is found where the groove is allowed to get full of dirt. I have seen places where the groove has been packed with a mixture of dirt, wood pavement scrapings, paper, &c., so hard as to resist any attempts to move it with a metal-tipped stick. The flange runs on this packing, and if the other groove does not happen to be packed so full, corrugations will appear on the opposite rail. In the course of a few days the first groove may get cleaned out, and the other groove may get packed, when the conditions will be reversed, and corrugations will then appear on the previously uncorrugated rail. In this way both rails become corrugated. I have in mind one large West-country town where the rails are corrugated in all directions simply because the grooves are allowed to get hard packed in this manner. If both grooves are equally packed, both wheels will ride on their respective flanges, and the rails will not be corrugated, but each side will be uniformly scored by the skidding thus caused. A very slight lowering or softening of the packing on either side will cause corrugations to appear on the other. Flange riding on a packed groove is responsible for some of the most perplexing vagaries of corrugation. The hardness of the packing depends very largely on the condition of the weather. Corrugations may be very pronounced in a certain place owing to a packed groove. A few days' rain will soften the packing and remove the cause of the corrugations, which will then get worn down and disappear, only to reappear again, perhaps on the other rail, when the necessary conditions are fulfilled. Or corrugations may be bad at a certain place owing to check cutting; a spell of dry weather will cause the grooves to get packed, the check cutting action which originally produced the corrugations will stop and flange riding with skidding will begin, causing the corrugations to disappear. In this way the marks on the rails are continually changing and shifting.

The corrugations which have appeared on certain steam railways in India illustrate the conclusions arrived at above as to the conditions under which corrugations are produced. For more than 10 years past corrugations have been noticed on some Indian railways, especially on the Eastern Bengal State Railway, a full account of which may be found in a Paper written by Mr. G. Moyle, M.Inst.C.E., published in the *Official Circular* of the Tramways and Light Railways Association for June, 1906. Investigations of an exhaustive character were carried out with a view to ascertaining the cause of these corrugations. The following definite conclusions were arrived at: (1) The track on which the corrugations appeared was invariably found to be boxed with burnt clay or brick; (2) corrugations were hardly ever found with stone boxing and never with earth boxing; (3) when the brick boxing was replaced by earth or stone boxing the corrugations disappeared; (4) to get this result it was necessary to change the boxing only, and not to remove the brick ballast packing under the sleepers; (5) corrugated rails removed and replaced on an earthed-boxed section would wear smooth, while smooth rails taken up and set down on a brick boxed section would become corrugated. A careful study of Mr. Moyle's Paper and the conclusions there stated convinced me that the corrugations were in some way caused by the gritty dust that would work up from the brick boxing and be scattered over the surface of the rail by the air suction of passing trains. A possible objection to this view might be found in the fact that corrugations had appeared on open girder bridges where, of course, there was no brick boxing. But the objection might turn out to be a confirmation if it could be shown that the approaches to these bridges were brick boxed, for in that case the brick-dust would be carried on to the bridge by the suction of the train. Upon inquiry I was informed that investigation showed that corrugation only developed on open girder bridges the approaches to which were brick-boxed, thus confirming the suspicion that the corrugations were in some way caused by the dust from the brick boxing. It remained to be ascertained in what way this dust could be essential to the production of corrugations. The subsequent experiments on the model, already described, showing how intermittent skidding is brought about by covering the rail with a gritty powder, seemed to afford the required solution. Through the kindness of Sir Alexander Rendel and Mr. F. E. Robertson I was supplied with a sample of the brick boxing taken from a section of the Eastern Bengal State Railway, where corrugations are very pronounced. Some of the brick was crushed, making an exceedingly sharp and gritty powder. The model was arranged as before with a spring coupler in the loose wheel. So long as the rail remained clean the skidding was quite uniform as the truck was pushed along the track. When a little of the brick powder was scattered over the rail the skidding immediately became intermittent, indicating clearly the part played by the brick boxing in the formation of corrugations.

The investigations outlined above appear to show that the following conditions are necessary for the formation of corrugations on grooved rails: (1) As regards the track—(*a*) Irregularities in gauge or level or (*b*) curvature; or (*c*) a packed groove. (2) As regards the rails—(*d*) Surface rough with sand or gritty dust. (3) As regards the rolling stock—(*e*) Wheels with check-cutting flanges. (4) As regards traffic—(*f*) A critical speed. Corrugations cannot be formed unless conditions (1), (2), (3) and (4) are all present at the same time—that is, peculiar conditions must exist simultaneously in the track, the rails, the rolling stock and the speed, and the absence of any one of these conditions will prevent corrugations being formed. These considerations suggest the lines on which it may be possible to avoid the formation of corrugations. My object this morning, however, is simply to put before you the conditions under which corrugations are produced, in the belief that a correct diagnosis of the disease is the first step to be taken towards providing a remedy.

DISCUSSION.

Mr. J. Dalrymple (Glasgow) said corrugation was costing him £10,000 to £15,000 per annum, and he would be glad to find a remedy.

Mr. A. N. Banister (Norwich) said that the first appearance of corrugation at Norwich was on the outside rail of a curve in a wood-paved street on a down grade, but that corrugations subsequently appeared on the other three rails in the same street. Two of the fastest routes on the system were macadamised roads with sett paving between the rails. The fastest running of these was practically straight, and corrugation was very bad there, but with very little indication of check cutting. On the other route, however, which was not straight, there was no corrugation, yet there was considerable check cutting on the curves. This did not seem to quite fit in with Prof. Carus-Wilson's theory. The corrugations, when they first appeared in Norwich, extended over long lengths of rail. They were rubbed out, and subsequently re appeared about two years later, but all in short lengths: whereas, first of all, the lengths extended over two or three rails they now only extended over 5 ft. to 10 ft.

Mr. G. M. Gibson (Mountain & Gibson) suggested that differential gear as possible remedy.

Mr. E. Benedict (late chief engineer of the Eastern Bengal and Scinde, Punjaub & Delhi Railways) said the same ballast was used on many Indian railways, and this, therefore, did not appear to come into the question, for corrugations were noticed on some of these railways and not on others. In certain districts where it was sandy there was naturally an enormous amount of grit, and yet no corrugations were

* Lecture delivered before the Congress of the Tramways and Light Railways Association.

found. He would like to ask why corrugations appear on underground railways where the conditions were altogether different.

Mr. H. M. Sayers said they must congratulate themselves upon the lucid way in which Prof. Carus-Wilson had put before them a definite cause for the troublesome affliction known as corrugation. He said a definite cause, because he thought there was no one cause for corrugation. This was the first time to his knowledge that a particular cause had been tracked down and proved in experimental fashion. He would further like to congratulate Prof. Wilson upon the results, which he promised 15 months ago, when Mr. Panton read a Paper on Rail Corrugation before the Institution of Electrical Engineers and brought forward the theory that corrugation was due to the action of rolling stock in a more or less unsatisfactory condition and suggested that it was due to flange action that axles became askew. Prof. Wilson at that time was a little sceptical, but as a result of investigations he had traced out the connection between the flange action and corrugation under certain conditions. It was so frequently the case that men stuck to preconceived notions and refused to receive light from any source, that he thought they should congratulate the open-mindedness shown in the present case. It was worth while to remind the Association that the influence of torsional vibration of the axles was first put forward in public by, he thought, Mr. Arnold, surveyor of Birmingham, who contributed some articles to a tramway journal two years ago, but did not go so far as Prof. Wilson in demonstrating the action by model or by experiment on actual track. There were, he thought, some other causes of a similar character. Prof. Wilson had called this action "skid and roll." There was no reason why alternating slip and roll should not produce the same effect, and this was sometimes apparent where cars were accelerated, particularly where the controller passed from series to parallel. Prof. Lasalle formulated that theory in a Paper published in a Belgian journal, and suggested that the characteristic of the series motor might produce corrugations in certain circumstances. For example, if the motorman turned over the controller lever too fast the armature torque might exceed the adhesion value of the load on a wheel, making the whole slip. As soon as it slipped, the motor would speed up, because the resistance was reduced, and the wheel would grind the rail. There could be little doubt that braking sometimes induced skidding and also caused alternation of skid and roll. He was not quite able to follow one point in the Paper—why the sand was a necessary accomplice to the damage. One other point was, why should successive cars fall into step and combine to corrugate and roll over exactly the same inches of rail? He was not sure that they did. There was also no question that in badly corrugated places all the high parts of the rail were rolled up. In fact, they were not only rolled up, but out into the grooves, so that the effect was not only grinding as regarded the hollows, but a cold rolling as regarded the heights.

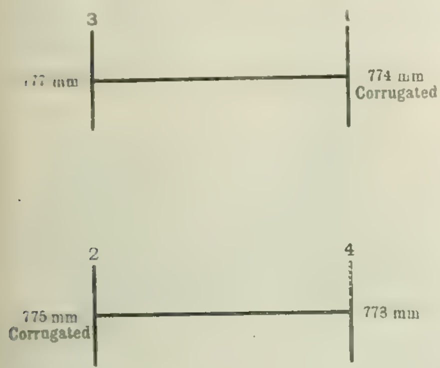
Mr. J. R. Salter (South Lancashire Tramways) said it seemed to him that if corrugations were due to the simultaneous presence of four sets of conditions, the chances were very remote that these four sets of conditions would happen in the same spot and the same way. For instance, the sand or grit was constantly shifting. He would like to suggest for Prof. Wilson's consideration whether the skidding was not due to corrugations, rather than the corrugations being due to the skidding. It would add considerably to the value of the Paper if experiments were made regarding skidding on a track with no corrugations. He would like to add a speculation, which was probably a somewhat wild one, as to the cause of corrugations. The cause of corrugations might arise through the magnetisation of the iron rails. They all knew that if a bar of iron were magnetised it extended in length, and there was some molecular change. If through the passage of the current and lines of force surrounding the rail always being constantly in one position the molecular structure of the rail altered, there might conceivably be some modification in the state of the iron such as to lead to these corrugations. Such a theory would support what were now considered as inconsistencies in the appearance of corrugations. The distribution of current in a rail must be, and usually was, totally independent of the car that happened to be on any particular section of the line. He did not know whether it was possible, where corrugations had appeared, to obtain a map of the cable lay-out, in order to get some idea of the distribution of the current. Prof. Wilson, from the point of view given in the Paper, had carried the subject almost to a conclusion, but he (Mr. Salter) thought they had still to look somewhat further for the cause of the corrugations.

Mr. J. S. Warner said they were all agreed that everyone interested in traction would contribute their thanks to the author of the Paper, who had raised himself head and shoulders above anyone else dealing with the problem. The lecture revealed a discovery of considerable importance by Prof. Wilson, who, he had no doubt, would not allow his investigations to stop at tramways, but would carry them through to railways, and ascertain whether the 3 per cent. slip occurred perpetually in railway wheels. If so, then the railway engineer had yet a good deal to learn about his own subject, just as engineers in general had a good deal to learn from the automobile engineer. In his opinion the conditions under which rolling stock was run over ordinary tramway and railway tracks were so very crude, and opposed to every engineering principle, that it was not at all surprising that corrugations took place. The wonder to him was that something very much worse did not take place. If he understood the lecturer correctly, flange pressure must be considered, on account of the form of the head of the rail, in street railway working quite differently from railway working, where they had the simple bull-headed rail and no check rail. Turning to Fig. 2, for the purpose of his remarks he would assume this was on a slight curve, and that the wheel was rolling at a velocity which was not the velocity of the tread of the wheel upon the measured distance on the track, but a higher velocity which, perhaps, it was convenient to call the flange velocity; that was to say, the wheel, instead of making over a given distance the revolutions corresponding with the diameter of the tread of the wheel, was really rolling at a velocity more in accordance with the outside diameter of the flange. The wheel was shown pressed against the check rail, and the influence of the pressure exerted by the flange on the rail was such that the wheel revolved at the flange velocity, which was a slower rate than if the wheel were running on its tread without such flange pressure. On a straight track the pair of wheels had previously been running at a regular slip of 3 per cent., and on arriving at a slight curve, where the pressure became excessive on one side and there was an almost complete clearance in the flange of the wheel on the outer rail, the whole of the slip took place on the Fig. 2 side, while on the other side, owing to the grit present on the track, it was possible to transmit a torsional storing up in the axle which intermittently released itself when the torsion of the axle was greater than the adhesion of that outer wheel upon the rail. Then followed, if he understood aright, the torsional oscillation of the outer wheel upon and with the axle. He could quite understand that if such torsional action took place, which it undoubtedly did, the axle would have a regular period of oscillation, but it appeared to him that such oscillations would be damped by the very adhesion of the wheel on the track under the conditions which pertained in practice with the weight of the car on the wheel, and it was not quite clear to him why that rhythmic oscillation of the axle should be maintained, in spite of the fact that the wheel was running upon the rail and carrying so many tons.

The Chairman (Mr. Stephen Sellon) said he was afraid his contribution to the discussion would interfere with Prof. Wilson's peace of mind. The Paper was very ingenious, and their thanks were due to the author, but Fig. 2 showed in his opinion an impossible condition. For if the condition of the rail and of the other wheel had been shown it would have been apparent that both rails and wheels would have been scrapped before arriving at such a condition. Prof. Wilson had fallen into error solely because he had not recognised that by the time the wheel had got to the condition shown the rail on the other side would be worn to such an extent that it would be scrapped. He would also like the author of the Paper to explain how the corrugations could synchronise with every car at different speeds. The question of the advantage of speed indicators had been discussed, but he did not know that any speed indicator or other means would enable them to arrive at a speed without variation. Prof. Wilson tried his experiments at 12 miles per hour, but a driver might be either late or early, and would be either going 8 or 14 miles perhaps. Had Prof Wilson considered also that when the grinding on the check rail began, grinding in the throat of the other rail also began? He also did not think it would be borne out in practice that because of the grinding of the flange the wheel would be running on a different diameter. Before that condition could be reached at which the flanges were grinding, except on a sharp curve, and the amount of wear in the rail was such that instead of having the ordinary clearance, which the author put at $\frac{1}{4}$ in., they would get nearly an inch. The Association was aware that he had the strong opinion that corrugations were not due to the causes put forward by Prof. Wilson, but were due to the rigid road beds, which offended engineering principles. Tramways had been constructed with the idea that they should have rigid road beds to last for ever, and this was, he believed, the first cause of corrugations. If not, why could not the author point to a single case of steam tramways where corrugations appeared and where the same conditions existed? In the old days the Board of Trade were very persistent about curves, and to relieve the friction round certain curves companies used to lay one girder rail and then one flat rail, so that the wheel, in going round the curve, ran round on the flat rail on its flange. Another point he did not think the author had considered. When a wheel and a rail had become worn to the condition shown in Fig. 2 the diameters of the wheels would be materially altered, and one might be larger than the other. Why were the corrugations dependent upon the wheel which had worn the check as against the wheel which had worn the head? He was bound to say the Paper was ingenious, but it was rather professorial. There seemed to be something missing, but whether practical experience he could not say; theory seemed to him to dominate the reason given for corrugations. Without intending it, the Professor had led them into a maze, and left them there without giving them any assistance to get out of it.

Mr. F. Bland (Edgar, Allen & Co.) (communicated) had taken considerable interest in this subject, but had no theory to put forward. He wished to place before the members an interesting addition to this subject, obtained during a recent visit to the Continent, one, he believed, which had not before been touched upon. A photograph (shown at the meeting) taken upon the Helingsfors tramways showed corrugations upon the tyres of the tramcar wheels. The diameter of the wheels and the relation to each other were as shown in the diagram. In the absence of suitable instruments no measurement could be made of the height of the single corrugations which were noticed several times, and which in this case were especially strong. This corrugation on diagonal wheels was found in several cases also upon three wheels of one car and upon four wheels of one car. The corrugation took place upon the smallest wheel of the same axle, and in relation to both axles upon diagonally situated wheels. On the opposite wheel no corrugation was found in spite of an exact and careful examination, whereas, as above stated, upon one car corrugations existed upon three wheels and upon all four wheels on another car. The corrugations first occurred upon a curve of 200 metres radius, which was run

over quickly, and upon this spot the under surface was very bad, and although all sorts of trials were made, the lie of the rails could not be improved and the corrugation was very strong. The tramway authorities at Helsingfors considered there was a possibility that corrugation took place upon the wheels and were thence transferred to other portions of the track. They drew this conclusion from the fact that the first corrugation was noticed after 1½ year's wear, and that now for the first time after about 5 years' corrugations had occurred upon the greater part of the remaining track. Further observations were now being made as to the increase, or otherwise, of these corrugations. The corrugations on the tyres corresponded exactly with the corrugations on the rails in form and length, and were distributed at about 7 cm. to 8 cm. distance from summit to summit on the circumference. The cars which had corrugated wheels made a peculiar buzzing noise when running quickly. The tyres were of Krupp's steel of at least 20 kilos per square millimetre, and were twisted off in the middle after running 50.000 km. The rails were Phœnix rolling—sec. 25 B—tensile strain 70 kilos per square millimetre, and at least 0·45 per cent. carbon. Brake shoes were of ordinary grey iron, but were not considered a contributory cause; "flats" caused by careless braking were often noticed on the tyres at first, but not for the last three years, and are not thought to lead to corrugation.



Prof. Carus-Wilson (in reply) said Mr. Dalrymple had regretted there was no remedy suggested in the Paper. He quite agreed, and sympathised in that regret, but would point to the last paragraph of his Paper, in which he stated that unless they agreed in the correct diagnosis of the disease, it was only wasting time to talk about remedies. Mr. Bannister had attempted to strengthen the web of the rails by adding fishplates on the lines of the remedy applied to the street railways in Philadelphia, but that did no good. A slight calculation would have saved Mr. Bannister a little trouble, and would have shown that the stiffness of the Philadelphia section of the 93 lb. used by Mr. Nicholls with increased web to $\frac{9}{16}$ in. was just as stiff as the standard section in this country. So that we had with our shallow rail almost exactly as stiff a rail as in Philadelphia by increasing the thickness of their web $\frac{9}{16}$ in. Mr. Gibson had suggested that if his arguments were correct the remedy would be found in differential drive, driving both wheels independently. He quite admitted the truth of this statement, but before recommending tramway engineers to fit their axles with differential gear they ought to know a great deal more about corrugation, because although he had ventured to bring forward a carefully worked out theory as to the cause of corrugation, they would notice that he laid great stress on the influence of the wear of the wheels. Until they knew more of what made the wheels wear as they did, it would be very rash to fit all wheels with differential drive. Coming to the discussion that afternoon, Mr. Sayers' remarks had interested him very much, and he regretted he had not had time to look through the very interesting theory developed by Mr. Lasalle. Mr. Sayers had alluded to the discussion on Mr. Panton's Paper. He confessed he had not looked through his remarks on this occasion. If he remembered aright, he deprecated the suggestion by Mr. Panton that askew action was the only reason of corrugation, and brought forward the corrugations on Indian railways, where apparently there was no such askew action. He quite admitted that the flange action, which he thought had so much to do with it, was set up by a truck out of the square. In that respect he thought Mr. Panton was quite right, but there were other causes which set up this flange action besides the truck being out of the square. Mr. Sayers had asked why sandy condition of the track was essential. That puzzled him for a long time, and if anyone could show a better explanation he was quite prepared to consider it. His explanation was that so long as a rail was perfectly clean, not from the æsthetic point of view, but the metal on the surface of the rail free from grit, then grit on the top had nothing to do with it. He meant that grit of one kind or another was ingrained into the surface of the rail. It might be cleaned, but it would still have the grit in the surface. When they had that, they had a high coefficient of friction for the wheel. Directly there was a skid, therefore, that layer of grit was cut through, clean metal was touched, and the coefficient dropped in a way it could not if there were not that layer of grit. This was not the drop between static and rolling friction, which happened on a clean rail. It was a different thing. It was that sudden drop which was necessary to allow the wheel to return itself sufficiently to allow of a subsequent roll and skid. Mr. Sayers asked why successive cars skidded at the same point. There again he was prepared to give his own view, but was also prepared to consider any other that might be advanced. His view was that when they got a car which began to produce corrugations, a series of skid marks, the fact was that they had a rail in which there was a succession of spots at which the grit was to some extent ground off the head of the rail. When the next wheel came along with its axle twisted up and reached a point when the coefficient was slightly less, there would be a tendency for the wheel to recover itself owing to the torsional stress. It was astounding what curious results there were from very little differences. He had noticed an outer rail in which some chisel marks had been made. At the time there were no corrugations, these having been ground out, but the conditions for forming corrugations were there, and corrugations began to form, but in a manner actually dictated by the chisel marks. Mr. Salter's point was mainly that the four conditions necessary were unlikely to be present at the same time so often as to cause corrugations. If they looked at these conditions they would find that the first condition was a permanent condition of tramway tracks, and No. 2 was a more or less permanent condition, although in certain places there was less grit than in others. In regard to No. 3, if they could get rid of check-cut wheels they would get rid of corrugations very largely, but he had not found a system where they had not got check-cut wheels. He would deal with No. 4 in connection with Mr. Sellon's remarks. He did not think the conditions were so unlikely as to discredit the arguments in the Paper. In regard to Mr. Salter's question as to whether he had made any other experiments on skidding, he had made experiments of an exactly similar character as those at Croydon on another system where there were hardly any corrugations at all on the rails, and found distinct evidence of a skid of the same character as at Croydon. The argument about magnetisation causing corrugations was a rather elaborate theory to tackle right off. He had made a great number of experiments in connection with the mechanical effect as to elongation, &c., due to magnetisation, but this was so infinitesimal that from the tramway point of view he thought it would have no effect whatever. Mr. Warner had said the wheel oscillations would be damped and could not imagine how they could get rhythmic oscillations of the wheel when a heavy load was on the wheel, which would exercise a damping effect. It did exercise a damping effect, and it was not difficult to see what the nature of that damping effect was due to the load. You had a wheel advancing and a torsion being stored up in the axle, and you got first a skid and then a roll. The weight determined the rate at which this skidding took place. This did not alter the fact that they got this rhythmic oscillation. Mr. Warner suggested they should make the flanges of the wheels thinner, and should practically keep the flanges from going on the check. He did not see why they should not do that, provided their flanges were too thick, but here was a difficulty. Could anybody tell in which direction the wheels and axle were going to wear? If the flanges were made thinner than now, all the wear came in one direction as a rule and they would get all the wear on one side of the flanges which would get worn through in half the present time. In regard to Mr. Sellon's criticism of Fig. 2, that they could not get a wheel with the flange cut in that way against the rail in the manner shown, would Mr. Sellon add to that criticism "under any circumstances." (Mr. Sellon: You could do so by putting an old worn-out car on a new track.) This wheel was taken off an actual car in actual working, and, if Fig. 2 was impossible, how did the wheel get cut in that way? It was cut in ordinary traffic, and that section applied to a curve. (Mr. Sellon, interposing, said he was not taking a curve, but a straight road.) How did Mr. Sellon, taking a perfectly straight track, account for the continued presence of check cutting which was almost everwhere apparent? It was unquestionably done by the flange cutting against the check rail. Whatever happened on the other side he could deal with separately. The check cutting of the rail was undoubtedly done by the grinding of the flange on the check. Mr. Sellon had said the rail on the other side must be ground. If they looked at Fig. 1, this represented the position of the wheel when new and when check cutting on the other side had presumably not begun. Even supposing the wear had taken place more than was represented by this figure, his argument was that the contact of the flange with the head of the rail on the throat side of the flange was always near the head of the rail when compared with the contact due to the check on the rail. His contention was that the cut of the flange on the check was a cut of an entirely different character to the cut of the flange on the head of the rail and the frictional line of contact was very much more below the surface in the check case than in the other case, and there was consequently a larger percentage of skidding than in the other case, and it was that large percentage of skidding which was necessary to get this effect. Mr. Sellon said there must be cars at other speeds, quicker or slower. The question of speed was exceedingly important, and he had laid it down as one of the conditions for corrugation. If they had a section of line on which the speed of the cars was always changing, he did not believe they would get corrugations. The conditions were so different according to the difference of speed that if they did not get on any particular track a certain more or less different speed—that was to say, the majority of the cars at a certain rate—he did not believe they would get corrugations. He believed it was because they had a series of cars at more or less the same rate that they got corrugations. Mr. Sellon had asked how it was that they did not get corrugations with the old steam traction. They did get corrugations on steam tramways. He had made careful inquiry, and had ascertained that there were corrugations on some of the steam tramways, but not very pronounced. Some of the conditions were existing, but not to the same extent as now. They got corrugations on steam railways; in fact, where the conditions approximated to those on a tramway. Mr. Sellon had given an instance of a flat outer rail. Without knowing exactly what the conditions were, he could not explain why they did not get corrugations here or there. The conditions were so complicated, and depended upon such a number of things, that it would be waste of time to try to explain why on any particular track they did not get corrugations, unless all the facts were available.

THE ELECTRICAL TESTING INSTRUMENTS OF MESSRS. SIEMENS BROS. & CO.

(Concluded from page 563.)

One of the most compact Wheatstone bridges which is at present on the market is undoubtedly that illustrated in Fig. 13. It is supplied with a leather case and strap handle, so that it can be carried conveniently and used in any situation. It contains balancing resistances of 1 to 500 ohms, two proportional branchs each of 1, 10 and 100 ohms, a moving coil galvanoscope, a battery of three dry cells and a double key, which certainly must be considered a record when it is known that the height of the complete instrument is only 8 in., its diameter 8¼ in. and its weight 8¾ lb., in the case, whilst it enables measurements to be made of resistance values from 0·1 to 100,000 ohms.

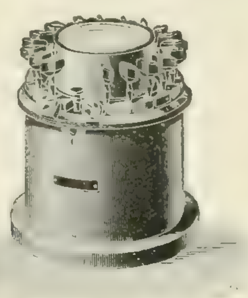


FIG. 13.—PORTABLE WHEATSTONE BRIDGE.

Whilst self-contained bridges for the measurement of resistances have been in existence for a long time, no very handy form of bridge has hitherto been put on the market. As the measurement of self-induction is no longer a laboratory test, but is necessary on a large scale for many purposes, such as measuring the induction of Pupin coils, &c., Messrs. Siemens have designed an instrument (Fig. 14) to meet these requirements. The bridge itself is very similar to the universal galvanometer previously described, and permits of the galvanometer being replaced by a telephone by means of a hand switch, the latter being required after the balance with direct current has been obtained. The instrument shown enables measurements to be made as low as 0·001 henry, and is fitted with plug resistances from 0·1 to 50 ohms. For producing

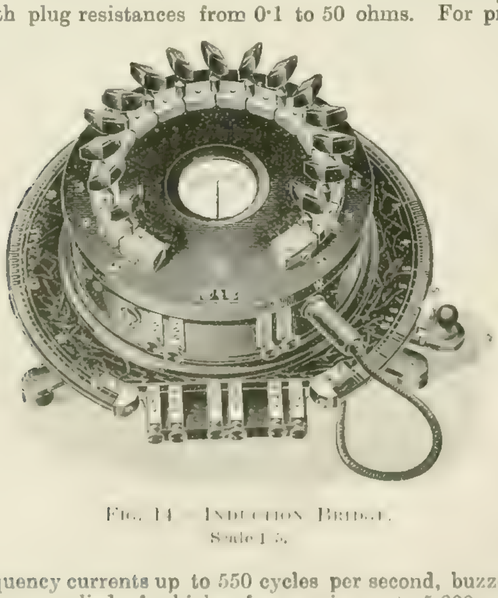


FIG. 14.—INDUCTION BRIDGE.
Scale 1/5.

high-frequency currents up to 550 cycles per second, buzzer transformers are supplied; for higher frequencies up to 5,000 cycles per second special motor-driven high-frequency machines are used; one of these is illustrated in Fig. 15. For laboratory measurements of small inductances, say, from 10^{-7} to 10^{-2} henry, the pattern of induction bridge shown in Fig. 16 should prove satisfactory and enable measurements on telephone circuits to be made rapidly. A variable standard of self-induction is employed, the value of which is read off by a pointer connected to a slide consisting of iron manufactured by a special process for this purpose, so as to obviate losses due to eddy currents. This induction bridge not only serves for determining induction constants, but also for measuring the energy losses in the inductive circuits under observation.

Probably the greatest amount of testing takes place in connection with telegraph and telephone lines. Messrs. Siemens have introduced what is termed a universal testing set for this purpose. The set consists of a galvanometer of about 20 ohms resistance and a sensitiveness of 5×10^{-6} amperes per scale division, a slate disc with slide wire, index and resistance scale, mounted on a common ebonite base with switches and plug-commutators. It enables resistance measurements to be made from 1 to 100,000 ohms and insulation tests up to 2 megohms. A supplementary resistance provides for current measurements up to 0·3 ampere and pressures up to 120 volts, and for measurements of the internal resistance of batteries.

Messrs. Siemens have also placed on the market a convenient portable testing set for mains superintendents. It weighs only 70 lb., and as will be seen in Fig. 17, is fitted with a permanent stand, the legs of which can be folded up for convenience in carrying.

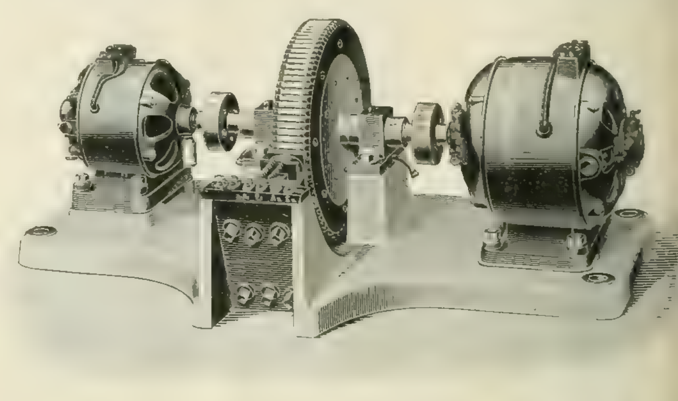


FIG. 15.—HIGH FREQUENCY ALTERNATOR FOR TESTING PURPOSES.

For the latter purpose the back of the case is well upholstered and is provided with broad shoulder straps so that the set can be easily taken about by one man. It will be noticed that the batteries, tools and testing instruments are all contained in one case and the galvanometer is provided with three metal supports which automatically connect it to the testing set when placed in position as shown in Fig. 17. Insulation and resistance measurements from 0·1 ohm to 1,000 megohms can be made with this set; also capacities from 0·005 mfd. to 4 mfd., and fault localisation. The battery capacity of the case as shown is 105 cells, which is, of course, sufficient for all ordinary measurements. In another type of this testing set, a supplementary Wheatstone bridge for localising faults is included.

The Siemens magnetising apparatus, illustrated in Fig. 18, consists of a moving coil and magnet, similar to the D'Arsonval instruments in design, but the employment of the parts is reversed—*i.e.*, the moving coil is supplied with a constant current, whilst the magnetism of the magnet is varied. It is thus possible to obtain direct readings of the magnetic induction and to plot the hysteresis

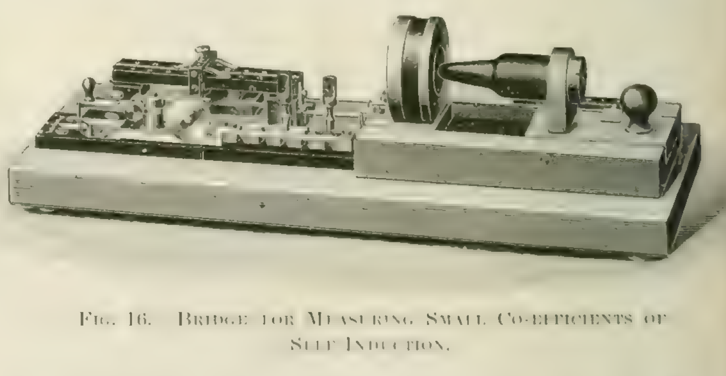


FIG. 16. BRIDGE FOR MEASURING SMALL CO-EFFICIENTS OF SELF INDUCTION.

loop. It is obvious that for different sections of iron under observation the instrument can still be made direct reading by simply changing the value of the constant current in the moving coil to the proper amount in relation to the cross-section of the iron. The material to be tested can be either in the form of bundles of strips or in the form of a round bar and is inserted through the opening (shown covered in Fig. 18) on the left-hand side of the centre instrument in the illustration.

It is a well-known fact that glow lamps vary very much in quality, and as a large number of new types have been put on the market during the last few years, the necessity for apparatus which will enable electrical contractors and users on a large scale to make their own measurements and form their own opinions of the commercial value of the various lamps—and to check for themselves how far the conditions of their orders have been complied with—is more than ever apparent. The new Siemens collapsible photometer (*see* Figs. 19 and 20) provides an instrument very suitable for this purpose.

and permits of making such measurements in the simplest and most convenient manner without a dark room and with an accuracy sufficient for all practical requirements.

The measuring system is based on the angle mirror method. The apparatus consists essentially of three boxes connected together by collapsible bellows, which, when not in use, can be closed up and then form a convenient and easily carried case. The middle part of the apparatus contains a voltmeter and an ammeter, the photometer screen and two collapsible rails screwed on to the top and engraved with millimetre and candle-power scales. Electromagnetic instruments, calibrated to within ± 1 per cent., for continuous

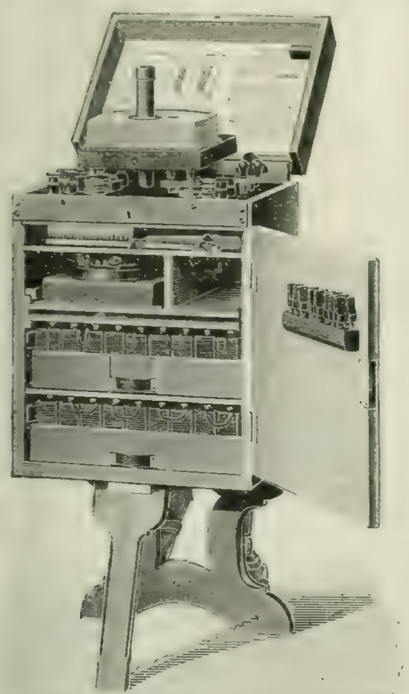


FIG. 17.—PORTABLE CABLE TESTING SET FOR STREET USE.
Scale 1:10.

and alternating current, can be fitted according to requirements; or moving-coil switchboard instruments can be supplied. The instruments are connected to the circuit in such a manner that they indicate only the current and the pressure flowing through and at the lamp terminals respectively, so that the actual watt consumption of the lamp is measured. In order that the instruments may be checked at any time or that the measurements may be made by means of wattmeters or moving-coil voltmeters and ammeters, special terminals are provided for connecting up such instruments,

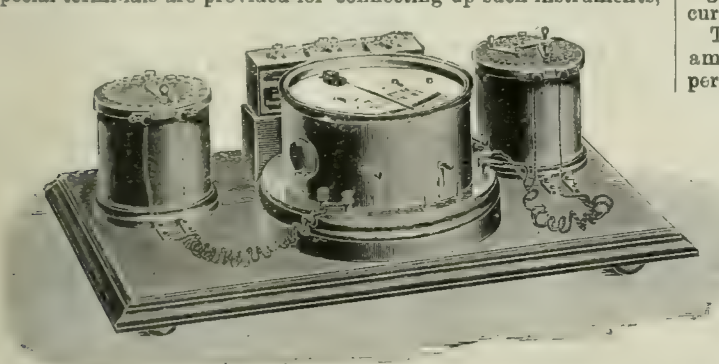


FIG. 18.—SIEMENS MAGNETISING APPARATUS.
Scale 1:10.

so that the apparatus is also suitable for more accurate laboratory measurements.

The Bunsen photometric system is employed, but the usual grease spot is replaced by a silver spot between two plates of matt glass. The instruments and the scales can be read off from the top and this applies also to the screen, so that the measurements can be made quickly and easily. The two other parts of the apparatus each contain two mirrors inclined at an angle of 120 deg. to each other, the standard lamp being in one part and the lamp to be tested in the other part. The lamps hang vertically so that the apparatus is suitable for testing lamps which can only burn in this position.

The tests can be made in full daylight. As the standard lamp and the lamp to be tested are connected in parallel and the former is in series with a resistance equal to the resistance of the ammeter which is in the circuit of the other lamp, it follows that both lamps have practically the same difference of potential at their terminals and can, therefore, readily be compared with one another. In order to be able to determine candle power in cases where the supply pressure is higher or lower than the rated pressure of the lamps, the standard lamp can be fixed at a different distance from the screen, so that the same amount of illumination is produced on the screen as at the rated voltage.

The photometer is shown closed in Fig. 20, whilst Fig. 19 shows it open ready for use, and an idea of its great utility and portability can be gathered from these illustrations.

We have only been able to refer briefly to a few of the many interesting instruments of which particulars are given in Messrs. Siemens Bros. & Co.'s new catalogue, and which we were enabled to inspect on a recent visit to their works at Woolwich. On that occasion, we were particularly struck with the excellent and up-to-date arrangements which had been provided for calibrating the instruments. In particular we were much interested in the plant employed for the purpose of calibrating alternating-current instruments, such as those of the Ferraris type and alternating current watt-hour meters. In order to obtain every possible phase displacement from 0 to 1 the double generator, one part of which is used for the supply of three-phase current whilst the other generates the three phase pressure, is arranged in such a manner that

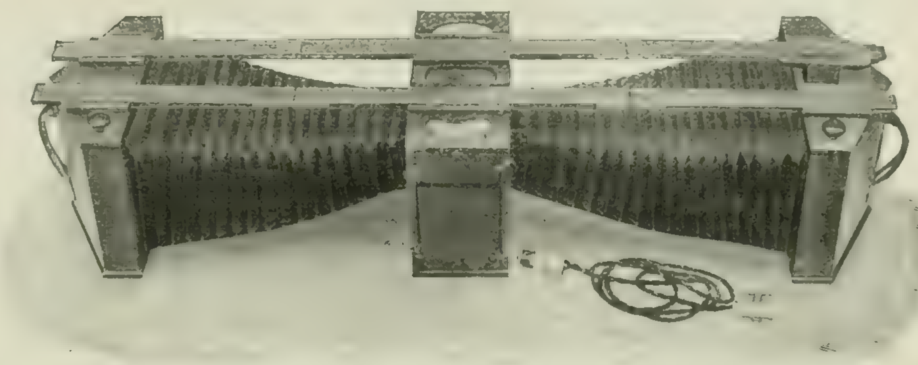


FIG. 19.—SIEMENS COLLAPSIBLE PHOTOMETER (ready for use).

any desired lag may be given to the pressure in respect to the current, without stopping the set. The stationary armature of the pressure generator can be moved through an angle of about 90 deg. by means of a worm wheel and worm; the latter is driven by a small motor which can be operated from the test room. The assistant who is testing is thus able to vary the phase to any required angle of displacement without leaving the calibrating board. In order that this double generator may be used for frequencies ranging between the wide limits of 20 to 100 cycles per second, a direct-current motor, with commutation poles, is employed for driving.

The calibrating boards are provided with a complete set of ammeters and voltmeters, and the required ranges are obtained by permanently mounted switches. It is, therefore, possible to calibrate the instrument under test by connecting its terminals to the board and by using the respective switches, without wiring up specially for the various requirements and quite independently of the instrument's range; the only portable instruments in use are the wattmeters. The controlling arrangements for current and pressure are placed alongside the board and consist of auto-transformers, by means of which the current can be varied in steps of 1·5 amperes for the fine adjustment, and up to 240 amperes for the coarse adjustment.

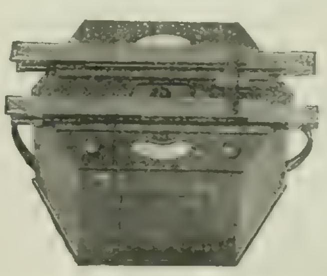


FIG. 20.—COLLAPSIBLE PHOTOMETER (closed).

ERRATUM.—In the first instalment the number of the catalogue to which we have referred was given as 506, whereas it should have been No. 508.

ON THE DENSITY, ELECTRICAL CONDUCTIVITY AND VISCOSITY OF FUSED SALTS AND THEIR MIXTURES.*

BY H. M. GOODWIN AND R. D. MAILEY.

Much of the discrepancy between the results obtained by previous investigators in connection with measurements of the density, conductivity and viscosity of pure salts and their mixtures over a wide range of temperature is due to inaccuracy in their temperature measurements. We therefore devoted considerable time to devising baths or thermostats in which temperatures up to 500°C. could be maintained constant to a few tenths of a degree as long as desired and to the measurement of these temperatures to the same degree of precision. Three different types of thermostats or furnaces were therefore used: (1) A vertical platinum resistance furnace of the usual type, the fire-clay cylinder on which the platinum was wound being 7·5 cm. in diameter and 25 cm. high, and packed in magnesium oxide. This furnace was used for heating the crucible containing the fused salt in the density measurements. (2) An air bath surrounded by a molten metal bath kept at constant temperature by electrical heating. (3) A fused nitrate bath, into which the viscosity apparatus was directly immersed.

The first of these needs no special description. The second contains some features worth mentioning, and is shown in vertical section in Fig. 1. The inner air bath C, in which the conductivity cell was suspended, was 32 cm. deep and elliptical in cross-section, the major and minor axes of the ellipse being about 8·5 cm. and 2·5 cm. respectively. This cross-section was chosen so as to reduce the air space about the conductivity cell to a minimum. A deep bath was used in order that radiation from the top might not affect the temperature in the neighbourhood of the conductivity cell. To further reduce the loss of heat to a minimum the top of the air bath was closed with a series of seven mica covers separated 1 cm. from one another. The necessary holes for the introduction of the thermo electric junction and lead wires to the cell were cut through these covers, which served not only to insulate but also to hold them in position in the furnace. The inner cylinder C was fitted into a circular iron plate, which formed the cover to the metal bath A. This cover was held in place by wing nuts, EE. The iron pot A containing the metal was about 15·5 cm. in diameter and 38 cm. deep. It was filled to within 3 cm. or 4 cm. of the top with an alloy consisting of 30 per cent. lead and 70 per cent. tin, which melted at about 180°C. The molten mass was stirred by means of two screw propellers, not shown, placed one on each side of the air bath C. These propellers were driven in opposite directions by an electric motor, and a thorough circulation of the bath was thus secured.

The furnace was heated by electricity. On the outside of A were wound 93 turns of No. 14 B. & S. nickel-steel wire, insulated from the iron by a layer of asbestos cloth and mica. This winding had a resistance of 22 ohms at room temperature and a resistance of about 28 ohms at 450°C. The current was regulated by an external rheostat; the energy absorbed was about 400 watts at 400°C. For lowering the temperature of the furnace 4 metres of steel tubing 7 mm. diameter were coiled about the inside wall of the pot. The ends F were brought out at the top of the furnace, and one connected to the waste pipe, the other to a three-way cock, by means of which air or water could be sent through the coil as desired. To reduce the violence of the vaporisation within the tube when water was introduced, the outside of the tube was wound with a thin layer of asbestos. The primary object of this coil was to cool the bath rapidly when necessary, but it also proved very convenient in regulating the temperature.

For heat insulation an 11 cm. jacket, K, of asbestos fibre surrounded the whole apparatus, except the top. The fibre was held in place at the sides and bottom by asbestos paper. In the bottom an opening, M, was left with the chimney N, so that the bath might be heated in part by a Bunsen burner when desired. The whole furnace was supported by lugs, H, which rested on an iron tripod. The conductivity cell was suspended in the heater from a brass frame P mounted on the cover. At the top of this frame were three binding posts insulated from each other and from the furnace by hard rubber. From these posts the cell was suspended by platinum wires, and the temperature regulation was effected by hand.

The third thermostat used in connection with our viscosity investigation consisted of a bath of fused sodium and potassium nitrate. This was contained in an iron pot 28 cm. high and 15·5 cm. in diameter, the outside of which was wound with No. 14 B. & S. nickel-steel wire as in the type of furnace just described. The bath was heat insulated by asbestos fibre 12 in. thick on the sides and 1½ in. on the bottom. An opening was left at the bottom so that the bath could also be heated by a Bunsen flame. This was used to keep the bath in a state of fusion, while the regulation of temperature was effected by the heating coil. Into this bath the viscosity apparatus was directly immersed.

All temperatures were measured by means of a carefully calibrated platinum rhodium couple which gave about 8 microvolts per degree centigrade. The part of the couple inside the furnace was encased in a clay tube to within 3 cm. or 4 cm. of the junction. Outside the furnace the wires were covered by small rubber tubing. The thermo-electric force corresponding to any temperature of the hot junction was measured in a special slide wire potentiometer, in conjunction with a very sensitive low resistance d'Arsonval galvanometer as indicating instrument. The arrangement of apparatus is shown in Figs. 2 and 3. In Fig. 2 the slide wire a is connected in series with a storage cell, b, of large capacity, and c, a variable resistance; d is the couple and g the galvanometer. When a balance point, a_c, as indicated by no deflection of the galvanometer, has been obtained, without changing the adjustment of a, b or c, the arrangement shown in Fig. 3 is thrown into the circuit in place of the thermal junction. Here e is a 20,000 ohm coil, h a variable resistance and f a cadmium cell of special design. By adjusting h, a fraction of the voltage of the cadmium cell may be tapped off of such magnitude as will give a balance a^s on the slide wire very near to the balance point obtained with the couple. From these readings the E.M.F. of the couple in terms of the E.M.F. of the standard cell may be calculated at once.

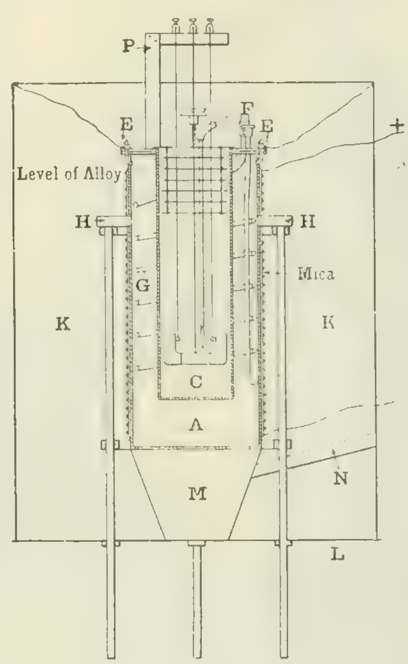


Fig. 1.]

The thermo-electric couple was calibrated at four fixed points—viz., the boiling temperatures of water, naphthalene, benzophenone and sulphur—and from these data curves connecting temperature and E.M.F. were plotted on a large scale.

In selecting salts for our investigation we required several whose melting point permitted them to be investigated over approximately the same range of temperature and which at the same time were univalent in order that the mutual effect of their dissociation might be as simple as possible. We chose, therefore, in the first instance, sodium and potassium nitrates, and afterwards added lithium nitrate, silver nitrate and silver chlorate. These salts were, with the exception of silver chlorate, obtained from Baker & Co., and marked C.P. They were purified by repeated recrystallisation until by the spectroscope practically all foreign metals were proved to be absent. They were then fused, cooled and ground to a powder and kept in a desiccator or glass-stoppered bottle.

Particulars are then given in the Paper of the measurements of density.

Fig. 2.

Fig. 3.

Conductivity Measurements. The conductivity of the fused salts was measured by means of the well-known Kohlrausch method. The bridge was of the horizontal drum type and consisted of 5 metres of manganin wire wound in 10 turns upon a marble cylinder. The wire was carefully calibrated by the method of Strouhal and Barus. An adjustable Swedish telephone was used for detecting the minimum, the alternating current being supplied by a small induction coil. The novel and most important feature of the apparatus was the form of conductivity cell used. The several properties which the material for a cell should possess if suitable for containing fused electrolytes at temperatures up to 500°C. are not readily found combined. The cell should be (1) a non-conductor of electricity at the highest temperature at which it is to be used; (2) chemically inert with respect to the substances contained in it; and (3) of such a form that the actual ohmic resistance of the fused salt is fairly high, 100 ohms or over, on account of the very high specific conductance of these electrolytes. The form of the cell should also be such that large electrodes may be used in order to diminish the effect of polarisation and consequent blurring of the minimum.

* Abstract from the *Physical Review.*

A substance admirably fulfilling these conditions is quartz, either in the vitreous or natural crystalline form. The design of cell which we devised is shown in Fig 4. B is a cylinder of rock crystal 5 cm. long and 14 mm. diameter, cut parallel to its axis, through which a capillary 1·5 mm. in diameter is bored with a diamond drill. The ends are carefully ground to a slight taper. The ends of this cylinder are closed by platinum elbows A, carefully ground on with rotten stone, and these in turn form the two electrodes of the cell. They are so designed that the flow lines from the end of the capillary spread out over a large platinum surface, thus reducing the effect of polarisation to a minimum. The cell is suspended in the furnace by means of platinum leads, DD, attached to the elbows by means of platinum plugs inserted in small platinum blocks, CC.

It was originally intended to use fused quartz for this cylinder in order to eliminate the effect of temperature on the cell constant, but, owing to the large differential expansion between this substance and platinum, the cell invariably began to leak when the temperature was raised to 300°C. or 400°C. We therefore chose natural quartz crystal as the coefficient of expansion of this substance at right angles to its axis happens fortunately to be very nearly that of platinum. The effect of the very slight leakage along the surface of B which was sometimes observed at high temperatures, was corrected by measuring, by means of an auxiliary platinum wire electrode, DE, wound around the centre of the cylinder, the resistance between this electrode and the two platinum ends.

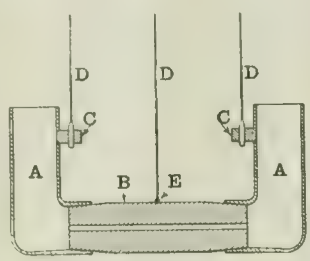


Fig. 4.

Another substance with which we experimented was pure magnesium oxide fused in the electric furnace. This substance is capable of being heated to nearly 2,000°C. before melting, is a fine insulator, and is chemically inert even at very high temperatures with respect to many neutral and alkaline compounds. The fused oxide is, however, crystalline in structure and liable to contain blow holes which make it a difficult matter to obtain cylinders of sufficient homogeneity to serve as conductivity cells. For temperatures above which quartz cannot be used, however, this substance offers great possibilities, particularly as its coefficient of expansion is not greatly different from that of platinum.

To standardise the cell a solution of sulphuric acid was used, as recommended by Kohlrausch and Holborn, and as a check on this

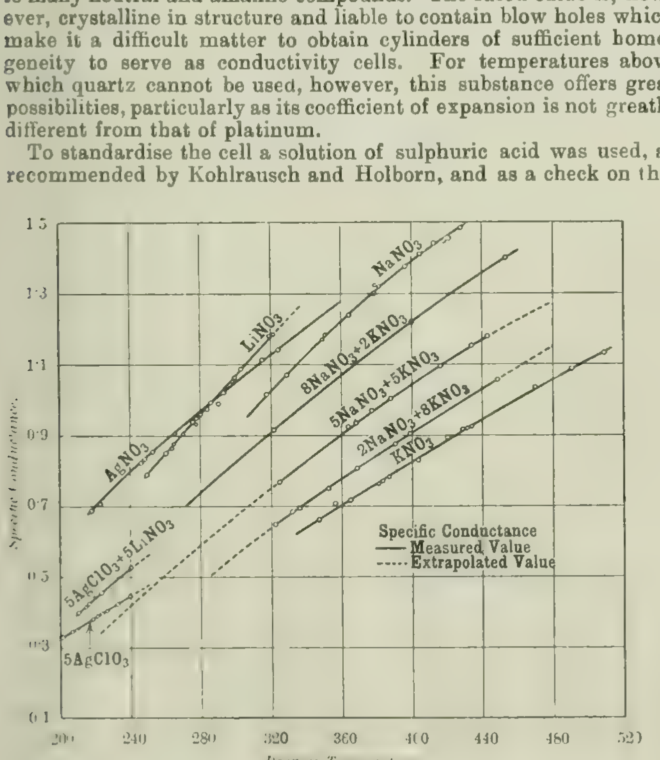


Fig. 5.

a saturated sodium chloride solution as well. The cell constant was determined at 18°C. in a felt-jacketed thermostat filled with xylene, and the same procedure was adopted in determining the conductivity of the fused salts.

Some of the results are given in Fig 5. Tables of equivalent conductance and temperature coefficients are also given by the authors, and their results show that, except in the case of lithium nitrate and silver chlorate, which could be measured over only a limited range of temperature on account of their instability, the specific conductance is not strictly proportional to the temperature, but increases less and less rapidly as the temperature rises. For the limited range of temperature over which lithium nitrate, silver chlorate and their mixtures were studied, the specific conductance is proportional to the temperature. The temperature coefficient is, generally speaking, less than one-fifth as great as that for the corresponding aqueous solutions. The equivalent conductance seems to increase very nearly linearly with the temperature The temperature coefficient decreases, therefore, with increasing temperature, but at any given temperature is slightly greater than that of the specific conductance at the same temperature. The equivalent conductance of the mixtures of the sodium and potassium nitrate is less than that computed from the equivalent conductance of the components. This is most marked in the case of the equimolecular mixture, and tends to confirm the view that the effect of dissolving one nitrate in another is to decrease the dissociation.

The remaining part of the Paper deals with the measurements of the viscosity of the fused salts described above.

ON THE SPECTRUM OF THE SINGING ARC LIGHT.*

BY DR. MICHELE LA ROSA.

As I have shown in a previous note,† a singing arc may be obtained not only under Duddell's conditions, but also when the shunt circuit across the terminals of the arc has no proper period, so long as it has a high capacity. Yet the phenomena obtained in the two cases differ notably in certain details, to which I drew attention in the note referred to. Since then I have observed further peculiarities which I shall briefly specify here, reserving a detailed description for a future publication.

A remarkable difference, observable at first sight in the arc when oscillating, consists in the shape assumed by the two carbons. Whereas in Duddell's singing arc their distinguishing characteristics are maintained (maximum development of light and heat on the positive carbon, which is hollowed out, while the negative carbon is pointed), these characteristics are not maintained in the arc singing simply under the influence of capacity, and it becomes difficult to distinguish between the two poles either during discharge or afterwards.

Of greater interest is the essential difference presented by the light emitted by the arc under the various conditions.

On examining in the spectroscope the light emitted by the arc singing under a condenser only, a spectrum is obtained differing from that obtained with the ordinary singing arc or with the continuous arc.

If the capacity of the condenser is sufficiently great, and if the inductance of the conductor joining its two armatures to the poles of the arc is the lowest possible, the spectrum emitted is a line spectrum, and recalls the spectrum of the dense spark between carbon terminals.

If the oscillations nearly cease, as happens from time to time, or if their amplitude diminishes, the line spectrum abruptly disappears, and is replaced by the well-known band spectrum of the arc. Slight traces of the latter spectrum are also seen when the oscillations are in full swing, but these traces are also observed in the characteristic spark spectrum.

On gradually diminishing the capacity of the condenser in the shunt, without altering the circuit otherwise, the spectrum of the light emitted is modified. Many luminous lines are weakened, others are extinguished. At the same time many characteristic parts of the arc spectrum, which at first were feeble, or altogether wanting, appear, or are strengthened. Thus we may obtain a gradual transformation of the original spectrum into that of the ordinary arc.

If instead of diminishing the capacity, successively higher inductances are introduced into the shunt circuit, a similar transformation is obtained, but more suddenly. A small inductance weakens the lines as much as does a large diminution of the capacity, or entirely substitutes the arc spectrum. The latter spectrum, barring slight differences, is that usually shown by the singing arc.

That the line spectrum above referred to really coincides, at least in its essential parts, with the spectrum of the high-pressure spark, I have ascertained partly by confronting it with a spark spectrum obtained between the same carbon terminals by means of two Leyden jars and an induction coil, partly by measuring the wave lengths of single lines on photographs, of which I took a great many.

I thus recognised very many lines of nitrogen and oxygen, and some of carbon, the brightest of which was 4,267, the first line which appears on employing small capacities. I observed in some lines of the metals contained as impurities in the carbons those changes of intensity which characterise the transition from the arc spectrum to the spark spectrum.

I also endeavoured to clear up the chief electrical elements of the phenomenon, in the hope of getting at the mechanism of the spectrum transformation described. I intend shortly to describe in detail the experiments made and the results obtained, together with some considerations thereby suggested.

* Translated from *Atti dei Lincei*.

† *Rendiconti dei Lincei*, 16, 112, 1907.

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"THE ELECTRICIAN" INDUSTRIAL SUPPLEMENT

With "THE ELECTRICIAN" for Sept. 14, 1906, was issued the first of a series of "Industrial Supplements," to be published from time to time with "THE ELECTRICIAN." The twenty-fifth issue of the Supplement was issued (Gratis) with "THE ELECTRICIAN" for July 24.

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RAIL CORRUGATION.

The subject of rail corrugation still continues to be one of the most vexed engineering questions of the day, although theories are not put forward quite so frequently as they were a year or two ago. Perhaps most of the theories have suffered from lack of breadth, the authors making an attempt to ascribe the whole of the evil to one cause; and there has also been rather a lack of that investigation which should precede the formation of theories. The latest contribution to the subject is that by Prof. CARUS-WILSON, who read a Paper on the subject before the recent Congress of the Tramways and Light Railways Association. We published the greater part of this lecture last week, and the remainder, with a report of the complete discussion, will be found in the current issue. The Paper is of more than usual interest because it depends upon experimental work, which, although not carried out in the main upon actual tramcars, is none the less valuable. A model truck with a $1\frac{1}{2}$ in. wheel base is, perhaps, a small thing from which to deduce far-reaching results, but it is possible to determine by means of models the direction in which investigations should be carried much more easily than by working upon the commercial vehicle, and such investigations have the great advantage that they can be carried through with comparative ease

Prof. CARUS-WILSON found that when the flanges of the wheels on one side of his model are forced against the rail these wheels travel with combined rolling and skidding, and that the latter is continuous on a clean rail but intermittent when the surface of the rail is covered with sand. There is a similar action when the flange of a wheel is

forced against a check rail in actual practice. This effect is due to the wheels attempting to roll on two circles of different radii, and to alterations in the coefficient of friction. We think that there is no doubt such an action must have a good deal to do with corrugation, but we are inclined to think that Prof. CARUS-WILSON requires rather too many essential and simultaneous conditions. At the conclusion of his Paper four sets of conditions are laid down, having reference to the track, to the rails, to the rolling stock, and to the traffic, and it is stated that these must all be present in order that corrugation may result. But we think it will generally be felt that if the track is to be in a certain condition, the rails to be rough with sand, the rolling stock to have wheels with check cutting flanges, and the cars to be run at a certain critical speed, all simultaneously, then probability would be against the formation of corrugation.

We feel that Prof. CARUS-WILSON has tried to go somewhat too far, and that in all probability the trouble cannot be diagnosed so exactly. It is difficult to obtain a theory which fits every case. For example, according to Prof. CARUS-WILSON's views, it is not clear why corrugations should exist on straight portions of a track. It is sometimes denied that such corrugations are formed, but in Mr. A. L. C. FELL's very valuable Paper, which was read before the Municipal Tramways Association last year, examples of corrugation on straight lines were given. Also, if corrugations depend upon the natural period of the axle, as suggested by Prof. CARUS-WILSON, then the length of the corrugation will increase with the speed of the car, because the time of transit per corrugation will be constant. Mr. FELL, on the other hand, states that corrugations are the same length for all speeds from 4 to 16 miles per hour. Again, an instance was given of an Indian railway on which corrugations appeared when a particular kind of ballast was used, but in the discussion it was pointed out that there were other Indian railways on which no corrugation was evident although the same ballast was in use.

Contradictory results of this kind show the very great importance of careful observation, and no doubt a good deal might be done by collecting information and getting together data of a really accurate kind. Meanwhile, investigations such as those of Prof. CARUS-WILSON, although they may not suggest an immediate cure, throw light upon a difficult problem, and we hope that work of this kind will be continued.

REVIEWS.

(Copies of the undermentioned works can be had from *The Electrician* Office, post free on receipt of published price, adding 3d. for books published under 2s. Add 10 per cent. for abroad or for foreign books.)

Electric Railways. By SIDNEY W. ASHE. Vol. II. (London: Archibald Constable & Co. Pp. VI.—275. 10s. 6d. net.

This book forms the second part of a comprehensive treatise, of which the first volume has already been brought out, and the third volume is still to come. The first volume was devoted to Rolling Stock, and the book now under consideration deals with "Engineering Preliminaries and Direct Current Substations."

The description given is hardly adequate, and it would have been better to have made an effort to be a little more precise. The engineering preliminaries are mainly the determination of the proper motor for any given case and the choice of locations for power house and sub stations; in addition, there are a few pages on what may be termed "non engineering" preliminaries, such as relation between population and car miles per annum. It is to be noted that only the 500 or 600 volt direct current system is considered, no mention being made of either three-phase or single-phase alternating current, or of high-tension direct current. As may perhaps be expected, the substations referred to are of the standard type employing rotary converters.

In dealing with the choice of a suitable motor, four alternative methods are given—viz., (1) the rule-of-thumb method, (2) Armstrong's method, (3) Storer's method and (4) Hutchinson's method, all of which will be familiar to students of the *Proceedings* of the American Institute of Electrical Engineers. This part of the book is illustrated with a number of diagrams explaining the various calculations.

The second and larger part, which deals with sub stations, is somewhat unequal; several chapters contain well-known information which can be found in many text books, and which seems rather out of place in its present setting. Thus, for example, Chapters VII. and VIII., which deal with the theory and construction of rotary converters and their heating in relation to the number of phases, and with the calculations and methods of connection of transformers, are more suitable to works on dynamo machine design; there is nothing in them that distinguishes them from similar chapters in books that have no relation to electric traction.

On the other hand, Chapter VI., which gives much general information in regard to sub-stations, is well worth studying, as it is evidently written by one who has a practical acquaintance with his subject. This can be seen all through this chapter; the treatment of the foundations, the general arrangement of the circuits, the practical details of the switchgear, the various methods of starting the machines, and the adjustment of load between different machines and different substations is valuable, simply because it contains much that cannot be found in other books.

Chapter IX., on "Insulating Oils," is also a practical chapter, and the author in a footnote acknowledges his indebtedness to two articles published in the *Electric Club Journal*, by C. E. Skinner and by S. T. Kintner. The information given is well worth republication in a more accessible form.

The last chapter, on Auxiliary Sub-station Apparatus, describes various forms of instruments and switches, such as power factor meters, synchronisers, relays, switches, lightning arresters, &c. There seems no particular reason why this should be included, as scarcely any of the various forms of apparatus are peculiar to sub-stations or to electric railways in general; the information may be obtained from other books, such as that by Andrews on the control of electric circuits.

The illustrations are numerous but are, like the text, unequal. The diagrams in the first part are excellent; but many of the illustrations in the chapters on sub-stations are of very little interest. Photographs of complete rotary converters, of armatures during winding, of complete transformers, of the outsides of instruments, and of knife switches, are all so well known that it is hardly worth while to publish them once more.

Taken as a whole, this volume can be commended for its good points, which depend on the practical experience of the author; but those who study it must not be disappointed if they do not find in it as much as they expect.

E. WILSON and F. LYDALL.

Thermoelemente und Thermosäulen. By Dr. F. PETERS. "Monographien über angewandte Elektrochemie." Vol. XXX. (W. Knapp, Halle a.S.) 184 pp. 192 Illustrations. M. 10.

In spite of the enormous output of technical books, the subject of thermopiles does not appear to have hitherto been deemed worthy of a volume to itself. The deficiency has now been remedied. This latest monograph of the well-known series opens with a brief historical survey and then deals in turn with the Preparation of Thermoelements; their Use in the building up of Thermopiles, and their Applications (high-temperature measurements, &c.).

The treatment is naturally brief, owing to the considerable amount of material to be handled, and purely theoretical matter is excluded. The main facts or results are given

simply without criticism or analysis, but examination shows that the desire for brevity has been, we think reasonably, curbed in the treatment of one or two of the more important practical thermopiles.

The completeness is a noticeable feature; another is the inclusion of a really satisfactory subject index and a name index as well as an index in numerical order of the patents on the subject which have been issued in the various countries, giving the pages where these are dealt with in the book. Perhaps the one chapter in which a further excursion into the theoretical might have been desirable is that relating to high-temperature measurements. However, the work seems likely to be of considerable service to the class of reader aimed at in the preface.

A few minor misprints may be noted. Thus, on p. 149 Messer elektrischer Motore should obviously be Motore elektrischer Messer, while Roberts-Austen (p. 130 and index) is spelt Austin, G. Seibt (index) appears as Seibl, and the names Duddell and I. Kitsee, correctly given in the text, appear in the index as Dudell and J. Kitsee.

THE GENERATION AND ELECTRICAL TRANSMISSION OF POWER FOR MAIN MARINE PROPULSION AND SPEED REGULATION.*

BY W. P. DURTNALL.

Few of the subjects which are to-day engaging the attention of the engineering world are comparable, either in scientific interest or in practical importance, with the generation and transmission of power for marine propulsion. In designing such a propelling mechanism the first object is to move the vessel through the water at a certain speed, the second to reverse or reduce this motion, and the third to arrange the machinery in as convenient a way as possible. Scientific development along these lines has been going on for the last 64 years, and the recent practical application of the steam turbine and torsion meter has enabled a closer investigation of the steam consumption and horse power developed to be obtained than has hitherto been possible.

As regards generation of power, steam still holds the leading position as the working fluid in heat engines and its economical generation is of the highest importance to engineers. Points which must be taken into consideration are simplicity of construction, supply of dry steam, rapidity of raising steam and capability for being overloaded for short periods, and finally light weight. The cylindrical marine type of boiler is still doing good work, though it possesses numerous disadvantages. The future would seem to lie with the water-tube boiler, especially if oil fuel be used; tests carried out on the French battleships "La Patrie" and "La Justice" on large Niclause water-tube boilers show that "forcing" may be indulged in, if desirable, with this type of boiler.

Until the introduction of large power internal-combustion engines is an accomplished fact the steam turbine is the most efficient, light and simple prime mover. It can be opened up and repaired without difficulty, and owing to its freedom from distortion is especially suitable for use with superheated steam. Although it has recently been fairly widely adopted for direct marine propulsion, it labours under distinct disadvantages. It has to be direct coupled to the propeller and must, therefore, be designed to run at very low speed in order to permit the use of a propeller of high propulsive efficiency. Consequently the weight per brake horse-power developed is increased to a very large extent, and owing to large diameter of rotor and casing, proportionately large blade clearance must be allowed in order to meet the conditions of expansion and contraction, &c., with consequent higher steam leakage and consumption per horse-power of work developed. Another disadvantage of this application is the difficulty of reversing for manœuvring and going astern. The provision of separate turbines for astern working cannot be looked upon as satisfactory, as the dead weight is thereby increased and the reverse engines are not so economical as those for ahead working.

Various methods of gearing have been adopted—viz., mechanical, compressed air and hydraulic—but they all offer distinct disadvantages and are scarcely touched upon by the author.

The use of electric power transmission is a method in which great possibilities seem to lie. It possesses the very elements that are required to take advantage of high speed turbines, by utilising them to drive electric generators, which in their turn drive slow-speed motors. These latter are coupled to suitable propellers, which can be so calculated as regards power and speed that high efficiency can be secured by the use of moderate-speed large-bladed propellers.

* Abstract of a Paper read before the Institute of Marine Engineers.

This method would further do away with the necessity for reverse turbines and greatly simplify the control.

The author is of the opinioo, after the closest investigation, that for marine propulsion, electrical power transmission can be only successfully carried out by means of polyphase alternating currents with synchronous generators, and squirrel cage induction motors, not only on account of the great simplicity of these machines, but on account of their low cost and low weight per horse-power developed. Also considering the immense power to be handled, it is his belief that the use of continuous current and other forms of machines embodying commutators and brush-gear is practically impossible. The utilization of a synchronous type of turbo-generator, with squirrel-cage type of motor, without synchronizing gear and absence of rubbing contacts, has been suggested. But they are expensive and less efficient, partly owing to large exciting current, and are very rarely used in good practice.

As regards the three-phase alternating current induction motor, this has become very popular in recent years, mainly owing to its powerful starting torque, light weight and freedom from commutators and brush gear. A burnt-out armature is practically unknown in this type of machine, even when put to very severe service; indeed, its depreciation under fair conditions is as low as in any other type of mechanical revolving machinery, and, owing to its peculiar running characteristics, it is especially suitable for marine propulsion work. It is very compact, and is noted for durability and simplicity; it also has the important qualification of low first cost combined with great mechanical strength. The absence of commutators and brush gear is an immense advantage, and as there is, the efore, no sparking limit, the output per unit weight is much greater in large size polyphase induction motors than in, say, a direct current machine. It is quite within the range of possibility to design and construct these motors for marine work of from 1,000 H.P. to 10,000 H.P., weighing from 35 lb. to 20 lb. per horse-power developed. This would be for continuous rating and without any sacrifice of efficiency, which would in these cases be about 93 to 97 per cent.

It is interesting to compare the various published steam trials that have taken place showing the results that are possible with electrical power transmission with high-speed steam turbines, and especially to show the saving in steam that is possible. Let us assume that we wish to know what will be the steam capacity of the boilers for a vessel fitted for electrical transmission, for four propellers each requiring 1,000 B.H.P. to rotate them at 250 revs. per min. The motor would be of the polyphase induction type, with squirrel-cage rotors, and with stators wound for full, half, and quarter speeds. The generators would consist of two turbo-alternators and exciters capable between them of generating 3,250 kw., when running at 1,500 revs. per min. These alternators would be two-pole machines, and if the motors are wound for 12 poles (for top speed) will be equal to a 6 to 1 reduction in turbine for propeller speed. For half-speed the second winding would be arranged for 24 poles, 12 to 1 reduction with two sets of windings in parallel, and for quarter speed this winding would be arranged for 48 poles, 24 to 1 reduction; with these windings in series the synchronous speeds would thus be full speed 250, half speed 125, and quarter speed $62\frac{1}{2}$ revs. per min. At top speed the above machines would be coupled in parallel, and would consume at full load 16 lb. of steam per kilowatt, or 13 lb. per shaft horse-power. The consumption with a direct coupled steam turbine is about 22 lb. per shaft horse-power. At the half speed one turbine could be shut down, and by this means a saving in steam consumption of 37 per cent. could be effected over the direct drive. The total weight of the electrical machinery and accessories is estimated at 184 tons, as against 148 tons with the direct drive, an increase of about 25 per cent. The boiler equipment, however, would weig h 260 tons, as against 440 tons, a saving of about 40 per cent., while as regards coal consumption it is estimated that the saving would be about 1·6 tons per hour. The reduction in dead weight obtained by not having to carry so much fuel is, therefore, very great and of the highest importance.

ELECTRIC FURNACE REACTIONS UNDER HIGH GASEOUS PRESSURES.*

BY R. S. HUTTON AND J. E. PETAVEL.

Summary.—A description is given of two electric furnaces specially designed for the researches undertaken by the authors into which modifications appropriate to high pressure work were introduced. The results obtained when calcium carbide is produced under these conditions are given, together with deductions therefrom and the phenomena noticed with silica, carborundum and alumina are discussed.

The progress that has been made during the last ten years in the study of high-temperature chemical reactions has been almost exclusively along technical lines and little work on the chemical or

* Abstracted from the *Philosophical Transactions* of the Royal Society

physical sides seems to have been published. The object of the research undertaken by the authors was the determination of the correlation between physical conditions and chemical effects in the electrical furnace and of the results produced by the use of high gaseous pressures. In order that such work might be successful, experiments had to be made on as large a scale as possible, and means had to be provided for modifying over a wide range the chief factors—viz., power, current, electromotive force and pressure. The carrying out of experiments of this nature, and especially the use of pressures up to 200 atmospheres, demanded special apparatus, and the following equipment was, therefore, designed for this purpose.

Large High Pressure Furnace.—This consisted essentially of a steel enclosure having a capacity of about 20 litres and provided with various fittings for the introduction of gas, gauges, observation windows and insulated carbon holders for conducting the current to the interior of the furnace. The upper part of the shell was removable and was provided with a water-circulating arrangement. Both of the cylindrical furnace ends had projections and glands through which the carbon electrodes passed, and the two halves were made gas-tight by means of a lead spigot joint. The carbon feeding mechanism was fitted to these projections and was made up of a small cover screwed to the projections and an insulated yoke separated from it by means of iron columns. A threaded feeding rod passed both through the yoke and the cover, and by means of a nut and levers the electrodes could be advanced or retired as required. This feeding rod was hollow and water circulation was provided; compressed gas could also be delivered into the furnace through this arrangement. The carbon holders were of two different patterns, according to the size of electrode used. The smaller carbons were held in clamps, while the larger, after being coppered at the end, were soldered into cup-shaped holders. In order that observations of the arc might be made, two diametrically opposite openings in the furnace case were provided. Into these were screwed windows consisting of a glass or quartz cone tightly fixed in a gun-metal fitting. The valves and gas connections used were of a type that has already been described.* The furnace was tested after completion at a pressure of 450 atmospheres, and has often been used at 200 atmospheres. No trouble has been experienced with the joints, though the bolts between the two main parts of the furnace were, under working conditions, subjected to a stress of over 100 tons. This furnace is also suitable for work in vacuo, and has occasionally been used in this way in connection with spectroscopic investigations.

Small Furnace for High-Tension Currents.—Since a considerable number of electric furnace reactions, *e.g.*, gas reactions, require the use of high-tension currents, a special furnace was provided for this work. Not only would a large capacity be a drawback, but in a high tension arc the natural temperature gradient is so steep that the maximum temperature is easily attained, even in a small enclosure. The rapid rate of cooling which results from the proximity of the arc to the cold walls of the furnace is also a material advantage. The small furnace consisted of a mild steel cylinder of 3 in. internal diameter surrounded by a water jacket. Two openings allowed the introduction of gas fittings and inspection windows of the same description as those used in the larger furnace. The carbons passed through a conical hole tapering outwards, which was bored in the cylinder cover, and which carried a cup-shaped bush of ebonite or red fibre. A plug fitted closely into this cup, and was lightly drawn against it by a nut while the gas pressure forced the plug down on its seat and secured a satisfactory joint. Three steel pillars projecting from the cover supported a triangular insulated plate, in which was fixed a nut carrying the screw gear. By means of a cord passing over a pulley on this screw arrangement the gear could be worked from a safe distance. This furnace has been used up to 25,000 volts, platinum wire electrodes being employed instead of carbon rods.

General Observations on the Electric Arc under High Gaseous Pressures.—At the time the present research was started very little information was available with regard to the electric arc burnt in a compressed atmosphere, the investigations having been limited to small arcs and pressures of about 15 atmospheres. It was then thought to be impossible to maintain an arc under gaseous pressures of 100 or 200 atmospheres. It is true that a relatively long arc can be maintained in a dense atmosphere only by means of an exceptionally high E.M.F., but even low-tension arcs will burn without difficulty, though in this case at ordinary current densities the phenomenon is confined to the crater. In high-pressure work the E.M.F. of the arc rises as the pressure of the surrounding atmosphere increases, and at the high pressures used in these researches it was often more than double the normal value; the first few atmospheres, however, produced the greatest effect. Although the maximum length of the arc was so much reduced the voltage was always high.

There were two very distinct types of arc; the most usual being found when a non-oxidising atmosphere was used. A deposit of carbon grew rapidly round the negative electrode, often also completely enclosing the positive end. The arc flame was replaced by a zone of incandescent carbon, and as the electrical conditions were ill-defined, it was only in the early parts of the experiment that concordant measurements could be obtained. As time went on the electrical conditions more nearly approached those of a resistance than of a true arc. Curves are given in the Paper comparing the results obtained with arcs in carbon monoxide at 11 and 16 atmospheres with those obtained by Mrs. Ayrton for an enclosed arc at ordinary pressures.

The increase in voltage due to an increase of 15 atmospheres in pressure was very considerable. An entirely different type was obtained in an oxidising atmosphere, and in this case alone were the results comparable with those of the ordinary open arc. Experiments were also made on an arc about 2 mm. long in air, but under a pressure of about 150 atmospheres. While a fair proportion of oxygen was present the arc showed a bright flame and could be easily maintained. The increase in voltage was again observed to be due to the first 10 or 15 atmospheres. In the course of chemical work when "smothered" arcs were employed, although the pressure used varied from 0·5 to 200 atmospheres, no consistent effect on the voltage could be ascribed to the influence of gas pressure. A noticeable feature in all the experiments carried out in air was the very rapid rate of burning of the electrodes. The burning was principally limited to the positive electrode, especially at higher pressures, while at low current-densities the negative exhibited scarcely any loss in weight. The combustion was generally very rapid, and the available oxygen was quickly exhausted. The carbon dioxide first formed was reduced to the monoxide, flocculent carbon being deposited.

Attempts made to fix the oxygen of the air present by using electrodes of copper, iron and aluminium were unsuccessful, but with iron electrodes and an atmosphere of pure oxygen an appreciable quantity of Fe_3O_4 was obtained.

On the Formation of Calcium Carbide.—The production of calcium carbide, constituting a simple and typical example of electric furnace reactions, was considered a suitable subject for the first series of experiments. To secure uniformity the same type of furnace was used throughout under, as far as possible, the same conditions. The furnace was placed in a vertical position and the bottom covered with powdered retort carbon, which formed the lower electrode. The mixture of lime and carbon were filled in round a paper tube, thus leaving a space free for the introduction of the upper carbon electrode. As the reaction proceeded the pressure, owing to the evolution of carbon monoxide, rose rapidly and the fused carbide collected on the bed of the furnace.

No difficulty was experienced in maintaining these smothered arcs, even at the highest pressures, while currents up to 500 amperes have been employed and maintained as long as desired. The upward rush of gases caused very little displacement of material and the low consumption of the carbon electrodes was very characteristic of these enclosed furnaces. In general practice the loss of weight in the electrodes is an important point, and it is considered to be due to atmospheric oxidation and not to dissociation of the lime as suggested by Gin.

In the reaction

$$CaO + 3C \rightleftarrows CaC_2 + CO,$$

definite equilibrium exists at about 1,600°C., the reaction tending to go from right to left at higher and from left to right at lower temperatures. It would, therefore, appear that if the carbon monoxide were allowed to remain in the furnace the reaction would soon come to a standstill. Experiments, however, proved that the temperature prevailing in the furnace was sufficiently far above the point of equilibrium to prevent the reverse reaction so long as heating was continued. It might also be supposed that at temperatures above 1,600°C. the formation of carbide would be rapidly completed if the gaseous products were removed as formed. The process being endothemic, however, can only proceed at a pace measured by the rate of heat supplied to the furnace.

The authors carried out an exhaustive series of experiments on the effect of the presence of carbon monoxide on the resulting calcium carbide, and are of the opinion that even a concentrated and compressed atmosphere of this gas has no deleterious effect on the resulting product. Further, the total power consumption did not affect the efficiency of the process, while the influence of pressure *per se* did not result in any marked change in either the chemical or physical properties of the product. Such variations in the purity or richness of the carbide, as were noticed, were attributable to the increased thermal losses in high-pressure gas.

On the Fusion of Silica.—Experiments made with a view to obtaining fused silica from quartz sand gave unsuccessful results, the material still containing small gas bubbles. An attempt to remove these by using an atmosphere of compressed hydrogen did not give the desired result, while using a more powerful arc was no more successful.

On the Formation of Carborundum.—As a result of experiments made in the high-pressure electric furnace, there is little

* *Phil. Trans., A.*, Vol. CCV., p. 369.

doubt that carborundum is produced by the interaction of silica vapour and highly heated granular carbon. The reaction did not, however, occur under pressure very readily, and the product obtained was nearly free from amorphous carborundum.

On the Direct Reduction of Alumina by Carbon.—Opinion seems to be divided as to the effect of heating carbon and alumina in the electric furnace, and though the question is of considerable importance it has not been investigated with the care it deserves. Experiments made by the authors at atmospheric pressure showed that a thermal reaction took place, but not until the fusing point of alumina was reached. Further experimental results showed that neither aluminium or its carbide was produced in a resistance furnace, while in the arc furnace there is more or less reduction, the product being chiefly aluminium carbide. In several cases small malleable lumps of metal were condensed in the powdered material surrounding the fused product, and it would thus appear that the required conditions—*i.e.*, the rapid removal of the metal vapour from reduction zone and its condensation under circumstances which precluded carbonisation—had for short periods been accidentally fulfilled. The reaction was considerably favoured by a dilution of the carbon monoxide, and in this case the relative quantity of aluminium metal was increased though still accompanied bp a considerable amount of carbide. Further experiments showed that the temperature of reduction of alumina is above the melting point of aluminium, for when special precautions were taken to protect the material from access of air, and to allow the vapours to cool before their exit from the chamber, the presence of finely divided alumina was unmistakable. To absorb any aluminium vapour formed a bath of molten copper was used, the reaction mixture being placed on its surface. The minimum temperature of reduction was found to coincide fairly with the melting point of alumina, and was not appreciably lowered by the introduction of fluor-spar or lime as a flux.

Although aluminium bronze and ferro-aluminium can be readily produced no process exists by which the metal can be obtained from the oxide. It would seem that the copper or other metal used serves chiefly to condense and dissolve the metal, but does not itself take any part in the primary chemical reduction of the oxide. Results obtained by J. N. Pinet, however, show that aluminium carbide reacts with either the oxide or metal forming an alloy.

Owing to the well-known affinity of aluminium for carbon monoxide it is important to remove this gas as completely as possible. The diluting gas was led in through the hollow electrode, thus not only diluting the monoxide but carrying forward the metallic vapour to a zone more favourable for its condensation. It has, therefore, been proved that the direct reduction of alumina by carbon can be effected, and the minimum temperature necessary for its reduction to occur is sufficiently high for the metal to be produced in the form of vapour. Future work must be directed towards the application of high pressure for reducing the vaporisation of the metal at the temperature of reaction; the rapid removal or dilution of the monoxide by a stream of inert or reducing gas and an arrangement for facilitating the condensation and preventing the collected metal from flowing into the bed of highly-heated carbon.

A CONTINUOUS PHOTOCOPIER.

Engineers generally have been familiar for many years past with the arc lamp copying apparatus for the production of blue and white prints from tracings of original drawings. The suspended arrangement of arc lamp with glass cylinder and pendulum control is useful enough for small work and fills a distinct want in this capacity, but in large engineering establishments where a number of specialised departments will each have its own drawing office, a very considerable quantity of tracings requires to be copied during the course of the day. When it is considered that most engineering work is carried out in centralised establishments divided up into departments in the manner mentioned, it will be readily understood that a demand exists for a machine in which tracings can be copied continuously. Messrs. B. J. Hall & Co., of 39, Victoria-street, London, S.W., who are well known as manufacturers and suppliers of drafting accessories, have recently introduced a new continuous copying machine, which they lately gave us an opportunity of inspecting in operation. A general view of this machine as seen from the back is shown in Fig. 1. It comprises a felt covered drum, A. working in a curved glass plate B, which is illuminated on its outer surface by a group of arc lamps which may be seen at C. The prints are inserted at the point D and discharged again at the point E. The whole of the apparatus is supported in an iron frame including the arc lamp resistances and the controlling switches. A sectional view of the apparatus is shown in Fig. 2. This will serve to bring out in detail the method adopted for the driving of the drum carrying the drawings. In the standard machine a small motor is belted to a countershaft which is fitted with a plain cone pulley attached to another shaft, the drive being transmitted by a short endless leather belt, upon which the two cones press. This belt is provided with a small jockey pulley, by the movement of which the position of the belt can be adjusted, so as to give a variation of the speed of the cones. This second shaft is provided with a three-stepped pulley, from which the drive is transmitted by belt to a similar pulley, attached to a worm shaft

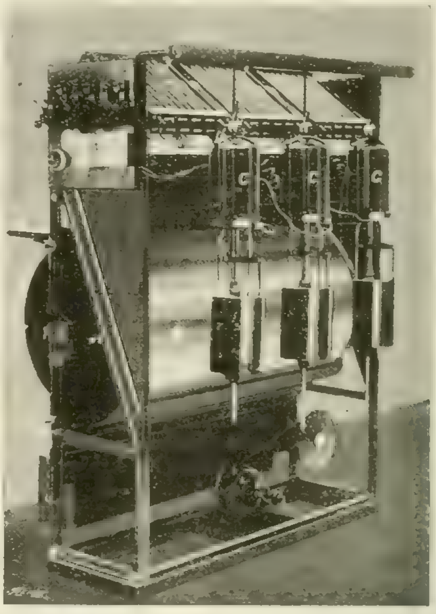


Fig. 1.—View of Photocopier.

driving a secondary spur-wheel. From a pinion on this latter the main revolving drum is driven. A certain variation of the speed of the main drum is possible by the stepped pulleys already referred to, and all finer adjustments are obtained by the movement of the

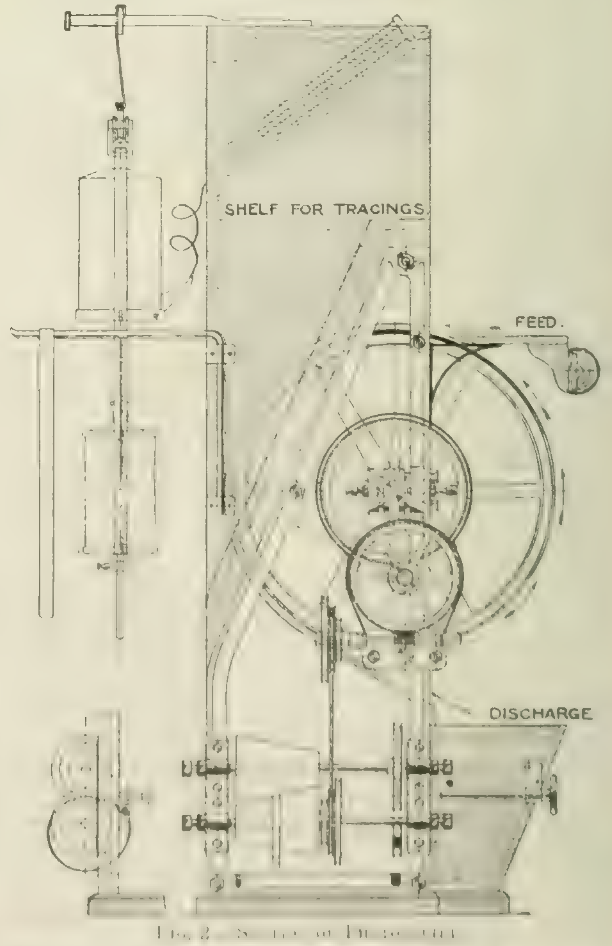


Fig. 2.—Section of Photocopier.

small leather belt between the two driving cones. This method of transmission allows of a range of speed varying from 1 ft. per minute, for rapid paper and tracings with strong outlines, to 3 in. per minute for the finer specimens of work. The speed of the small

driving motor, which will be noticed in Fig. 1, is 1,400 revs. per min., and it has a rating of ½ H.P. Either direct-current or alternating current motors can be used.

The surface of the revolving drum is covered with a layer of felt, and the tracing from which prints are to be made has thus a springy backing, which tends to keep it constantly in contact with the curved glass plate. The pressure of the drum on this plate can be adjusted, but it is always such that creases in the tracings are taken out as they pass into the machine. The illustration in Fig. 2 shows a roll of ferro-prussiate paper attached to the feed board. This is, of course, used when continuous printing is going on, but it is always feasible to cut the paper to suit the requirements of single tracings. It is possible to utilise one set of arc lamps for two copying machines if a large amount of work is required to be done. By the removal of the reflectors and by placing two machines back to back the light can be thrown on to both revolving drums. The makers claim that this copying machine, owing to the friction on the internal surface of the curved paper being greater than that on the external surface, there is constantly a greater frictional difference maintained than in continuous machines, where the tracing is passed round the outer curve, or along the flat surface of a glass plate. Prints, therefore, taken on the drum copier are, by reason of this intimate contact, exceedingly sharp in definition. It is also stated that efficiency in apparatus for photographically copying long plans in one piece without a joint depends on the difference between the coefficients of friction of paper on a polished plate glass and on paper. Usually there is an ample margin, but at times, owing to the texture and finish of the tracing paper or cloth and the photo paper the difference is very slight, and when overbalanced the tracing remains stationary, whilst the paper runs on and the copy is spoiled. We understand that there is no liability of lateral or vertical creeping. The makers state that with rapid ferro prussiate paper cut to the size of each tracing and fed into the machine, 50 prints an hour can be made, a capacity which compares favourably with the average of 30 to 40 prints per hour. It is also claimed that on account of the saving of time in setting the prints into the machine five times as much work can be done as with the vertical pattern copier.

CORRESPONDENCE.

FIRST COST OF ELECTRIC RAILWAYS.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: I have watched in vain for reviewers of "Electrical Traction," by Wilson and Lydall, to query a figure on p. 311, copied from p. 881, Vol. LII., *The Electrician*, March 18, 1904, fixing the cost of a two—200 H.P.—motor equipment for the Underground Electric Railways at £2,920. This was evidently unchecked when copied, because Sir George Gibb, at a meeting of the Metropolitan District Railway, August 16, 1906, gave the cost, *including equipment*, for 198 motor cars and 236 trail cars at £30 per seat, or a total of £677,000.

I can fancy the bodies and trucks might average £1,200, or total £521,000, leaving £156,000 for 198 two-motor equipments, or only £800 per equipment, which is vastly different from Messrs. Wilson and Lydall's figure, £2,920. Perhaps by dealing abroad the average price of body and trucks was £1,000, but this only leaves £1,200 per two-motor equipment.

There is no object in publishing figures that are so inaccurate. Is it not worth the space necessary to point out this discrepancy, since Messrs. Wilson and Lydall have copied it unchecked and omitting the suggestion, *which you included*, that it was only hearsay? Perhaps the £2,920 really included body and trucks and brakes, but, if so, the statement criticised is still wrong and needs correction.—I am, &c.,

London, July 17. CAR BUILDER.

[We understand that the point referred to will be corrected in the next edition.—ED. *E.*]

WEAVING CONCRETE POLES.

The use of concrete poles, particularly for transmission lines, has often been suggested and some systems in Canada have experimented with this form of support for the overhead wires. The poles, however, have been fashioned in a rectangular mould and built up into sections which telescoped into each other. Their cost was lower than that obtaining for steel towers and special A poles made up of wood. On Monday last we were given an opportunity of inspecting a special machine which is being introduced for the manufacture of cylindrical concrete poles in single lengths extending to 40 ft. The machine is the invention of Mr. Hans Siegwart and was shown in operation at the works of Messrs. Cubitt & Co., Gray's Inn-road, London. Difficulties had hitherto been experienced in casting concrete poles sufficiently light both for transport and easy erection. A solid cylindrical pole presents no constructional difficulties, but hitherto the problem has been to produce a satisfactory hollow round pole. With the Siegwart process it is claimed that this problem is solved and in an efficient and commercially economical manner. A taper

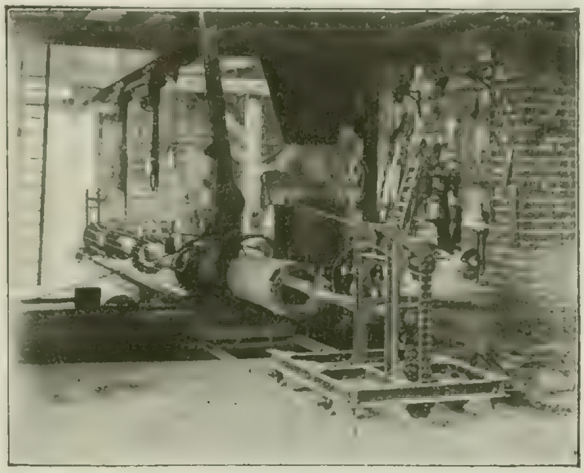


FIG. 1.—VIEW OF CONCRETE POLE MAKING MACHINE, LOOKING TOWARDS DELIVERY END

is given to the pole, and the reinforcement of the concrete by steel rods is reliable and substantial. The machine is also suitable for the production of columns and pipes of any required size and length. In the case of pipes, we understand that the length exceeds that of earthenware or iron some four times, so that joints are reduced considerably.

FIG. 2.—LINE OF CONCRETE POLES FOR THREE-PHASE TRANSMISSION.

The process of manufacture is as follows:—A long sheet iron core is mounted on two trestles, running on rails, so as to be capable of rotation and longitudinal movement. Upon this core small longitudinal steel rods are fixed. The core is drawn through the machine which is stationary. Concrete made of clean screened grit and Portland cement is mixed very dry in a mechanically-driven mixer overhead and discharged through a shoot into a hopper or drum in which rotating paddle wheels regularly discharge the concrete upon a bandage of coarse cloth webbing laid on a conveyor belt that takes one lap round the core. This continuous travelling conveyor belt

is stretched so that the concrete is wrapped round the core under great pressure. As the core issues beyond the conveyor belt steel wire is fed spirally round it so as to press into the concrete wrapping and small rollers then apply great pressure by working on the webbing the slack of which, produced by the reduction in circumference and external diameter resulting from this pressure, is taken up by another device. A general view of the machine is shown in Fig. 1. The core as it issues from the machine is wrapped round spirally with a bandage of cloth containing the concrete. The machine pulls the trestles with the suspended core regulary forward, so that the core passes through it as the concrete is wrapped on, and when the core has passed completely through the machine, it is lifted by an overhead travelling crane and placed on one side for the concrete to harden, this being constantly damped to ensure it gaining the maximum hardness. In about 12 hours the interior sheet-metal core is reduced in diameter by a screw attachment inside and withdrawn from the pole. After hardening for about six days the bandage of webbing is removed, and the pole is then complete ready for erection. Poles are made by the machine up to 39 ft. long, and pipes up to 20 ft. long and 2 ft. in diameter.

Fig. 3. 54 ft. Concrete Pole in course of Erection.

Poles for carrying wires have to sustain stresses induced by the suspended wires and wind pressure. Where poles are required for long-distance transmission, the importance of adequate security is very great, for the execution of repairs over a wide area is troublesome and costly. For such purposes the reinforced concrete pole offers many advantages. The Siegwart poles have been constructed on a proper theoretical basis of calculation with any desired factor of safety, and tests have been conducted upon poles of standard construction which have established a safety factor of 5·5. Large contracts have been placed abroad by municipalities for large numbers of these poles, and the following estimates of the cost of these poles, compared with other poles over a period of 50 years, have been prepared by Messrs. Siegwart (Ltd.).

Tramway Poles, Height [illegible] Ordinary Type.

	Siegwart.		Iron.		Wooden (impregnated)
Price of pole	£3 0 0		£6 10 0	..	£0 14 5
Erection	1 0 0	....	1 0 0	.	0 9 7
Painting or renewal.		.	2 11 0		9 8 4
Total cost in 50 years	4 0 0	..	10 1 0		10 12 4

Poles for Power Distribution, Height [illegible] Ordinary Type.

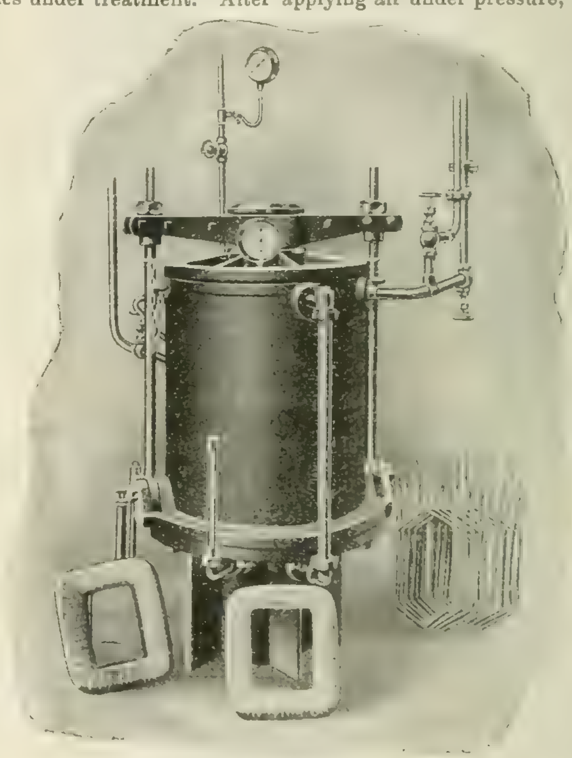
	Siegwart.		Iron.		Wooden (impregnated)
Price of pole	£4 0 0	....	£9 0 0	.....	£0 19 3
Erection	1 1 0	....	2 0 0		0 9 7
Painting or renewal		.	2 11 6		12 5 0
Total cost in 50 years	5 1 0		13 11 6	....	13 13 10

A line of transmission poles erected in the same condition as they left the machine is shown in Fig. 2. The attachments to the pole top for the insulator supports vary in shape and design according to the conditions governing each particular case. Any desired amount of ornamentation may be given to the pole. Fig. 3 shows a long pole being erected in a special ground socket required to give the increased length of pole required, the height from the ground being 54 ft. Some tests on a pole 32 ft. 9 in long showed a deflection of 2·75 in. with a tensile strain of 15,400 lb. When the strain was removed the pole returned to its initial position. The Siegwart process is also applicable to the manufacture of concrete piles.

SAMPSON & BROWN'S DRY INSULATING MACHINE.

This machine, a view of which is given in the accompanying illustration, is designed for treating armatures or coils with insulating varnish.

The process is as follows: The articles to be treated are placed in the cylinder seen in the illustration, and after being heated to the desired temperature are subjected to a high vacuum, thus removing from them all traces of moisture. Insulating varnish is then drawn by the vacuum into the impregnating chamber through a suitable arrangement of pipes and valves, completely flooding the articles under treatment. After applying air under pressure, so as



Sampson & Brown's Dry Insulating Machine.

to force the varnish into every pore of the covering of the armature or field coil, the varnish is drained off and the articles are removed for drying, or better results are said to be obtained by leaving the articles in the machine until they are thoroughly dried, the heat being kept applied for that purpose.

Steam is usually employed for heating the apparatus, but where it is not available electrical heating can be fitted. The apparatus has been placed on the market by Mr. A G. Brown, 23, King-street West, Manchester, and should prove of service to tramway companies for treating and re-insulating their armatures and field coils.

AN ELECTROLYTIC DISINFECTING FLUID.

We have from time to time in the columns of *The Electrician* referred to what is known as the "Hermite" electrolytic disinfecting fluid. Thanks to the efforts of the Medical Officer of Health its use has been largely developed in the Metropolitan Borough of Poplar, where it is prepared by a private plant, and it has also been employed at many other large establishments, among them the Royal Military Hospital at Netley.

In order, however, to bring its virtues more prominently before the public, and to supply them with it, it is of course necessary to establish a plant where this commodity can be manufactured and sold on commercial lines. Its manufacture has, therefore been undertaken by the Thalassol Mfg. Co., of Red Lion street, Clerkenwell, E.C., who are placing it on the market in small quantities, such as will be convenient for private users.

The name adopted for this bleaching solution is "Thalassol," which vaguely suggests its origin: it is made from solutions of

magnesium and sodium chlorides, ingredients that are present in sea water.

Readers of *The Electrician* are probably already familiar with "Thalassol" and its numerous advantages. It will be remembered that it is obtained by the electrolysis, in special cells, of a saturated solution of magnesium and sodium chlorides. Sea water can be, and is in some cases, used; but its employment is not recommended, partly owing to the presence of organic matter and partly owing to the varying strength of the solution so obtained, which makes an alteration in the operating conditions necessary. Economically no advantage is gained by using sea water as the artificial solution is exceedingly cheap to prepare.

The cells in which electrolysis takes place contain electrodes of zinc and platinum, and are arranged in tiers so that the electrolyte can flow over them. In this particular case 40 cells are arranged in series, and the necessary current is supplied from a small motor-generator coupled to the supply company's mains.

Mr. Biggs, in his Paper before the Faraday Society (*The Electrician*, Vol. LVIII., p. 205), described the electrolytic process in detail. Briefly, it consists in the electrolysis of the magnesium chloride solution, the sodium chloride acting simply as a carrier, hydroxide of magnesium and chlorine being the products. It is stated that the latter combines with the oxygen of the water to form oxides of chlorine, which constitute the vehicle for the bleaching action, and not merely hypochlorite. To the solution thus formed is added a special alkali, and is transferred to carboys with repeated stirring.

As a disinfectant "Thalassol" offers numerous advantages. It is non-poisonous, and may, therefore, be contained in quite ordinary bottles. In spite of the fact that it contains chlorine when quiescent, it is nearly odourless and quite pleasant to smell. It gives off chlorine when in action, especially when attacking organic matter. We understand that in certain parts of the country it has become quite a household article, being used for such wide-apart objects as brushing the teeth and washing the floors. It is a great advantage in laundry work and is said to be excellent for removing stains.

We are indebted to Mr. McClelland of the Thalassol Mfg. Co., for showing us round their works and explaining the various features of the plant there installed.

PARLIAMENTARY INTELLIGENCE.

WIRELESS TELEGRAPHY IN THE NAVY.

In the House of Commons on Monday, the First Lord of the Admiralty stated, in reply to a question, that a telegraphist branch had been instituted and was in process of formation. The wireless section would be trained from boys and be advanced to the various grades according to requirements when qualified by service and examination. To meet immediate requirements, a proportion of signal ratings who had been performing wireless duties had been accepted for transfer to the wireless branch, and also a certain number of volunteers from other ratings. The arrangements for their transfer and advancement were given in a circular letter to the Fleet.

Telegraph Construction Bill. This bill passed through the Committee stage in the House of Lords on Tuesday and was reported, after slight amendment.

LEGAL INTELLIGENCE.

Tunbridge Wells Corporation v. Leigh.

At Kent Assizes recently plaintiffs obtained judgment for £27.12s 6d. against Mrs. Gerard Leigh, the cost of replacing an arc light standard which was broken through the negligent driving of defendant's motor vehicle. The standard stood 18 ft. above the ground, and was 3 ft. 8 in. below the ground, embedded in concrete. It broke off about 3 ft. from the ground, where it was 7 in. diameter and 1½ in. thick.

Harrison & Co v. Goodwin.

Recently, at Marylebone (London) County Court, plaintiffs, electrical engineers, sought to recover £6. 14s. 6d., balance of an account for electrical work done.

For plaintiffs it was stated that defendant had asked them for an estimate for fitting up the electric light in a villa in Willesden. An estimate was furnished and the work commenced, and later on defendant asked them to expedite the work. After its execution defendant refused to pay because Willesden Council had declined to supply electric current as their mains had not been brought up to the premises by 80 yds. to 100 yds.

DEFENDANT said the fittings as put up were useless without the supply, and plaintiffs ought not to have gone on with the work till the decision of the local Council had been ascertained.

HIS HONOUR held that plaintiffs had not contracted to do more than put up the fittings, and gave them judgment and costs.

MUNICIPAL, FOREIGN & GENERAL NOTES.

APPOINTMENTS VACANT AND FILLED.

Foreman electrical instrument maker is required, well acquainted with modern requirements and rapid production of work. See advertisement.

Well connected engineers are wanted as district agents for steam plant suitable for electrical work. See an advertisement.

A junior assistant is required for the electrical laboratory in Hadfield's Steel Foundry, Sheffield. See advertisement.

A charge engineer is required for Eastbourne electricity department. Salary £104 per annum. Applications to the Borough Electrical Engineer by Aug. 7.

As stated in our issue for June 19 (p. 386), Mr. J. E. Donoghue has resigned his position as chief assistant electrical engineer to Sydney Municipal Council, and he has been appointed chief engineer to the New Electric Light & Power Supply Corpn., whose power house will be in Balmain, Sydney, N.S.W.

EDUCATIONAL NOTICES.

University of London (University College).—In the faculty of engineering at University College, London, a new lectureship in electrical design has been instituted, and Mr. Henry Metcalf Hobart, M.I.E.E., has been appointed thereto. Mr. R. E. Middleton, M.Inst.C.E., M.I.Mech.E., F.S.I., has been reappointed lecturer in municipal engineering, and the following appointments have been made in civil engineering and surveying: H. Deans, B.A., M.Inst.C.E. (railway engineering); A. T. Walmisley, M.Inst.C.E. (waterways, harbours and docks); W. N. Blair, M.Inst.C.E. (roads, street paving, tramways); M. T. Ormsby, M.Inst.C.E.I. (surveying). Mr. E. Sprague, A.M.Inst.C.E., has been appointed assistant in surveying.

By the assistance of a committee of former engineering students and of other friends of the college, the new laboratories and extensions of the departments of the faculty of engineering which were opened by the chancellor (Lord Rosebery) last March, will be further equipped during the long vacation. The new equipment will include a new boiler in the department of mechanical engineering, a steam turbine and hydraulic apparatus, and equipment for research in metallography and radio-telegraphy. The facilities for advanced and postgraduate students as well as for undergraduate students will thus be considerably increased.

King's College (London).—The session 1908 9 commences on Sept. 30. In addition to the ordinary day courses in the faculty of engineering and applied science, there are evening classes in mechanical and electrical engineering, architecture and building construction, drawing mathematics, physics and other science subjects. There is a large staff of lecturers and demonstrators, and prospectuses, &c., from the secretary, Mr. Walter Smith, Strand, W.C.

University of Birmingham.—The full courses in engineering extend over four years, and students who enter after matriculation and who pass successfully the examination at the end of each year will be entitled to the degree of B.Sc. in the branch of engineering to which they have devoted themselves.

The technical engineering classes include lectures on the strength of materials, theory of steam, gas and other heat engines, hydraulics, machine design, strength of structures and distribution of power. In drawing, the design of tools, prime movers, dynamos and other forms of machinery. The courses in civil engineering include constructional work in masonry and steel, railway work, dams, bridges and water engineering. In the engineering laboratory the work will include the determination of the strength of materials, including compressive, bending, tensile and torsion tests, experimental study of the steam engine and boiler, frictional efficiency tests, flow of water over weirs and through orifices, &c. There are lectures and demonstrations on all branches of electrical engineering, and in the electrical laboratory the work will include the testing of continuous and alternate current machinery, electrical instruments, meters lamps and batteries, insulation and magnetic testing.

The session 1908-9 commences on Oct. 5. Detailed syllabuses, &c., from the secretary.

Armstrong College (Newcastle-on-Tyne).—The session 1908-9 will commence on Sept. 28. There are complete courses of instruction in mechanical, civil, electrical and marine engineering, naval architecture, mining, metallurgy, &c. Particulars from the secretary (Mr. F. H. Pruen).

City and Guilds of London Institute.—At a meeting of the Council on Monday it was resolved to award the diploma of associate of the City and Guilds of London Institute to 91 matriculated third year students of the Central Technical College who have completed a full course of instruction as prescribed by the Council—viz., 58 students in civil and mechanical engineering, 33 in electrical engi-

neering and seven in chemistry. The following are the names of the students in electrical engineering :—

R. E. Neale (Siemens' Memorial medal and premium), G. S. Terry, H. E. Poole, F. G. Barrow, R. A. S. Thwaites, L. B. Gilbert, A. H. Finnis, B. A. M. Cooper, E. J. Barnes, D. W. Dye, E. Bate, S. S. A. Watkins, R. J. Spencer-Phillips, R. T. H. Roche, F. W. Geoghegan, E. Holder, J. D. A. Vincent, A. D. Richardson, H. M. Thompson, T. M. Klein, E. A. G. Harvie, M. C. A. H. Genève, C. Kelly, A. F. Henderson, V. W. Newman and J. de la C. Tapia-Contreras.

In addition to the above, certificates have been awarded to 25 matriculated third year students who have completed a full course of instruction at the Central Technical College and to 62 students who have completed a full course of instruction at the Technical College, Finsbury.

Northampton Polytechnic Institute (London).—The full day courses in the theory and practice of mechanical and electrical engineering will commence on Monday, Oct. 5. Entrance examination on Sept. 30 and Oct. 1. The courses include periods spent in commercial workshops and extend over four years; they also prepare for the degree of B.Sc. in Engineering at the University of London. Three entrance scholarships of the value of £52 each will be offered for competition at the entrance examinations in September. In the technical optics department there are full and part time day courses. Full particulars as to fees, &c., can be obtained at the Institute or on application to the Principal, Dr. R. Mullineux Walmsley.

Technological Scholarships.—The West Riding of Yorks County Council offer four technological scholarships (each of the value of £60 per annum), open to residents within the administrative area of the West Riding of Yorkshire, and available for courses of instruction in connection with textiles, dyeing, engineering (mechanical or electrical), metallurgy or other approved industry. These scholarships are intended for young artisans who already have a suitable amount of mill or workshop experience. The awards will be mainly based on the results obtained at examinations of the Board of Education, and of the City and Guilds of London Institute. Application forms and full particulars may be obtained from the Education Department (technical branch), County Hall, Wakefield.

Argentina.—The "Review of the River Plate" states that Messrs. Ugarte & Segovia have obtained a concession for electricity supply (including 150 street arc lamps) in San Juan city. It is proposed to utilise the falls of the river Estero de Sonda, a little over 9 miles distant, where, it is stated, 1,000 H.P. is available. Siemens-Schuckert plant will be employed, and electrical energy will be transmitted at 10,000 volts from the station to San Juan.

Cordoba Government have received authority to spend $200,000 on electricity works to supply current "when the water in San Roque dam is insufficient to work the power house of the Cordoba Electric Light Co."

Australasia.—The "Australian Mining Standard" states that Perth (W. Australia) Council have decided to give six months' notice of intention to purchase the electricity supply and gas undertakings of the Perth Gas Co.

Hawthorn (Victoria) Council have engaged Mr. W. Corin (at a fee of 100 guineas) to report on the question of electricity supply and electric tramways.

Bulla (Victoria) Shire Council have asked the Government for permission to borrow £5,000 (at 4 per cent. interest and with a 2 per cent. sinking fund) for the erection and equipment of electricity works for Sunbury Township.

Mr. C. H. Merz's report on the question of the conversion of the Melbourne suburban railways to electric traction has been despatched to the Victorian Railway Commissioners.

Brighton.—Provisional arrangements have been made by the Corporation electricity department for the supply of electrical energy to the London, Brighton & South Coast Railway Co., who propose to adopt electric driving at their works.

The company guarantee to take supply of current for five years, and to have supply disconnected between 5.30 and 8 p.m. during Dec. and Jan., so that the demand shall not overlap the peak of the lighting load in those months. There is a fixed charge of £750 a year, plus ·56d. per unit metered, but should the price of coal be above 16s. per ton the company will pay a proportionally increased price for current. The company are fixing motors of some 1,500 H.P., which will run in such a way as to give a load on the electricity works during daytime of 400 H.P. to 500 H.P. The consumption will probably be from 500,000 to 750,000 units a year, yielding a revenue of from £2,000 to £2,500. The cost of laying mains to connect the railway works with the North road sub-station is £3,3[illegible].

In a discussion on the report of the Finance committee last week Councillor Pearce urged the importance of providing "adequate reserve funds" to meet the long periods of the tramway and electricity loans. The subject arose on the following note of the city accountant :—

I take this opportunity of calling attention to the somewhat unusually long periods granted for repayment of the tramways loan of £[illegible]60,000 and the electricity loan of £311,000. In each instance 40 years has been sanctioned, 10 years longer than the maximum period usually allowed by the L.G. Board for the redemption of tramway loans, and 15 years longer than the period usually allowed for electricity loans. The fact that these long periods have been granted renders it the more necessary that every effort should be made to build up adequate reserve funds in connection with the undertakings.

Chelsea.—The wiring of the Town Hall building is to be overhauled at a cost of £100.

Croydon.—At the Council meeting last week the following revised scale of charges for electric current was adopted :—

Lighting flat rate, 4½d. (reduced from 5d.); heating and cooking flat rate, 1½d. (2½d.); public lighting, reduction of £1 per arc lamp per annum; power (with time switch during evening load), 3d. and 1d. (3d. and 1½d.); traction, 2d. per unit for 1,000,000 units per annum and 1½d. after (instead of 2d. per unit whole supply). The estimated loss of revenue by these changes (based on last year's demands) is £4,774.

The new scale is to take effect as from June for traction supply and from September for public and private lighting.

Customs Duties.—The duty on electric tramcars (whether mounted on wheels and axles or not) into Finland is 800 marks each (equal £32), electric motors (whether attached or not) being charged separately at 14·70 marks per 100 kg. (equal 6s. per cwt.).

Edinburgh.—At the City Council meeting on Tuesday Treasurer Harrison moved disapproval of the minutes of July 14 with regard to the electric lighting, because the charge for current had been estimated without leaving sufficient margin for eventualities.

Mr. ARBUTHNOT MURRAY said the rates were approved by a majority of 25 to 11, and were thus laid down by the committee after full consideration and on a very conservative basis.

Treasurer HARRISON said the turnover of the department was estimated at over £131,000, and the free balance, after making provision for reduction in price, at only £3,365. That was much too small a covering, being only 2½ per cent. on the income, and an inadequate protection to the rates from loss on what was essentially a trading concern. Section 52 of this act provided for the application of the revenue to meet working charges, sinking fund and interest, and any contribution to reserve fund, and thereafter it went on to say—"Provided always that if the surplus in any year exceed £5 per centum per annum upon the aggregate capital expenditure on the undertaking, the undertakers shall make such a rateable reduction in the charge for the supply of energy as in their judgment will reduce the surplus to the said maximum rate of profit." They would see that in that clause a margin was contemplated which would amount on their capital not to £3,000, but to £50,000, and it was only when that was reached that consumers had a right to interfere. He held that the ratepayers had the right to insist on a 5 per cent. margin on the turnover being estimated for. On the only occasion on which the committee estimated for a margin as small as shown in the present estimates, the year's working showed a considerable loss. The motion was defeated by 25 to 14.

Electric Traction in the Crimea.—A company has been formed for constructing and working an electric railway in the Southern Crimea.

Electrical Exhibition, Manchester.—The committee have now adjudicated upon the tenders sent in for wiring the exhibition, and the accepted tender is the result of a good many variations in and alterations to the original specification. The successful tenderers are Messrs. J. Lomax Kendal & Co., of Manchester.

Electrically Operated Bascule Bridge.—A bridge, 1,123 ft. in length and with an opening span of 136 ft., has been built across the Walney Channel between Barrow and the Isle of Walney on which latter is situated the model village inhabited by the employés of Vickers, Sons & Maxim. A 25 H.P. electric motor suffices to lift each of the two 440 ton bascules.

Epsom.—Cable extensions, which have been temporarily paid for out of revenue, are to be placed to a suspense account, and the Council have applied for sanction to a loan of £1,500 to meet expenditure on extensions, &c.

France.—The Chamber of Deputies have approved a project for the construction of three electric railways (1) from Auch to Lannemezan, 43 miles in length; (2) from Castelnau-Magnoac to Tarbes, 33 miles; and (3) from Arreau to St. Lary-Vielle-Aure, 7 miles. Power is to be generated at works at Eget, which will obtain water-power from the Oule, the water being stored by means of a dam 6,450 yds. in length and thence conducted by a canal to the Eget Plateau.

Greenwich.—In a report upon Major Cardew's experiment of deodorising sewer gases by means of an ozone generating apparatus suspended in each manhole and supplied with energy from the street mains, the Public Health committee state that although the apparatus might deal with the normal flow of sewer gas they doubt whether it would treat effectively gas coming from sewers at high pressure. Further experiments would be costly and of uncertain advantage, and they had decided that no further expense should be incurred in the matter.

Hendon.—The Council have accepted the offer of Hendon Electric Supply Co. to erect two electric lamps to give a demonstration of public electric lighting.

Ilford.—Sanction has been received to a loan of £27,000 for extensions of the electricity undertaking.

Light Railways.—On Tuesday the Light Railway Commissioners held an inquiry at Sheerness into an application for the construction of the Minster-on-Sea Light Railway. The promoters desired to construct a tramway from Sheerness east to Minster, Sheppey.

Mr. W. Cripps opposed on behalf of the South Eastern & Chatham Railway committee on the ground that there was no need for the tramway, and that it would compete with and attract traffic from the Sheppey Light Railway, which had been opened only a few years, and the traffic on which had not grown sufficiently to give an adequate return for the outlay.

The Commissioners refused the application.

An inquiry was held last week into the application of the Aluminium Corpn. (Ltd.) for an order authorising them to construct a light railway of about 3½ miles in length and for using water from the Afon Dulyn in generating current for working the railway.

The consulting engineers, Messrs. Harper Bros., estimated the cost with the water power works at £65,000. There are, they say, no engineering difficulties, and the local authorities in the district supported the scheme. After hearing evidence, the Commissioners announced that they would grant an order, but it must be an essential part of the order that the line should be completed through to Trefriw.

London County Council.—On Tuesday the following loans for electric lighting were granted: Battersea, £8,558; Shoreditch, £4,365 and £7,000; Stepney, £6,000; and Stoke Newington, £3,148.

Lighting Contract.—It was agreed to accept the offer of the Charing Cross, West End & City Electricity Supply Co. to supply current for lighting Victoria Embankment and Westminster Bridge at 1d. per unit for four years and 0·95d. per unit for the succeeding period of four years.

Electric Power Bills.—The Parliamentary committee presented a long report on the London Electric Supply and Power Bills setting out the present position of the bills, and the committee recommended that no opposition be offered to either of them on second reading in the House of Commons.—Agreed.

Drury Lane Theatre.—The Theatre and Music Halls committee reported on the plans for reconstructing the stage portion of Drury Lane Theatre, and the plans were approved, subject to certain conditions, including the installation of electric lighting, heating and power services in accordance with the Council's regulations.

Meter Testing Department of L.C.C.—The Establishment committee presented a report recommending that as a matter of urgency an estimate of £2,650 for structural alterations, adaptation work and removal of machinery at the Victoria Embankment generating station and for removal thereto of machinery and apparatus of the meter testing department from Cranbourn-street.—Adopted.

Surface Contact System.—The Highways committee submitted a report dealing with the surface contact system experiment in the Mile End-road. It was recommended that the system be discontinued and that the overhead system be installed.—The report was referred back.

New Tramway Proposals.—The Highways committee reported as to the proposals for new tramways which should be laid before Parliament next session. These included lines from Harrow-road to Edgware-road; from Farringdon-road to Charterhouse street; Mare-street, Hackney, to Wick-road; Essex-road to Kingsland-road; Kingsland High-street to Amhurst-road; New North-road to City-road; Battersea Park-road to King's-road; Battersea Bridge to Uxbridge-road; and from York-road to Putney Bridge. The total length of lines is 17 miles odd and the estimated cost £403,430. There were further proposals for reconstructing 12 miles of existing line at a cost of £297,830.

Metal Filament Lamps.—The Fire Brigade committee reported that metallic filament lamps had been experimentally used at the Clerkenwell fire station, with the result that the consumption of current had been considerably reduced and the illumination nearly doubled. The committee recommended that similar lamps be installed at the chief station of the Brigade and at the stations at Shepherd's Bush, Bayswater, Kilburn, West Hampstead, Islington, Scotland Yard and Whitefriars, at an estimated cost of £136.—Approved.

L.C.C. Tramways.—The electric tramway from Plumstead Church to Abbey Wood was inspected by Col. Yorke on Friday. This line will connect up with the Erith and Bexley tramways. There now remains only the L.C.C. horse tramway from Charlton to Woolwich intervening between the London network and the new Plumstead section.

Luton.—The salary of the electrical engineer (Mr. W. H. Cooke) has been increased to £350 per annum.

Maesteg.—The Council have rejected a proposal to erect electricity works at an estimated cost of £15,000. The Maesteg provisional order was obtained in 1903.

Marathon Race.—It is of interest to note in connection with this event that the signal for the start was conveyed by H.R.H the Princess of Wales by means of an electrical device. This was an indicating apparatus fixed in a suitable position behind the competitors, operated by a special push on the table in front of the Princess. Mr. J. S. Huddleston, of Messrs. Siemens Bros. & Co., who was one of the stewards, fitted up this apparatus, which was made at the company's Woolwich works.

Presentation.—On leaving Kettering for Kilmarnock Mr. P. F. Roberts has been presented by the station staff and employés with a toilet outfit and leather case.

Railway Electrification.—Lord Claud Hamilton stated at the meeting of the East London Railway Co. on Tuesday that the six companies who leased and worked the line had obtained a report from Messrs Jones & Firth (electrical engineers to the Metropolitan and Great Eastern Co.s) as to the cost of equipping and working the line by electricity. The report had been referred for consideration to the general managers of the six lines. The subject bristled with difficulties, but the spirit in which the matter had been taken up by the companies was encouraging. The cost of the total equipment of the line, including entrance into Liverpool-street and New Cross stations, coupled with the equipment in connection with the supply of electrical energy was estimated under one scheme at £59,600 and under an alternative scheme at £79,300.

Social Side of Submarine Cabling.—"British cable stations throughout the world have come to be regarded as the social centre of the regions in which they are situated, and the cablists enjoy a well earned reputation for genial hospitality. The majority are smart well-read, sociable fellows, who have travelled extensively, speak two or three languages with enviable fluency, and pride themselves on their skill as raconteurs. They are usually the life and soul of all social and sporting functions organised among the British residents within the radius of their stations. They have introduced cricket into practically every corner of the earth. Very frequently they play a friendly match with the officers of our navy, and this naturally results in the establishment of the most excellent relations between the naval men and the cablists, who are, after all, both vital factors in the maintenance of British prestige, throughout our far-flung Empire. It should be added that the directors of the leading cable companies strongly support the social development of their stations, and neglect nothing that can conduce to the comfort and general welfare of their staffs."—"Standard" Weekly Supplement of Empire. (See also *The Electrician*, for March 27, 1908, p. 930.)

Southampton.—Last week the Electricity committee recommended the Council to obtain Parliamentary powers to undertake free and assisted wiring, hire of electric motors, arc lamps, &c. The matter was deferred for 12 months.

Tonbridge.—An inquiry was recently held into the Council's application for sanction to borrow money for:—

(*a*) 150 kw. steam dynamo, condenser and spare armature (£965), (*b*) steam and water pipes (£303), (*c*) extension to switchboard, &c. (£245), (*d*) foundations and brickwork (£80), (*e*) tools at works (£30), (*f*) Lancashire boiler (£540), (*g*) extension to economiser and alteration to brickwork (£120), (*h*) steam and feed piping (£70), (*i*) contingencies (£340), (*j*) expenditure on mains, meters, &c., to March 31, 1908 (£612. 9s. 2d.), (*k*) future extensions of mains and other capital expenditure (£887. 10s. 9½d.)—a total of £4,200.

The electrical engineer (Mr. P. Plunkett) gave evidence of the progress of the undertaking, and there was some opposition by ratepayers, including the local gas company.

Walthamstow.—Application has been made for sanction to borrow £1,299 for mains extensions and house services.

A reciprocal arrangement has been made with Leyton Council to supply current at 1⅜d. per unit for the tramways in the event of a breakdown, and Leyton will supply current to Walthamstow, if necessary, at the same price.

Watford.—The electrical engineer (Mr. F. W. Purse) has been instructed to report on the extensions of plant necessary to meet the load for the winter of 1909-1910. Mr. Purse has also been authorised to make experiments in street lighting with metallic filament lamps.

Application has been made to the L.G. Board for permission to borrow £1,575 for providing surface condenser, with pumps, piping, superheaters, &c.

West Ham.—An inquiry was held last week into the application of the Corporation for sanction to borrow £51,600 for extensions of the electricity undertaking.

Mr. E. Morten, who appeared for the Corporation, said the electricity undertaking was a rapidly developing one. Since the application had been made the account for the expenditure had been made up for a further period of six months, and the result was that the application would probably be reduced by about £4,709.

The Inspector (Mr. H. Ross Hooper) asked a number of questions as to the financial aspect of the undertaking, and it appeared that the capital expenditure had been £453,083, and the amount sanctioned up to March 31 last was £364,769. The Inspector pointed out that, in respect of the last sanction for £54,617, they had over-expended £15,612, and on the present application they had already expended £8,612.

Proceeding to deal with the details which went to make up the sum applied for, it was stated by the borough electrical engineer (Mr. A. H. Seabrook) that £51,500 was applied for on April 15 last. They had sanctions amounting to £64,317, made up of seven separate items, one

of which was for an excess on the Abbey Mills station of £1,442, and the other to meet an excess on the Canning Town station of £5,287. The first item in the application was a sanctioned expenditure of £17,076 for additional plant, and that had been exceeded by £951. 10s. 8d. The next sanction was for an extension at the Silvertown works, and that had been exceeded because there was a large rise in the price of copper, which seriously affected the laying of special cables for the special route. The sanction for expenditure on the Silvertown mains was £17,212, but the actual expenditure came to £25,784. 13s. 6d., as they had to do a great deal more work than was anticipated.

The Inspector: So that, though you applied for an ordinary loan of £14,300 for three years, in two years you have spent £21,566. 18s. 10d. for mains extension and service?—Yes. For the transformers at Silvertown the amount sanctioned was £9,915, but the expenditure came to £10,750.

The Inspector said that there were therefore four separate items on which there were excesses of expenditure, the total of which was £13,566. 11s. 5d. In one case £3,000 was sanctioned for meters, and the expenditure up to March 31 last was £1,318. 7s. 11d. The actual excess on the Silvertown transformers was £721. 8s. 5d.

On the boiler house accounts the Inspector remarked that there were several small amounts charged to capital which he thought should be charged to revenue account.

Mr. Seabrook said it was found more convenient to pay for repairs out of revenue and small new sundries out of capital.

The Inspector: I think these small sundries should be paid out of revenue.

Mr. Seabrook said the plan they had adopted had been found to work very satisfactorily. For switchgear the sanction amounted to £1,685, but the expenditure was £2,351. 11s., the excess being accounted for by increased cost of cable connections. There was also an excess of £865. 12s. 11d. over a sanction of £1,640 in connection with some trunk mains at Silvertown, as a third supply feeder had to be laid. On jointing the cables the sanction was for £500, but the expenditure was £1,421, while on the sanctions for laying the cables there was an excess of £2,743, due to the fact that a sewer that had been closed up for 21 years had to be opened, and the expense of that work was very heavy.

A discussion arose as to whether a certain item should be charged to capital, and

Mr. Seabrook asked if the Inspector was fully cognisant of the capital expenditure in other places. If their figures were worked out it would be found that there were only two places in the country which had a lower capital expenditure than West Ham.

The Inspector said the results must be looked at. There had been an enormous increase in the number of units sold, but revenue had not risen in proportion. The question was whether certain charges should have been met out of capital or revenue.

Mr. Seabrook said he thought these charges should have been met out of capital. During the last two years the Corporation had spent £80,000 on the undertaking, and in giving a supply of electricity throughout the whole district. Items were made capital charges when the things were being put in and the works carried out, but as soon as they were in working order they came under revenue. The work at first was largely unremunerative.

The Inspector said the increase had been 5,000,000 units, but revenue had not increased as was expected. Therefore, the point was whether those things were properly chargeable to capital.

In reply to Mr. Robb (who opposed on behalf of the India Rubber Co.), Mr. Seabrook said that he could not say what proportion would be charged in the accounts for labour, as it was direct labour supplied by the Corporation.

Mr. Robb said the estimate for labour was £3,041. His argument was that the estimate had been prepared by the engineer for £2,441, and when it was carried out by direct labour the result was an excess of £274. He suggested that a very large proportion of it was due to having had direct labour employed on the work.

Mr. Seabrook said he could not accept that. £14,300 had been sanctioned for general expenses, but the excess was £7,000.

The Inspector said that, though the grant was for three years, £21,000 had been spent in two years.

Mr. Seabrook said it had been incurred in a few months.

The Inspector proceeded to deal in detail with various accounts for laying mains, &c.

In reply to a question Mr. Seabrook said that the loss of £4,600 on last year's working was largely due to increase in capital expenditure and giving a double supply of current to the whole of the manufacturing districts of the borough. A loss of £4,600 might look very unfortunate to an ordinary individual, but he knew the possibilities of the district thoroughly and had not the slightest anxiety as to the future.

Mr. Robb asked questions as to rates paid for current by various consumers, and referred to contracts entered into with five large firms in the borough.

Mr. Seabrook said he was prepared to give the general terms of the contract, but he could not put in the actual contracts.

Mr. Robb said he would ask that they be put in. He proposed to show that these contracts were absolutely unremunerative and that the loss was due, not to capital charges, but to cut-throat competition.

After discussion, the Inspector said he thought it right to put in the tariff charges. It was maintained that the purpose of that future capital expenditure would be to increase the revenue of the undertaking.

Mr. Robb said every burgess was entitled to know what the Corporation were charging for current. It was one of the penalties of municipal trading that they had to "lay their cards on the table." The L.G. Board were asked to sanction a large capital outlay, which admittedly was required for those large consumers, and yet he and those he represented were not to know whether or not the terms were remunerative. He would prove that the rates were not remunerative.

The Inspector: I think we must know what the tariff is, although it is unnecessary to mention who the consumer is. We want to know the prices which are charged for current. This was a public inquiry, and the tariff must either be given or the Corporation state clearly that they refused to give it. He doubted if the Corporation had the power to make private contracts and withhold the terms from ratepayers. Having regard to the fact that over £25,000 had been charged to the rates, and, moreover, that there was no reserve, he thought it was desirable that they should know exactly what was being charged for current. He must leave it to the Corporation to decide whether or not they would withhold the prices.

Mr. Morten said that was different from their producing contracts.

Mr. Robb said they ought to know the terms of each contract.

Mr. Morten: That is what I object to. Various circumstances decide these terms. They had excellent reasons for refusing the information which was now sought. Mr. Robb was certainly coached by someone intimately connected with a power company. Because they sought for that loan of £50,000, they were asked to give every detail of their undertaking, not merely to ratepayers, but to officials of power companies.

Mr. Robb: The statement as to a power company or power companies is absolutely incorrect.

The Inspector said he did not think it was right to ask him to recommend a further loan of £50,000 unless he knew the prices to be charged. He had asked for the tariff, and he expected it to be given.

Mr. Morten said he had no doubt Mr. Seabrook would answer any questions put to him with regard to the tariff charges.

Mr. Robb asked what was the charge made to a particular firm.

Mr. Seabrook said he did not think he ought to reply. Those people did not want their private business publicly discussed.

Mr. Morten: Mr. Seabrook would not be justified in giving information on the point unless he had the instructions of his committee.

The Inspector: Then we have come to a deadlock. If I am not allowed to know what prices are charged, I do not think we can get on much further. So long as this is a public inquiry, I must conform to the terms of the notice, and, if any questions are asked about prices, I do not feel that they are out of order.

Mr. Morten: It is the question of producing the contracts.

After further discussion, the inquiry was adjourned sine die.

Wigan. An inquiry was held on Wednesday into the Council's application for sanction to borrow £22,000 for extensions of the electricity undertaking. The inspector (Mr. H. Ross Hooper) adjourned the inquiry to enable further particulars to be prepared.

Woolwich.—Messrs. E. Allam & Co. have resigned their appointment of official wiring contractors to the Council for Plumstead and Woolwich.

The borough electrical engineer (Mr. G. W. Keats) has been instructed to obtain three or more quotations from suitable wiring contractors when applications are received for hire purchase of installations costing over £5 each. Emergency work, the cost of which is less than £5, is to be executed by the Council's staff. Subject to the conversion of 13 lamps en route from gas to electricity, distribution mains are to be extended, and a feeder is to be laid at a cost not over £2,000.

In order to meet an application for current for power Mr. Keats has been instructed to carry out an extension of mains costing £1,820.

ELECTRICITY SUPPLY AND TRAMWAY ACCOUNTS.

Bristol.—The accounts of the electricity department (submitted to and adopted by the Council on Tuesday) show receipts £79,887 and expenditure £36,761.

The gross profit was £43,126, and after paying dividends on stock, interest on loans, &c., the net profit was £474, which with £8,657 from last account, made £9,131, out of which £2,150 has been carried to credit of capital account for wages of men engaged on works chargeable to capital and £6,981 carried forward. Total capital expenditure is £769,410. There are 409,421 equivalent 30 watt lamps connected (against 365,552 in previous year). 3,088,005 units were supplied for private lighting, 3,718,296 for power, and 843,773 for public lighting, an aggregate increase of 1,231,928.

The report of the city electrical engineer (Mr. H. Faraday Proctor) stated that the installation of the two 5,000 kw. turbo-generators has not yet been completed by the manufacturers, and this has affected the working of the department throughout the year. The machines were set to work on July 16. No main extensions of any magnitude have been carried out, excepting in connection with the completion of the laying of e.h.t. cables to sub-stations at St. George, and the commencement of the laying of e.h.t. trunk mains from the Avonbank electricity works to Avonmouth. The units sold for power have increased more than 40 per cent. Additional plant has been added to the two motor generator stations at Temple Back and Underfall yard, Cumberland Basin, another 500 kw. converter having been placed in the former, and a 500 kw. in the latter. A 300 kw. set has also been placed in the Avonbank generating station. Four static sub-stations

have been constructed during the year and are supplied with three-phase current at extra high pressure. One transformer kiosk has been added to the system at Cotham Park. A considerable improvement has been effected in public lighting by the substitution of 116 yellow flame arc lamps for a corresponding number of ordinary open type arcs in the more important thoroughfares. Continued progress is being made in the production of metallic filament incandescent lamps. The extended use of these lamps has operated very much in favour of the consumer during the past 12 months, and as a natural consequence they have reduced the increase of units sold for and the revenue derived from lighting. This check will only be temporary. There has been a very large increase in the connection of motors to the system, the total horse power supplied to date being over 7,000, of which 1,300 H.P. has been added during the year, whilst the units for power have increased nearly 50 per cent. During the year showrooms have been opened and systematic canvassing is being commenced. A stock of fittings and heating and cooking apparatus is kept although no sales are effected - the intention being to utilise the premises solely for gratuitous information regarding the uses of electricity. There is practically no decrease in the total costs, although there is a substantial reduction in the different items, excepting coal.

Burnley.—The accounts of the electricity department for the year ended March show capital expenditure £94,761, increase £1,922.

Revenue was £22,390, expenditure £10,436. Gross profit was £11,954 (against £10,983 in previous year); interest required £2,501 (£2,479) and sinking fund £3,198 (£3,120). The net profit was £6,254 (£5,384). Works costs were 0·562d. (0·595d.) per unit sold, total working expenses 0·729d. (0·836d.). 745 (657) consumers are connected and total connections are equal to 58,827 (51,759) 8 c.p. lamps. 165 (142) motors of an aggregate of 527½ (411½) H.P. are connected. Maximum load was 1,661 kw. (1,592 kw.) and load factor 23·61 (21·19). 3,434,979 (2,954,608) units were sold.

Chester.—The accounts of the electricity department for the year ended March last show capital expenditure £117,185, increase £2,002.

Revenue was £17,591, expenditure £8 941, gross profit was £8,650. Interest and sinking fund required £7,219 and reserve £853, £380 was appropriated for renewals, leaving £316 to carry forward. 1,983,762 units were generated, 438,996 supplied to public lamps, 333,435 to tramways and 871,033 to private consumers, total sales being 1,643,464 (against 1,543,676 in previous year). There are 1,040 (980) consumers with 68,130 (64,652) equivalent 8 c.p. lamps connected. The maximum load was 41,000 kw. (34,375 kw.). Coal costs were 0·390d. (0·313d.), works costs 0·718d. (0·717d.), and total costs (apart from capital charges) 1·062d. (1·092d.) per unit.

Ealing.—At March 31 the capital expenditure of the electricity department was £192,987, increase £2,628.

Revenue was £26,947 (against £26,056 in 1906-7), expenses were £12,719 (£12,652), gross profit was £14,228 (£13,403). Capital charges were £12 215 (£11,635), and net profit £2.013 (£1,768). There are 3,620 (3,271) consumers and 122,418 (111,691) equivalent 8 c.p. lamps connected. The maximum supply demanded was 1,211 kw. (1,159 kw.). 1,527,893 (1,487,221) units were sold.

The report of the borough electrical engineer and manager (Mr. J. Douglas Knight) states that working costs have been again lowered notwithstanding increased cost of fuel, increased competition and the introduction of metallic filament lamps. Slot meter collections showed an increase of £100. Although the output of current was considerably more than twice that of 1901-2 the cost of coal was £22 less. 8·85 lb. of coal was used per unit sold (against 9·7 lb. in previous year). Working and general expenses were 1·930d. (1·993d.), or 3·849d. (3·87d.) including capital charges.

Harrogate.—The electricity department accounts for the year ended March last show capital expenditure £121,282, increase £1,180.

Revenue was £17,610, expenditure £8,835. Interest, sinking fund and instalments of loans amounted to £7,546, £250 has been placed to reserve and £1,297 applied to relief of rates. 1,652,658 units were generated. The maximum demand was 910 kw.

Llandudno.—A net profit of £1,480 has been earned by the electricity undertaking in the year ended March last. The maximum demand rates for current are to be reduced from 7d. and 2½d. to 7d. and 2d., the flat rate from 5½d. to 5d., and the rate for consumers of 1,500 units and over from 4¼d. to 4d. per unit.

London County Council Tramways Accounts.—At the meeting of the London County Council on Tuesday the Highways committee presented the accounts of the tramways department for the year ended March 31.

On March 31 the total length of the tramways system was 119¾ street miles—68¼ miles electric and 51¾ miles horse lines. The whole of the system is worked by the Council with the exception of a short length of ⅞ mile (double line) in Archway-road, Highgate, worked by the Metropolitan Electric Tramways. Capital expenditure amounted to £8,414,590. 15s. 11d., of which £1,468,280. 4s. 11d. represents expenditure during 1907-8. The total debt repaid amounted to £819,376. 18s. 11d. out of revenue, and £264,515. 18s. 2d. from the proceeds of sales of horses, old materials, &c. The outstanding debt was £7,330,697. 18s. 10d., or deducting £68,558 for value of surplus land, £7,262,139. 18s. 10d. The Council decided in June to repay the debt (estimated at £961,954) on the capital which will have become obsolete at March 31, 1914, owing to the electrification of horse tramways, within 15 years from that date. The amount of obsolete capital at March 31 was £978,843. 14s. 11d. Deducting the debt in respect of such capital repaid out of revenue—viz., £203,243. 2s. 4d.—the outstanding debt is £775,600. 12s. 7d.

The total receipts and working expenses were as follows :—

	Electric traction.	Horse traction.	Total.
Total receipts	£1,274,660 5 7 ...	£388,371 10 8 ...	£1,663,031 16 3
Working exp.	724,381 10 0 ...	445,734 2 2 ...	1,170,115 12 2
Surplus	£550,278 15 7 ...	*£57,362 11 6**	£492,916 4 1

After deducting the interest (£233,820. 12s. 1d.) and repayment of capital (£216,203. 11s. 2d.), income tax (after crediting £11,691. 0s. 7d. for tax retained from interest on debt (£3,308. 19s. 5d.), parliamentary expenses, &c., and net interest on cash balances, &c. (£8,692. 8s. 7d.), there was a net balance of £45,406. 3s. 8d. This amount, together with balance from 1906-7 (£5,923. 1s. 11d.) has been carried to renewals.

The Council decided in June that provision should be made for renewals at the rate of ⅝d. for each car mile on the total car mileage run on the electric tramways each year, and that the question of the adequacy or otherwise of that provision should be again considered at the expiration of five years. Provision for 1907-8 on this basis would require £71,086, and similar provision in each year of electrical working would, with accumulations, have amounted at March 31, 1908, to £196,741 (£200,733, less expenditure £3,992). The Council also decided in June that a general reserve fund (to provide for general contingencies) should be established, and that to form the nucleus of this fund £34,634 (the amount of £30,772, total of renewals reserve fund on April 1, 1904, in respect of the horse system, with interest accumulated to March 31, 1908) should be transferred to the fund. The accounts give effect to these decisions of the Council. The total standing at credit of renewals reserve fund at March 31, 1908, was £193,256. Deducting the amount now transferred to general reserve (£34,634) the balance of the renewals fund is £158,622.

The total operating expenses for electric traction were £724,381. 10s., or 6·79d. per car-mile run, compared with 7·06d. per car-mile in 1906-7. For horse traction £445,734. 2s. 2d., or 10·73d. per car-mile run. On April 1, 1907, the system included about 58 miles of electric tramways, and during the year 10 miles further were opened, total 68 miles. The total number of passengers carried and the car-miles run during the year were

	Electric traction.	Horse traction.	Total.
No. of passengers	279,166,461 ...	93,349,293 ...	372,515,754
No. of car miles run ...	25,591,028 ...	9,970,161 ...	35,561,189

The total number of units generated during the year at Greenwich was 51,805,633, and the cost of generation amounted to 0·570d. per unit, including interest and sinking fund charges, compared with 0·676d. per unit in 1906-7.

Marylebone (London).—At the end of the second complete year's working of the municipal electricity undertaking the capital expended was £2,008,108, an increase of £42,503 during 1907-8.

Deducting amount repaid, the net liability was £1,955,218. The revenue from private consumers was £151,778 and the total net income was £161,492 (against £158,459). Total working expenses were £57,659. There was an increase in the number of units sold of 629,175. After providing for interest and repayment of loans there was a deficit on the year's working of £3,136.

The auditors (Messrs. Price, Waterhouse & Co.), in their report, state that, for the purpose of ascertaining the result of the year's working, they are of opinion that the repayments of principal should be disregarded, and if the balance were struck before charging these instalments there would be a profit on the year of £25,179.

* Deficit.

Oldham.—At March 31 the capital expenditure of the electricity department was £284,432, increase £3,353.

Revenue was £39,767 (against £35,793 in previous year), working expenses £20,177 (£18,109), leaving a gross profit of £19,590 (£17,634). Interest and sinking fund required £17,866 (£16,225), so that the net profit was £1,724 (£1,459). 5,842,332 (5,052,268) units were generated, 983,874 (928,978) supplied to private consumers for lighting and 376,813 (176,753) for power, 21,961 (22,185) for public lighting, and 3,888,404 (3,453,038) for traction. The maximum load was 2,849 kw. (2,743 kw.), the load factor 21·06 (19·03), and the average price obtained for private lighting 3·16d. (3·27d.), power 1·23d. (1·38d.), public lighting 2·49d. (2·44d.) and traction 1·50d. (1·50d.). There are 932 (858) consumers with 117,183 (93,659) equivalent 8 c.p. lamps connected.

Southampton The tramway accounts for the year ended March show capital expenditure £200,678 (increase £496).

Total receipts were £54,628 (against £51,004 in previous year). Total expenses were £35,358 (£36,657), gross profit was £19,270 (£14,347) Interest and income tax required £6,181 (£6,434), sinking fund charges £5,345 (£5,192). Other expenditure brings the balance to £7,564 (£2,535), and this has been transferred to depreciation and renewals fund, 1,157,451 (against 1,143,085) passengers were carried and 10,121,887 (9,437,336) car-miles run; 1·25d. (1·25d.) was the average fare per passenger, 11·35d. (10·71d.) the average total receipts per car-mile, 7·33d. (7·70d.) the average working expenses and 4d. (3·01d.) the gross profit.

Yarmouth -The electricity accounts to March 31 show capital expenditure £97,126, increase £3,156.

Revenue was £19,523 (against £18,066 in 1906-7), expenses £12,374 (£10,190). Interest, sinking fund and income tax required £6,412 (£6,080) and discounts, rebate and bad debts £751 (£677), leaving a deficiency of £14 (against £1,054 profit). 1,513,937 (1,348,088) units were sold, and the total maximum demand was 1,113 kw. (1,046 kw.)

TRADE NOTES AND NOTICES.

TENDERS INVITED.

The *Metropolitan Asylums Board* invite tenders for the installation of electric storage battery, motor-driven booster and switchboard and connections on the training ship "Exmouth," Grays, Essex, in accordance with drawings and specifications prepared by the engineer in chief of the Board (Mr. W. J. Hatch, M.Inst.C.E., M.I.M.E.). Forms of tender from the offices of the Board, Embankment, E.C., after Aug. 5. Tenders to the offices by 10 a.m. Sept. 1. See also an advertisement.

Rawtenstall Corporation invite tenders for supply and delivery of 16 tramcars, and also for station lighting, wiring to motors, supply of testing instruments, &c. Copies of general conditions, specifications, &c., may be seen at the offices of the consulting engineers (Messrs. Lacey, Sillar & Leigh), 2, Queen Anne's gate, Westminster, and 78, King street, Manchester, and obtainable from the former offices only. Tenders to the town clerk (Mr. Jas. Whalley), Municipal Offices, Rawtenstall, by Aug. 15. See also an advertisement.

Manchester Electricity committee want tenders by 10 a.m. Aug. 12 for supply of a storage battery for Stuart street generating station. Specifications, &c., from Mr. F. E. Hughes.

Edmonton Guardians want tenders by 9 a.m. Aug. 26 for electric lighting at the nurse's home, Upper Edmonton. Specifications, &c., from Messrs. May & Hawes.

By command of the *Postmaster-General* tenders will be received until noon Sept. 7 for supply of telegraph poles of (*a*) home-grown larch or fir and (*b*) Swedish, Norwegian, Finland or Russian red fir, delivered at one or more ports in the United Kingdom as directed. Forms of tender from the Controller of Stores (Mr. G. Morgan), 17 19, Bedford street, London, W.C.

Auckland (*N.Z.*) Harbour Board want tenders for supply of 16 electric cranes. Specifications from Messrs. A. & W. McArthur, 18 and 19, Silk-street, London, E.C., to whom tenders by Oct. 1.

TENDERS RECEIVED AND ACCEPTED.

London County Council received the following tenders for reconstructing on the conduit system the existing tramways (about 5½ miles of single line) from Euston-road to Holloway-road.

	£	s.	d.
W. Manders (*accepted*)	£59,761	6	5
R. W. Blackwell & Co.	63,114	5	3
J. G. White & Co.	62,144	14	7
John Mowlem & Co.	61,471	0	0
Dick, Kerr & Co.	61,272	13	10
R. C. Brebner & Co.	58,485	15	2

Mr. Manders is allowed to sublet to Hall & Co. or the Associated Cement Manufacturers the cement; to the Anderston Foundry Co. the cast-iron work; to Hadfield's Steel Foundry Co. the plough hatches, &c.; to Callender's Co. the jumper cable; to the Lahmeyer Electrical Co. or the Forest City Electric Co. the bonds; to A. C. W. Hobman & Co. the tar paving; to Bayliss, Jones & Bayliss the tie bars, bolts, &c.; and Improved Wood Pavement Co. the wood paving.

For the roadwork and platelaying (exclusive of supply of rails and special track work) for reconstructing on the overhead system the Loughborough Junction–Norwood tramways, for constructing the Hammersmith–Putney lines and for paving work, &c., the following tenders were received by London County Council:

	£	s.	d.
G. Wimpey & Co. (*accepted for part*)	£48,309	1	3
W. Manders (*accepted for part*)	48,381	6	10
J. A. Ewart	60,834	14	11
R. W. Blackwell & Co.	52,240	4	1
John Mowlem & Co.	51,690	0	0
J. G. White & Co.	51,623	15	8
Reid Bros.	51,020	3	2
Fry Bros.	50,104	11	10
Dick, Kerr & Co.	49,572	10	7

The chief engineer's estimates were £48,239. 2s. 6d. for tramway works and £2,757. 5s. 3d. for paving, total £50,996. 7s. 9d. The amounts of the contracts proposed to be entered into with G. Wimpey & Co. and Mr. Manders are £19,728. 12s. 2d. and £28,324. 14s. 10d. respectively. The recommendation was adopted, and Messrs. Wimpey are allowed to sublet to Bayliss, Jones & Bayliss the tie bars and to J. & B. Lee & Sons the deal wood blocks. Mr. W. Manders is allowed to sublet to the Lahmeyer Electrical Co. or the Forest City Electric Co. the bonds; to Hall & Co. or the Associated Portland Cement Manufacturers the cement; to Bayliss, Jones & Bayliss the tie bars, bolts, &c.; to the Improved Wood Pavement Co. the wood paving; to Hadfield's Steel Foundry Co. the drain boxes; to A. C. W. Hobman & Co. tar paving; and to the Limmer Asphalte Co. the asphalte.

For the supply of two turntables and covers at the central car repair department London County Council received the following tenders:

W. G. Bagnall (Ltd.) (*accep.*)	£250	Isca Foundry Co	£420
Cowans, Sheldon & Co.	720	Bolling & Lowe	350

For supply of laminated leather belting for use at the central car repair depot of London County Council the following tenders were submitted:

James Hendry (*accep.*)	£308	6	8	Geo. Angus & Co.	£355	11	5
Buck & Hickman	342	16	10	R. H. Haylock	332	1	8
S. E. Norris & Co.	339	10	0				

For supply of rolled steel for magnetic brake shoes for L.C.C. tramways the following tenders were received:

Lilleshall Co. (*accepted*)	£980	Frodingham Iron & Steel Co.	£1,050
Cammell, Laird & Co.	1,295	Earl Dudley's Round Oak Works	1,033
Henry Bessemer & Co.	1,260		

For wiring Chelsea and Kentish Town fire stations London County Council received the following tenders:

Chelsea Station

Comyn Ching & Co. (*accep.*)	£108	0	J. Bryden & Sons	£116	0
G. N. Haden & Sons	145	0	W. J. Fryer & Co.	112	0
Nursey & Mair	116	6			

Kentish Town Station.

G. E. Taylor & Co (*accep.*)	£153	15	6	W. J. Fryer & Co.	£175	0	0
H. J. Cash & Co.	215	0	0	Tredegar & Co.	160	0	0
W. G. Cannon & Sons	181	0	0				

The chief engineer's estimate of the cost of the work at Chelsea was £110 and at the Kentish Town station £204

London County Council have accepted the tender of Wm. Griffiths & Co. for 1,500 tons Guernsey granite setts in connection with the tramways at £2,343. 15s.

Woolwich Council has accepted the tender of Siemens Bros. Dynamo Works in substitution for that of the British Thomson-Houston Co. for supply of a motor-alternator.

The Electricity committee reported that the B.T.-H. Co. declined to conform to the Council's standing order requiring them "during the continuance of the contract to display upon the site of the works, and in every factory, workshop or place occupied or used by them in or about the execution of the contract, in a position in which the same could be easily read by workmen, a copy of the rates of wages and hours of labour to be observed in carrying out work for the Council." The committee therefore, approached three other firms whose guaranteed efficiencies of the alternator were appreciably near to that of the B.T. H. Co., and Siemens Bros.' Dynamo Works were prepared to agree to all the conditions of contract and to the borough electrical engineer's specification without qualification, and if allowed to increase the amount of their tender from £775. 5s. to £799. 5s. were prepared to guarantee an increased efficiency as follows: Full, 83; ¾, 81·5; ½, 77·5; ¼, 62. (guaranteed efficieney in original tender—Full, 81; ¾, 75·6; ½, 68·6; ¼, 51·6). The offer of increased efficiency and the consequently amended tender has been accepted. The amount of the tender of the British Thomson-Houston Co. was £784. 10s.

Middlesex County Council have received the following tenders for constructing 9 miles of tramway from Finchley-road, Hendon, to the Great North-road, Finchley, and from Edgware-road to Finchley-road, Hendon:—

Dick, Kerr & Co. (*accepted*)	£116,978	12	0	Thomas Adams ...	£120,095	3	7
A. Fasey & Son ...	127,978	17	1	G. Wimpey & Co.	119,991	0	0
				Clift Ford	116,978	12	0

County Engineer's estimate, £121,346. 18s. 9d.

For constructing the line from Green Lanes, Southgate, to Enfield the following tenders were received:—

Geo. Wimpey & Co. (*accepted*)	£40,220	0	0	Law & Co.	£41,405	7	2
C. Wall (Ltd.)	45,027	0	0	Holloway & Co. ...	40,917	15	3
A. Fasey & Son ...	43,820	16	4	Clift Ford	40,643	7	11
Thomas Adams ...	41,709	11	6	Dick, Kerr & Co....	40,643	7	11
				J. Mowlem & Co....	40,342	0	0

County Engineer's estimate, £41,349. 10s.

Fulham Electricity and Lighting committee has accepted the following quotations for a crane and grab and electric motor for clearing the river sump at the electricity works, at a total cost of £178 (including £20 for foundations, &c.): Lewis & Lewis, crane, £64; Priestman, grab, £59; British Thomson-Houston Co., electric motor, £35. For the crane and grab eight firms sent in tenders.

Southend Council have accepted the following tenders:—

Measures Bros., rolled steel joists for condenser tank, £7. 12s. 6d. per ton; H. Gielgud (Soc. anon. des Acièries d'Angleur), 22 tons rails, £6. 2s. 6d. per ton; Herbert Morris & Bastert, crane and gantry, £28. 9s. 9d.; Glenfield & Kennedy, valve for condenser, £28.

Walthamstow Council have placed an order with Babcock & Wilcox for supply of coal elevator and distributing chutes. The tender of A. Blackmore & Co. for 12 months' supply of anthracite washed peas at 21s. per ton has also been accepted.

Gillingham (Kent) Education committee have accepted the tender of the Medway Motor Engineering Co. (at £322) for wiring the four schools in the Borough. 30 tenders were received, the highest being £878.

Wakefield Corporation have placed (per J. & J. Horsfield) an order with Ed. Bennis & Co. for two stokers and self-cleaning compressed air furnaces for a 9 ft. 6 in. dia. Lancashire boiler for the electricity generating station.

Lowestoft Corporation have accepted the tender of Mann Egerton & Co. for wiring the central boys', the central girls' and St. Andrew's schools.

Pembroke Urban Council have placed an order with Ed. Bennis & Co. for two compressed air furnaces for Lancashire boilers for their electricity works.

St. Helen's (I.W.) Council have accepted the tender of the Isle of Wight Electric Light & Power Co. for public lighting for five years at 50s. per lamp per annum.

The Bastian Meter Co. have again secured the contract for the supply of 2½ and 5 ampere meters to Manchester Corporation.

Watford Council have accepted the tender of Ferranti Limited for two six-way fuse boards with 50 fuses at £165. 10s.

Rawtenstall Education committee have accepted the tender of Chas. Romily for wiring Alder Grange Schools.

Croydon Education committee have accepted the tender of W. D. Wilson for wiring work at Thornton Heath Polytechnic.

High Wycombe Council have accepted the tender of the local electric light company for wiring the Spring Gardens Schools at £80.

West Ham Electric Lighting and Tramways committee have accepted the tender of Ferranti (Ltd.) for switchgear at £248.

Derby Corporation have accepted the tender of G. F. Tomlinson for the lay out for the new carsheds at £568 17s.

The Postmaster-General's Department, Sydney, N.S.W., have accepted the tenders of British Insulated & Helsby Cables for h d. copper wire and copper binding tape, Siemens Bros. Dynamo Works for insulators and Langley Bros. for tallow wood crossarms.

The Postmaster-General's Department, Melbourne, Victoria, have accepted the tenders of Siemens Bros. & Co. for supply and laying of two submarine cables between Victoria and Tasmania at £47,955, and for 30 nautical miles of spare main cable £2,691, 5 n.m. of intermediate cable £674 and 5 n.m. of shore-end cable £1,127.

The Postmaster-General's Department, Melbourne, have also accepted the tenders of R. B. Hungerford for 11 sections of common battery switchboard, &c., at £19,305. Orders (without competitive tenders) have also been placed with Richd. Johnson, Clapham & Morris for 20 tons g.i. wire and Geo. Sweet for insulators, jarrah sleeves and stoneware conduit.

The Postmaster-General's Department, Brisbane, Queensland, have accepted the tenders of the Brisbane Electrical Co. for Daniell glass cells, Calland glasses, glass cells, corks and tubes, for Meidinger batteries and carporous glasses; and C. A. Stone for Daniell porous cups. An order has also been placed (without competition) with H. Henderson for cross-arms.

Coal and Ash-Handling Plant.—Messrs. Ed. Bennis & Co., Little Hulton, Bolton, have received an order for an interesting installation at the Corporation electricity works, Burnley. The contract is for a complete coal and ash-handling plant consisting of overhead bunkers of reinforced brickwork of the capacity of 280 tons.

The coal is received into a brick hopper below the ground and fed by an automatic arrangement into the gravity-bucket conveyor, by which it is elevated above the bunkers, and delivered into them at any point desired. The return line of conveyor passes below the firing floor and receives the ashes which are fed into the buckets by the travelling automatic feeder. This can be placed central to any boiler. The ashes are fed automatically to each bucket, according to its capacity, thence elevated into an overhead ash hopper and ultimately taken away by carts. The battery of ten boilers is fitted with stokers and fed from the overhead bunker by means of shoots, any one of which can be shut off by the fireman. The whole plant is motor-driven and complete with all gantries, floor plates, ladders, pits and guards.

BUSINESS NOTICES.

The directors of Marconi's Wireless Telegraph Co. (Ltd.), having decided to close their Dalston works and carry on the manufacturing business at Chelmsford, notify that as from Aug. 1 all communications intended for the works department of the company should be addressed to Hall-street Works, Chelmsford, Essex.

Messrs. Crompton & Co. notify that Arc Works, Chelmsford, will be closed from noon Aug. 1 to Monday, Aug. 10. No goods should be despatched to arrive during that period. The head office at Salisbury House, London Wall, E.C., will remain open for business as usual.

Mr. Harry W. Turner who, as consulting engineer, has, for the last two years, been occupied in advising firms in matters relating to insulation and winding, will from Aug. 1 be associated exclusively with the Sterling Varnish Co. at Brougham-street, Blackfriars-road, Manchester.

Sale by Auction.—*Postponement of Sale.*—Messrs. Fuller, Horsey, Sons & Cassell announce that the auction sale of the surplus plant and machinery at the works of Marconi's Wireless Telegraph Co. (Ltd.), Tyssen-street, Dalston Junction, London, N.E., is *postponed* until Wednesday next (Aug. 5) at 11 a.m. Catalogues of the auctioneers, 11, Billiter-square, London, E.C. See also an advertisement.

Plant for Sale.—Two 350 H.P. compound Willans engines and alternators, a Westgarth air pump, and a single ram Cameron pump are advertised for sale.

Provisional Order for Sale.—The Town Council of a borough within 60 miles of London and with a population of about 6,000 are prepared to dispose of their provisional electric lighting order. Further particulars from Messrs. Andrew Wood, Purves & Sutton, solicitors, 8 and 9, Gt. James-street, London, W.C. See an advertisement.

Patents Development.—The owners of patent No. 10,219 of 1900, relating to "Improvements in Electric Energy Meters," desire to arrange for granting licences thereunder. Particulars from Messrs. Lloyd Wise & Co., 46, Lincoln's Inn Fields, London, W.C.

The owners of patents Nos. 26,174/03, 7,012/04 and 14,520/04, relating to "Couplings for Electric Cables," desire to negotiate with manufacturers for the sale of the patents or the granting of licences under them. Applications to Messrs. Lloyd, Wise & Co., 46, Lincoln's Inn-fields, London, W.C.

The proprietor of British patent No. 12,688/1902, for "Improvements in or relating to Polyphase Current Transformers,"

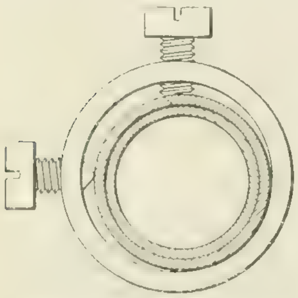
desires to enter into arrangements by way of licence or otherwise for developing and working same in this country. Applications to Messrs. W. P. Thompson & Co., Chartered Patent Agents, 322, High Holborn, London, W.C.

The proprietors of patents Nos. 2,746/1899 and 8,974/1900, for "Improvements in Drawgear and Coupling Devices for Railway and Like Vehicles," 2,403 1903, for "Improvements in Storage Battery Systems" and 25,053/1903, for "Improvements in Electric Lighting and Power Systems," desire to enter into arrangements, by way of licence or otherwise, for exploiting same and insuring their full development and practical working in this country. Communications to Messrs. Haseltine, Lake & Co., Chartered Patent Agents and Consulting Engineers, 7 and 8, Southampton-buildings, Chancery-lane, London, W.C.

CATALOGUES, &c.

Electrolytic Meters.—The Reason Mfg. Co. have issued a most instructive pamphlet on their electrolytic meters. We can recommend this booklet to those desiring to know "how it works" as a fascinating study. All the details of the arrangement, both practical and theoretical, are given, and the *tout ensemble* is all that can be desired. Descriptions of the "ordinary," "two rate," and "three-wire" meters are given, as well as of the "wall plug" and "laboratory" types." These have all been described in *The Electrician* from time to time, but their merits entitle them to renewed acquaintance.

Conduit Grip.—Messrs. Albert Gee & Co., 52, Jackson-street, Hulme, Manchester, send us a sample of continuity grip which they have just introduced for conduit work. Particulars of the grip will be readily understood from the attached drawing, which shows that it comprises an annular saddle containing two set screws practically at right angles to each other. One of these screws, the left-hand in the figure, is tapped into the saddle and its point is embedded into the socket on the end of the conduit. The other screw, shown in the centre of the figure, passes through a plain hole in the socket at the end of the conduit, and its point impinges on the end of the conduit itself. The tightening up of the two screws presses the socket against the conduit and practically makes a sound mechanical joint. The makers claim that by the use of this grip no special stock need be carried in the way of couplings or fittings as the case may be. The cost of the device is stated to be considerably lower than anything which has yet been introduced. From our inspection of the sample we can vouch for the simplicity of the arrangement.



VIEW OF CONDUIT CONTINUITY GRIP.

Accumulators.—Messrs. Peto & Radford send us a copy of their 1908-9 list of ignition cells, traction batteries and special hand lamps for automobiles, mining, &c. Details will also be found of a line of pocket instruments and a quantity of accessories for country house lighting and accumulator charging.

Induced Draught.—The subject of induced draught for steam boilers is one of increasing importance in these days of central station economies. Considerable interest, therefore, attaches to a publication which has been issued by Messrs. Mathews & Yates. The argument for the induced draught fan is represented in the best possible way, and it is further substantiated by testimonials from various electrical departments and other users of fans. The data and drawings included in the pamphlet are such as will be read with interest by engineers.

Power Batteries.—The D.P. Battery Co. have prepared an interesting pamphlet in which particulars are given of the use of one of their batteries in conjunction with an installation of electric cranes at Southampton Docks.

Gre Solvent.—A reminder reaches us from Beanland, Perkin & Co. that their "Gre Solvent" is the best substitute for soap for engineers and mechanics and others who are likely to soil their hands with oily machinery.

Fiorit.—This is the name given to a new sheet packing which is being introduced by Watts, Fincham & Co., Billiter buildings, London, E.C. It is stated to be suitable for superheated steam, oil, &c., and for all purposes where packing of some kind is generally used. From the same source we have to acknowledge a pamphlet dealing with iron and steel stores and leather goods, such as machine belting, &c.

BANKRUPTCIES, LIQUIDATIONS, &c.

The trustee (Mr. J. B. Ottley, 6, Bond-terrace, Wakefield) in the bankruptcy of Hy. Wainwright, electrical engineer, George-yard, Barnsley, has been released.

Meetings of creditors and contributories of Illuminated Signs (Ltd.), 120A, Manor-street, Clapham, London, S.W., will be held on Aug 7 at 132, York-road, London, S.E.

Claims against Reed's Electrical Co. (Ltd.) by Sept. 7 to Mr. D. S. Fripp, 90, Cannon-street, London, E.C.

A meeting of creditors of Dolter Electric Traction (Ltd) will be held on Aug. 5 at 90, Cannon-street, London, E.C., to determine whether application shall be made to the Courts for the appointment of any person as liquidator in the place of or jointly with the liquidator appointed by the company or for the appointment of a committee of inspection."

A meeting to receive an account of the winding-up of Bergtheil & Young (Ltd) will be held at 12, Camomile-street, London, E.C., on Sept. 4.

A meeting to receive an account of the winding-up of the United States Power Synd. (Ltd.) will be held at the Royal Station Hotel, Hull, on Aug. 28.

PATENT RECORD.

APPLICATIONS FOR PATENTS.

NOTE.—*The undermentioned Applications (except those marked †) are not open to public inspection until after acceptance of Complete Specifications. Those marked † are open for inspection 12 months after the date attached to them, if they have not been published previously in the ordinary course. Names within parentheses are those of communicators of inventions. When Complete Specification accompanies application, an asterisk is affixed.*

March 17, 1908.

5,946 BLÁTHY. Securing windings in the grooves of electric machines.*
5,950 BARTON & SONS, BARTON & HARPER. Coupling electrical conduits.
5,972 WHIGH. Electrical lantern.
5,974 B.T.-H. Co. (G.E. Co., U.S.) Dynamo electric machines.

March 18, 1908.

5,996 PINSON & BIBBY. Brackets for electric light globes.
6,008 HORSTMANN & HORSTMANN GEAR CO. Electricity meters.
6,029 COMPANY BISMARCKHÜTTE. Refining of steel in electric furnaces. (Date applied for, 16/9/07.)*†
6,054 VERNUM. Accumulator plate connections or bridges.
6,059 BARON. Suspension devices for electric lamps.
6,065 FERRANTI. Methods of working in power installations and apparatus therefor.

March 19, 1908.

6,079 JORDAN. Fuses for blasting and like purposes.
6,082 BROWN. Electric trolleys.
6,101 CHAMBERS. Teaching instrument for wireless and other telegraph operators.*
6,105 SIEMENS BROS. & CO. (Siemens & Halske A.-G., Germany.) Ozonising air.*
6,119 ERPELDING. Dynamo-electric generators.
6,149 SYKES. Switches.*
6,157 BOSCH. Apparatus for the electric ignition of large internal combustion engines. (Date applied for, 16/9/07.)†
6,162 SOCIÉTÉ D'ELECTRICITÉ NIL MELIOR. Contact breaker mechanism for explosion motors. (Date applied for, 9/11/07.)†
6,170 MAWDSLEY. Brush holders for dynamo-electric machines.*
6,173 GROSWITH. Telephone systems for fire hose.

March 20, 1908.

6,187 HODGSON. Switches.
6,229 DIGBY. Arc lamps for theatrical and other stages.
6,275 BOUVIER & HOPE-JONES. Electrically striking clock bells, gongs, &c.
6,245 WESTINGHOUSE METAL FILAMENT LAMP CO. Metal filament lamps. (Date applied for, 27/3/07.)†

March 21, 1908.

6,285 EACHUS. Variable gears, electrical and other machinery.
6,292 JONES. Resistances.
6,295 CRAMMEL. Vehicle electric lamps with switch plug combination.
6,318 HEYS. Appliance for fishing up cables under water.*
6,325 STEINERT & STEIN. Electro magnetic treatment. (Date applied for, 21/3/07.)*†
6,331 BROWNE. Metallic conduits for electric wiring.
6,336 MONROT & KINGSWAY SYND. Radio-active substances.
6,337 MONROT & KINGSWAY SYND. Instruments for utilising radio activity.
6,338 MOSELEY. Accumulators.
6,348 VINCENT & DYSON & CO. Electrical device for releasing and attaching levers, bolts, &c.
6,370 HARRISON. Starting switches.

March 23, 1908.

6,381 DALEY & ROGERS. Runback automatic electric brake.
6,407 DRESSLER. Absorbing vibration in electric lamps.
[illegible] PATCH. Electric incandescent lamps. (Application for patent of addition to No. 27,541/07.)*
6,412 LOWENSTAM. Sliding or other contacts.
6,421 CROMPTON & CO. & CROMPTON. Arc lamps.

6,452 KINSELLA & HODGETTS. Electrical alarms for tramcars and the like. (Date applied for, 21 3,07.)*†
6,453 JIROTKA. Production of ozone. (Date applied for, 25 3/07.)*†
6,[illegible] WOODS & GRAHAM. Thermostatic circuit closers.
6,477 BEAVER & CLAREMONT. Apparatus for use with cables.

March 24, 1908.

6,493 LIDDLE. Concentric pinion geared electric capstan.
6,501 CHARLES. Switch boxes
6,520 DARNLEY. Telephone shield.
6,547 WEINSTRAUB. Appliance connected with telephone mouthpieces.
6,543 SIMPSON. Generation of electric energy.
6,[illegible] B.T. H Co. (Ripley, U.S. Electric clock winding mechanisms.
6,568 STATTER. Circuit-breakers. (Application for patent of addition to No. 14,577 06.)*

March 25, 1908.

6,605 MORRISON. Holding electric globes or shades in their galleries.
6,638 MONTGOMERY. Current converters.
6,644 ECCLES & MAKOWER. Generating electrical oscillations

March 26, 1908.

6,7[illegible]0 STONE & QUILLIAM. Combination of materials for conveying lubricants to the journals of motors and the like.
6,751 HOLMAN. Arc lamps.
6,753 BERRY & HARRISON. Preventing access of moisture to conductors and fittings.
6,757 VON PINDTERSHOFEN. Cables.*
6,764 SOCIETE CH. LEGRAND ET CIE. Electrically controlled locks particularly applicable to carriages and like vehicles. (Date applied for, 29/3/07.)*†
6,767 SOCIETE DES TELEGRAPHES MULTIPLEX (SYSTEME E. MERCADIER). Mono-telephone relay transformer. (Date applied for, 27 3 07.)*†
6,771 NEWTON & WRIGHT. Electric contact breakers for induction coils.

March 27, 1908.

6,795 POUGHER & ATKINSON. Automatically transferring currents of accumulator, magneto or similar ignition systems from one to the other for motor car and the like engines.

March 28, 1908.

6,895 SIEMENS & HALSKE A.-G. Electrical indicators. (Date applied for, 28/3/07.)*†
6,904 LECOCHE. Polar dynamo-electric generator and motor.
6,928 SOCIETE DES TELEGRAPHS MULTIPLEX SYSTEME E. MERCADIER. Mono-telephone relay transformers. (Application for Patent of Addition to No. 6,767/08.)*
6,931 FRANK. Apparatus for heating by electricity.
6,945 BIRGER LJUNGSTRÖM. Turbines. (Date applied for, 2/4/07.)*†
6,953 AMALGAMATED RADIO-TELEGRAPH CO. (Van Der Woude, Germany.) Radio telegraphy*.
6,955 LJUNGSTRÖM. Electrical machines. (Date applied for, 12/4/07.)*†
6,959, 6,960, 6,961, 6,962 & 6,963 B.T.-H. Co. (G.E. Co., U.S.) Alternating-current motors of the commutator type.*

SPECIFICATIONS PUBLISHED.

1906 SPECIFICATIONS.

29,086 LODGE. Exciting Ruhmkorff and other coils.

1907 SPECIFICATIONS.

18,243 SZUBERT. Arc lamps.
18,849 DUSSEK & DUSSEK. Laying underground conduits and laying conductors therein.
19,274 EISENSTEIN. Receivers for wireless telegraphy.
19,875 NOBBS & NOBBS. Electric hot-water radiator.
20,128 EISENSTEIN. Connections for multiple wireless telegraphy.
20,372 SCHOLZ. Manufacturing metal filaments from colloidal metals.
20,670 DRAULT. Mercury interruptors for electric currents. (Date applied for, 21/9/06.)
20,788 HADDAN. (Thompson & Martin.) Batteries for medical purposes.
20,932 FRIEDHEIM. Moulds used in the electrolytic manufacture of honeycomb radiators and apparatus connected therewith. (Date applied for, 27/11/06.)
21,173 SIEMENS BROS. DYNAMO WORKS. (Siemens Schuckertwerke Ges.) Automatic switches.
21,407 GARRATT. Brush holder for dynamo-electric machines.
21,670 ALLGEMEINE ELECTRICITATS GES. Control of electric motors. (Date applied for, 1/10 06.)
22,832 LAMME. Armatures for electric motors. (Date applied for, 3 11/06.)
23,037 CONRAD. Alternating current motors. (Date applied for, 3/11/06.)
23,098 SCHOTT & CARL-ZEISS-STIFTUNG. Manufacture of incandescent lamps. (Date applied for, 5 11/06.)
23,225 TIMAR & VON DREGER. Arc lamps. (Date applied for, 6,9/07.)
23,603 BOULT. (Normal-Zeit Ges.) Electromagnetic winding gear for clocks or the like
23,681 STEINTHAL & JESSOP. Electric contact or connecting plugs.
23,877 BARTH & LOKKEN. Electromagnetic sound producers.
23,994 MOSCICKI & DE MODZELEWSKI. Electric condenser. (Date applied for, 30 10/06.)
24,587 KELLER. Flexible electrical connection devices.
24,697 VIEL. Electric furnace for effecting fusion or for refining.
24,770 WOLHAUPTER. Insulated railway rail joints. (Date applied for, 8/11/06.)
25,448 TARDIEU. Microphones and telephonic receivers.

BOOKS RECEIVED.

(Copies of the undermentioned works can be had from *The Electrician* [illegible] on receipt of published price, plus [illegible] for book postage [illegible])

"A Handbook of Electrical Testing." By H. R. Kempe. 7th edition. (London: E. and F. N. Spon.) 18s. net.

"Technical Dictionary in Six Languages." By Kurt Deinhardt and Alfred Schlomann. Vol. III. Steam Boilers, Steam Engines Steam Turbines. Edited by Wilhelm Wagner. (London: A. Constable & Co.) 10s. net.

"Electrical Engineering." By W. Slingo and A. Brooker. (London: Longmans, Green & Co.) 12s. 6d.

"Laboratory and Factory Tests in Electrical Engineering." By George F. Sever and Fitzhugh Townsend. 2nd edition. (London: A. Constable & Co.) 10s. 6d. net.

"Science Abstracts." July, 1908. Vol. XI. Part 7. Section A, Physics. Section B, Electrical Engineering. (London: E. & F. N. Spon) 1s. 6d. each.

"English Prices with Russian Equivalents." By A. Adiassewich. (London: E. and F. N. Spon.) 1s. net.

"Fortschritte der Elektrotechnik." By Karl Strecker. 1907. Part III. (Berlin: Julius Springer.) M. 10.

"Einführung in die Maxwellsche Theorie der Elektrizitat und des Magnetismus." By Dr. Clemens Schaefer. (Leipzig: B. G. Teubner.) M. 3.40.

"Einführung in die Theorie des Magnetismus." By R. Gans (Leipzig: B. G. Teubner.) M 2 40.

"Elektromagnetische Ausgleichsvorgange in Freileitungen und Kabeln." By Karl Willy Wagner. (Leipzig: B. G. Teubner.) M. 2.40.

COMPANIES' MEETINGS AND REPORTS.

City & South London Railway Co.

The forty-eighth ordinary general meeting was held on Tuesday, the Rt. Hon. C. B. STUART-WORTLEY, K.C., M.P., presiding.

The SECRETARY (Mr. W. F. Knight) read the notice calling the meeting.

The CHAIRMAN said: Gentlemen, I rise to make the usual motion for the adoption of the report and accounts, and I do so on this occasion in the circumstances that the extension to King's Cross and Euston has been in operation during the whole of the six months as compared with only seven weeks in the corresponding period of last year. The first result to be noted is that we have an increased gross revenue from all sources of £6,044. That increase of revenue has been earned at the cost of what I hope you will think is but a moderate increase of working expenses, which have gone up in the half-year by £4,372. The new line means more stations and more road to keep in order, more train-miles to run, more power to generate, more wear and tear to carriages and engines, more men in your employ and more rates and taxes to pay. Yet our working expenses still stand at the modest proportion of only 46·28 per cent. of our gross receipts. The resulting increase on the sum that you are able to pass to net revenue account is £1,672. Unfortunately, this is all that we have to set against the heavy increased charges entailed by the capital cost of our new works. These increased charges on capital cost we have had for the first time to bear practically the whole of on our own shoulders and for the whole half-year, and the result is that we have £6,108 less available for dividends than we had this time last year. This is, however, not the whole of the difference that the ordinary stockholder has to feel, for there is £1,282 more to be found for preference dividends than there was last year. The £7,400, which will be made available, if you sanction our paying 1 per cent. less on ordinary stock than last year, just covers the £6,108 and the £1,282, and enables us to carry forward just about the same amount as we did in the account for last June. With respect to receipts and expenditure I may say that the June half-year of 1908 is fractionally worse than the December half of 1907 in respect of receipts per train-mile (2s 5·03d. against 2s. 7·84d.) But the June half-year of 1908 is fractionally better than that of 1907 in respect of receipts per train (17s. 9·04d. against 17s. 1·73d.), expenses per train-mile (1s. 2·16d. against 1s. 2·94d.), locomotive charges per train-mile (4·68d. against 4·70d.), and traffic expenses per train-mile (6·29d. against 6·80d.). And these improvements have been shown in spite of the fact that we have had to pay higher prices for coal and other stores in 1908 than in 1907. I may say that coal cost us an average of 14s. 5½d. per ton in 1908, against 13s. 10¾d. in 1907. I submit that these figures taken as a whole show that we have resisted with very fair success the constant tendency of expenses to rise. Secondly, as to receipts attributable to the new extension. We find that the bookings to and from Euston and King's Cross and our two new stations and from stations on the Hampstead Tube produced in the first 19 weeks of this half-year the gross sum of £13,386, as against nil in the corresponding weeks of the 1907 half-year, during which those two stations were not as yet open. These bookings from the Hampstead Tube represent entirely new passengers brought to us by our extensions. Calculations have been furnished to me which suggest (not, of course, finally or conclusively) that the old line shows a decrease on the half-year of

£3,353. This certainly looks as if the new line had come in strongly to the aid of the old, and had, therefore, served well to mitigate the effects of tramway competition and other influences of an adverse kind. If we are right, then, in our estimate that the new line has not unduly increased working expenses, and has brought in more than its share of new revenue, we have to look elsewhere for the causes of our not having received a better gross revenue. The report mentions some of them—better weather in 1908 than in 1907, a less attractive exhibition at the Agricultural Hall, increased tramway competition to the Angel and, possibly, also elsewhere. To these may be added the fact of diminished exchange bookings between ourselves and the Great Northern & City Railway. I feel bound to mention the fire which occurred on July 16 at Moorgate-street Station, which was, happily, prevented in good time from ever becoming dangerous, caused no panic and no injury to any passenger and did very little harm to railway property. I am not able to suggest the cause, because that is now the subject of the official inquiry which is being held under the authority of the Board of Trade. I may say we have done everything we could to assist the officials of the Board of Trade to hold the inquiry. But I can say that your officers are already busily at work considering and effecting over the whole system, in the light of the indications that this case affords, the removal of every discoverable thing that would possibly lead to such a thing happening again, and every possible addition to the existing provisions and regulations for securing at all times and in all places the safety of passengers. You have doubtless seen for yourselves the low traffic receipts we have had since the fire. My only reason for mentioning this is to bring to your minds and to those of the public the fact that we have no pecuniary interest in adopting any other policy than that which I have described. I hope you will agree with me that the conduct of our staff on this occasion was such as to reassure the public and deserves their confidence. I now move the adoption of the report and accounts.

Mr. CHARLES SEYMOUR GRENFELL seconded the motion, which, after some discussion, was carried.

A resolution approving the dividends was then carried unanimously and a cordial vote of thanks to the chairman, directors and officials of the Company terminated the proceedings.

Direct United States Cable Co. (Ltd.)

The sixty-second ordinary general meeting was held on Tuesday, under the presidency of E. M. UNDERDOWN, Esq., K.C.

The GENERAL MANAGER and SECRETARY (Mr. T. Finnis) read the notice calling the meeting.

The CHAIRMAN said: The revenue for the six months to June 30 last, after deducting outpayments, was £51,367, while the working and other expenses, including income tax, but exclusive of the cost of the maintenance of cables absorbed £24,932 leaving a balance of £26,435 as net profit. This, with £6,397 brought forward from the previous half-year and £2,299 in adjustment of income tax, makes a total of £35,131, which has been appropriated as follows: Interim dividend of 4s. per share to March 31, £12,142; proposed final dividend of 4s. per share and bonus of 1s. per share to June 30, £15,177; transferred to reserve fund account £5,000, leaving a balance, which is proposed to be carried forward, of £2,812, making up the before-mentioned total of £35,131. The revenue has shown a falling off of £5,688 during the past half-year as compared with the corresponding half of 1907, when the great activity which had characterised the Altantic business for some time appeared to be beginning to slacken off. That was followed soon afterwards, as you all know, by serious financial difficulties in America, the effects of which have not yet entirely disappeared; but, on the whole, I think we may congratulate ourselves that we have not suffered more in consequence of the disturbance in financial matters. Working expenses in London and at the stations show very little variation; in fact, on the whole, they are £195 less than they were in the corresponding period of 1907. Other expenses and payments include only two varied items, showing that there has practically been no increase whatever in the working of the Company, because there was an amount of £243 arising out of the adjustment of income-tax and £138 for the expenses of the International Telegraph Conference, which was held at Lisbon during the past half-year. The next point which is of importance is the question of the reserve fund. This has been credited with £9,295 from interest on the investments, £2,189 from profit on the sale of securities, and with £5,000 transferred from revenue, and, on the other hand, it has been debited with £12,853 for the cost of the maintenance of cables. The balance of the account now amounts to £505,196. If we take the result of the interest and profits upon the reserve fund for the whole year, it will be found that the expense of the maintenance of cables has been completely covered. One of the most important features of our Company is the reserve fund. I was asked how we protected ourselves against fluctuations in business, the state of the cables, &c., and I replied that the very best way to protect ourselves was by the accumulation of a very large reserve fund. The ideal figure we aimed at for the reserve fund was £[illegible], and it is very little short of that at the present moment, allowing for the reduced amount at which the investments now stand, and considering that so large a sum has had to be invested and the difficult period we have passed through, we think we must congratulate ourselves that we have not suffered more than we have done in that respect. In fact, you will remember that 12 months ago matters were looking very gloomy, and we thought it prudent to set aside the sum of £40,000 in order to cover any depreciation which might arise in the value of our securities. I am very glad to say that the sum at which our securities now stand, their estimated value, would be realised almost completely if they were sold. The result of the working during the whole of the financial year was as follows: We have receipts £111,935, expenses and other ordinary outpayments £50,035, leaving £61,900. We have paid away in dividends £51,603, we have placed to reserve £10,000, and we have an increased balance in hand as compared with June, 1907, of £297, making up the total I have just mentioned of £61,900. The reserve fund account has been increased on balance during the year by £13,228, as follows: Transferred from revenue £10,000, interest on investments £18,490, and profit on sale of securities £2,688, making altogether £31,178. Deducting the cost of the maintenance of the cables, £17,950, we have increased the balance of the reserve account, as stated, by £13,228 which I need not say is a satisfactory state of things. There are one or two matters which it may be necessary for me, perhaps, to touch upon as being of a certain amount of interest to the Company. I daresay you have seen in the newspapers that there has been some apprehension as to injury to the cables by trawling vessels, which now trawl at a very great depth off the coast of Ireland, and it was found that in many cases the trawlers had damaged the Atlantic cables. While that does not perhaps apply so much to our cables, nevertheless, it was a matter of very great importance, and the Postmaster-General appointed an Interdepartmental Committee to examine into the question. That Committee is now considering the matter, and I have no doubt that measures will be taken, as far as practicable, to secure our cables from damage in that way. It is unnecessary to state that our communications to America would be imperilled if matters were allowed to reach any dangerous position. We have attended that Committee, and our recommendations and reports will receive attention. During the half-year the International Telegraph Conference took place at Lisbon at which we were worthily represented, but nothing of a prejudicial character to our undertaking has resulted. That Conference will not be renewed for another seven years. I now move the adoption of the report and accounts, and the dividend therein set out.

Sir JAMES PENDER, Bart., seconded the motion which was carried unanimously.

Resolutions were afterwards passed re-electing the retiring Directors, Mr. E. M. Underdown, K.C., and Mr. H. C. B. Underdown, and the auditors, Messrs. Deloitte, Plender, Griffiths & Co., and Messrs. J. & J. Sawyer & Co.

A cordial vote of thanks to the Chairman and the Directors brought the meeting to a close.

Electric & General Investment Co. (Ltd.)

The nineteenth ordinary general meeting was held on Tuesday, Mr. J. B. BRAITHWAITE in the chair.

The SECRETARY (pro tem.) (Mr. S. R. Shaw) read the notice calling the meeting, and also the auditor's report.

The CHAIRMAN, in moving the adoption of the report and accounts, said: This is a finance company especially connected with electrical investments, and the past year has been one in which there has been little or no finance going on for electrical securities, and in which electrical investments themselves have been out of favour. In these circumstances the opportunities we have had of carrying on profitable business on your behalf have been very much curtailed, and we have had to fall back almost entirely upon revenue from our various investments and on our remuneration as trustees. There is one satisfactory point, I think, in the report, and that is this—it shows us that, apart from our ordinary financial profits, the revenue derived from our investments and trustees' fees is sufficient to provide a dividend on our preference shares and our expenses and then leave a small margin. The result of the year's working is that, after payment of the preference dividend, there is a small balance of £568. 7s. 4d., which we propose to add to the contingencies fund, raising that account to £67,556. We are proposing to make a small distribution from the reserve fund according to the separate classes of shares. I am now the sole trustee, and I am proposing to distribute £10 a share on each founders' share and a small dividend of 6d. a share on the ordinary shares. I think, on the whole, we may congratulate ourselves that our Company throughout the whole of its career has done so well. We have been established for 18 years, and during that time we have distributed in dividend on the ordinary shares of £1 paid £4. 8s. 7½d. from the Company and 7s. from the reserve fund, making a total of £4. 15s. 7½d. paid for each £1 paid-up by each shareholder, or 475 per cent. That works out at about 26½ per cent. per annum for the whole period of 18 years. During the same period the founders' shares of £5 each have received the total sum of £707—£546. 5s. per £5 share from the Company and £160. 16s. per £5 share from the founders' share reserve fund—so that those of us who were shareholders in the concern from the beginning have no cause to complain, I think, of the profitable character of our investments, and I see no reason to doubt that, as soon as business improves in the direction in which we are especially interested, we shall not again make similar profits to those of the past. I now move the adoption of the report and accounts.

Mr. EMILE GARCKE seconded the motion.

Mr. H. H. S. CROFT: You have not said why the carefully considered scheme of reconstruction, submitted to the shareholders on June 26, 1907, failed to meet with the approval of the holders of the founders' shares. I think it is a subject of very great regret, considering the large amount they have received from the funds of the Company, that they should not have seen their way to agree to this carefully considered scheme which certainly would have been, as I understood it, very favourable for the shareholders generally.

The CHAIRMAN: I quite reciprocate what the shareholder has said. We very much regret that a certain section of the founders' share-

holders absolutely refused to agree to the scheme, and, as you have to get it passed by a three fourths majority a comparatively small number are in the position to defeat it. We have still failed to devise any more equitable scheme to all classes. If business improves we shall make another effort to induce them to consent.

The resolution was then carried unanimously.

Resolutions approving the payment of the preference dividend, the re election of the retiring director and auditor were carried, and the meeting closed with a vote of thanks to the chairman and directors.

BAKER-STREET & WATERLOO RAILWAY CO.—The accounts for the half-year ended June 30 provide for full dividend on the 4 per cent. preference shares and a dividend at the rate of ¾ per cent. per annum on the ordinary share capital. The holders of ordinary shares (other than the Underground company) will receive an additional dividend at the rate of 2¼ per cent. (making 3 per cent. per annum in all) out of the moneys payable by the Underground Electric Railways Co. of London.

CENTRAL LONDON RAILWAY CO.—The capital expended during the half-year ended June 30 was £52,268. 11s. 2d. mainly for additional generating plant at the power house and the extension of the line from Shepherd's Bush to Wood-lane. Compared with the corresponding period in 1907 there has been an increase of £8,761. 5s. 5d. in revenue receipts, and of £184. 17s. 10d. in working expenses. The balance carried to net revenue is £83,526. 16s. 4d. After providing for debenture interest, &c., the balance is £74,125. 5s. 10d. The directors recommend dividends at the rate of 3 per cent. per annum for the half-year on the undivided ordinary stock and at the rate of 4 per cent. per annum for the half-year on the preferred-ordinary stock. Dividend on the deferred ordinary stock is not payable until the result of the year's business is ascertained, and the balance (£34,671. 16s. 10d.) is, therefore, carried forward. 19,901,750 passengers were carried, against 20,260,871 for the corresponding half-year of 1907. A very substantial increase in business has resulted from the opening of the Franco-British Exhibition. The system of through booking between stations on the Central London Railway and those of the Baker Street & Waterloo, the Charing Cross, Euston & Hampstead, the Great Northern, Piccadilly & Brompton, the City & South London, the Great Northern & City and the Metropolitan Railways has steadily developed, and about 25,000 passengers per day are exchanged. The average receipt per passenger for the half-year is 1·97d. comparing with 1·85d. The cost per passenger is 1·08d. comparing with 1·06d.

CROMPTON & CO (LTD.)—At the meeting on Monday the chairman (Mr. John Trotter) said that the results achieved during the year were satisfactory, although obtained with great difficulty, notwithstanding the over-production and the low prices ruling in the industry. He complained of the forced cutting of prices which the keenest of competition had brought about. In the last three years 16 to 25 per cent. reduction had taken place in the price of standard makes of machinery. The directors refused orders which did not leave a fair margin of profit. The Chelmsford works had shown a large advance in the output, compared with that of the previous year. In the sales department there had also been an increase, and the contract department had been active. They were able to select good contracts, and were not driven into accepting those of an undesirable character. Sooner or later, however, they would certainly have to increase the permanent capital of the company in order to cope with the growing expansion of the business. The company's investments were satisfactory, and good progress had been made by the electricity undertakings owned by the Electric Supply Corpn.

DUBLIN UNITED TRAMWAYS CO. (LTD.)—At the meeting on Tuesday the chairman (Mr. W. M. Murphy) said the accounts for the past half-year showed satisfactory features in the working of the tramways. Although the receipts showed a falling off compared with those of 1907, as was to be expected, they were substantially in excess of the receipts for the same period in 1906, but the unsatisfactory feature is that working expenses were greater than in 1907. The continuous increase under normal conditions in the gross earning powers of the tramways showed no signs of exhaustion. For the first time there was a small check to the expansion of the parcels traffic. In general expenses there was more or less increase under each of the main heads of expenditure, amounting in the aggregate to £2,849. More than half was due to the increased cost of generating electricity for operating the tramways, owing mainly to the enhanced price of coal. Out of the large profits made in the second half of 1907 they were enabled to appropriate £10,000 towards the reconstruction of portion of the Southern District tramways, which was estimated to cost about £14,000. They were substituting rails of 105 lb. to the yard, which should last three or four times as long as the rails which they were replacing. As the result of the half-year's working, they were able to pay the usual dividend of 6 per cent. (free of tax) on the ordinary shares.

EDMUNDSONS' ELECTRICITY CORPN. (LTD.)—The directors' report for the year to March 31 states that net profit, after payment of debenture interest, amounts to £2,610. 9s. 9d., added to £17,806. 16s. brought forward, total £20,417. 5s. 9d. The directors recommend this should be carried forward. The loss on working the local authority undertakings has this year, in addition to the net amount of the Urban Co. guarantee, been deducted from the gross trading profit. The diminished return shown on loans and investments is entirely owing to a much larger provision for reserve and depreciation being made by the subsidiary companies. The gross profits of the subsidiary companies have increased during the year by £9,433, the amount expended on capital during the year being £69,065 (against £92,760 for the previous year). The reduction of £40,926 in investments and advances to subsidiary companies is accounted for by a reduction in the amount of the advance to the Urban Co. consequent upon the issue of £75,000 debenture stock by that company. £1,491. 3s. 10d has been added to reserves, which now amount to £183,564. 6s. 9d., making, with the reserve fund of £95,000 and the profit balance of £20,530. 12s. 5d., a total reserve of £299,094. 19s. 2d. Mr. F. E. Gripper has resigned his position of managing director, and is now the general manager of the company.

GENERAL ELECTRIC CO. (LTD.)—At the meeting on Friday the chairman (Mr. G. Byng), said that the profit made during the year was nearly £9,000 less than last year. The profit made throughout the year was not satisfactory, and the return for the large capital invested was not adequate. The rise and fall in the price of raw material had affected their stock, of which they were obliged to keep a large amount, both ways. When a stock of £300,000, largely composed of copper, iron, indiarubber, &c., had to be written down in accordance with market fluctuations, some of which were 30 or 40 per cent. below the prices quoted six months ago, they could imagine that that was a serious item which affected their balance-sheet adversely. He referred to the developments in the sale of metal filament lamps and telephone equipment, for which they had made extensive alterations in their Peel works. Mr. Byng also alluded to a movement for a combination of electrical manufacturers with a view to remedying the evils of their industry, but he was afraid that no real improvement of a permanent nature could be effected unless their fiscal policy was altered. The electrical industry at present was almost the prime mover of every other industry in the country, and if it dropped behind it would more or less affect all other industries.

GREAT NORTHERN & CITY RAILWAY CO.—The total revenue receipts for the six months ended June 30 were £46,476. 10s. 2d., and working cost £23,286. 10s. 3d. (50·10 per cent.) Inclusive of balance forward, and after providing for debenture interest and other charges, and setting aside £500 to renewals, there remains £419. 10s., which the directors recommend be carried forward. The number of passengers, including season ticket holders, was 6,875,602, against 8,269,435 for the corresponding period last year. The number of local season tickets issued was 4,004, against 3,995. The number of three-route season ticket holders using the company's line during the past half-year was 2,892. The heavy falling off in the number of passengers is attributable to the increasing competition of the London County Council's electrified tramways, by which the company is seriously affected.

GREAT NORTHERN, PICCADILLY & BROMPTON RAILWAY CO.—The accounts for the half-year ended June 30 provide for the 4 per cent. dividend on the ordinary shares, converted into preference shares as from July 1, 1908, and a dividend of ¾ per cent. per annum on the ordinary share capital.

LANCASHIRE POWER CONSTRUCTION CO. (LTD.)—A special meeting of the company was held on Wednesday for confirming a resolution passed at the ordinary general meeting appointing Mr. H. F. Parshall chairman of the company at a salary of £1,000 a year and a commission of 10 per cent. on all profits above £20,000 calculated before charging interest on the debenture stock and income bonds, and also appointing as directors Sir Robert A. Hampson, Mr. John Young and Mr. James Lever Rushton. Powers were asked to increase the capital of the company by the creation of income bonds for £100,000. The company has made arrangements with three local authorities to supply them with electricity in bulk, and 12 local authorities have handed over their provisional orders for the company to carry out. The company are at present supplying 4,000 H.P. from the station, and could supply three times the amount without addition to the machinery beyond extra mains and connections.

LIVERPOOL OVERHEAD RAILWAY CO.—The accounts for the past half-year show an available balance of £7,206. 16s. 9d., and the directors recommend payment of a dividend at the rate of 5 per cent. on the (1892) preference shares (absorbing £3,000), carrying forward £4,206. 16s. 9d.

METROPOLITAN RAILWAY CO.—The total receipts for the half-year ended June 30 were £356,786. 16s., and the expenses £199,780. 5s. 10d., leaving £157,006. 10s. 2d. profit. Compared with the corresponding half-year of 1907 the receipts show an increase of £11,267. 6s. 8d., and the expenses an increase of £6,419. 1s. 7d. After providing for debenture interest, other fixed charges and dividend on preference stocks, the balance is £18,002. 16s. 8d., and the directors recommend a dividend of 10s. per cent. on the ordinary stock for the half-year. The carry-forward is £3,672. 13s. 7d The opening of the several tubes in London has caused a serious diversion of traffic from the Metropolitan line, but it has at the same time given rise to a large increase in the amount of local travel generally which will be a continuing benefit to the company. Throughout the half-year the electrical plant and machinery have given every satisfaction in working and current continues to be produced at a figure which compares very favourably with other installations. During the half-year 48,243,951 passengers were carried.

PARA ELECTRIC RAILWAYS & LIGHTING CO. (LTD.)—At the meeting on Wednesday Sir W. Evans-Gordon said construction work did not commence until Aug. 15, 1906. The contractors (Messrs. J. G. White & Co.) were from the outset confronted with many difficulties, but those had been overcome, and the whole system of about 35 miles (single track) had now been converted. The report and accounts dealt with the year ended Nov. 30, 1907. For the year to Nov. 30, 1906, the gross receipts from the tramways were £136,166, compared with £137,098 for 1907; and from lighting £63,728 against £67,485. The net receipts from the tramways were £22,132 in 1906 and £16,794 in

1907, and from lighting £27,636 and £24,838 respectively. Although the gross receipts had, on the whole, come up to expectations, the cost of operation was extremely heavy—namely, for 1906 (animal traction) 83 74 per cent., and for 1907 94·96 per cent. Although the cost of operating by electricity would replace mule traction, and coal was expensive in Para, still the motive power for working the line should cost not much more than one-third of the outlay on animals. With regard to the supply of light and power, the demand had increased beyond the company's power of supply, and a new unit of 450 kw. would shortly be shipped. When that was installed they would be in a position to canvass for more private customers and to provide electric fans, for which there should be a heavy demand. The entire system of lighting was in course of reconstruction. After full consideration the directors decided to replace the old overhead feeders by underground cables, involving the laying of 23,472 yds. of cable, which had been completed, and it only remained to transfer the transformers to the underground system. The board felt justified in estimating that the gross receipts from the joint undertaking for the first complete year commencing Dec. 1, 1908, would be £220,000, from which they had to deduct the probable operation expenses of £132,000. They estimated a profit of £83,000. Interest and redemption of debentures would require £38,500, and preference dividend £16,500, leaving £28,000 for depreciation, reserve and dividend on ordinary share capital.

TORQUAY TRAMWAYS CONSTRUCTION SYND. (LTD.)—The report for the period from Aug. 24, 1905, to Dec. 31, 1907, states that there is a surplus of £2,271, which the directors recommend shall be carried forward.

NEW COMPANIES, STATUTORY RETURNS, MORTGAGES AND CHARGES, AND APPOINTMENT OF RECEIVERS, &c.

NEW COMPANIES.

CERTUS GEARLESS CO. (LTD.) (98,950.)—Reg. July 24, capital £25,000 in £1 shares, to acquire the assets and liabilities of the "Certus" Gearless Co. (Ltd.) and to carry on the business of mechanical, electrical, gas and water engineers, makers of electrical tramcars, motor cars, engines, machines, &c. First directors, the Earl of Kinnoul, Sir James H. Renals, Bart., and C. Nathan. Reg. office, 43-4, Great Windmill-street, London, W.

DEY TIME REGISTERS (LTD.) (98,801.)—Reg. July 13, capital £50,000 in £1 shares, to take over the business of patentees, inventors and manufacturers of and dealers in time recorders, tell-tale and other clocks and watches, &c., carried on by Howard Bros., and to carry on the said business and that of electrical engineers and contractors, suppliers of electricity, synchronisers of clocks and timepieces, manufacturers of and dealers in railway, tramway, electric, magnetic, galvanic and other apparatus, &c. Private company. First directors, F. M., E. S. and W. R. Howard. Reg. office, 40, Paradise-street, Liverpool.

UNDERWOOD (MANCHESTER) (LTD.) (98,910.)—Reg. July 20, capital £5,000 in £1 shares, to adopt an agreement with W. G. Underwood, and to carry on the business of electricians, electrical, telephonic and telegraphic engineers, fitters, &c. Private company, with two subscribers (W. G. Underwood and T. N. Underwood), each taking one share. First directors, W. G. Underwood (permanent) and others to be appointed at statutory meeting. Reg. office, 34, Pall Mall, Manchester.

STATUTORY RETURNS.

BRITISH WESTINGHOUSE ELECTRIC & MFG. CO. (LTD.)—Return to May 18 gives capital as £1,875,000 in 500,000 preference shares of £3 each and 75,000 ordinary shares of £5 each, all of which have been taken up. £3 per share has been called up on the preference and £1,500,000 has been received. £375,000 is considered as paid on the ordinary. Mortgages and charges, £1,491,353.

DURHAM COLLIERIES ELECTRIC POWER CO. (LTD.)—According to return to June 16 capital is £155,000 in 125,000 6 per cent. cumulative participating preference and 30,000 ordinary shares of £1 each, of which 85,619 preference and 25,045 ordinary have been taken up. £1 per share has been called up on 85,102 preference and 10s. per share on 517 preference and 45 ordinary, and £85,380 has been received, leaving £3 in arrears. £25,000 is considered as paid on £25,000 ordinary. Mortgages and charges, £150,000.

TONYREFAIL & GILFACH GOCH ELECTRIC LIGHT CO. (LTD.)—In return to July 7 capital is £5,000 in £1 shares, of which 3,421 have been taken up. £1 per share has been called up and £3,406 15s. has been received, leaving £14 5s. in arrears. Mortgages and charges, £935.

MORTGAGES AND CHARGES.

BOURNE END ELECTRIC INSTALLATION CO. (LTD.)—Particulars of £2,500 debentures created by resolution of July 17, 1908, have been filed pursuant to sec. 10 (3) of the Companies' Act, 1907. Property charged: the company's undertaking and property, present and future, including uncalled capital. No trustees. All above debentures have been issued.

A. C. COSSOR LTD.—Particulars of £3,500 debentures created by resolution of July 9, 1908, have been filed pursuant to sec. 10 (3) of the Companies' Act, 1907. Property charged: Company's assets, present and future, including uncalled capital. No trustees. All the above debentures were issued on the same date.

DURHAM COLLIERIES ELECTRIC POWER CO. (LTD.)—A mortgage, dated July 15, 1908, to secure £2,500, charged on company's under taking and property, present and future, has been registered. Holders, Trustees & Executors Insurance Corpn.

ELECTRO-MECHANICAL BRAKE CO. (LTD.)—A mortgage on land and premises at West Bromwhich, dated July 11, 1908, stamped to cover £3,400, has been registered. Holders, Metropolitan Bank of England and Wales.

SWITCHGEAR CO. (LTD.)—A trust deed dated June 30, 1908, to secure not more than £2,000 debenture stock, charged on certain of the company's property, has been registered. Holder, J. Sermon.

UNITY MOTOR ELECTRICAL AND GENERAL ENGINEERING CO. (LTD.)—Particulars of £1,000 5 per cent. debentures created by resolution of July 4, 1908, have been filed pursuant to sec. 10 (3) of the Companies' Act, 1907. Property charged: Company's undertaking and property, present and future, including uncalled capital. No trustees. Issue on same date of £325 debentures, part of above series, also registered.

APPOINTMENT OF RECEIVERS, &c.

CONSOLIDATED SUPPLY CO. (LTD.)—A notice of the appointment of J. E. Ward, 122, Cannon-street, E.C., as receiver and manager, has been filed pursuant to sec. 11 (2) of the Companies Act, 1907.

ILLUMINATED SIGNS (LTD.)—Notice of appointment of C. F. Farmery (120A, Manor-street, Clapham, S.W.) as receiver and manager, on July 3, 1908, under powers contained in first mortgage debentures, has been filed.

ROWLAND BARNETT & CO. (LTD.)—A notice of the appointment of Mr. J. W. Pace, C.A., Emerson-chambers, Newcastle-on-Tyne, as receiver, on July 9, 1908, under powers contained in a debenture dated April 4, 1908, has been filed pursuant to sec. 11 (2) of the Companies Act, 1907.

W. T. SKELDING & CO. (LTD.)—A notice of the appointment of D. E. Campbell, 51, Lichfield-street, Wolverhampton, as receiver or manager, on May 4, 1908, under powers contained in a mortgage debenture dated Jan. 3, 1908, has been filed pursuant to sec. 11 (2) of the Companies Act, 1907.

CITY NOTES.

MEMORANDA (July 30).—Bank rate 2½ per cent. (since May 28, 1908) Price of silver, 24 5/16d. per oz. Consols 86¾—86⅞ for money and 86¾—86⅞ account. Consols Pay Day, Aug. 6; Stock and Shares Continuation Days, Aug. 11 and 25; Ticket Days, Aug. 12 and 26; Pay Day, Aug. 13; Mining Share carry-over Day, Aug. 10.

Prices of Metals (London).—*Copper*, cash, 59¾—60; three months, 60½—60¾. *Lead*, English, 13⅜—13⅝; foreign, 13¼—13⅓. *Spelter*, foreign, 19—19¼. *Tin*, English, 137½—138½; foreign, cash, 137¾—138¼, three months, 139—139½. *Iron*, Cleveland, cash, 50/-—50/2; three months, 49/1—49/3.

BRISTOL TRAMWAYS & CARRIAGE CO. (LTD.)—An interim dividend has been declared at the rate of 6 per cent. for the half-year ended June 30.

BRITISH COLUMBIA ELECTRIC RAILWAY CO.—The directors announce a dividend at the rate of 5 per cent. per annum in respect of the three months ended June 30, together with an additional dividend at the rate of 1 per cent. per annum for the same period.

BROMPTON & KENSINGTON ELECTRICITY SUPPLY CO. (LTD.)—The directors have declared an interim dividend for the half year to June 30 at the rate of 9 per cent. per annum on the ordinary shares.

BULLERS LIMITED.—The directors have declared an interim dividend of 1¼ per cent. (2s. 6d. per share), tax free, on the ordinary shares for the past quarter.

CHARING CROSS, EUSTON & HAMPSTEAD RAILWAY CO.—The accounts for the half year ended June show net revenue sufficient to pay the debenture interest, carrying forward £832.

CHELSEA ELECTRICITY SUPPLY CO. (LTD.)—An interim dividend at the rate of 4 per cent. per annum has been declared on the ordinary shares.

IMPERIAL TRAMWAYS CO.—An interim dividend has been declared at the rate of 8 per cent. for the half year ended June 30.

METROPOLITAN DISTRICT RAILWAY CO.—The directors recommend a dividend on the 4 per cent. guaranteed stock for the past six months at the rate of 1½ per cent., against 1 per cent. for the corresponding period of 1907.

METROPOLITAN ELECTRIC SUPPLY CO. (LTD.)—An interim dividend of 2s. 6d. per share has been declared on the ordinary shares.

SIEMENS BROS. DYNAMO WORKS (LTD.)—The accounts for 1907 show a credit balance of £1,416.

UNITED ELECTRIC TRAMWAYS OF MONTE VIDEO (LTD.)—The company announces that a further 20 miles of single track have been opened to electric service, making a total of about 75 miles in operation out of a total of 80 miles.

WESTMINSTER ELECTRIC SUPPLY CORPN. (LTD.)—The directors have declared an interim dividend for the half year ended June 30 at the rate of 10 per cent. per annum (less tax), payable Sept. 1.

ELECTRIC TRAMWAY AND RAILWAY TRAFFIC RECEIPTS.

Line	Week ended.	Amount.	Inc. or Dec. (a)	Aggregate: No. of weeks.	Aggregate: Amount.	Aggregate: Inc. or Dec. (a)
		£	£		£	£
Aberdeen Corporation	July 22	1,900	+ 239	8	11,570	– 631
Airdrie	,, 17	252	+ 39	28	6,346	+ 80
Anglo-Argentine	,, 22	22,327	+ 452	29	628,785	+ 67,804
Ayr Corporation	,, 25	891	+ 360	10	3,975	– 260
Baker St. & Waterloo Ry.	,, 25	2,870	+ 425	4	12,080	+ 1,935
Barnsley	,, 17	170	+ 1	28	4,891	+ 306
Barrow	,, 17	284	– 58	28	6,693	– 166
Bath Electric Trams, Ltd.	,, 22	833	– 101	29	20,376	– 1,398
Birkenhead Corporation	,, 25	1,677	+ 12	4	4,520	+ 62
Birmingham Corporation	,, 25	6,208	+ 147	17	102,953	+ 5,341
Birmingham & Mid.	,, 10	858	+ 10	27	22,339	+ 955
Blackburn Corporation	...	...	...	...	...	...
Blackpool Corporation	,, 23	1,971	– 150	§16	18,411	+ 933
Blackpool and Fleetwood	,, 25	1,258	– 11	4	4,407	+ 81
Bolton Corporation	,, 26	2,409	+ 22	17	40,478	+ 1,644
Bombay	,, 2	R32,348	+ R3,801	26	R939,067	+ R187,327
Bournemouth Corporation.	,, 22	1,723	– 100	16	26,583	– 1,182
Bradford Corporation	,, 25	4,923	– 50	17	80,264	+ 579
Brighton Corporation	,, 25	1,065	+ 68	17	15,142	+ 156
Bristol Trams & Carriage	,, 24	5,383	+ 219	35	144,775	+ 556
Burnley Corporation	,, 24	1,270	– 78	17	22,052	+ 991
Burton Corporation	,, 25	280	– 23	17	4,028	– 380
Bury Corporation	,, 19	1,248	– 53	‡15	19,385	+ 1,762
Calcutta Tramways Co.	,, 25	R15,970	– R1,128	4	R182,528	– R8,208
Cardiff Corporation	,, 18	2,317	– 362	16	34,911	– 934
Cavehill	,, 17	132	– 77	28	2,499	+ 115
Central London Railway	,, 25	8,020	+ 2,806	4	29,806	+ 8,915
Charing C., Euston & H'stead	,, 25	3,235	+ 720	4	13,200	+ 2,755
Chatham & Dist. Lt. Rys.	,, 23	817	– 46	§29	21,298	+ 491
City & South London Rly.	,, 26	2,733	– 395	4	11,722	– 1,045
City of Birmingham	,, 17	2,905	– 195	28	78,398	+ 197
Colchester Corporation	,, 22	212	– 24	3	650	– 33
Cork Electric Trams Co.	,, 23	514	– 59	29	13,109	– 497
Croydon Corporation	,, 24	1,559	+ 49	17	24,603	+ 10,707
Devonport & Dist. Trams	,, 17	438	– 95	28	12,621	– 46
Dover Corporation	,, 25	287	+ 26	17	3,801	– 139
Dublin & Lucan Railway	,, 24	162	+ 5	3	300	– 49
Dublin United	,, 24	5,931	– 1,233	¶3	19,745	– 5,766
Dudley-Stourbridge	,, 17	884	– 31	28	22,647	– 1,108
Dundee Corporation	,, 22	1,205	– 14	‡10	12,039	+ 806
East Ham Council	,, 25	856	– 86	17	14,535	– 871
Exeter Corporation	,, 24	371	+ 14	17	5,328	– 138
Falkirk and District	,, 22	321	...	3	590	...
Gateshead & Dist. Trams	,, 17	1,013	– 33	28	28,300	+ 288
Glasgow Corporation	,, 25	14,159	– 1,507	8	137,464	+ 1,945
Glossop	,, 25	133	– 14	30	4,689	– 215
Gravesend—Northfleet	,, 17	231	– 55	28	5,787	– 854
Great Northern & City Rly.	,, 25	1,281	– 380	4	5,462	– 1,505
Gt. Northern, Piccadilly, &c	,, 25	5,100	+ 970	4	21,175	+ 4,085
Greenock & Port Glasgow	,, 17	481	– 397	28	14,551	– 3,988
Hartlepool Tramways	,, 17	231	– 88	26	6,440	– 1,310
Hastings Elec. Trams Co.	,, 23	1,229	– 51	4	4,562	– 603
Hong Kong	,, 25	$6,072	– $1,925	..	...	...
Huddersfield Corpn.	,, 25	1,605	– 29	17	27,642	+ 649
Hull Corporation	,, 25	2,441	+ 112	17	40,595	+ 133
Ilford District Council	,, 25	470	– 22	17	7,681	– 495
Ilkeston District Council	,, 22	146	+ 3	16	2,322	+ 49
Ipswich Corporation	,, 25	471	– 28	17	6,717	– 69
Isle of Thanet Co.	,, 25	1,205	+ 87	43	17,674	– 393
Jarrow	,, 17	140	– 20	28	2,948	– 398
Keighley Corporation	,, 23	177	– 11	3	552	– 15
Kidderminster & District	,, 17	147	– 25	28	2,975	– 139
Kilmarnock Corporation	,, 25	169	– 86	10	1,730	– 225
Lanarkshire Trams Co.	,, 23	1,696	+ 58	29	37,900	+ 3,836
Lancashire United	,, 22	1,471	– 44	29	38,069	+ 2,067
Leamington	,, 17	204	+ 8	28	4,454	+ 243
Leeds Corporation	,, 25	6,903	+ 116	17	114,776	+ 5,617
Leicester Corporation	,, 22	2,449	+ 60	4	9,337	+ 259
Leith Corporation	,, 25	708	+ 112	§10	5,898	– 34
Lincoln Corporation	,, 25	126	+ 6	17	2,023	– 62
Liverpool Corporation	,, 18	11,048	– 836	29	306,356	– 2,509
Liverpool Overhead Rly.	,, 26	1,487	– 146	4	5,869	– 556
London County Council	,, 18	35,012	+ 2,557	†16	544,009	+ 57,859
London United	,, 25	8,069	+ 241	29	189,824	+ 2,719
Lowestoft	,, 25	307	+ 15	43	7,410	+ 118
Maidstone Corporation	,, 25	217	...	17	3,297	...
Manchester Corporation	,, 25	15,704	+ 209	17	256,471	+ 10,587
Mersey Railway	,, 25	1,815	+ 68	4	7,329	+ 26
Merthyr	,, 17	214	– 14	28	5,867	+ 51
Metropolitan Dist. Railway	,, 25	9,027	+ 1,321	4	37,000	+ 5,044
Metropolitan Elec. Trams	,, 17	5,952	+ 308	28	154,854	+ 30,772
Middleton	,, 17	370	– 42	28	10,068	+ 378
Nelson Corporation	,, 25	158	– 6	¶16	2,423	– 140
Newcastle-on-Tyne Corp.	,, 25	3,841	– 174	17	66,796	– 4,364
Newport (Mon.)	,, 25	647	+ 4	17	11,543	– 828
Northampton Corporation	,, 24	480	+ 26	¶16	7,862	+ 478
Oldham, Ashton & Hyde	,, 17	580	– 60	28	16,685	– 23
Oldham Corporation	,, 25	2,097	+ 88	18	35,489	+ 582
Perth (N.B.) Corporation	,, 22	192	– 19	10	1,569	– 123
Perth (W.A.) Elec. Trams	,, 24	1,324	– 51	¶30	41,814	– 751
Peterborough	,, 17	132	– 9	28	3,465	+ 77
Portsmouth Corporation	,, 25	2,294	+ 73	17	33,967	+ 42
Potteries	,, 17	1,879	+ 36	28	51,292	– 430
Rotherham Corporation	,, 23	612	+ 25	§16	10,916	+ 196
Rothesay	,, 17	371	– 847	28	4,217	– 842
Salford Corporation	,, 27	4,781	+ 40	17	81,465	+ 665
Sheerness	,, 15	62	– 6	28	1,520	– 8
Sheffield Corporation	,, 25	5,747	+ 65	†18	99,632	+ 26
Singapore Trams	,, 25	$8,390	– $912	4	$35,669	– $1,171
South Metropolitan	,, 17	812	– 142	28	21,744	+ 594
South Staffs	,, 17	825	– 64	28	24,615	– 292
Southend Corporation	,, 22	557	+ 20	17	6,807	+ 153
Southport Tramways	,, 17	319	– 69	28	7,503	– 348
Sta'ybdge, Hyde, &c., Jt Bd.	,, 25	962	– 38	†17	13,476	– 176
Sunderland Corporation	,, 26	1,404	– 172	17	20,150	– 4,334
Sunderland and District	,, 22	561	+ 36	38	17,775	+ 1,306
Swansea Trams	,, 17	990	– 43	28	25,578	+ 1,817
Swindon Corporation	,, 22	139	– 26	...		...
Taunton	,, 17	45	– 1	28	1,117	– 46
Tynemouth and District	,, 17	318	– 100	28	5,619	– 474
Tyneside Trams Co.	,, 22	521	– 75	26	1,268	– 162
Wallasey District Council	,, 25	1,019	+ 69	†17	15,251	+ 825
Walsall Corpn	,, 25	549	+ 26	30	15,806	+ 1,384
Warrington Corpn.	...	...	...	...	...	...
West Ham Corporation	...	...	...			...
Weston-super-Mare	,, 15	252	– 102	28	2,627	– 47
Wolverhampton Co.	,, 17	127	– 74	28	12,782	– 322
Wolverhampton Corpn	,, 22	826	– 27	7	6,111	+ 351
Worcester	,, 17	316	– 23	28	7,008	+ 37
Wrexham	,, 17	104	11	28	2,808	+ 16
Yorkshire W.R. Trams	,, 25	1,187	+ 18	30	35,928	...
Yorkshire Woollen District	.. 17	832	– 162	28	25,469	– 1,127

(a) The comparisons are with the corresponding period last year. § Plus 2 days. ¶ Plus 3 days. * Partly electrical. † Minus 3 days. ‡ Minus 2 days.

ELECTRICAL COMPANIES' SHARE LIST.

Share	Last Dividend	Name.	Price Wed., July 29	Rate % Yielded.	Dividend Due.	Business Week to July 29: Highest.	Lowest.
		ELECTRICITY SUPPLY.		£ s. d.			
10	9 0	Bournemouth & Poole Elec. Sup. Ord.	10½ – 11	6 7 0	Mar, Sept.	10	..
10	4 6	Do. 4½ per Cent. Cum. Pref.	9½ – 10½	4 7 0	Feb, Aug		–
10	6 0	Do. 6 per Cent. Cum. Second Pref.	10½ – 11½	5 11 0	Feb, Aug	10	..
St.	4½%	Do. 4½ per Cent. Deb. Stock (red.)	100 – 103	4 7 6	Jan, July	..	..
5	3 6	Bromley (Kent) El. Lt. & Power Shares	4½ – 5	5 10 0	April, Oct	..	..
St.	4½	Do. Do. 1st Debs.	94 – 97	4 12 9	May, Nov	..	..
5	5 6	Brompton & Kensington Elec. Sup. Ord.	7 – 8	6 6 6	March....	..	..
5	3 6	Do. 7 per Cent. Pref.	6¾ – 7¼	4 10 0	Mar, Sept		..
St.	4%	Central Elec. Sup. Co. 4% Guar. Db. Stock	98 – 101	4 0 0	June, Dec	99	..
5	2/6	Charing Cross (W. End & City) El. Sup. Co.	3½ – 4	6 5 0	Feb, Aug	..	..
5	2 3	Do. 4½ per Cent. Pref.	4 – 4	5 0 0	Feb, Aug	4	..
St.	4%	Do. 4 per Cent. Deb. Stock (red.)	94 – 97	4 2 6	Jan, July	..	..
5	2 3	Do. City Undertaking 4½% Cm. Pref.	2¾ – 4½	5 11 0	Jan, July	..	..
5	2/6	Chelsea Electric Supply Ord.	8 – 8½	6 8 9	March ..	..	..
St.	4½%	* Do. 4½ per Cent. Deb. Stock (red.)	100 – 103	4 7 6	June, Dec	..	..
10	7 0	City of London Electric Lighting Ord.	9½ – 10	6 16 6	Feb, Aug	10	..
10	6/0	Do. 6 per Cent. Cum. Pref.	12 – 13	4 12 0	Jan, July	..	..
St.	5%	Do. 5 per Cent. Deb. Stock (red.)	122 – 125	4 0 0	June, Dec	..	..
St.	4½%	Do. 4½ per Cent. 2nd Deb. Stock (red.)	101 – 104	4 6 6	Jan, July	..	..
5	2%	County of Durham Elec. P.D. Ord.	2¾ – 3	3 9 7	April, Oct	..	..
5	5%	Do. 5 per Cent. non Cum. Pref.	3⅞ – 4½	6 5 0	April, Oct	..	..
10	6 0	County of London Elec. Supply Ord.	7½ – 8½	5 17 9	Feb, Aug	7¾	..
10	6 0	Do. 6 per Cent. Cum. Pref.	10½ – 11	5 9 0	Mar, Sept	10	..
St.	4½	Do. 4½% Deb. Stock (red.)	106 – 109	4 4 0	Jan, July	109½	..
St	4½	Do. Second Deb. Stock	98 – 101	4 9 9	May, Nov	..	..
5	3 6	Folkestone Electricity Supply Co. Ord.	4¼ – 5¼	5 7 0	April, Oct	..	–
5	2 6	Do. 5 per Cent. Cum. Pref.	5 – 6½	4 11 0	Mar, Sept	..	..
St.	4½%	Do. 4½ 1st Deb. Stock (red)	98 – 101	4 9 0	Feb, Aug	..	..
5	4 6	Hove Electric Lighting Ord.	6 – 6½	6 11 0	April, Oct	..	..
5	5 0	Kensington & Knightsbridge Ord.	8 – 9	5 11 0	Feb, Aug	..	..
5	6%	Do. 6 per Cent. 1st Pref.	6 – 6½	4 12 0	Jan, July	..	–
St.	4%	Do. 4 per Cent. Deb. Stock (red.)	96 – 99	4 1 0	..	..	..
St.	4%	Kensingtn. & Kngtbg. Co. & Notting Hill Co. (Joint Station) 4% Deb. Stock (red.)	97 – 101	3 19 0	April, Oct	-	..
St.	4½	† Kent Elec. Power Co.	86 – 90	5 0 0	Jan, July		..
3	1 6	London Electric Supply Ord.	1¼ – 1½	5 8 0	Mar, Sept	..	..
5	3 0	Do. 6 per Cent. Pref.	4½ – 5	6 0 0	Mar, Sept	..	–
St.	4%	Do. 4 per Cent. 1st Mort. Deb.	89 – 92	4 7 0	Jan, July	..	..
5	3 6	Metropolitan Electric Sup. Ord.	4½ – 5½	6 6 6	April, Oct	5	..
5	2 3	Do. 4½ per Cent. Cum. Pref.	4½ – 4¾	4 12 6	Jan, July	..	..
St.	4½%	Do. 4½ per Cent. Deb. Stock 1st Mort.	105 – 109	4 1 6	June, Dec	..	..
St.	3½	Do. 3½ per Cent. Mrt. Deb. Stock (red.)	84 – 89	3 19 0	Jan, July	..	..
100	4½%	Midland Elec. Corp. for P.D. 1st Mort. Db.	94 – 97	4 12 6	June, Dec	..	–
10	4	Newcastle & Dist. Elec. Ltg. Ord.	7½ – 8	5 3 2	Feb, Aug	..	–
100	4½%	Do. 4½ per Cent. Deb.	94 – 96	4 14 9	Jan, July	..	..
5	8%	† Newcastle Elec. Supply Ord.	5½ – 5½	7 8 10	Feb, Aug	..	..
5	5%	† Do. 5 per Cent. non Cum. Pref.	5¼ – 5½	4 15 8	Feb, Aug	..	..
100	4%	Do. 4 per Cent. Mort. Deb. red. 1907.	95 – 97	4 3 4	Jan, July	..	..
1	3%	Northern Counties Elec. Sup.	—	..	Mar, Aug	..	..
100	4½%	Do. 4½ per Cent. Deb.	93 – 95	4 15 9	Jan, July	..	..
10	6/0	Notting Hill Electric Ord.	12 – 13	5 8 0	March ..	..	..
5	4 6	Oxford Electric Ord.	5¾ – 6¼	5 12 0	March ..	..	..
St.	4%	† Do. 4 per Cent. Deb. Stock	95 – 98	4 2 0	Jan, July	..	..
5	5 0	St. James' & Pall Mall Elec. Ord.	7½ – 8½	5 18 0	Feb, Aug	7	7¾
5	3 6	Do. 7 per Cent. Pref.	6½ – 7½	4 16 6	Feb, Aug	..	..
St.	3½%	Do. 3½ per Cent. Deb. Stock (red.)	85 – 90	3 18 0	Jan, July	..	..
5	..	Smithfield Markets Electric Sup. Ord.	½ – ⅝	..	Feb	..	..
St.	4%	Do. 4 per Cent. Deb. Stock	70 – 74	5 8 0	Feb, Aug	..	..
5	4 0	South London Electric Supply Ord.	2½ – 3½	5 19 0	April	..	..
1	0/6	South Metrop'n Elec. Lt. & Power Ord.	⅝ – ⅞	4 0 0	..	..	..
1	0 8⅔	Do. 7 per Cent. Cum. Pref.	1 – 1¼	5 12 0	Feb, Aug	1	1⅛
St.	4½%	Do. 4½ 1st Db. Stk. Red.	100 – 103	4 7 6	April, Oct	..	–
5	2 6	Urban Electric Supply Ord.	½ – 1½	16 12 0	April, Oct	-	..
5	2 6	Do. 5 per Cent. Cum. Pref.	1⅛ – 1½	10 12 0	April, Oct	1	..
St.	4½%	Do. 4½ per Cent. 1st Mort. Deb.	82 – 85	5 6 0	April, Oct	..	..
5	5 0	Westminster Elec. Sup. Ord.	7¾ – 8¾	5 14 0	Mar, Sept	8¼	..
5	2 3	Do. 4½ per Cent. Cum. Pref.	5 – 5½	4 2 0	Jan, July	5¼	5⅜
		ELECTRIC RAILWAYS, TRAMWAYS, &c.					
St.	4%	† Baker St. & Waterloo 4% Perp. Db. St.	90 – 92	4 7 0	Jan, July	..	–
1	.	Bath Elec. Trams Pref. Ord.	¼ – ⅜	10 13 0	April	..	–
1	0/6	Do. 5 per Cent. Cum. Pref.	⅝ – ¾	5 14 0	Jan, July	..	..
St.	4½%	Do. 4½ 1st Mort. Deb. Stock (red.)	86 – 91	4 19 0	April, Oct	87½	87½
St.	4½	B'ham & Midland Trams 4½ 1st Db. Stk.	91 – 94	4 17 0	Jan, July	91¾	..
10	9%	Bristol Tramways & Carriage Ord.	11 – 11½	7 16 0	Feb, Aug	..	..
10	4%	Do. Cum. Pref. (fully paid)	8½ – 9	4 9 0	..	..	..
St.	4%	Do. 4 per Cent. Debs.	95 – 98	4 2 0	Feb, Aug	..	..
10	..	British Electric Traction Ord.	1¾ – 1 .	..	June, Dec	..	..
10	1/5½	Do. 6 per Cent. Cum. Pref.	4¼ – 4¾	..	Feb, Aug	4¼	..
St.	5%	Do. 5 per Cent. Perpetual Debs.	95 – 98	..	April, Oct	97	..
St.	4½%	Do. 4½ per Cent. 2nd Deb. Stock	76 – 78	5 15 0	May, Nov	..	..
St.	3%	Central London Ordinary Stock	68 – 71	4 4 6	Feb, Aug	71	69
St.	4%	Do. 4 per Cent. Pref. Stock	87 – 89	4 10 0	Feb, Aug	88¼	87
St.	2%	Do. Deferred Stock	53 – 56	3 11 3	Feb	55	..
100	4%	† Do. 4 per Cent. Debs.	101 – 104	3 17 0	Jan, July	..	..
St.	4%	Charing X, Euston & Hmpstd Per. Db. Stk.	81 – 84	4 15 0	Jan, July	..	..
5	2/6	City of Birmingham Trams. 5% Cm. Pref.	4½ – 4¾	5 5 0	April, Oct	..	..
100	4%	Do. 4 per Cent. 1st Mort. Debs.	97 – 100	4 0 0	April, Oct	..	..
St.	1¾%	City & South London Rly. Con. Ord.	33 – 34	5 3 0	Feb, Aug	34¼	33
St.	5%	Do. 5 per Cent. Perp. Pref. (1891)	113 – 116	4 6 0	Feb, Aug	..	..
St.	5%	Do. (1896)	112 – 115	4 7 0	Feb, Aug	..	..
St.	5%	Do. (1902)	110 – 113	4 8 6	Feb, Aug	..	..
St.	5	Do. (1903)	104 – 107	4 15 6	Feb, Aug	104	..
St.	4%	Do. 4 per Cent. Perpetual Debs.	100 – 103	3 17 6	May, Nov	..	..
10	7/0	Dublin United Trams. Ord	12¼ – 13¼	4 10 6	Feb, Aug	..	..
10	6/0	Do. 6 per Cent. Pref.	12½ – 13½	4 9 0	Feb, Aug	13	–
10	..	Gt. Northern & City Rly. Pref. Ord. (4%)	¾ – 1¼	..	Feb, Aug	1	..
10	4/0	G. Northern, Piccadilly & Brompton Ord.	7¼ – 7¾	5 6 0	Feb, Aug		.
St.	4%	Do. 4 per Cent. Deb. Stock	90 – 92	4 7 0	Jan, July	91½	91¼
5	4/0	Hastings & Dist. Elec. Trams. 6% Cm. Pf.	3¼ – 3¾	8 0 0	Mar, Sept	..	..
St.	4½%	Do. 4½ Db. St.	93 – 96	4 13 9	April, Oct	..	..
10	9%	‡ Imperial Tramways Ord.	10½ – 11½	7 17 0	Mar, Sept	..	..
10	6%	‡ Do. 6 per Cent. Pref.	9½ – 10	6 0 0	Mar, Sept	..	..
St.	4½%	‡ Do. 4½ per Cent. Debs.	90 – 92	4 18 0	Jan, July	..	..
5	..	I. of Thanet E. T. & Lt. 5 per Cent. Pref.	⅝ – 1⅜	..	Mar. Sept	..	..
St.	4%	Do. 4 per Cent. Deb. Stock	59 – 61	6 11 0	Jan, July	..	..
10	6/0	Lanarkshire Tramways	9½ – 10½	5 9 0	Feb, Aug	10	10
St.	5%	Lancs. Utd. Trams 5% Prior Lien Db. St.	91 – 93	5 7 6	Jan, July	..	..
10	..	Liverpool Overhead Railway Ord.	1¼ – 1¾	..	Feb, Aug	..	..
10	5%	Do. 5 per Cent. Pref.	5¾ – 6¼	8 0 0	Feb, Aug	..	..
St.	4%	Do. 4 per Cent. Deb.	84 – 85	4 13 0	Jan, July	..	..
10	5 0	London United Trams. 5% Cum. Pref.	6½ – 7	6 13 6	Jan, July	6½	..
St.	4%	Do. 4 per Cent. 1st Mort. Deb. Stock	79 – 84	4 15 0	Jan, July	80	79
St.	..	Mersey Con. Ord. Stock	1 – 3	—	Feb, Aug.	..	..
St.	..	Do. 3 per Cent. Perp. Pref	8 – 6	—	..	..	..
1	..	Metropolitan Elec. Tramways Def.	¼ – ½	–	April.. .	..	..
1	0/6	Do. 5 per Cent. Cum. Pref	⅞ – 1	6 3 6	Feb, Aug		..
St.	4½%	Do. 4½ per Cent. Deb. Stock	93 – 96	4 13 9	Jan, July	94½	..
St.	½%	Metropolitan Railway Consolidated	34½ – 35½	1 6 6	Feb, Aug	37½	34½
St.	2¾%	Do. Surplus Lands Stocks	67 – 69	4 0 0	Feb, Aug	68¾	67½
St.	3½	Do. 3½ per Cent. Preference	86 – 89	3 19 9	Feb, Aug	89	86½
St.	3½	Do. 3½ per Cent. "A" Preference	76 – 79	4 5 6	Feb, Aug	78	..
St	3½%	Do. 3½ per Cent. Convertible Pref.	73 – 76	4 12 0	Feb, Aug	..	..
St.	3½%	† Do. 3½ per Cent. Debenture Stock	90 – 93	3 15 3	Jan, July	91½	90¼
St.	3½	† Do. 3½ per Cent. "A" Ditto	88 – 91	3 17 0	Jan, July	..	..

* In calculating the yield allowance has been made for accrued interest but *not* for redemption

† Ex Dividend

ELECTRICAL COMPANIES' SHARE LIST.—*Continued.*

Share	Last Dividend	Name	Price Wed., July 29.	Rate % Yield.	Dividend Due.	Business Week to July 29. High-est.	Low-est.
		ELECTRIC RAILWAYS & TRAMWAYS—Continued.		£ s. d.			
St.	..	Metropolitan District Railway Ord.	11½—12½	..	Feb, Aug	12	11⅝
St.	..	Do. Extension Pref. (5 per Cent.)	21 —26	..	Feb, Aug	22	21½
St.	3½	Do. Assented Ext. Pref. (Int. Guar. by Und. Elec. Rlys. Co. of London, Ltd.)	47 —51	6 16 6	Feb, Aug	..	..
St.	3%	Do. 3 per Cent. Consolid. Rent-charge	73 —76	3 19 0	Jan, July	74½	..
St.	4%	Do. 4 per Cent. Midland Rent-charge	98 —102	3 18 0	Jan, July	..	..
St.	1½	Do. Guar. Stock 4 per Cent.	44 —49	3 11 0	Mar, Sept	47	..
St.	6	Do. 6 per Cent. Perp. Deb. Stock	115 —120	5 0 0	Jan, July	..	..
St.	4	Do. 4 per Cent. Ditto	71 —76	5 5 0	Jan, July	..	..
5	..	New Gen. Tract. 6 per Cent. Cum. Pref.	¾—1	..	May	..	..
1	0/9¾	Potteries Electric Traction Ord.	⅞—1⅛	8 0 0	April, Oct	..	..
1	0/6	Do. 5 per Cent. Cum. Pref.	⅞—⅞	6 13 0	Feb, Aug	..	..
St.	4½%	Do. 4½ per Cent. Deb. Stock	93 —96	4 14 6	May, Nov	..	..
1	0 7½	S. Met. Elec. Trams. & Ltg. 6% Cm. Pref.	¾—1	6 0 0	Feb, Aug	..	..
St.	4%	Do. 4 per Cent. Deb. Stock	76 —80	5 0 0	Jan, July	..	..
100	5%	Sunderland Dist. Elec.Trms.5% 1stMt.Db.	75 —80	6 5 0	Jan, July	..	..
..	5%	Underground Elec. Rys. Co. of London	39 —43	11 12 0	June, Dec	40½	..
5	..	Yorkshire (W.R.) Elec. Trams. Ord.	⅞—1⅛	—	March	..	..
5	..	Do. 6 per Cent. Cum. Pref.	3⅛—3⅝	—	..	..	..
St.	4½	Do. 4½ per Cent. 1st Debs.	83 —86	5 5 0	Jan, July	..	..
		ELECTRIC MANUFACTURING, &c.					
1	..	Aron Electricity Meter Ord.	⅞—1⅛	..	..	..	..
1	1 4½	Do. 6% Cum. Pf. ex on a/c arrears)	1⅛—1⅜	7 12 0	April, Oct	..	..
1	2/4½	Babcock & Wilcox Ord.	3½—3⅝	4 16 3	April, Oct	3½	3½
1	0/7½	Do. Pref.	1⅝—1⅞	3 16 9	..	..	..
5	6 0	British Insulated & Helsby Cables Ord.	6¼—6¾	7 4 0	July, Feb	..	..
5	3/0	Do. 6 per Cent. Pref.	6 —6½	4 12 0	Jan, July	..	..
St.	4½%	Do. 4½ per Cent. 1st Mort. Deb. (red.)	102 —105	4 5 6	Jan, July	..	..
St.	4½%	British Thoms'n-Houst'n 4½% 1st Mt.Db.	93 —98	4 12 0	Mar, Sept	..	..
5	..	British Westinghouse 6 per Cent. Pref.	1⅛—1⅝	..	Feb, Aug	..	..
St.	4%	Do. 4 per Cent. Mort. Deb. Stock	43 —48	8 8 0	Jan, July	..	..
2	..	Brush Electrical Engineering	½	—	March	..	..
2	..	Do. 6 per Cent. Pref. non-Cum.	⅞—1⅛	—	Mar, Sept	..	..
St.	4½%	Do. 4½ per Cent. Perp. 1st Deb. Stock	70 —75	6 0 0	Mar, Sept	..	..
St.	4½%	Do. Perpetual 2nd Deb. Stock	53 —58	7 14 0	Jan, July	..	..
5	16 0	Callender's Cable Con. Ord.	9½—10½	7 1 0	Jan, July	10⅛	..
5	2/6	Do. 5 per Cent. Cum. Pref.	5¼—5¾	4 7 0	Jan, July	5⅝	..
St.	4½%	Do. 4½ per Cent. 1st Mort Debs. (red.)	105 —107	4 4 0	Nov, May	106½	105½
1	1/0	Castner-Kellner Alkali Co.	1⅛—1⅜	8 14 0	May, Nov	1¼	1¼
St.	4½%	Do. 4½ per Cent. 1st Mort. Deb. (red.)	102 —105	4 5 6	Feb, Aug	..	..
1	0 9¾	Chadburn's (Ship) Telegraph Ord.	1⅛—1¼	8 8 0	March	..	..
1	0/7½	Do. 6 per Cent. Cum. Pref.	1 —1⅛	5 6 6	April, Oct	..	..
1	0/8	†Consolidated Electrical Co.	1—1½	7 0 0	August	..	..
1	1/0	Consolidated Signal Co.	1¼—1⅜	8 17 9	April, Oct	..	..
1	0 7½	Do. 6 per Cent. Cum. Pref.	⅞—1⅛	6 4 0	April, Oct	..	..
3	3/0	* Crompton & Co. (Nos. 1 to 86,000)	1⅜—1⅝	8 1 6	Jan, July	..	..
100	5%	Do. 5 per Cent. 1st Mort. Debs. (red.)	90 —93	5 7 0	Jan, July	..	..
1	0/7½	Davis & Timmins	⅞—1½	..	Mar, Sept	..	..
5	2/0	Dick, Kerr & Co. Ord.	1⅜—1⅝	7 11 0	Sept	..	..
5	0/7½	Do. 6 per Cent. Cum. Pref.	1 —1¼	4 16 0	Sept	..	..
St.	4½	Do. 4½ per Cent. Deb. Stock	99 —102	4 8 6	Jan, July	..	..
5	2/6	Edison & Swan United ("A" Sh.) (£3 pd.)	⅞—⅞	..	Feb, Aug	..	..
5	1/2	Do. (£5 paid)	1½—2½	5 0 0	Feb, Aug	..	..
St.	4%	Do. 4 per Cent. Mort. Deb. Stock (rd.)	76 —79	5 1 6	June, Dec	..	..
St.	5%	Do. 5 per Cent. 2nd Deb. Stock	85 —87	5 15 0	Mar, Sept	..	..
5	..	Edmundson's Elec Corp. Ord.	⅞—⅞	..	Jan, July	..	..
5	..	Do. 6 per Cent. Cum. Pref.	¾—1	..	May, Nov	..	..
St.	4½%	† Do. 4½ per cent. 1st Mort. Deb. (red.)	60 —67	6 14 0	Jan, July	..	..
2	..	Electric Construction Co.	½ —⅞	..	Jan, July	..	..
2	..	Do. 7 per Cent. Cum. Pref.	1½—2	..	July	..	..
St.	4%	† Do. 4 per Cent. Perp. 1st Mort. Debs.	66 —71	6 13 0	Jan, July	..	..
10	5/0	General Electric (1900) 5% Cum. Pref.	7½—8	6 5 0	June, Dec	..	..
St.	4%	Do. 4 per Cent. 1st Mort. Debs.	84 —87	4 12 0	Mar, Sept	..	..
1	1 0	Henley's Telegraph Works Ord.	10½—11½	6 10 0	Feb, Aug	..	..
5	2/3	Do. 4½ per Cent. Pref.	5 —5½	4 2 0	Feb, Aug	..	..
St.	4½%	Do. 4½ per Cent. 1st Mort. Deb. Stock	106 —108	4 3 6	Mar, Sept	..	..
10	5/6	India Rubber, Gutta Percha, &c., Wrks.	15½—16½	6 2 0	Feb, Aug	16	15⅞
100	4%	Do. 4 per Cent. Debs. (red.)	98 —100	4 0 0	April, Oct	..	..
1	..	National Elec. Construction Co.	⅞—⅞	..	April	..	..
1	0/9¾	Richardsons, Westgarth & Co., Ltd. Ord.	1⅛—1⅜	7 2 0	Nov	..	..
1	0/7½	Do. 6 per Cent. Cum. Pref.	⅞—⅞	6 17 0	May, Nov	..	..
St.	4½%	Do. 4½ per Cent. Perp. Deb. Stock	87 —90	5 0 0	Jan, July	..	..
1	..	Simplex Conduits Ord.	1½	..	..	..	..
5	..	Do. 6 per Cent. Cum. Pref.	5¼	..	..	..	..
12	12/0	†Telegraph Construction & Maintenance	31 —33	6 8 0	Mar, July	32½	31
100	4%	Do. 4 per Cent. Deb. Bonds (1909)	100 —102	3 18 0	Jan, July	..	..
1	2 0	Vickers, Sons & Maxim, Ltd. Ord.	1⅝—1⅞	8 11 0	..	1⅞	1⅞
1	0/6	Do. 5 per Cent. non-Cum. Preference	1 —1⅛	4 9 0	..	1	..
St.	5%	Do. 5 per Cent. non-Cum. Preferred	102 —106	4 14 6	..	104	..
St.	4%	Do. 4 per Cent. 1st Mort. Db. Sk. (red.)	103 —105	3 16 0	June, Dec	..	..
100	4½%	Do. 4½ per Cent. 2nd Mort. Deb. (red.)	104 —106	4 5 0	June, Dec	..	..
100	15/6	Do. 5 per Cent. 3rd Mort. Debs. Scrip.	102 —104	..	..	103½	102⅝
15	10/0	J. G. White & Co. 6% Cm. Pref. xd&bonus	7 —8	7 10 0	..	..	..
5	1/0	Willans & Robinson Ord.	¾—1¼	4 0 0	Apr, Oct	..	..
5	3/0	Do. 6 per Cent. Cum. Pref.	3 —3½	8 11 6	Apr, Oct	3	..
100	4%	Do 4 per Cent. 1st Mort. Debs.	72 —76	5 5 6	May, Nov	..	..
		TELEGRAPHS.					
10	..	Amazon Telegraph	1¾—2¾	—	June, Dec	2	—
100	5%	Do. 5 per Cent. Debs. (red.	86 —89	5 12 0	June, Dec	..	..
St.	15/0	Anglo American	57 —60	5 13 6	F,My,Ag,N	..	..
St.	20 0	Do. Preferred	103½—104½	3 16 0	F,My,Ag,N	103½	..
St.	1%	Do. Deferred	15¼—15¾	6 7 0	F,My,Ag,N	15⅝	15⅝
St.	4%	Commercial Cable 4 per Cent. Deb. Stk.	83 —86	4 13 0	Jn,Ap,Jy,O	85½	84½
10	6 0	Cuba Submarine Ord.	7½—8½	7 0 0	Feb, Aug	..	..
10	10/0	Do. Preference 10 per Cent.	15½—16½	6 1 6	Feb, Aug	..	..
5	2 0	Direct Spanish Ord.	3 —3½	6 4 0	April, Oct	..	..
5	5/0	Do. 10 per Cent. Cum. Pref.	8 —9	5 11 0	April, Oct	7	..
100	4½%	Do. 4½ per Cent. Deb.	100 —103½	4 7 6	Jan, July	..	..
20	4 0	Direct United States Cable	13⅛—13⅞	6 11 0	Ja,Ap,Jy,O	13⅞	13½
100	4½%	Direct West India Cable 4½% Rg. Db. (rd.)	98 —100	4 10 0	June, Dec	98½	..
St.	7 0	Eastern Ordinary	132 —135	5 4 0	Ja,Ap,Jy,O	134½	132½
St.	17 6	† Do. 3½ per Cent. Pref. Stock	83½—86½	4 2 0	Ja,Ap,Jy,O	84½	84½
St.	4	Do. 4 per Cent. Mort. Deb. Stk. (red.)	101 —103	3 17 6	May, Nov	102½	102½
10	2 6	†Eastern Extension	12⅞—13½	5 8 6	Ja,Ap,Jy,O	13	12⅞
St.	4%	Do. 4 per Cent. Deb. Stock	101 —103	3 17 6	Feb, Aug	102½	101⅞
100	4%	Eastern & S. African 4% Mort. Deb. 1909	100 —102	3 18 6	Feb, Aug	..	..
25	4%	Do. 4% Mauritius Sub. Debs. red.	100 —102½	3 18 6	May, Nov	..	..
10	5 0	G. N. of Copenhagen ex.d. b Coupon 74	27 —29	6 15 0	Jan, July	29	28½
100	4½	Halifax & Bermuda 4½% 1st Mt. Db. (red.)	98 —100	4 12 0	June, Dec	..	..
25	7 6	Indo European	56 —59	5 12 0	May, Nov	..	..
100	$1	Mackay Companies Common	66 —70	5 14 0	Ja,Ap,Jy,O	..	..
100	$1	Do. Preference	66 —70	5 11 0	Ja,Ap,Jy,O	..	..
1	..	Marconi's Wireless Telegraph Co.	⅝—⅞	..	April	..	..
100	4	Pacific & European Tel. 4% Guar. Dbs. (red.)	96 —100	4 0 0	June, Dec	..	—
1	1/3	West Coast of America	1¼—1½	4 5 0	May	..	..
100	4	Do. 4 per Cent. Deb.	98 —101	3 19 6	Jan, July	..	..
10		West India & Panama	[illegible]—[illegible]	..	May, Nov	[illegible]	..
10	[illegible]	Do. 6 per Cent. 1st Pref.	[illegible]—8½	7 1 0	May, Nov	[illegible]	8½
10	[illegible]	Do. 6 per Cent. 2nd Pref. [illegible]	8½—9½	..	May, Nov	9	..
100	[illegible]	Do. 5 per Cent. Deb.	99 —102	4 18 0	Jan, July	100	..
10	[illegible]	Western Telegraph	13⅞—14½	4 19 0	Mr,Jn,O,D	14¼	13⅞
St.	4%	Do. 4 per Cent. Deb. Stock (red.)	99½—101½	3 18 6	June, Dec	..	..
..	4%	Western Tel. Co. [illegible] 4% Bonds	80 —85	4 14 0	..	..	..

Share	Last Dividend	Name	Price Wed., July 29	Rate % Yield.	Dividend Due.	Business Week to July 29. High-est.	Low-est.
		TELEPHONES.		£ s. d.			
100	2$	†Amer. Telephn. & Telegh. Cap. St.	122 —127	6 6 0	..	..	..
..	4%	Do. Coll. Trust $1,000 4 per Cent. Bds	89 —92	4 7 0	Jan, July	..	..
St.	5%	Anglo-Portug'se Tel. 5% 1st Mt. Db. Stk.	101 —104	4 16 0	Mar, Sept	..	..
5	3 0	Chili Telephone	8 —8½	4 14 0	August	..	..
1	0/7½	Monte Video Telephone Ord.	1⅛—1¼	6 12 0	Nov	1¼	..
1	0/6	Do. 5 per Cent. Pref.	⅞—1⅛	5 6 0	May, Nov	..	..
St.	6%	National Co. Pref. Stock	109 —111	5 8 0	Feb, Aug	110½	109
St.	6%	Do. Def. Stock	118 —120	5 0 0	Feb, Aug	121½	118
10	6/0	Do. 6 per Cent. Cum. 1st Pref.	10½—12½	4 18 0	Feb, Aug	10⅝	..
10	6/0	Do. 6 per Cent. Cum. 2nd Pref.	10 —12	5 0 0	Feb, Aug	..	..
5	2/6	Do. 5 per Cent. non-Cum. 3rd Pref.	5⅝—5⅞	4 5 0	Feb, Aug	5½	..
St.	3½%	* Do. Deb. Stock 3½ per Cent. (red.)	97½—99½	3 10 6	June, Dec	98½	..
St.	4%	Do. 4 per Cent. Deb. Stock (red.)	101 —103	3 17 0	Jan, July	..	..
1	1/0	Oriental	1⅛—1⅜	6 6 8	April, Oct	..	..
1	0 7½	Do. 6 per Cent. Cum. Pref.	1¼—1½	4 16 0	April, Oct	..	..
St.	4%	Do. 4 per Cent. Red. Deb. Stock	88 —91	4 8 0	Jan, July	..	..
St.	4½%	Telephone Co. of Egypt 4½% Db.Stk.(red.)	98 —101	4 11 0	Jan, July	..	..
5	3/0	United River Plate	6½—7½	5 10 0	July	6⅞	..
5	2/6	Do. 5 per Cent. Cum. Pref.	5 —5½	4 11 0	June, Dec	..	..
St.	4½%	Do. 4½ Deb. St. Red.	99½—101½	4 8 6	Jan, July	101	101
		FINANCIAL, INVESTMENT, &c.					
5	8/0	Elec. & Gen. Investment 6% Cum. Pref.	3½—4	7 10 0	Jan, July	..	..
10	5/9	†Globe Telegraph & Trust	10¼—10¾	5 11 0	SpDcMrJu	10⅜	10⅛
10	3/0	† Do. 6 per Cent. Pref.	13½—13¾	4 7 6	SpDcMrJu	13⅝	13½
10	6%	Submarine Cables Trust (Cert.)	127 —130	4 12 0	April, Oct	127½	127
		COLONIAL AND FOREIGN ELECTRIC RAILWAYS, TRAMWAYS, &c.					
5	3/0	Anglo-Argentine 6% Cum. 1st Pref.	6½—6¾	4 14 0	April, Oct	6⅜	6¼
5	5/0	Do. 10% Non-cum. 2nd Pref.	8 —8½	5 13 0	Jan, July	8	8
St.	6%	Do. Permanent 6% Deb. Stock	141 —146	4 2 0	June, Dec	..	..
St.	5%	Auckland Elec. Trams. 5% Deb. (red.)	103 —106	4 14 3	Jan, July	101½	101
5	4/0	Brisbane Electric Trams. Invest. Ord.	4⅛—4⅜	4 8 6	May	4⅜	4¼
5	2/6	Do. 5 per Cent. Cum. Pref.	5⅛—5⅜	4 17 6	May, Nov	..	..
St.	4½%	Do. 4½ per Cent. Db. Prov. Certs.	98 —102	4 8 0	Jan, July	..	..
St.	8%	British Columbia El.Ry.Df. Ord.	124 —129	6 4 0	Mar, Sept	..	..
St.	6%	Do. Pref. Ord. Stock	109 —113	5 6 0	May, Nov	112½	110
St.	5%	† Do. 5% Cum. Perp. Pref. Stock	104 —108	4 12 6	Jan, July	106½	105
40	4½%	Do. 4½ per Cent. 1st Mort. Debs.	99 —102	4 8 0	April, Oct	..	..
100	4½%	† Do. Vancouver Power Debs.	100 —103	4 7 6	Jan, July	..	..
St.	4½%	Do. 4½% Perp Con. Deb. St.	101 —104	4 1 6	—	102⅝	102
St.	5%	Buenos Ayres Elec. Trams (1901) Ltd. Deb. St.	93 —97	5 2 6	Ja, Jul	..	..
5	..	Buenos Ayres Grand National Ord.	2¼—2⅝	..	..	2⅜	..
5	2/6	Do. 5 per Cent. Cum. Pref.	3⅞—4⅛	..	Feb, Aug	..	..
100	5½%	Do. 5½ per Cent. Pref. Debs.	99 —103	5 7 6	Jan, July	..	..
100	6%	Do. 6 per Cent. 1st Deb. Bonds.	100 —104	5 14 6	April, Oct	..	..
St.	5%	Buenos Ayres Lacroze Trams 1st Mt. Db	93 —96	5 4 0	Mar, Sept	..	..
St.	6%	Buenos Ayres Port & City Tram. 1st Mt. Deb. Stock £75 Paid	64 —68	6 12 0	Feb, Aug	..	..
5	2/6	Calcutta Tramways (1 to 137,810)	4½—4¾	5 14 0	Mar, Sept	5	..
100	2/6	Do. 5 per Cent. Cum. Pref.	4⅜—5⅛	4 13 0	Jan, July	4⅞	..
1	4½%	Do. 4½% 1st Deb. Stock (red.)	101 —104	4 6 6	Jan, July	102½	..
St.	..	Cape Electric Tram Shares	⅞—1⅛	..	..	..	..
5	1/3	City of Buenos Ayres Trams Co. (1904,Sh.	5½—5⅞	4 5 0	F,My,A,N	5	..
St.	4%	Do. 4 per Cent. Deb. Stock	97 —101	3 19 0	June, Dec	..	..
	5%	Colombo Tr. & Ltg. 5% 1st Mt. Db.	88 —91	5 10 0	May, Nov	..	..
100	5%	Electric Traction Co. of Hong Kong 5 per Cent. 1st Mort. Debs.	87 —90	5 10 0	June, Dec	..	..
1	5%	†Havana Elec. Ry. Con. Mt. 5% $1,000 50 year Coup. Bds.	80 —85	5 9 6	Feb, Aug	84½	83½
1	..	Kalgoorlie Elec. Trams Sh.	⅛—¼	..	..	..	..
100	5%	Do. 5 per Cent. "A" Deb. Stock	85 —87	5 12 0	Jan, July	..	..
1	6%	Do. 6 per Cent. "B" Ditto	69 —73	8 4 0	Jan, July	..	..
5	1/0	Lisbon Elec. Trams. Ord.	1 —1¼	4 0 0	July	..	..
100	0/7½	Do. 6 per Cent. Cum. Pref.	1 —1¼	4 16 0	Jan, July	..	..
St.	5%	Do. 5 per Cent. Reg. Mort. Debs	92 —97	5 3 0	Jan, July	..	..
St.	5%	Madras Elec. Trams. 5% Deb. Stk.	93 —96	5 4 0	Jan, July	94½	..
	5%	Manila Elec. Ry. $1,000 Gold Bonds	86 —90	5 11 3	Feb, Aug	..	..
100	$1	Mexico Trams Co. Com St.	108½—110½	3 12 9	..	110	105
500	5%	Do. Gen. Con. 1st Mort. 5% Gold Bds.	91½—92½	5 7 6	..	92½	92½
St.	4½	Montreal St. Ry. Sterling 4½ per Cent Debs. (1922)	102 —104	4 6 6	Feb, Aug	..	..
1	1/0	Perth Elec. Trams Ord	3 —3½	7 3 6	May	..	..
St.	5	Do. 1st Mt. Db. Stock	101 —104	4 16 0	Jan, July	..	..
5	3/0	Rangoon Elec. Trams & Supply Co. 6 Cum. Pf.	5⅛—5⅝	5 6 6	..	..	..
St.	4½	Do. 4½ 1st Mort. Deb. Stk.	94½—95½	4 10 6	..	..	—
..	$1½	Sao Paulo Tramway, Light & Power Co $100 Stock	142 —146	6 3 0	..	144½	141½
..	5%	Do. 5 per Cent. 1st Mt. $500 Db.	98 —99	5 2 0	June, Dec	98½	98½
100	4½%	Toronto Ry Co. 1st Mt. 4½% Ster. Bonds	99 —101	4 9 0	Feb, Aug	..	..
		COLONIAL AND FOREIGN ELECTRICITY SUPPLY &c.					
5	3 0	Adelaide Elec. S'ply Co. 6% Cu. Pr.	4½—5¼	5 14 0	Mar, Sept	..	..
10	5/2½	Bombay E. S. & T. 6% Cm. Pf.	10½—10¾	5 11 6	..	..	..
St.	4½	Do. 4½ per Cent. Deb. Stk (red.)	94 —96	4 13 9	Jan, July	94½	93½
5	4/9	Calcutta Elec. Supply Ord.	5½—6¼	5 17 0	April, Oct	5½	5
100	7/2	Canadian Gen. Elec. Co. Com. St.	93 —95	7 11 0	..	93½	93
100	5%	Castner Electrolytic Alkali Co. (of U.S.A.) 1st Mort. Stl. Debs.	92 —97	5 2 6	Jan, July	..	..
500	5	Elect. Development Co of Ontario	80 —83½	6 1 0	..	..	..
5	..	Elec. Ltg. & Trac. Co. of Aust. 6 per Cent. Cum. Pref.	2 —2½	..	Feb, Aug	..	..
St.	6%	Do. 6 per Cent. Deb Stock	85 —90	5 9 0	Jan, July	..	..
St.	5%	Elec. Supply Co of Victoria 5 per Cent. 1st Mort. Deb. St.	90 —93	5 7 6	Jan, July	..	..
St.	6%	Indian Elec. Sup. & Trac. Co. Constn Deb. St. Rd.	30 —40	15 0 0	Jan, July	39½	39
100	0 3	Kalgoorlie Elec. Power & Ltg. Ord.	[illegible]—	..	..	..	..
1	0/7½	Do. 6 per Cent. Cum. Pref	⅞ —1	8 0 0	April, Oct	..	..
St.	6%	Madras E. S. Corp. 6 per Cent. Constn Deb. St	85 —90	5 11 0	April, Oct	..	..
500	6%	Mexican Elec. Light Co. 6% 1st Mort. Gold Bonds	84½—86½	5 17 0	..	85	84½
St	$1	Mexican Lt. & Power Co. Cap. St.	68 —69	..	..	68½	68½
500	5%	Do. 5% 1st Mort. Gold Bds.	90½—91½	5 9 6	..	91½	90½
100	6 2	Montreal Lt. Ht. & Power Co. Cap. St.	93 —99	6 1 0	F,My,A,N	9[illegible]	..
1	1/[illegible]	River Plate Electricity Co. Ord.	⅞ —1	6 0 0	April	..	..
1	1 2½	Do. 6 per Cent. non-Cum. Pref.	[illegible]—1	6 0 0	May	..	..
St.	6%	Do. 6 per Cent. Deb. Stock	96 —98	6 [illegible] 6	Jan, July	97½	93½
5	3/0	Rosario Elec. Co. 6% Pref. (1–20,000)	4½—5	5 17 6	April, Oct	..	..
100	$1	Shawinigan Water & Power Co. Cap. St.	73 —75	5 6 6	..	74	70½
..	5%	Do. 5 per Cent. Bds.	101 —103½	4 17 6	Jan, July	103½	102½
..	6d	Victoria Falls Power Co. Pref.	..	—	Jan, July	..	..

* In calculating the yields allowance has been made for accrued interest but not for redemption. † Ex dividend. ‡ The London Stock Exchange Committee have declined to quote these.

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CONTENTS OF THE CURRENT NUMBER.

NOTES.

The London Power Bills.

THE London and District Electricity Supply Bill, which was under discussion in the House of Commons as we went to press last week, has passed its second reading and is to be considered in Committee during the forthcoming autumn session, when the other two Bills relating to electricity supply in London will also be brought forward for their second reading. An account of the debate, which will be found in our Parliamentary columns, evidences great determination on the part of the Government to secure an early settlement of the question of power supply in London. It will also be observed that many members of the Progressive party on the London County Council were amongst the supporters of the Bill. The opponents to the measure comprised first those who are desirous of protecting municipal undertakings within the area covered by the Bill from the possibility of competition, and second, those who are opposed to private enterprise in any shape or form.

MR. WINSTON CHURCHILL made a lengthy speech in support of the second reading, and employed arguments which showed clearly that the right hon. gentleman had not devoted as much time to the subject as is necessary to become fully conversant with all the details. His notion, that because London is larger than Newcastle it therefore ought to have a cheaper supply of electricity, is of the very crudest. It would be equally reasonable to demand that coal should be cheaper in London than in Newcastle, simply because the former is the larger city and therefore presumably consumes more in a given time. As a matter of fact it is utterly useless to attempt comparisons between the two cities, and the sooner this is realised by all concerned the sooner is the problem—for there is undoubtedly a problem—likely to reach solution. If it were not for the gravity of the issues involved, Mr. CHURCHILL's speech would provide a good deal of amusement, especially to members of the electrical engineering profession. He deprecated any suggestion of the debate rising to "tragic heights," but a few minutes before he had said that for the people of London, "all these millions, rich and poor alike, whether in their units or in combination, cheap electricity was scarcely less important than cheap and abundant food." His technical knowledge is well illustrated by his statement that "the mains of London should be flushed with a cheaper supply of electricity."

Electrical Nomenclature.

WE publish on another page the first part of the schedule of terms which has been drawn up by the Sub-committee on Nomenclature appointed by the British Committee of the International Electrotechnical Commission. On the whole, there is very little in this list to which exception can be taken, and in many instances the definitions are largely a matter of individual taste. Nevertheless, we may perhaps point out that the definition of "candle-power" does not come within this category. It is the word "intensity" to which we call attention. Hitherto, intensity has been regarded from an entirely different point of view. For instance, intensity of field is the number of lines per square centimetre. In exactly the same way, intensity of illumination is defined as the total light energy falling on a surface, divided by the area of that surface, provided, of course, that the illumination is uniform. Following this idea, luminous intensity can only be regarded as "candle-power per unit area of source."

Another definition to which exception will probably be taken is that of "coherer." Strictly, a coherer is a device whose resistance is *lowered*, and not merely altered, on the reception of a signal. For this reason such an arrangement as that devised by Dr. Lee de Forest, consisting of a tiny electrolytic cell, the resistance of which *increases* on the reception of a signal, could by no stretch of imagination be called a coherer; yet its resistance is altered. However, we regard this definition as of minor importance compared with that involving candle-power, and there is no very great objection to making a more general use of the word.

Electric Haulage on Canals.

It is undoubtedly a fact that the construction of a vast network of railway track in this country was largely responsible for the disuse of canals, and that the result was accelerated by absorption of interests in a number of cases. The consequence is that the existence of canals has been almost forgotten, or at any rate seriously neglected, so far as their utilisation as highways is concerned. Yet there is a possibility of their being used again, in a remunerative fashion, and schemes are continually being put forward to attain this end. Obviously the traffic would be mainly for goods, but, on the other hand, there are many features of interest on the canals in the South of England which might even attract a leisured class of passenger. Judging from the evidence which was taken during the sitting of the Royal Commission on Canals and Waterways nearly two years ago, electric haulage on canals does not seem to be very favourably considered by many of those responsible for these waterways, but it has been adopted in several instances in other countries. The Paper by Messrs. L. B. Stillwell and H. St. C. Putnam, read a short time ago before the American Institute of Electrical Engineers, and reproduced in abstract in this issue, contains much useful information on this subject, and the figures given as the result of many tests should prove valuable to engineers who are interested in this question.

A Large South Wales Colliery Power Plant.—In our description of the Ferndale Colliery equipment which appeared on p. 594 of our last issue we stated that four Stirling boilers of the three-drum type were installed for generating the necessary steam. We are informed by the Stirling Boiler Co. that this should be four Stirling boilers of the *four*-drum type, as three-drum type boilers are only made in small sizes, and those in use at Tylorstown are very large.

Electrical Transmission of Power for Marine Propulsion.—In our last issue we gave an abstract of a Paper by Mr. W. P. Durtnall dealing with this interesting subject which was considered to be rather "in the air." It is now stated, however, that, while the system has not yet been adopted for ocean liners, it is being employed successfully on the fire boats in Chicago. The same turbines drive both the main generators and the centrifugal fire pumps, thus saving special pumping engines and at the same time tending to economy, as very little power is required for propulsion when the pumps are at work.

Cable Interruptions and Repairs.

	Date of Interruption.	Date of Repair
Las Palmas—Arrecife	May 18, 1908 ...	—
Kotonou—Grand Bassam ...	July 20, 1908 ...	Aug. 4, 1908
[illegible]	July 27, 1908	—
[illegible]	July 23, 1908 ...	—
[illegible]	[illegible] 1, 1908 ...	—
[illegible]	Aug. 5, 1908 ...	—

First Atlantic Cable.—On August 5, 1858 (50 years ago on Wednesday last) the laying of the first submarine telegraph cable between Great Britain and America was accomplished.

International Conference on Electrical Units.—The President of the Board of Trade has appointed the Right Hon. Lord Rayleigh, O.M., P.R.S., Prof. J. J. Thomson, F.R.S., Dr. R. T. Glazebrook, F.R.S., Sir John Gavey, Kt., C.B., and Mr. A. P. Trotter to be the British delegates to the International Conference on Electrical Units and Standards, which is to assemble in London on October 12. Mr. W. Duddell, F.R.S., and Mr. M. J. Collins, of the Board of Trade, will act as secretaries to the British delegates, and Mr. F. E. Smith and Mr. C. W. S. Crawley as assistant secretaries.

Telegraphy in Africa.—*L'Electricien* announces that a telegraph system will shortly be completed in the French African colonies enabling communication to be established with the most distant posts. The Government of French West Africa is erecting a line connecting Timbuctoo with Zinder, thus putting the basins of the Niger and Tchad in communication with the Coast. This Government, in conjunction with that of Algeria, has, it is stated, under consideration a line connecting North and Central Africa, which will, in effect, duplicate the submarine cable from Brest to Daken.

Faraday House Journal.—The July number of this journal is quite up to the usual excellent standard that we are now accustomed to expect. Perhaps, but this may only be due to the hot weather, the number before us is rather thinner than usual, but the contents make up in quality what they may lack in quantity. *Pièces de résistance* are provided by Messrs. A. S. Cross, H. W. Swann, T. C. Harrison and T. C. Kay, who write on subjects so far apart as "Tramway Rail Potentials" and "Systems of Works Cost Keeping." The list of examination results at the end of the issue has doubtless rejoiced many hearts and disappointed as many more

A Solderless Cable Connection.—The *Electric Railway Review* describes an arrangement whereby the load on the traction feeders of the Brooklyn Rapid Transit Co. was equalised. The cables are about $2\frac{1}{2}$ in. in diameter, are run along the Brooklyn Bridge and are supported in insulated cradles from the structure. The nearness of the cables to each other prevented the use of the ordinary splice. A solderless connection was, therefore, designed, which grips the cable, while a copper conductor connects the clamps. By this arrangement the cables were not cut, just enough insulation being removed to accommodate the connection. After their insertion the connectors were taped and then covered with insulating compound.

The Induction Motor in Mining Work.—In an address on this subject recently delivered by A. W. K. Pierce before a meeting of the South African Association of Engineers, held at Johannesburg, the author stated that the most suitable induction motor for general use was one running at as high a speed as was consistent with its size, at a voltage not exceeding 400 and on a circuit having a frequency of 50 cycles per second. He confined his attention to three-phase motors of the induction type, and said that certain special applications of electric power, or the limitations imposed by the existing systems of supply, might occasionally render the employment of other types necessary, but such circumstances would only be exceptional.

Use of Selenium in Signalling.—A patent which has been issued in Germany dealing with the use of selenium for signalling purposes is described in a recent issue of the *Western Electrician*. The arrangement, which is due to Hirt, endeavours to eliminate the disturbances caused by the variation of sunlight or other external illumination. The car carries a source of polarised light, which on passing the signal point is reflected through a Nicol's prism. In the paths of the two sets of rays thus formed are two selenium cells connected to a battery. In series with these cells are placed the opposing windings of a differential relay controlling a suitable source of current which operates the signal mechanism. It will thus be seen that unpolarised light, such as emanates from the sun or other external source, will not affect the relay, which will only be operated by the polarised source of light on the car.

Single-Phase Electric Traction in America.—According to the *Electric Railway Review* the Pennsylvania Railway authorities have been studying the relative merits of the various systems of traction available for the operation of their lines in the vicinity of New York. To obtain more extensive information on the value of high-voltage single-phase overhead construction under special conditions, the company has determined to equip about five miles of their system where experimental work will not interfere with the traffic. The branch line chosen is practically straight with easy gradients, and suitable for running at speeds up to at least 65 miles per hour. Several types of overhead catenary construction, both for tunnel and open line conditions, will be installed and tested for both locomotive and multiple unit train operation. The tests will be conducted during the summer and early autumn.

The Electric Drive in Cement Mills.—According to the *Western Electrician*, the new mill of the Santa Cruz Portland Cement Co. at Davenport, Cal., with a capacity of 12,000 barrels per day, is entirely operated by the electric drive. The necessary power is purchased from the Bay Counties Power Co. The incoming 60,000 volt current is stepped down to 2,000 volts by three 1,100 kw. oil-insulated and water-cooled transformers in a separate building with a concrete floor and concrete side walls. The 2,000 volt current is delivered to various parts of the mill by overhead circuits. A circuit-breaker and a starting box are provided on a board adjacent to each motor. The motors are all standard induction motors, which, being placed in separate rooms, where comparatively little dust reaches them, give practically no trouble in operation. The wiring and automatic protection devices are also enclosed in such a manner as to eliminate danger of fire risk due to sparking.

Electricity Supply at Bilbao.—According to the *Scientific American*, three water-power stations at Leizaran, Quintana, and Puentelarra respectively, the first two with a capacity of 4,000 H.P. and the last of 8,000 H.P., supply the town of Bilbao with electric energy for light and power. There are four three-phase Siemens-Schuckert generators at the first-mentioned stations; these are driven by 1,000 H.P. Pelton wheel turbines running at 375 revs. per min. They generate at 3,000 volts 50 cycles, and this pressure is raised to the transmission pressure of 30,000 volts by four groups of single-phase transformers, each group of three being star connected. The second station contains four 1,000 H.P. Francis turbines and the third contains four 2,000 H.P. units. The stations are repectively 49, 38 and 35 miles distant from Bilbao, in which town a sub-station with a capacity of 6,800 kw. has been built. The town of Basconia has a 1,700 kw. sub-station, and smaller sub-stations are situated at St. Sebastian, Vitorio, Arrigorr iogo and Mirando.

Temperature of Coal Mines.—According to the *Engineering and Mining Journal*, M. Durnerin has recently communicated to the Société de l'Industrie Minérale the result of his observations on temperature taken during some deep boring operations in Meurthe-et-Moselle. The principal difficulties in the observation of the earth's temperature are streams of underground water, the admission of outside water into the bore-hole, and the heat produced by oxidation which goes on when the hole passes through carboniferous or pyritiferous strata. He found that 1 deg. of temperature was gained every 53 metres (175 ft.) in Triassic sandstones and every 16·5 metres (54 ft.) to 20 metres (66 ft.) in carboniferous conglomerates having a shaly matrix. These results confirm the previous knowledge that the rise in temperature is more rapid in the older strata. It is probable that in the future development of the deep coal measures of Lorraine relatively high temperatures, necessitating, perhaps, the use of artificial cooling apparatus, will be encountered.

British Association.—The following arrangements have been made as regards Papers to be read before Section A of this Association. The president of the Section (Dr. W. N. Shaw, F.R.S.) will deliver his inaugural address on Thursday morning (September 3rd), while discussions will take place on "The Isothermal Layer of the Atmosphere," to be opened by M. Isissereux, and on "The Theory of Wave Motion," to be opened by Prof. H. Lamb, F.R.S. As already announced, this Section will take part, with Section G, in a discussion on "Gaseous Explosions." Among the Papers to be read before Section A are the following:—"On the Measurement of Large Inductances containing Iron," by Sir O. Lodge, F.R.S., and Mr. B. Davies; "Secondary Radiations," by Prof. J. A. McClelland; "Do the Radioactive Gases (Emanations) belong to the Argon Series?" by Sir Wm. Ramsay, K.C.B., F.R.S.; "Further Experiments on the Constitution of the Electric Spark," by Mr. T. Royds; and "The Self-Inductance of Two Parallel Wires," by Dr. J. W. Nicholson. The reports of the various committees connected with the Section will also be presented.

Wireless Telegraph Notes.—It is announced that during the entire journey of the Prince of Wales from this country to Quebec in the "Indomitable" wireless communication was maintained. When the extreme limit of the range of the Marconi Company's station at Clifden (Galway) was reached, messages were picked up by the station on the other side at Glace Bay, messages being forwarded from Glace Bay to Clifden, and so enabling communication between the Prince on the "Indomitable," and the Princess and the Prince's family in this country to be continuously kept up. Details are lacking, but are promised.

Mr. Marconi is stated to have claimed that when the new wireless station at Catonia (Italy) is completed a 6,000 miles radius of wireless operation from that centre will be possible.

An interesting reference to the "competition" between the submarine telegraph cable service and the wireless telegraph service across the Atlantic was made by the chairman of the Anglo-American Telegraph Co. at the meeting of shareholders last Friday. A full note of this reference will be found on another page of this issue of *The Electrician.*

A powerful "wireless" station has recently been opened at Emden (the most important submarine telegraph centre on the Continent of Europe) for the training and examination of operators in wireless telegraphy desirous of obtaining employment on liners flying the German flag.

A fortnight ago we published a statement from the Paris *Eclair* announcing that an offer to instal a wireless telegraph station in the Vatican had been declined by the Pope on the ground of impracticability. It is now stated that work has been begun on a station in the Vatican gardens, and that its effective range will be 400 miles.

Electrical Matters in the City of London.—The report on the works executed by the Public Health Department of the City of London during 1907, recently issued by the engineer, contains some interesting details as regards public lighting, a matter which has been lately given a great deal of prominence. The prices paid to the Gas Light & Coke Co., from January 1st to June 30th, for public lighting were reckoned on the basis of 2s. 2d. per 1,000 cubic ft., together with a fixed sum of 6s. per lamp per annum for incandescent mantles. During the last six months of the year the price was raised to 2s. 5d. per 1,000 cubic ft. The total number of gas lamps in use was 2,765, a decrease of 39. The total number of arc lamps employed for public lighting was 451, exclusive of those used experimentally. 400 of these were charged at £26 each per annum, 33 at £17. 10s. per annum, and 18 at £12. 10s. per annum. There has been an increase of two electric lamps over the number in 1906. The report also deals with the question of overhead wires. During the year 546 yds. of derelict wire have been removed. The number of private owners of lines was 133 and the number of companies 22. The number of spans crossing public thoroughfares is now 733,200, as against 731,500 last year, while the National Telephone Co. has a net increase of 1,211 miles of wire. The number of wires increases in a greater ratio than the spans owing to the fact that a number of smaller cables are being replaced by a few heavy ones. 2,795 cases of broken wires and other contraventions of bye-laws have occurred during the year. It is a rule that all clocks erected since 1903, and overhanging the public way shall be synchronised from Greenwich. These, unfortunately, form but a small percentage of those installed, and the engineer is of the opinion that it would be an inestimable boon to the public frequenting the City if the Corporation compelled all owners of clocks overhanging the public way to keep them synchronised.

ELECTRIC TRACTION ON RAILWAYS.*

VII.—AXLES.

BY PHILIP DAWSON.

(Continued from page 556.)

Summary.—In this article the author considers the important question of axles, and gives details of present practice, after which an outline is given of the calculations involved in axle design.

OUTLINE OF AXLE CALCULATION.

Consider an axle for electric traction with gear wheel on the right. The following forces (shown in Fig. 3), act upon it in a vertical plane; in addition to these there are a horizontal force and a twisting moment, the effect of which will be considered later in these calculations.

F_1 = Left journal pressure.

F_2, F_3, F_4, and a part of F_8=force due to flange action (explained later).

F_5=Left motor bearing.

F_6=Right ,, ,,

F_7=Force transmitted through gear wheel.

In addition to these forces, R_1 and R_2, the wheel reactions form the two unknown quantities in the graphical solution, referred to later, and can be found from the others by the principle of moments if an anlyatical solution is required.

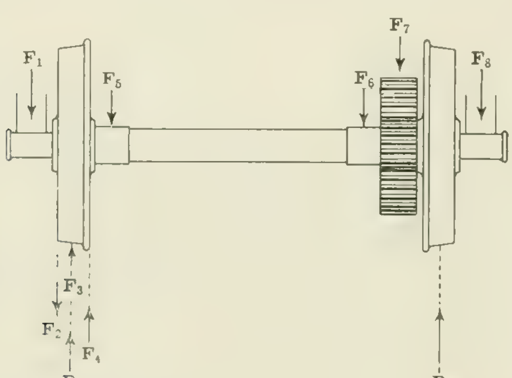


FIG. 3.

Before evaluating the forces, two actions which effect the results must be considered. These will be called for brevity (1) Flange action, and (2) Motor action.

1. *Flange Action.*—As the result of carefully made experiments and practical experience, it has been found that the effects produced by jolting or jarring at points and crossings, and the centrifugal actions at curves, can be grouped together and satisfactory results obtained by the substitution for them of a single force, acting through the centre of gravity of the car at right angles to the direction of motion, and equal to 0·4 of the weight borne by the journals. For ordinary steam work Woyler has proposed 0·386 of the weight being applied as above. The effect of applying this force is to increase the journal pressure on one side, and to decrease it on the other by an amount given by evaluating the vertical component as follows.

Let P_1 = Normal dead load on *one* journal. This is in the case considered composed as follows:—

$$P_1 = \frac{\text{Total weight of car + wheels and axles + }\frac{1}{2}\text{ motors}}{\text{number of journals}}$$

Then the flange action force will be $2 \times 0{\cdot}4 \times P_1$.

In Fig. 4 let H be the height of the centre of gravity above the *axis* of the axle, and a = separation of journal centres.

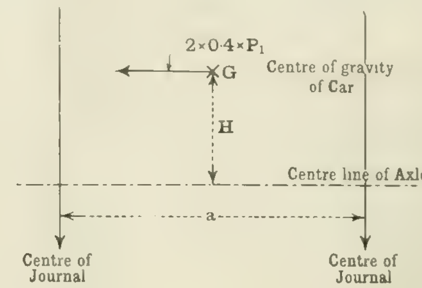


FIG. 4.

Then, calling P_2 the increase on the left hand journal, we have, according to Fig. 5, the following relation:—

$$P_2 = (2 \times 0{\cdot}4 \times P_1)\left(\frac{H}{a}\right).$$

P_2 also equals the decrease on the right hand journal.

Now, in addition to the effect on the journal pressure, the flange force, so named after its reaction, produces a horizontal pressure, at right angles to the line of motion, on the flange of the left wheel as shown in Fig. 6. This reaction is equal to the force $2 \times 0{\cdot}4 P_1 = P_3$.

Considering the effect of P_3 acting at the flange, we find that P_3 produces a compression at the points b and c, Fig. 6. Calling this compression P_4, we have the relation $P_4 r_4 = P_3 r_3$, where r_3 is the distance from the top of rail to centre of axle, and r_4 the width of the wheel. This couple $P_4 r_4$ applied at

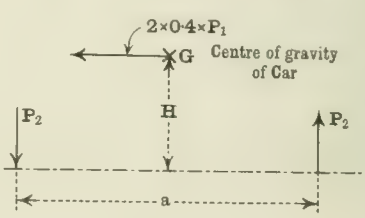


FIG. 5.

the bearing of the wheel on the axle must be balanced by an opposite couple $P_5 r_5$ acting between the left hand contact plane, and the right hand journal.

The flange action then contributes to the force we have called F_1, representing the left journal pressure as shown in Fig. 3, by an amount $\pm P_2$, and to F_2 by $\pm P_4$. To F_3 by $\mp P_5$. To F_4 by $+P_4$. To F_8 by $\pm P_5$, and $\mp P_2$, counting the forces acting downwards as positive and those acting upwards as negative. The upper signs for the sideway

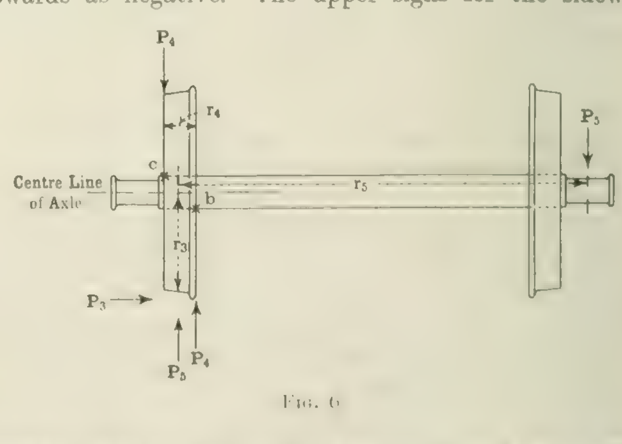


FIG. 6

force acting to the left, it will be noticed that the sum of the flange action forces is zero, which must, of course, be the case.

2. *Motor Action.*—By reason of the torque produced by the motor on the gear wheel, a set of forces are produced which affect the axle strains in the following way as shown

in Fig. 7, calling the forces T_1, T_2, &c., and their arms t_1, t_2 &c. Call the tractive effort produced at the rim of the wheel, T_1, and the radius, t_1, as shown in Fig. 6. Then the force at the contact of gear wheel and pinion will be T_2, where $T_2 = T_1 \frac{t_1}{t_2}$, (since $T_1 t_1 = T_2 t_2$).

This force T_2, which is the force developed electrically in the armature at a radius t_3, as will be seen by referring to Fig. 8, produces a couple $T_2 t_3$ tending to make the motor as a

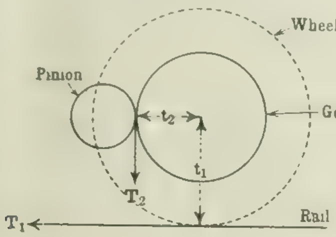


Fig. 7.

whole revolve around the car axle, a tendency balanced at the nose support, and the motor bearings, by an equal couple $T_4 t_4$. We have, therefore, as contributions to the motor bearing forces $\mp \frac{T_4}{2}$ (as there are two motor bearings), and $\pm \frac{T_4}{2}$ as parts of the journal pressures.

Now, if we consider Fig. 9, representing diagramatically the motor and its relations to the wheel it drives, we see that in addition to this effect the force T_2 is transmitted directly, either downwards through the gear wheel and upwards through the supported points of the motor, or *vice versa.*

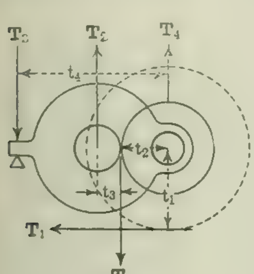


Fig. 8.

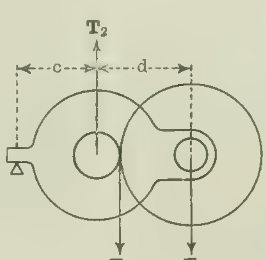


Fig. 9.

Calling distance of motor axle to car axle d, and distance of motor nose to axle c we have a gear wheel force of $\pm T_2$, and a motor support force of $\mp \frac{1}{2}\left(T_2 \frac{c}{c+d}\right)$, and a journal force of $\mp \frac{1}{2}\left(T_2 \frac{d}{c-d}\right)$.

In each case the upper side of the alternatives shows the condition depicted in the figure, which is that of a down ward force at the gear contact, giving a train motion from right to left.)

Summing up the motor action effects we have, as part of

$$F_1 \text{ the forces } \pm \frac{T_4}{2} \text{ and } \mp \frac{1}{2}\left(T_2 \frac{d}{c+d}\right),$$

of F_5 .. $+\frac{T_4}{2}$ and $\mp \frac{1}{2}\left(T_2 \frac{c}{c-d}\right)$,

of F_6 .. $\mp \frac{T_4}{2}$ and $\mp \frac{1}{2}\left(T_2 \frac{c}{c+d}\right)$,

of F_7 .. $\pm T_2$,

of F_8 .. $\pm \frac{T_4}{2}$ and $\mp \frac{1}{2}\left(T_2 \frac{d}{c+d}\right)$.

The sum of the upper and under signs is zero, as one would expect.

We can now, by using the weights and dimensions and tractive effort of a train in question, evaluate the forces F_1 to F_8 mentioned above. We have

	Dead Weight.	Flange Action.	Motor Action.
F_1...	P_1	$\pm P_1$	$\pm \frac{T_4}{2} \mp \frac{1}{2}\left(T_2 \frac{d}{c+d}\right)$
F_2...	...	$\pm P_1$	...
F_3...	...	$\pm P_1$	...
F_4...	...	$\mp P_1$	...
F_5...	$\frac{M}{4}$	...	$\mp \frac{T_4}{2} \mp \frac{1}{2}\left(T_2 \frac{d}{c+d}\right)$
F_6...	$\frac{M}{4}$	...	$\mp \frac{T_4}{2} \mp \frac{1}{2}\left(T_2 \frac{c}{c+d}\right)$
F_7...	...	...	$\pm T_2$
F_8...	P_1	$\pm P_1 + P_1$	$\pm \frac{T_4}{2}$ and $\mp \frac{1}{2}\left(T_2 \frac{d}{c+d}\right)$

NOTE.—M = dead weight of one motor, It is assumed that half the motor weight has been included in deducing P_1.

Having thus determined the intensity and direction of action of the principal forces applied to the axle, it will be seen that there are four principal cases to be considered in order to determine what will be the most dangerous section of the axle, and what stresses the forces applied at this point will produce in the axle itself.

It will be seen, on considering the motor axles, when these are gear driven, that the gear wheel acts at one end of the axle. Thus the torque of the motor causes an unsymetrical loading of the axle, and in consequence of this there are four principal conditions to be considered as follows, for each of which the bending movements must be set out.

1. The train is travelling away from the spectator on a curve bearing to the right.
2. The train is travelling towards the spectator on a curve bearing to the right.
3. The train is travelling away from the spectator on a curve bearing to the left.
4. The train is travelling towards the spectator on a curve bearing to the left.

The four journal pressures corresponding to the four cases previously considered are made up as follows :—

1.	Dead load	+	Live load	+	Motor action.
2.	..	−	..	−	..
3.	..	—	..	—	..
4.	..	—	..		..

In the above the dead load is the weight of the body and underframe with attachments, plus the weight of the trucks, not including wheels and axles and those parts of the weight of the motor supported from the truck, divided by the number of journals.

In considering the effect of the live load it must be remembered that the leverage is different in length according to the direction in which a train is going round a curve. This is clearly shown in figure 10. For when going round one curve the wheels will occupy, relatively to the rail, the position indicated in full lines, whilst when going round a curve in an opposite direction the wheels will occupy relatively to the rail the position indicated in dotted lines.

As the points of application of the forces F_1 to F_8 do not change relatively to the axle, it will be seen that they will change relatively to the points of application of the reactions R_1 and R_2, and this must be borne in mind when constructing the four diagrams of bending moments referred to hereafter.

For the sake of these calculations the amount of play between the wheel flange and rail may be taken at 2 in.

After deducing the various forces acting on the axle by the methods indicated a bending moment diagram should be constructed in the u ual way, and from this the maximum bending moment deduced for each different section of the axle. Dividing this maximum bending moment by the moment of resistance of the section in question gives the maximum stress at that section.

t wi l be necessary to ascertain the most dangerous section of the axle, and then ascertain by the formula referred to later what the stresses in that section will amount to. For this purpose a diagram of bending moments must be constructed for each of the four cases already referred to, similar to that illustrated in Fig. 11.

In addition to the above there is a horizontal couple acting, one force through the wheel centre, the other through he journal centre, each force being equal to the maximum resistance between wheel and rail at braking. It should be assumed that the other wheel is slipping to give this effect its maximum value. This force S is equal to $W \times cf$ where cf is the co-efficient of friction of wheel and rail (generally about 0·15), and to the total weight borne by the rails at the axle considered.

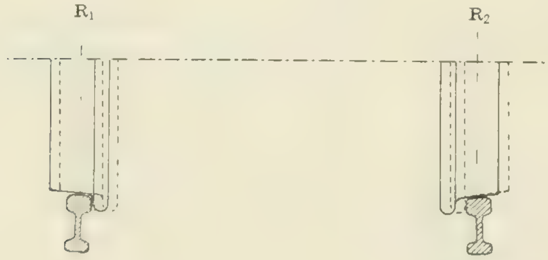
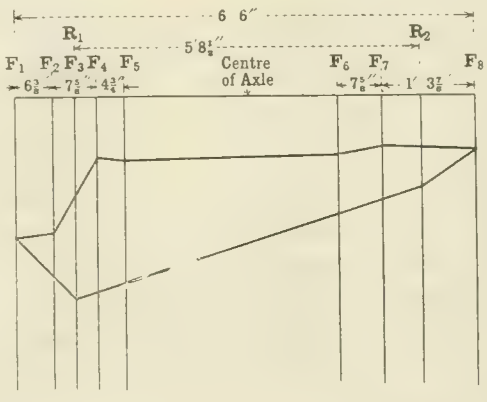


FIG. 10.



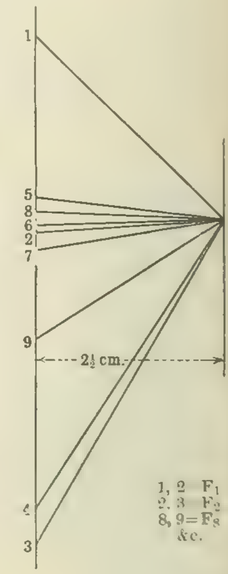


FIG. 11.—DIAGRAM FOR CASE II. CENTRIFUGAL FORCE ACTING TO LEFT, MOTOR PRESSING GEAR WHEEL DOWN. Scale, ⅜ in. = 1 ft.

1 cm. = 8,000 lb.

Max. moment at F_4 = 20·75 × 20,000 lb. = 185 in.-tons.
Diameter at F_4 = 7·813 in. Moment of resistance $= \frac{\pi \times 7{\cdot}813}{4 \cdot 8} = 46{\cdot}8$.

Max. stress at $F_4 = \frac{185}{46{\cdot}8} = 3{\cdot}95$ tons per sq. in.

It does not follow this is the most strained section, since other sections are smaller.
This would have to be examined for each section.

If e=the distance between journal and wheel bearing (centre to centre), the horizontal moment will be Se, and, although not really the case, it will be best to consider this moment as having constant value throughout the axle between journals. Calling the moment produced in any section by the vertical forces Mv, and by the horizontal couple M_h, the resultant bending moment M_1 will be given by

$$M_1 = \sqrt{M_v^2 + M_h^2}$$

twisting moment. The value of this is St_1 where S is as given above, and t_1 is the wheel radius.

Call the twisting moment M_2. Then $M_2 = St_1$.

If, as already stated, the greatest bending moment is called M_1 and the greatest twisting moment is called M_2 the radius of the axle at the section under consideration r, and the moment of inertia, I, of the section considered, then, as the section under consideration is a circular one

$$I = \frac{\pi r^4}{4}.$$

And if the greatest stress in the section considered be called f there are two formulæ by which this stress can be determined as a function of M_1 and M_2. The one is given by Grashof and Unwin, and the other by Rankine.

The Grashof formula is

$$f = \frac{r}{I}\left(\frac{3}{8}M_1 + \frac{5}{8}\sqrt{M_1^2 + M_2^2}\right)$$

and the Rankine formula is—

$$f = \frac{r}{2I}\left(M_1 + \sqrt{M_1^2 + M_2^2}\right).$$

Of these two the first is usually employed for axle calculations. The theory on which these two formulæ are based is very complex and need not be given here.

Having by means of the diagrams of bending moments ascertained the most dangerous section of the axle, it will be necessary to determine the value of the resultant stress at this section by taking all the momen's relative'y to what may be called the danger section. This will enable us to get the stress in tons per square inch at the danger section of the axle, and a comparison with the other electric motor-car axles will act as a guide as to whether the axle is safe or not.

For reference the following table may prove of interest :—

—	Gross Lichterfelde Electric Motor-car.		L.B.&S.C.Ry.	
	Kgs. per sq. cm.	Tons per sq. in.	Kgs. per sq. cm.	Tons per sq. in.
Maximum stress at danger section	1,030	6·54	1,027	6·52
Journal maximum stress	840	5·33	417	2·65

The following comparison of electric railway axles in general may also prove useful :—

Items.	L.B.&S.C. Ry.	Metro.Ry. elec. loco.	American Standard.	Prussian State Ry.
Weight carried by axle in lbs.	33,105	22,903	31,000	24,540
Weight carried on journals in lbs.	29,915	20,020	-	22,330
Diameter in inches :				
Journals	5¾	5½	5	3¾
Wheel seat	7[illegible]	7[illegible]	6 15/16	6·3
Gear seat	7[illegible]	7½	7	6·3
Motor bearing	7[illegible]	6¼	6¼	6·3
Centre	6[illegible]	6¼	6¼	6·3
Journal shoulders	6[illegible]	6¼	6¼	—
Distance between centres of journals	6′ 6	6′ 6	6′ 4	6′ 5″

In places where braking is applied only through one shoe on each wheel, and not through two, as should be done wherever possible, an additional horizontal bending moment will have to be included.

The distance between the point of application of the brake block and the reaction on the journal is the same on

both sides, and remains constant under all conditions of train motion—that is, does not vary as the wheel reaction does, due to side play at curves. The calculation of the moment due to this effect is therefore quite simple, and is equal to $F \times a$ for the part between the two wheel seats, and drops off by a straight line relationship between wheel seat and journal, becoming zero at the journal centres. Call the moment thus calculated M_4 = horizontal moment.

If M_v is the vertical bending moment at any section in question, the resultant bending moment $M_R = \sqrt{M_4^2 + M_v^2}$ and should be used with the twisting moment in Grashof's or Rankine's formula as already explained.

To show by an example how to calculate the force required. Suppose we require a maximum retarding force of $\frac{1}{10}$ the train weight, giving a retardation of 3·2 ft. per second per second, and that the train weight is 6 tons per wheel.

If the co-efficient of friction is 0·18 between brake block and wheel we must apply a force of

$$\frac{6}{10} \times 0{\cdot}18 = 3\tfrac{1}{3} \text{ tons per brake block.}$$

The preceding remarks should suffice to clearly indicate the course to pursue in checking the sizes of any given axles of a given material, bearing always in mind that the greatest care must be taken in designing an axle to avoid all sudden changes of section, and sharp ended key ways, and experience alone combined with careful calculation can nsure satisfactory axles being obtained.

(*To be continued.*)

INTERNATIONAL ELECTROTECHNICAL COMMISSION.*

The following schedule of terms with definitions† has been drawn up by the Sub-committee on Nomenclature of the British Committee of the International Electrotechnical Commission. Any criticisms by our readers will be welcomed, and may be transmitted to Mr. C. Le Maistre, British Electrotechnical Committee, 28, Victoria-street, London, S.W.

Accumulator.—An electric cell consisting of plates or of grids in an electrolyte of such a character that the electrical energy supplied to it is converted into chemical energy (a process called "charging"). The chemical energy can be reconverted into electrical energy (a process called "discharging"). Sometimes called a STORAGE CELL or a SECONDARY CELL. Several accumulators connected together in one circuit are sometimes called a SECONDARY BATTERY.

Alternator.—A machine for generating alternating current. The exciting current is generally supplied by a separate machine called an EXCITER. (The word dynamo should be reserved for a continuous current generator.)

Alternating Current.—An electric current which alternately reverses its direction around a circuit in a periodic manner. The time occupied by each pair of half-waves is called a PERIOD. Abbreviated "A.C."

Ammeter, Ampere Meter.—An instrument which indicates directly, in amperes, the value of an electric current

Ampere.—The current which is produced by the electrical pressure of 1 volt applied to a conductor the resistance of which is 1 ohm. The PRACTICAL unit of electric current. It is one-tenth of the centimetre-gramme-second (C.G.S.) unit.

Ampere-Hour.—One ampere flowing for one hour, or its equivalent, such as 4 amperes flowing for 15 minutes, &c.

Ampere-Turn.—A practical unit of magnetomotive force. The number of turns or windings of a coil multiplied by the current in amperes which flows through it.

Annunciator.—An apparatus containing a series of signals for indicating which of several circuits is making the call.

Anode.—(*a*) In an electrolytic cell, the conductor through the surface of which the current enters the liquid. (*b*) In a primary cell, the metal (usually zinc) through which the current enters the electrolyte. (*c*) The terminal by which the current enters a cell or other apparatus, such as a vacuum tube, &c.

Aperiodic.—The motion of the moving part of a mechanism is said to be "aperiodic" when it does not overshoot the mark on taking up a new position. Must not be confused with "dead-beat." See also DAMPED.

Arc.—A discharge, continuous or alternating, of electricity through a gas in which the material of one or both the electrodes is volatilised and takes part in the conduction of the current accompanied by a brilliant light.

Armature.—(Originally the pole-pieces attached to a loadstone.) (*a*) Of a permanent magnet. An iron bar for completing the magnetic circuit, sometimes called a KEEPER. (*b*) Of a simple electromagnetic mechanism. The iron part of the magnetic circuit which is not covered with wire; it is generally set in motion by an electromagnet. (*c*) Of a generator. That part of the machine which is acted upon inductively by the magnetic flux; and from which the induced current is transmitted to the terminals. (*d*) Of a motor. That part of the machine which receives the current, and is acted upon inductively by the magnetic flux. In continuous current machinery it usually rotates, in alternating current machinery it is sometimes stationary. See STATOR and ROTOR.

Armouring.—Of a cable. A protective metallic covering of wires or tapes, usually of iron or steel (verb: to armour).

Arrester.—An abbreviation. See LIGHTNING ARRESTER.

Astatic.—A system of magnets or coils is said to be astatic when the polarities of its parts are so adjusted that the polarity of the whole is zero and no directive effect is exerted on the system by a uniform magnetic field.

Asynchronous.—A term applied to an alternating-current generator or motor, the speed of which has no fixed relation to the frequency of the current.

Auto-Transformer.—A transformer in which part of the winding is common to both the primary and the secondary circuits; sometimes called a COMPENSATOR.

Balancer.—A dynamo, pair of dynamos, motor generator, or rotary converter, arranged to maintain the equality of pressure on the two sides of a three-wire system.

Bank.—A number of similar pieces of apparatus grouped and connected to act together is sometimes called a bank. Thus lamps are banked in parallel or in series, to form a resistance; and several transformers are banked to act as a single transformer.

Barretter.—An instrument in which the current to be measured, generally alternating, flows through and heats a fine wire strip or filament, and causes a change in its resistance, which is taken as the measure of the current.

Battery.—Two or more cells connected in one circuit.

Bifurcating Box.—A box containing the joints between a two-core and two single-core cables.

Blow (*verb*).—When a fuse melts it is sometimes said to "blow," a term suggested, probably, from the result of the melting of a fusible plug in a steam boiler. The same expression is sometimes applied to the automatic opening of a circuit breaker.

Board of Trade.—A British Government Department charged with the administration of, inter alia, the Electric Lighting and Power Acts, Railway and Tramway Acts, and of regulations made thereunder for the safety of the public, &c.

Board of Trade Unit.—One KILOWATT-HOUR. The expression "Unit" is officially used, and not the expression "Board of Trade Unit."

Bolometer.—An instrument in which radiant energy to be measured causes an alteration of the resistance of a fine wire strip or filament.

Bond.—(For tramway and railway rails.) A connector, usually of copper, used for electrically connecting the rails to each other or to a return conductor, in order to ensure good conductivity. (Verb: to bond.)

Boom.—See TROLLEY BOOM.

Booster.—A dynamo, alternator or transformer, interposed in a circuit for the purpose of increasing or decreasing the E.M.F. acting in the circuit.

Braiding.—A plaited covering of fibrous material or wire. (Verb: to braid.)

Branch Circuit.—A circuit which derives its supply of current from points on another circuit.

B.T.U., *Bo.T.U.* } See BOARD OF TRADE UNIT. Terms not recommended.)

British Thermal Unit.—The quantity of heat required to raise 1 lb. of water 1 deg. from 60°F. to 61°F. Abbreviated "B.Th.U."

Brush.—A conductor for collecting or delivering current from commutators or slip rings. Originally made of copper wires, afterwards of copper strips or gauze, or of carbon blocks.

Brush Discharge.—A discharge having a feathery form and consisting of an intermittent partial discharge which takes place from a conductor to a surrounding non-conductor when the P.D. exceeds a certain limit, but is not high enough to cause the formation of a true spark or arc. It is always accompanied by a hissing or crackling sound.

Brush Holder.—The apparatus which holds the brushes.

Brush Rocker.—The apparatus which enables the position of all the brushes carried by it to be altered simultaneously in either direction.

Buckling.—Of accumulator plates. The distortion caused by uneven expansion.

Busy-Back—An electrical signal transmitted from one telephone exchange to another to indicate that the line wanted is in use.

'Bus Bar.—Abbreviation for OMNIBUS BAR. Conductors (generally

* The Sub-committee on Nomenclature consists of: Mr. A. P. Trotter (chairman), Col. R. E. Crompton, C.B., Mr. W. Duddell, F.R.S., Mr. J. E. Edgcome, Sir John Gavey, C.B., Dr. R. T. Glazebrook, F.R.S., Mr. Robert Hammond, Mr. H. W. Miller, Mr. F. H. Nalder, Mr. H. Talbot, Mr. L. G. Tate, Prof. S. P. Thompson, F.R.S., Mr. A. H. Walton and Mr. C. H. Wordingham.

† Words printed in small capitals in the definitions are themselves defined elsewhere.

on a switchboard and of comparatively large size) to which several mains or feeders are connected.

B.W.G.—Abbreviation for Birmingham wire gauge.

C.G.S.—Abbreviation for centimetere-gramme-second.

Cable.—For electrical purposes: a stranded conductor with or without protective covering.

Calibration.—Of a measuring instrument. The determination of the value of the divisions of the scale of an instrument by comparison with a standard, or by some fresh determination.

Calorie.—(*a*) The calorie or GRAMME-CALORIE (also called the SMALL-CALORIE) is the quantity of heat required to raise the temperature of 1 gramme of water 1°C. (*b*) The kilo-calorie (also called the GREAT-CALORIE) is 1,000 calories and is the quantity of heat required to raise the temperature of 1 kg. of water 1°C. NOTE.—The value of the calorie depends to some extent on the temperature at which the water is taken and on the scale of the thermometer employed. The hydrogen thermometer is usually adopted as the standard and the temperature selected is generally 15°C. or 20°C., or the mean 0°-100°C.

Candle-power.—The luminous intensity, or illuminating power, of a source of light.

Candle Foot.—See FOOT CANDLE.

Capacity.—(*a*) Of an accumulator. The quantity of electricity in ampere hours which may be taken from a cell at a given rate of discharge. (*b*) Of a condenser. The quantity of electricity which must be imparted to a condenser, or to a conductor acting as a condenser, in order to raise its potential from zero to unity. (*c*) Of a machine or of a generating station. This use of the word capacity is not recommended. The term RATING should be used.

Carcase.—Of a dynamo, alternator or motor. The assembled pole cores, pole pieces and yoke or frame.

Cascade.—(*a*) A series connection of two or more condensers. (*b*) A method of electrically connecting induction motors, whereby the induced part of one motor is connected electrically with the inducing part of the other. Also called CONCATENATION and TANDEM.

Cathode.—See KATHODE.

Cell.—(*a*) A source of electrical energy dependent on chemical action, complete in itself. (*b*) A compartment of a high pressure cellular switchboard. (*c*) A combustion chamber of a dust or refuse destructor.

Choking Coil.—A coil with so great a self-induction that its impedance depends chiefly on the self-induction rather than upon the resistance.

Circuit.—The conductors connected with a source of electrical supply are collectively called a circuit. When they form a closed path through which a current circulates there is a CLOSED CIRCUIT. When the path is not closed and no current circulates there is an OPEN CIRCUIT.

Circuit-breaker.—A switch which is opened automatically when the current or the pressure exceeds (or falls below) a certain limit, or which can be "tripped" by hand.

Closed Circuit.—See CIRCUIT.

Coherer.—(In wireless telegraphy.) A device employed at the receiving end consisting essentially of an imperfect contact, or system of contacts, such that its resistance is altered on the reception of a signal.

Collecting Rail.—See CONDUCTOR RAIL.

Collector.—A sliding piece which makes contact and collects the current from a fixed part of an electrical apparatus, or vice versa.

Collector Ring.—A ring used for making a sliding connection between a fixed and a revolving part of an apparatus such as an alternator or a searchlight projector.

Commutator.—An apparatus for reversing the direction of a current in any circuit. In a dynamo or motor that portion on which the brushes press and collect or deliver the current.

Compensator.—See AUTO TRANSFORMER.

Compound Wound.—A generator or motor is said to be compound wound when the magnetic field is excited partly by series and partly by shunt coils, or independently-excited coils.

Concatenation.—See CASCADE.

Concentric Cable.—A cable consisting of two or more separate conductors arranged concentrically with insulation between them. Three conductors so arranged form a TRIPLE CONCENTRIC CABLE. The external conductor should be called "external" and not "outer," in order to avoid confusion with the outer conductors of a three-wire system.

Conductor Rail (Positive or Negative).—A rail employed on electric railways for conducting current to or from the train. The terms LIVE RAIL, THIRD RAIL, FOURTH RAIL, EARTH RAIL, COLLECTING RAIL and WORKING CONDUCTOR are not recommended.

Conduit System.—(*a*) For electric light and power distribution. A system of bare conductors carried on insulators in a conduit or culvert, generally of concrete. (*b*) For wiring. A system of metal or other pipes into which wires are drawn. (*c*) For traction. A system of bare conductors carried in a conduit having an open slot through which a PLOUGH makes contact between the conductor rails and the electrical equipment of the car. (*d*) For telegraphs and telephones. A group or collection of ways or passages called DUCTS into which cables are drawn.

Consumer's Load Factor.—The number obtained by dividing the actual consumption during a given period of time by what that consumption would have been had the maximum load reached during that period continued in use throughout the whole of that period.

Contactor.—An electromagnetic, electropneumatic or automatic switch used for controlling heavy current circuits to motors, and which is itself controlled by a MASTER or PILOT CONTROLLER.

Continuous Current.—An electric current in one direction and sensibly steady or free from pulsation. Abbreviated C.C. The term DIRECT CURRENT is not recommended.

Controller.—A compound or multiple switch containing the means for introducing resistance, or for connecting motors in series or in parallel. It has several steps or positions called NOTCHES, and is intended for use on any notch for an appreciable period of time. It is to be distinguished, in this respect, from a STARTING SWITCH. It is used for varying the speed or power of, as well as for starting, traction and other motors. A MASTER CONTROLLER, sometimes called a PILOT or MULTIPLE UNIT CONTROLLER, does not act directly on the current supplied to the motors, but works CONTACTORS.

Converter.—A revolving apparatus for converting alternating current into continuous current or vice versa; sometimes called a ROTARY CONVERTER. To be distinguished from a TRANSFORMER, RECTIFIER or MOTOR GENERATOR.

Core.—(*a*) Of a magnetic circuit. That part which is within the winding. The part outside the winding, if any, is called the YOKE. (*b*) Of a transformer. The whole of the iron forming the magnetic circuit. (*c*) Of a cable. The conductor with its insulation or dielectric. Two, three or more cores may be laid together to form a TWIN, THREE-CORE or MULTICORE cable. (*d*) Of an arc lamp carbon. The longitudinal filling.

Coulomb.—The PRACTICAL unit of electrical quantity. One coulomb is equivalent to 1 ampere flowing for 1 second; 3,600 coulombs equal 1 ampere-hour. The term AMPERE-HOUR is almost universally adopted; the coulomb is seldom used.

Cutout.—A device for protecting apparatus from damage by overload. The term cutout comprises all the separate parts which, together with their mountings and base, form the complete device, and the term includes FUSES and CIRCUIT BREAKERS.

Cycle.—A term not recommended as a synonym for PERIOD. See PERIOD, ALTERNATING CURRENT.

Damped.—The motion of a piece of mechanism is said to be damped when any oscillations which may be started rapidly die away. If no oscillations can be produced it is said to be APERIODIC. See DEAD BEAT.

Dash Pot.—An appliance for preventing sudden or oscillatory motion of any portion of an apparatus by the friction of air or of a liquid.

Dead Beat.—An instrument or other mechanism is said to be dead beat when the oscillatory movement rapidly dies away. To be distinguished from APERIODIC.

Derived Units.—See PRACTICAL UNITS.

Dielectric.—Any material which offers high resistance to the passage of an electric current.

Discriminating Cutout.—A cutout, usually on a switchboard, for interrupting the circuit when the normal direction of the flow of energy is reversed.

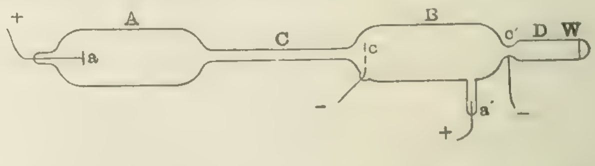
(To be continued.)

POSITIVE ELECTRONS.*

BY JEAN BECQUEREL.

In a preceding note† I briefly described some experiments which I interpreted by postulating the existence of *free positive electrons.* In order to justify this conclusion, it is necessary to show that the radiations known up to the present do not suffice to account for the new facts observed.

The canal rays issuing from an aperature, *c*, in a Crookes' tube (see diagram), penetrate into a tube B, together with the cathode beam emanating from the same cathode. A secondary cathode *c*′, consisting of a piece of wire netting or a loop 1·5 mm. in diameter, attracts the positive charges and makes them penetrate into the tube D, in which a willemite screen is mounted.



We have seen that if the vacuum is sufficiently high, and if the cathode rays get as far as *c*, it suffices to bring a small magnet near *c*′ or against the tube B between the two cathodes *c* and *c*′, to recognise the existence of a beam attracted by *c* and strongly deflected normally to the magnetic field in the sense corresponding to a flux of positive charges. Furthermore, this beam ceases to be sensitive to the magnet as soon as it has traversed the cathode *c*′.

The positive radiation attracted by *c* and deflected by the magnet is distinct from the canal rays emitted by *c*. In fact, if the screen *w* is joined to the cathode, a new patch is observed to appear on the screen which, when a magnet is approached to *c*, is only very slightly displaced, and not in the same sense as the cathode rays passing from B towards D. This patch is produced by a canal-ray beam insensible to a feeble magnetic field, whose very small displacement is due to a slight deformation of the electric field.

The patch due to the canal rays is barely perceptible when the screen *w* is not negatively charged, no doubt on account of the loss of impetus suffered by the positive ions in leaving *c*. On the other hand the movable patch due to the prolongation of the easily

* Translated from *Comptes Rendus*, July 13, 1908.

† *Comptes Rendus*, June 22, 1908, *The Electrician*, Vol. LXI., p. 525, 1908.

deflected beam changes neither in position, nor intensity, nor shape, whether the screen is joined to the cathode or not. If the wall of D is touched, this last patch is not modified, whereas the canal-ray patch is deformed and displaced. The beam prolonging the deviable rays *appears not to be electrified.*

To explain the existence of a positive ray deviable by the approach of a magnet, various hypotheses may be introduced.

1. The displacement of cathode rays may produce in the vicinity of c' a deformation of the electric field which modifies the trajectory of the positive ions.

It is easy to make out that the deviation of the cathode rays must bring about a displacement of the positive beam towards the side whither the negative charges are transported on to the walls—*i.e.*, the side towards which the cathode rays are deflected. This is precisely the sense of the slight observed displacement of the canal rays. On the other hand, the very mobile beam is deflected in the opposite sense.

Besides, it can be proved in another manner that the electric field is only very slightly modified by the displacement of the cathode beam. By means of a magnet placed at c', the cathode rays issuing from that cathode are brought to form on the wall of B a patch situated a few centimetres from c'. If a second magnet deflecting the principal beam is brought near the cathode c without acting perceptibly on the beam from c', it is found that the patch formed by this last beam remains unmoved and unchanged in shape.

2. It might be thought that one part of the canal rays passes sometimes through one region of the loop c', and again through another, and that in this way the direction of the corpuscles is changed. Now, in one of the tubes employed there just happened to be a great instability in the orientation of the canal rays: these rays passed sometimes through the centre of c', and sometimes through the space between the loop and the walls. That being so, the canal ray patch was seen to jump *suddenly* from one point to another (especially under the influence of the displacement of the cathode beam), but the range within which that patch was displaced was fixed and limited to a figure reproducing a deformed image of the loop. Beside the canal rays, there was always another beam, which *progressively* moved under the influence of the magnetic field.

3. The hypothesis that the deflected beam might be due to ions of feeble velocity is not admissible if we once more take note that besides the mobile beam there is also an undeviated canal-ray beam which has traversed the same potential gradient.

4. Finally, the fact that the prolongation of the sensitive ray appears to be unelectrified suggests the idea of a combination of positive ions with negative electrons. But A. Righi* has just shown that the systems formed by an electron gravitating round an ion form "magnetic rays" capable of displacement not normally to the lines of magnetic force, but parallel to them.

5. Not having succeeded in explaining the observations with the help of known phenomena, I have been driven to consider the deflected radiation as constituted by *positive electrons* liberated by the action of cathode rays on canal rays.

The mechanism by which the positive electrons are liberated escapes us for the present. Yet we may make the following remarks: Lilienfeld has already put forward the hypothesis that positive electrons, grouped about the centre of the atom, may be brought to its surface and then liberated by the attraction of the atmosphere of cathodic corpuscles. I may add that the shock of these corpuscles on the ions forming the canal rays must play an important part. In fact, the negative electrons, which possess a small mass endowed with a high velocity are, considering their kinetic energy, the corpuscles best qualified to break up material atoms, upon which they act like projectiles.

A remarkable result is the rapidity with which the positive electrons disappear as soon as they emerge from the atmosphere of cathode rays. If we admit this surprising fact it is natural that the beam observed on the other side of the cathode c' should be uncharged. This beam must be a flux of neutral matter whose formation is related to the disappearance of the free positive electrons. The positive electrons have been able to recombine with the gas of the tube. But if we consider that the isolation of both kinds of electrons constitutes the complete disintegration of matter, a more daring hypothesis may be hazarded; perhaps the positive electrons combine direct with negative electrons which they meet in the free state or which they extract from matter, and the question arises as to what is the substance which may thus be formed. Could we not find in that combination the chief origin of hydrogen, which always appears during discharges in Crookes tubes?

NOTES ON THE WORKS AND PRODUCTIONS OF MESSRS. WILLANS & ROBINSON.

The firm of Willans & Robinson needs no introduction to our readers nor to electrical engineers at large. At one time the name Willans was engraved on the records of almost every electricity works in operation both in this country and the colonies. The Willans engine gave the initial impetus to electricity supply in furnishing the station engineer with a satisfactory prime mover which could be direct-coupled to dynamo-electric machinery. Experience also went to prove that the Willans high-speed engine was economical both with steam and floor space, and that by its introduction the business of generating and distributing electrical energy could be developed on a progressive commercial basis.

The history of this well-known engineering firm if written in detail would make very interesting reading, and whenever the story of the electrical industry comes to be told in full there is not the least doubt that the name of Willans & Robinson will be prominently identified with it. Unfortunately, limitations of space will only admit of our passing briefly in review the development of this undertaking.

Our readers will recall the fact that the original works of Willans & Robinson were laid down on an extensive scale at Thames Ditton, and that the bulk of the pioneering work of the company was carried out from this point. So rapid and yet so steady was the growth of the business in high-speed engines that a move to a more favourable manufacturing site was necessary. A spot in the Midlands was selected at Rugby as being most central, served by canal and railway communications, and also within reasonable distance of iron and coal-producing districts. The Rugby works were opened in March, 1897, and the entire business of manufacturing Willans high-speed engines was transferred from Thames Ditton to the new shops. These latter were laid down with due regard to economy of production in so far as the organisation and efficient co-operation of departments was concerned. The policy of moving into the provinces from London appears to have been in every way justified by subsequent experience.

The march of progress in engineering and electrical engineering developments has relegated the Willans engine to the limbo of an honourable past, but the Willans steam turbine has taken its place on a certainly more imposing scale. A large and constantly expanding business has been built up with these modern forms of prime mover, and in addition the attention of the engineers of the company has been successfully turned towards the manufacture of condensing plant of the most efficient kind. The present flourishing condition of the company and the high opinion in which its products have always been held afford a striking testimony to the foresight of the management in keeping abreast of engineering developments, not only in the matter of the opinions of engineers, but also in the character of the products of its works. The changes which have taken place in electrical engineering during the past decade have been sufficiently rapid in themselves to test to the utmost the abilities of the management of manufacturing undertakings, and we feel sure that our readers will appreciate the manner in which Willans & Robinson have kept their name constantly in the forefront of progressive engineering.

The present works at Rugby cover a site of 12 acres, which is devoted to workshops. The works buildings are of solid brick and steel construction, and the design of the roof of the shops in each case has been carefully arranged so as to give a maximum of light on the floor below. The shops comprise three large machine shops and a large iron foundry, these being respectively 240 ft. long by 500 ft. wide and 150 ft. long by 400 ft. wide. Adjoining the works is a large building, a portion of which is devoted to the testing plant and the power house, the other portions being divided up into a mess room, lecture hall, club room, &c. Lying parallel to the machine shops and giving directly on to them are the main offices, comprising an imposing building extending the entire width of the works. The works are served by the London & North-Western Railway, which has a very extensive goods junction at Rugby. The works' site is also within reach of the London-Birmingham Canal.

The general equipment of the shops has been carried out upon modern lines, the various departments being linked up by a narrow gauge railway, which facilitates the interchange of parts by various departments. Both the machine shops and the foundry are served by large electrically-operated cranes which have a lifting capacity varying from 3 to 50 tons. As may be expected, the machine tool equipment has received more than ordinary care, especially since the manufacture of steam turbines has been carried out on a large scale. The heavier parts of these machines naturally call for large boring mills and heavy lathes in which stators can be bored out and rotors turned up. When it is considered that many of

* *Atti Acc. Lincei*, A. Vol. XXVII., p. 87. *The Electrician*, Vol. LXI., p. 335.

these parts weigh several tons, the size of the tools to deal with them will be readily understood. Among the largest boring mills we may mention one of 12 ft. capacity. There are also large electrically operated lathes which are capable of taking work up to 6 ft. 6 in. by 24 ft.

From the station engineer's point of view the most interesting shops are those devoted to the manufacture of blading for steam turbines and the general work of inserting these blades in both rotors and casings. As was to be expected the whole of the tools required for this work are of a special character and have been designed entirely by the engineers of the company. They have also involved the expenditure of large sums of money, but being of a semi-automatic character they prove a profitable investment. Among these tools we may mention a special machine for cutting the slots in the base rings both for casings and rotors to receive the turbine blades. With this machine the correct curve is given to the slots, and they are also accurately spaced out around the circumference of the ring.

The whole of the blading required for both standard and special turbines is supplied from outside and stocked in the main stores ready for use in the shops. Previous to this being passed into the

View in one of the Turbine Shops at Messrs. Willans & Robinson's Works at Rugby

blading department it is carefully gauged and examined, and no pieces are allowed to go through if they show signs of pitting or thickness inaccuracies. The cutting up and notching of the blading is done on special machines.

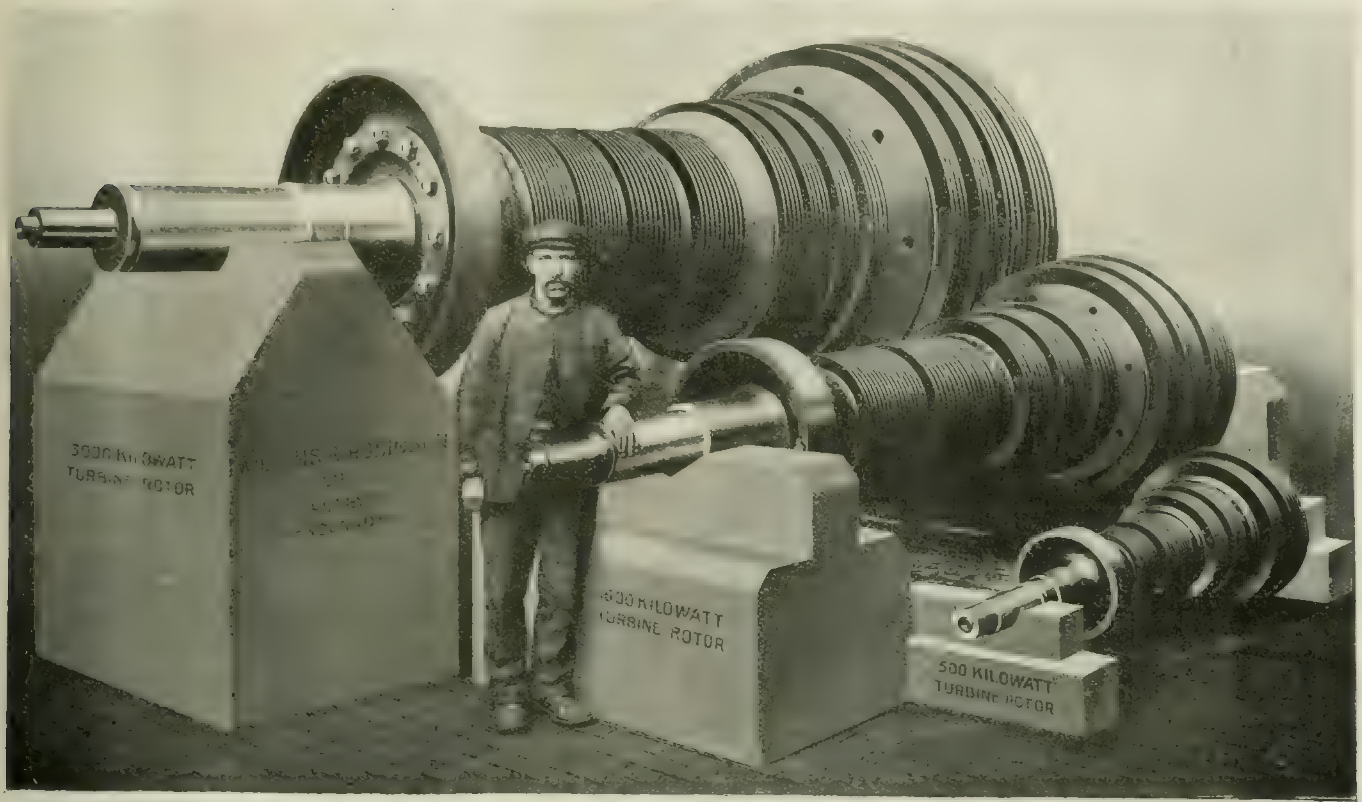
The actual blading of turbines and rotors is carried on in a portion of one of the main machine shops. The base rings and caulking strips are put in and hammered up by hand. The shroud rings are also put in position and the tops of the turbine blades riveted over by hand. One of the large machine shops is devoted to the building up of the various types of condensers which are produced in large quantities by the firm. Many of these are in operation in electricity works, both in this country and abroad, and in a general way the production of condensing plant has been undertaken on systematic lines, backed by a large and fruitful experience of steam engineering.

Main Products. Having briefly commented upon the main features of the Rugby shops, we may now turn to their principal manufactures. As we have already intimated, steam turbines figure most prominently in the products of the company. The larger pattern of Willans turbine is now very well known, and we have on various occasions described the features of its design and construction in detail. We may, however, recall one or two of these features as being of considerable interest.

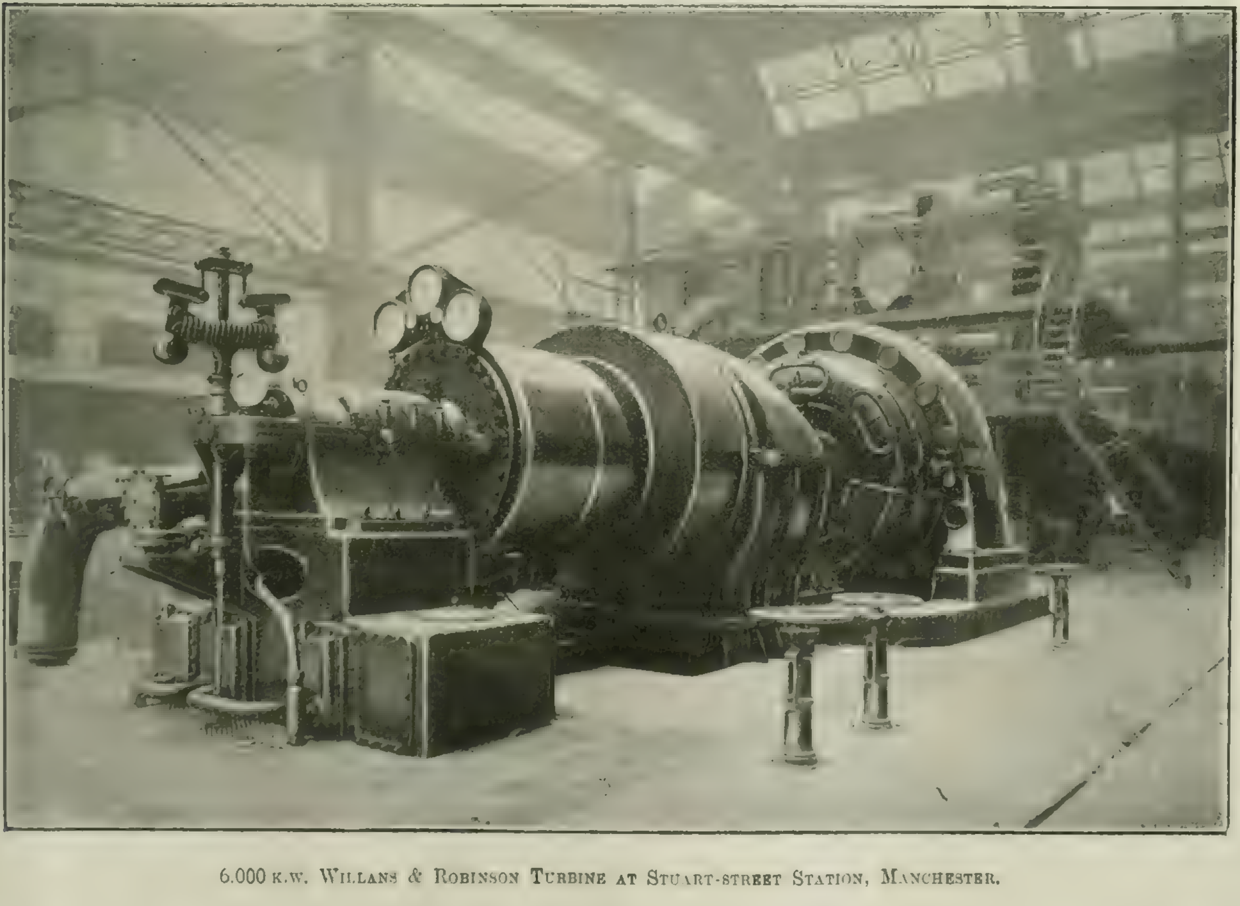
In addition to the high-capacity turbines, Messrs. Willans & Robinson have recently found that excellent results can be obtained with the smaller sizes of turbine, and such as will compare favourably with reciprocating engines. With this consideration as a starting point the production of steam turbines of a capacity of 200 kw. and upwards has been undertaken. The general features of this turbine are identical with those of the larger types, so that we need not refer to their construction at length. Two of these small turbines have recently been supplied to pulp mills in Scandinavia and two others have been put down in a Lancashire cotton mill. A speciality is also made of exhaust steam turbines, of which we saw a number in process of manufacture during our inspection of the shops. It has been found that there is a distinct demand for turbines of this class to run in conjunction with existing steam plant. Possibly the best conditions for the installation of exhaust steam turbines are those prevailing in works or factories which have been previously driven by steam. In these cases when extensions are undertaken it is more economical to drive the machinery situated at a distance from the power house by electricity than by making additions to countershafting and the mechanical transmission by turning the exhaust steam from the existing steam engines into a special turbine, electrical energy can be generated for transmission to the newer extensions of the works. We saw two machines in process of completion, which are being supplied to Messrs. Sir Bernard Samuelson's Iron Works, Middlesbrough. Each of these has a capacity of 1,350 kw. and runs at the high speed of 2,400 revs. per min. They are coupled to 40 period three-phase alternators, and are, we understand, the largest exhaust steam turbines which have been built in this country. The exhaust steam turbine does not complete the range of turbines manufactured by Messrs. Willans & Robinson. Another type is the Willans "mixed pressure" turbine, with which it is possible to work economically both on exhaust and live steam. This machine is suitable for running without a reducing valve, and it can be used directly on superheated steam. Colliery work may be selected as suitable for the introduction of turbines of this class. It is frequently necessary to carry on wind-

ing during during the day, but during the night the pits are comparatively empty of men. During the day the turbine can be run as an exhaust steam machine with considerable economy, and during turbines of this class have been recently completed for a large coal mine in South Wales.

A few notes on the general construction of Willans steam tur-



Typical Rotors for Willans & Robinson Turbines.



6.000 k.w. Willans & Robinson Turbine at Stuart-street Station, Manchester.

the night, when the winding engine is shut down, and the power is still required for pumping and ventilating, the turbine may be run economically as a high-pressure machine. Two 1,000 kw. bines may at this juncture be of interest. The turbine operates on the reaction or Parsons' principle, and is arranged with a horizontal shaft for the axial flow of the steam.

The rotor is of forged steel, in one piece with the high pressure end shaft, a construction which prevents any tendency to work loose owing to the variation in temperature which takes place at this point. The rotor is bored inside, nearly up to the high-pressure spindle, and is balanced in the shops statically after boring. Owing to the accurate manner in which the blading is constructed, the dynamical balancing in bearings which has usually to be undertaken can be done away with, and we understand that it has been found that with the Willans' construction a machine which is balanced statically will run in balance dynamically.

The casing is usually built up in five sections bolted together, to avoid cross and axial ribs in the casing. Owing to the great difference in temperature at the high and low-pressure ends of the machine, cross strains due to variation in temperature are avoided, and warping of the casing is prevented. In the normal type of steam turbine the casing is cast in two halves only and is not divided along the axis of the machine. This means large distorting strains, not merely in the foundry but when working, due to the large differences in temperature.

The governor is of the direct-acting type working on a balanced double-beat throttle valve, and is arranged to give a variation in speed not exceeding 2½ per cent. An automatic emergency stop valve is fitted which is normally arranged to cut off the steam from the machine in the event of the speed exceeding the normal by 10 per cent. This was described in *The Electrician*, Vol. LIX., p. 300.

The construction of the blading is covered by Willans & Robinson and Sankey patents. It is built up in segments previous to assembly and fixing on the rotor or casing, being held in place by means of caulking strips which are driven into dovetail grooves in the rotor and body respectively. The blading itself is made of drawn strip and is of special alloy, being tested at the highest superheat temperatures met with in modern commercial practice.

The individual blades are cut to length by special semi-automatic tools, and the shrouding and base ring fitted and machined in a similar class of machinery. The actual fitting of the blading in place is of a very simple nature, and it can be put in by any fitter of average intelligence.

Oil is circulated round the bearings of the turbine and generator by means of a special oil pump geared to the main shaft. This pump is of the centrifugal type and draws the oil direct from a small tank and pumps it round the bearings. The oil then returns into the tank through a simple filter.

Surface Condensers.—The manufacture of surface condensers, for use principally in connection with the different types of turbine manufactured by Messrs. Willans & Robinson has been undertaken on a large scale. Up to the present time some 60 sets, giving a capacity of over 1,500,000 lb. of steam per hour, have been installed and put to work.

The accompanying illustrations show turbines during erection and completed.

In order to be in a position to deal with the question of condensing on the most economical lines, Messrs. Willans & Robinson have taken out a licence from the Contraflo Condenser Synd. for the manufacture of the "Contraflo" type of condenser, and they are also enabled to use the vacuum augmenter principle with their condensers.

With regard to the "Contraflo" condenser, this is specially suitable where a high vacuum is to be obtained with circulating water of high temperatures, such as those obtainable in tropical countries or for use with cooling towers, and the method of construction adopted in the "Contraflo" condenser makes possible a higher vacuum than is practicable with the ordinary type of condenser.

We are indebted to the company for the above particulars and take this opportunity of thanking them for giving us facilities for going round the shops.

NOTES ON ELECTRIC HAULAGE OF CANAL BOATS.*

BY L. B. STILLWELL AND H. ST. CLAIR PUTNAM.

Summary.—The authors describe a series of tests made to determine the pull and power required at various speeds, the best speed and length of tow and the relative merits of electric locomotives operating upon a track and of a mono-rail system.

The following notes are based upon the results of tests conducted by the authors during the autumn months of 1907 on a section of the Lehigh Canal, near Mauch Chunk, Pennsylvania. The object of the tests was to determine: (*a*) Pull required to propel canal boats at various speeds and with varying numbers of boats in tow; (*b*) the relative merits, for the purpose contemplated, of locomotives supplied by trolley and operating upon a track of 42 in. gauge, and a monorail system; (*c*) the best speed and length of tow as fixed by physical conditions; (*d*) the power required to operate the canal between Coalport and Bristol; (*e*) the equipment required for such operation. The data presented in this Paper are included under the headings (*a*), (*b*) and (*c*).

The upper section of the canal from lock No. 2 to Coalport, a distance of 10,095 ft., is equipped with the "locomotive system." On this section an ordinary mining locomotive is used. Two locomotives were tested, each weighing under test conditions 16,000 lb. without testing instrument equipment and crew. Each locomotive is equipped with two direct current motors of 28 H.P., operating on 500 volt trolley circuits. The locomotive wheels are 28 in. diameter and gear-ratio of 69/15. The wheel-base is 44 in. The outline drawing of this locomotive is shown in Fig. 1. The locomotives were operated on a track of 42 in. gauge and ballasted on the river section with broken stone, elsewhere with gravel. 40 lb rails were used. The track was uneven and comparatively rough. On this

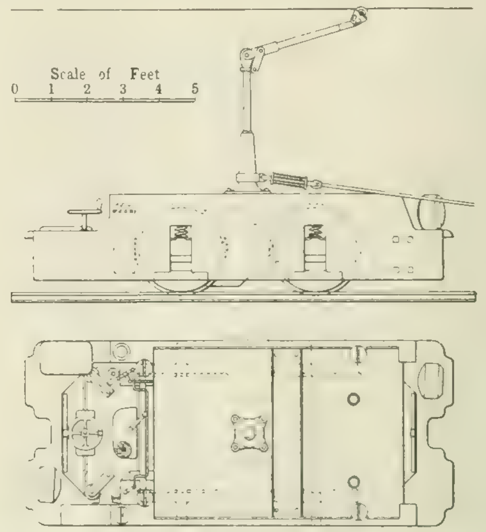


FIG. 1.—MINING LOCOMOTIVE.
Gauge, 42 in. Weight, 8 tons. 2 GE—58 Motors. 28 H.P. Gear ratio, 4.6. Wheel, 28 in.

section, two levels of the canal, aggregating 5,600 ft in length, were in the open river exposed to the river currents. The voltage of the trolley circuits was varied to obtain various towage speeds, an experimental generating plant being used as a source of power supply.

The section of the canal from lock No. 3 to lock No. 7, a distance of 10,555 ft., was equipped with the "monorail system," three traction machines being used, hereinafter designated "tractors." Two of these tractors (Nos. 1 and 2) were manufactured in the U.S.A. The electric equipment of each comprised one direct current 40 H.P. motor. The gear-ratio was 5·78 to 1, diameter of wheels 12 in., and length of wheel-base 42 in. The construction is illustrated in Fig. 2.

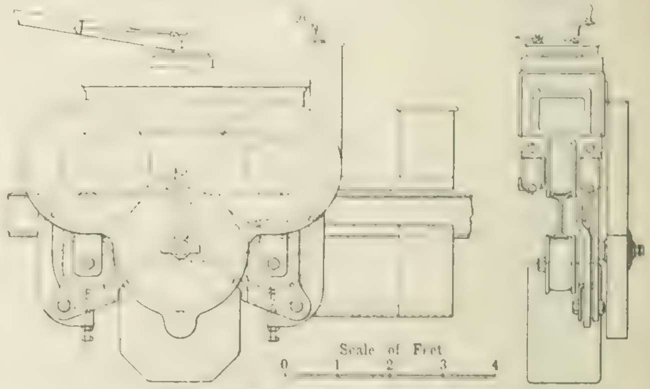


FIG. 2. TRACTORS NOS. 1, 2 AND 3.
Nos. 1 and 2. Weight, 6,450 lb. GE 61 A 40 H.P. motor. 500 volts. 5·78 Gear Ratio. 12 in. Wheel. Leverage, 4·7.
No. 3.—Weight, 5,013 lb. West. 65 Mining Motor, 25 H.P. 500 volts. 3·4 Gear Ratio. 11¼ in. Wheel. Leverage, 4·7.

The ratio of leverage on lever wheels was 4·7 to 1—*i.e.*, the lower wheels are pressed upward against the lower face of the rail with a force 4·7 times the drag on the tow line. The adhesion of the machine, therefore, is a function not only of its weight, but also of the pull which it exerts. Each tractor weighs 6,450 lb., and, under test conditions with instruments and crew, 7,350 lb. Tractor No. 3 was manufactured in Paris, and equipped with one 25 H.P. mining motor. Its wheels are 11·25 in. diameter, gear ratio is 3·4 to 1 and wheel base 42 in. The general design is the same as that of tractors Nos. 1 and 2.

Owing to the fact that the frame of this tractor had not been designed to receive a motor of the exact dimensions of that with which

* Abstract of a Paper read before the American Institute of Electrical Engineers.

it was equipped, it was impossible to locate the motor in its proper position; it was necessary, therefore, to use 500 lb. counterweight to secure equilibrium of the machine. The weight of the tractor complete was 5,093 lb.; including counterweight, test apparatus and crew, 6,493 lb. The mechanical construction and workmanship of Tractor 3 made it superior to Nos. 1 and 2, as was evidenced not only by inspection but also very conclusively by tests. In comparative calculations of power required respectively by the locomotive and monorail systems, therefore, we have used the results obtained in using Tractor No. 3.

The tractors were operated upon a monorail supported at a height of 4 ft. above the ground by steel posts placed at intervals of 18 ft. The rail, as used in the installation at Mauch Chunk, is an ordinary 10 in. I-beam weighing 75 lb. to the yard. The monorail with supports and braces complete weigh 120 lb. per yard and is erected along the canal outside the tow path. The construction is illustrated in Fig. 3.

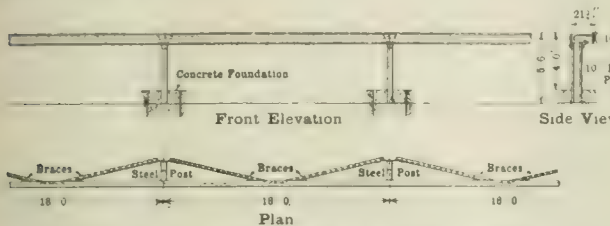


FIG. 3.—CONSTRUCTION OF MONORAIL SYSTEM.

A fourth tractor, No. 4, built in Paris, was also subjected to certain tests. This machine, without testing crew and instruments, weighed 3,465 lb. It was equipped with one direct-current 500-volt motor of 15 H.P. The diameter of wheels was 12·75 in. and the wheel base 24 in. For this smaller machine a section of monorail track 1,200 ft. long was erected on wooden posts between locks Nos. 2 and 3. The rail in this case was a 7 in. I-beam, weighing 45 lb. per yard, and was erected at a height of 4 ft. from the ground. Preliminary tests, however, showed that this machine was not adequate in mechanical strength and power equipment for the service.

The following instruments were used in making the tests:—Direct current graphic recording wattmeter with time attachment, also with a signal pen used to record distances and special points by

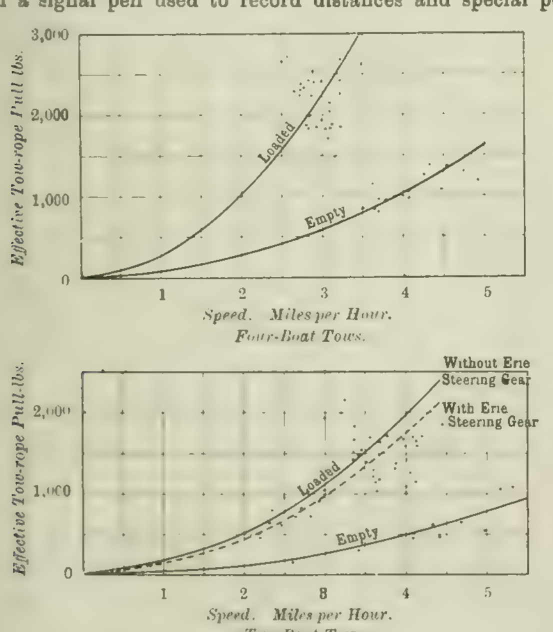


FIG. 4.—TOWING RESISTANCE TESTS, CORRECTED FOR AVERAGE ROPE ANGLE.

means of a push-button Weston ammeter. Weston voltmeter. Three spring dynamometers. Two integrating wattmeters used to measure respectively the energy delivered to the monorail and locomotive sections. Distance marks were located at distances of 52·8 ft. along the track. As each point was passed by the machine undergoing test a push button record was made by the signal pen in the graphic recording wattmeter and at the same instant the voltmeter and dynamometer were read. In addition, during one complete run the angle formed by the tow-rope and the centre line of the track was determined at each distance point. All test results are corrected for this angle, and the tow-line pulls stated are the effective pulls in the direction of motion. In the tests the tow-line was approximately 200 ft. long.

Four canal boats, each 87 ft. 6 in. long and 10 ft. 5 in. wide, draft about 5 ft. 2 in., were used, the weight of each loaded being about 137 tons (of 2,000 lb.) and empty about 24 tons. In addition to tests of these boats the regular canal traffic was handled by the test machines during September, October and November. The velocity of the current of water flowing in each section of the canal was determined at the time the tests were made, but to obtain an average value for towing resistance, including the effect of this current and also of track grade, all tests were made in both directions over each section of the canal. The average results are used in our calculations.

Effective Tow-rope Pulls Required.—The effective tow-rope pulls as determined by dynamometer tests and corrected for the rope-angle for four, two and one-boat tests, both light and loaded, are given in Figs. 4 and 5. In the majority of the two-boat tests, the boats

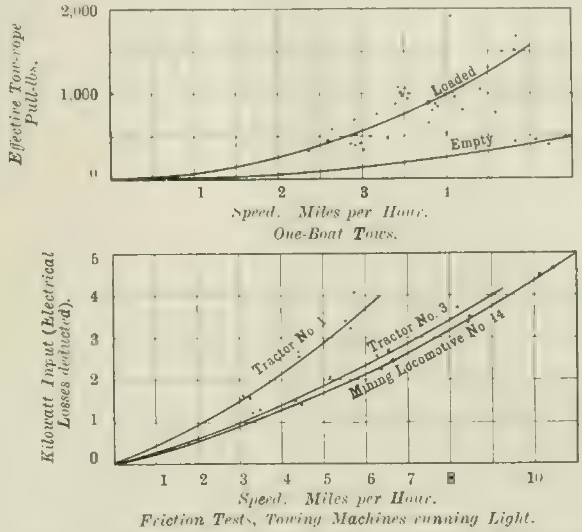
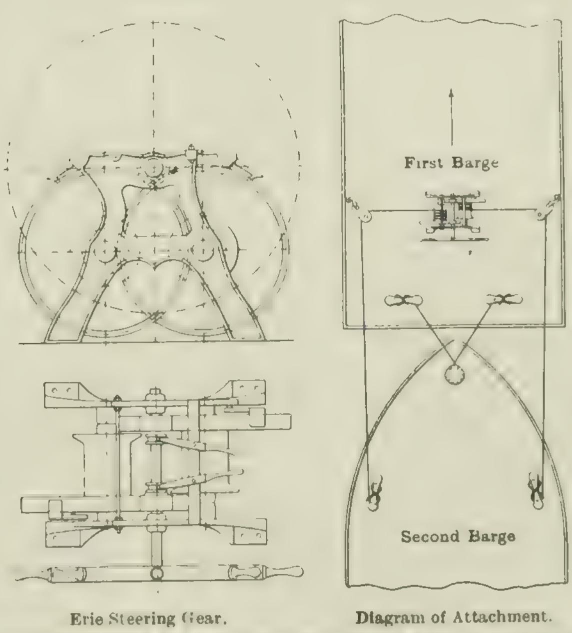


FIG. 5.—TOWING RESISTANCE TESTS, CORRECTED FOR AVERAGE ROPE ANGLE.

were equipped with the so-called Erie steering gear. With this gear the second boat is used as a rudder for the first boat, to which it is tightly lashed. The arrangement is illustrated in Fig. 6. The effect, so far as resistance of the water is concerned, is a reduction of approximately 8 per cent. in the pull required; in addition to which saving the boats are kept in better alignment and are under better control. In the majority of the four-boat tests, the first two boats were equipped with the Erie steering gear, but this beneficial effect as regards reduction of pull required was apparently lost, owing probably to the effect of the drag of the last two boats, which tended to alter the position of the first two with reference to the line of motion.



Erie Steering Gear. Diagram of Attachment.

Diameter of Handwheel, 3 ft. 6 in. Diameter of Drums, 6½ in. Gear Ratio, 0·25.

FIG. 6.

It appears that for boats, such as are used on the Lehigh and Delaware canals, the effective tow-rope pull in pounds required for any number of loaded boats is expressed approximately by the formula $0{\cdot}45V^2T$, and for empty boats by $0{\cdot}67V^2T$, where V is the speed in miles per hour and T the total tons (2,000 lb.). The immersed cross-section of a loaded boat is 54 sq. ft.. while the average

cross-section of a canal on those sections upon which most of the tests were made is 440 sq. ft.

Acceleration and Maximum Rope Pulls.—Compared with electric railway operation, the rate of acceleration practicable of attainment in towing canal boats is low, but is relatively unimportant. A table of results is, however, given in the Paper, and shows for four boats loaded an average of 0·0243 miles per hour per second, and for one boat loaded 0·0667 miles per hour per second.

Towing Machines Tests.—In most of our tests mining locomotive 15 and tractors 1 and 3 were used. Comparison was made at speeds and effective pulls as nearly identical as was found practicable. As to meet these conditions the various machines tested required different operating energy, and as change in the energy affected the motor efficiency, the electric losses in the motors in all cases have been deducted from the kilowatt input in determining the mechanical efficiency of the machines. The mechanical loss of the motors and gears in each case is charged against the respective machines, and the tow-line pull has been corrected to the effective pull in pounds in the direction of motion. With an effective pull of 1,000 lb. the efficiency of the locomotive was 80 per cent., of tractor 1 68 per cent. and of tractor 3 73 per cent.; whilst with 3,000 lb. pull the figures were 84, 74·8 and 77·5 per cent. respectively. The performances when machines were running light are given in Fig. 5.

In order to assist in determining the cause of the apparently excessive friction of these tractors at low rope-pulls and when running light, tests were made on a wet rail to determine the relative amount of reduction in friction due to a bad rail. The results of these tests show that at a speed of 6 miles an hour the wet rail effects a saving of about 16 per cent. in total friction, running light, and at the same speed the gear and motor friction amounted to 28 per cent. of the total. It is apparent from the tests that frictions at light loads are relatively small, and at large pulls the difference is to a large extent lost as the mechanical friction approximates the theoretical amount to be expected from the pull exerted. It would seem that the mechanical efficiency of tractors of this type might be improved, thus: (1) An increase in the size of wheels would tend to decrease losses (2) The wheel-base should be long and the "flange clearance" small. (3) The mechanical construction must be such that alignment of all bearings is preserved under all conditions of operation. (4) The point of rope attachment should be carefully selected in order to reduce flange friction to a minimum. (5) The rail surface should be as good as on ordinary railway tracks, and the construction should be such as to minimise vibration. (6) The use of guides for the pressure wheels should be avoided if practicable. If used, the vertical motion in the guides for the pressure wheels should be free. (7) The pressure wheels should have no flange. (8) Arrangements for oiling the bearings of tractors as well as of locomotives should follow railroad practice.

Speed Limits.—These depend upon: (*a*) Ability to steer the boats; (*b*) wash of canal banks; (*c*) time required for locking; and (*d*) tonnage capacity and length of tow. The selection of a best speed depends also upon the number of boats which must pass through the canal in a given time to handle its business.

Our conclusions in regard to limits of speed, as fixed by conditions of practicable steering, are: (*a*) Single boats, loaded or empty, can be operated satisfactorily on tangents at speeds exceeding 5 miles an hour, but on the canal for satisfactory working 5 miles an hour is probably about the limit of average speed. (*b*) Two-boat tows are handled satisfactorily at speeds of from 3·5 to 4 miles an hour. (*c*) Four-boat tows loaded can be operated with a fair degree of success at speeds up to 3 miles an hour except on very sharp convex curves. (*d*) Four-boat tows, light, were found impracticable as tested. It is possible that improved steering gear might remedy the difficulties encountered. Our estimated average time for locking is for one boat 10 minutes, two boats 15 minutes, four boats 35 minutes, although these figures were improved on when tested. In four-boat locks, with the first two boats and the last two boats equipped with Erie steering gear, it would not be necessary to disconnect the steering gear and the time of locking would not greatly exceed that for two boats.

The following is a tabulation of the speeds recommended for tows varying from one to four boats, loaded and empty, assuming (*a*) that direct current series motors are employed, and (*b*) that single-phase alternating current motors of the compensated type be used:—

Maximum Speed between Locks.

—	Direct current.	Alternating current.
	Miles per hour.	Miles per hour.
Four boats loaded	3·00	2·88
Four boats empty	4·00	4·20
Two boats loaded	3·45	3·45
Two boats empty	4·60	5·00
One boat loaded	4·00	4·20
One boat empty	5·30	6·00

Direct Current Motors.—The total efficiencies, kilowatt input at trolley and speeds for the mining locomotive and tractor are given below. The efficiencies and inputs include all mechanical and electrical losses:

Effective pull.	Speed. Miles per hour.	Mining locomotive.		Tractor.	
		Per cent. Effici'ncies	Input. Kilowatts.	Per cent. Effici'ncies	Input. Kilowatts.
1,000 lb.	4·0	70·2	11·3	67·2	11·8
2,000 lb.	3·1	71·6	17·3	70·0	17·7
3,000 lb.	2·7	69·5	23·3	69·0	23·5

Single-phase Alternating Current Motors.—The following table shows the comparison of the two machines, including all mechanical and electrical losses:—

Effective pull.	Speed. Miles per hour.	Mining locomotive.		Tractor.	
		Per cent. Effici'ncies	Input. Kilowatts.	Per cent. Effici'ncies	Input. Kilowatts.
1,000 lb.	4·3	66·8	13·0	64·5	13·4
2,000 lb.	2·9	68·4	17·0	67·0	17·3
3,000 lb.	2·3	67·2	21·2	66·5	21·5

It is evident that the difference in efficiency of the mining locomotive and the tractor, and of alternating current and direct current equipment, are relatively unimportant as compared with other factors upon which the choice of one or the other as a system of electrical haulage must depend. Characteristic curves showing the average speed including locking for runs of different length, the average power required at the trolley, and the watt-hour per ton-mile for four, two, and one-boat tows for the mining locomotive and the tractor and for both alternating current and direct current are shown in the Paper, and the following table shows the more important points:—

Speed, Kilowatt Input, and Watt-hours per Ton-mile. Average Run 1·52 Miles—Two-boat Locks.

—	Speed.		Mining loc'm'tive		Tractor.	
	Maximum speed. Miles per hour.	Average speed including locking. M.p.h.	Average input at trolley. Kw.	Watt hours per ton-mile.	Average input at trolley. Kw.	Watt-hours per ton-mile.
Direct current.						
4 boats loaded..	3·00	1·40	8 7	11·3	8·8	12 0
4 boats empty..	4·00	1 60	4·3	29 2	4 6	30 3
2 boats loaded..	3·45	2 22	9·1	14 8	9·3	15·5
2 boats empty..	4·57	2·65	5·2	41·9	5·4	44·0
1 boat loaded ...	4·00	2·81	7·7	20·0	8·0	21·0
1 boat empty ...	5·30	3·42	4·9	61·0	5·2	64·5
Alternating cur.						
4 boats loaded..	2 88	1·37	8·1	11·0	8·2	11·1
4 boats empty ..	4·13	1·59	5·0	33·5	5·3	34·8
2 boats loaded..	3·45	2·22	9·6	15·5	9·9	16·0
2 boats empty ..	4·98	2·78	6·6	50·8	6·8	53·0
1 boat loaded ...	4·19	2·90	9·0	22·6	9·4	23·3
1 boat empty ...	6·00	3·67	6·7	77 0	6·9	80·8

DISCUSSION.

Mr. R. Lamb did not agree that efficiency could, to a great extent, be disregarded. As engineer for the company that contracted to tow canal boats on the New York State canals, he had occasion to investigate, in a practical way, the subject of canal-boat towing. The results of the tests made on the Erie Canal at Tonawanda, N.Y., showed that the cost for towing a boat from Albany to Buffalo by mules, steam propellers and by electric motor were, respectively, $42.24, $17.60 and $15.32, with relative speeds of 1·3 miles, 3 miles and 3·6 miles per hour. In order to compete with the principal motive power now in use, the mule, great care should, therefore, be taken to obtain the most efficient motor, from both mechanical and electrical standpoints. In U.S.A. attempts had been made to utilise the towpath for a railroad bed, and to tow the boats by standard locomotives. These tests proved unsatisfactory because of the necessary slow speed at which the boats had to be towed. The dead load and the fuel consumption of a locomotive going only 3 miles an hour made the standard locomotive very inefficient for this purpose. A low rate of speed was the governing factor in canal boat towing. This attribute was inherent because of the limited distance between the bottom of the boat and the bottom of the canal. The bottom of an Erie canal boat was nearly flat and was 17·5 ft. wide. The distance from the bottom of a loaded boat to the bottom of the canal was 1 ft. Conceive of an area equal to the width of boat and the distance from the bottom of the boat to the bottom of the canal as being an orifice through which water must flow. The area was 17·5 sq. ft. When the boat was stand-

ing still there were 12,827 gallons of water under her. At 6 miles per hour 1,166 gallons per second would have to pass through 17·5 sq. ft. of sectional area, if the boat remained as it was, but the boat settled as the speed increased, and therefore the sectional area under the boat decreased, making it impossible for so large a quantity of water to pass under the boat in so limited a time. Hence the water passed to easier channels, to both sides of the boat, until there was no water under the boat and it stopped. Therefore, as soon as the maximum speed was reached, the boat stopped. An intumescence of the water at least 1 ft high formed about a loaded Erie canal-boat when going 3 miles an hour. This water, not being able to pass under the boat, passed to either side, making a wave. At 4 miles an hour a loaded canal boat on the Erie canal generated dead water under the stern so that it was practically impossible to steer her, and the curves on the canal made navigation at this speed difficult and dangerous. He considered that after equating for first cost and maintenance of canal and electric towing plant, and the maximum carrying capacity of boats, that a speed of 3 miles an hour was the greatest that should be sought. The wash of the canal bank, caused by the waves generated by a boat going more than 3 miles an hour, was no inconsiderable factor in maintaining the canal. The tests recorded showed that a tractor weighing 6,493 lb., and getting its tractional friction from the pull on the tow line, was not so efficient as a mining electric locomotive weighing 16,000 lb. The tractor exercised a greater resistance to its own propulsion than a mining electric locomotive of over twice its weight.

Mr. C. P. Steinmetz thought it would be still more interesting to have not merely a comparative test of two rival systems, but a comprehensive Paper covering the subject of canal haulage—a comparison of the relative advantages, efficiencies, financial economies, &c., of the different systems of electric haulage, of steam propulsion and of other methods which had not been mentioned. Other methods were the chain drive, where a chain was laid at the bottom of the canal or river, and raised up to propel a boat, carried over a drum, and dropped again. He understood that this system gave good service abroad. Mule propulsion of a canal boat appeared to be a rather antiquated method, but they might find, nevertheless, that mule power was, after all, under some conditions, the most economical form of drive. Comparing the cost of electric power per ton-mile as given in the Paper with the cost of maintaining the same mule power, he should not be astonished to find that under the average conditions of canal haulage, the mule was the cheaper power. In systems of canal haulage a condition essentially different from that of the railroads had to be met, in that most of the canals were public highways, and electric propulsion must not interfere with any other established method of propulsion on the State or national canals. Financially, the most serious feature was that canal traffic, in very many cases, was extremely light and intermittent. Any equipment installed to take care of the maximum traffic would lie idle a part of the year, and might be very uneconomically used during some years. Under such conditions an electric system might be rather uneconomical. It appeared to him, therefore, that to show a superior efficiency to other forms of haulage, the field which electric haulage would cover, the traffic which it would take care of, would not be the traffic which exists now on waterways like the Erie canal, but a new form of traffic which would probably be created.

Mr. L. B. Stillwell said the Paper showed that from the mechanical standpoint the tractor was materially less efficient than the mining locomotive. While the difference in losses was small in comparison with the total energy utilised, it was large when expressed in terms of losses. For an effective pull of 2,000 lb., for example, the mining locomotive lost a pull in the machine equivalent to 400 lb., while the best of the tractors lost 600 lb. The lesson to be drawn was that the tractor needed mechanical improvement. With reference to Mr. Steinmetz's remarks the authors had studied the economy of the electric haulage system as compared with haulage by mules and established, to their own satisfaction at least, that if a canal was worked at anything approximating its full traffic capacity, electrification would pay handsomely. The capital costs when divided by a very large number of ton-miles per annum were reduced to so small an amount that they were absorbed by the general economies resulting from electrification.

ON THE BEST METHOD OF DEMAGNETISING IRON IN MAGNETIC TESTING.*

BY C. W. BURROWS.

Summary.—The author first discusses the various proposed methods of demagnetising iron, and then examines the polarisation effects which have to be removed by demagnetisation. The upper and lower limits of the demagnetising force are also ascertained. The demagnetising efficiency of an alternating current is then investigated, and the time interval of demagnetisation, the normal induction, the effect of viscosity, the effect of repetition and the effects of vibration and temperature on the magnetism are all dealt with. Finally, the author gives what he considers the best method of procedure in magnetic testing.

The magnetic permeability of a specimen of iron depends on its previous mechanical, thermal and magnetic history as well as on its chemical composition. While, therefore, the magnetic permeability of a given piece of metal may be measured quite accurately at a given instant, in general the very process of measurement may leave it with magnetic properties different from those it had at the beginning of the test, and such a test may be quite misleading as regards the real magnetic properties of the specimen. The after effects of various details in the history of the magnetic substance are, therefore, described, and a plan outlined whereby a specimen may be freed from all effects of previous magnetic treatment, and so be brought to a standard condition for testing.

The author first refers to the work of Ewing and Searle, and quotes a number of results stated by these writers, which have been confirmed during the present investigation, and explains that in the case of a piece of iron possessing residual induction the applied magnetising force does not determine the absolute induction, but only the change. He therefore gives the following definitions:—The magnetic induction is one-half the change of magnetic flux per square centimetre observed on the reversal of a given magnetic force, or $\frac{1}{2}(B_H - B_{-H})$. Permeability is the ratio of this induction to the corresponding magnetising force, or $\mu = B/H$. The differentia permeability is the ratio of an infinitesimal change in B to the corresponding change in H,—*i.e.*, the tangent of the angle which the tangent to the curve makes with the H axis. The hysteresis loop is the path traced by the state point on a double reversal of a given magnetising force after sufficient repetition has made the path cyclic. A normal hysteresis cycle is one which is symmetrical about the origin. The induction and permeability are normal or apparent, according as the corresponding hysteresis loops are normal or not. Iron is in a neutral state when it exerts no external field and yields as readily to a positive magnetising force as to a negative one.

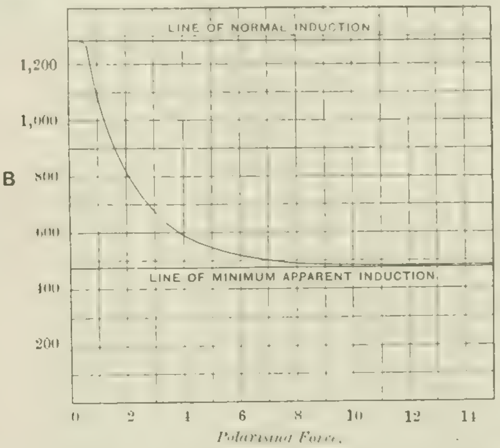


Fig. 1.—Showing the Relation between the Polarising Force and the Apparent Induction in Annealed Transformer Iron for $H = 0·5$.

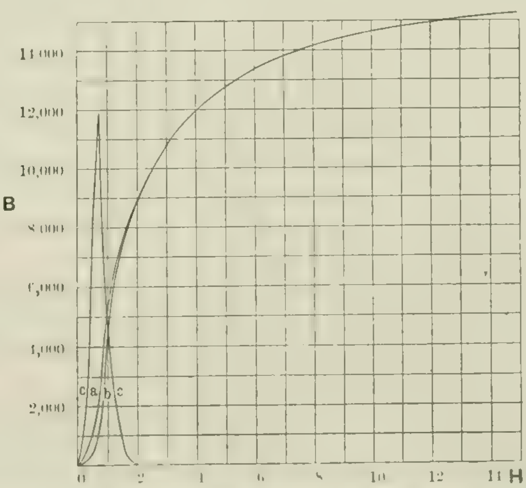


Fig. 2.—Showing Characteristics of Annealed Transformer Iron.

Apparatus.—In these experiments the magnetic circuit usually consisted of two specimens about 50 cm. long placed side by side with their adjacent ends joined by suitable wrought-iron yokes. The magnetising coils consisted of two sections, each 40 cm. long, wound with a single layer of 400 turns of No. 22 double cotton-covered magnet wire. The secondary coil was uniformly distributed over

* Abstracted from the *Bulletin* of the Bureau of Standards.

the middle portion of the specimen. The shearing correction due to end effects is small and has been allowed for in the results. The specimens tested consisted of transformer iron, common iron, low carbon steel and high carbon steel, two pieces of each being used.

Criterion of Perfect Demagnetisation.—In order to reduce iron to a magnetically neutral state, it must be freed not only from all polarisation producing an external field, but also from all internal polarisations which produce no external field, and it may be magnetically homogeneous with no external field and yet not be in the neutral state. Before a satisfactory criterion of perfect demagnetisation can be determined upon, it is necessary to know something of the nature of the influence a residual induction has on the apparent induction. With this in view, the following experiment was carried out: A specimen was demagnetised as thoroughly as

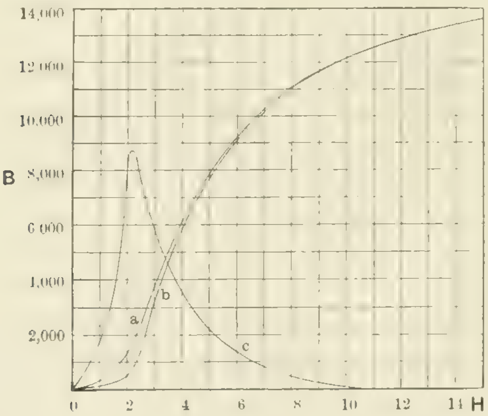


FIG. 3.—SHOWING CHARACTERISTICS OF COMMON SHEET IRON.

might be and its apparent induction measured. Then the specimen was subjected momentarily to a magnetising force which would give it a certain residual induction. After the removal of this force the apparent induction for the same force as before was determined. These operations were repeated with successively increasing polarising forces. The results are shown graphically in Fig. 1, and show that as the polarising force increases the resultant induction decreases. In consequence of this fact, which holds in every case examined, the criterion of perfect demagnetisation is that the induction shall be a maximum.

Methods of Demagnetisation.—The method most generally employed is that of descending reversals in which the demagnetising force is repeatedly reversed while it is gradually decreased in value. Ewing* suggests a "potential slide," and Searle used an alternating

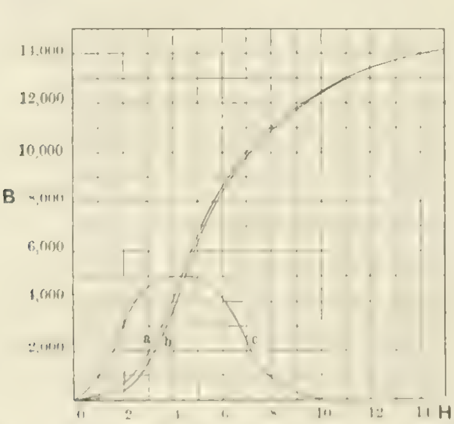


FIG. 4. SHOWING CHARACTERISTICS OF LOW CARBON STEEL.

current of 90 cycles supplied from the city mains, the resistance consisting of a narrow glass trough containing dilute copper sulphate solution, and furnished with two copper electrodes, one of which was movable. By tilting the trough so that one end was dry the current could be reduced to a very small value.

In this investigation all the available methods of current control were tried. In some of the liquid resistances the electrodes were moved apart so as to give a longer path through the liquid. In others the liquid was removed from the containing vessel by tilting the vessel, by siphoning off the liquid, and again by allowing the liquid to run out through a stopcock in the bottom of a tall cylindrical vessel. The latter was the most satisfactory of the liquid type. The most satisfactory rheostat used was a cylinder of slate wound with bare wire, having a sliding contact moving parallel to the axis of the cylinder. Several of these resistances of different sizes of wire are connected in series and are highly satisfactory. Current decrease was also effected by changing the applied E.M.F. while keeping the resistance constant. This method was found to offer no advantage over the preceding, and has some obvious disadvantages.

* "Magnetic Induction in Iron and other Metals," p. 44.

Early in the investigation it became apparent that the efficiency of demagnetisation depended not so much on the total time consumed as on the rate at which the demagnetising current was reduced. To test this point the demagnetising current was reduced successively in three different ways:—(1) so that the rate of increase of resistance was constant, (2) so that the rate of decrease of current was approximately constant, and (3) so that the rate of decrease of induction was constant. This last method gave the best results and has been followed in all the later work.

The E.M.F. to be used is determined largely by the requirements of the induction measurements to be made after the demagnetisation, and 20 volts has been used in this series of experiments.

Polarisation Effect.—Several specimens of iron were examined after having been exposed to different magnetic treatments. The iron was first demagnetised as well as might be and its apparent induction determined for a series of values of the magnetising force. Then the iron was subjected to a strong magnetising force of 100 units (gausses), after which the induction was re-determined. This polarising force was applied and removed several times, but it was not reversed. The results are shown in Figs. 2, 3, 4 and 5, in which (*a*) represents normal **B**-**H** curves, (*b*) apparent **B**-**H** curves after intense polarisation, and (*c*) polarisation effect magnified tenfold. Tables of values are also given in the Paper.

It is noted that the four specimens of iron show several common characteristics. (1) The induction after demagnetisation is greater than the apparent induction after the intense polarisation. The

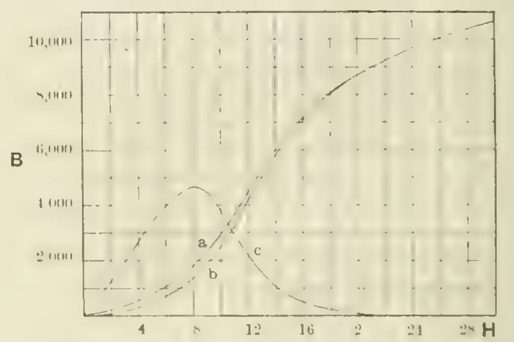


FIG. 5.—SHOWING CHARACTERISTICS OF HIGH CARBON STEEL.

difference between these two inductions may be called the "polarisation effect," and is a measure of the completeness of the previous demagnetisation. (2) As the magnetising force under which the apparent induction is measured increases, the polarisation effect at first increases, then passes through a maximum, and finally decreases to zero. (3) The point at which the polarisation effect is a maximum is somewhat lower than the point of maximum permeability and near the point where the differential permeability is a maximum. (4) The point at which the polarisation effect vanishes is somewhat above the point of maximum permeability. This vanishing point is a critical point magnetically. We shall therefore denote the corresponding force and induction as "critical demagnetising force" and "critical induction." (5) While the initial polarisation effect initially increases, the normal induction increases so much faster that the percentage polarisation effect decreases continuously with increasing magnetising force.

To test the nature of this polarisation effect still further, the annealed transformer iron was demagnetised and subjected momentarily to successively increasing polarising forces. After each application of the polarising force a magnetising force of 0·5 was applied and slowly reversed several hundred times. After the iron had reached a cyclic condition the apparent induction was measured. The results are shown in Fig. 1.

Certain experiments on the effects of imperfect demagnetisation seemed to indicate that the data recorded above do not represent the maximum possible polarisation effects for the given polarising forces. To test this point the polarising force was applied in different ways, and this showed that a given force left a greater residual polarisation effect if it were reversed several times than if it were simply applied and removed the same number of times, and numerical particulars are given in the Paper.

Since the polarisation effect is a continuous function of H and has a maximum at the same value of H, it was assumed that it would be a maximum at the same value of H under all conditions, and when it vanished at this force it would have vanished for all other magnetising forces. This assumption is later justified for all the ordinary methods of demagnetisation.

Upper Limit of the Demagnetising Force.—It has usually been assumed that a necessary condition for perfect demagnetisation is that the demagnetising current must carry the iron from an induction greater than any previous one it has experienced down to a vanishing small one. To determine the maximum value of a necessary yet sufficient demagnetising force the following experiment was carried out: The specimen was first strongly magnetised by a force of 100 to insure a considerable initial polarisation. Then it was demagnetised from a certain value of the demagnetising force down to a vanishing small force. The cyclic apparent induction was then measured for the value of H, at which the previously

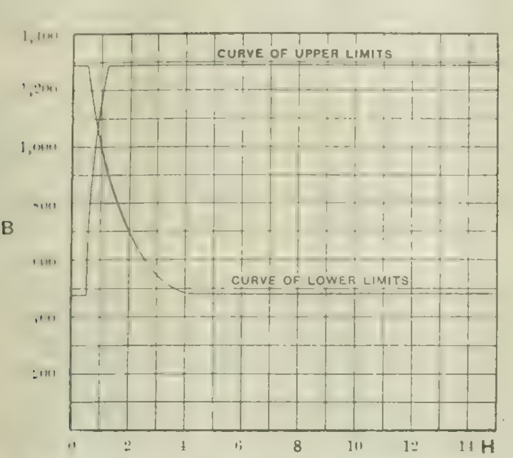


Fig. 6.—Showing the Influence of the Upper and Lower Limits of the Demagnetising Force on the Apparent Induction of Annealed Transformer Iron, for $H = 0{\cdot}5$.

observed polarisation effect was a maximum. After this measurement the specimen was again strongly magnetised as before, demagnetised from a second maximum down to the same vanishingly small force, and finally the cyclic apparent induction was measured for the same magnetising force as before. This process was repeated for a series of values of the maximum demagnetising force. The results of these experiments are shown graphically in curves marked "curve of upper limits" in Figs. 6, 7 and 8. These show that the demagnetisation is not improved by carrying the demagnetising force beyond the critical demagnetising force, and shows that such demagnetisation produces no effect that the simple reversals of the magnetising force used in determining the induction would not accomplish. The two horizontal portions are connected by a smooth curve, indicating that over this range the demagnetisation is more or less imperfect, but is approaching completeness very rapidly with increase of maximum demagnetising force. Also a comparison of the curves shows that the steepness of the sloping portion and the sharpness of the bends decreases as the hardness of the iron increases.

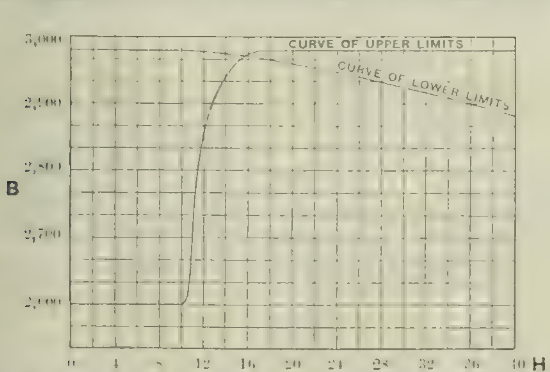


Fig. 7.—Showing the Influence of the Upper and Lower Limits of the Demagnetising Force on the Apparent Induction of High Carbon Steel, for $H = 10$.

The above applies to a single value of the magnetising force. To show that this is typical, the full range of points was taken for different sets of magnetising limits, and tables of results are given by the author. From these the following conclusions may be drawn: (1) The demagnetisation is complete throughout the whole range if the upper limit is at least as great as the critical demagnetising force. (2) If the maximum demagnetising force is less than the critical demagnetising force, the demagnetisation is in general incomplete, and the incompleteness extends over practically the whole region from the lowest values of the magnetising force up to the critical value. This region may be called the domain of the polarisation effect. (3) The polarisation effect increases as the maximum demagnetising force decreases, but preserves its general characteristics as described above. (4) In certain cases the polarisation effect is greater after a feeble demagnetisation than without any demagnetisation. This phenomenon occurs at or below the point of maximum permeability.

Lower Limits of the Demagnetising Force.—To determine the necessary and sufficient final minimum value of this force, an experiment similar to the preceding was carried out.

The results are shown in the curves marked "curve of lower limits" in Figs. 6, 7 and 8, and the following conclusions may be drawn: (1) The demagnetisation is not improved by carrying the demagnetising force below the lowest magnetising force to be studied. (2) The demagnetising force does not modify the previously exist-

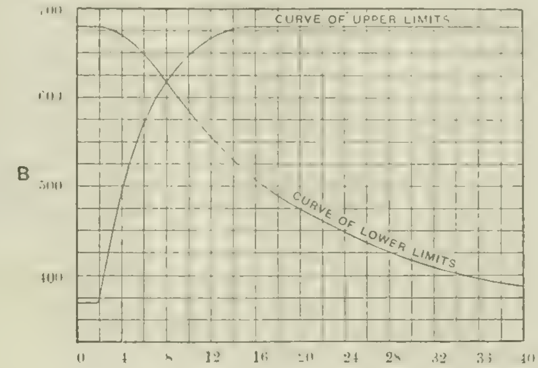


Fig. 8.—Showing the Influence of the Upper and Lower Limits of the Demagnetising Force on the Apparent Induction of Low Carbon Steel, for $H = 2$

ing polarisation effect; at least that portion of it which repeated reversals of the given magnetising force do not eliminate. (3) Between the two horizontal portions is a continuous sloping curve, which indicates a partial demagnetisation increasing in completeness very rapidly as the lower limit of the demagnetising force decreases. (4) The steepness of the curved portion of the curves and the sharpness of the bends at the upper and lower extremities decrease as we pass from the softer to the harder material. To justify the above conclusions drawn from measurements made at a single value of the magnetising force, several complete apparent induction curves were obtained under different details of demagnetisation, of which particulars are given by the author. From these data the following generalisation appears: If the demagnetisation is carried from the critical demagnetising force down to a certain point, the demagnetisation is complete for all values above the final demagnetising force. For magnetising forces below this final value of demagnetisation the demagnetisation is incomplete, and the incompleteness is greater the greater the interval between the final demagnetising force and the magnetising force used to produce the induction desired.

(To be continued).

THE OPERATION OF RÖNTGEN TUBES WITH PURELY UNIDIRECTIONAL INDUCED CURRENTS.*

BY ERNST RUHMER.

As is well known, the operation of an induction coil, fitted with mercury interrupter, such as is used in Röntgen ray work, is attended by an induced current at "make" whose value is in direct proportion to that of the voltage used. This induced current at "make," which is opposite to that at "break," has an exceedingly deleterious effect on the life of Röntgen tubes, especially when they are soft, a condition advantageous for certain purposes; fluorescent rings and shadowy figures then occur making both sharp illumination and photography impossible.

As in late years the tendency has been for supply voltages to increase to a higher value—*e.g.*, 220 to 440 volts—it has become necessary for efficient Röntgen ray work to devise some method whereby the disadvantages enumerated above may be overcome.

The methods used up to the present for this purpose may be divided into two classes. In the former the "make" voltage is reduced by including some arrangement, such as a choking tube or spark-gap, in series with the Röntgen tube, thus making it impossible for it to be broken down by the current induced at "make."

* Lecture delivered at the Fourth Annual Meeting of the Deutsche Roentgen Gesellschaft.

The operation of the newer type of choking tube is exceedingly good, but possesses the disadvantage of being very fragile, while at the same time the vacuum gradually changes, thus making some kind of regulation necessary, as it must always bear a certain relation to that of the Röntgen tube.

Attention should be called to the endeavours made to combine Röntgen and choking tubes, though the results obtained have in general left much to be desired, especially as regards the relatively small load factor and the great unsteadiness of the rays.

The principal objection to the use of a spark-gap is that it gives rise to high-frequency oscillations, which pass through the tube. The noise made by the spark-gap can, it is true, be overcome by enclosing it, though the oxides of nitrogen then generated soon become very unpleasant.

Spark-gap arrangements may also be divided into two classes—those which are kept constantly connected in series with the tube and those which are only so connected at "make." The first method naturally weakens the "break" voltage as well, which is not the case in the second arrangement. In practice, however, the making and breaking of high-tension current has certain disadvantages, if it is not done under the surface of an insulating liquid, an arrangement which in itself introduces complications. If the methods of the first group are shortly reviewed it will be seen that the valve tube is the simplest and most practicable arrangement for obtaining unidirectional working. For this reason, no doubt, it has obtained a wider application than any other.

In the second principal group, whose use we should like to see more developed, the working relations are so arranged that the voltage induced in the secondary winding at "make" is not sufficient to break down the tube. A simple mathematical treatment enables the necessary factors to be determined.

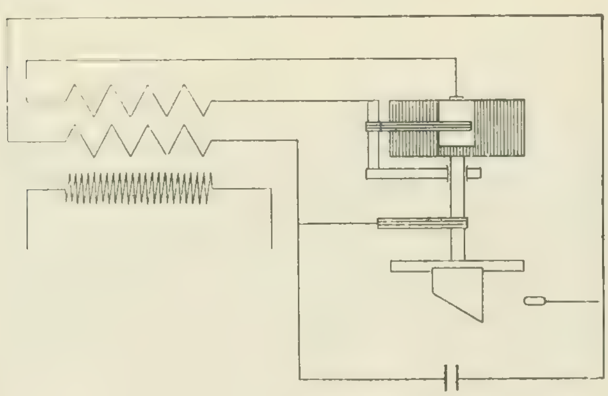


Fig. 1.

Suppose an E.M.F., E, to be applied to a primary winding, of resistance R and self-induction L, then the current at time t is given by

$$i_t = \frac{E}{R}\left(1 - e^{-Rt/L}\right)$$

and the field induced by this E.M.F.

$$\Phi_t = \frac{L}{N_p} \cdot i_t,$$

where N_p is the number of turns on the primary.

If the effect on the secondary winding of the primary is considered in its simplest form, we obtain in the secondary coil, which has N_s turns, when the field alters, an induced voltage.

$$e_t = -N_s \cdot \frac{d\Phi}{dt} = -\frac{N_s}{N_p} \cdot L \cdot \frac{di}{dt}$$

$$= -\frac{N_s}{N_p} \cdot L \cdot \frac{ER}{RL} \cdot e^{-Rt/L} = -\frac{N_s}{N_p} \cdot E \cdot e^{-Rt/L}.$$

There are, therefore, two possible ways of reducing the voltage at "make," so that it cannot break down the tube—viz., by decreasing either the ratio of transformation or the primary voltage.

The method most used in high-voltage work is to reduce the pressure by the employment of a shunt resistance, an arrangement which only uses a fraction of the energy called into play, though, at the same time by raising the number of turns on the primary the other factor can also exercise some influence. This can, however, only be carried to a certain limit, as with a given ratio of transformation, in spite of the increase in the time the circuit is closed, the field strength at the moment of break is too small and the voltage is not sufficient to work the tube efficiently. Practical experience indicates, however, that even under the most favourable conditions unidirectional operation with a very soft tube is quite impossible. This is my view after a consideration of a number of facts which are now well known. A very soft tube has a much smaller resistance to the "break" than to the "make" voltage, while with moderate and hard tubes the reverse is, as is well known, the case so that for these tubes the induced "make" voltage is not of so much importance.

The arrangement which I am now about to describe belongs in some ways to the second group, though it is so operated that while fully removing the "make" voltage it in no way interferes with that at "break." Even at 220 volts it has given absolutely unidirectional operation with a very soft tube without the employment of any choking tube or shunt resistance.

The method is characterised by the fact that the greater part of the induced current at "make" is taken from an auxiliary or protective winding on the primary core of the coil and so passes away into the secondary winding. Besides this the whole arrangement consists of a contact fitted to the interrupter so that the current in this winding is kept in synchronism (Fig. 1).

The method of working is as follows: The protective winding is closed before, or at least at the same time as, the primary winding and takes up the energy induced in the latter. Shortly before the primary winding is opened the contact of the protective winding is also released. It thus becomes dead, and allows the "break" induced voltage in the secondary to develop undamped. In practice it is of considerable importance that under certain conditions it is possible to interrupt the protective winding, without causing a spark, as E.M.F.s are only generated in it when the primary current is altered. If the primary current has reached its higher limit the inductive effect on the protective winding also ceases, and its current falls to zero. The auxiliary contact can, therefore, be as sparklessly broken as made. By this means all complication is avoided, and the greatest safety is ensued for a permanent and reliable operation of the apparatus.

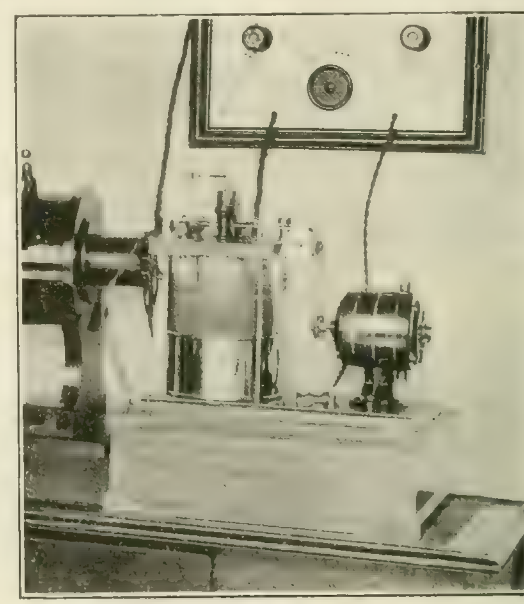


Fig. 2.

It is not devoid of interest to analyse mathematically the conditions present in the new method as has already been done above for the older. To simplify the calculation we will consider the primary and protective windings to have the same number of turns. (N_p).

The E.M.F. of the source will be designated by E, the resistance of the primary circuit by R_1, the self induction of the primary (and of the protective winding) by L and the resistance of the protective winding by R_2. Then, as a result, there is an energy transformation which is as follows for the primary current:—

$$i_{(t)} = \frac{E}{R_1}\left(1 - \frac{R_2}{R_1 + R_2} \cdot e^{-R_1R_2t/L(R_1+R_2)}\right)$$

and for the current in the protective winding

$$i_{s(t)} = -\frac{E}{R_1 + R_2} \cdot e^{-R_1R_2t/L(R_1+R_2)}.$$

The resultant magnetic field is then

$$\Phi_t = \frac{L}{N_p} \cdot \frac{E}{R_1}\left(1 - e^{-R_1R_2t/L(R_1+R_2)}\right).$$

Any alteration of this induces an E.M.F. in the secondary windings of N_s turns given by

$$e_t = -N_s \frac{d\Phi}{dt}$$

$$= -\frac{N_s}{N_p} \cdot E \cdot \frac{R_2}{R_1 + R_2} \cdot e^{-R_1R_2t/L(R_1+R_2)}$$

The induced voltage is a maximum when $t=0$; it is then given by

$$e_{t=0} = -\frac{N_s}{N_p} \cdot E \cdot \frac{R_2}{R_1+R_2}.$$

$\frac{R_2}{R_1+R_2}$ is always less than unity; the voltage induced at make is, therefore, considerably smaller with than without the protective winding, as shown by the expression $-\frac{N_s}{N_p} \cdot E$.

From these relations we learn that the voltage induced at "make" can be reduced by making R_2 small compared with R_1.

The relation of the two methods is clearly shown by making $R_1 = R_2$. Then we get

$$e_t = -\frac{N_s}{N_p} \cdot \frac{E}{2} \cdot e^{-Rt/2L},$$

$$e_{t=0} = \frac{N_s}{N_p} \cdot \frac{E}{2},$$

i.e., the voltage induced at "make" is at its maximum only one-half as great as without the protective winding.

To sum up, the efficient working of the protective winding is dependent on a slow rise of the electromagnetic field. By altering the value of R_1 and R_2 this rise can be regulated as required.

The advantages of the unidirectional arrangement here described and shown in Fig. 2 lies in its great simplicity and efficient operation. By using a glow-light oscilloscope-tube as an indicator, the absence of the current induced at "make" can be ensured even with the highest direct current voltages and the softest tubes.

A DETECTOR FOUNDED UPON MAGNETOSTRICTION.*

BY A. G. ROSSI.

(Preliminary Note.)

One apparatus based on such a system, that presented to the Parma Congress, is founded on the property of cycles of magneto-elastic hysteresis, discovered in 1903 by Prof. Sella, of having their amplitude affected by Hertzian electric vibrations. Its mechanical working utilises Wiedemann's phenomenon of torsion by magnetostriction shown by a wire of magnetic metal when two magnetisations are superimposed in it, the one longitudinal, produced either by a coil coaxial with the wire, or by a suitable system of magnets, the other circular, and furnished by a current which traverses the wire itself.

The apparatus now presented consists of an iron (or nickel) wire, stretched vertically between two clamps provided with torsion heads, so that the wire may be previously subjected to a certain constant tension and an independent torsion. The wire is 20 cm. to 25 cm. long, and its diameter is not less than 0·1 mm. Three points of soft iron approach the two ends and the centre of the wire respectively to within a short distance, and so guide the magnetic flux furnished by two small straight bar magnets, which are attached to the reverse side of the insulating plate holding the clamps that the two halves of the wire may be magnetised in opposite directions to a suitable extent.

A very weak alternating current is sent through the wire. It is sensibly sinusoidal, and furnished by a small dynamo worked by a small motor of uniform and adjustable speed.

If the frequency of this current is just that which corresponds to the proper period of torsional vibration of the wire, which (neglecting the mass of the mirror attached to its centre) depends, as regards dimensions, only upon the length of the wire 2L,

$$T = 2\pi L \sqrt{\frac{\delta}{\sigma}}$$

(δ = density, σ modulus of torsion)—then the wire vibrates with maximum amplitude, on account of its resonance with the alternating helical magnetisation excited in it, and the consequent alternating couple of the Wiedemann torsion.

The mirror reflects on a screen the track of a spot of light in the form of a luminous horizontal band, of a length which is constant so long as the magnetisation remains constant in amount and frequency.

Now the amplitude of these torsional vibrations is affected by the stationary waves of the ordinary wireless telegraphy.

If, between the usual antenna and the earth, a small coil of insulated copper wire is introduced, and wound upon a small glass tube divided into two parts, which embrace the stretched wire without touching it, the oscillating magnetic field created within the coil by the waves, reduces (under suitable conditions of elastic deformation and magnetisation) the torsional vibrations of the wire, and so reduces the length of the luminous band on the screen.

It is easy in this manner to obtain the photographic registration of wireless signals. This apparatus was, in fact, devised with a view to such photographic registration, which is not offered by the most sensitive detectors.

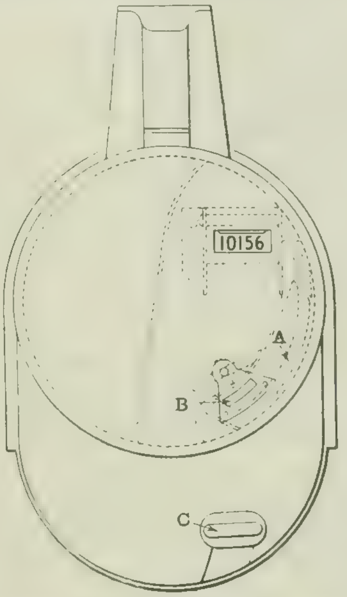
As regards the sensitiveness obtainable with this kind of apparatus, it is sufficient to point out that, whereas in the admirable detector of Marconi the mass of iron temporarily subjected to the waves is at least of the order of a gramme, and that the energy transformed has also to account for the buzzing of the telephone disc, in my apparatus the mass of iron subjected to the action of the waves is less than 15 milligrammes, with a total active length of 20 cm. to 25 cm., and no transformation of energy is required beyond the production and registration of the optical effect.

* Translated from *Nuovo Cimento*.

A MAGNETIC TICKET PUNCH.

Most tramway managers have experienced trouble from the misplaced ingenuity of conductors, against whose deft fingers most mechanical devices are useless. Mr. Mallins, traffic manager of the Liverpool Corporation tramways, has for some time had this question under consideration, and he has finally evolved a form of ticket punch which up to the present has baffled all attempts at dismemberment by the employés on those tramways.

In appearance it resembles the type which is in use on most tramways, and which depends on the ticket to provide the necessary link for the transmission of the power to operate the punch. In the diagram herewith C represents the punching lever which is operated by the conductor. The opening of all previous punches of this pattern has been by mechanical means, a seal serving to cover



MALLINS MAGNETIC TICKET PUNCH.

up the locking arrangement; in the punch designed by Mr. Mallins, however, the unlocking can only be performed magnetically. For this purpose a special electromagnet has been installed in the traffic office for the use of the cash clerks. This magnet has specially shaped poles which fit to the contour of the punch, and the latter has to be placed in a certain position so that the magnetic force withdraws the catch A (see Fig.) and allows the cover of the punch to be removed. The winding of the electromagnet is connected up in series with a lamp connected to a 220 volt circuit, so that the only operation necessary to be performed by the clerk is to place the punch in the jaws of the electromagnet and to switch on the current by means of an adjacent tumbler switch, the releasing of the catch taking place almost instantaneously.

As a further indication of illegal tampering with these punches the word "CAUGHT" appears at the small window B (see Fig.) should any mechanical means of opening the punch be attempted, and it is impossible for this indication to be replaced except at the traffic office, so that the culprit is unfailingly brought to justice.

We understand that these punches have been in use on the Liverpool Corporation Tramways since the beginning of this year, and have proved perfectly satisfactory, so that Mr. Mallins is to be congratulated on his ingenuity in baffling dishonest employés.

BOOKS RECEIVED.

(Copies of the undermentioned works can be had from *The Electrician* office, post free, on receipt of published price, adding 3d. for books published under 2s. Add 10 per cent. for abroad or for foreign books.)

"Lathe Design for High and Low-Speed Steels." By J. T. Nicholson and Dempster Smith. (London: Longmans, Green & Co.) 18s. net.

"Les Rayons Cathodiques." By P. Villard. 2nd edition. (Paris: Gauthier-Villars.) 2 fr.

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PROGRESS IN ELECTRICITY SUPPLY.

In a report of the Committee on Progress, read before the recent meeting of the National Electric Light Association at Chicago, Mr. T. C. MARTIN, of the *Electrical World*, one of the oldest, and probably the best known, of all American writers on electrical engineering subjects, gives some interesting figures in regard to the progress that is being made in electricity supply. Notwithstanding somewhat difficult financial conditions, progress in the United States during 1907 from the point of view of expansion of electricity supply was very considerable. The number of generating stations up to April, 1908, appears to have been 5,037, or, including 396 in Canada and 62 in Mexico, a total of 5,495 for "North" America. During the past year 485 new stations came into operation, which appears to be an extraordinarily large number having regard to the figures to which we are accustomed in the United Kingdom. It is noticeable that although there are a number of municipal plants they are chiefly of small size, and the amount of capital controlled by municipalities is small in comparison with that invested in private enterprise. Municipalisation is by no means regarded with favour in America. Out of the 485 stations just mentioned the United States accounts for 441, the remainder being due to Mexico and Canada.

The statistics issued by the *Elektrotechnische Zeitschrift* also show a rapid expansion in electricity supply in Germany. The figures, which apparently are only brought up to April, 1907, show that there were 1,530 stations in the German Empire, though probably the actual number is more nearly 1,700. Here, however, municipal work predominates. Thus of the 1,530 stations no fewer than 1,023

are owned by the State or by municipalities. Connected to these plants at that time were 9,736,563 incandescent lamps, 178,912 arc lamps, and 582,862 H.P. in motors. The motor load is said to be very little less than the whole incandescent and arc lighting load, notwithstanding that the vast majority of the plants are small. Berlin accounts for about 10 per cent. of the total connected load. The rate at which new stations have come into operation during the last eight years is 114 per annum, so that there does not seem to be any great question of "saturation."

In France the number of stations at the beginning of 1906 was 1,413, whereas the number of gas works was only 824.

Coming now to the United Kingdom, *The Electrician* tables show only 430 electricity supply systems. The connections at the beginning of the year 1908 amounted, approximately, to 1,250,066 kw., of which 823,550 kw. were to municipal and 426,516 kw. to private enterprises. It is somewhat curious that the number of stations should be comparatively small, being much less than that of France, Germany or the United States, although the population of the United Kingdom is roughly about the same as that of France, three-fourths that of Germany, and half that of the United States. What is still more striking is that the number of stations in progress is practically nil. There are, no doubt, a number which are projected or in progress, but, as mentioned by Mr. MARTIN, they would perhaps be more appropriately placed under a "report of delay."

We think that such figures as these, indicating stagnation in the business of electricity supply in this country, point to one of the sources of trouble of the electrical industry. The large construction work has already been done; what remains to be accomplished is only small. There is, however, the undoubted fact that what is small in this country is not small in other countries. The responsibility for this lies on grandmotherly legislation, which does not allow us to deal with small undertakings in such a way as to enable them to pay a dividend; therefore, small towns are not supplied with electrical energy, and are likely to remain an unworked field as far as electricity supply is concerned.

PROGRESS IN THE ELECTRIC IRON AND STEEL AND FERRO-ALLOYS INDUSTRIES.

BY JOHN B. C. KERSHAW.

The electric furnace methods of iron and steel manufacture and the similar methods for producing ferro-alloys continue to make rapid progress, and the following list of places where one or other branches of this new industry are carried on, shows how widely the electric furnace method has extended :—

France.—La Praz, Allevard, Saut du Tarn, Unieux, Notre Dame de Briancon, Ugine, Creusot, St. Michel, Livet, Kerrousse, Bozel.

Germany.—Remschied, Essen, Volklingen, Rheinfelden, Gleiwitz.

Austria.—Jaice, Mattri, Kladno, Vocklebruck.

Switzerland.—Gurtnellan, Schaffhausen, Meran, Lonza, Gampel, Courtpin, Montbovon.

Italy.—Turin, Turin Arsenal.

Spain.—Arava.

Norway.—Sarpsborg.

Sweden.—Kortfors, Gysinge, Guldsmedhutte.

United States.—Syracuse, Niaraga Falls, Holcombe Rock, Kanawha Falls, Philadelphia, Héroult-on-the-Pitt.

Canada.—Welland, Niagara Falls.

England.—Sheffield, London.

The majority of these works have adopted either the Héroult or the Kjellin furnace—the former being now generally admitted as the most satisfactory type of the arc furnace, and the latter as the best type of induction furnace. A notable installation of the latter has occurred at the Forges d'Eich in Luxembourg, where electric power generated from the waste gases of the blast furnaces is being employed to produce electric steel. This furnace is of 500 kg. capacity, and the writer believes that it represents the first step in a development of enormous magnitude, since the latent heat energy of these gases is at present almost entirely wasted.

An important report upon electric furnace methods of steel production has been presented during 1907 to the St. Etienne Societe de l'Industrie Minérale, by J. Saconey, who with other engineers had been deputed to report for an Italian company upon the furnaces of Gin, Héroult, Keller, Kjellin, and Stassano.

Five charges were worked in the Stassano furnace in presence of the experts. The furnace and process were stated to be worthless for the production of steel direct from the ore, but it was stated to have a field of utility in the manufacture of special steels and alloys from pig-iron and steel scrap. Since the temperature attained in the Stassano furnace was comparatively low, it was not possible to eliminate the sulphur and phosphorus from the raw materials. As regards the Héroult process and furnace, the claim made by the patentee that the impurities of the raw materials can be eliminated, was substantiated. The method adopted for regulating the two electrodes by hand during the first heating of the charge, however, was condemned, and objections were raised to the use of two electrodes in series. The power consumption for this furnace and process was stated to be 600 kw. hours per ton with molten iron, and from 1,200 to 1,400 kw. hours per ton with cold pig and scrap as raw materials. The Girod furnace was of the cylindrical type with the upper electrode 300 mm. square. The power consumption was 800 kw. hours per ton of steel with cold materials. Comparing the three furnaces and processes, the report states that the Girod furnace was the best of the three named above, since it raised the metal to a higher temperature than the Stassano furnace and avoided, by the use of one electrode in place of two in series, some of the difficulties attaching specially to the Héroult furnace and process.*

The figures given by Saconey for the power consumption per ton with the Héroult and Girod furnaces, may be usefully compared with those given by the writer, in the final article of his series on this subject. In the case of the Héroult furnace the power consumption is higher, while for the Girod furnace it is lower, and this no doubt accounts for the favourable opinion formed by Saconey of the latter furnace. Eichoff has criticised this report as unfair to the Héroult furnace, and has pointed out that the steel made in the Girod furnace during the trials which Sacony witnessed at Ugine, was not equal in purity to that made with the Héroult furnace at Remscheid.

Further information relating to the total works costs of producing steel by the Girod furnace was given in a discussion upon the electro-metallurgy of iron and steel at a meeting of the French Society of Civil Engineers. The following figures were given by Girod for the operation of his 250 kw. furnace at Ugine :—

	Total works costs per ton of steel.
Water power costing 0·007 fcs. per kilowatt-hour	21·10 fcs.
Blast-furnace gas costing 0·02 fcs. per kilowatt-hour	31·50 fcs
Steam power costing 0·04 fcs. per kilowatt hour..	47·50 fcs.

L. Guillet, the well-known French metallurgist, opened this discussion, and stated that steel made by the electric furnace was superior to ordinary steel in several respects, especially in its resistance to shock ; this superiority being explained by its higher temperature when tapped. This high temperature allows the more complete separation of impurities, facilitates the escape of imprisoned gases, and leads to more perfect refining by the completion of the chemical reactions. The practical significance of this superiority is shown by the great demand for the products of the electric furnace in the motor car industry, the chrome steels, nickel steels, and tungsten steels made in this way being greedily snapped up by the manufacturers of motor car axles and cranks. A further advantage of the electric furnace method of production is that steel of any desired composition as regards the alloyed metals can be easily produced. It is to be regretted that in spite of the growth of the English automobile industry the

* *Science Abstracts*, No. 879, 1907.

working parts are still largely imported in the finished state, and it may be hoped that the Sheffield steel makers will take up this manufacture of steel alloys by electric furnace methods before it is too late.

A modified form of the Kjellin furnace has been designed by Rochling and Rodenhauser and erected at Volklingen in Germany. This furnace has the form of the figure 8. The annular space holding the metal is built up around each leg of the transformer, and these meet in the centre and join to form a wide trough common to the two loops of the complete figure 8. This furnace is also provided with fixed electrodes at each end of the central trough, and the induced current is here reinforced by one flowing from end to end of the trough. These electrodes are formed of iron plates, covered with a mixture of magnesite and graphite. Slight electrical advantages result from the adoption of this form of furnace, and the electrical efficiency of the furnace is said to be rather higher than that of the original Kjellin form.

The largest of these furnaces are the Kjellin furnaces erected at Volklingen and at Essen, each of 750 kw., and taking up to 8,500 kg. of metal per charge. The furnace erected at Sheffield is stated to be of 175 kw. capacity, while that in London is 60 kw. and yields 100 kgs. per charge. The illustration shows the combination form of Rochling-Rodenhauser furnace.

The modified form of Kjellin furnace described above is being exploited by the Gesellschaft fur Elektrostahl Anlagen, a new company formed in Berlin, with Messrs. Siemens & Halske as its chief promoters. The U.S.A., Great Britain and its Colonies, Norway and Sweden are, however, excluded from the operations of this new company, since in those countries companies already exist for promoting the use of one or other forms of the Kjellin furnace. Two of these furnaces are in continuous work at Volklingen producing rails, of which 1,500 tons have already been delivered to the Prussian Government. These rails, made from electric furnace steel, command a price 30s. per ton higher than the Thomas steel rails produced by the same firm. In order to meet the growing demand for these steel rails the firm at Volklingen are building larger furnaces of 8 tons capacity.

Latest Form of Rochling-Rodenhauser Furnace.

According to Engelhardt, however, the chief gains are metallurgical in character. The chemical changes dependent upon temperature for their completion, are effected not in the annular rings but upon a hearth similar to that of the Siemens-Martin furnace, and a better control can thus be kept over the refining process. This combination type of furnace, using both direct and induced current for heating the charge, is said in fact to be specially suited for dealing with impure raw materials and it thus enters into competition with the Héroult arc type of furnace for refining purposes. The following list shows the number of large induction furnaces, of either the Kjellin or Rochling-Rodenhauser type now in operation:

Kjellin Furnace.—Volklingen, Essen, Gleiwitz, Kladno, Vocklabruck, Gurtnellan, Arava, Sheffield, London, Gysinge Guldsmedhutte, Philadelphia, Niagara Falls (2), total 14.

Rochling-Rodenhauser Furnace.—Volklingen (2), Dommeldingen (1), total 3.

Another modified form of induction furnace has been constructed by the Elektrometall Aktien Gesellschaft in Sweden. In this furnace the annular space holding the metal is divided into two portions, one of which forms an incomplete circle around one leg of the transformer, while the other consists of a loop formed by two neighbouring circles which are so arranged that they form with the centre portion of the furnace one continuous trough. This construction of furnace enables one to employ a considerable length with small area, and the cross-section of the bath can thus be made extremely small with corresponding increase of the ohmic resistance. The conditions for obtaining a good working factor are thus very favourable.

The induction furnace erected at Gurtnellan differs from that built at Volklingen chiefly in the arrangements made for tilting

when discharging. At Gurtnellan a mechanical tilting device is employed, while at Volklingen and Araya in Spain an electric motor is used for this duty.

As regards the greater purity of the steel made at higher temperatures than those of the ordinary Siemens-Martin furnace, Wolff has published figures recently giving tests for the September, 1907, productions of the La Praz works. The steel in this case was made from the cheapest form of scrap and ore, in the usual type of Héroult crucible furnace with combined arc and resistance heating.

The raw material showed tests high in phosphorus and sulphur, while the product was high-grade tool steel intended for consumption in tool works, situated in France and abroad. The sulphur tests during September, 1907, varied between the limits 0·004 and 0·013 per cent., the average being 0·008 per cent. As regards the phosphorus contents of the finished steel, this averaged 0·009 per cent., the highest test recorded being 0·014 per cent., and the lowest 0·004 per cent.

The Héroult steel refining furnace is employed in U.S.A. at the works of the Halcombe Steel Co., Syracuse, the raw material in this case being scrap, which is subjected to a preliminary heating in a Wellman gas-fired furnace. At Héroult-on-the-Pitt, California, pig-iron is produced in the Héroult electric smelting furnace, while another electric smelting plant is about to be erected at Pocatello, Ida, by the American Falls Electric Smelting & Refining Co.

II. Ferro Alloys.

The chief centres of the electric furnace industry for the manufacture of ferro-alloys are in south-eastern France and Switzerland, many of the water powers in these districts, developed for the production of calcium carbide in the period 1895-1900, being now devoted to the more profitable manufacture. In France the Société Electrometallurgique Francaise and Messrs. Keller, Leleux & Cie. are the leading producers, while in Switzerland the Société Anonyme Electrometallurgique Girod takes the lead.

Stahl und Eisen, the leading paper of the German iron smelting industry, in its issue of January 8, 1908, contains a most exhaustive article by W. Venator dealing with the present development of the ferro-alloys industry. The raw materials, the methods of production, the composition, application and price of all the more important ferro-alloys are described in considerable detail, and readers interested in this branch of metallurgy will find the original paper well worth perusal and study.

Ferro-chrome.—Venator estimates the present annual production at 5,000 tons, and expresses the belief that this output will be rapidly increased to meet the growing demand for the alloy. Ferro-chrome is largely used in the manufacture of the special steels employed for armour plates, guns, tools and cutlery; and many quaternary steels contain chromium as one of the hardening elements.

Messrs. Bolckow, Vaughan & Co. are reported to be producing direct from pig iron a steel (containing 1·5 per cent. nickel, 0·25 per cent. cobalt and 0·30 per cent. of chromium), which possesses all the qualities of a steel containing a much higher percentage of nickel, and it is believed that this steel will find a wide field of usefulness for engine and motor car construction. In this case the chromium and nickel are not introduced in the form of alloys, but are present in the original ore, and the difficulties of satisfactorily smelting such an ore, and of converting the pig-iron into steel have been surmounted by the firm named.

The following tests are given by Haynes in the *Iron Trade Review* of a high quality chrome-nickel-steel (made by Krupp, of Essen) to show the effect of the after heat treatment upon the strength of the steel :—

	Normal.	Slightly hardened.	Greater degree of hardness.
Tensile strength in lbs. per square inch	111,943	155,326	221,325
Elastic limit in lbs. per square inch	86,909	148,072	193,589

The quaternary steels containing nickel and chronium possesses in fact most remarkable properties, for they can be rendered uncommonly hard by heating to redness and quenching in oil, and they can also be given a considerable degree of toughness by drawing the temper after the first hardening. The working and machining of these steels, in the lathe, presented great difficulties until the general adoption of the high-speed tungsten steels for tools. When the nickel chromium steel just described has been properly made and treated it is the most resistant material yet produced as regards resistance to shocks and blows, and it is therefore in great request for sliding gears.

The refined ferro-chrome alloys are generally sold in two qualities containing 60 to 70 per cent. Cr. and 0·30 to 0·75 per cent. carbon and 60 to 70 per cent. Cr. and 1 to 2 per cent. carbon.

The alloy containing the lower percentage of carbon sells at from £145 to £150 per ton, while the No. 2 product only fetches £90 to £95 per ton. In spite of its high price, ferro-chrome made in the electric furnace is in wide demand by the high-grade steel makers, since a small addition of the alloy has a notable effect upon the value of the finished steel. The melting point of 44 per cent. ferro-chrome is given by Hadfield as 1,445°C. while the 66 per cent. alloy only softens at 1,475°C. The Société Anonyme Electrometallurgique Girod, with works at Ugine, France, are one of the leading producers of this alloy, and their annual output is estimated to be now over 2,500 tons per annum.

Ferro-silicon.—Low grade ferro-silicon containing up to 20 per cent. silicon has been produced for some years by ordinary metallurgical processes before the advent of the electric furnace, and according to Venator the blast furnace is still employed for making this low grade product. Ferro-silicon containing from 50 to 80 per cent. of the latter element can, however, be produced only by aid of electric heat, and the manufacture of this alloy is now one of the most important branches of electro-metallurgical industry. One of the chief advantages of the high-grade product is that it can be added to metal intended for casting purposes when in the ladle, without greatly reducing its temperature, and thus by varying the amount of the alloy added, castings containing different percentages of silicon can be obtained from the one blow and charge of the cupola furnace. The silicon contained in the alloy serves the double purpose of combining with the oxygen in the molten iron, and of rendering it more or less hard according to the percentage of silicon remaining distributed in the free state in the metal when cold. The silicon in cast iron usually varies from 1 up to 2·75 per cent. The price of the alloy varies with the percentage of silicon, rising from £12 per ton for the 25 per cent. alloy up to £32 per ton for the 75 per cent. product. The price of all grades was raised during the latter part of 1907, owing to the action of the French syndicate which controls practically the whole of the production. The leading manufacturers of ferro-silicon are the firms of Keller, Leleux & Cie. at Livet, and the Girod Co. at Ugine; while the alloy is also made by the following companies and works :—Bozel Moutiers, Volta Lyonnaise, Mattrei, Sarpsborg, Rheinfelden, Lonza, Plan-du-Var, Lechbruck, Meran, Jaice, Hafslund, Giffre, Notre Dame de Briancon Hagnek, La Praz. Ferro-silicon is the only ferro-alloy which has shown dangerous properties when stored, and the high-grade product has caused more than one death during shipment and transport. It is believed that the fatalities that have occurred are due to the action of moisture and the liberation of arseniuretted and phosphoretted hydrogen gas from the impurities contained in the alloy, while the explosions are believed to be due to disintegration and dissociation from some unknown cause. The prevention of these mishaps should not be difficult, for the packing and shipping of the alloy in a *dry* condition in air-tight drums would reduce the danger to a minimum. A project for introducing the manufacture of this alloy into the United Kingdom is now under consideration in connection with the development of water power upon Loch Awe in Scotland. The scheme, if it takes practical shape, will involve the erection of a factory on Achnacree Moss, near Benderloch, a supply of peat fuel, for reduction purposes, being considered necessary for the success of the proposed manufacture. The electric power would be

transmitted a distance of 10 miles to this factory by overhead cables from the generating station on the River Awe.

Ferro-vanadium.—Considerable attention is being devoted at present, especially in America, to the properties and uses of the vanadium steels, and the manufacturers of ferro-vanadium are thus obtaining many inquiries for this alloy. It is of interest to note that Messrs. Willans & Robinson, of Queens Ferry, were the first to produce vanadium steel upon a commercial scale, and the credit for the introduction of this alloy into the steel industry thus belongs to an English and not to an American firm. The cost of ferro-vanadium is of course high, vanadium being one of the rare elements, and it is only steel for exceptional purposes and uses, that can bear the cost of the amount of ferro-alloy necessary to obtain even 0·50 Vd. in the final product.

The value of the vanadium in the raw ore is from 4s. to 5s. per kg., and in the form of the ferro-alloy the value rises to 40s. or more per kg. As a steel which is to contain 0·50 per cent. Vd. in the finished state will require an addition of at least 5½ kgs. per ton in the ladle the additional cost of producing this steel will be 220s. or £11 per ton. In spite of this great addition to the cost of the final product, ferro-vanadium is finding increasing use, since next to carbon vanadium appears to have the most influence of any element upon steel, an additon of 0·10 and 0·20 per cent. producing notable effects upon the properties of the finished steel.

The most important producer of ferro-vanadium is the Société Anonyme Electrometallurgique Girod; according to Hutton this company manufactures from 5 to 10 tons of the alloy yearly. The alloy contains from 30 up to 52 per cent. Vd. and the value varies from £600 to £1,060 per ton.

The following shows the composition of two grades of ferro-vanadium alloy, made at the Albertville Works in France by the Société Girod :—

	per cent.		per cent.		per cent.		per cent.
Fe.	45·84	..	64·22	Vd.	52·80	..	34·10
C.	1·04	..	1·42	Si.	0·09	..	0·12

The effect of very small additions of vanadium to steel is to impart an extraordinary resistance to dynamic stress and to deterioration under work or strain. The vanadium steels have thus been named "anti-fatigue steels." The vanadium also retards segregation, and it is thus of considerable service in tempering, since it enables the fullest advantage to be taken of the results of heat treatment. All classes of steel are in fact improved by the addition of vanadium, and the following analysis of the latest tool steel developed by Mr. Taylor of the Bethlehem Tool Steel Works shows that vanadium is present, though in small amount :—

	per cent.		per cent.		per cent.
Tungsten....	18·91	Chromium....	5·47	Carbon....	0·67
Vanadium ..	0·29	Manganese ..	0·11	Silicon....	0·043

A special quality of open-hearth vanadium steel, tempered in the ordinary way, has shown the following figures under physical tests :—

Elastic limit	224,000 lb. per sq. inch.
Ultimate strength	232,000 lb.
Elongation	11 per cent.
Contraction of area	39 per cent.

According to Haynes, the high elastic limit, strong contraction of area (which is characteristic of this steel) and silky fracture, together with its great resistance to dynamic stress, makes this steel an ideal material for parts of motor cars. In Haynes' table of the comparative strengths of the materials used in automobile construction work the vanadium steel easily heads the list.

Guillet has published recently some tests made with the nickel vanadium steels, and has recommended for them the following proportions :—

Nickel	2 to 7 per cent.
Vanadium	0·10 to 0·30 per cent.
Carbon	0·10 to 0·30 per cent.

A steel containing 6·2 per cent. nickel, 0·16 carbon and 0·12 per cent. vanadium (after tempering) showed the following physical tests :—

Ultimate strength	220,000 lb. per sq. inch.
Elastic limit	209,000 lb.
Elongation 10 per cent.	Contraction of area 40 per cent.

Since the discovery of the valuable nature of ferro-vanadium new sources of vanadium ore have been opened up, and important mines in the Cerro de Pasco province of Peru have been purchased by the American Vanadium Co. The ore of the mine is stated to be a rich sulphide, carrying up to 22 per cent. of metallic vanadium. The company is now mining the ore at the rate of 10 tons per day, and a maximum output of 100 tons per day is spoken of. The United Steel Co. of Canton, Ohio, are now making vanadium steel for commercial purposes, in 50 ton open-hearth furnaces, and recently this company made a heat of about 30 tons, which is believed to be the largest yet made of vanadium steel. In the United Kingdom the New Vanadium Alloys Co., of Swansea, is the leading firm in the industry, the ore employed by this company being obtained from their own mines in Spain.

The author's thanks are due to the Gründel Kjellin Co., of London, for the loan of the block used in illustrating this article.

CORRESPONDENCE.

THE PREDETERMINATION OF THE RADIATION RESISTANCE OF ANTENNÆ.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: The predetermination of the radiation from a pair of spheres, or a straight wire, or a circle with a gap in it, or from a pair of cylinders, &c., is comparatively simple. These and other cases have been treated fully and accurately by J. J. Thomson ("Recent Researches"), Macdonald ("Electric Waves") and others. The calculation for a complex antenna, such as is generally used in practice, consisting of a number of localised inductances and capacities and several distributed capacities of different forms and distributed inductances is much more difficult by the usual methods. In fact, until recently I have never been able to predetermine the radiation from such an antenna, and I am inclined to doubt if it is possible to do it by the methods heretofore used; I feel quite certain that if it can be done at all by the usual methods it will only be at the expense of an entirely disproportionate amount of time and labour.

Within the last year a somewhat novel method has given good results. In an alternating current circuit we have five quantities, ohmic resistance, capacity, inductance, leakance and radiance. The complete differential equations for a circuit having the first four of these quantities were first given by Oliver Heaviside. Dr. A. E. Kennelly, in an extremely able series of Papers, gave the solutions for these equations and applied the results to long distance transmission lines, cables, telephone lines, &c.

The solution for an artificial line must obviously shade off into that for a distributed line. Until recently, however, no apparent connection between the two sets of equations was known. Last summer Dr. A. E. Kennelly discovered some extremely interesting relations between direct and alternating continued fractions and hyperbolic functions, which show the connection most clearly and beautifully. (Incidentally I believe that Kennelly's theorems would be found of value in the theory of numbers.) These relations were published by Dr. Kennelly in a Paper entitled "The Expression of Constant- and of Alternating Continued Fractions in Hyperbolic Functions" ("Annals of Mathematics," second series, Vol. IX., No. 2, January, 1908).

I have found that by using Dr. Kennelly's formulæ, expressing the flow of the current in the antennæ, and by considering the radiation as due to changes in velocity of the corpuscles, and integrating the radiation so obtained at the various points in the antennæ circuit, the radiation and resistance of any form of antennæ can be predetermined.

On account of pressure of other work I would ask to be excused from giving an example with complete calculations, since for my purposes a first approximation is sufficient, and I have not the time to work out the examples as fully as I would wish to before publishing them. I mention the method, however, for the reason that I think it will be found of value.

I find it is possible to get differential equations which will express fully the effect of all the above five constants, and also general solutions for these equations. While I am unable to undertake the work myself, I hope that someone, in whose line it lies more than it does in mine, will feel like taking it up.—I am, &c.,

REGINALD A. FESSENDEN.

SYMBOLS FOR PHYSICAL QUANTITIES.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: The suggestion put forward with regard to the above matter by Mr. Miles Walker in your issue of July 24th is certainly a very ingenious one. I am afraid, however, it is somewhat too ingenious to be practical. I think Mr. Miles Walker altogether underestimates the number of new symbols that would be necessary in his system. For example, consider temperature. We have firstly centigrade, fahrenheit and reaumur degrees, all of which are in daily use. Then we have absolute temperature likewise expressed in centigrade, fahrenheit and reaumur degrees. In addition, we have critical temperatures, boiling point, freezing point, and vaporisation temperatures, temperatures by which the freezing point is lowered or the boiling point raised of solutions as compared with the pure solvent, open and closed flash point temperatures, firing and explosive temperatures, "corresponding" temperatures, "reduced" temperatures, "transition point" temperatures, &c., and all these can be expressed either in centigrade, fahrenheit or reaumur degrees. If I understand Mr. Walker correctly, his proposition is to represent all these various temperatures by different kinds of decorated thermometers. From the philological standpoint, it seems to me, this is a return to the ancient hieroglyphical method. A new terror will be placed in the path of the unfortunate student, who will have placed in his hands, on entering the technical college, a not insignificant volume containing the international scientific symbols which he will have to commit to memory. Learning Chinese won't be in it. To some of us, who are not classical scholars, the retention of the Greek alphabet even is a thorn in the flesh, and we feel thankful to Messrs. Munro & Jamieson for so considerately placing it at the beginning of their pocket book. Mr. Walker's proposal for the creation of some thousands of brand new symbols is, therefore, I think, a very tall order.

International symbols are almost as great a difficulty as international languages. If we had the latter we could very soon have the former. There is no doubt, however, that if something could be done in the matter it would be of great advantage. Progress, I think, is most likely to be made if we follow the Esperanto method and standardise symbols which would be at once recognised, say, by French, German and English readers, or, at any rate, symbols which represent the greatest common measure of such recognition on the part of the three nationalities concerned. Thus the expressions $\sim$ for "complete periods per second," d = diamètre, durchmesser, diameter, &c., &c., illustrate my meaning.

The artificial manufacture of a very large number of new hieroglyphics, which shall not only represent the abstract quantities, but also the system of units employed, is, in my opinion, a too complicated method to be generally adopted.—I am, &c., CHARLES C. GARRARD.

Manchester, Aug. 4.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: In reply to Dr. Garrard's letter of the 4th inst. I would point out that the proposal is not to have a new symbol for every temperature expressed in every scale but to have at most two symbols for temperature. One of these would replace the t or θ now commonly used. The other (a slight modification of it) might be used when the temperature was expressed in degrees centigrade. One of the advantages of having a distinct symbol for a quantity expressed in the best recognised system of units is that it would induce writers to use that system whenever possible. If a writer wished to employ reaumur degrees he could still do so as easily as at present, and the reader would have no more or no less difficulty than he has at present. But if he employed degrees centigrade his symbol would show the scale on the face of it, and his formulæ would be exact statements of physical facts without being dependent on any explanatory paragraph.

If the new symbols were used writers would still give a list of the symbols appearing in their writings. It would never be necessary to sit down and commit them to memory. We do not now try to remember what symbols each writer uses for each quantity. It would be impossible. But if every writer used the same symbols we would soon become familiar with those with which we were most concerned. Reading would become easier and formulæ more intelligible.

There is no objection to 200 symbols as long as we are not expected to remember more than half a dozen of them while we are reading an article on the quantities they represent.

As to the suggestion of d for diameter, we cannot possibly decide on that until we have considered what we shall have for the *depth* of a beam, the *dip* of a magnetic needle, the symbol for a *differential* coefficient and the other cases where d might be required.—I am, &c.,

Altrincham, Aug. 5. MILES WALKER.

THE MANAGEMENT OF ENGINEERING WORKSHOPS.*

BY E. THOMAS, B SC.

Summary.—The author gives some impressions received from a number of visits paid to engineering works engaged in widely different manufactures, and attention is drawn to the many economies possible, owing to the variety of ways in which waste of time and material come about.

The amount of "paper" necessary for handing on instructions and keeping records and costs varies greatly, being very large in some works and quite small in others. There seems to be no generally adopted system and the same result is often achieved in quite different ways. It is here proposed to deal only with the general principles and common objects of such systems.

Most of the shops visited, which had an efficient modern organisation, were specialised shops where the work was almost wholly standard, and non-standard work was discouraged. Such shops often reach a wonderful degree of efficiency and simplicity. The organisation of a general shop, where changes are frequent and much material is built to special order, is much more difficult; and efficiency is frequently much less. While this fact is usually recognised, such general shops exist in large numbers. As people really come to realise the difference at its full value, such general shops must diminish in number. And if it is possible to run such a shop efficiently it should be easily possible to run a specialised one; hence, much of what follows will be stated with the general shop in mind.

To give these impressions some pretence of an orderly arrangement the author has grouped them under the following heads:—(1) Separation of head work and manual work, and manual work and development of routine. (2) Handling and distribution of material. Waste. (3) Labour efficiency. Day, piece, and premium systems. (4) Cutting and non-cutting times. (5) Execution of work to time.

1. *Separation of Head Work and Manual Work.*—It is generally agreed that the workman in every case should have a drawing, or even a sketch, to work to, fully dimensioned; that is, that the workman should have only manual work, and all head work should be done by the draughtsman or designer. On the same principle a complete list of material should be prepared in the office, containing every single detail that may be required. The application of the rule is frequently carried out imperfectly. In one works every part of the gear was detailed in a printed specification with catalogue numbers, except the bolts, nuts, split pins, and other small store parts used in erection. The list should be prepared in the office even if only one article is to be made, but in such form that it may be readily available for any future work. A still further application which is only seldom made, and only in the most advanced shops, is that there should be provided also a list of operations in every case where a new workman might possibly be in doubt. Also a list of tools, jigs, &c., should be prepared, so that the foreman can have the tools collected in advance by the labourer who collects material, and deposited ready on the man's bench or machine before he requires them.

The same principle deserves the most careful consideration in defining the duties of foremen. These may come under two heads: (A) *Clerical or Administrative.*—Such as giving out work, seeing that there is no delay caused by waiting for material; watching the efficiency of the workmen, planning to get work executed to

* Abstract of a Paper read before the Manchester Local Section of the Institution of Electrical Engineers.

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time, &c. (B) *Technical.* Methods, tools, and jigs, for executing work, for overcoming difficulties, for reducing cost of production, &c. Probably, in most existing shops, these two functions are combined, a foreman's clerk being often provided to assist function (A) and tool fitters to assist (B). The most modern tendency seems to be to give the foreman function (A) to carry out. In regard to (B) he must be technical enough to know if matters are not going rightly, and in such case set an expert tool fitter to study them out and do what is required. This seems to the author essentially the right system, especially when day work is going on.

The best way to minimise slackness, &c., on the part of employés is to have a sufficient amount of red tape or routine, and to have the routine for each man written out. The best way that the author knows of is to have a routine book for each man who has routine duties. This to have columns ruled off for days or weeks. Each day or each week a tick or a date is put in the appropriate column to signify that that duty has been attended to, or to show the date to which that duty has been brought up. All these routine books go to the manager at a stated hour each week, and he can glance through a large number in a very short time. In the same way each week at a fixed hour the manager should walk round the works, and all books used should be laid out in readiness.

In some of the works visited, all sorts of summaries and abstracts were prepared, which, if periodically inspected and acted on would probably be more than worth their cost. In some cases, however, they certainly were not regularly examined, and then are worse than useless.

It is of little use recording comparative costs if they are not looked at. Where kept on cards, it is easy to place all cards on which entries have been made in a separate drawer each day. The manager can then inspect these quickly each day before they are put into their respective places.

2. *Handling and Distribution of Material.*—Material must be booked, and this means that someone must write out a list of it. It is far the best way to do this in the office, even if only one article is required, and to preserve in this way a uniform routine system. But the same list, if prepared with thought for standard work, can serve several important purposes, plenty of copies being prepared and distributed. The storekeeper marks it for material in stock or to order. The stores issue goods from it to the foreman's auxiliary stores without further requisition. The foreman can check by it all material at any stage. The drawings having been cut up into as many parts as there are pieces or groups of pieces to be made, a copy of the list is also cut up and pieces attached to the divided-up drawings for the workmen's use. On a further copy, against each item is marked the time by which it must be completed, in order that the whole of the work may go through to the date desired. Each shop foreman must have his own copy marked. A copy goes to the cost department. The work can be priced against this list in advance if required, and actual issues and returns can be checked against it. Where work is executed in different shops it is of assistance to subdivide the list accordingly.

It is well worth while to devise a system of catalogue numbers to cover all single pieces. The number appears on each drawing and on each piece of material. In this way it facilitates comparison of costs, estimations, standardisation, &c.

To save time it is probably well worth while to let the foreman have an auxiliary stores under his own control. All material for an order is delivered here and sorted out in a space prepared for it. With each lot is placed the drawing and even the job ticket. Any partially completed work is returned to the same spot to await assembly.

Shop drawings consist of pieces of cardboard carrying that part of the drawing required for any one piece or group of pieces given out to one man only at a time. On the same card is the list of material, cut off the general list, the list of operations, and the list of tools, gauges, jigs, &c. The separate cards are numbered serially and usually kept together. Those required for a job are distributed in the auxiliary stores in the space allotted. There should be some material to each card, if all material has been collected. If a rigid rule is made that small material shall always be returned to the stores when any part of the work is completed or is stopped from any cause, there will be fewer losses, and the man concerned may be made responsible. All scraps and defects in workmanship should be entered on the job ticket and in a report book which goes before the management. There is no doubt inspection at each stage pays for itself even in such work as switch work. Where both special or general work and stock work are going on together, it is easy to break off a stock job. This is always disadvantageous, and to avoid it: Stock jobs should not be too large, work should be done on as few stock jobs as possible at one time, concentrating on these as many men as available. In this way no stock job need last long, and the liability to break off or to finish a part only of the order is consequently diminished. This matter needs emphasising.

3. *Labour Efficiency.* If a number of shops are visited in succession, some working on day work and some on piece or premium systems, the difference impresses itself most strongly. With piece or premium work there is not only a brisker air about, but also the author seemed always to notice a more cheerful atmosphere. The author points out the advantages of this latter system over day work. In cases where day work seems necessary, it should be insisted on that a price and time are estimated for each job, even although these are not made known to the men. The actual price and time must be compared later with this estimate. The simplicity, comfort and general advantage of piece or premium work cannot be sufficiently proclaimed. So much so, that where appreciated every manager of a general shop will find means to introduce it to a much greater extent than is at present common.

It was well known that with piece work a man seldom attempted to earn more than about time and a quarter for fear of getting the rate cut. This caused an uneasy feeling in the employers that they were not getting the best efficiency, and it was hoped by the introduction of the premium system that this difficulty would be got over, a promise being made that the time allowed should not be altered unless a new method were adopted. The men know quite well that if they make too much premium a new method will always be found. The practical result is that the premium system, after all, requires just as much vigilance as the piece-work system. It has the disadvantage of requiring rather more book keeping, and of rather more difficulty in adjusting the price when a mistake has been made. Where it is considered that the best results are not being obtained, the author is convinced that the only way to improve matters is to have enough expert men who are paid well, and can be relied upon to work in the employer's interest. Such men, for example, may act as rate fixers. One or more of them can work on such of the jobs as seem to require checking, and they will advise on any changes that seem likely to be profitable.

4. *Cutting and Non-Cutting Time.*—A little thought will show how antiquated and wasteful are the ordinary methods of gauging. A cheap gauge or micrometer is badly required, which will tell in a second or two to ordinary men just how far they are off the final dimension; and then means are required to set the tool forward just that amount. Micrometer heads on lathe screws are useless without the micrometer or gauge for showing how much remains to be taken off.

With belt-driven machines and cone pulleys, the speeds usually change in not less ratio than 1·75 to 1 or even 2 to 1. In the latter case we shall on the average be working at just three-quarters of the correct speed, and the cutting time is increased one-third. This is a very serious loss, and argues strongly the advantage of a gradual speed change device; also of some cheap speed indicator to be applied to the work and show instantaneously the rate of cutting. The changing of speed should also be made simple.

Quick-change drill chucks, which enable the drill to be changed instantaneously without stopping the spindle, may easily save anything from 10 to 50 per cent. In small and thin work the cutting time is often very little, and the setting and handling of the jig may be a large percentage of the whole. There is also much loss in finding and picking up the exact tool required. A large block, having exactly as many holes as tools and gauges, and with these arranged in suitable groups, will save its cost many times over. Thus there is a large field open at present for improvement to reduce the non-cutting time as well as the cutting, and employers may often profitably take obvious oportunities of economising which lie ready to their hands, instead of looking abroad for new tools.

In any single concern there must be some tendency to stagnation, and there seems as good reason for the visiting consultant as for the visiting auditor, whose services are now regarded as essential, and taken as a matter of course.

5. *Execution of Work to Time.* In a general shop having many small jobs in hand at once it requires a very clever foreman to give times of completion of all work in hand which he can adhere to, and yet not have too much labour employed. The author has devised a special indicator for the purpose, which gives the foreman a bird's-eye view of the work in hand, and of the capacity for work. It requires that time shall be estimated on all work in detail, whether on the day, piece or premium systems. One or more suitable boards are laid out with horizontal grooves to represent the different men in classes according to employment, wages, &c.; some spare grooves are also allowed to each class. Vertical lines are drawn to scale to represent hours, days and weeks. Fairly narrow strips of card are cut off for each job, of length equal to the number of hours estimated, and marked with the job number and date by which completion is required. These are then set up in the grooves, always to the left of the date marked on them. If there is more work in hand than capacity in men some cards must go into the spare grooves. The card to the left in each groove is always the job in progress at the time with that man, those to the right being arranged in the order of present urgency. Thus the foreman or manager can see at a glance what work is likely to be late, what is the present capacity for new work, stock work, &c., what jobs are hanging, and where it is desirable to take on or discharge men. The material labourer can also see what materials, tools, &c., are likely to be required soon, and get them ready. The cost of keeping up is small, and amply repaid by the advantages.

DISCUSSION.

Mr. M. B. Field said that although the question of the management of engineering works was of great importance, he could not recollect any Paper on the subject having been read before the Institution previously.

Mr. Gunther said that much, naturally, depended upon the class of work being done as to the type of organisation. In small work it was possible to specialise considerably more than in large work, and to devise special arrangements. He did not agree with the author in stating that as a rule general shops were less efficient than specialised shops, but considered that the well organised methods of handling large pieces in general shops permitted a very fine efficiency to be attained. In all well organised places the drawings had to be of a most complete character, carrying all leading particulars in case of repetition work. In the case of intricate pieces requiring a good deal of consideration in laying out, the operations once defined should be denoted on the drawings for future reference. With reference to routine books, he considered that these would only be of service when a man was engaged on the same class of work day by day or extending over several days. He had considered carefully the question of numeration and had arrived at the conclusion that it was best to commence with the drawings. A drawing might be D.1 up to D.10,000 or more, the pattern bore a P and its number, and a stock piece the prefix S with its number. The same applied to tools which carried the title letter T and the corresponding number. In connection with stock orders he considered that when a particular article could be made to stock and used in connection with several other pieces, the number made for stock was best worked on the maximum and minimum system. He feared that premium and piecework were gradually dying out in engineering works; when dealing with non-union and unskilled labour, and especially with small repetition work, it was easier, but when dealing with union workmen and work of a large class with few jobs entirely alike, it was rather too big a task.

Mr. H. Bevis (General Electric Co.) thought they could not overestimate he value of foremen, whom he considered should be employed more exclusively under clause A. It was a mistake to give them the technical points such as indicated in clause B, which should rather fall on the tool shop or drawing office. He would not like to carry out the author's suggestion of weekly inspection; he found it much more efficient to walk round frequently and where he felt disposed. He agreed, however, regarding the value of statistics. The Paper appeared to refer to large engineering works, and not such works as manufacture large quantities of small articles. It was very important to have what was called a sub or auxiliary stores; but this stores should only hold material used exclusively in the particular department, such material as screws, nuts, bolts, &c., being kept in the main stores. He advocated the use of assembly rooms, as these obviated the possibility of material not being in the main or sub-stores when required. It was stated in the Paper that "If the assemblers are on piece or premium work they draw attention themselves to any inaccurate manufacture of parts coming to them." This was certainly a check, but where large quantities were being manufactured it was rather too late, causing great waste of material and consequent loss of time in waiting for renewal of parts. He thought the name "visiting consultant" a very good one, but, like the card system rather over-rated. He believed in observing the methods of others and selecting the best.

Mr. A. Eckstein (Eckstein, Heap & Co.) disagreed with the previous speaker in saying that the Paper appeared to bear upon large engineering works manufacturing heavy class work. He thought the Paper referred throughout to repetition work of a small nature. He always encouraged men to use their common sense and did not believe in making a working man rely absolutely on red tape. In the matter of weekly inspection he agreed with Mr. Bevis. Referring to auxiliary stores, he could not see, where a job had to be stopped, by what system the material would then be returned to the main stores. He considered that visiting consultants might be excellent for comparatively small works without a staff of experts, and perhaps also for works whose representatives had not the opportunity of inspecting modern methods in other factories, but for a large works with an expert staff a consultant might cause more mischief than good, as he could hardly be expected, during his brief survey, to fathom matters as well as the permanent staff, and furthermore he might possibly give wrong impressions to a board of directors.

Mr. H. W. Wilson cited several instances in which organisation had been carried to extremes, thereby involving great loss of time and money in rectifying trivial mistakes.

Mr. E. Thomas, in reply, said that in speaking of weekly inspection he did not wish to suggest that the manager should take a tour with a view to finding out things which were wrong in the works itself, but rather for the purpose of inspecting the papers and books which were very liable to be neglected. He still considered the matter of catalogue numbers a most important one. Mr. Gunther had spoken about the numerous letters and figures involved, and this was the very reason for utilising catalogue numbers. He had found that in doing a great deal of general work and having to design special pieces for special apparatus, these were apt to become associated with a particular job which was forgotten in a short time. A new draughtsman being employed, and having no recollection of this job, would start and redesign the same article, and so the parts would be multiplied beyond reason. He had not yet embodied the principles of the Paper in his own works, but he hoped eventually to carry this out. He thought that everyone would agree in confining the duties of foremen to clause A. Referring again to visiting consultants, he thought they might possibly do considerable good without entailing much expense. It was true, and yet regrettable, that workmen as a whole had deteriorated very considerably in consequence of the system of manufacture adopted. It was necessary to specialise considerably in order to obtain efficiency. In dealing with work which was not absolutely straightforward, it usually paid one to go in for what was apparently an exorbitant and absurd expense in preparing certain things to carry out a job. Advantage was gained not merely in manufacture, but in the diminished cost of assembly, in the less time the job hung about, the less anxiety, and the better satisfaction to both makers and buyers.

THE EARTHED NEUTRAL, WITH AND WITHOUT SERIES RESISTANCE, IN HIGH-TENSION SYSTEMS.*

BY P. M. LINCOLN.

Summary.—In the first part of this Paper the author deals with the advantages and disadvantages of earthing the neutral of an alternating current system, and then discusses the use of resistances, parallel earths, &c.

The advantages and disadvantages of an earthed neutral may be summarised as follow:—

Advantages. (*a*) E.M.F. between conductor and earth remains fixed and constant. (*b*) Prevents abnormal static induction on neighbouring circuits. (*c*) Provides opportunity for using the earth as a working conductor. (*d*) Makes possible the detection (and immediae removal if desired) of any earthed portion of the system. (*e*) Insures equality in the condenser current drawn from each phase.

Disadvantages. (*f*) One earth disables a part or the whole of the system. (*g*) A proper earth is difficult to obtain.

Dealing with these in detail. (*a*) In practically every transmission system the greatest danger of breakdown of insulation exists between line and earth, rather than between lines: it is therefore highly important that the voltage from line to earth be permitted to assume no abnormal or excessive value. The higher the line voltage the greater becomes the importance of this point, since the factor of safety of insulation naturally decreases with increasing line voltage. With the neutral fixed at earth potential, it is impossible to obtain, between any conductor and the earth more than a certain definite proportion of the maximum line voltage. With an unearthed three-phase system an earth on one conductor will cause full line potential to develop between the two remaining conductors and earth. On further analysis it is doubtful if all the advantage apparent at first sight is really obtained, for it can safely be asserted that in the large majority of cases it is not the action of the steady line voltage that causes breakdowns in the insulation of transmitting or distributing systems, but surges. A very material advantage, however, is that the lightning arresters can be adjusted so that a comparatively small rise above normal potential to earth will discharge across them. In an unearthed transmission system it is not safe to adjust for a discharge potential materially less than line voltage; otherwise, in the event of one conductor becoming earthed, the constant discharge which necessarily occurs over the lightning arresters between the two good conductors and earth will destroy the arresters within a short time.

(*b*) An advantage incident to keeping the neutral of a transmission system at earth potential is to prevent abnormally large static induction by a transmission line on neighbouring circuits, such as telephone circuits. As to electromagnetic induction, it is evident that the earthed neutral can have no influence unless the earth is carrying current. In that event, electromagnetic induction on neighbouring circuits is increased.

(*c*) In a three-phase transmission system with the neutral earthed both at the generating station and a sub-station, it is perfectly possible to continue the transmission of power with one of the conductors out of commission. Furthermore, it is perfectly possible to continue to transmit single phase power with only one of the three conductors remaining. In fact, some transmission plants make a practice of running but a single wire to some customers using single-phase current, and but two of their three conductors to other of their customers using polyphase currents, relying in each case on the earth to act as a return conductor for the normal operating current.

(*d*) and (*f*) With an earthed neutral, an earth on any conductor will cause a short circuit. If it is possible by use of the earthed neutral automatically to cut out the damaged conductor, and continue service to the affected part of the system over other lines, the earthed neutral may undoubtedly be regarded as an advantage. If, however, the earthing of the neutral means an interruption of service which could be avoided with an unearthed neutral, the earthing may be justly regarded as a disadvantage. That certain portions of the system are temporarily overloaded, or that part of his line conductors are temporarily undergoing an abnormal insulation strain to earth, is of no particular moment, so long as service is being rendered and the abnormal condition does not give rise to further trouble.

* Abstract of a Paper read before the American Institute of Electrical Engineers.

(c) All alternating-current transmission lines take from the generators a condenser current whose amount depends upon the size, length and disposition of the transmitting conductors and upon the voltage and frequency supplied to them. These currents may be considered as flowing over two paths, as follows: (1) Through the condensers formed by the conductors as opposite plates, and (2) through the condensers formed by considering the conductors as one plate and the earth as the other. The currents flowing through the former condensers are evidently independent of any earthed neutral conditions. Those flowing through the latter, however, depend entirely upon the potential of the neutral with respect to earth.

(g) A satisfactory earth is very difficult to obtain. The antiquated idea that the earth is of zero resistance, because it is of practically infinite cross section, has long since been recognised as an error. In case of earthing to a buried plate, most of the resistance of the earth occurs in the immediate neighbourhood of the earth-plate. This is to be expected on account of the fact that it is only in the immediate neighbourhood of the earth-plate that the cross section of the earth, considered as a conductor, is sufficiently restricted to give rise to any appreciable resistance. The conditions other than the character of the soil that make for a low-resistance earth are moisture and the exposure of a large surface of the earth-plate: the larger the exposed surface the lower the resistance. It is this reason that makes water supply systems good earths. Even where good engineering practice dictates a resistance in the neutral, the unavoidable resistance in the earth connection is not so valuable as it might be, because of its extreme variability.

Modifications Due to Use of Resistance and Multiple Earths.—If the object of earthing is to use the earth as a working conductor, there must naturally be earths both at the generating and receiving points. On the other hand, if the object is to prevent an abnormal voltage rise on any conductor, due to the earthing of another, then the earthing of the neutral at one point is sufficient and in most cases preferable. In some methods of connection the problem is still further complicated by the entire absence of an available neutral. In any three-phase system a delta connection of transformer or generator windings gives no opportunity of obtaining a neutral. A delta connection requires the use of a separate autotransformer connected across proper points of the delta, from the winding of which a tap may be brought out for the neutral connection. A three-phase star connected generating system has, of course, the neutral at the star connection. If, however, a bank of transformers has both the primary and secondary connected in star, the star connection is not necessarily at the neutral point. In this case the neutral is practically free to move around anywhere within the three-phase triangle; in case of a dead short-circuit on any transformer, the voltage on that particular one disappears and the two remaining transformers assume the whole potential of the line, being then virtually connected in V. If, therefore, the star connection of a star-to-star group of transformers be connected to earth, it does not follow that the neutral is earthed; if one side is connected in delta and the other in star, then the star connection can be treated as a fixed point at the centre of the three-phase triangle. In a star-to-star group proper conditions can be assured only by connecting the star point on either side to a fixed neutral—such, for instance, as the connection of the star of the transformers to the star point of the generating system. The star point of the generating system being fixed at neutral, this also fixes the transformers.

Probably the most important question in connection with earthing the neutral is as to the use of resistance between the neutral and earth and the amount of resistance that is best. In any polyphase system, so long as conditions on the transmitting or distributing system remain normal, there is no occasion for earthing the neutral, as nothing will be accomplished thereby. The object sought in earthing the neutral is to take care, not of normal conditions, but abnormal ones. These may arise from (1) short-circuits, (2) open circuits, and (3) earths.

1. By short-circuits is meant accidental connection in any manner between conductors of opposite polarity, and it is evident that the behaviour of automatic devices is in no way influenced by earthing the neutral.

2. In a three-phase line, with the neutral earthed at both generating and receiving stations, the earth will, under normal conditions, carry no current, even though the earth be of zero resistance. If, however, one of the conductors should break, the earth immediately begins to carry current. If induction or synchronous motors are being used at the receiving end, the three-phase relation will be approximately maintained, the degree of approximation depending upon the earth resistance and upon the relative motor load to non motor load. If the neutral is earthed at one point only, an open circuit in one conductor will have an effect no different from that which would take place if the neutral were not earthed, except that the distribution of charging current between conductors will be somewhat disturbed, and more or less of this current would pass through the earth connection.

3. An earth is the most frequent abnormal condition that is encountered, and also is the one most affected by earthing the neutral. With the neutral connected direct to earth, another earth on any conductor means a short-circuit; the action of automatic circuit-breakers will then take place accordingly. The amount of current that will flow through such a short-circuit can be limited by inserting resistance, and practically the only object of resistance is to cause such a limitation of current. The flow of excessive currents, such as would take place were there no resistance, is detrimental for several reasons. It throws an unnecessarily great strain upon the circuit-breakers which are called upon to interrupt the current. The large current flow which takes place may cause a phase distortion and drop of voltage, which may, in turn, be sufficient to cause synchronous apparatus on the line to drop out of step. Almost invariably an arc takes place at the point of earthing of conductors, and an excessive current will cause excessive destruction at this point. A dead short-circuit on any system causes a heavy shock due to the tremendous currents, and a consequent tendency to distort the windings of any synchronous apparatus connected to the system.

All of these objections can be overcome to a greater or less degree by resistance in the neutral. Increased neutral resistance, however, while it limits the current flow through an earthed conductor and overcomes the above objections, can do so only by allowing an increase in the potential of the two good conductors above earth while the current flows. If the object in earthing is to prevent such an abnormal rise, the inserting of resistance tends to defeat that purpose. The choice of the proper resistance becomes a question of compromise between the disadvantages of going to either extreme. There seem to be good reasons for adopting an earth resistance which will lie between the following limits—on the one hand, large enough to prevent a severe shock to the system, or the voltage on the affected phase dropping to a point where the synchronous apparatus will drop out of step. This consideration will dictate a resistance that will not allow more than, say, three times full-load current at the most to flow through the armatures of the generators supplying the circuits. On the other hand, the resistance must be small enough to permit sufficient current to flow to trip the heaviest circuit-breaker on the system.

In all alternating-current circuits there is present a condition equivalent to a neutral earthed through a certain amount of resistance; in that static capacity exists between any conductor and earth. The longer the line and the higher the voltage and frequency, the lower the resistance in the equivalent circuit having a resistance in earthing connection. The effect of an earthed neutral, either with or without resistance, is, in case a conductor becomes earthed, to pass a current of greater or less volume through the affected conductor and into the earth. The effect of the static capacity of conductors to earth is exactly the same, the difference being that no current passes into the earth at the generating station, and that the phase relation of the current through the capacity to the E.M.F. producing it are not the same in both cases. The static capacity of an overhead conductor to earth is, with ordinary line construction, from 30 to 50 per cent. greater than that between conductors. Assuming a fault that makes the affected conductor of the same potential as the earth, the affected conductor will take roughly 50 per cent. more charging current than the unaffected ones. It may be noted also that the total kilovolt-amperes of charging current in all conductors will be increased about 33 per cent. Where the normal charging current amounts to a considerable percentage of the total generating capacity, as it will in long, high-voltage, high-frequency lines, it will be seen that the condenser effect has the same action as a moderately-low earth resistance.

Usually the time during which current will flow through an earth resistance is limited to the time required to trip a circuit-breaker, probably not more than a few seconds at most. The quantity of current that will flow as a maximum is also fixed as that which is required to trip out the heaviest set circuit-breaker. The question of current carrying capacity is, therefore, one which depends upon the character and setting of the safety devices used.

As to the character of resistance, permanency is the most essential. A metallic resistance is satisfactory but has the objection of being expensive and bulky when the voltages involved are high. This problem has not yet been satisfactorily solved, but it seems probable that where high resistances are demanded—200 ohms or more—some form of non-metallic resistance will be found of sufficiently permanent character to be satisfactory.

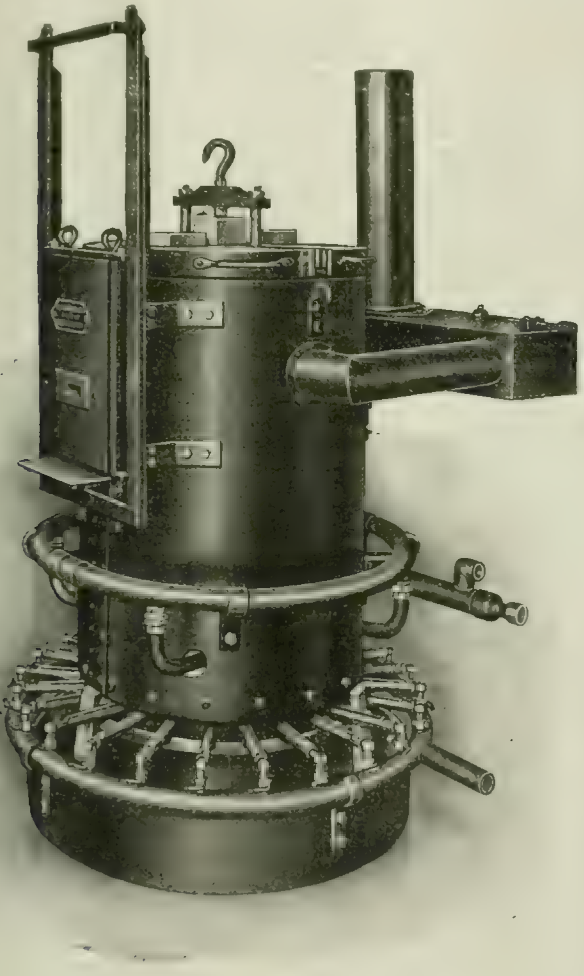
Manufacture of Steel by Electrical Methods.—According to *L'Industrie Electrique* the Compagnie du Fer et de l'Acier Roehling of Volklingen have recently put down at their works a new type of electric furnace of 3 tons capacity. It has been in uninterrupted service for several weeks, and purifies the impure metal poured in from the blast furnace, depriving it of all traces of sulphur and phosphorus. This furnace is an adaptation of that due to Kjellin, but contains some new features.

BRAYSHAW'S METHOD FOR HARDENING HIGH-SPEED STEEL.

The necessity for hardening and maintaining in that condition all cutters and tools which are to be used in high-speed work is too manifest to mention. The means by which these results can be arrived at are not so obvious, and a consideration of them is of much interest.

In what follows is described a method due to Mr. S. N. Brayshaw, of Hulme, Manchester, by which the desired results can be obtained. It follows to a great extent the Taylor-White process, with certain important modifications. The furnace employed is the result of lengthy experiments, and although it was first intended for private use alone, its success induced the inventor to place it on the market.

The furnace consists essentially of two chambers, the bottom one being slightly the larger and maintained at a higher temperature. By means of gas or oil heating the temperature of the lower chamber is raised to about 1,400°C., while the upper chamber is at a bright red heat. A reducing atmosphere is obtained in the furnace by so mixing the gas and air (or oil vapour and air) before they enter the furnace that all local air currents which would oxidise the steel cam are prevented.



BRAYSHAW'S SALT-BATH FURNACE.

The opening to the bottom chamber is covered by two hanging doors of fireclay securely held in iron frames. These doors slide horizontally along a bar either together or independently. Furthermore, the bottom half of the doorway may be closed by a block which fits into it, thus restricting the height of the opening. At any moment, therefore, it is possible simply by sliding the doors to close them, either partly or wholly, and at the same time the hot side of the door is never presented to the operator, thus allowing him to work in comfort. The furnace body is of fireclay, bound with iron, and stands on an iron table.

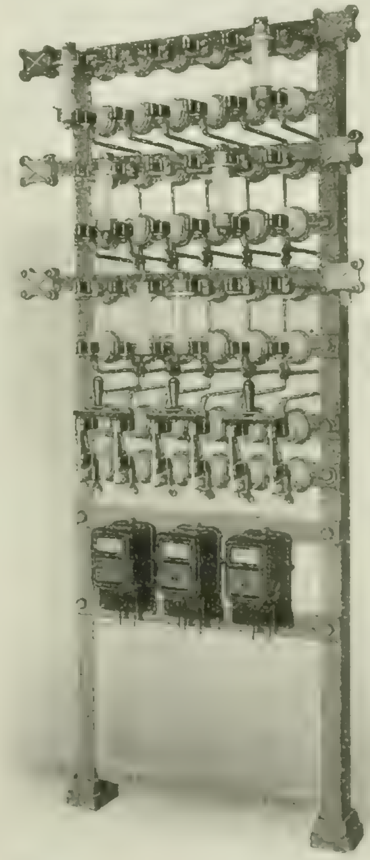
The tool to be hardened is first heated in the top chamber to a bright red heat, and is then transferred to the lower chamber, where it reaches the very high temperature required for the best results. It is then transferred to the salt-bath furnace, shown in the illustration, which is maintained at about 690°C. The tool slowly cools to the dull red heat of the salt balt, and is then removed and allowed to cool off in air.

It is claimed that, although the tool is cooled with such extreme rapidity, yet there is no risk of breakage, the cooling being arrested at about 690°C., and the tool comes to an absolutely uniform temperature throughout before being removed from the melt. Any stresses that may be set up by the subsequent cooling in the air are very slight and are never sufficient to cause a crack.

The salt-bath furnace consists essentially of an iron or steel pot fitted with a mixture of fusible salts which comes about half way up the furnace and in the space above it is a tray suspended by two rods, which pass through the top of the furnace, above which they are attached to the hook shown in the illustration. By means of a chain and balance weight this tray may be raised out of the melt or lowered into it at will. After the high-speed tools have been heated to the high temperature they are immediately transferred to this rising and falling tray and stirred vigorously in the melt at a low-red heat, as already described. In the process of high-speed hardening the salt-bath furnace is, therefore, used for the purpose of quenching the steel, or rapidly lowering its temperature from a white heat to a dull red.

"SKELETON" SWITCHBOARDS.

The progress and development of electricity supply have brought about many changes in the apparatus installed in connection with generation and distribution. Thus, the modern turbo-generator is hardly recognisable as a descendant of the old horizontal engines driving by means of ropes or belts the dynamos at that time in vogue.



"SPAGNOLETTI" TYPE OF SKELETON SWITCHBOARD.

The backs of early switchboards usually gave one the impression of a hopeless tangle of cables which, frequently hidden away behind an imposing panel, were usually left to take care of themselves until an outbreak of fire served to call attention to the necessity of some alteration. The skeleton type of switchboard of Messrs. Spagnoletti's manufacture, which we illustrate herewith, may be considered as providing the maximum security against fire, and as all parts are always in view, little chance is afforded for any failure of insulation. It will be noticed that the connections consist of bare copper rods, whilst all current-carrying parts are mounted on porcelain.

The board shown is intended for sub-station use, and is, therefore, arranged for distribution purposes. The 'bus bars are shown running in front of the main frame and supported on insulators, but in a later type they are held in special brackets fixed behind the iron framework. It will be noticed that the upper switch fuse contacts are fixed on to the 'bus bars, whilst the lower ones, as well as all

switch contacts, are mounted on porcelain insulators, thus ensuring a very high and permanent insulation resistance.

A special feature of this construction is the ease with which additional panels can be fitted whenever desired, the 'bus bars being of the laminated type provided at the ends with clamps for extensions, whilst the framework merely rests in cast-iron sockets and is supported by the usual stays fixed into the wall.

The method of construction shown is, of course, only suitable for low-tension distribution up to pressures of, say, 500 or 600 volts, but for sub-station work and for many other purposes it offers many advantages over slate and marble, not the least of which is the high insulation resistance obtainable. It is well known that when slate or marble panels are employed all current-carrying parts, as well as all constructional bolts, have to be bushed with ebonite or fibre where they pass through the panels, whereas in the skeleton type of construction no insulation is necessary in addition to the main porcelain insulators referred to above. We understand that several of these skeleton-type boards have been supplied to the Post Office authorities, which is sufficient guarantee of the excellence of their design and construction.

PARLIAMENTARY INTELLIGENCE.

LONDON AND DISTRICT ELECTRICITY SUPPLY BILL.

As stated briefly in our last issue (p. 588), on the order for the second reading of this bill in the House of Commons on Thursday last,

Mr. CHAPLIN moved its rejection as he objected to the inclusion of Wimbledon and Merton in the area of supply. He said the needs of those districts were amply met under Provisional Orders of 1897 and 1903, and Wimbledon Council, who were the undertakers for the existing works, had erected a generating station at a cost of £182,394. The competition to be set up under the Bill would deprive the local authority of its best business, and it would be worth the while of the promoters of the bill to supply electricity in those districts even at a loss in order to cripple a competitor and force the local authority to sell their undertaking to the company.

Mr. T. DAVIES seconded, and said his objection was not to details, but to the principle of the bill. Cheap electricity was a very important thing, but the bill did not give small consumers a lower price than they already paid in any of the areas of the borough councils which were now supplying electricity in London, and, as for the large consumers, they could look after themselves. If the bill was passed, the company would have the power of spending a huge amount of money for a short time in certain areas, until it compelled the weaker authorities to sell at any price it might offer them. The purchase proposals he considered were monstrous.

Mr. PICKERSGILL supported the rejection of the bill on the ground that it created a new monopoly, with competitive powers alongside the existing municipal distributors of electricity. It was proposed to put the company in a position to destroy businesses built up with the money of the London ratepayers, and when those businesses had been destroyed it was proposed to buy up the company again with the money of the ratepayers represented by the London County Council. Large industrial concerns might get their supply at a shade lower cost than they did now, but there was no protection for the small man.

Mr. MCKINNON WOOD said he did not know of any subject more complicated than the present position of the supply of electricity in London, or of any question affecting great industrial interests that was in a more unsatisfactory position. The new company would be obliged to sell electricity. It was for the protection of the borough councils that the provision as to the small consumer had been put in. He did not hold any brief for the company, but must point out that the price in the bill was the lowest ever inserted in any bill ever submitted to Parliament, and was lower than the price the County Council itself imposed. That was a matter of great industrial importance and urgency. He agreed in preferring a complete municipal solution of the matter. In 1906 he introduced on behalf of the London County Council a bill for dealing with the matter by creating a municipal supply for London. Last year when the County Council brought in another bill although he was entirely opposed to it, he advocated the second reading in the hope that it might be so shaped in Committee as to bring about the objects he desired. He did not approve in the least the terms of purchase in this bill, but that was a matter for argument in committee, and if the result was not satisfactory it could be dealt with on third reading. The powers of competition were carefully safeguarded. If the proposals before Parliament of the existing companies were carried without this bill, then they were throttling the development of electricity in London, and were putting a stop to any development, because, once they gave the companies power to link up, they would hear no more of cheap electricity. The borough councils, in their opposition to the bill, took a purely parochial view. They had frequent applications from borough councils for capital in order to extend generating stations which in many cases were inadequate, too small for economic working, and too badly placed to supply cheap electricity. The remedy for that was to have a cheap bulk supply, so that a supplementary supply might be got, not by extravagant capital expenditure on inadequate generating stations, but from a large generating station which could supply on the cheapest possible terms. The whole question resolved itself into this, they not only had not got a proper municipal supply in London, but they had no prospect of a unified municipal supply. Under the present system the power of purchase that existed in the case of borough councils was not an effective right. He recommended the House to give the bill a second reading and refer it to a committee.

Mr. J. ROWLANDS opposed the bill. The London County Council did not secure control of the water supply because the area of supply extended beyond the county; and in regard to the supply of electricity the same objection to the control of that Council applied. The outside local authorities must have a voice.

Mr. CAVE said that as Parliament had for many years not only allowed but encouraged local bodies to supply electricity, he did not favour the proposal to create a private body, with power to compete. Why should London County Council be empowered to purchase an undertaking which would give them powers of interference with Surrey and other authorities?

Mr. W. CROOKS said they were asked to create the biggest trust London had ever known or ever would know. He asked the Government to leave the matter to the House.

Mr. DICKINSON referred to the previous London power bills, and said the House ought to consider the matter from a practical standpoint and recognise that the municipal authorities in London for the present were not willing to undertake anything like the duties which such a bill would have placed upon them. The bill would facilitate cheapness of supply. That was the first time a bill establishing a bulk supply had contained a purchase clause. There was no authority which could properly purchase the undertakings at present, but by the Board of Trade clause the London County Council would now be made the authority to purchase.

Mr. BURDETT-COUTTS thought the bill was a Machiavellian scheme to convert London County Council into the real lighting authority for London, making it the greatest employer in London, and a machine which could be manipulated for electoral purposes by the Government of the day. There was a clause in the bill protecting the powers possessed by Westminster Council, and he wanted to know what bearing the instruction would have on the clause.

Sir J. BENN said London badly needed a bulk supply, and two Parliaments had recognised that the only way of giving that supply was by means of one or two large generating stations on the outskirts of the metropolis, from which all parts of the area would get electricity at one price. If the bill were adopted, with the instruction suggested by the President of the Board of Trade, it would be possible for London County Council in the fulness of time, to become possessed by purchase of the electrical supply of London, which they could develop and work with the same profit to the public as their great tramway service.

Mr. FORSTER intended to vote against the second reading, because he still believed the best way of supplying electricity was by private enterprise.

Mr. CHURCHILL said there were before the House three bills. They could only deal with one that night, although they must not overlook the other two, because all three were inter-related, and it was intended to ask the House to apply a common policy in regard to all of them. He would ask the House to afford every facility for the extension of private enterprise and to develop the best possible system of electrical supply for London, and then to arrange for the transference of the supply at the earliest possible moment to the governing body for London. At present there were 66 different generating stations and 65 main distributing centres within the London area. The average price of electricity over the whole of the vast area of London was 1·38d., or more than double the cost of electrical power in Newcastle, and yet London, owing to its size, ought to have the cheaper supply. The industries of London were specially suited to derive benefit from a cheap supply of electrical power. It was now proposed to establish a *great outside factory so that the mains of London should be flushed with a cheaper supply of electricity*, and that the railways and tramways should be supplied. The whole intention of this proposal was that there would be a superior economy from production in bulk. *He did not think it possible to flush London with cheap electricity* without that benefit reaching the small consumers. All the ordinary harnessing apparatus for controlling private enterprise according to modern ideas was in full operation in the bill. The maximum prices were fixed, and fixed at a lower rate than had ever been specified in any bill before; there was compulsion to supply, and the usual limitation of dividends by a sliding scale; and in order to ensure that it was not a bogus enterprise it was provided that the whole enterprise should lapse unless £600,000 was subscribed in the first year, and unless substantial progress was made in the second. The Borough Councils had, no doubt, rendered great services, but a borough council could not claim immunity from all competition which most improvements created. They were not committed to the purchase terms. All he suggested was that they should have these terms thoroughly scrutinised by a trustworthy Parliamentary committee. They must remember they were not dealing with a brand new area, but with an area already fully occupied, in which the operation of the new supply authority would be strictly guarded in reference to the interests of the existing occupants of the ground. Any hon. member who stood between the great City of London and an absolutely modern and uniform system of electric supply would run the gravest risk and assume the gravest responsibility. He submitted that they would take a grave responsibility if they dismissed that great enterprise of solid material advantage to London without allowing it to be examined by a committee. If the House were to reject the present measure on the second reading, the need would still be important, but it would press no more.

Mr. LYTTELTON said that for years he and his colleagues had maintained that no more excellent way of contributing to the public service

was to be found than in such enterprises as this – first, a private company, with a limitation, if they liked, of dividend, as in the case of the gas companies, a sliding scale to secure prices, and, ultimately, purchase by some public authority, not necessarily the County Council. He believed that was a sound view.

The House then divided, and there were for the amendment 90, against 138. The bill was accordingly read a second time.

Royal Assent. On Aug. 1 Royal assent was given to the following Acts of Parliament:– Ayr Corporation Tramways Order Confirmation, Patents and Designs, Telegraph (Construction), Electric Lighting Orders Confirmation (Nos. 1, 2 and 3), Lanarkshire Tramways Order Confirmation, Paisley District Tramways Order Confirmation, Tramways Orders Confirmation (No. 2), North East London Railway, Bristol Tramways, Metropolitan District Railway, South Wales Electrical Power Distribution Co., Wishaw Burgh Electricity, &c., London County Council (Tramways and Improvements), Macclesfield and District Tramways (Abandonment), Metropolitan Electric Tramways, Gt. Northern, Piccadilly & Brompton Railway, London United Tramways, Nottinghamshire & Derbyshire Tramways, Central Ireland Electric Power, Liverpool Corporation (General Powers), Burnley Corporation, Blackburn Corporation, Keighley Corporation, Leicester Corporation, Doncaster Corporation, Wolverhampton Corporation, Stockport Corporation.

LEGAL INTELLIGENCE.

Reid Newfoundland Co. v. Anglo-American Telegraph Co.

On Saturday the Judicial Committee of the Privy Council delivered judgment in this appeal from a judgment of the Supreme Court of Newfoundland of July, 1907, ordering that an account be taken before the Registrar of the messages passed or transmitted over a special wire by the late Sir Robert Reid and the appellant company other than messages connected with or for purposes incidental to the management, operation and control of the line of railway between St. Johns and Harbour Grace, via Whitbourne, and between Harbour Grace and Carbonear, Newfoundland. The Anglo Co. is successor of the New York, Newfoundland & London Telegraph Co., which, incorporated under an Act of the Legislature of Newfoundland and by sec. 14 of that statute, the Anglo Co. alleged that the use of any part of the territory of Newfoundland by others than itself for telegraphic communication was prohibited. The Supreme Court of Newfoundland decided that the Reid-Newfoundland Co. was bound to account to the Anglo for certain messages transmitted by it through a wire carried along a section of the system of railways now in the appellant company's occupation. The wire, which belongs to respondents, was originally provided by it for the use of a company incorporated in 1881 under the name of the Newfoundland Railway Co., which was predecessor in title of the Reid-Newfoundland Co. The question at issue was the meaning and effect of an agreement of Aug. 10, 1888, between the Newfoundland Railway Co. (which was then insolvent) and the receiver and manager of the Newfoundland Railway Co. (appointed in January, 1885, by the Court of Chancery in England at the instance of bondholders whose interest was in arrear) and the Anglo-American Telegraph Co., as successor in title of a company which enjoyed a statutory monopoly for 50 years from April 15, 1884, in regard to telegraphic communications in Newfoundland.

In delivering judgment, Lord MACNAGHTEN pointed out that the Newfoundland Railway Co. was no longer in existence, and now formed a portion of the undertaking of the Reid-Newfoundland Co., which operated a system of railways known as the Newfoundland Railway, connecting the city of St. Johns with Port Basques, near Cape Ray. At the date of the agreement in 1888 the old Newfoundland Railway Co. had completed only about 84 miles out of 340 miles of its authorised undertaking, and in carrying out the work so far the company had exhausted its means and was in the hands of a receiver. The line was without telegraphic communication, and there were no funds available. In this state of things the agreement now in question was approved by the Court in the bondholders' suit and duly executed. The agreement provided that the Anglo-American Co. should for 27½ years from Nov. 1, 1888, have the exclusive right to enter upon the lands mentioned therein and to erect, maintain and operate upon the lands forming the roadways of the company's railway as many lines of telegraph for their business as it might deem necessary, and a special wire for the use of the railway company, its servants, agents, successors and assignees, "for use in and about the management, operation and control of the said railway and all purposes connected with or incidental to such management, operation and control." It was further provided that the railway company should not "pass or transmit any commercial messages over the special wire, except for the benefit and account of the telegraph company." On the other hand, the telegraph company agreed to erect, equip and maintain for 27½ years in good working order and operate at least two lines of telegraph wire "from the railway station in St. Johns to the railway station at Harbour Grace, and from Harbour Grace to Carbonear," one of such wires to be for the use of the telegraph company and the other to be "for the special and exclusive use of the railway company and the receiver and manager." Then followed a provision enabling the railway company, in the event of the special wire becoming disabled, to use any other of the wires of the telegraph company, for the purposes for which it would be entitled to use the special wire. In accordance with the agreement, the telegraph company provided and maintained a special wire, and its case was that since April, 1898, the special wire had been used for unprivileged as well as privileged messages, and that the Reid-Newfoundland Co. had not duly accounted for the unprivileged messages. The Newfoundland Railway Co. and its receiver and manager sold to the Newfoundland Government all the railways and property of the company, "subject to the subsisting contract with the Anglo-American Co. as regards the telegraph lines along the said railway." By a contract (dated May 3, 1898) between the Government and Sir George Reid, Sir Robert Reid took over the entire railway system of the colony on a lease for 50 years, with a provision for the purchase or reversion, and also that Sir George Reid should take over for a certain period all the Government telegraph lines in the colony, and Sir George did take possession of the Government railways and telegraph lines on April 1, 1898; but by an act passed in 1901 an agreement was confirmed under which the reversion of the Newfoundland Railway was resold and reconveyed to the Government, and the Government resumed possession of the telegraphs. With those exceptions, all the rights, privileges and liabilities of Sir George Reid under the contract of 1898 were transferred to the Reid-Newfoundland Co., incorporated by the same act for working the system of railways which Sir George Reid was then operating. Besides the business of the railway, appellants were authorised to carry on the business of shipowners and a number of other undertakings. It was not disputed that since April, 1898, the special wire had been used in these businesses. It was clear that the scope of the agreement of 1888 was limited to the railway described in the agreement, and there was nothing to indicate that it had any reference to any future development of the undertaking by the old Newfoundland Co. By the agreement under which Sir George Reid took over the Newfoundland Railway system it was stipulated that from April 15, 1904 (the date when the monopoly of the Anglo Co. expired), Sir George Reid should establish, at his own cost, telegraphic communication; but the vice-president of the Reid-Newfoundland Co. admitted that the telegraph wire was used for all purposes of the company's business. Their Lordships therefore decided that the decision of the Supreme Court of Newfoundland was right, and that they would advise His Majesty that the appeal should be dismissed with costs.

MUNICIPAL, FOREIGN & GENERAL NOTES.

APPOINTMENTS VACANT AND FILLED.

Applications are invited for the positions of assistant masters in the physics and electrical engineering and the chemistry and natural science departments of Portsmouth Municipal Technical College. Salary £125, increasing after approved service by £5 per annum to £150. In the physics department qualification in electrical engineering will be a recommendation. Applications (on forms to be obtained from the Secretary, Offices for Higher Education, the Municipal College, Portsmouth) by Aug. 22. See an advertisement.

Two telegraph inspectors are required for service on the Federated Malay States Railways, age not to exceed 30, and preferably unmarried. Candidates must have been employed on an English railway and be competent to take charge of the erection and maintenance of telegraph and telephone lines, single needle and Morse telegraph instruments, electric block signalling instruments, electric signal repeaters and electric train tablet apparatus. Engagement for three years. Salary £300, rising by annual increments of £10 to £350 per annum. Applications will be received by the Crown Agents for the Colonies, Whitehall-gardens, London, S.W., up to Aug. 12. See also advertisement.

There are vacancies in the electrical engineer's department, Devonport Dockyard, for three sub-station attendants having good experience in batteries and automatic boosters. Applications to the Electrical Engineer, H.M. Dockyard (North), Devonport. See an advertisement.

Mr. A. E. K. Pitcher (of the Government Telegraph Department) has been appointed telegraph superintendent on the South Indian Railway at a salary of R450 (£30), rising to R600 (£40) per month.

Mr. C. Oddy has been appointed surveyor and district engineer of telegraphs for the northern district of Cape Colony, with headquarters at Kimberley.

EDUCATIONAL NOTICES.

University of Liverpool.—The session 1908-9 commences on Tuesday, Oct. 6. The courses of study in the faculty of engineering, leading to the ordinary degree of B. Eng., or the certificate in engineering, are so arranged as to confer a general scientific training for those intending to become engineers or to enter any allied profession. The honours course enables students to specialise in some branch of the profession, and opportunities are afforded for post-

graduate work and research. Prospectuses from the registrar, Prof. P. Hebblethwaite, M.A.

Armstrong College (Newcastle-on-Tyne).—The session 1908 9 will commence on Sept. 28. There are complete courses of instruction in mechanical, civil, electrical and marine engineering, naval architecture, mining, metallurgy, &c. Particulars from the secretary (Mr. F. H. Pruen).

Wigan and District Mining and Technical College.—The day and evening classes commence on Monday, Sept. 14. The main objects of the College are to supply the growing demand for higher scientific instruction in coal and metalliferous mining, and to meet the requirements of those who intend to become mining engineers, colliery managers, &c. In the day department there is a three years' diploma course, and also a special course for University students. The courses of instruction are organised on the "sandwich" system. The calendar contains full particulars of classes, fees, diplomas, &c.

Aberdeen.—The Electricity committee recommend the Council to make extensions at Dee Village electricity supply works as follows: Engine room buildings, foundations, &c., £3,040; boiler house buildings, foundations, pump room and water tanks, £5,590; switchboard extensions and gallery £500; coal bunkers and coal conveyors, &c., £3,500; boiler and engine foundations, £1,500; extension of engine room overhead crane, £370; water purifying plant, £600; removing of temporary engine room, temporary cables, and alterations to works' railway, £200—£15,300, plus 10 per cent. for contingencies, £1,530—£16,830.

Barking.—The Council have appointed a sub-committee of six to negotiate the terms of the sale and transfer of the municipal electricity works to the promoters of the London and District Electric Supply Bill.

Beckenham.—Sanction to a loan of £1,700 for public electric lighting has been applied for by the Council.

Bellshill (Glasgow).—There is a local agitation in favour of the extension of the Glasgow Corporation tramway system to this village, and the Parish Council have unanimously passed a resolution in favour of the extension via Tannochside. The distance from the city to the proposed terminus is about eight miles.

Brazil.—Mr. Consul-General A. Chapman reports that last year imports into Brazil show an increased demand for electric plant of all kinds.

The Rio de Janeiro Tramway, Light & Power Co., a Canadian enterprise, which has been operating in Rio de Janeiro since 1905, and by March last had completed its hydro-electric station on the river Lages, has now one of the most complete hydro electric stations yet constructed in Brazil. It is situate about 51 miles from the city of Rio de Janeiro, and comprises a concrete dam 100 ft. high and 700 ft. long, giving a reservoir capacity of 221,000,000 cubic metres of water. From the dam to the power station, a distance of about 7,420 ft., the fall is about 1,080 ft. The station is a steel construction with concrete walls for the lower portion and brick for the upper. Six turbine wheels, each of 9,000 H.P., and two of 400 H.P. for the exciters, have been installed, and the company owns the entire route of the 51 miles of transmission lines, the land varying from 130 ft. in width to 300 ft. in the outlying districts. The distributing station is situate in the Rue Frei Caneca and is of similar construction to the power station. In connection with the works the company has constructed a railway 16½ miles in length, connecting the main line of Government railway with the power station at Rio das Lages. The company estimates that it has now in use steam power to the extent of 20,000 H.P., which is all to be replaced by the electric drive. In addition to the Rio das Lages power station of a maximum capacity of 50,000 H.P., the company holds a concession to utilise the waters of the river Pirahy, which flows in a valley adjacent to that of Rio das Lages, and has a greater flow than the latter river. This will enable the company to increase the power at its command up to at least 100,000 H.P., and the work of extension can be made at comparatively small cost. Included in the company's field of operations are the following:

Tramways.—The company is owner of the capital of the Companhias São Christovão, Carris Urbanos and Villa Isabel, which provide about three parts of the tramway service of Rio de Janeiro. These concessions were last November consolidated and extended until 1970, the company undertaking to electrify the lines within about three years and to construct about 20 miles of new lines. The lines of the Villa Isabel are already electrified, and the work of transforming other lines has been commenced.

Illumination.—The Société Anonyme du Gaz de Rio de Janeiro, a Belgian concern, has been acquired by the Rio de Janeiro Co., and controls the whole of the illumination of the city by gas and electricity in virtue of a concession lasting till 1945, with a monopoly up to 1915. All parts of the city are now illuminated by gas, electric light being confined for the present to the new avenues recently opened and the central commercial section. It is expected that during [illegible] electric lighting will be greatly extended.

Electric Power.—The company enjoys a monopoly for the distribution of electric power until 1915, and thereafter without monopoly until 1990. At present only about 3,000 H.P. is supplied, but the company expect within a few months to greatly increase this supply, as many factories now using steam power contemplate the change to electric driving.

Telephones.—This concession, formerly exploited by a German company, was recently acquired by the Rio de Janeiro Co., and gives exclusive right for telephones in the Federal district. The system has been recently reconstructed on modern lines. There are now about 2,500 subscribers, and the company expects within another year to increase this to the full capacity of 5,000.

Brighton.—At the meeting of the Council last week the proposal of the Lighting committee in regard to the supply of electrical energy to the works of the London, Brighton & South Coast Railway was adopted. The terms of the contract, conditions of supply, &c., were given in our last issue.

Chartered Institute of Patent Agents.—The qualifying examination of persons desirous of being registered as patent agents will be held in November next. A notice giving particulars appeared in the "Illustrated Official Journal (Patents)" for July 8th, and a copy of this notice can be obtained from the Secretary, Chartered Institute of Patent Agents, Staple Inn-buildings, London, W.C.

Co operation in Municipal Electricity Undertakings.—Representatives of Haslingden, Rawtenstall and Bacup Corporations are considering a suggestion of Mr. H. R. Hooper, L G. Board inspector, as to the advisability of co-operating in establishing electricity supply for the three towns. Rawtenstall Council is taking electricity in bulk from the Lancashire Electric Power Co.

Customs Duties.—According to a recent decision of the New Zealand Customs Department, maximum demand indicators (under electrical appliances) are subject to 20 per cent. if of British and 30 per cent. if of foreign manufacture

It has been decided that only necessary components of electrical appliances for illuminating or producing power will be included as "parts of electrical installations," under No. 271 of the Danish import tariff. Accessories or tools, although auxiliary, will not be included.

Dartford.—An inquiry was held last week into the application of the Council for sanction to a further loan of £2,880 for extensions of the electricity undertaking.

Denny (N.B.).—Denny and Dunipace Corporation have decided to proceed with the scheme for electricity supply in the burgh, and have agreed to take current from the Scottish Central Electric Power Co., whose power station is at Larbert, about 3 miles distant.

Dundee.—The Tramways committee have further considered the question of the adoption of the trackless tramway system, and recommend the Council to make an experiment with the system.

In a joint report by the tramways manager (Mr. P. Fisher) and the city electrical engineer (Mr. H. Richardson) it is stated that there is no difficulty so far as the practicability of a trackless trolley system of cars in Dundee is concerned, and they estimate the cost of such a system for Clepington-road at £2,600—two cars, £1,500 and overhead equipment, £1,100. Mr. Fisher estimates that the working of the system will mean a deficiency of £140 per annum.

Eccles.—An unopposed inquiry was held last week into the application of the Council for sanction to borrow £16,278 for extensions of the electricity undertaking.

Electricity in Mining.—The first sod of two new pits which are being sunk at Blaencwmdu, Maesteg, by North's Navigation Collieries, was cut recently. The whole of the machinery will be driven by electric power, and an independent generating station is to be erected at a cost of between £20,000 and £30,000.

Franco British Exhibition.—It will be seen from our report elsewhere of the meeting of the Central London Railway Co. yesterday that the chairman was able to announce that the promoters of the Exhibition at Shepherd's Bush were endeavouring to arrange for its continuance next year.

Guernsey States Telephone Department.—The tenth anniversary of the inauguration of this undertaking was celebrated last week, when an inspection of the Clifton exchange was made by some of the principal residents under the guidance of Mr. A. R Bennett (consulting engineer) and Mr R McLean (resident engineer and manager of the department).

The population served by the system is 40,300 and the telephones connected are now 1,698, equal to one for each 23.8 persons. The capital expenditure to Dec. last was £31,661, or £18. 17s. 9d per instrument for the 1,676 then connected (including 165 extension lines). There are no party lines. Last year's receipts were £5,613 (an average of £3 7s. per line) and £511 went to the Post Office as royalty. After paying working costs and capital charges and placing £1,055 to reserve, there was a net profit of £310. The reserve stands at £9,407. Renewals have been made and the system kept in repair out of revenue and the reserve has never been drawn upon.

Hammersmith (London). The Council have applied for a loan of £10,000 for electricity supply extensions.

Hull.—The Tramways committee received 11 tenders for supply of a new generating set at the Osborne-street station, and the city engineer (Mr. A. E. White) and the tramways and electrical engineer (Mr. J. Wilkinson) are to inspect the works of the British Thomson-Houston Co. and Siemens Bros. dynamo works in order to ascertain the most desirable type of plant to adopt. The prices quoted are £5,845 and £5,904 respectively.

Inquests.—At Tyne Dock on Tuesday an inquest was held on a youth of 18 named Young, employed at Harton Colliery, and who was killed on 1st inst.

A banksman named Stokes said he was with the deceased about 40 yds. from the shaft bottom and saw Young take hold of some piping which enclosed electric wires. A few minutes later Young shouted "Pull me off," and another lad said he had received a shock. They pulled Young off, whereupon he fell to the ground. There was a warning on the pit-heap against touching the conduit. He had known lads get hold of the tube, which had been pulled down two or three times recently. They were aware of the danger. Witness had never seen anyone swinging on the tube, and he thought it would require some force to break it.

Thomas Weymess, a putter, said when deceased shouted to be pulled off he thought he was only larking. Young never spoke after he was taken down. He had seen lads touch the tube before, but had not seen them swinging on it.

Mr. Lishman (for the Harton Coal Co.) said he found the tube broken in two joints, 12 ft. apart. The wires in the tube were insulated, but the insulation having been broken, the tube become electrified. The tube had been broken on the Thursday night, but it was all right on the following evening.

Mr. A. Barker, resident electrician, said the breaking of the tube would not have given the shock. The insulation would have to be broken.

A verdict of accidental death was returned.

An inquest was held at Pinxton (Derbyshire) on Monday into the death of a youth named Phillips.

SURGEY, locomotive driver for the Pinxton Colliery Co., said deceased, who was working under him, was putting a set of new brake blocks on the locomotive. Witness left him to fetch some accessories, and was surprised on his return to find his assistant apparently dead. He was holding the flexible of a portable electric lamp.

Mr. F. SMITH, electrician, said when he inspected the lamp he found signs that it had been tampered with. The pressure of the electricity supply was 230 volts, and the utmost that would pass through the body of deceased would be 145 volts. The lamp was examined the day before and found all right.

At this point Mr. STOKES (H.M. Factory Inspector) drew witness's attention to a defect in the flexible, which was considered to be quite as strong an element of danger as the defect pointed out in the lamp.

A verdict of accidental death was returned.

Institute Lighting.—The electric lighting of the Albert Institute, Dundee, has been re-organised, and electric current is now taken from the Corporation mains. There are three 10 ampere Excello arcs, each of 2,700 c.p., in the reading-room; four tantalum 25 c.p. lamps, arranged in series, and one 10 ampere arc for lighting the staircase. By the re-arrangement the total illumination is increased from 2,764 to 10,900 c.p., and the consumption of electrical energy is less than one-half of what was required when current was generated on the premises. The cost of the new installation will be met by the sale of the old generating plant and of the heavy copper wiring necessitated by the system further discarded, and it is estimated that a saving of £130 per annum will accrue in working.

Islington (London).—The Finance committee have reported that it is not desirable at present to depart from the present system of repayment of loans for electric lighting or to form a special reserve to supplement the loan repayments.

Leyton.—Sanction has been received to a loan of £895 for additional plant at the electricity works.

Newcastle-under-Lyme.—The salary of the electrical engineer (Mr. De Rienzi) has been increased.

Nuneaton.—The Council have adopted a revised scale of charging for electricity.

At the last meeting Ald. BATES, chairman of the Electricity committee, said that the effect of the changes was to do away with any preferential treatment to consumers. The basis was to make a charge of 15 per cent. upon the rateable value of the property of consumers and 1½d. per unit. There was an alternative flat-rate charge of 5d. per unit.

Sheffield-Warrington Electric Railway.—It is reported that a scheme is being formulated for the construction of an electric railway from Sheffield to Warrington. The proposed line would be of the standard gauge and would pass through Macclesfield, Chelford, Buxton and Knutsford. Several landowners have already expressed themselves favourably disposed towards the scheme.

Southall-Norwood.—The Council have informed the Metropolitan Electric Supply Co. that they cannot accept their proposals for public lighting, but would consider an offer to purchase the Council's provisional order without conditions.

IMPORTANT NOTICE.

Extra Copies of "The Electrician" Special Mining Issue (July 10th, 1908), are obtainable, price 1/- nett (post free U K., 1/4; abroad 1/6).

Southampton.—An inquiry was held on Friday into the application of the Corporation to borrow £3,000 for extensions of the electric light mains, &c.

Southgate.—Mr. W. C. C. Hawtayne is to advise the Council on the proposed transfer of their provisional electric lighting order to the North Metropolitan Electric Power Supply Co.

Torquay.—To meet the increasing demand for supply of electric current for traction the Electric Lighting committee have decided to increase the capacity of the generating station. The consulting engineers (Messrs. Kincaid, Waller, Manville & Dawson) made further suggestions for meeting the difficulty, including the installation of oil driven plant at the present station at an estimated cost of £6,820.

The committee reported that they found themselves unable to entertain this suggestion, but had considered a report of the electrical engineer (Mr. P. Storey), who pointed out that whatever additional plant was installed in the present station the difficulty could only be met temporarily, and that the ultimate removal of the works could only be deferred for a year or two. Mr. Storey was of opinion that before any decision was arrived at in regard to the addition of plant on the present site, the Tramway Company should be asked to give a guarantee not to apply for any further increase of the maximum demand last made for a period of at least two years. The means at present provided for the supply of energy for the tramways was by a single steam generator set of 250 kw. capacity to which was coupled a 75 kw. alternating current generator, the latter furnishing the daylight supply to the town for lighting and power. The steam set in conjunction with the battery and reversible booster was capable for periods of short duration of supplying the demand of 500 kw. Should the use of the steam set, from whatever cause, be interfered with, the only means of supplying the company's demand would be by the motor-generator. Should the occasion arise in the winter for the use of the motor-generator set during the peak load, the consequences would be serious. Taking into consideration all the circumstances, Mr. Storey thinks it inadvisable to instal additional boiler power. His advice is that the motor generator be divided up and a new high-speed steam engine and sole-plate be fitted to the direct current portion, forming a completely new unit of 250 kw. He proposes also to put in a new surface-condensing plant for the new steam engine, with electrically-driven air and circulating pumps. Cost of removing foundations and other alterations Mr. Storey estimates will bring the total cost to £2,964.

The Council have adopted the committee's report endorsing Mr. Storey's recommendations.

Whitehaven.—An unopposed inquiry was held last week into the Council's application for sanction to borrow £2,000 for electric lighting extensions.

Whitworth Institute.—The new Whitworth Institute, Manchester, which was formally opened to the public on 29th ult., is lighted throughout by Nernst and AEGMA metal lamps.

The new buildings comprise a noble entrance hall, a large gallery, fine library, concert room, curator's room, and a beautiful hall on the first floor to be used for meetings and lectures. The whole of the ground floor (including entrance hall) is lighted by means of 111 ½-ampere Luna Nernst lamps, oxydised copper, 12 1-ampere ditto, 10 1½-ampere, and 2 3-ampere multiple Nernst lamps, 5 D type and 28 ½-ampere A type Nernst lamps, giving approximately 21,678 c.p. The first floor (lecture hall, &c.) is illuminated by about 200 50 c.p. AEGMA metal lamps, wired two in series, fitted in special glass shades. Messrs. Crews & Handford, Manchester, were consulting engineers to the Institute committee, and the work was carried out by Messrs. E. M. Evans & Son, Fountain-street, Manchester, the lamps being supplied by the Electrical Co., 121-5, Charing Cross-road, London, W.C.

Workhouse Lighting.—Haslingden Guardians have accepted the terms of Rawtenstall Corporation for supply of electricity for lighting and power at the workhouse.

Wrexham.—The salary of the borough electrical engineer (Mr W. G. Pickvance) has been increased to £225 per annum. Sanction to a further loan of £3,000 for electricity supply extensions has been applied for.

ELECTRICITY SUPPLY AND TRAMWAY ACCOUNTS

Aberdeen.—The total revenue of the tramways department for the year ended May was £71,930, a decrease of £675.

Working expenses were £38,669 (against £40,434), and the balance was £33,261 (against £32,170). Interest, sinking fund and depreciation absorbed £18,341 (against £18,748), leaving net profit £14,920, which is carried to the renewal account. The total sum written off the original capital value of cars, buildings and plant, out of revenue during the past 10 years is £30,583. Total capital expenditure now stands at £319,978, and mortgage and loan debt is £277,307.

Dartford. Traffic receipts of the tramways (which are worked by J. G. White & Co.) for the year ended March 25 were £11,463.

Total expenses (including £4,752 for year's rent) were £13,257. 2,055,033 passengers were carried and 317,127 car-miles run. 423,600 units of electrical energy were consumed, for which £2,940. 6s. was paid to the Council.

Ilford.—The capital expended on the electricity undertaking at March 31 was £157,272, an increase of £5,578 on the year.

Revenue was £27,637 (against £26,586 in previous year), gross profit £9,671 (£10,555), capital charges £10,046 (£9,670). There was a deficit of £375 (against £885 surplus). Works and management expenses were 1·17d (1·13d.) per unit sold.

Gloucester.—The accounts of the Corporation's light railway department for the year ended March show capital expenditure £131,097 (increase £313).

Revenue was £14,583 (against £15,023 in previous year), expenditure £10,802 (£11,055). Gross profit was £3,781 (£3,978) and £4,945 was raised by city rate, making £8,725 towards meeting capital charges and debit balance of £2,909 brought forward. The debit balance carried forward is £1,672.

Hull.—The total income of the electricity department for the year ended March was £49,555. 15s. 8d.

Working expenses amounted to £26,080. 4s. 6d., leaving a gross profit of £23,475. 11s. 2d. Interest came to £11,805. 1s. 7d., and sinking fund to £9,271. 17s. 11d., the net balance being £2,398. 11s. 9d. 5,306,726 units were sold, and the total working cost was 1·07d. per unit (against 1·21d.) and the total cost 2·02 (against 2·29d.).

The figures indicate another successful year's working, and the city electrical engineer (Mr. H. Bell) points out that the net profit (£2,398. 11s. 9d.) is arrived at after providing £1,500 for switchboard renewals, which in the previous year's accounts was only made in the net profit appropriation account. Thus the net profit for 1907-8 is £3,898 against £1,813. 6s. 7d. The total capital expenditure now stands at £371,854, and £16,877 was expended during the past year. In October, 1906, a general reduction was made in the lighting and power tariffs, and the latter six months of 1906-7 were affected accordingly. These reduced tariffs have operated during the whole of the past year, thereby reducing the revenue to a considerable extent, the results now shown being so much the more gratifying. The private lighting sales for last year increased by 28,121 units, and there was a decreased revenue of £559, whilst the power sales increased by 864,847 units, with an increased revenue of £3,836, which exemplifies the utility of and the advantage of catering largely for the power consumer, large and small. Coal costs have increased very slightly, although the ruling prices have been approximately 40 per cent. above those of 1906-7, and the average cost per unit under this head has dropped from 0·41d. to 0·39d. Works costs generally show a satisfactory reduction from those of the year 1906-7, and point to economy in working. The motor hiring department is making rapid and satisfactory progress, and has up to the present fully justified the department's foresight in providing for this particular class of consumer. During the year the committee inaugurated a commercial department and is on the point of opening a large showroom in the centre of the city, and it is confidently anticipated that beneficial results will accrue from this innovation. With regard to the coming year, there is every prospect that this will show even better commercial and financial results than the one under review, and considerable further business is already in hand.

Leith.—After paying all expenses (including interest and sinking fund) there was a profit of £179 on the past year's working of the electricity department. Coal cost £2,000 more than in 1906-7, and the price of current for private lighting was ¼d. less.

Working expenses of the tramways department were £18,040, repayment of loans £6,815, interest £5,763, stamp duty £119—total £30,742. Receipts were £27,503, an increase of £434, leaving a deficit of £3,239.

Lynn.—The total receipts of the electricity department for the year ended March were £6,978.

Expenses were £3,187; interest required £1,196 and sinking fund £2,017. There was a net profit of £564. Out of this sum the outstanding balance of £4 19s. 9d. has been paid off; £137. 8s. has been applied in part payment of £687 deducted from the last loan and £421. 5s. 8d. has been placed to credit of the local rate. There are 625 private consumers and the equivalent of 29,547 8 c.p. lamps connected. The electrical engineer Mr. J. Pillinger reports that a few 50 c.p. metallic filament lamps are being tried for street lighting.

Nottingham.—The total income of the tramways department for the year ended March was £153,748, increase £18,570.

Expenses, including interest and sinking fund, were £131,386, leaving a net profit of £22,357. £17,000 has been contributed to relief of rates, the last instalment (£900) written off cost of motor omnibuses, and the balance £4,457 carried to reserve, which now amounts to £50,313. 15s. 8d. The number of passengers carried was 34,411,860, increase 3,193,169, and the car miles run 3,210,283, increase 567,731. The number of workmen's return tickets issued was 156,370, increase 29,651. The average fare per passenger was 1·05d., compared with 1·06d. The consumption of electrical energy for traction, car and depot lighting, &c. was 5,234,979 units, an average of 1·63 per car mile, compared with 4,316,656 units (1·61 per car-mile) during 1906-7.

Pontypridd.—There was a gross profit of £2,554. 1s. 7d. on the past year's working of the electricity department.

After providing for the payment of interest, sinking fund, &c., there is a deficit of £1,235. 15s. 7d., against a deficit of £2,582 in 1906-7.

The income of the tramways department was £14,882. 17s. 10d., against £8,858. 11s. 3d., and the expenditure £10,801. 7s. 9d., against £7,538. The deficit, after payment for loan charges, interest, &c., was £3,541. 7s. 11d., against £2,098. 11s. 7d. The passengers carried totalled nearly 3,500,000, or 92 times the population of the district served by the tramways.

TRADE NOTES AND NOTICES.

READY.

"THE ELECTRICIAN" ELECTRICAL TRADES' DIRECTORY AND HANDBOOK.—The 1908 Edition of the Big Blue Book, price 15s., or post free in the United Kingdom, 15s. 9d. The new and enlarged volume brings a great mass of statistical and technical data quite up to date, and the Directorial Division has been thoroughly revised and amplified.

All branches of Electrical Engineering and Industry are fully treated, and Electro-Financial matters have received every attention in the new volume, which aggregates more than 2,000 pages. The Directory Division is complete and thoroughly accurate, and has been completely revised. All mere lists of members of Societies and Institutions (so easily and cheaply available) are excluded, as quite unreliable for Manufacturers' and Dealers' purposes. The full set of valuable Statistical and Engineering Tables, &c., have been very carefully revised and extended, and remodelled into handy book form; these are included in the 1908 Blue Book, making it the most complete book of the kind ever published.

TENDERS INVITED.

The *Metropolitan Asylums Board* invite tenders for the installation of electric storage battery, motor-driven booster and switchboard and connections on the training ship "Exmouth," Grays, Essex, in accordance with drawings and specifications prepared by the engineer-in-chief of the Board (Mr. W. J. Hatch, M.Inst.C.E., M.I.M.E.). Forms of tender from the offices of the Board, Embankment, E.C. Tenders by 10 a.m. Sept. 1.

Rawtenstall Corporation invite tenders for supply and delivery of 16 tramcars, and also for station lighting, wiring to motors, supply of testing instruments, &c. Copies of general conditions, specifications, &c., may be seen at the offices of the consulting engineers (Messrs. Lacey, Sillar & Leigh), 2, Queen Anne's-gate, Westminster, and 78, King-street, Manchester, and obtainable from the former offices only. Tenders to the town clerk (Mr. Jas. Whalley), Municipal Offices, Rawtenstall, by Aug. 15.

Brumby and Frodingham Council want tenders by Aug. 24 for supply of sewage disposal plant, including electric motor, switchboard, 600 yds. electric cable, oil or petrol engine, &c. Specifications from Messrs. Strachan & Weekes.

Manchester Electricity committee want tenders by 10 a.m. Aug. 12 for supply of a storage battery for Stuart-street generating station. Specifications, &c., from Mr. F. E. Hughes.

Edmonton Guardians want tenders by 9 a.m. Aug. 26 for electric lighting at the nurse's home, Upper Edmonton. Specifications, &c., from Messrs. May & Hawes.

TENDERS RECEIVED AND ACCEPTED.

St. Pancras Council have accepted the tender of Johnson & Phillips for additions to l.t. switchboard at Kings-road station at £112. The following firms also tendered:

Spagnoletti Limited £113, Whipp & Bourne £116, Electric & Ordnance Accessories Co. £119, B. Thomas £126, Walsall Electrical Co. £126, B.T.-H. Co £131, British Westinghouse Co. £135, Cowans Limited £151, Switchgear Co. £156. 10s., Edison & Swan Co. £162, Siemens Bros. Dynamo Works £176, E. M. F. Mfg. Co. £205, A. W. Penrose & Co. £224, Electric Construction Co. £225.

Marylebone (London) Council received the following tenders for supply of ¼ mile of 0·15 sq. in. t.c.c. paper-insulated, lead covered, jute served and compound cable

W. T. Henley's Co. (*acc.*)	£287 10		Siemens Bros. & Co.	£287 10
Callender's Co.	295 0		British Insulated & Helsby Cables	287 10
St. Helens Cable Co.	295 0			
W. T. Glover & Co.	287 10			

In our last issue (p. 619) we stated that the tender of the Medway Motor & Engineering Co. had been accepted by Gillingham Council for the electric lighting of four schools. The following is a complete list of the tenders received :—

Medway Motor & Engineering Co. (accepted)	£322	Dargue, Griffiths & Co.	£449
Donnison, Sillem & Co.	878	R. H. & J. Pearson	443
Cannon & Sons	726	Suter & Wood	432
Alliance Elec. Co.	700	Woodville Elec. Co.	431
Strange & Son	652	Haden & Sons	406
Electrical & Motor Co.	644	W. R. Reynolds	387
Rayfield & Jenner	573	Cossey & Co.	384
Harland Bowden & Co.	527	Jones & Co.	380
Smeeton & Page	505	Davis & Co.	365
Gibson & Co.	495	Newton & Co.	359
Chas. Pullan	481	Electrical Co.	358
Philpot & Sons	480	Wright & Co	352
Davis & Co.	476	B. J. Quick & Co.	338
Cash & Sons	460	Tilley Bros.	329
Chapman & Co.	453	H.E. Wright (only for 1 school)	178

The engineer's estimate was £326. The borough electrical engineer (Mr. A. D. Chalmers) is to supervise the execution of the work.

St. Pancras (London) Council have accepted the tender of J. H. Beattie & Co. for 11,000 tons Bolsover (Mansfield) best nutty slack coal at 12s. 4d. per ton ; Brentnall & Cleland, 11,000 tons Desford steam coal at 14s. 8d. per ton; and Facer & Co., 600 tons Bwllfa coal at £1. 1s. 6d. per ton.

Hammersmith Council have accepted the tender of the British Electric Transformer Co. for 100 kw. air-cooled transformers at £112, and for 200 kw. transformers at £175. Johnson & Phillips quoted £101. 5s. and £148, Siemens Bros. & Co. £106 and £140, the Brush Co. £127 and £203.

Hammersmith Council have placed orders with the Main Colliery Co. for 12 months' supply of Graigola and Victoria coal at 15s. 1d. a ton, and with Cory Bros. & Co. for Pentre coals at 14s. 11½d. a ton.

Lowestoft Corporation have accepted the tender of W. T. Glover & Co. for rubber insulated cables, that of Johnson & Phillips for paper insulated cables, and that of Fredk. Smith & Co. for bare copper trolley wire.

Stoke-on-Trent Council have accepted the following tenders :—G. Till, 200 meter boards, £25 ; British Insulated & Helsby Cables, cable, £49 ; John Spencer, steam piping, £41. 10s. ; Staveley Coal & Iron Co., c.i. piping, £3. 10s. per ton.

Marylebone (London) Council have placed orders with Donnison, Sillem & Co. for electric light fittings for premises in Somerset-street, at £26, and with Siemens Bros. Dynamo Works for four circuit-breakers, at £69, 10s.

Hampstead (London) Guardians have accepted the tender of E. R. Smith for making alterations for reducing the voltage of electric current at the workhouse from 210 to 105 to enable metallic filament lamps to be used.

Messrs. Ward & Goldstone have received an order for supply of wires and cables for the Manchester Electrical Exhibition through Messrs. J. Lomax Kendal & Co., the contractors.

Islington (London) Council have accepted the tender of the Midland Engineering Co. for a cooling tower at £2,170. There were 11 tenders.

Venner & Co. have received an order from the North Metropolitan Electric Power Supply Co. for 120 C type time switches for the street lighting of Tottenham.

Croydon Corporation have accepted the tender of Babcock & Wilcox, at £530, for mechanical stokers, and that of Casperd & Co., at £151, for wiring the Scarbrook-road swimming bath.

Belfast Corporation have accepted the tender of W. Lucy & Co. for house service cutouts, and that of the British Insulated & Helsby Cables for trolley wire.

Ilford Council have accepted the tender of Cole, Marchent & Morley for surface condensing plant and cooling tower, and that of John Spencer (Ltd.) for steam and feed pipes, boiler feed pump, &c.

Wandsworth (London) Council have accepted the tender of H. J. Whitehead for extensions of the electric lighting installation at the Town Hall.

The D.P. Battery Co. have received an order for the renewal of the Cottesloe (W. Australia) central station battery, with their W.L.9 type of cell.

Hull Electricity committee have placed an order with Thos. Parker (Ltd.) for four transformers.

Leyton Council have accepted the tender of E. H. Grimshaw & Son for wiring work.

The D.P. Battery Co. have secured the order for supply of a battery of L.15 cells at Chipping Norton.

Electric Pumping.—Messrs. D. Balfour & Son, of Newcastle-on-Tyne and London, are preparing plans for Doncaster Rural Council for an additional pumping station for the sewerage of Bentley-with-Arksey and Rostholme. Besides the laying of sewers and the construction of storage tank, the work includes engine house equipment (including electric motors and pumps).

BUSINESS NOTICES.

Messrs. E. P. Allam & Co. announce that, owing to the increasing demand for their Premier patent motor-starting switches, regulators, controllers, &c., it became necessary to extend the scope of the business and a private limited liability company has been formed under the title of the Premier Electric Control (Ltd.), which has acquired the manufacturing side of the firm's business. Arrangements are being made for a speedy removal to new works. The electrical contracting department will continue to be conducted by Mr. Allam as E. P. Allam & Co.

It is announced that the connection hitherto existing between Messrs. Schiff & Co. and Messrs. H. G. Mayer & Co. has been dissolved by mutual consent. Orders or letters intended for, or remittances due to Messrs. Schiff & Co. should be sent to 67, Aldersgate-street, London, E.C., where the business will be continued. It is also notified that the business in England will shortly be known as "Ship Carbons (Ltd.)."

Association Cables Discounts.—W. T. Henley's Telegraph Works Co. announce that the prices given in their list dated March, 1907, for Association grade cables, wires and flexibles, will be subject, until further notice, to discounts of 20, 15 and 10 per cent. The reduced prices will apply to all orders received after 1st inst.

Annual Holidays.—The Works of Messrs. Mountain & Gibson (Ltd.), Elton Fold Works, Bury, Lancs., will be closed from Friday evening, Aug. 7, till Monday morning, Aug. 17, and no goods will be received or dispatched between these dates. A small staff will be in attendance to deal with important and urgent matters.

Sale by Tender.—By direction of the liquidator of Reed's Electrical Co., Ltd. (in liquidation), the whole of the stock and effects are offered for sale by private tender. The stock includes a large number of lamps of various voltages, several electric motors from ⅙ H.P. to 5 H.P., desk fans, fan motors, electrical accessories, &c. The whole or any portion may be tendered for, but preference will be given to tenders for the whole. Tenders to the liquidator (Mr. Daniel S. Fripp, C.A.), 90, Cannon-street, London, E.C., by 11 a.m. 17th inst. Further particulars, forms of tender, &c., from the liquidator, or from Messrs. Maxwell & Dampney, solicitors, 41, Bishopsgate-street Within, London, E.C. See also an advertisement.

Provisional Order for Sale.—The Town Council of a borough within 60 miles of London and with a population of about 6,000 are prepared to dispose of their provisional electric lighting order. Further particulars from Messrs. Andrew Wood, Purves & Sutton, solicitors, 8 and 9, Gt. James-street, London, W.C.

Dynamo Wanted.—An advertiser wants a second-hand dynamo to give 250 kw. to 300 kw. at about 340 revs. per min., but if possible to safely run to 700 revs. per min.

Partner Wanted.—A partner is wanted in a small electrical manufacturing business, to bring in at least £2,000 for developing several patents. See an advertisement.

Patents Development.—Messrs. Herbert Haddon & Co., 31 and 32, Bedford-street, Strand, London, W.C., have a number of important English patents of which the owners are desirous of arranging, by licence or otherwise, for the manufacture and commercial development of the inventions in this country.

Messrs. Haseltine, Lake & Co., 7 and 8, Southampton-buildings, London, W.C., have patents relating to "Apparatus for Wireless Telegraphy or Telephony," the proprietors of which are desirous of entering into arrangements, by way of licence or otherwise, for exploiting same in this country.

The proprietor of letters patent No. 23,491/1902, relating to "Magnetic Wheels," desires to dispose of the patent or to grant licences. Inquiries to Messrs. Cruikshank & Fairweather (Ltd.), International Patent Agency, 65 and 66, Chancery-lane, London, W.C.

The owner of patent No. 11,058/1906, relating to "Improvements in Electric Circuit-breakers," wishes to negotiate with electrical engineers with the view of granting licences thereunder. Information from Messrs. Lloyd Wise & Co., 46, Lincoln's Inn-fields, London, W.C.

The owners of patents Nos. 1,919, 1,920 and 1,921 of 1905, relating to "Dynamo-electric Machines," are prepared to sell the patents or to grant licences thereunder. Applications to Mr. Philip M. Justice, 55, Chancery lane, London, W.C.

CATALOGUES, &c.

G. E. C. Instruments.—The accuracy of modern electrical instruments is a noticeable feature of specialised methods in this branch of manufacture; the great variety of instruments available must also strike the casual observer. A glance at the latest catalogue of the General Electric Co. will impress the reader with the importance of electrical instruments. The main portion of the list is devoted to "Stanley" and "Stanley D'Arsonval" instruments for switchboard and portable use. Another important section is that devoted to Aron motor and clock meters, both of which are well known in the electricity supply business. The list is got up in the usual G. E. C. size and style, and will prove a welcome addition to the company's comprehensive series of publications.

"Excello" Arcs.—There is much virtue in the mail card as a means of keeping a trade name well to the front. This has been recognised by the Union Electric Co., who are issuing a somewhat novel card dealing with Excello arc lamps. On the front, next the address, is a written reminder of the good points of the lamp, and on the back is a coloured design showing graphically the attractive power of the lamp, for round the globe is a small shoal of moths. The card itself would prove attractive in a window and is stiff enough to survive mail transit.

Cooking Outfits.—A pamphlet illustrating and briefly describing the Archer system of electric cooking apparatus reaches us from the General Electric Co. The outfit comprises an oven, large and small saucepans and hot-plate. The aggregate energy consumption of these utensils is 4¾ units, which at 1d. per unit would represent the cost of cooking a dinner for eight persons. It is possible to do roasting, baking, stewing and boiling with the outfit, and the total cost is just under £20.

Electrolytic Valves.—Siemens Bros. & Co. send us a new supplement to their catalogue of electromedical apparatus. This describes an electrolytic valve for rectifying alternating currents, while the apparatus is standardised for the application of the valve to X-ray work, high-frequency work, accumulator charging, electroplating, &c. The construction and use of the valve are very fully described and illustrated.

Cables.—A comprehensive cable list just issued by Johnson & Phillips deals with practically every class of cable manufactured. It will be sent on request to interested inquirers.

Small Motors.—The small motor is not exploited to the extent it might be by station engineers to users of electrical energy generally. A list just published by the Electrical Co. gives full details of a line of small motors and dynamos which should be useful to all small power users.

"Ediswan" Fittings.—The latest Ediswan leaflet (F. 2,127) describes and illustrates a line of special fittings suitable for use outside shops. Three lights can be fitted in the globes, so that by using high candle-power metal filament lamps the fittings will replace small arcs outside shops and in other exposed positions, &c.

Suction Gas Plants.—A fully illustrated catalogue of gas engines and suction gas plant is being sent out by Kynoch Limited, Witton, Birmingham

Electrical Accessories.—Messrs. Ward & Goldstone, Manchester, are issuing a complete catalogue of their accessories, which will be found useful by all contractors, wiremen, &c.

BANKRUPTCIES, LIQUIDATIONS, &c.

Mr. Paul J. Mallmann, engineer, has obtained his discharge, subject to judgment being signed for £1,000 against him.

Liabilities ranking for dividend were returned at £16,292 5s 11d., assets estimated at £573 11s 1d net. The trustee reported the lodgment of proofs amounting to £11,[illegible] 14s 4d, of which £1,300 6s 3d had been actually admitted, and probable claims amounted to £5,000. Nothing had been realised in respect of the estate, but there was a probability of £75 being recovered. Bankrupt came to England in 1900 with about £50 capital. For two years he travelled the country as agent for a number of German engineering firms. Bankrupt attributed his failure to losses in connection with processes for the manufacture of steel which he owned and to failure of negotiations for the formation of a company to work same.

Mr. HANSELL (for debtor) pointed out that the process was a valuable one. Nine-tenths of the creditors had been willing to accept shares in a proposed company in satisfaction of their debts; but as soon as there was a hint of bankruptcy the contracts fell through.

The liquidator (Mr. Wm. MacConnal) in the winding up of Patent Exploitation (Ltd.) has been released.

Dolter Electric Traction (Ltd.) is being wound up voluntarily, Mr. W. S. Ogle, 90, Cannon-street, London, E.C., is liquidator.

The Commercial Electro-Chemical Analysis Co. (Ltd.) is being wound up voluntarily, Mr. A. C. Roberts, 9 and 10, Pancras-lane, London, E.C., is liquidator.

PATENT RECORD.

APPLICATIONS FOR PATENTS.

NOTE.—*The undermentioned Applications (except those marked †) are not open to public inspection until after acceptance of Complete Specifications. Those marked † are open for inspection 12 months after the date attached to them, if they have not been published previously in the ordinary course. Names within parentheses are those of communicators of inventions. When Complete Specification accompanies application, an asterisk is affixed.*

March 30, 1908.

6.972 FENNELL & PERRY. System of electric wiring.
6.973 FENNELL & PERRY. Accumulators.
6.974 FENNELL & PERRY. Lamp holders.
6.999 BAKER & HUGHES. Accumulators.
7.002 COHEN & COHEN (trading as CITY IGNITION CO.). Induction coils.
7.009 DREWELL. Connection for closing an optional branch of a frequently branched circuit.*
7.014 ZAHRINGER. Magneto-electric ignition apparatus.*
7.028 SCHIESSLER. Apparatus for alternative wireless telegraphy and telephony. (Application for patent of addition to No. 1848/08.)*
7.041 RUHMER. Powerful interrupted impulses of high frequency. (Date applied for, 8/1/07. Comprised in No. 539, dated 8/1/07.)*
7.045 NOEGGERATH. Dynamo-electric machines. (Date applied for, 1/4/07.)*†

March 31, 1908.

7.048 STATTER. Time element devices.
7.077 BEVIS & ANGOLD. Arc lamps. (Date applied for, 5/4/07. Comprised in No. 7941, dated 5/4/07.)
7.118 WARWICK MACHINERY CO. (A.E.G., Germany.) Turbine and like wheels.
7.119 B.T.-H. Co. (G.E. Co., U.S.) Dynamo electric machines.

April 1, 1908.

7.169 GARDNER. Telephone and telegraph systems.
7.188 NATHUSIUS & WESTDEUTSCHE THOMASPHOSPHATWERKE G.M.B.H. Electric furnaces.*
7.219 ADAMIAN. Electrically controlled apparatus for seeing at a distance.*
7.223 POHL, STATTER, & PHOENIX DYNAMO MFG. CO. Motor-generator sets for controlling electric supply.
7.231 BRUSH ELECTRICAL ENGINEERING CO., & ACLAND. Tramway and like trucks.*
7.233 LAKE. (Electrelle Co., U.S.) Automatic musical instrument players.*

April 2, 1908.

7.261 GLEW. Electric timing and recording devices.
7.289 SIEMENS SCHUCKERTWERKE G.M.B.H. Regulation of alternating current commutator machines. (Date applied for, 2/4/07.)*†
7.327 B.T.-H. Co., & CLOUGH. Dynamo electric machines.*
7.328 ALLGEMEINE ELEKTRICITÄTS GES. Arc lamps. (Date applied for, 2/8/07.)*†
7.335 JACKSON. Electric motor control systems.
7.337 FELGATE. Non corroding terminal for accumulators and the like.

April 3, 1908.

7.382 ELECTRIC & ORDNANCE ACCESSORIES CO., HALL, & MUELLER. Electromagnetic circuit breakers for use in motor controllers.
7.398 EVERSHED & VIGNOLES, & EVERSHED. Apparatus for measuring electrical resistance.
7.409 RORKE & RORKE. Switches.
7.431 B.T.-H. Co. (G.E. Co., U.S.) Electric traction and like systems.

April 4, 1908.

7.480 SIEMENS & HALSKE A.-G. Testing electrolytic valve cells or the like. (Date applied for, 4/4/07.)*†
7.490 HORN. Fixing of insulators to the arms of poles.
7.492 FESSENDEN. Telephone transmitters or relays. (Date applied for, 5/4/07.)*†
7.494 FESSENDEN. Wireless signalling. (Date applied for, 5/4/07.)*†
7.507 OERLEY & DEPREZ. Electrically heated tools. (Date applied for, 6/4/07.)*†

SPECIFICATIONS PUBLISHED.

1907 SPECIFICATIONS.

1,596 PARK & MASON. Electric switches specially applicable to railway vehicles.
4,813 HAYDON & WILLIAMS. Dynamo-electric transmission of power.
6,855 WARWICK MACHINERY CO. (G.E. Co., U.S.) Governing mechanism for prime movers.
6,932 FOSTER & SPOOR. Electric igniting apparatus.
7,555 HANDCOCK, DYKES & SMITH. Electrical wiring.
7,556 & 7,557 HANDCOCK, DYKES & SMITH. Boxes for electric wiring.
7,563 FRIEDHEIM. Electro-deposition of metal on hollow articles. (Date applied for, 30/3/06.)
7,642 LAKE (Parker Clark Electric Co.). Filaments for incandescent lamps.
7,712 LAKE (Ingersoll Rand Co.). Electro-pneumatic track channelers.
7,926 HATFIELD & LEWIS. Arc Lamps.
8,020 B.T.-H. Co. (G.E. Co., U.S.) Electric motor control.
8,036 CRAIG. Electrodes for the evolution of ozone from oxygen or atmospheric air.
8,153 B.T.-H. Co. (G.E. Co. U.S.). Electric motor control systems.
8,388 B.T.-H. Co. (G.E. Co., U.S.) Systems of lighting by arc lamps.
8,629 HUMAN. Utilisation of electrical energy in the case of intermittent or suddenly changing loads.
9,270 CUMMINS. Automatic electromagnetic sanding gear and foot sanding gear.
10,071 B.T.-H. Co. (G.E. Co., U.S.). Supports for filaments of incandescent lamps.
11,022 HIRST & LEOSCHER. Lightning arresters.
11,854 GIBBONS. Telemotor apparatus.
13,044 WEBB. Insulators for telegraph, telephone, and like wires.
14,101 B.T.-H. Co. (A.E.G., Germany). Control of winding gear.
17,147 SOUTHAM. Electrically-operated fountains. (Date applied for 4/8/06.)
17,783 MEYER. Electromagnetic reversing coupling.
17,972 SIEMENS & HALSKE A.-G. Incandescent lamps having filaments made from a plastic mass. (Date applied for, 28/8/06.)
18,406 EWART. Switches.
19,027 CHAUMAT. Electrolytic process for the preparation of indigo dyes. (Date applied for, 28/8/06.)
19,975 SIEMENS BROS. & Co. (Siemens & Halske A.-G.). Apparatus actuated by the passage of trains to control railway points or signals.
21,104 FLETCHER. Magazine fuses for electric light and power circuit.
21,623 MOLLER. Electric striking mechanism for time-pieces.
22,745 SIEMENS BROS. & Co. (Siemens & Halske A.-G.). Telephone exchanges.
24,135 ALLGEMEINE ELEKTRICTATS-GES. Alternating current commutating machines. (Date applied for, 1/11/06.)
24,769 WOLHAUPTER. Insulated railway rail joints. (Date applied for, 8/11/06.)
24,802 TIMAR & VON DREGER. Transforming electric currents.
25,126 COWPER-COLES. Apparatus for the electro-deposition of metals.
25,832 WOLHAUPTER. Insulated railway rail joint.
25,833 WOLHAUPTER. Insulated railway rail joint. (Date applied for, 6/12/06.)
26,081 MEYERLING. Electricity meter for direct current having a permanent magnet and an armature oscillatory in the field thereof. (Date applied for, 23/11/06.)
26,531 GES. FUR DRAHTLOSE TELEGRAPHIE. Receiver for wireless telegraphy. (Date applied for, 3/12/06.)
26,647 PALMER. Electric alarm clocks.
26,925 UNTERBERG & HELMLE. Method of ensuring insulation of high tension magneto sparking apparatus.
27,232 MEYERLING. Ampere-hour meter with an armature rotating in the field of a permanent magnet. (Date applied for, 19/4/07.)
27,400 RAWLINGS & SMITH. Electrical box couplings.
28,212 HOFFE & JELFS. Electrical locking-apparatus for railway signals.
28,425 ALLGEMEINE ELEKTRICITÄTS GES. Electric measuring instruments. (Date applied for, 2/1/07.)
28,542 HIORTH. Electrical induction furnace. (Date applied for, 4/1/07.)

1908 SPECIFICATIONS.

79 KRYLOFF & SCHIMUNEK. Electromagnetic apparatus for determining the hardness of para-magnetic metals.
220 NICHOLSON. Selective electric signalling.
324 CHRISTIAN. Electrically-heated hot water bottles. (Date applied for, 8/1/07.
328 LERTOURNE. Electric motors. (Date applied for, 10/1/1907.)
549 TRUMPLER. Electrical heating apparatus. (Date applied for, 1/2/07.)
660 ALLGEMEINE ELEKTRICITÄTS GES. Multiple-rate electricity meters. (Date applied for, 11/1/07.)
897 BOSCH (firm of). Testing installation for electromagnetically-operated sparking plugs. (Date applied for, 22/3/07.)
468 SIEMENS BROS. DYNAMO WORKS. (Siemens Schuckertwerke Ges.) Maximum demand electricity meters.
1,333 NICHOLSON. Telephonic receivers.
6,228 GROB. Producing a constant booster voltage with variable speed.
6,323 STEINERT & STEIN. Apparatus for electromagnetic treatment.
6,432 KINSELLA & HODGETTS. Electrical alarms for tramcars.

COMPANIES' MEETINGS AND REPORTS.

Anglo-American Telegraph Co. (Ltd.).

The half-yearly meeting was held on Friday last, Mr. FRANCIS A. BEVAN presiding.

The SECRETARY (Mr. T. H. Wells) read the notice convening the meeting and the auditors' report.

The CHAIRMAN said: Gentlemen, there has been during the last half-year a decrease in our receipts amounting to £15,000 compared with the corresponding half of last year. I do not think we should be much surprised at this, seeing how very slack business has been, and that we have not yet recovered from the effect of the American crisis of last year. There is little doubt, I think, that over there they cannot give themselves thoroughly to business until the very important matter of the election of a new President for the United States is decided. We hope that when this matter is settled we shall see a revival of business. Now, although our ordinary receipts have decreased, there was an increase in receipts to the amount of £6,400 from the "Minia." The net result is that our receipts were £8,650 less. I think, perhaps, I ought to add that we do not think that decrease is in any marked manner owing to the operation of wireless telegraphy. I mention this because a question might be asked on that point. The effect of wireless telegraphy, so far as I can see, has been very little indeed upon us. They may have taken a little business from us at Montreal, but it is so little that I do not think it has really had much effect upon our receipts. On the other side of the accounts there has been a slight decrease in working expenses of £1,460, chiefly owing to our not having to charter a ship, as we did last year, for the renewal and repair of cables. But, on the other hand, we have had to carry £10,000 to renewal fund, so as to gradually make up that fund to the £1,000,000 agreed upon. Therefore, we have had to debit ourselves with £8,540 more. These two items make about £17,000, which shows you the difference in the carry forward this year compared with last year, £7,000, against £24,000. I am glad to inform the shareholders that we have completed the renewal of our short ends at this side, running out 60 miles to 200 miles on the west coast of Ireland, and during the last two years, during which time we have been carrying out these operations, we have had no damage from trawlers. We believe this has been the case with our cables at the shore end, because they are now so strong that trawlers cannot inflict the injury upon them that they used to do, but it would be premature to say they cannot damage our cables, for their heavy nets can now be let down to a depth of 300 fathoms, and we believe that they are making them still more powerful, and that they will be able to let the nets down to 500 fathoms. Attention has been called by this company, and by the Commercial Company to this, and in deference to our remonstrances a Departmental Committee of the Government is considering this matter. Now what the result may be I cannot say, because the committee has not yet reported. It is a rather difficult matter, the sea being free to everyone, but we have suggested that steps might be taken by the Government to warn ships off just the particular line or zone along which our cables are laid, and to enforce this warning a gunboat or a Government steamer might cruise about. I cannot say whether the Government are likely to carry out our wishes, but considering the enormous importance of obtaining and retaining uninterrupted communication between this country and the United States, I do think the Government ought to do something to help the cable companies (hear, hear). We have had many breaks on the other side, which have occurred, we believe, from the same causes, and if only the Government here will do something, then we might make representations to the Canadian and the United States Governments, and ask them to follow suit. The only other matter I need allude to is to tell you that our new building in Old Broad-street is nearly completed. We have already spent £43,000 on the purchase and erection of that building, and we shall have to spend, perhaps, something under £7,000 more. We shall have a good property, fitted with the latest appliances, and I believe it will be in every way suitable for our purposes. I now move the adoption of the report and accounts.

Sir GERALD FITZGERALD, K.C.M.G., seconded the motion, which was carried unanimously.

Votes of thanks to the chairman, directors and staff were passed, and the meeting terminated.

BAKER STREET & WATERLOO RAILWAY CO.—Gross receipts for the half-year to June 30 amounted to £83,529, an increase of £20,077 (31·64 per cent.) over the corresponding half of 1907. Working expenses were £45,453, increase £3,325 (7·89 per cent.) After providing for interest, &c., and for 4 per cent. preference dividend (and crediting net revenue with £2,142. 5s. 8d. receivable from the Underground Electric Railways Co. of London) there remains £9,835. The directors recommend a dividend at the rate of ¾ per cent. on the ordinary shares and an additional dividend at the rate of 2¼ per cent. (making 3 per cent. per annum) on the ordinary shares other than those held by the Underground Company or their nominees. 12,940,801 passengers (including workmen and season ticket holders) were carried (against 9,936,995). Passenger receipts were £79,869 (1·48d. per passenger) against £61,501 (1·49d.), and train mileage was 522,406 (against 468,460).

BLACKPOOL & FLEETWOOD TRAMROAD CO.—Including the balance from last half-year, the profit for the half-year ended June 30 (after providing for debenture interest) is £3,662. 7s. 11d., and the directors

recommend a dividend at the rate of 4 per cent., absorbing £3,000, and writing off £500 to depreciation. The number of passengers carried during the half-year was 899,346, receipts from all sources being £11,042. 2s. 10d.

BRITISH THOMSON-HOUSTON CO. (LTD.)—At the meeting on Thursday last Mr. J. F. Nauheim said the accounts were distinctly better than last year, and amounted to £98,000 against £50,000. The increase was due to improved methods of manufacture and strict economy. The directors had reduced their indebtedness by purchasing debentures to the extent of £3,560, and had also written off excess cost incident to the establishment of the manufacturing business by £6,707, leaving £10,000 to be written off. The company had now acquired all the outstanding interest in the patents of the Curtis steam turbine.

CENTRAL LONDON RAILWAY CO.—At the meeting yesterday (Thursday) Sir Hy. Oakley said the company had had no very serious trouble during the past half-year. The undertaking had been completed by the construction of a loop at Shepherd's Bush, and a station had been constructed opposite the Franco-British Exhibition. During the first four months of the half-year there was a decrease of 1,034,000 passengers, and it was no doubt due to loss of traffic for distances over which passengers were carried for a penny by motor and other omnibuses. At the opening of the exhibition, however, new life appeared on the line, and in six weeks they had 676,000 more passengers than in the corresponding period last year. Through bookings had been developed during the past year, and in the half-year alone they carried 2,296,000 through passengers. They were reluctant to abandon the twopenny universal fare, but the extra penny on the former fares had compensated them by nearly £12,000, and the earnings had increased by £3,761. He understood the promoters of the exhibition were trying to arrange for its continuance next year.

CHARING CROSS, EUSTON & HAMPSTEAD RAILWAY CO.—Gross receipts for the half-year ended June were £88,883, and working expenses £55,493. After providing for interest, &c., there remains £832. 16s. 4d. to be carried forward. 12,132,639 passengers (including season ticket holders) were carried, against 9,881,357 in the December half-year.

GREAT NORTHERN & CITY RAILWAY CO.—At the meeting on Wednesday the Earl of Lauderdale referred to the serious falling off in revenue and passengers during the past half-year, due mainly, he urged, to the severe competition of London County Council electric tramways and in some degree to the alteration of certain fares, as from Nov. 1 last. The additional revenue from increased fares had compensated to a great extent for the heavy loss in passengers. Out of the total decrease of 1,363,105 in local bookings, over 1,000,000 was for 1d. distances. The board had done their best to meet the competition by speeding up the trains. Referring to the recent fire at the Moorgate station of the City & South London Railway he said that it was hard to find anything on their system that was combustible. Their station platforms, signal boxes and the whole equipment were practically fireproof. Their later carriages were all constructed of steel, while their older carriages had been rendered fireproof by careful insulation of all electric cables.

GREAT NORTHERN, PICCADILLY & BROMPTON RAILWAY CO.—Gross receipts for the half year ended June amounted to £147,764, an increase of £41,193 (38·65 per cent.) on the corresponding half of 1907. Working expenses were £74,984, a decrease of £811 (1·07 per cent.). After providing for interest, &c., and for preference dividend there remains £22,476. The directors recommend a dividend at the rate of ¾ per cent. on the ordinary shares. 17,446,477 passengers (including workmen and season ticket holders) were carried (against 11,953,759) the train mileage was 956,933 (against 919,884), and the passenger receipts £142,111 (1·95d. per passenger) against £102,836 (2·06d.).

LIVERPOOL OVERHEAD RAILWAY CO.—Gross revenue receipts for the half-year ended June 30 were £37,868. 7s. 4d. and working expenses £30,511. 0s. 8d. Passengers carried were 5,367,286, against 5,804,629 in the December and 5,423,595 in the June half of 1907. The falling off in traffic is attributable to the shrinkage in trade and the considerable number of steamers laid up. The railway has been carefully maintained, and the train service has been worked satisfactorily. The balance available for dividend is £7,206. 16s. 9d., and the directors recommend a dividend of 5 per cent. per annum on the 1892 preference shares (less tax), leaving £4,206. 16s. 9d. to be carried forward.

METROPOLITAN DISTRICT RAILWAY CO.—The report for the half-year ended June states that the gross receipts were £247,900, increase £27,272 compared with the corresponding half of 1907. Working expenses were £154,829, increase £10,893. After providing for interest, &c., there was a deficit of £8,951, added to £10,937, proportion of net revenue arising from the City lines joint undertaking total of £19,889, compared with £28,191 in 1907. The passengers (including workmen and season ticket holders) were 29,626,586, increase 4,199,761. The average receipt per passenger was 1·76d., decrease 0·05d., and the train mileage was 1,449,347, increase 269,604.

METROPOLITAN RAILWAY CO.—Sir Charles MacLaren, Bart., M.P., stated at the meeting last week that passenger traffic showed an increase of £5,080. There was a decrease in all classes of passengers due to several causes. There were more season tickets issued, and there was also the increase in their fares made in conjunction with the Central London Railway a year ago. The latter cause had somewhat augmented their receipts, but it had diminished the number of passengers. Omnibus and tube competition would not affect them in future. The receipts per passenger had grown from 1·392d. to 1·453d. Under present conditions it was impossible to contemplate extensions under capital account, and orders for railway materials and engineering products were being withheld because the state of the net revenue account of so many companies did not warrant the issue of further capital. The depression in the steel and engineering trades was largely due to the condition of things to which he was referring and the trading interests of the country were being thereby injuriously affected. They proposed to pay a dividend on the ordinary stock at the rate of 10s. per cent.

The work of installing automatic signalling was proceeding rapidly, and when the whole system is completed during the current half-year the earning power of the line will be considerably enhanced, by reason of their being able to get so many more trains per hour.

NEW COMPANIES, MORTGAGES AND CHARGES.

NEW COMPANIES.

FOREIGN & COLONIAL LIGHTING CO. (LTD.) (99,020.)—Reg. July 29, capital £30,000 in £1 shares to carry on the business of engineers, producers of electric light or power, &c. Reg. office, 58, Finsbury-pavement, London, E.C.

NEWCASTLE-EMLYN & DISTRICT ELECTRIC SUPPLY CO. (LTD.) (99,027.)—Reg. £2,000 in £1 shares, to generate, develop and accumulate electrical power derivable from the falls of the River Tivy, and to carry on in Newcastle-Emlyn and adjoining districts the business of an electric light and power company.

YORKSHIRE CABLE CO. (LTD.) (99,015.)—Reg. July 28, capital £5,000 in £1 shares, to carry on the business of electricians, engineers, contractors and manufacturers or producers and workers of and dealers in electricity, electric wires, cables, dynamo and instrument wires, &c. First directors, R. R. Stell, W. J. Stell and W. J. Stork.

MORTGAGES AND CHARGES.

NORFOLK ELECTRICAL CO. (LTD.)—Particulars of £1,000 debentures created by resolution of June 13, 1908, have been filed pursuant to sec. 10 (3) of the Companies' Act, 1907, the whole amount being now issued. Property charged: Company's undertaking and property, present and future, including uncalled capital. No trustees.

SWITCHGEAR CO. (LTD.)—Second debenture dated July 7, 1908, to secure £2,000 charged on company's property, present and future, including uncalled capital, has been registered. Holders, Cowans Limited.

CITY NOTES.

MEMORANDA (Aug. 6).—Bank rate 2½ per cent. (since May 28, 1908) Price of silver, 24 3/16d. per oz. Consols 86⅜—86½ for money and 86½—86⅝ account. Consols Pay Day, Sept. 1; Stock and Shares Continuation Days, Aug. 11 and 25; Ticket Days, Aug. 12 and 26; Pay Days, Aug. 13 and 27; Mining Share carry-over Day, Aug. 10.

Prices of Metals (London).—*Copper*, cash, 60 13/16—61 3/16; three months, 61¾—62. *Lead*, English, 14¼; foreign, 13⅝—13⅞. *Spelter*, foreign, 19—19½. *Tin*, English, 138—139; foreign, cash, 138⅝—139⅛, three months, 139⅞—140⅛. *Iron*, Cleveland, cash, 51/1—51/3; three months, 49/11—50/-.

CALCUTTA ELECTRIC SUPPLY CORPN. (LTD.)—During the four weeks ended June 26, 561,055 units were delivered to consumers, compared with 490,743 units in the corresponding period of 1906.

CHARING CROSS, WEST END & CITY ELECTRICITY SUPPLY CO. (LTD.) This company has declared an interim dividend at the rate of 5 per cent. per annum on the ordinary shares of the West End undertaking, and increased the carry forward in the case of this undertaking to £4,748, and in the case of the City undertaking to £4,591. The figures for the half-year ended June 30, compared with the corresponding period of last year (excluding bulk supply from one undertaking to the other) are:—*West End*—5,509,773 units sold (against 5,098,880 in 1907), revenue £68,237 (against £65,093). *City*—4,792,333 units sold (against 4,234,389), revenue £50,114 (against £46,372).

DUBLIN & LUCAN ELECTRIC RAILWAY CO.—The report for the half-year ended June states that after providing for interest there is available £868. 9s. 2d., and the directors recommend payment of the half-year's preference dividend, £393. 9s. 2d. being carried forward.

W. T. HENLEY'S TELEGRAPH WORKS CO. (LTD.)—The directors have declared an interim dividend on the preference shares at the rate of 4½ per cent. per annum, and on the ordinary shares at the rate of 10 per cent. per annum for the half-year ended June 30, both less tax, payable Sept. 1.

KENSINGTON & KNIGHTSBRIDGE ELECTRIC LIGHTING CO. (LTD.) The directors have declared an interim dividend at the rate of 8 per cent. per annum (4s. per share), less tax, on the ordinary shares for the past half-year.

LIVERPOOL & DISTRICT LIGHTING CO. (LTD.)—The directors have declared an interim dividend at the rate of 5 per cent. for the half-year ended June 30.

LONDON, BRIGHTON & SOUTH COAST RAILWAY CO.—The Earl of Bessborough on Wednesday said that, with regard to their suburban traffic, the electrification of the South London lines was proceeding rapidly, and the experimental running between Peckham Rye and Battersea Park would be commenced before the end of the current half year.

ELECTRIC TRAMWAY AND RAILWAY TRAFFIC RECEIPTS.

Line	Week ended.	Amount.	Inc. or Dec. (a)	Aggregate: No. of weeks.	Aggregate: Amount.	Aggregate: Inc. or Dec. (a)
		£	£		£	£
Aberdeen Corporation	July 29	2,112	+ 584	9	13,681	− 47
Airdrie	„ 24	205	+ 28	29	6,554	+ 109
Anglo-Argentine	„ 29	23,305	+ 7,168	30	575,8 1	+ 81,704
Ayr Corporation	Aug. 1	526	+ 105	11	4,502	− 164
Baker St. & Waterloo Ry.	„ 1	2,720	+ 450	5	14,800	+ 2,385
Barnsley	July 24	183	+ 15	29	5,074	+ 321
Barrow	„ 24	234	− 49	29	6,977	− 215
Bath Electric Trams, Ltd.	„ 29	895	+ 5	30	21,272	− 1,392
Birkenhead Corporation	Aug. 2	1,108	− 21	5	5,628	+ 45
Birmingham Corporation	„ 1	6,326	+ 192	18	113,279	+ 5,533
Birmingham & Mid.	July 17	829	− 16	28	23,169	+ 939
Blackburn Corporation	„ 29	1,162	+ 56	§18	21,283	+ 1,130
Blackpool Corporation	„ 30	1,954	− 38	§17	20,395	+ 839
Blackpool and Fleetwood	Aug. 1	1,297	− 23	5	3,704	+ 59
Bolton Corporation	„ 2	2,500	− 364	18	42,979	+ 1,279
Bombay	July 9	R31,623	+ R2,822	27	R970,630	+ R190,150
Bournemouth Corporation.	„ 29	1,879	− 324	17	28,462	− 1,505
Bradford Corporation	...	...	...	..	...	...
Brighton Corporation	Aug. 2	1,244	+ 138	18	16,427	+ 294
Bristol Trams & Carriage	July 31	5,576	+ 265	36	150,351	+ 1,211
Burnley Corporation	Aug. 1	1,419	− 42	18	22,094	+ 1,033
Burton Corporation	„ 2	309	− 14	18	4,937	− 373
Bury Corporation	„ 2	1,260	+ 112	‡18	21,832	+ 1,504
Calcutta Tramways Co.	„ 1	R45,968	− R626	5	R228,196	− R8,834
Cardiff Corporation	July 25	2,335	+ 90	17	37,247	− 843
Cavehill	„ 24	112	− 14	29	2,611	+ 129
Central London Railway	Aug. 1	6,504	+ 1,676	5	36,310	+ 9,691
Charing C., Euston & H'stead	„ 1	3,109	+ 825	5	16,400	+ 3,560
Chatham & Dist. Lt. Rys.	July 30	936	+ 162	§20	22,234	+ 653
City & South London Rly.	Aug. 2	2,548	− 64	5	14,567	− 1,109
City of Birmingham	July 24	2,765	− 62	29	81,166	+ 135
Colchester Corporation	„ 29	237	+ 2	4	917	− 31
Cork Electric Trams Co.	„ 30	514	− 33	30	13,623	− 530
Croydon Corporation	„ 31	1,546	+ 74	18	286,149	+ 225
Devonport & Dist. Trams	„ 24	460	− 40	29	13,081	− 85
Dover Corporation	Aug. 1	336	+ 56	18	4,138	− 83
Dublin & Lucan Railway	July 31	161	+ 3	4	661	− 41
Dublin United	„ 31	5,820	− 1,340	¶14	25,564	− 7,164
Dudley-Stourbridge	„ 24	863	− 4	29	23,510	− 1,111
Dundee Corporation	„ 29	1,254	+ 246	‡11	13,394	+ 961
East Ham Council	Aug. 1	905	− 23	18	15,440	− 851
Exeter Corporation	July 31	371	− 8	18	5,669	− 146
Falkirk and District	„ 29	293	...	4	883	...
Gateshead & Dist. Trams	„ 24	1,021	+ 1	29	29,321	+ 289
Glasgow Corporation	Aug. 1	15,498	− 1,375	9	152,962	+ 1,040
Glossop	„ 1	127	− 8	31	4,816	− 253
Gravesend—Northfleet	July 24	230	− 45	29	6,017	− 579
Great Northern & City Rly.	Aug. 1	1,262	− 311	5	6,724	− 1,617
Gt. Northern, Piccadilly, &c	„ 1	4,815	+ 935	5	25,910	+ 5,020
Greenock & Port Glasgow	July 24	742	− 4	29	15,293	− 3,992
Hartlepool Tramways	„ 24	297	− 48	29	6,737	− 1,358
Hastings Elec. Trams Co.	„ 30	1,359	+ 55	5	5,921	− 548
Hong Kong	Aug 1	$7,789	− $308	..	...	...
Huddersfield Corpn.	...	...	...	...	...	...
Hull Corporation	„ 1	2,443	− 21	18	43,038	+ 112
Ilford District Council	...	...	...	...	...	...
Ilkeston District Council	July 29	155	+ 8	17	2,477	+ 56
Ipswich Corporation	Aug 1	507	+ 19	18	7,225	− 50
Isle of Thanet Co.	„ 1	1,459	+ 99	44	19,133	− 294
Jarrow	July 24	110	− 16	29	3,068	− 114
Keighley Corporation	„ 30	193	+ 21	4	751	+ 6
Kidderminster & District	„ 24	142	− 11	29	3,117	− 149
Kilmarnock Corporation	Aug. 1	243	+ 67	11	1,833	− 158
Lanarkshire Trams Co.	July 30	1,095	− 84	30	38,995	+ 3,752
Lancashire United	„ 29	1,396	+ 64	30	39,467	+ 2,015
Leamington	„ 24	220	+ 43	29	4,674	+ 286
Leeds Corporation	...	...	...	...	...	...
Leicester Corporation	Aug. 1	2,475	+ 123	5	11,872	+ 387
Leith Corporation	„ 1	587	+ 34	§11	6,485	...
Lincoln Corporation	„ 1	124	...	18	2,148	− 62
Liverpool Corporation	July 25	11,403	− 80	30	317,758	− 2,589
Liverpool Overhead Rly.	Aug. 2	1,481	− 176	5	7,350	− 1,132
London County Council	July 25	36,695	+ 5,188	†17	580,704	+ 63,047
London United	Aug. 1	8,342	+ 855	30	198,206	+ 3,574
Lowestoft	„ 3	437	+ 9	44	7,777	+ 157
Maidstone Corporation	„ 1	233	...	18	3,520	..
Manchester Corporation	„ 1	16,445	+ 1,450	18	272,916	+ 12,032
Mersey Railway	„ 1	1,855	+ 16	5	9,214	+ 36
Merthyr	July 24	225	+ 23	29	6,092	+ 74
Metropolitan Dist. Railway	Aug. 1	8,773	+ 1,484	5	45,773	+ 6,528
Metropolitan Elec. Trams	July 24	6,299	+ 1,138	29	161,153	+ 31,910
Middleton	„ 24	451	+ 32	29	10,529	+ 410
Nelson Corporation	Aug. 1	160	+ 5	¶17	2,583	− 135
Newcastle-on-Tyne Corp.	„ 1	3,851	− 260	18	70,647	− 4,623
Newport (Mon.)	„ 1	713	+ 10	18	12,256	− 818
Northampton Corporation	July 31	527	+ 74	¶17	8,389	+ 553
Oldham, Ashton & Hyde	„ 24	616	− 46	29	17,301	− 69
Oldham Corporation	Aug. 2	2,175	+ 129	19	37,663	+ 711
Perth (N.B.) Corporation	July 29	204	+ 13	11	1,774	− 100
Perth (W.A.) Elec. Trams	„ 31	1,278	− 49	¶31	43,092	− 814
Peterborough	„ 24	138	+ 7	29	3,603	+ 84
Portsmouth Corporation	Aug 1	2,631	+ 265	18	36,609	+ 306
Potteries	July 24	1,940	+ 59	23	53,232	− 371
Preston Corporation	„ 29	748	− 32	4	3,090	− 119
Rotherham Corporation	„ 20	624	+ 27	§17	10,671	+ 224
Rothesay	„ 24	1,053	+ 389	29	5,270	− 453
Salford Corporation	Aug. 3	5,379	+ 352	18	86,843	+ 1,019
Sheerness	July 22	62	− 6	29	1,593	− 14
Sheffield Corporation	Aug. 2	5,774	+ 133	†19	105,406	+ 165
Singapore Trams	„ 1	$3,726	− $371	5	$14,395	− $1,545
South Metropolitan	July 24	895	− 16	29	22,639	+ 578
South Staffs	„ 24	859	− 9	29	25,474	− 301
Southend Corporation	„ 29	631	+ 68	18	7,439	+ 522
Southport Tramways	„ 24	370	− 4	29	7,873	− 352
Stalybridge, Hyde, &c., Jt Bd.	Aug 1	876	+ 24	†18	14,352	− 161
Sunderland Corporation	„ 2	1,431	− 129	18	21,582	− 4,462
Sunderland and District	July 29	559	− 2	39	18,335	+ 1,393
Swansea Trams	„ 24	1,030	+ 17	29	26,608	+ 1,834
Taunton	„ 24	44	− 5	29	1,161	− 52
Tynemouth and District	„ 24	390	− 29	29	6,009	− 511
Tyneside Trams Co.	„ 29	415	− 17	4	1,717	− 180
Wallasey District Council	Aug. 1	1,030	+ 83	†18	16,311	+ 909
Walsall Corpn	„ 1	544	+ 16	31	16,350	+ 1,400
Warrington Corpn.	July 30	367	− 15	17	6,628	− 44
West Ham Corporation	„ 23	2,187	− 235	17	38,069	− 2,466
Weston-super-Mare	„ 22	318	− 11	29	2,344	− 58
Wolverhampton Co.	„ 24	441	+ 42	29	13,223	− 364
Wolverhampton Corpn.	„ 20	843	− 10	8	7,284	+ 311
Worcester	„ 24	314	− 1	29	7,879	+ 36
Wrexham	„ 24	115	− 2	29	2,923	+ 14
Yorkshire W.R. Trams	Aug 2	1,307	+ 87	31	37,235	...
Yorkshire Woollen District	July 24	949	− 284	29	26,418	− 1,411

(a) These comparisons are with the corresponding period last year. § Plus 2 days. ¶ Plus 3 days. * Partly electrical. † Minus 3 days. ‡ Minus 2 days.

ELECTRICAL COMPANIES' SHARE LIST.

Share	Last Dividend	Name.	Price Wed., Aug. 5.	Rate % Yielded. £ s. d.	Dividend Due.	Business Week to Aug. 5: Highest.	Business Week to Aug. 5: Lowest.
		ELECTRICITY SUPPLY.					
10	9 0	Bournemouth & Poole Elec. Sup. Ord.	10½−11	6 7 0	Mar, Sept,	—	..
10	4 6	Do. 4½ per Cent. Cum. Pref.	9¾−10⅛	4 7 0	Feb, Aug		.
10	6 0	Do. 6 per Cent. Cum. Second Pref.	10⅝−10⅞	5 11 6	Feb, Aug	10⅝	10½
St.	4½%	Do. 4½ per Cent. Deb. Stock (red.)	100−103	4 7 6	Jan, July	..	..
5	3 6	Bromley (Kent) El. Lt. & Power Shares	4½−5	5 10 0	April, Oct	..	..
St.	4½%	Do. Do. 1st Debs.	94−97	4 12 9	May, Nov	..	..
5	5 6	Brompton & Kensington Elec. Sup. Ord.	7−8	6 6 6	March....	..	..
5	3 6	Do. 7 per Cent. Pref.	6¾−7¾	4 10 0	Mar, Sept	..	..
St.	4%	Central Elec. Sup. Co. 4% Guar. Db. Stock	98−101	4 0 0	June, Dec	..	..
5	2 6	Charing Cross (W. End & City) El. Sup. Co.	3½−4	6 5 0	Feb, Aug	..	..
5	2 3	Do. 4½ per Cent. Pref.	4−4½	5 0 0	Feb, Aug	..	..
St.	4%	Do. 4 per Cent. Deb. Stock (red.)	94−97	4 2 6	Jan, July	..	..
5	2/3	Do. City Undertaking 4½% Cm. Pref.	3⅞−4⅛	5 11 0	Jan, July	..	..
5	2/6	Chelsea Electric Supply Ord.	3−3½	6 8 9	March ..	..	..
St.	4½%	* Do. 4½ per Cent. Deb. Stock (red.)	100−103	4 7 6	June, Dec	..	..
10	5/0	†City of London Electric Lighting Ord.	9¾−10¼	5 17 0	Feb, Aug	10	..
10	6/0	† Do. 6 per Cent. Cum. Pref.	12−13	4 13 0	Jan, July	12½	..
St.	5%	Do. 5 per Cent. Deb. Stock (red.)	122−125	4 0 0	June, Dec	..	..
St.	4½%	Do. 4½ per Cent. 2nd Deb. Stock (red.)	101−104	4 6 6	Jan, July	..	..
5	2%	County of Durham Elec. P.D. Ord.	2¾−3	3 9 7	April, Oct	..	..
5	5%	Do. 5 per Cent. non Cum. Pref.	3¾−4¼	6 5 0	April, Oct	..	..
10	4 0	†County of London Elec. Supply Ord.	7¼−8¼	5 17 0	Feb, Aug	8	7¾
10	6 0	† Do. 6 per Cent. Cum. Pref.	10¼−10¾	5 11 6	Mar, Sept	10¾	10
St.	4½%	Do. 4½% Deb. Stock (red.)	106−109	4 4 0	Jan, July	..	..
St.	4½%	Do. Second Deb. Stock	98−101	4 9 9	May, Nov	..	..
5	3 6	Folkestone Electricity Supply Co. Ord.	4¾−5¼	5 7 0	April, Oct	..	—
5	2 6	Do. 5 per Cent. Cum. Pref.	5−5½	4 11 0	Mar, Sept	..	..
St.	4½%	† Do. 4½ 1st Deb. Stock (red)	96−99	4 1[illegible] [illegible]	Feb, Aug	..	..
5	4/6	Hove Electric Lighting Ord.	6−6½	6 11 0	April, Oct	..	..
5	5/0	Kensington & Knightsbridge Ord.	8−9	5 11 0	Feb, Aug	..	..
5	6%	Do. 6 per Cent. 1st Pref.	6−6½	4 12 0	Jan, July	..	—
St.	4%	† Do. 4 per Cent. Deb. Stock (red.)	94−97	4 2 6	..	..	..
St.	4%	Kensingtn. & Kngtbg. Co. & Notting Hill Co. (Joint Station) 4% Deb. Stock (red.)	97−101	3 19 0	April, Oct	—	..
St.	4½%	Kent Elec. Power Co.	86−90	5 0 0	Jan, July	..	..
3	1/6	London Electric Supply Ord.	⅞−1⅛	5 8 0	Mar, Sept	..	..
5	3/0	Do. 6 per Cent. Pref.	4½−5	6 0 0	Mar, Sept	..	—
St.	4%	Do. 4 per Cent. 1st Mort. Deb.	89−92	4 7 [illegible]	Jan, July	..	..
5	2/6	†Metropolitan Electric Sup. Ord.	4¾−5¼	6 4 0	April, Oct	5[illegible]	..
5	2/3	Do. 4½ per Cent. Cum. Pref.	4⅜−4⅞	4 12 6	Jan, July	..	..
St.	4½%	Do. 4½ per Cent. Deb. Stock 1st Mort.	105−109	4 1 [illegible]	June, Dec	..	..
St.	3½%	Do. 3½ per Cent. Mrt. Deb. Stock (red.)	84−89	3 19 0	Jan, July	..	..
100	4½%	Midland Elec. Corp. for P.D. 1st Mort. Db.	94−97	4 12 6	June, Dec	..	—
10	4%	Newcastle & Dist. Elec. Ltg. Ord.	7½−8	5 3 2	Feb, Aug	..	—
100	4½%	Do. 4½ per Cent. Deb.	94−96	4 14 9	Jan, July	..	..
5	8%	Newcastle Elec. Supply Ord.	5⅛−5⅜	7 12 4	Feb, Aug	..	..
5	5%	Do. 5 per Cent. non Cum. Pref.	5¼−5¾	4 15 8	Feb, Aug	..	..
100	4%	Do. 4 per Cent. Mort. Deb. red. 1907.	95−97	4 3 4	Jan, July	..	..
1	3%	Northern Counties Elec. Sup.	—	..	Mar, Aug	..	..
100	4½%	Do. 4½ per Cent. Deb.	93−95	4 15 9	Jan, July	..	..
10	6 0	Notting Hill Electric Ord.	12−13	5 8 0	March ..	..	..
5	4 6	Oxford Electric Ord.	5¾−6¼	5 12 0	March ..	..	..
St.	4%	Do. 4 per Cent. Deb. Stock	95−98	4 2 0	Jan, July	..	..
5	6 0	†St. James' & Pall Mall Elec. Ord.	7½−8½	6 1 6	Feb, Aug	7⅞	..
5	3 6	† Do. 7 per Cent. Pref.	6½−7½	4 16 6	Feb, Aug	6¾	..
St.	3½%	Do. 3½ per Cent. Deb. Stock (red.)	88−90	3 18 0	Jan, July	..	..
5	..	Smithfield Markets Electric Sup. Ord.	¼−¾	..	Feb	..	..
St.	4%	† Do. 4 per Cent. Deb. Stock	68−72	5 11 0	Feb, Aug	..	..
5	4/0	South London Electric Supply Ord.	2⅝−2⅞	5 19 0	April	..	..
1	0/6	South Metrop'n Elec. Lt. & Power Ord.	⅝−⅞	4 0 0	..	..	..
1	0 8⅖	Do. 7 per Cent. Cum. Pref.	1−1¼	5 12 0	Feb, Aug	..	..
St.	4½%	Do. 4½ 1st Db. Stk. Red.	100−103	4 7 6	April, Oct	..	—
5	2/6	Urban Electric Supply Ord.	½−1½	16 12 0	April, Oct	—	..
5	2 6	Do. 5 per Cent. Cum. Pref.	1⅛−2⅛	10 12 0	April, Oct	..	..
St.	4½%	Do. 4½ per Cent. 1st Mort. Deb.	82−85	5 6 0	April, Oct	..	..
5	5/0	†Westminster Elec. Sup. Ord.	7½−8½	5 17 6	Mar, Sept	..	..
5	2/3	Do. 4½ per Cent. Cum. Pref.	5−5½	4 2 [illegible]	Jan, July	..	..
		ELECTRIC RAILWAYS, TRAMWAYS, &c.					
St.	4%	Baker St. & Waterloo 4% Perp. Db. St.	90−92	4 7 0	Jan, July	90¾	—
1	..	Bath Elec. Trams Pref. Ord.	¼−⅜	10 13 0	April	..	—
1	0/6	Do. 5 per Cent. Cum. Pref.	⅝−⅞	5 14 0	Jan, July	..	..
St.	4½%	Do. 4½ 1st Mort. Deb. Stock (red.)	86−91	4 19 0	April, Oct	87½	..
St.	4½%	B'ham & Midland Trams 4½ 1st Db. Stk.	91−94	4 17 0	Jan, July	..	..
10	9%	†Bristol Tramways & Carriage Ord.	10¾−11½	8 0 0	Feb, Aug	..	..
10	4%	Do. Cum. Pref. (fully paid)	8¾−9¼	4 6 6	..	..	..
St.	4%	Do. 4 per Cent. Debs.	96−98	4 2 0	Feb, Aug	..	..
10	..	British Electric Traction Ord.	1⅜−1⅞	..	June, Dec	..	..
10	1/5½	Do. 6 per Cent. Cum. Pref.	4¼−4¾	..	Feb, Aug	4[illegible]	..
St.	5%	Do. 5 per Cent. Perpetual Debs.	95−98	..	April, Oct	97	95¾
St.	4½%	Do. 4½ per Cent. 2nd Deb. Stock	76−78	5 15 0	May, Nov	76¼	..
St.	3%	Central London Ordinary Stock	69−71	4 4 6	Feb, Aug	70¼	68½
St.	4%	Do. 4 per Cent. Pref. Stock	87−89	4 10 0	Feb, Aug	..	..
St.	2%	Do. Deferred Stock	53−56	3 11 3	Feb	54	..
100	4%	Do. 4 per Cent. Debs.	101−104	3 17 0	Jan, July	.	..
St.	4%	Charing X, Euston & Hmpstd Per. Db. Stk.	81−84	4 15 0	Jan, July	83¼	82¾
5	2/6	City of Birmingham Trams. 5% Cm. Pref.	4¼−4¾	5 5 0	April, Oct	..	..
100	4%	Do. 4 per Cent. 1st Mort. Debs.	97−100	4 0 0	April, Oct	94¾	98½
St.	1½%	†City & South London Rly. Con. Ord.	32½−33½	4 17 6	Feb, Aug	33½	..
St	5%	† Do. 5 per Cent. Perp. Pref. (1891)	111−114	4 7 6	Feb, Aug	..	..
St.	5%	† Do. (1896)	109−112	4 9 3	Feb, Aug	..	..
St.	5%	† Do. (1901)	107−110	4 11 0	Feb, Aug	..	..
St.	5%	† Do. (1903)	102−105	4 15 3	Feb, Aug	102¼	..
St.	4%	Do. 4 per Cent. Perpetual Debs.	100−103	3 17 6	May, Nov	..	..
10	6/0	†Dublin United Trams. Ord	12−13	5 0 0	Feb, Aug	..	..
10	6/0	† Do. 6 per Cent. Pref.	12¼−13¼	4 10 6	Feb, Aug	..	..
10	..	Gt. Northern & City Rly. Pref. Ord. (4%)	½−1	..	Feb, Aug	⅝	⅝
10	4/0	G. Northern, Piccadilly & Brompton Ord.	7¼−7¾	5 6 0	Feb, Aug	.	
St.	4%	Do. 4 per Cent. Deb. Stock	90−92	4 7 0	Jan, July	91½	..
5	4/0	Hastings & Dist. Elec. Trams. 6% Cm. Pf.	3¼−3¾	8 0 0	Mar, Sept	..	..
St.	4½%	Do. 4½ Db. St.	93−96	4 13 9	April, Oct	..	..
10	9%	†‡Imperial Tramways Ord.	10−11	7 7 3	Mar, Sept	..	..
10	6%	‡Do. 6 per Cent. Pref.	9½−10	6 0 0	Mar, Sept	..	..
St.	4½%	‡Do. 4½ per Cent. Debs.	90−92	4 18 0	Jan, July	..	..
5	..	I. of Thanet E. T. & Lt. 5 per Cent. Pref.	⅞−1⅜	..	Mar, Sept	..	—
St.	4%	Do. 4 per Cent. Deb. Stock	59−61	6 11 0	Jan, July	..	—
10	6/0	Lanarkshire Tramways	9⅝−10⅛	5 9 0	Feb, Aug	.	..
St.	5%	Lancs. Utd. Trams 5% Prior Lien Db. St.	91−93	5 7 6	Jan, July	..	..
10	..	Liverpool Overhead Railway Ord.	1¼−[illegible]	..	Feb, Aug	..	—
10	5%	Do. 5 per Cent. Pref.	5¾−6¼	8 0 0	Feb, Aug	..	..
St.	4%	Do. 4 per Cent. Deb.	81−83	4 13 0	Jan, July	..	..
10	5/0	London United Trams. 5% Cum. Pref.	6½−7½	6 13 0	Jan, July	..	..
St.	4%	Do. 4 per Cent. 1st Mort. Deb. Stock	79−81	4 15 0	Jan, July	..	..
St.	—	Mersey Con. Ord. Stock	1−3	—	Feb, Aug.	..	..
St.	..	Do. 3 per Cent. Perp. Pref.	3−6	—	..	..	..
1	..	Metropolitan Elec. Tramways Def.	½−[illegible]	—	April..	..	..
1	0/6	Do. 5 per Cent. Cum. Pref.	[illegible]	6 8 6	Feb, Aug	[illegible]	[illegible]
St.	4½%	Do. 4½ per Cent. Deb. Stock	93−96	4 13 9	Jan, July	93¾	..
St.	½%	Metropolitan Railway Consolidated	36½−37½	1 6 6	Feb, Aug	37¼	36¾
St.	2¾%	Do. Surplus Lands Stocks	67−69	4 0 0	Feb, Aug	68¼	65¾
St.	3½%	Do. 3½ per Cent. Preference	86−89	3 19 9	Feb, Aug	86½	..
St.	3½	Do. 3½ per Cent. "A" Preference	76−79	4 8 6	Feb, Aug	..	—
St.	3½%	Do. 3½ per Cent. Convertible Pref.	73−76	4 13 0	Feb, Aug	..	..
St.	3½%	Do. 3½ per Cent. Debenture Stock	90−93	3 15 3	Jan, July	90	..
St.	3½	Do. 3½ per Cent. "A" Ditto	[illegible]	[illegible]	Jan, July	..	.

* In calculating the yield allowance has been made for accrued interest but *not* for redemption

† Ex Dividend

ELECTRICAL COMPANIES' SHARE LIST.—*Continued.*

ELECTRIC RAILWAYS & TRAMWAYS *Continued.*

Share	Last Dividend	Name	Price Wed., Aug. 5.	Rate % Yield-ed. £ s. d.	Dividend Due	Business Week to Aug. 5. Highest	Lowest
St.	..	Metropolitan District Railway Ord.	11½—12½	..	Feb, Aug	..	..
St	..	Do. Extension Pref. (5 per Cent.)	21 —26	..	Feb, Aug	..	..
St.	3½%	† Do. Assented Ext. Pref. (Int. Guar. by Und. Elec. Rlys. Co. of London, Ltd.)	45 —49	7 2 6	Feb, Aug	..	..
St	3%	Do. 3 per Cent. Consold. Rent-charge	73 —76	3 19 0	Jan, July	..	..
St.	4%	Do. 4 per Cent. Midland Rent-charge	98 —102	3 18 0	Jan, July	..	..
St.	1½	Do. Guar. Stock 4 per Cent	46 —50	3 8 6	Mar, Sept	47	
St.	6	Do. 6 per Cent. Perp. Deb. Stock	115 —120	5 0 0	Jan, July	118	
St.	4	Do. 4 per Cent. Ditto	71 —76	5 5 0	Jan, July	74½	73½
5	..	New Gen. Tract. 6 per Cent. Cum. Pref.	½—¾	..	May	..	..
1	1/9⅜	Potteries Electric Traction Ord.	⅞—⅝	8 0 0	April, Oct	..	..
1	0/6	Do. 5 per Cent. Cum. Pref.	⅝—¾	6 13 0	Feb, Aug	..	..
St.	4½%	Do. 4½ per Cent. Deb Stock	93 —96	4 14 6	May, Nov	..	..
1	0 7½	§S. Met. Elec. Trams. & Ltg. 6% Cm. Pref.	¾—1	6 0 0	Feb, Aug	..	..
St.	4%	Do. 4 per Cent Deb. Stock	76 —80	5 0 0	Jan, July	..	..
100	5%	Sunderland Dist. Elec.Trms.5%1stMt.Db.	75 —80	6 5 0	Jan, July	..	..
..	5%	Underground Elec. Rys. Co. of London...	39 —43	11 12 0	June, Dec	39½	..
5	..	Yorkshire (W.R.) Elec. Trams. Ord.	⅜—1⅛	—	March ..	..	..
5	..	Do. 6 per Cent. Cum. Pref.	8⅛—3⅝		..	..	..
St.	4½	Do. 4½ per Cent. 1st Debs.	83 —86	5 5 0	Jan, July	..	..

ELECTRIC MANUFACTURING, &c.

Share	Last Dividend	Name	Price Wed., Aug. 5.	Rate % Yield-ed. £ s. d.	Dividend Due	Highest	Lowest
1	..	Aron Electricity Meter Ord.	⅛—⅜	..	..	..	..
1	1 4½	Do. 6% Cum. Pf. ex (n s/2 arrears)...	⅞—1	7 12 0	April, Oct	..	⅞
1	2/4½	Babcock & Wilcox Ord.	3⅛—3⅜	4 16 3	April, Oct	3⅛	3⅜
1	0/7½	Do. Pref.	1⅛—1⅛	3 16 9	..	..	..
5	6,0	British Insulated & Helsby Cables Ord.	6½—6¾	7 4 0	July, Feb	6⅝	..
5	3,0	† Do. 6 per Cent. Pref.	6 —6½	4 12 0	Jan, July	..	..
St.	4½%	Do. 4½ per Cent. 1st Mort. Deb. (red.)	102 —105	4 5 6	Jan, July	..	..
St.	4½%	British Thoms'n-Houst'n 4½% 1st Mt.Db.	93 —98	4 12 0	Mar, Sept	..	..
5	..	British Westinghouse 6 per Cent. Pref...	⅛—1⅛	..	Feb, Aug	..	..
St.	4%	Do. 4 per Cent. Mort. Deb. Stock	43 —48	8 8 0	Jan, July	..	..
2	..	Brush Electrical Engineering	⅜	—	March ..	..	..
2	..	Do. 6 per Cent. Pref. non-Cum.	⅜—⅞	..	Mar, Sept	..	..
St.	4½%	Do. 4½ per Cent. Perp. 1st Deb. Stock	70 —75	6 0 0	Mar, Sept	..	..
St.	4½%	Do. Perpetual 2nd Deb. Stock	53 —58	7 14 0	Jan, July	..	..
5	10 0	Callender's Cable Con. Ord.	9½—10½	7 1 0	Jan, July	10½	10
5	2/6	Do. 5 per Cent. Cum. Pref.	5½—5¾	4 7 0	Jan, July	..	..
St.	4½%	Do. 4½ per Cent. 1st Mort Debs. (red.)	105 —107	4 4 0	Nov, May	..	..
1	1/0	Castner-Kellner Alkali Co.	1⅛—1⅜	8 14 0	May, Nov	1⅛	..
St.	4½%	† Do. 4½ per Cent. 1st Mort. Deb. (red.).	101 —104	4 6 6	Feb, Aug	103	..
1	0 9⅜	Chadburn's (Ship) Telegraph Ord.	1⅛—1⅛	8 8 0	March ..	..	..
1	0/7½	Do. 6 per Cent. Cum. Pref.	1 —1⅛	5 6 6	April, Oct	..	..
1	0.8⅜	Consolidated Electrical Co.	⅞—1	7 0 0	August ...	..	..
1	1,0	Consolidated Signal Co.	1⅛—1⅛	10 9 0	April, Oct	..	..
1	0/7½	Do. 6 per Cent. Cum. Pref.	⅞—⅞	6 4 0	April, Oct	..	..
3	3/0	†*Crompton & Co. (Nos. 1 to 86,000)	1½—1⅞	8 11 0	Jan, July	..	..
100	5%	Do. 5 per Cent. 1st Mort. Debs. (red.).	90 —93	5 7 0	Jan, July	..	..
1	0/7½	Davis & Timmins	⅞—1⅛		Mar, Sept	..	..
5	2/0	Dick, Kerr & Co. Ord.	1⅜—1⅝	7 11 0	Sept	..	..
5	0/7½	Do. 6 per Cent. Cum. Pref.	1 —1⅛	4 16 0	Sept	..	..
St.	4½%	Do. 4½ per Cent. Deb. Stock	99 —102	4 8 6	Jan, July	..	—
5	2/6	Edison & Swan United ("A" Sh.) (£3 pd.)	1½—⅞		Feb, Aug	..	..
5	4/2	Do. (£5 paid)	1½—2½	5 0 0	Feb, Aug	..	..
St	4%	Do. 4 per Cent. Mort. Deb. Stock (rd.)	76 —79	5 1 6	June, Dec	..	..
St.	5%	Do. 5 per Cent. 2nd Deb. Stock	85 —87	5 15 0	Mar, Sept	—	..
5	..	Edmundson's Elec Corp. Ord.	⅜—⅝	..	Jan, July	..	..
5	..	Do. 6 per Cent. Cum. Pref.	¾—1	..	May, Nov	..	..
St.	4½%	Do. 4½ per cent. 1st Mort. Deb. (red.)	68 —65	6 18 0	Jan, July	59½	..
2	..	Electric Construction Co.	⅜ —⅞	..	Jan, July	..	..
2	..	† Do. 7 per Cent. Cum. Pref.	1⅛—1⅞	..	July	..	..
St.	4%	Do. 4 per Cent. Perp. 1st Mort. Debs.	66 —71	5 13 0	Jan, July	..	..
10	5,0	General Electric (1900) 5% Cum. Pref....	7½—8	6 5 0	June, Dec	..	..
St	4%	Do. 4 per Cent. 1st Mort. Debs.	84 —87	4 12 0	Mar, Sept	..	..
5	10,0	Henley's Telegraph Works Ord.	10½—11½	6 10 0	Feb, Aug	11½	..
5	2/3	Do. 4½ per Cent. Pref.	5 —5½	4 2 0	Feb, Aug	..	..
St.	4½%	Do. 4½ per Cent. 1st Mort. Deb. Stock	106 —108	4 3 6	Mar, Sept	..	..
10	5/0	India Rubber, Gutta Percha, &c., Wrks.	16½—16¾	6 2 0	Feb, Aug	16	15⅞
100	4%	Do. 4 per Cent. Debs. (red.)	98½—100½	8 19 6	April, Oct	..	..
1	..	National Elec. Construction Co.	⅜—⅝	..	April......	..	..
1	0,9⅜	Richardsons, Westgarth & Co., Ltd. Ord.	⅞—⅞	7 2 0	Nov	..	..
1	0/7½	Do. 6 per Cent. Cum. Pref.	⅞—⅞	6 17 0	May, Nov	..	..
St	4½%	Do. 4½ per Cent. Perp. Deb. Stock	87 —90	5 0 0	Jan, July	..	..
1	..	Simplex Conduits Ord.	1⅛		..	..	—
5	..	Do. 6 per Cent. Cum. Pref.	5⅛		..	..	..
12	12/0	Telegraph Construction & Maintenance	31 —33	6 8 0	Mar, July	32⅛	..
100	4%	Do. 4 per Cent Deb. Bonds (1909)	100 —102	3 18 0	Jan, July	..	..
1	2 0	Vickers, Sons & Maxim, Ltd., Ord.	1⅛—1⅛	8 15 6	..	1⅜	1⅝
1	0/6	Do. 5 per Cent. non-Cum. Preference	1 —1⅛	4 9 0	..	1⅛	..
St	5%	Do. 5 per Cent. non-Cum. Preferred	102 —106	4 14 6	..	103½	..
St.	4%	Do. 4 per Cent. 1st Mort. Db.Sk. (red)	103 —105	3 16 0	June, Dec	105	..
100	4½%	Do. 4½ per Cent. 2nd Mort. Deb. (red.)	104 —106	4 5 0	June, Dec	105	..
100	15 6	Do. 5 per Cent. 3rd Mort. Debs. Scrip.	102 —104	..	..	103½	2½
10	10,0	J. G. White & Co. 6% Cm. Pref.	8 —9	6 13 6	..	..	..
5	1/0	Willans & Robinson Ord.	¾—1¼	4 0 0	Apr, Oct	..	..
5	7/0	Do. 6 per Cent. Cum. Pref.	3 —3½	8 11 6	Apr, Oct	..	..
100	4%	Do 4 per Cent. 1st Mort. Debs.	72 —76	5 5 6	May, Nov	..	..

TELEGRAPHS.

Share	Last Dividend	Name	Price Wed., Aug. 5.	Rate % Yield-ed. £ s. d.	Dividend Due	Highest	Lowest
10	..	Amazon Telegraph	1¾—2¾	—	June, Dec	..	—
100	5%	Do. 5 per Cent. Debs. (red.)	86 —89	5 12 0	June, Dec	..	..
St	15/0	†Anglo American	56 —59	5 14 0	F,My,Ag,N	58	57
St.	30 0	† Do. Preferred	102½—103½	3 17 0	F,My,Ag,N	103	102½
St.	1%	Do. Deferred	15¼—16¾	6 7 0	F,My,Ag,N	15⅞	—
St	4%	Commercial Cable 4 per Cent. Deb. Stk.	83 —86	4 13 0	Jn,Ap,Jy,O	85½	84⅞
10	10 0	Cuba Submarine Ord.	7½—8½	7 0 0	Feb, Aug	..	..
10	10/0	Do. Preference 10 per Cent.	15½—16½	6 1 6	Feb, Aug	..	..
5	2/0	Direct Spanish Ord	3 —3½	6 4 0	April, Oct	..	..
5	5,0	Do. 10 per Cent. Cum. Pref.	8 —9	5 11 0	April, Oct	..	..
St	4½%	Do. 4½ per Cent. Deb.	00 —103½	4 7 6	Jan, July	..	..
20	1 0	Direct United States Cable xd & bonus	13½—13⅞	6 5 0	Ja,Ap,Jy,O	13⅛	..
100	4½%	Direct West India Cable 4½% Rg. Db. (rd.	98 —100	4 10 0	June, Dec	..	..
St	0	Eastern Ordinary	133 —136	5 2 9	Ja,Ap,Jy,O	134½	133½
St	17 6	Do. 3½ per Cent. Pref. Stock	83½—85	4 2 0	Ja,Ap,Jy,O	84	..
St.	4%	Do. 4 per Cent. Mort. Deb. Stk. (red.)	101 —103	3 17 6	May, Nov	102½	102½
10	2/6	Eastern Extension	12½—13	5 8 0	Ja,Ap,Jy,O	12⅝	12
St	4%	† Do. 4 per Cent. Deb. Stock	99½—101½	3 18 6	Feb, Aug	—	..
100	4%	Eastern & S. African 4% Mort. Deb 1900	99 —101	3 19 0	Feb, Aug	..	..
..	4%	Do. 4% Mauritius Sub. Debs. (red.)	100 —102	3 18 6	May, Nov	..	..
10	1 0	G. N. of Copenhagen, with Coupon 74	27 —29	6 15 0	Jan, July	28½	..
100	4½%	Halifax & Bermuda 4½% 1st Mt. Db. (red.)	98 —100	4 19 0	June, Dec	..	..
..	2 6	Indo-European	66 —69	5 12 0	May, Nov	..	..
100	$1	Mackay Companies Common	70 —73	5 10 0	Ja,Ap,Jy,O	..	..
100	$1	Do. Preference	69 —78	5 10 0	Ja,Ap,Jy,O	..	..
1	..	Marconi's Wireless Telg. Co.	⅞—	..	April	..	..
100	4	Pacific & European Tel. 4% Guar Dbs. red.	97 —100	4 0 0	June, Dec	..	—
10	1 3	West Coast of America	1⅛—1⅛	4 5 0	May	..	..
100	4	Do. 4 per Cent. Debs.	98 —101	3 19 0	Jan, July	..	..
10	..	West India & Panama	—1⅛	..	May, Nov	..	..
10	4	Do. 6 per Cent. 1st Pref.	—1½	7 1 0	May, Nov	..	..
10	..	Do. 6 per Cent. 2nd Pref.	8½—9½	..	May, Nov	..	..
100	4	Do. 5 per Cent. Debs.	100 —102	4 18 0	Jan, July	..	..
10	..	Western Telegraph	14½—14¼	4 18 0	Mr,Jn,O,D	14½	13⅞
St	4	Do. 4 per Cent. Deb. Stock (red.)	99½—101½	3 18 6	June, Dec	..	..
..	4	Western Union Tel. $1,000 4% Bonds	80 —85	4 14 0	..	101	100

TELEPHONES.

Share	Last Dividend	Name	Price Wed., Aug. 5.	Rate % Yield-ed. £ s. d.	Dividend Due	Highest	Lowest
100	2⅜	Amer. Telephn. & Telegh. Cap. St.	123 —127	6 6 0	..	..	—
..	4%	Do. Coll. Trust $1,000 4 per Cent. Bds	89 —92	4 7 0	Jan, July	..	..
St.	5%	Anglo-Portug'se Tel. 5% 1st Mt. Db. Stk.	101 —104	4 16 0	Mar, Sept	..	—
5	5/0	†Chili Telephone	7⅜—8½	4 17 0	August ..	..	—
1	0/7½	Monte Video Telephone Ord.	1—1⅛	6 11 0	Nov	..	..
1	0/6	Do. 5 per Cent. Pref.	⅞—1⅛	5 6 0	May, Nov	..	..
St.	6%	†National Co. Pref. Stock	108½—109½	5 10 6	Feb, Aug	107⅞	107½
St.	6%	† Do. Def. Stock	116½—117½	5 2 6	Feb, Aug	116⅞	115⅞
10	6/0	† Do. 6 per Cent. Cum. 1st Pref.	10 —12	5 0 0	Feb, Aug	..	..
10	6,0	† Do. 6 per Cent. Cum. 2nd Pref.	10 —12	5 0 0	Feb, Aug	10⅞	..
5	2/6	† Do. 5 per Cent. non-Cum. 3rd Pref.	5½—6⅛	4 7 0	Feb, Aug	5⅞	..
St.	3½%	* Do. Deb. Stock 3½ per Cent. (red.)	98 —100	3 10 0	June, Dec	98½	..
St	4%	Do 4 per Cent. Deb. Stock (red.)	102½—104½	3 16 6	Jan, July	103½	..
1	1/0	Oriental	1⅛—1..	5 6 8	April, Oct	..	..
1	0,7½	Do. 6 per Cent. Cum. Pref.	1⅛—1⅛	4 16 0	April, Oct	—	..
St.	4%	Do. 4 per Cent. Red. Deb. Stock	88 —91	4 8 0	Jan, July	88½	..
St.	4½%	Telephone Co. of Egypt 4½%Db.Stk.(red.)	98 —101	4 11 0	Jan, July	—	..
5	5/0	†United River Plate	6½—7	5 11 0	July	..	..
5	2/6	Do. 5 per Cent. Cum. Pref.	5 —5½	4 11 0	June, Dec	..	..
St.	4½%	Do. 4½ Deb. St. Red.	99½—101½	4 8 6	Jan, July	101	..

FINANCIAL, INVESTMENT, &c.

Share	Last Dividend	Name	Price Wed., Aug. 5.	Rate % Yield-ed. £ s. d.	Dividend Due	Highest	Lowest
5	3/0	Elec. & Gen. Investment 6% Cum. Pref.	3½—4	7 10 0	Jan, July	..	..
10	5/9	Globe Telegraph & Trust	10½—10⅞	5 11 0	SpDcMrJu	10⅜	10
10	3/0	Do. 6 per Cent. Pref.	13½—13⅞	4 7 6	SpDcMrJu	13⅜	..
10	6%	Submarine Cables Trust (Cert.)	127 —130	4 12 0	April, Oct	127½	127

COLONIAL AND FOREIGN ELECTRIC RAILWAYS, TRAMWAYS, &c.

Share	Last Dividend	Name	Price Wed., Aug. 5.	Rate % Yield-ed. £ s. d.	Dividend Due	Highest	Lowest
5	3/0	Anglo-Argentine 6% Cum. 1st Pref.	6⅛—6½	4 14 0	April, Oct	6½	6⅛
5	5,0	Do. 10% Non-cum. 2nd Pref.	8⅛—8⅜	5 13 0	Jan, July	8⅜	8
St.	6%	Do. Permanent 6% Deb. Stock	141 —146	4 2 0	June, Dec	..	..
St.	5%	Auckland Elec. Trams. 5% Deb. (red.)	103 —106	4 14 3	Jan, July	..	..
5	4,0	Brisbane Electric Trams. Invest. Ord.	4⅛—4⅜	4 8 6	May	4⅜	..
5	2 6	Do. 5 per Cent. Cum. Pref.	4⅞—5⅛	4 17 6	May, Nov	5	..
St.	4½%	Do. 4½ per Cent. Db. Prov. Certs.	98 —102	4 8 0	Jan, July	..	..
St.	8%	British Columbia El.Ry.Df. Ord.	124 —129	6 4 0	Mar, Sept	..	..
St.	30 0	† Do. Pref. Ord. Stock	109 —113	5 6 0	May, Nov	111½	..
St.	5%	Do. 5% Cum. Perp. Pref. Stock	104 —105	4 12 0	Jan, July	107½	106½
40	4½%	Do. 4½ per Cent. 1st Mort. Debs.	101 —104	4 6 6	April, Oct	..	—
100	4½%	Do. Vancouver Power Debs.	100 —103	4 7 6	Jan, July	..	—
St.	4½%	Do. 4½% Perp Con. Deb. St.	101 104	4 1 6	—	102½	..
St.	5%	Buenos Ayres Elec. Trams (1901) Ltd. Deb. St.	93 —97	5 2 6	Ja, Jul ..	..	..
5	..	Buenos Ayres Grand National Ord.	2⅛—2⅜		..	..	..
5	2/6	Do. 5 per Cent. Cum. Pref.	3⅜—4⅛	..	Feb, Aug	..	..
100	5½%	Do. 5½ per Cent. Pref. Debs.	99 —103	5 7 6	Jan, July	..	..
100	6%	Do. 6 per Cent. 1st Deb. Bonds.	100 —104	5 14 6	April, Oct	..	..
St.	5%	Buenos Ayres Lacroze Trams 1st Mt. Db.	94 —97	5 2 6	Mar, Sept	94½	94⅛
St.	6%	†Buenos Ayres Port & City Tram. 1st Mt. Deb. Stock £75 Paid	61 —65	6 12 0	Feb, Aug	..	..
5	2/6	Calcutta Tramways (1 to 137,610)	5 —5¼	5 9 0	Mar, Sept	5⅛	5
100	2/6	Do. 5 per Cent. Cum. Pref.	4⅞—5⅛	4 13 0	Jan, July	—	..
1	4½%	Do. 4½% 1st Deb. Stock (red.)	101 —104	4 6 6	Jan, July	..	..
St	..	Cape Electric Tram Shares	⅞—⅞	..	..	..	..
5	1/3	City of Buenos Ayres Trams Co. (1904) Sh.	5⅛—5⅜	4 5 0	F,My,A,N	5⅛	..
St.	4%	Do. 4 per Cent. Deb. Stock	97 —101	3 19 0	June. Dec	..	..
	5%	Colombo Tr. & Ltg. 5% 1st Mt. Db.	88 —91	5 10 0	May, Nov	..	—
100	5%	Electric Traction Co. of Hong Kong 5 per Cent. 1st Mort. Debs.	85 —90	5 10 0	June, Dec	..	..
1	5%	Havana Elec. Ry. Con. Mt. 5% $1,000 50 year Coup. Bds.	80 —85	5 9 6	Feb, Aug	..	..
1	..	Kalgoorlie Elec. Trams Sh.	⅛—⅜	..	..	..	..
100	5%	Do. 5 per Cent. "A" Deb. Stock	85 —87	5 12 0	Jan, July	..	..
6	6%	Do. 6 per Cent. "B" Ditto	69 —73	8 4 0	Jan, July	..	..
5	1/0	Lisbon Elec. Trams. Ord.	1 —1¼	4 0 0	July	1⅛	..
100	0/7½	Do. 6 per Cent. Cum. Pref.	1 —1¼	4 16 0	Jan, July	..	..
St.	5%	Do. 5 per Cent. Reg. Mort. Debs	92 —97	5 3 0	Jan, July	..	..
St.	5%	Madras Elec. Trams. 5% Deb. Stk.	93 —96	5 4 0	Jan, July	..	..
	5%	Manila Elec. Ry. $1,000 Gold Bonds	86 —90	5 11 8	Feb, Aug	..	..
100	4/ ½	†Mexico Trams Co. Com. St.	112 —114	3 10 0	..	112	109
500	5%	Do. Gen. Con. 1st Mort. 5% Gold Bds.	92½—93½	5 7 0	..	93½	92⅞
St.	4½%	†Montreal St. Ry. Sterling 4½ per Cent. Debs. (1922)	100 —102	4 8 0	Feb, Aug	101½	..
1	1/0	Perth Elec. Trams Ord	⅞—1	7 3 6	May	..	..
St	5%	Do. 1st Mt. Db. Stock	101 —104	4 16 0	Jan, July	..	..
5	3,0	Rangoon Elec. Trams & Supply Co. 6 Cum Pf.	5½—5⅞	5 6 6	..	..	..
St.	4½	Do. 4½% 1st Mort. Deb. Stk.	91½—92½	4 10 6	..	..	..
..	$2½	Sao Paulo Tramway, Light & Power Co. $100 Stock	142 —146	6 3 0	..	144½	143
	5%	Do. 5 per Cent. 1st Mt. $500 Db.	98½—99½	5 0 6	June, Dec	99½	..
100	4½%	Toronto Ry Co. 1st Mt. 4½% Ster. Bonds	99 —101	4 9 0	Feb, Aug	..	..

COLONIAL AND FOREIGN ELECTRICITY SUPPLY &c.

Share	Last Dividend	Name	Price Wed., Aug. 5.	Rate % Yield-ed. £ s. d.	Dividend Due	Highest	Lowest
5	3/0	Adelaide Elec. S'ply Co. 6% Cu. Pr.	4½—5½	5 14 0	Mar, Sept	..	..
10	6/0	†Bombay E. S. & T. 6% Cm. Pf.	10 —10½	5 14 0	..	..	..
St.	4½	Do. 4½ per Cent. Deb. Stk. (red.)	94 —96	4 13 9	Jan, July	95½	93½
5	4,9	Calcutta Elec. Supply Ord.	5¾—6¼	5 17 0	April, Oct	..	..
100	7/2	Canadian Gen. Elec. Co. Com. St.	107 —112	6 8 0	..	111½	112
100	5%	Castner Electrolytic Alkali Co. (of U.S.A.) 1st Mort Stl. Debs.	92 —97	5 2 6	Jan, July	..	..
500	5	Elect. Development Co of Ontario	80 —83½	6 1 0	..	83	8
5	..	Elec. Ltg. & Trac. Co. of Aust. 6 per Cent. Cum. Pref.	2 —2½	..	Feb, Aug	..	—
St.	5%	Do. 5 per Cent. Deb Stock	85 —90	5 9 0	Jan, July	..	..
St.	5%	Elec. Supply Co. of Victoria 5 per Cent. 1st Mort. Deb. St.	90 —93	5 7 6	Jan, July	..	..
St.	6%	Indian Elec. Sup. & Trac. Co. Constn Deb. St. Rd.	30 —40	15 0 0	Jan, July	..	..
10s	0 3	Kalgoorlie Elec. Power & Ltg. Ord.	—	..	..	..	..
1	0,7½	Do. 6 per Cent. Cum. Pref	⅜—⅞	8 0 0	April, Oct	..	..
St.	5%	Madras E. S. Corp. 5 per Cent. Constn Deb. St.	85 —90	5 11 0	April, Oct	..	..
500	5%	Mexican Elec. Light Co. 5% 1st Mort. Gold Bonds	84½—85½	5 16 6	..	85⅞	85
St.	$1	Mexican Lt. & Power Co. Cap. St.	72 —75	..	..	73½	71
500	5%	† Do. 5% 1st Mort. Gold Bnds.	88½—89½	5 8 0	..	91½	87½
100	6/2	†Montreal Lt. Ht. & Power Co. Cap. St.	99 —101	5 19 0	F,My,A,N	99½	98½
1	1/7½	River Plate Electricity Co. Ord.	⅞—1	6 0 0	April ..	1	..
1	1 7½	Do. 6 per Cent. non-Cum. Pref.	⅞—1	6 0 0	May	..	..
St.	5%	Do. 5 per Cent. Deb. Stock	96 —98	5 3 0	Jan, July	..	..
5	3/0	Rosario Elec. Co. 6% Pref. (1-20,000)	4⅞—5½	5 17 6	April, Oct	..	..
100	$1	Shawinigan Water & Power Co. Cap. St.	73 —75	5 6 6	..	74	73½
..	5%	Do. 5 per Cent. Bds.	102 —104½	4 16 6	Jan, July	103½	103
..	6d.	Victoria Falls Power Co. Pref.	⅜—⅝	—	Jan, July	..	..

* In calculating the yield allowance has been made for accrued interest but not for redemption. † Ex dividend. ‡ The London Stock Exchange Committee have declined to quote these.

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CONTENTS OF THE CURRENT NUMBER.

NOTES.

The Synchronising of Clocks.

If the British Science Guild succeeds in its efforts to secure the synchronising of public clocks it will earn no small amount of public gratitude. We can imagine nothing worse than the chaotic condition of affairs in this respect in London, while the variety of times exhibited by City clocks would be highly amusing if it were not of such grave importance. A report has just been issued by a committee appointed by the British Science Guild to consider this question, and some valuable recommendations are made. At present the various post offices receive correct time daily, but the control and correction of their clocks is effected by hand. The committee make the admirable suggestion that the Postmaster-General should be asked to arrange for these functions to be performed automatically, The cost would not be excessive, and the advantages would be very great. It is also suggested that deputations should be sent to the Corporation of London, the L.C.C., the Office of Works, and the various railway authorities, asking them to cooperate by synchronising the clocks under their control. A highly important recommendation is that the Local Government Board should be asked to secure the passing of a bye-law making it compulsory for owners of clocks exhibited to the public either to have such clocks synchronised or to remove them. We imagine there ought to be no great difficulty in adopting this suggestion, for it will not be disputed that a clock which indicates the wrong time is worse than no clock at all, and might almost be classed as a public nuisance.

Reflected Illumination.

We have heard much in the past few years of the illuminating engineer. His rise has been practically contemporaneous in this country with that of the metal filament lamp; yet it appears that he has done little to apply this lamp for reflected or indirect illumination. The arguments of the illuminating engineer are sound enough in so far as they relate to the grouping of lighting points and either the decrease or increase of the number of units to meet the needs of particular cases. With reflected lighting he has at command an almost perfect system of distribution, and by the use of metal filament lamps can obtain a steady white light pre-eminently adapted for indirect illumination. The installation described on another page, while it may not be the first of its kind, is certainly the first to which our attention has been directed where modern metal filament lamps have figured prominently in the illumination of a first-rate hotel. We commend it to the notice of illuminating engineers and electrical contractors generally, because it seems to us to open up a new field for the modern incandescent lamp, while incidentally it solves a troublesome problem for hotel managers. The illumination of a large room which may be devoted to the purposes of dining, smoking, lounge, reception, reading, &c., is not to be undertaken lightly if the "house" is to achieve a reputation. We do not hesitate to say that the present system of suspended lamps, or electroliers, with its many points of lighting to disturb and arrest the eye, leaves much to be desired. Most hotel rooms are lofty and have plenty of white ceiling expanse, so that reflected lighting is not difficult of application, given an efficient illuminating unit. The metal filament lamp appears to supply this need exactly, both on the score of economy, energy and effective illumination.

Traffic Increase on the Tubes.

At a time when the railway companies of this country are much troubled by diminished local and suburban passenger traffic, it is gratifying to notice the excellent progress which is recorded in the recently issued half-yearly reports of most of the underground railways of London. Thus, the "Bakerloo" tube records an increase of over 30 per cent. in the number of passengers, compared with the corresponding half-year in 1907; whilst the Great Northern, Piccadilly & Brompton tube shows an increased traffic of no less than 46 per cent., and the Metropolitan District Railway, which has been established for many years, and consequently has less opportunity for development, about 16 per cent. The increased number of passengers making use of these underground railways can scarcely be attributed entirely to the opening of the Exhibition at Shepherd's Bush, since the improving prospects of the several companies were apparent some months ago. It is, however, to the co-operation of the various companies in encouraging the interchange of traffic that the improved conditions are largely due. That this interchange of passengers is now taking place on a considerable scale is evident from the statement, on Monday last, of Sir George S. Gibb, chairman of the Baker Street and Waterloo Railway, that 36 per cent. of their passengers travelled with through tickets from or to other tubes. The importance of co-operation in working has now been fully realised by the railway, omnibus and tube companies, so that whilst the general public are provided with improved means of transit, the necessity for carrying passengers at a loss should be, to a large extent, removed.

Gas Problems.

Some interesting statements were made last Friday at the half-yearly ordinary general meeting of the London Gas Light & Coke Co. The Governor, Mr. Corbet Woodall, referred, first, to the decreased sale of gas and, second, to the increased quantity unaccounted for. He explained the diminished sale on the basis of climatic conditions, the substitution of new lamps for old, and methods of burning which are increasingly economical from year to year; but he did not refer in any way to the competition by electricity. The total quantity of gas sold was $\frac{1}{2}$ per cent. less than that sold in the corresponding six months of last year, and although this appears an insignificant amount when thus stated, yet it represents no less than 61,000,000 cubic ft. We do not imagine that the situation causes any alarm to the gas industry generally, nor is there any reason why it should; but the point should be observed by the electrical industry, for it is likely that a similar experience will befall it. For the same reason that improved methods of consumption have affected the gas industry, so will the electrical industry be affected, and it should be prepared for the contingency, which, however, can be met largely by energetic canvassing for new consumers. Metal filament lamps will undoubtedly cause a reduction in consumption by existing consumers, but they will also prove a powerful means of obtaining fresh revenue.

The second point raised at the meeting is of great interest, not only to engineers, but also to the public at large. It appears that no less than 956,000,000 cubic ft. of gas were unaccounted for by the Gas Light & Coke Co. during the six months ended June, 1908. This is undoubtedly a serious matter for both company and public, and is rightly regarded in that light by the officials of the company. Moreover, the quantity unaccounted for is increasing at an alarming rate, being $\frac{1}{2}$ per cent. of the total output greater than during the corresponding period last year. It was suggested at the meeting that the enhanced loss is due to the great increase in the weight of vehicles using public roads and the speed at which they run. Whatever the cause, it is certainly a matter of great urgency, and every effort should be made to devise a remedy.

University of Manchester.—Dr. J. E. Petavel, F.R.S., has been elected professor of engineering and director of the Whitworth Laboratories in this University.

Wireless Telephony.—The Amalgamated Radio Telegraph Co. confirms a statement published some time ago that effective wireless telephonic communication was established between Syngby, near Copenhagen, and Weissensee, near Berlin, a distance of 260 miles.

Sebastopol-Varna Cable.—The new submarine telegraph cable, recently laid by Messrs. Siemens Bros. & Co. between Sebastopol and Varna is reported to be working perfectly. The first messages exchanged over the cable were cordially-worded telegrams between the Czar and Prince Ferdinand.

"Progress in the Electric Iron and Steel and Ferro-Alloy Industries."—With reference to the article on this subject by Mr. J. B. C. Kershaw which appeared in our last issue we are informed by the New Vanadium Alloys (Ltd.) that their works are situate at Llanelly and not at Swansea, as stated.

Tunnels on Tramways.—According to *The Times* a tunnel more than a mile in length, which is said to be the longest in existence for use by municipal electric surface car lines, has just been opened for operation by the Genoa Street Railway Co. It connects Genoa with the adjacent large commune of Rivarolo, which previously was reached by circling the mountain, the distance being now shortened by $1\frac{1}{2}$ miles, so that the trip is made in 15 minutes less time. The constructive works were begun on June 1, 1905. The boring was accomplished by 900 workmen, by hand, electricity and compressed air.

"The Electron."—We are pleased to note that, if size is any criterion, this young magazine is doing extremely well, and in spite of the fact that the editor still complains of lack of copy it is considerably thicker and stuffed fuller of good things than was the first issue. A Paper read before Siemens' Stafford Engineering Society on "The S.S.W. Single-phase Series Motor," by Mr. M. Schenkel seems to be a very valuable Paper, and not unexpectedly gave rise to a very good discussion. The most interesting feature of this issue is an historical account of the English Siemens' firms. It is intended to publish a series of articles, of which this is the first, dealing with "Siemens" as a whole and its great influence on electrical engineering history. We quite look forward to reading these in future numbers. The Literary and Debating Society has been passing through stirring times, "Home Rule for Ireland" being the principal topic discussed. The athletic sections of the Institute are also progressing. We wish the Editor success in his search for copy, and only hope he will not need, after all these efforts, an extra W.P.B.

Cable Interruptions and Repairs.

	Date of Interruption.	Date of Repair.
Las Palmas—Arrecife	May 18, 1908 ...	—
Jeddah—Suakim	July 27, 1908 .	—
Assab—Massowah .	July 28, 1908 ...	
Trinidad—Demerara	Aug. 1, 1908 ...	Aug. 10, 1908
Kwandang—Manado	Aug. 5, 1908 ...	—

Mixed Pressure Turbines.—With reference to the note on this subject which appeared on p. 512 of our issue of July 17th, we are informed by the British Westinghouse Co. that they were negotiating with the Gloucester Carriage & Wagon Co. in January, 1907, for the supply of a one-cylinder mixed pressure turbine. A turbine of this type was, therefore, developed by them and is now working regularly and satisfactorily. On this ground, the company claim priority of manufacture of the mixed pressure turbine.

The Tramways and Light Railways Association.—The *Official Circular* of this Association for August contains a full report of Prof. Carus-Wilson's Paper on "Rail Corrugation," already dealt with in *The Electrician.* We notice that Prof. Carus-Wilson communicated a few extra remarks on Mr. S. Sellon's criticism of Fig. 2 in the Paper. We reproduce these hereunder :—

Prof. CARUS-WILSON (communicated) remarked that, with regard to Mr. Sellon's criticism of Fig. 2, he (Mr. Sellon) said that by the time the wheel arrived at the stage shown, the other rail would be worn down in proportion. He thought this explained the point of difference between them. Mr. Sellon took no account of the fact that along with check cutting on the one wheel there was always a thinning down of the flange on the other wheel, so that the rail had not to be worn away "in proportion" to the cutting of the check. It was this thinning of the flange that made check cutting on the straight possible, and justified the practical accuracy of Fig. 2.

Telephonic Control of Lifts.—The *American Telephone Journal* gives an interesting account of a system of telephone lift control which is being employed in the Singer Building at New York. This building is 612 ft. high and contains 47 stories. There are 16 lifts, grouped in three sections, which are all controlled from the engineer's offices by a switchboard equipped with visual signals and fitted with 50 line circuits and five cord circuits. A lamp indicator board shows exactly where each lift is, while other lamps show whenever a circuit-breaker is tripped and the floors on which the various lift fitters are at work. Each lift is equipped with an ordinary telephone set by which communication can be established with the engineer, while a loud-speaking receiver allows orders to be given to the lift man, but cannot be used for conversational purposes. These arrangements have been found so useful, both as regards actual operating and accessibility of the lift men and repair staff, that it is thought not improbable that many other buildings will be equipped in a similar manner.

Test on 5,000 kw. Turbine at Manchester.—During June last, tests were carried out on the 5,000/6,000 kw. steam turbine recently completed by Messrs. Willans & Robinson, of Rugby, at the Stuart-street station of the Manchester Corporation. This set was illustrated on p. 637 of our last issue. The plant was supplied to the specification of Mr. S. L. Pearce, and the tests in question were carried out to ascertain whether it complied with the guarantees laid down in the contract, and, further, whether any penalty or bonus had been incurred on account of steam consumption. It will be remembered that the unit in question is normally rated at 5,000 kw. at full load, whilst it is capable of running continuously on a load of 6,000 kw. The speed of the set is 1,000 revs. per min., and the turbine is supplied with steam superheated 100°F. and exhausts into a vacuum of 27 in., this being the highest commercial vacuum possible in view of the high temperature of the circulating water. The result of the trials showed that between the loads of 5,000 kw. and 6,000 kw. the results were somewhat better than those guaranteed by the contractors. In other words, at the 5,000 kw. load the results were 0·03 lb. lower than the guarantee. At the 5,500 kw. load the results were 0·07 lb. better than those guaranteed, and at the 6,000 kw. load the results obtained complied exactly with those guaranteed. It will be remembered that at the time this contract was placed doubt was expressed in certain quarters as to whether the results promised would be obtained in actual practice, and it is, therefore, satisfactory to note that the guarantees at the normal loads of operation are somewhat better than the actual guarantees.

Water-Power in France.—The *Journal* of the Royal Society of Arts contains an interesting report on this subject. According to this the total water-power utilised in the Alps is nearly 300,000 H.P., while the yearly average obtainable is estimated by various experts at between 2,300,000 H.P. and 15,000,000 H.P. Power is supplied to undertakings of two kinds. The first consists of factories engaged in the electro-metallurgical and electrochemical industries, and utilising water-power obtained by them on the spot for the manufacture of aluminium, calcium carbide, and ferro-silicon. These at present utilise over 100,000 H.P. in Dauphiné alone. The other kind consists of enormous power stations, pure and simple, for supplying current, not only to various works in the neighbourhood, but within an ever-growing area. Lyons is lighted by power from the Volta Works at Moutiers, belonging to the Grenoble Power & Light Co., which transmits 6,000 H.P. over a distance of 112 miles under a pressure of 57,000 volts, while from Lyons to Valence the whole Rhône valley is fed by power stations situated in the Departments of the Savoy and Isère. Even St. Etienne and Roanne, in the Department of the Loire, will before long be using electricity generated far away on the other side of the Rhône, in the valley of the Drac, a tributary of the Isère. As is well known, proposals have also been made to supply Paris from the Rhône, and schemes have been got out whereby 100,000 H.P. could be thus transmitted. These are, however, merely suggestions so far, but if the present rate of progress be maintained, in a few years the whole of France will be supplied with hydro-electric power from a few distributing centres. The industrial importance of such a development would necessarily be very great.

Wireless Telegraph Notes.—The *Electrical World* states that the Swiss War Department operates three wireless stations in the Alps, on the Righi and St. Gothard summits and at Dailly, above St. Moritz. According to an official report just published the authorities expended last year £6,500 on experiments with wireless telegraphy across the mountains, and the results are reported as most satisfactory. One unexpected result was practical proof that the Alps are a great "attraction" to messages despatched from stations in distant parts of Europe. Marconigrams from steamers in the Atlantic and from stations in Cornwall and on the Baltic coast have reached the Righi and St. Gothard stations. These long-distance messages are reported to arrive more frequently when the weather is unsettled or stormy, and chiefly in the early hours of the morning. On one or two occasions it has happened that while two Swiss stations were unable to establish wireless communication with each other, such messages were picked up from abroad.

In the *Observer* for August 9th some interesting notes appeared of an interview with Mr. W. W. Bradfield, deputy manager of Marconi's Wireless Telegraph Co. Mr. Bradfield expressed a doubt as to the maintenance of continuous communication between H.M.S. Indomitable and the Marconi wireless stations at Clifden and Glace Bay throughout the journey, to Quebec and back, recently undertaken by the Prince of Wales, Mr. Bradfield's estimate of the reliable working of the ship and shore apparatus being about 500 miles in the day time, and, probably a further distance at night. That is to say, the "Indomitable" equipment does not admit of longer distance communication than is expressed in these figures. Mr. Bradfield stated that shore to ship communication with vessels at sea for at least 2,000 miles is accomplished daily where the equipment is adequate.

The question as to which wireless system holds the record for effective long distance transmission has, perhaps, greater interest for the experts than for the public, but already there are rival claims. The 2,000 miles distance mentioned by Mr. Bradfield is claimed to have been exceeded by the Amalgamated Radio-Telegraph Co.'s apparatus on the afternoon of July 31, 1907, when the ss. "Hellig Olaf," of Copenhagen, equipped with Poulsen apparatus, transmitted a 21 word message to the Poulsen Company's temporary station at Steglitz, Germany, when at a distance of about 2,050 miles from the station. It is interesting to note that the Amalgamated Company's station at Knock Roe, near Tralee (Ireland), is nearing completion, and Mr. Hubert Malpas, joint managing director of the company, states that the Canadian Government has granted the company a licence for a site at Cape Causo, Nova Scotia, where trans-Atlantic transmission will be attempted with a power which Mr. Malpas estimates at one-fourth that employed by the Marconi system.

ALTERNATING CURRENT COMMUTATOR MOTORS.*

BY DR. RUDOLF GOLDSCHMIDT.

(*Continued from page 593.*)

Summary.—In this article the author discusses the theory of the single-phase commutator motor. The production of the field is first considered, and then the shunt and series methods of excitation, it being shown that the simple shunt is an impossible method. The characteristics of the ideal series motor are then given in some detail, after which the complications and difficulties encountered in the real motor are considered, including commutation and the circulating currents in the short-circuited coils. Finally, the various losses are considered.

To study the working conditions of the ideal motor at different loads we will build up a simple circle diagram (Fig. 14). In the diagram representing the relation between the three voltages on field, armature and at the terminals, the angle OAB between E and E_L is always 90 deg. Keeping the terminal voltage e constant, the point A at different loads moves on a circle with $OB = e$ as diameter. E_L is proportional to the current, provided the motor is not saturated, and therefore AB is representative of *the current* itself. If we have

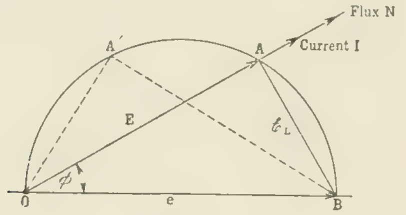

FIG. 14.

once determined the scale—1 ampere equal to a certain number of millimetres or inches—we can take the absolute value of the current as AB, the phase naturally remaining in the direction OA. *The useful power* is $P = e \cdot I \cdot \cos \phi$. As e is a constant, the watt component of the current $I \cos \phi$ is a measure of P. Drawing (Fig. 15) AC vertical on OB, AC is $I \cdot \cos \phi$, and therefore can stand for P.

To obtain a measure of *the speed*, we remember that OA = E is proportional to the current and the speed. E_L is proportional to the current only, and therefore the speed is equivalent to the ratio E/E_L, or OA/AB. A line in the diagram standing for this ratio is easily found. We draw OD vertical on OB and DF parallel to OB, then the triangle ODF is similar to OAB and DF/OD = OA/AB. As OD is a "constant" determined by convenience of scale only, DF is a measure of the speed.

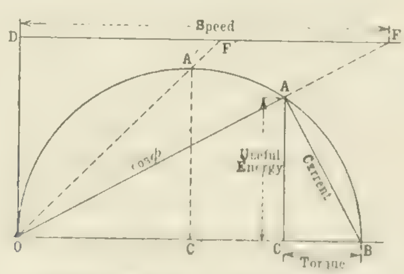

FIG. 15.—DIAGRAM OF IDEAL MOTOR.

It is convenient to have not only the angle ϕ, but also $\cos \phi$ given as a line. We can take OA for it, OB being put equal to unity.

It only remains to discover a line for *the torque.* The latter is proportional to the square of the current—*i.e.*, proportional to $(AB)^2$. As $AB/OB = BC/AB$; $AB^2 = BC \times OB$. OB as terminal voltage being constant, BC is a measure of the torque. OB itself would be *the starting torque* with full voltage on the terminal of the motor. It is interesting to note that BC is also proportional to the wattless component of the current ($I \cdot \sin \phi$), so that the torque is proportional to this wattless component, while the useful energy is proportional to the watt component of the current.

The preference for the mathematical or graphical representation is a matter of taste, but I think that many people will agree with me that a very simple diagram, as the present one, will lead more quickly to a clear result and can more easily be borne in mind than a more or less complicated formula.

From our diagram we see how at starting (speed DF equal to zero) F falls into D, $\cos \phi$ being also zero, as the whole energy sent into the motor is the wattless energy consumption of the field, and the useful energy AC becomes zero. The current $\overline{BA}$ is then equal to BO, the highest value it can assume. As is customary, we will call this current taken by the motor at standstill under full voltage *the short-circuit current.*

The torque has the highest figure possible, CB becoming identical with OB. As the speed DF increases, the line OF swings round O towards OB. The torque BC gradually is reduced, reaching zero at infinite speed. The current likewise becomes smaller and smaller with increasing speed. $\cos \phi$ (OA) grows and approaches 1 asymtotically. The useful energy AC grows at first as the speed goes up, and reaches a maximum when A is on the top of the circle and the angle ϕ is 45 deg. ($\cos \phi = 0{\cdot}705$). Then the useful energy becomes smaller again as the current drops.

The linear diagram (Fig. 16) has been drawn by taking the different dimensions from Fig. 15. We have chosen the currents as abscissæ.

Prominent points in these diagrams are: (1) The point of starting; (2) the point where the maximum electrical energy is reached; (3) the normal load whatever it may be. We shall have to study these three conditions separately.

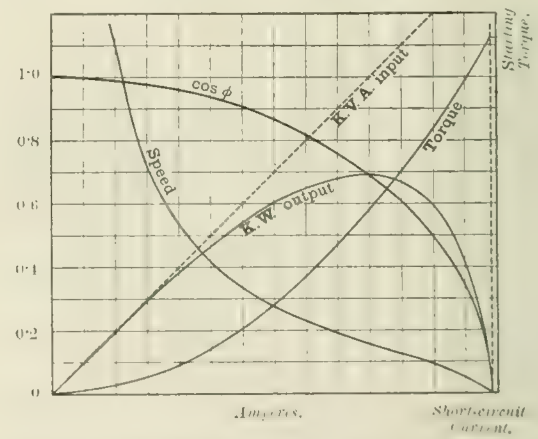

FIG. 16.—LINEAR DIAGRAM OF IDEAL SERIES MOTOR.

If we switch the full voltage on to a stationary motor, we produce the starting condition as represented in the circle diagram, when the point A falls into O. Our ideal machine has no drop in the armature, and therefore the latter does not consume any voltage at the speed zero, no E.M.F. being induced.

The whole voltage, therefore, is used up in the field winding. The current produced by this voltage is a good measure of the quality of the machine. If, for instance, at starting under full voltage the current produced is twice that current which the motor takes at normal load, then at normal current the voltage on the field is one-half of the full voltage. In this case the sine of the phase displacement of the current from the voltage at full load (Figs. 11 and 14) is $\sin \phi = E_L/e = \frac{1}{2}$ and consequently $\cos \phi = \sqrt{1 - \sin^2 \phi} = 0{\cdot}868$.

So we see that an ideal motor, with a short-circuit current equal to twice the normal, has a power factor of 0·868. If, generally speaking, the short-circuit current is b times normal, then $\cos \phi_{\text{norm.}} = \sqrt{1 - 1/b^2}$.

As the torque is directly proportional to the square of the current, *a machine with a short-circuit current equal to b times the normal has a starting torque equal to b^2 times the torque of the machine under normal conditions of load if under full voltage at starting.*

We must note that with increasing short circuit current the torque grows with the second power, so that the starting torque per kilovolt ampere input at starting is bigger the higher the short circuit current of the machine. If means are provided to

reduce the voltage at the terminals of the motor at starting, we can for a given torque reduce the starting current further with a better motor.

The higher the short-circuit current the better the machine. A motor, where the field winding keeps the current down when it is stationary, will also suffer from the drop in the field under full-load working.

We can easily conceive that the short-circuit current i_K fixes the current scale of the diagram $OB = i_K$. If we have calculated this figure, or obtained it from tests, we can draw the circle, and that fixes the current and power-factor curve of the whole machine. But not only this, it fixes also the maximum watt component of the current AC, which, as stated above, is equivalent to the electrical energy, the voltage being constant. The maximum AC is equal to the radius of the circle—*i.e.*, one-half of the short-circuit current—and, therefore, *the maximum overload capacity of an ideal series motor is equal to one-half of the energy consumed at short-circuit.*

A 500 volt machine having, say, 100 amperes short-circuit current can give out $\frac{1}{2} \times \frac{500 \times 100}{746} = 33\frac{1}{2}$ H.P. as a maximum.

We can ask, further, what is the maximum overload capacity of a 100 H.P. motor with a power factor of 0·85? The diagram gives the reply to this question. We draw a semicircle and AO under an angle, the cosine of which is 0·85. Then the radius of the circle, compared with the vertical AC on OB, gives the overload capacity. In our case the ratio of the maximum to the normal output is 1·27. The diagram tells us

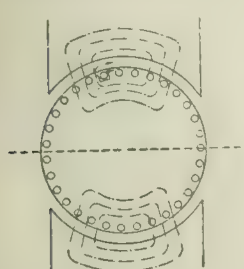

FIG. 17.—THE CROSS FLUX.

FIG. 18.—LEAKAGE OF END CONNECTIONS.

that, if the power factor of the motor is given, the overload capacity can be calculated. We can see from Fig. 15 that

$$\text{Overload capacity} = \frac{0{\cdot}5}{\sin\phi \cdot \cos\phi} = \frac{0{\cdot}5}{\cos\phi \cdot \sqrt{1-\cos^2\phi}}.$$

Fig. 16, which is available for any motor, can be directly used to solve such questions.

It remains to fix the scale for the speed in our diagram. This can be done easily by considering (Fig. 15) the moment of maximum output (A on the top of the circle). Then OA is equal to AB and $E = E_L$, therefore, $k = E_L/E = 1$. Formulæ (8) and (9) furnish us with the result:

$$k = 1 = \frac{\pi}{2} \times c \times \frac{n}{n_s} \times \frac{\text{AT field}}{\text{AT armature}},$$

(AT = ampere-turns) and the speed DF′,

$$n = \frac{\pi}{2} \times c \times \frac{\text{AT field}}{\text{AT armature}} \times n_s.$$

Speed at maximum output = synchronous speed $\times \frac{\pi}{2} \times$ leakage coefficient $\times \frac{\text{field ampere-turns}}{\text{armature ampere-turns}}$.

If the leakage coefficient is 1·1, the ratio $\frac{\text{field ampere-turns}}{\text{armature amp.-turns}} = 0{\cdot}5$. DF′ is $= \frac{\pi}{2} \times 1{\cdot}1 \times 0{\cdot}75 \times$ synchronous speed $= 1{\cdot}30 \times$ synchronous speed.

This settles the scale for the speed. Naturally, if one speed for a certain output is known from calculation or test, the scale is fixed through this.

The study of the ideal series motor has given us a general idea of the working of the machine. It remains now to consider the complications and difficulties attached to the real motor.

5. The Self-Induction of the Armature.

The armature current produces a magnetic flux, the main portion of which passes through the pole shoe and twice through the air-gap. With a direct-current machine the only effect of this cross flux (Fig. 17) is the field distortion with which we have connected the presence of the torque in the machine. With an alternating-current motor this flux is an alternating one, inducing an E.M.F. in the conductors which it surrounds—in our case the armature conductors themselves. Besides, the flux passing through the pole shoe, some lines do not reach the latter at all. They close along the air space, or only across the slots. Others surround the end portion of the armature coils, having their paths entirely in the air (Fig. 18), or using partly the surrounding iron, shaft, end bells, bearings, &c. As a rule, about 85 to 90 per cent. of the cross flux passes through the pole shoe in the regular way, finding here the shortest path in the biggest section—provided the teeth are not very highly saturated by the main flux, which increases the reluctance of the path very much. Setting aside saturation for a moment, and taking the conductors as uniformly distributed over the circumference of the armature, then at a distance x (Fig. 19) from the centre of the pole the maximum flux density is

$$B_x = \sqrt{2} \cdot \frac{\pi}{10} \times \frac{i \cdot s_a}{\lambda} \times \frac{x}{t}.$$

λ = air-gap, including an allowance for the opening of the slots, which makes the air-gap appear larger.

AW_a = armature ampere-turns, spread over the pole pitch t.

The E.M.F. induced in the $\frac{s_a}{2} \times \frac{2x}{t} = s_a \times \frac{x}{t}$ conductors by the flux passing at x is $E = \sqrt{2} \cdot \pi \times s_a \times \frac{x}{t} \times v \times B_x \times dx \times l \times 10^{-8}$ volts (Fig 19).

l = length of armature in pole in axial direction.

b = pole width, and the total E.M.F. of self-induction in the armature

$$E_{La} = 2 \cdot \frac{\pi^2}{10} \cdot \frac{s_a^2}{t^2} \cdot \frac{i \cdot v}{\lambda} \cdot l \cdot \int_0^{\frac{b}{2}} x^2 \cdot dx \cdot 10^{-8}.$$

$$E_{La} = \frac{\pi^2}{60} \cdot 10^{-8} \times s_a^2 \times i_a \times v \times (b/t)^2 \times \frac{b \cdot l}{2\lambda}, \quad . \quad . \quad (11)$$

and the wattless power consumed in the armature is

$$P_{La} = \frac{\pi^2}{60} \cdot 10^{-8} \times (i_a \cdot s_a)^2 \times v \times (b/t)^2 \times \frac{b \cdot l}{2\lambda}.$$

The ratio pole width/pole pitch $= b/t$ is of the order 0·85 – 0·89 with this class of motor. The expression $2.\lambda/b.t$ is the reluctance of the air path for the main flux, which we called R.

Putting aside the magnetic resistance of the iron, we have the same reluctance R governing P_{La} as well as P_{Lf}.

$$P_{Lf} = 7{\cdot}8 \times \frac{(i_f \times s_f)^2}{R} \times v \times 10^{-8},$$

$$P_{La}/P_{Lf} = (1/47{\cdot}5) \times (i_a \cdot s_a/i_f \cdot s_f)^2 \times (b/t)^2.$$

Since in the series motor $i_a = i_f$

$$P_{La}/P_{Lf} = (1/47{\cdot}5) \times (s_a/s_f)^2 \times (b/t)^2,$$

or, by introducing the ratio of ampere-turns

$$\frac{P_{La}}{P_{Lf}} = 1/3 \times \left(\frac{\text{armature ampere-turns}}{\text{field ampere-turns}}\right)^2 \times \left(\frac{\text{pole width}}{\text{pole pitch}}\right)^2. \quad (12)$$

This ratio is independent of the number of poles. So we see that *we can express the wattless energy consumed in the armature as a percentage of the wattless energy consumed in the field.*

The armature ampere-turns may be 140 per cent. of the field ampere-turns, corresponding to a power factor of 0·79 when it revolves at twice synchronous speed. If, further, the pole width is 90 per cent. of the pole pitch, the inductive drop in the armature is 53 per cent. of that in the field winding. This ratio is not influenced by the fringe of the lines at the pole corners (Fig. 20), the spreading affecting field and armature flux in the same way. Also the reluctance of saturated teeth, which can only approximately be taken into account, affects both in the same direction, though not exactly in the same degree.

We may assume, when using formula 12, that the leakage lines of the field (coefficient c) practically compensate for the lines sent across slots and end connectors by the armature ampere-turns.

For practical purposes our formula 12 gives quite good results.

We can easily see that the influence of the armature self-induction is the same as if it were in the field, or as if the leakage coefficient c of the field was larger. If the ratio $\frac{\text{inductive drop in armature}}{\text{inductive drop in field}}$ is 0·53, as in the example just calculated, and the leakage coefficient is 1·1, all the formulæ we developed for the ideal motor, as well as the diagram, will hold good, provided we count $c = 1{\cdot}53 \times 1{\cdot}1 = 1{\cdot}69$.

As the ratio of armature self-induction to field self-induction is fixed, it is evident that the former, just as the latter, is reduced proportionately if we increase the number of poles.

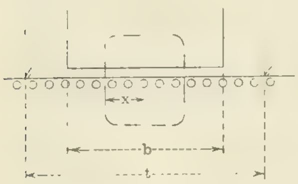

Fig. 19.

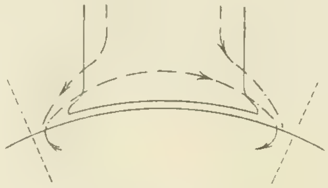

Fig. 20.

Special designs have, however, been got out to reduce the self-induction of the armature. The simplest way for reducing the cross flux seems to be the introduction of an air-gap in the middle of a pole (Fig. 21). This almost halves the self-induction of the armature provided the gap is big enough.

More effectual is the use of a *compensating winding* embedded in slots on the face of the poles. This winding carries the main current, and is so dimensioned that it has practically the same ampere-turns as the armature itself, but acts in the opposite direction, and thus stops the cross flux to a very great extent (*see* Figs. 22 and 23). What cannot be stopped by the compensating ampere-turns is the magnetic leakage across the armature slots and the ends of the armature winding. In fact, this flux will be doubled, because the newly added compensating winding has its own leakage across the slots where it is embedded and round the coil ends. About 75 per cent. of the cross flux can be nullified by the method described.

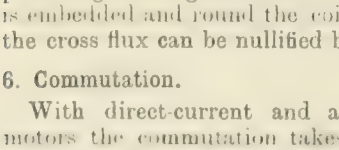

Fig. 21.—Motor with Gap in Middle of Pole.

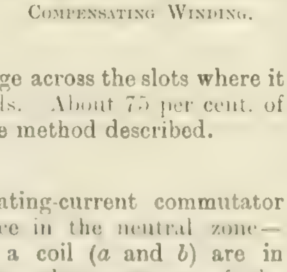

Fig. 22. Series Motor with Compensating Winding.

6. Commutation.

With direct-current and alternating-current commutator motors the commutation takes place in the neutral zone—*i.e.*, when the two active sides of a coil (a and b) are in the interpolar space. If we know the reactance of the coil we can take a fictive average reactance voltage equal to $\frac{\text{reactance field}}{\text{time of commutation}}$ as a measure for the tendency to spark. The reactance field is proportional to the current in the coil and inversely proportional to the magnetic reluctance. The latter is lower the greater the portion of the coil embedded in the iron and is also slightly influenced by the free coil ends. As the latter effect is generally small we can put Reactance field = constant × core width × current.

The constant is dependent on the form of the slot where the coils lie, but does not vary very much with the slots now in general practical use. The time of commutation is smaller the higher the speed and the higher the number of commutator bars. So we obtain a formula for the reactance voltage—

e_R = Constant × revs. per min. × commutator bars m × current per coil i × (turns per coil)^2 × core width; or

$e_R = \text{Constant} \times n \times m \times i \times (z_a/2m)^2 \times l$: $z_a/2m = w$.

It is not necessary to obtain this voltage in "volts" as we must bear in mind that the voltage does not actually exist, as it is partly used up by producing a current. At any rate, the product

$$[n \times m \times i \times w^2] = C_K \quad . \quad . \quad . \quad . \quad . \quad (13)$$

affords a means of judging the sparking conditions of a machine, and actual experience has taught us the limits we have to keep for obtaining satisfactory commutation. The coefficient is about 2·5 to 3×10^{-8} for machines where the brushes must remain in the neutral position—*i.e.*, in such a position

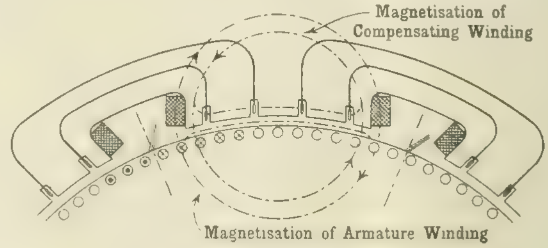

Fig. 23.

that the direction of rotation does not affect the sparking in any way. The constant 2·5 to 3×10^{-8} refers to direct current only. For alternating currents we should have to introduce the maximum of the current into the formula, or, introducing the root mean square of the current, to reduce the permissible value in the ratio $1 : \sqrt{2}$—*i.e.*, so that the constant becomes 1·8 to $2{\cdot}2 \times 10^{-8}$. On account of other conditions (circulating current, as we shall see presently) which make the commutation worse, we ought to choose the constant not higher than 2×10^{-8}.

Now, it is a well-known fact that the neutral position of the brushes with direct-current machines is not the most favourable. With a motor the commutation is better if the brushes have a backward lead. This has the effect of making the brushes follow the shifting backwards of the actual neutral zone, due to the armature reaction (section 1); it also lets the commutation take place when the short-circuited coil is under the trailing-pole corner. An E.M.F. is then induced in the coil during short-circuit, which has the direction of the counter E.M.F. of the armature winding (opposite to that of the

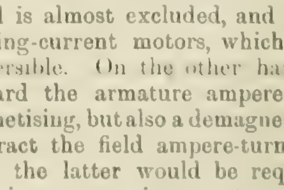

Fig. 24.

current in Fig. 24), and therefore is reversing the current in the coil under commutation. In a reversible motor, brush shifting from the neutral is almost excluded, and cannot be easily applied to alternating-current motors, which are, as a rule, required to be reversible. On the other hand, if we shift the brushes backward the armature ampere-turns not only exercise a cross magnetising, but also a demagnetising, influence. They would counteract the field ampere-turns, and therefore a larger number of the latter would be required to create a certain flux. This is a more serious matter with alternating-current machines than with direct-current ones, as the armature ampere turns are far greater in proportion to the field ampere turns than in the latter. A glance at Figs. 25 and 25A tells us that the leakage of the field will be considerably increased, and, therefore, the power factor would suffer. If, for instance, the ratio of field ampere-turns to armature ampere-turns were 0·6, a brush shifting to such an extent that the commutated coil is under the pole corner would involve 30 to 40 per cent. more field ampere-turns, the span of the armature coils being assumed equal to full pole pitch. With a non-compensated machine, brush shifting would make little improvement in

sparking, because the comparatively high armature ampere-turns, by their strong demagnetising power at the exact place in the field where the commutation goes on, would actually reverse the direction of the field at this place, so that we should not obtain the expected benefit from the brush shifting. Further, it is clear that, in actual practice a shifting of brushes together with the compensating winding would be a matter of great difficulty. These are the reasons why brush shifting is out of the question with a plain series motor.

With direct-current machines auxiliary poles are in use, which are placed between the main poles and excited by the main current in series with the armature winding (Fig. 25A).

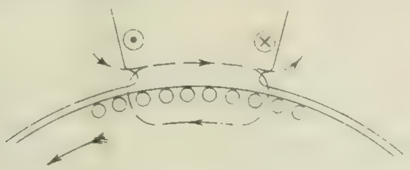

FIG. 25.

Their effect is similar to that of the trailing pole-tip under which the brushes are shifted, in order to facilitate commutation by means of the flux of the main pole. The auxiliary pole produces such a flux, but with the advantages (1) that the brushes can remain in the neutral position, the flux being now shifted to the brushes, whereby reversibility is ensured; (2) that the commutating flux increases proportionately as the current increases. Actually, the winding on the commutating poles it nothing but a continuation of the compensating winding, except that it contains a few more turns than the remaining single coils, so that it is very easy to provide for this pole with an alternating-current commutator motor.

It is very easy to apply formula (13) for the reactance voltage if all the required data are given, but for application

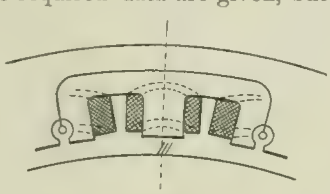

FIG. 25A.

in a more general way we will put it into a different form combining it with the formula for the E.M.F. of the armature

Taking a series-wound armature as basis, we have

$$E = z_a \times \frac{p}{2} \times \frac{n}{60} \times N \times 10^{-8} \text{ volts.}$$

Combined with formula (16) we find, after some transformation,

Total flux from all poles together

$$p \times N_{max} = 1 \cdot 12 \times 10^{18} \times \text{horse-power} \times w \times l. \quad . \quad (14)$$

Formula (14) is in words:—

The minimum total flux a machine must work with so as to run sparklessly is proportional to the horse-power, the number of turns per section and to the width of the armature.

With larger machines the number of turns per section w is 1, so for these we can put

Flux per centimetre core width

$$= p \,.\, N_{max}\, l = 1 \cdot 12 \times 10^{18} \times \text{horse-power}. \quad . \quad . \quad (15)$$

Taking the commutator diameter as large as possible, so as to reduce the number of turns per section to a minimum, say, commutator diameter = 0·85 × armature diameter, and applying as high a number of commutator bars as practicable, we can put

$$p \times N = \text{constant} \times \sqrt{\frac{\text{H.P.}}{\text{revs.}}} \times \sqrt{\text{volts}} \times \sqrt{\frac{\text{length of armature}}{\text{diameter of armature}}}.$$

In this general form the formula will do good service in forming a general idea of the amount of flux required without our knowing anything but horse-power, speed, voltage and approximately the ratio of length to diameter of armature, a figure varying between 0·5 and 0·9, the square root of this figure being 0·7 to 0·95.

(*To be continued.*)

INTERNATIONAL ELECTROTECHNICAL COMMISSION.

(*Continued from page 634.*)

We give herewith a further instalment of the schedule of terms with definitions* that has been drawn up by the Sub-committee† on Nomenclature of the British Committee of the International Electrotechnical Commission. Any criticisms by our readers will be welcomed, and may be transmitted to Mr. C. Le Maistre, British Electrotechnical Committee, 28, Victoria-street, London, S.W.

Distributing Board.—A board carrying small 'bus bars, used for connecting a number of circuits to a pair of mains. Sometimes called a DISTRIBUTION BOARD.

Distributing Mains.—The conductors which intervene between the feeders and the service lines, and which are collectively called "distributing network," or "low-pressure network," or the NETWORK.

Diversity Factor.—The number obtained by dividing the sum of the maximum loads of the individual consumers supplied from any works during a given period of time by the maximum load delivered from the works during the same period.

Draw-in Box.—A box used in connection with a draw-in system of mains. When complete it contains no links, fuses or switches, but in some cases permanent joints.

Draw-in System.—A system of laying mains in which the cables or wires are drawn into pipes or DUCTS after the latter have been laid or fixed in position, in such a manner that the cables or wires can be withdrawn at any time without disturbing the pipes or ducts. Draw-in boxes, manholes or junction boxes are usually provided through which the cables or wires may be drawn in or withdrawn.

Dielectric.—Any material which permanently offers high resistance to the passage of electric current.

Drop (in Pressure).—A difference of potential between any two points in a conductor through which a current is flowing, the conductor itself not being the seat of any electromotive force.

Drop Signal.—See ANNUNCIATOR.

Ducts.—Pipes or blocks perforated with holes through which cables are drawn. Usually non-metallic and set in concrete. The holes themselves are sometimes called ducts.

Dynamo.—A continuous current GENERATOR.

Dynamometer.—(*a*) An instrument for measuring forces. (*b*) An apparatus for measuring the torque exerted by a prime mover or motor. (*c*) An instrument for measuring electric currents depending on the measurement of the electromagnetic forces between two or more cells. (Abbreviation for ELECTRO-DYNAMOMETER.)

Ear.—In overhead tramway work. A grooved metal fitting riveted over, soldered or otherwise attached to a trolley wire for the purpose of: (*a*) Supporting the wire; (*b*) altering the horizontal direction of a trolley wire, termed a "PULL-OFF"; (*c*) anchoring a trolley wire.

Earth.—(*a*) An electrical connection with the earth, intentional or unintentional, is called an EARTH. (*b*) (Verb: to earth). To connect any conductor with the general mass of the earth in such a manner as will ensure at all times an immediate and safe discharge of electrical energy. (Board of Trade definition of "efficiently connected with earth.") (*c*) Earth circuit. A circuit of which the earth forms a part.

Earthed Circuit.—A circuit, one pole of which is earthed at one or more points.

Earth Rail.—See CONDUCTOR RAIL.

Effective Volts.—A term not recommended. See VIRTUAL VOLTS.

E.H.P.—Contraction for ELECTRICAL HORSE POWER.

Electrode.—A conductor by which an electric current passes into or out of an electrolyte or other substance.

Electro-dynamometer.—See DYNAMOMETER.

Electrolysis.—The passage of an electric current through an electrolyte.

Electrolyte.—Any substance which undergoes chemical decomposition by the direct action of an electric current passing through it.

Electrocution.—A form of capital punishment for criminals by electric shock.

Electromotive Force.—That which causes or tends to cause an electric current. Abbreviated "E.M.F." See POTENTIAL, PRESSURE, TENSION, VOLTAGE.

Exciter.—A dynamo used for exciting the field magnets of another machine. See ALTERNATOR.

Farad.—The PRACTICAL unit of electrical capacity. It is inconveniently large and therefore capacities are usually reckoned in MICROFARADS.

Factor of Safety.—The ratio of the "ultimate breaking stress" to the "maximum normal working stress."

Fault.—Any local defect in the insulation or continuity of a conductor which interferes with its use.

* Words printed in small capitals in the definitions are themselves defined elsewhere.

† The Sub-committee on Nomenclature consists of: Mr. A. P. Trotter (chairman), Col. R. E. Crompton, C.B., Mr. W. Duddell, F.R.S., Mr. J. E. Edgcome, Sir John Gavey, C.B., Dr. R. T. Glazebrook, F.R.S., Mr. Robert Hammond, Mr. H. W. Miller, Mr. F. H. Nalder, Mr. H. Talbot, Mr. L. G. Tate, Prof. S. P. Thompson, F.R.S., Mr. A. H. Walton and Mr. C. H. Wordingham.

Feeders.—Conductors for conveying electrical energy from the place where generated or transformed to FEEDING POINTS or sub-stations. Not used for supplying consumers directly, owing to the varying pressure along their length.

Feeder Box or Pillar.—(For tramways or railways.) A box or pillar containing switches, links and sometimes fuses for connecting sections of trolley wire or conductor rail with feeders. (For electric lighting and power.) A box containing links and sometimes fuses for connecting feeders with distributing networks.

Feeding Point.—The point or junction of a FEEDER with the NETWORK.

Field, Electrostatic.—Any region in which there are electric lines of force, as in the space between a positively-charged surface and a negatively-charged surface.

Field, Electromagnetic.—See FIELD, MAGNETIC.

Field Magnet.—Any magnet or electromagnet employed for the purpose of providing a magnetic field. (It is incorrect to speak of the field magnets of a dynamo or motor as its "fields"; they should be called its "magnets," if the term "field magnets" is too long.)

Field, Magnetic.—Any region in which there are magnetic lines of force as in the space between the poles of a magnet or within a magnetising coil. The intensity of the field is usually expressed in C.G.S. measure as the number of lines per square centimetre. One line per square centimetre is called a GAUSS. See LINE.

Figure of Merit.—(*a*) Of a galvanometer. The deflection in millimetres per microampere at a scale distance of 1 metre. (*b*) The current in amperes required to produce a deflection of 1 millimetre at a scale distance of 1 metre. Sometimes expressed as the number of megohms through which 1 volt will give that deflection. The complete period of a swing is taken at 20 seconds unless otherwise stated. (*c*) Of a telegraph instrument. The minimum current necessary to work the instrument with absolute certainty.

Flashing.—(*a*) Any process of manufacture involving the temporary electrical superheating of a glow lamp filament. (*b*) The coating of glow lamp filaments with a layer of carbon by heating them electrically in a hydrocarbon vapour.

Flashing Over.—The temporary formation of an arc from brush to brush on a commutator.

Flash Test.—The momentary application of a high electrical pressure between two conductors insulated from each other.

Foot Candle.—The illumination produced by 1 candle-power falling perpendicularly on a surface at a distance of 1 ft.

Fourth Rail.—See CONDUCTOR RAIL.

Frequency.—The number of complete periods per second of an alternating current. Symbol ~. The term PERIODICITY is not recommended.

Frog.—In tramway overhead work. A fitting uniting two diverging trolley wires with a single wire (*a*) provided with a spring tongue, or (*b*) pull-over tongue, or (*c*) of the fixed type.

Fuse.—The actual wire or strip of metal in a cutout, which may be fused by an excessive current.

Gauge.—(*a*) A general term applied to various kinds of measuring instruments and to linear measurements; (*b*) the thickness of a plate or the diameter of a wire on the inch, millimetre or on any arbitrary scale; (*c*) the distance between the rails of a railway or of a tramway. In the case of a railway it is the distance between the inner sides of the heads of the rails. In the case of a tramway it is the distance between the inside edges of the tread of the rails, *i.e.*, over and including the grooves.

Gauss.—A name given to the absolute electromagnetic unit of magnetic induction in the C.G.S. system.

Generator.—Any machine capable of transforming mechanical into electrical energy, *e.g.*, a dynamo or alternator.

Glow Lamp.—A term recommended instead of INCANDESCENT LAMP in order to avoid confusion with the "INCANDESCENT GAS" mantle.

Gramme Calorie.—See CALORIE.

Great Calorie.—See CALORIE.

Grid.—In an Accumulator. The framework supporting the active material.

Ground.—A term used in America, having practically the same meaning as earth. See EARTH.

[The remaining definitions are at present under consideration by the Sub-Committee.—ED. *E*].

The Liquefaction of Helium.—Prof. Kamerlingh Onnes has now communicated the details of his success in liquefying helium, announced in *The Electrician* of July 24th, to the Amsterdam Academy. He describes the apparatus, which is exceedingly complicated in nature, and the obstacles which he successfully overcame. It appears that the equipment was tested to its utmost capacity in spite of the elaborate preparations, and the professor and his assistants were very exhausted by the work involved. The results show that the boiling point of liquid helium is −268·5°C, and that after exhaustion to below 1 cm the temperature dropped to about −270°C without affecting the mobility of the liquid. The density of liquid helium is 0·15, or about double that of liquid hydrogen. The critical pressure is about two or three atmospheres, and Prof. Onnes is of the opinion that its critical temperature is not much above −268° C.

ON THE BEST METHOD OF DEMAGNETISING IRON IN MAGNETIC TESTING.*

BY C. W. BURROWS.

(*Concluded from page 643.*)

Summary.—The author first discusses the various proposed methods of demagnetising iron, and then examines the polarisation effects which have to be removed by demagnetisation. The upper and lower limits of the demagnetising force are also ascertained. The demagnetising efficiency of an alternating current is then investigated, and the time interval of demagnetisation, the normal induction, the effect of viscosity, the effect of repetition and the effects of vibration and temperature on the magnetism are all dealt with. Finally, the author gives what he considers the best method of procedure in magnetic testing.

Eddy Currents.—If we use an alternating current in demagnetising, we must consider the shielding effect which the eddy currents exert on the interior of the specimen. The magnetising force at any point is the resultant of the force due to the current in the wire and the force due to the eddy currents in the specimen. The calculation of this force presents great difficulties unless certain simplifying assumptions are made. Heaviside, in a Paper entitled "The Induction of Currents in Cores," gives a solution for the special case of a round rod of constant permeability magnetised by a simple harmonic force. This case is considered by the author and calculated values are shown in Fig. 9. The variation of the

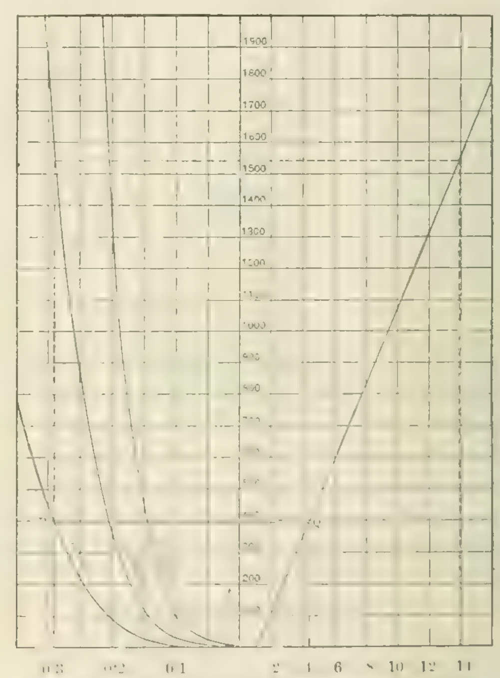

FIG. 9. THEORETICAL CURVES BASED ON HEAVISIDE'S FORMULA, SHOWING HOW THE AMPLITUDE OF AN ALTERNATING MAGNETIC FLUX VARIES OVER THE CROSS SECTION OF A ROUND ROD, FOR VARIOUS ASSUMED VALUES OF THE PERMEABILITY.

resultant magnetic force throughout the cross-section of the rod increases with increase of radius, frequency, conductivity and permeability, and leads us to expect incomplete demagnetisation by alternating currents unless relatively large currents are used. The following experiments show that the observed facts are in harmony with the theory.

Frequency of the Demagnetising Current.—The transformer iron was investigated under three conditions: (1) The apparent induction was measured with the magnetic circuit composed of the two specimens placed as close as the magnetising coils would allow and the air-gaps between the adjacent ends—that is, the specimens were not united by yokes. (2) The ends of the specimens were joined by U shaped pieces of iron of the same material and cross section. This was an attempt to have a homogeneous magnetic circuit. (3) The specimens were connected by massive soft iron yokes such as might ordinarily be used in the double yoke method. The data for this experimental work on the transformer iron are shown in Fig. 10, where curves I., II. and III. show the results obtained without yokes, with the equisectional yokes,

* Abstracted from the *Bulletin* of the Bureau of Standards.

and with the massive yokes respectively. The data for the low and the high carbon steels are also given.

The following conclusions are drawn: (1) In every case an increase in the frequency of the demagnetising current is accompanied by a decrease in the apparent induction as subsequently measured. (2) In the case of the transformer iron, the polarisation effect is greater as the cross section of the yokes increases. That the polarisation effect does not vanish when the yokes are removed shows that while the yokes modify its magnitude, they are not the cause of it. In comparing the transformer iron with the other specimens the data obtained with the massive yokes should be used, as heavy yokes were used on the other specimens. (3) The diminution in apparent induction—that is, the polarisation effect—is relatively greater in the softer material. This statement holds also for the maximum polarisation effect. The rate of increase of the polarisation effect with the frequency of the demagnetising current is greater in the softer materials.

The author gives particulars showing that the above conclusions hold for all magnetising forces. Fig. 11 is based on these data.

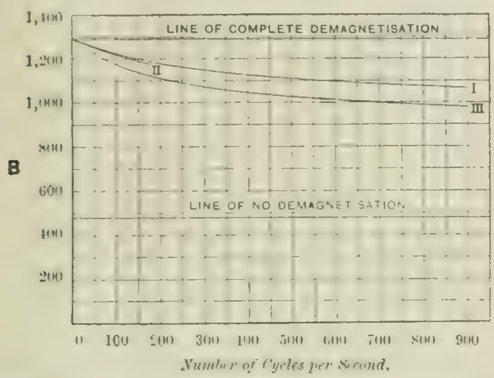

Fig. 10.—Showing the Influence of the Demagnetising Frequency on the Apparent Induction of Annealed Transformer Iron for H = 0·5.

As was expected, the demagnetising efficiency of an alternating current is less than that of a slowly reversed direct current. This difference is much greater in the thick round rod of low carbon steel than in the thin strip of transformer iron. Referring to Fig. 9 and assuming a mean permeability of 1,000 for the round rod we see that the magnetic force on the axis is only 7 per cent of the magnetising force (30 units) exerted by the alternating current of 60 cycles. So that in the case of the low carbon steel where the induction does not reach a constant value at the magnetising forces used, the incompleteness is due to the combined effect of frequency and too low magnetising current. There seems no doubt that this decrease in induction after demagnetising by alternating current is mainly an eddy current effect: nevertheless, to test this point further, one of the strips of annealed transformer iron was placed in a copper tube and the inductions measured in the regular way after various demagnetisations. The data have been expressed as

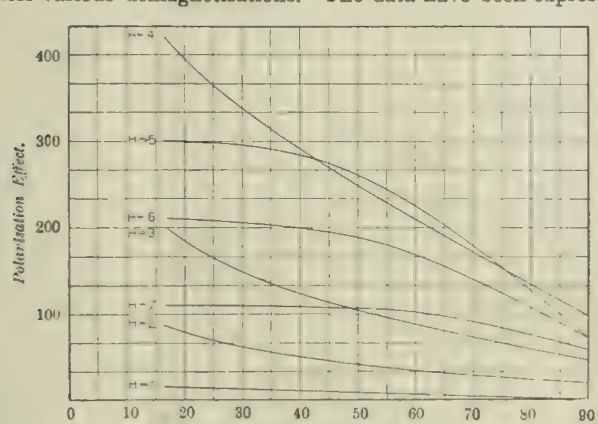

Fig. 11.—Showing how the Polarisation Effect in Low Carbon Steel, due to Excessive Frequency, varies with the Maximum Demagnetising Force.

polarisation effects and are recorded graphically in Fig. 12. From the data we may conclude: (1) The polarisation effect, even after slow reversals, is not zero as we should expect for perfect demagnetisation. (2) The polarisation after a maximum demagnetising force of 5 is much greater than it was when the copper tube was off.

Another and very important fact brought out during the course of these experiments is the uniform consistency with which results are reproduced. No evidence of imperfect demagnetisation exists except the fact that higher inductions may be obtained under other methods of demagnetisation. This probably accounts for the fact that so many experimenters consider an alternating current demagnetisation as entirely satisfactory. Furthermore, the polarisation effect remaining after demagnetisation by alternating current decreases with decrease in the thickness of the specimen, so that it is in the case of specimens of large cross section that the objections to

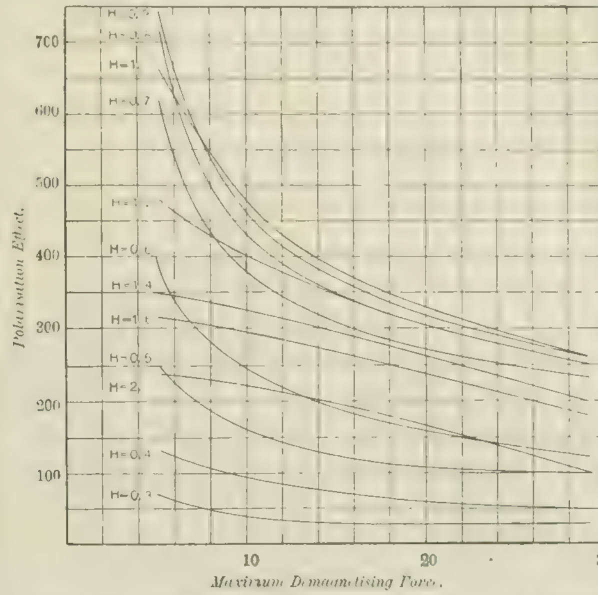

Fig. 12.—Showing how the Polarisation Effect in a Specimen of Annealed Transformer Iron, surrounded by a Copper Tube, after Demagnetisation by an Alternating Current of 60 Cycles, varies with the Maximum Demagnetising Force.

alternating current demagnetisation have most weight. As the curves of Fig. 10 cut the vertical axis at a value of the induction not far different from the value at a demagnetising frequency of one cycle per second this value may be taken in practice.

Time Interval of Demagnetisation.—To determine the effect of variations in the time interval of demagnetisation, the iron was demagnetised at a slow rate of reversal and between the limits previously determined. Tables are given by the author, and it appears

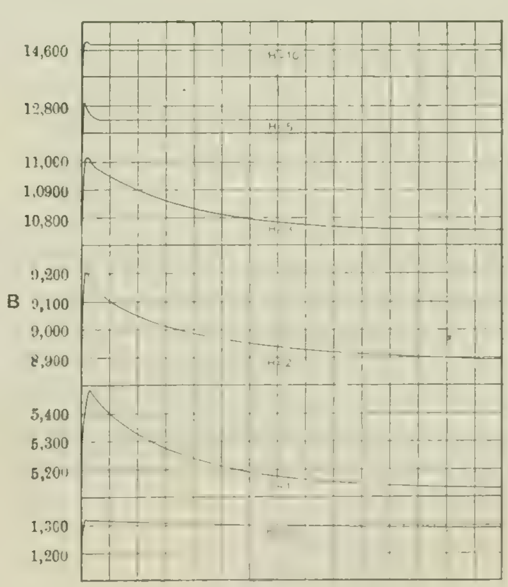

Fig. 13.—Showing the manner in which Demagnetised Transformer Iron approaches the Cyclic State for Various Values of H.

that the polarisation effect is zero for all values of the magnetising force, provided the demagnetisation has taken approximately a minute. Another table shows the effects of variations in the time interval when the demagnetisation is carried on at a somewhat higher frequency. The full effect of the demagnetisation while less than before is reached in a shorter interval of time and, therefore, seems to depend on the number of cycles rather than the time. From this it is evident that if the time of demagnetisation is kept

constant while the frequency is varied, there will be a tendency for the induction to increase as the frequency decreases as long as the time interval is great enough to allow the demagnetising current to accomplish its full effect.

The Normal Induction.—After the iron has been thus freed from all traces of previous magnetic polarisation it is ready for the ballistic determination. The true induction has been defined as the normal cyclic induction. The author has examined the manner in which the cyclic state is reached for various values of the magnetising force, and data for complete induction curves are given. The curves for transformer iron are given in Fig. 13. In view of these results it seems proper to fix upon the final minimum value of the apparent induction as the *definition* of the true normal induction.

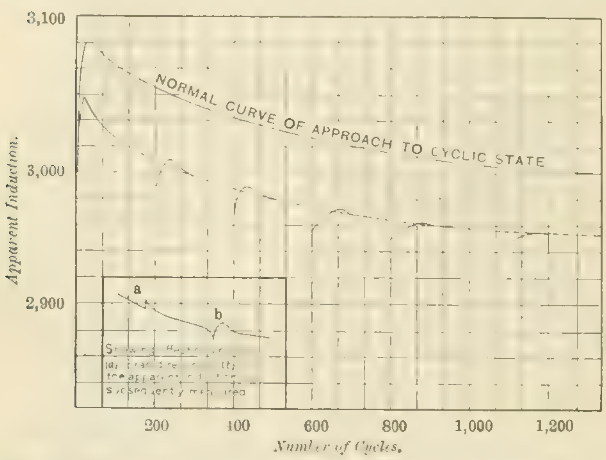

Fig. 14.—Showing how the Manner of Approach to the Cyclic State in High Carbon Steel is Modified by Rapid Reversals of the Magnetising Force and by Long Pauses.

The initial and maximum values are rejected because of their uncertainty and the fact that they cannot be verified by repetition without another demagnetisation.

Two sets of data were also obtained—one for a single demagnetisation and another in which the specimen was demagnetised before each measurement of the induction. The final values of the induction are the same in each case, and the main characteristics of the manner of approach to the cyclic state are maintained in each, one demagnetisation thus being sufficient.

Effect of Viscosity.—Fig. 14 shows the manner of approach to the cyclic state under two circumstances. The upper curve shows how a specimen of high carbon steel comes to a cyclic state on repeated reversals of the magnetising force by hand switch. The solid portion of the curve just below this shows apparent inductions as actually observed after imperfect demagnetisation. Between the solid portions of this curve reversals were made quite rapidly—several times per second. The dash lines give the hypothetical curve the apparent induction would have followed if the apparent induction had been measured for each reversal and no rapid reversals had been made. A pause at any point in the curve causes the

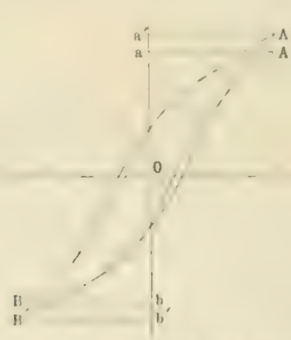

Fig. 15.—Ideal Curve to Illustrate the Effect of Magnetic Viscosity on the Apparent Induction.

apparent induction of the succeeding reversal to be a little larger than the one immediately preceding. This is most pronounced in the softer materials and for any specimen is greatest in the steep part of the induction curve. The phenomenon may be attributed to magnetic viscosity. Thus, in Fig. 15, suppose the iron has been subjected to forces of + H and − H alternately at the rate of one reversal per second. Then it will trace a hysteresis loop having its vertices at two symmetrical points as A and B. If, however, the reversals are interrupted when the iron is at the point A, the steady application of the force will cause the induction to creep from A to A'. After this creeping has ceased a reversal of the magnetising force will bring the state point down to B. A further pause will again show a creeping from B down to B', which is symmetric with A'. A magnetometric measurement would take account of this creeping and would measure the induction Oa'. A ballistic measure-

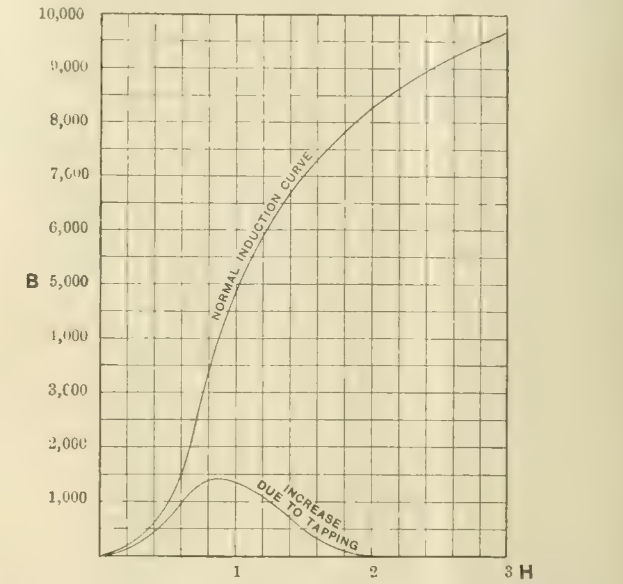

Fig. 16.—Showing the Influence of Gentle Vibrations on the Induction in Soft Iron.

ment, however, would indicate only the portion Oa, the remainder, aa' being lost on account of its slowness. This assumes that a ballistic galvanometer with sufficient torsion in its suspension to bring its movable system back to zero is used. An instrument whose movable system has no directive force, such as the Grassot fluxmeter, would measure the full induction as completely as the magnetometer. However, even with an ordinary ballistic galvanometer this full induction can be determined. Let a ballistic de-

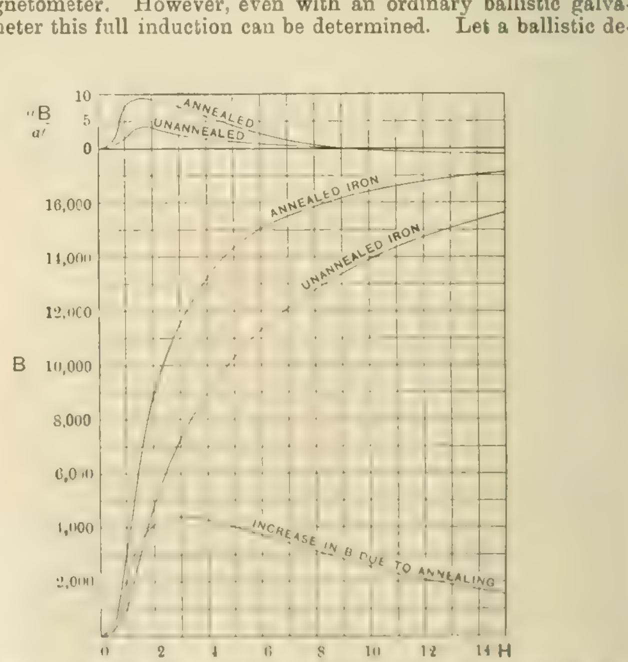

Fig. 17.—Showing the Effect of Temperature and Annealing on the Induction in Soft Iron.

flection be taken when the iron is traversing the cycle AB. This will be proportional to ba. After a pause take the deflection on the return reversal. This will be proportional to $a'b$. The second deflection exceeds the first by aa', which is the amount of creeping at one end of the cycle. The full induction would, therefore, be proportional to $ba + aa'$.

Another irregularity in Fig. 14 is the peculiar effect of several rapid reversals. After such treatment the first inductions are too

low, then the succeeding ones are too high, as shown graphically in the lower corner of Fig. 14.

Effect of Repetition The author gives particulars showing that a number of reversals of the magnetising force does not obviate the necessity of demagnetisation.

Strong Vibrations.—The effect of vibration is to shake in more induction if the magnetic force is acting, and to shake out the residual induction if no magnetic force is acting. The hysteresis loop is contracted and draws in close to the induction curve, which loses its point of inflection and apparently starts out with a maximum permeability which steadily decreases. While the increase in permeability is appreciable in moderately strong fields, it is in weak fields that the effect is most striking.

Gentle Vibrations.—Fig. 16 shows the results of experiments made to ascertain the effect of small vibrations on the magnetism. A comparison of the results with those noted under the study of viscosity shows a close connection between the creeping up of the induction due to viscosity and the same thing for tapping. Both these phenomena may be accounted for by assuming a frictional force opposing the movements of the molecular magnets. It was found that such gentle vibrations as these were of little help in demagnetising either when used alone or with current. It appears desirable that the magnetic system be protected from small mechanical vibrations. A pad of felt ½ in. thick accomplishes this very nicely for all ordinary cases.

Influence of Temperature.—It is well known that for a small rise of temperature the permeability of iron increases for low inductions and decreases for high inductions. At higher temperature this temperature coefficient is always negative and increases rapidly with the temperature, until finally the iron becomes practically non-magnetic at some temperature between 690°C. and 870°C.

Little work has been done at ordinary temperatures. Four specimens of transformer iron were examined at different temperatures, and some of the results are plotted in Fig. 17. From the data the following observations may be made: (1) The change in induction per 1°C. rise is greatest in the neighbourhood of the maximum permeability. (2) The temperature coefficient is greater for the annealed than for the unannealed iron. (3) Temperature must be taken account of if an accuracy of 1 per cent. is to be attained. (4) The increase of induction due to annealing is greatest near the point of maximum permeability.

The Best Method of Procedure.—As a result of this research the following rule may be outlined as the best (ballistic) method of procedure in magnetic testing: The magnetic system, consisting of the test pieces and the connecting yokes, should be mounted with its plane perpendicular to the earth's field. If necessary the system should be protected from mechanical vibrations by means of a pad of felt or something equivalent. If an accuracy of 1 per cent. in the steep part of the B-H curve is desired the temperature should be kept at some standard temperature (*e.g.*, 20°C.) constant to 1°C. or 2°C. It is not feasible to apply a temperature coefficient correction on account of the difficulty in getting its value. The demagnetisation should be accomplished by a current reversed at the rate of approximately one cycle per second, while gradually diminished in such a way that the rate of decrease of the induction is as nearly as may be uniform. An ammeter in circuit and a rough estimate of the shape of the B-H curve will enable one to regulate the rate of decrease of current with sufficient exactness. The initial demagnetising current should be sufficient to carry the induction beyond the knee of the B-H curve,* and the final current should be not greater than the smallest magnetising current to be used. The full demagnetisation may be accomplished in about 90 seconds. Now apply the lowest magnetising force desired and reverse at the same speed as in demagnetising. At intervals get a ballistic deflection. Continue this until two deflections about 25 reversals apart show only a negligible difference. This final deflection is the normal induction. Without demagnetising again, apply the next larger magnetising force and reverse as before.

Continue in this way till all the required points on the curve have been obtained.

* Without going to the trouble of a preliminary test an initial demagnetising force of 15 units may safely be assumed for all specimens of soft iron.

REFLECTED LIGHTING WITH METAL FILAMENT LAMPS, AT THE INNS OF COURT HOTEL, LONDON.

One of the earliest applications of electric lamps, more particularly the arc lamp, was to reflected lighting, by the simple process of inverting the arc and providing a suitable reflector. The use of inverted arc lamps has, however, been mainly confined to offices, drafting rooms, photographic studios, &c. Carbon filament lamps have met with little success for reflected lighting, a fact which may be attributed to the low candle-power of the lighting units and the high cost of electrical energy, if anything approaching a good effect was to be obtained. There should, however, be a distinct opening for the application of the metal filament lamp for reflected lighting. The low energy consumption of such lamps, combined with the fact that a high candle-power unit is available, both contribute towards the utilisation of metal filament lamps in suitable fittings for reflected lighting.

Fig. 1.—Drawing Room, Inns of Court Hotel, Illuminated by Reflected Light from Metal Filament Lamps.

An interesting installation on the above lines has recently been completed at the Inns of Court Hotel, Holborn, London. It should be noted that, previous to the adoption of the lighting scheme described later, experiments were made with enclosed arc lamps and an arrangement of reflectors. This proved entirely unsatisfactory for two reasons. The light emitted from the arcs was cold and almost repellent to the eye, and the feeding of the lamps at intervals caused either complete interruption of the lighting or an annoying flicker. Subsequently metal filament lamps were suggested as more likely to give the desired effect. It had been rightly agreed that some form of reflected lighting was desirable, and consequently, although the arcs had proved unsatisfactory, the new lamps

were to be given a trial before finally returning to the more usual but infinitely less beautiful method of scattered illumination. The prospects of the inverted system were, moreover, greatly enhanced by the lofty rooms and their general appointments.

By far the most beautiful effect has been obtained in the drawing room, which is a large room looking on to Lincoln's Inn Fields. The illumination of this is clearly brought out in Fig. 1 which depicts the room as seen at night by the light of the lamps in the special fittings hung from the ceiling. This photograph, in conjunction with the others which accompany this article, was taken by the light of the lamps themselves and without any other light, artificial or daylight. The prints also were absolutely untouched for the making of the blocks. Reference to Fig. 1 will indicate at once that the downward distribution of light is very good, and that a person seated on the couch in the foreground would be able to read easily. Three fittings are used for the illumination of the room, and each contains 10 lampholders radiating at an angle corresponding to that of the reflector below them. This reflector is of enamelled iron and can be easily cleaned. The fittings are given a pleasing and harmonious appearance by a special arrangement of basket work which is hung below the lampholder fitting and reflector and is tastefully lined with silk. The other inverted fittings in the hotel are made up in this way and we must say that the effect produced is charming to a degree.

Figs. 2 and 3 show the lighting effect obtained in the hotel foyer and one of the banqueting rooms. The former has two 10 light fittings and the latter three, but in the foyer it has not been found necessary to use all the lights in each group. Our illustrations bring up well the even distribution of the light. In Fig. 4 the Masonic Temple, itself a new feature of the hotel, is shown by the light of the 10 fittings installed for its illumination. The fittings are of bronze to a special design selected to be in keeping with the character of the meetings held in the room. Each carries two 35 c.p. tantalum lamps in place of four 16 c.p. carbon lamps previously installed. The light distribution here is very even, and, as is the case with all the other inverted fittings, there are no shadows cast. The lamps used in the various fittings are both tantalum and "Z," and it is noteworthy that the total energy consumption of these lamps is only 6 kw., in contrast with 13·5 kw. required previously for the carbon filament lamps. In all there are 27 inverted pendants installed in the hotel.

In addition to the pendants containing the metal filament lamps there are four fittings in the restaurant in which Beck flame arc lamps are used. These are hung round with basket fittings which are lined with golden silk. There is no inverted reflector, but the direct rays of the arc are allowed to diffuse themselves through the cloth, giving a soft glow to the illuminating effect.

Fig. 2 -- Banqueting Room, Inns of Court Hotel, showing Fittings for Reflected Light.

The lighting improvements in the hotel have necessitated the re-wiring of certain sections in screwed conduit, this work together with the manufacture of the metal portions of the fittings and the reflectors being carried out by Messrs. Pinching & Walton. The baskets are the work of Messrs. Goodyear. The general supervision of the installation has been in the hands of Mr. Adrian Collins, consulting engineer. Our thanks are due to Mr. Hippisley-Cox, general manager of the Inns of Court Hotel, for permission to photograph the various rooms and for his courtesy in showing us the features of the installation. We are sure that the new lighting effects which have been carried out to Mr. Cox's ideas will prove a strong attraction to visitors to whom good illumination in the principal rooms of a hotel is a desideratum.

Fig. 3.—Foyer of Inns of Court Hotel, Illuminated by Reflected Light.

Fig. 4.—Masonic Temple, Inns of Court Hotel.

THE WORK OF THE PHYSIKALISCH TECHNISCHE REICHSANSTALT IN 1907.

In such establishments as the National Physical Laboratory, researches of scientific value can be carried on unaffected by the hampering commercialism necessarily met with in industrial concerns. The results obtained in institutions of this kind both in this country and abroad are, therefore, of great interest to electrical engineers and others engaged in scientific pursuits. The pioneer in this field is, as is well known, the Physikalisch Technische Reichsanstalt at Charlottenburg, where the standardisation dear to the Teutonic mind is allowed full play with excellent results. In what follows we briefly describe the matters of electrical interest which have been dealt with there during 1907, though this by no means exhausts the activities of the institution, which include the whole range of physical science :—

The question of the constancy of standard resistances and cells is first dealt with. The former of these show little alteration from year to year, while, as regards the latter, the size of the mercurous sulphate crystals seems to exercise a deleterious effect. The question is being dealt with in conjunction with the National Physical Laboratory and the Bureau of Standards, but the researches are not far enough advanced to make any publication of results possible. As regards the silver voltameter, the difficulties experienced in weighing have been found to be due only to temperature variations, for the temperature of the plate may differ greatly from that of the surrounding air even when it has been in the scale pan for some considerable time. These difficulties have been overcome by placing the balance in a room kept at a constant temperature.

Messrs. Siemens & Halske have altered their standard 1,000 ohm moving-coil galvanometer, installed at the Reichsanstalt, so that it is now suitable for measuring resistances of the order of 10 ohms with greater accuracy than is the low-resistance galvanometer made by the same firm. The greater part of this resistance has been removed by replacing the lower leading-in wire, which was of bronze, by a silver spiral, thus reducing the total resistance to 9 ohms. The new instrument gives, with the scale 3 metres distant and a period of oscillation of 5 seconds 1 mm. deflection with $1{\cdot}5 \times 10^{-7}$ volts. It is damped aperiodically, when the total resistance is 20 ohms, and seems to work well.

The majority of the apparatus dealt with during the year in the "heavy-current" laboratory comes under the heading of measuring instruments. Of these 507 were tested and calibrated, among them instruments for wireless telegraphy, besides the more common ammeters, voltmeters and wattmeters for direct and alternate-current work.

During the year 1907 the laboratory has undergone extensions and additional machinery has been installed. These include a high-frequency alternator with a capacity of 5 kw., which supplies three-phase currents at frequencies up to 2,300. It is driven by an interpole motor whose speed can be adjusted within wide limits. Several transformers have also been added, which are so arranged that they can be connected up to give various voltages, an arrangement made possible by suitable switchgear. In order that the alternate current machines may be more advantageously used they have been connected to horizontal copper bars ; from these, by means of screwed plugs, connection is made to vertical bars, and thence to the various apparatus. The re arrangement and alterations which have taken place have permitted adequate protection to be provided in places where extra high voltages are employed.

In a former report an instrument was described for measuring small alternating currents. This consisted of a number of manganin-constantan thermo-elements enclosed *in vacuo* and was connected in circuit on Salomonson's bridge method, so that the current under test could not affect the galvanometer which measured the thermo electric power. Differences found by this method when measuring rectified and alternating currents of the same strength were not explained in spite of numerous researches. The readings of the instrument were found to be unaffected by altering the frequency between 3 and 2,500, while the error noted above was not the same in vacuo as when high pressures were used. It was thought that this difference was due to the heat generated by the Peltier effect when direct current was used, but this has lately been shown not to be the case, and experiments on the subject are still being carried on.

A number of researches have also been undertaken regarding the "contact" potential of a highly sensitive quadrant electrometer and on the electrolytic valve action of various metals, both with direct and alternate currents. Exhaustive Papers on the results of these tests have been published in the German physical journals.

Researches were made on the behaviour of the new self induction standard when submitted to high frequency alternate currents and it was found that the small self-induction of the bridge coils introduced considerable errors into the result. In "skin effect" measurements this value has to be determined, for which purpose a Wheatstone bridge, whose arms consist of "bifilar" stretched wires, has been used. With this arrangement the coefficient of self-induction can be determined from geometrical measurements and the coefficient of self-induction of high-resistance coils can be measured even when the resistance varies within wide limits. For instance, by this method the self induction of a conductor whose time constant is $1{\cdot}6 \times 10^{-8}$ seconds can be measured to within a few per cent. Measurements have also been made on the length of electric waves, the results being correct to within 0·1 to 0·2 of 1 per cent in the case of waves over 1,000 metres, while for short waves the accuracy was about 1 per cent. Researches were also undertaken on undamped oscillations, which were generated by means of a special arc whose wave length was kept constant. In this lamp the electrodes consisted of a cooled copper cylinder and a carbon rod. By means of a magnet the arc was kept constantly in rotation so th t the carbon was equally burnt away all round. This arrangement enabled constant oscillations to be obtained over considerable periods.

By means of an oscillograph due to Gehrcke, the operation of which depends on the properties of cathode rays, it has been possible to analyse electric oscillations of wave-lengths up to 500 metres. Damping and shape of the waves, oscillations in coupled systems and the influence of spark-gaps on undamped oscillations can be photographically determined by this arrangement.

In the "small current" laboratory a number of tests were carried out on electrical materials, resistances, measuring instruments and standard cells. Among the resistance sets tested was a comparator due to Diesselhorst. Several of the Clark cells tested showed variations from the standard value from 0·0004 to 0·001 volt. Two cells tested were outside these limits, and three others were defective. A number of Weston cells were tested and gave fairly constant results ; 10 were defective, especially as regards high internal resistance.

Tests were carried out on the intermittent working of several sets of dry cells, the current being allowed to flow four minutes in every quarter of an hour. It was found that allowing the terminal voltage to drop to 0·8, 0·6 and 0·4 volt respectively, the capacity of the cell was 40 per cent., 10 per cent., and 5 per cent. greater than when continuously discharged to the same terminal voltage. The quantity of current given out as the voltage drops from 0·8 to 0·6 volt seems to depend to a great extent on the quality of the manganese dioxide used. Work on standard cells and the silver voltameter have been carried on in conjunction with the Bureau of Standards, the Laboratoire Central d'Electricité and the National Physical Laboratory.

The question of the alteration of wire resistances with the humidity of the atmosphere has been thoroughly gone into with the Bureau of Standards, and the results were summarised in *The Electrician*, Vol. LIX.. pp. 339, 626. During the year 21,067 meters have been tested, 10,621 restandardised, and 4,598 repaired for various electricity supply works. Systematic tests were also carried out on a number of makers' instruments.

THE DIRECT PRODUCTION OF COPPER TUBES, SHEETS AND WIRE.*

BY S. O. COWPER-COLES.

Summary.—The author describes electrolytic processes for the production of copper tubes, sheets and wire, and shows how he has been able to employ current densities up to 500 amperes per square foot by using revolving cathodes, although 200 amperes per square foot is found to be the most economical density. Particulars are also given of an ingenious method for producing copper wire by electrolytic means.

The refining of copper by electrolysis has now assumed vast proportions, and the annual output of electrolytic copper in the year 1907 has been estimated at 400,000 tons, equal to 56 per cent. of the world's production, and the capital sunk in the industry at about £15,000,000. The whole of the copper thus produced is in the form of rough slabs or cathode plates which have to be smelted and worked to the desired forms. Electrometallurgists have been striving for many years to devise a process which does away with the smelting of copper after it has been electrolytically refined, and to electro-deposit copper after the refining operation in such a form that it can be placed direct on the market as finished sheets, tubes and wire.

Wilde's Process.—It was observed shortly after Elkington practically applied Faraday's law to the refining of copper in the year 1865, that the electric current density, or the rate at which the copper is deposited, could be considerably increased by circulating the electrolyte or moving the electrodes. It was soon found that circulating

* Abstract of a Paper read at the recent Bristol meeting of the Institution of Mechanical Engineers.

the electrolyte alone was unsatisfactory, and that the best results could be obtained with a vertical mandrel revolved in the electrolyte. Wilde was one of the first to use a cylindrical cathode, his object being to deposit copper on iron rollers suitable for textile printing purposes, for which he took out a patent in the year 1875. The anodes consisted of copper cylindrical tubes, and the iron cylinder to be coated with copper (the cathode) was placed in the centre of the cylindrical vat and caused to rotate on its axis. Such an arrangement, in conjunction with a circulating propeller, placed in the electrolyte, ensured an even distribution of copper over the whole of the surface uniformly along the length of the roller by means of the motion imparted to the solution, and the equal density thus maintained. The current density was low, considerably under 20 amperes per square foot.

Elmore's Process.—The next development of importance was the Elmore process, which consists of using horizontal mandrels on which copper sheets or tubes are deposited, while agate burnishers travel continuously over the copper, so as to consolidate it, and at the same time prevent the growth of copper trees or nodules. Even with the use of a burnisher the current density could not be increased beyond 30 amperes per square foot, and the mechanical difficulties introduced by the burnisher are considerable. Large works were erected to operate this process near Leeds and on the Continent, and are principally engaged in the production of large tubes and cylinders for special purposes.

Dumoulin's Process.—Dumoulin introduced, at a later date, a process for burnishing copper during deposition with sheepskin as a substitute for agate, and claimed that the process had also the advantage of insulating any projections that might be formed on the

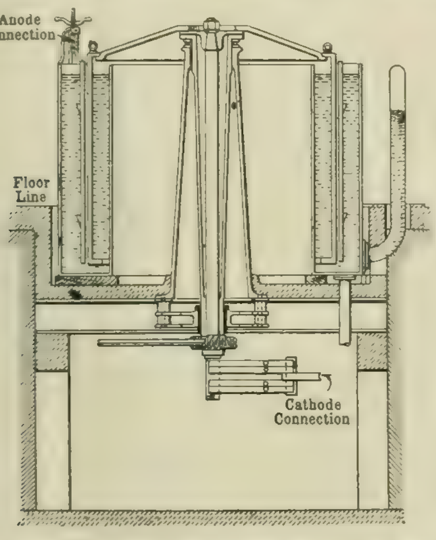

FIG. 1.—VAT USED FOR CENTRIFUGAL PROCESS.

deposited metal, the sheepskin impregnator coating all projecting parts with a thin film of animal fat, thus preventing further deposition until the surrounding depressions are raised to the common level. It was also claimed for this process that a current density of from 30 to 40 amperes per square foot of cathode surface could be employed at a voltage of about 1·6 per vat. This process was tried on a large scale in England but was soon abandoned.

Other Processes.—Attempts have been made at various times to further increase the rate of deposit by Swan, Elmore, Thofehrn, Graham, Poore and others, by impinging jets of the electrolyte against the cathode surface. The quality of the copper is liable to vary in density if impinging jets alone are employed; it is therefore necessary to remove the cathode, otherwise the copper is deposited in the form of annular rings of varying density and smoothness.

The author, when carrying out some experiments on the production of copper tubes and sheets by electro-deposition on rotating cathodes, observed that when the speed was greatly increased entirely new results were obtained, and that a current density of 500 amperes or more per square foot could be employed, the copper remaining smooth and having a tensile strength equal to the best rolled or drawn copper, and in some cases a tensile strength some 50 per cent. higher than that obtained by the ordinary process of casting and rolling, the tensile strength increasing with the rate of rotation of the mandrel. The result of revolving a mandrel at a comparatively high speed is that every molecule, as it is deposited is burnished or rubbed down so as to produce a tough fibrous copper, the usual order of things being reversed, the present practice being to put the mechanical work into a mass of copper by rolling or drawing instead of treating each molecule separately.

Centrifugal Process.—This observation led to further experiments, which resulted in evolving the process now known as the centrifugal copper process for the manufacture of sheets, tubes and wire, which will now be described in detail, together with the results obtained.

After a long series of experiments had been made to determine the best composition for the electrolyte and the most economical current density to employ, the critical speed was accurately determined by means of revolving cathodes in the form of cones. By observing the point at which the copper remains smooth, and by measuring the circumference of the cone at that point and multiplying it by the number of rotations per minute, the critical speed is readily determined; 200 amperes per square foot is found to be the most economical current density, although a current density up to 500 amperes per square foot can be employed by increasing the rate of rotation,

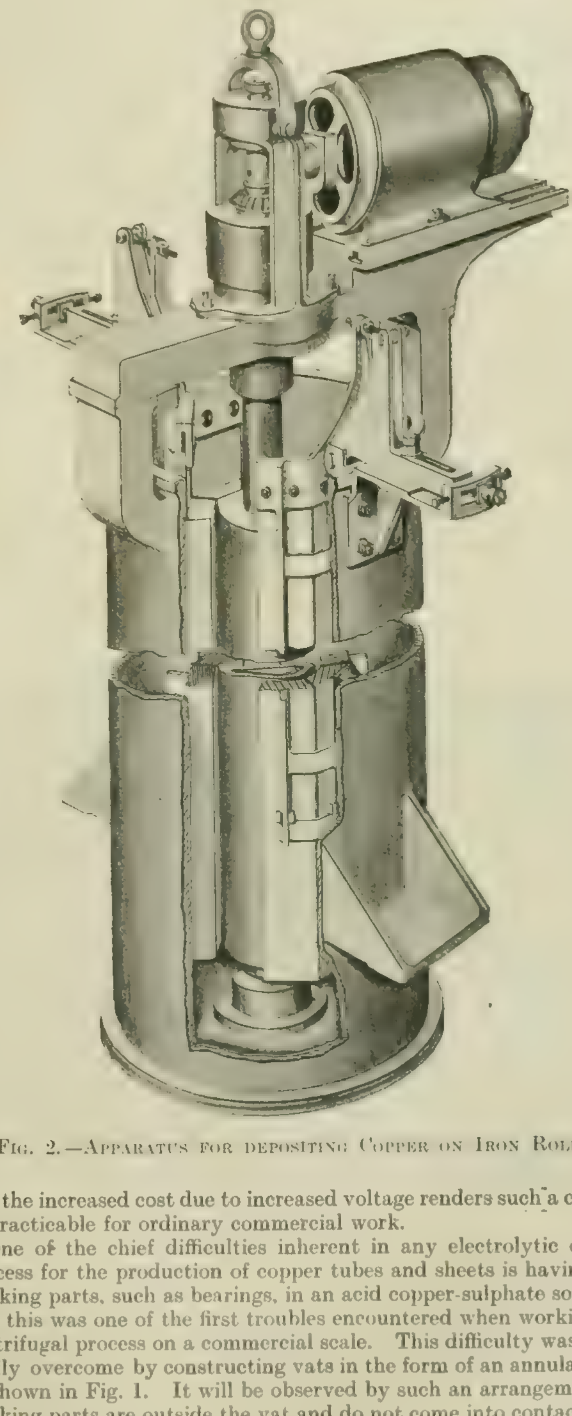

FIG. 2.—APPARATUS FOR DEPOSITING COPPER ON IRON ROLLS.

but the increased cost due to increased voltage renders such a current impracticable for ordinary commercial work.

One of the chief difficulties inherent in any electrolytic or wet process for the production of copper tubes and sheets is having any working parts, such as bearings, in an acid copper-sulphate solution, and this was one of the first troubles encountered when working the centrifugal process on a commercial scale. This difficulty was eventually overcome by constructing vats in the form of an annular ring, as shown in Fig. 1. It will be observed by such an arrangement all working parts are outside the vat and do not come into contact with the electrolyte, so that the bearings can be lubricated in the ordinary way; only the actual face of the mandrel on which the copper is to be deposited is immersed in the electrolyte. The cathode consists of a steel or cast-iron cylinder closed at one end, to which is attached on the inside a steel rod projecting below the edge of the mandrel to guide it into position; the cylinder can be 5 ft. or 6 ft. in diameter, or

even larger, so as to produce a copper sheet of, say, 20 ft. long by 4 ft. or 5 ft. broad. Anodes composed of crude copper are placed around the mandrel with intervening spaces and are fed forward by suitable mechanical means, as the copper dissolves away, so as to keep the voltage constant.

One great advantage of the centrifugal process is that a very low voltage is required even when employing a very high current density; for instance, only 0·8 volt is required at the terminals of the vat when working at a current density of 200 amperes per square foot of cathode surface. The effect of revolving the cathode is five-fold. Firstly, it keeps the electrolyte agitated, so that there is always a fresh supply of copper ions in proximity to the cathode; secondly, each molecule of copper as it is deposited on the cathode is burnished or rubbed down by means of the skin friction between the revolving

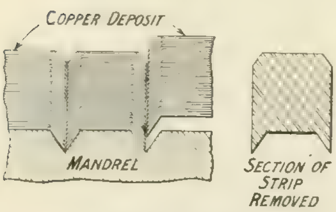

Fig. 3.—Diagram showing Method of forming Weak Line of Cleavage due to Crystalline Structure.

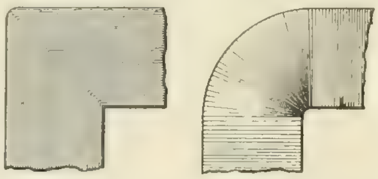

Fig. 4.—Diagram showing the Effect of Sharp and Rounded Corners on the Crystalline Structure of Metal Castings.

cathode and the electrolyte; thirdly, the rotation prevents any foreign matter that may be in suspension in the electrolyte settling on the cathode and becoming entangled by further copper being deposited around or over it; fourthly, it brushes away any air-bubbles on the cathode, which are the cause of nodules forming; and fifthly, the rotation of the cathode ensures the thickness of copper being uniform even when a mandrel of, say, 8 ft. in length is employed.

The method of making tubes by the centrifugal process is as follows: A mandrel somewhat smaller than the finished internal diameter of the tube is prepared by coating it with an adhesive coating of copper by first depositing copper upon the surface from an alkaline solution and then thickening it up in an acid solution, the surface being highly burnished and treated chemically to ensure the

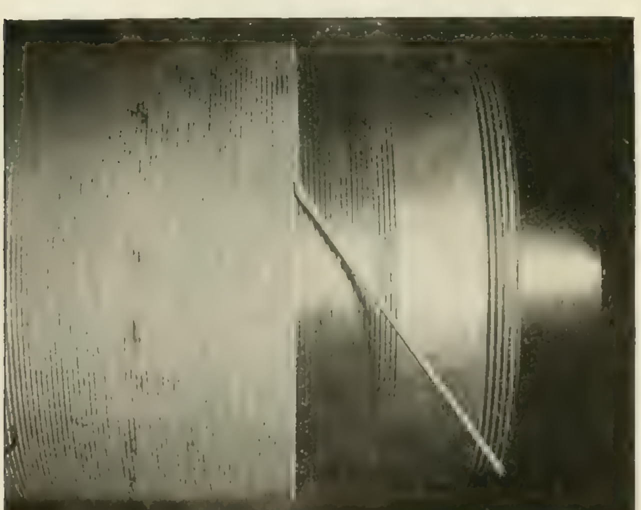

Fig. 5.—Mandrel showing Method of Unwinding the Copper Strip.

easy removal of the deposited tube. The mandrel thus prepared is then placed in a vat as shown in Figs. 1 or 2, according to the diameter of the tube and its length. When the desired thickness has been obtained, the mandrel is removed and placed in a horizontal or vertical lathe, and a round faced roller run over the surface so as slightly to expand the deposited copper, which can then be readily drawn off. Copper sheets are prepared in a similar manner, the only difference being that the mandrels are of much larger diameter, and a narrow insulating strip is fitted down one side so that the sheet can be easily removed by inserting a tool under one of the edges of the deposited copper. It is no more costly by the centrifugal process to make thin sheets than thick ones; copper foil can be made in five minutes direct from crude copper.

Copper tubes produced by this process without any drawing have given a maximum stress of 17 tons, and tubes after drawing have withstood a pressure of 3,000 lb. per square inch without showing any signs of distress. Sheets made without any rolling have given a maximum stress of 28 to 30 tons and more per square inch according to the peripheral speed at which the mandrels were revolved. Particulars of tests are given in the Paper.

The formation of copper trees and nodules was another difficulty that had to be overcome, but which has been reduced to a minimum in the centrifugal process, for the reason that impurities held in suspension in the electrolyte have no opportunity of settling on the cathode, and all gas bubbles are swept from the surface on which the copper is being deposited. Photographs reproduced in the Paper show the way in which nodules crystallise radially from a microscopic nucleus differing in their structure from the copper sheet which crystallises at right angles to the surface of the cathode, thus forming a weak line of cleavage enabling the nodules to be easily separated from the copper sheet; for which reason it is impossible to produce a good sheet by any after process of rolling. The form of the nodules or trees is largely dependent on the amount of free acid in the electrolyte; if the percentage is high, the form is rounded; if the percentage is low, then the growth is more fern or tree-like. The percentage of free acid employed in the centrifugal process is high, amounting to 12 or 13 per cent. The electrolyte, the usual composition of which is 12·5 per cent. of copper sulphate and 13 per cent. of sulphuric acid at a temperature of 40°C., is kept in the cupric state and the impurities in suspension separated by means of a centrifugal filter provided with arc lights and an atomiser for breaking the solution up into a fine spray. It has been found that by subjecting the solution to a strong light the impurities are more easily precipitated, and the solution is kept in the cupric state.

The production of copper wire by electrolytic means is a more difficult problem than the production of copper tubes and sheets. Various processes have been suggested and tried from time to time, such as the electro-deposition of copper on thin wire, until it has obtained a considerable thickness, and then drawing the thickened wire down to a comparatively fine wire. Swan and Saunders have both experimented with such processes, but so far they have not been worked commercially. Elmore's process consists of producing copper tubes by his burnishing process, cutting them into long spirals and then drawing them into wire. Other experimenters have tried placing an insulated spiral strip on a cylindrical mandrel so as to produce long copper spirals, but such an arrangement only allows of a very low current density being employed, on account of the nodules which form on the edges of the strip, even at very low current densities, rendering the strip unsuitable for drawing down into wire.

Copper wire is made by the centrifugal process in the following manner:* A mandrel similar to that used for making copper sheets is employed, around which a spiral scratch is made, the pitch being determined by the size of wire required. The effect of the spiral scratch (which need only be very light, but must be angular) is to cause the crystalline structure of the copper to form a cleavage plane, as shown in Fig. 3. It will be observed that the copper divides exactly at the apex of the scratch, that is, the copper deposited in the scratch is equally divided and forms a small V-shaped fin on two sides of the copper strip, Fig. 3. If the scratch is not angular, but rounded at the base, the copper will not divide, as the crystals are radial, as shown in Fig. 4. After the desired thickness has been obtained, approximating the pitch of the spiral scratch, the mandrel is removed from the depositing cell and placed in a vertical position on a lathe, and the copper strip is unwound at an angle of about 45 deg. to the face of the mandrel, Fig. 5. During the process of unwinding, the small fin or burr is removed by passing the wire through a suitable die and then through a wire-drawing machine provided with three or more draw plates to reduce the strip to the desired diameter. By employing a mandrel of 6 ft. or 7 ft. in diameter, lengths of wire 4 or 5 miles long can be made in one operation.

Conclusion.—The advantages of an electrolytic process as compared to a smelting process are many, and the day is not far distant when copper will no doubt be leached direct from the ore and electrolysed with insoluble anodes, to produce finished copper sheets and tubes in one operation direct from the ore without the intermediate process of smelting and refining. The centrifugal process is a step in this direction, as it is capable of depositing copper from its solutions by using insoluble anodes in the form of finished tubes or sheets in one operation. The centrifugal process is at least 10 times faster than any existing electrolytic process, and a high current density can be employed without deteriorating the quality of the copper. There is no risk of lamination, as no burnishers are employed. The plant is simple and free from mechanical complications, and the amount of copper locked up for a given output is small compared to other processes.

* Described in *The Electrician*, p. 136, Nov. 10, 1905.

In an appendix to the Paper diagrams are given showing the comparative cost of producing copper sheets and wire by the process of smelting, refining and rolling, as compared with the centrifugal process. For sheets the centrifugal process shows a saving of £2. 10s. per ton and for wire £7 per ton.

The following is a typical percentage analysis of the copper produced by the centrifugal process: Iron 0·0189, arsenic 0·0015, lead 0·0013, antimony 0·0010, bismuth 0·0008, silver absent, nickel absent, sulphur absent, copper (by difference) 99·9765; total 100. Under favourable conditions the theoretical weight of copper is obtained, and a table given in the Paper shows the weights and thicknesses of copper deposited in an hour at the current densities usually employed.

The capital expenditure of a plant for the centrifugal process both for the manufacutre of sheets, tubes and wire, compares very favourably with an up-to-date rolling mill and wire-drawing plant. The cost of such a plant, with buildings, is about £80,000 for an output of 100 tons per week or 5,000 tons per year. The following is an estimate of the cost of a plant for the centrifugal process capable of dealing with 10,000 tons of tubes, sheets, and wire per annum:

Estimated Cost of Plant for producing 10,000 tons of Tubes, Sheets, and Wire per annum by the Centrifugal Process.

Cost of 95 vats and accessories	£64,000
Machinery for finishing tubes, sheets and wire	5,000
Cranes and lifting gear	1,500
Building	15,000
Plant for mandrel-making	2,000
Machinery for fitting shop	1,500
Pumps, atomisers, filter tanks	5,000
Driving machinery for vats	5,000
Conductors and electrolyte	5,000
	104,000
Floating capital for copper	30,000
	£134,000

Estimate of Cost per ton of producing Copper Tubes, Sheets and Wire by the Centrifugal Process direct from Crude Copper.

Power per ton (2,240 lb.), 1,015 kw.-hours at 0·275d. per kw.	£1	2	2
Wages at 8d. per hour, 18½ hours	0	12	4
Management	0	5	0
Interest on copper lock-up	0	1	0
Depreciation on plant and building	0	10	0
Heating electrolyte	0	1	0
Finishing and gauging	0	5	0
Cost per ton	£2	16	6

These figures represent the actual working cost on which there would be a further reduction of the precious metals recovered, and if £1. 10s. be deducted from the above cost, which may be taken as an average difference between Chili-bar and electrolytic copper, the cost per ton is reduced to £1. 6s. 6d.

A TANTALUM WAVE-DETECTOR, AND ITS APPLICATION IN WIRELESS TELEGRAPHY AND TELEPHONY.*

BY L. H. WALTER, M.A.

It has been known for some years that the metal mercury lends itself well to the purpose of constructing a detector of electric oscillations which is capable of spontaneously returning to its initial or sensitive condition, or, in other words, is spontaneously decohering. The two elements which have hitherto been known to show this property when used in conjunction with mercury are iron (steel) and carbon. Both of these have been employed, singly or together, in the Italian Navy coherer, otherwise known as the Castelli or also the Solari coherer. The use of carbon is, however, very undesirable for reasons which are well known, while iron is a very unsuitable metal for use in places where there is any considerable amount of moisture in the air;† at the best it is only a question as to how long rusting can be deferred.

These considerations had, as early as 1902, led the author to consider means for utilising a noble metal in combination with mercury. It was at that time found impossible to make use of platinum without the employment of some liquid dielectric—in this case pure water—interposed between the mercury and the platinum, and then only when the platinum wire was glass-sheathed. Such an arrangement required, in addition, to be mechanically restored to the sensitive state.* The recent trend of work in wireless telegraphy has all been in the direction of the employment—at least for general use—of telephonic or aural reception, and hence coherers have mostly fallen into disuse, especially as the only reliable and durable ones were those which required mechanical restoration. The advent of the tantalum lamp, which appeared to promise that this hitherto unobtainable metal would soon be commercially available, seemed to hold out some possibility of successfully overcoming the previous difficulties in the way of finding a suitable noble metal. For the fact that tantalum is a noble metal in so far as its chemical behaviour is concerned; that it is indifferent to atmospheric influences; that it has great strength and ductility; and, finally, that it is absolutely indifferent to mercury, seemed to bear out the above view. The chemical and physical properties of tantalum have been fully dealt with by von Bolton and by von Pirani, and owing to the importance of the metal in the incandescent lamp industry these have become fairly generally known. One difficulty presented itself at the outset, in that it was impossible at that time (whatever may be the case at present) to obtain even the smallest quantity of the metal in any other form than fine wire as is used in the tantalum lamps. It was, therefore, necessary to try whether under the apparently unfavourable conditions which the use of the metal in such a form imposed, any wave-sensitive effect could be observed when used with mercury.

A first experimental detector was made by passing two tantalum wires, taken from an ordinary tantalum lamp, down two fine glass capillary tubes, and allowing the wires to project about 1/20 inch, and their points to just touch the surface of a small pool of mercury. The sensitiveness of the metal to heating when in the state of fine wire made it impossible to solder joints satisfactorily, and so in later forms the tantalum wire was held in a minute clip hammered out at the end of a stouter platinum wire. Trials of this detector gave remarkable and unexpectedly good results. It was found that both the liquid dielectric and the insulating sheathing could be dispensed with, and yet a perfect spontaneously restoring detector be

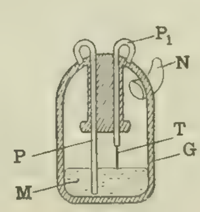

FIG. 1.

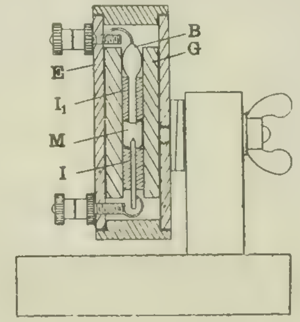

FIG. 2.

obtained, and one that, while exceedingly sensitive, gave signals which are notable for their loudness and pure tone. Further, the mercury surface could be made as large as was desirable, with benefit to the sensitiveness, as opposed to the case of the Italian Navy coherer, where it is only by the artificial augmentation of the surface tension of the mercury relatively to its mass (*i.e.*, by reducing the diameter of the mercury globule) that the spontaneous restoration is rendered at all possible. It was soon found that better results could be obtained with a single tantalum point, provided this was connected to the negative pole of the potentiometer arrangement, the best applied voltage being apparently 0·2 to 0·4 volt.

The general construction and actual size of the detector as now used is shown in section in Fig. 1, the whole arrangement being hermetically sealed in a glass bulb. Here P is a sealed-in platinum wire, forming one terminal, dipping into a small pool of mercury M, in the glass vessel G; the other terminal is also a platinum wire P_1 having a clip at its end, holding a short length (3/16 inch about) of tantalum wire T of 0·05 mm. diameter. The sealed-in platinum loops form a handy means of connecting up, with the aid of a lamp-holder of the Swan type. Before sealing up, mercury is poured into the bulb, through a small side neck N, to such a level that the tantalum point is just immersed, which is best ascertained experimentally by the sound in the telephone receiver. The bulb can then be sealed, having previously been exhausted, if so desired. When properly constructed such detectors are permanent, and do not deteriorate apparently, at any rate over a considerable number of months, which is as long as they have been available up to the present. To guard against accidental breakage of the fine wire point, three such wires are now generally held in the clip, two being turned up out of the

* Paper read before the Royal Society.

† J. A. Fleming, "Principles of Electric Wave Telegraphy," p. 371.

* Prasch, "Sammlung Elektrotechnischer Vorträge," Vol. VI., p. 254.

way; either of these can at any time be bent down into the mercury by means of a wire inserted after opening the sealed neck, the bulb being then resealed. For this reason the bulbs are preferably left unexhausted. The author has carried one of these detectors about in his coat pocket and in a hand-bag to France and other places, and after seven months the fine point is absolutely unmoved from its original position in spite of the hundreds of times the half ounce or so of mercury in the bulb has been jolted about. This disposes of any idea that the point arrangement is at all fragile.

Detectors of this form have been tested at actual wireless telegraph stations, and it has been found that, while possibly not so sensitive for very weak oscillations (signals) as the electrolytic or magnetic detector, for slightly stronger oscillations the sound is *several times louder* than that obtained with the electrolytic, which is itself much more sensitive than the magnetic detector, and these results were obtained when each (the tantalum and the electrolytic) detector had the telephone most suitable for it. With the same telephones as are supplied with the "Telefunken" apparatus for use with the Schloemilch electrolytic detector, and consequently not so suitable for the tantalum detector, the signals obtained when the latter replaced a new Ferrié electrolytic detector were several times louder. (It is notoriously difficult to estimate telephonic sounds quantitatively, but the signals can be described as "good readable" and "loud" in the case of the electrolytic and the tantalum detectors respectively.) With the second detector made, very loud signals were obtained at a distance of 70 miles over sea, without any attempt at tuning, louder than those obtained with the electrolytic detector with the aid of a step-up oscillation transformer and careful tuning. Using one of the less satisfactory of the later models of the tantalum detector, loud commercial signals have also been obtained at a distance of 450 miles, the transmitter in this case not being one of the high-power stations, which are but poor tests, but an ordinary 2-kilowatt ship installation. The signals were in this case only slightly less loud when the tantalum detector replaced the electrolytic detector in the circuit, and since the very high resistance telephones used were not suited to the tantalum detector, it is clear that the latter may be regarded as on practically an equal footing with the electrolytic detector, provided the signals are not too weak. The apparent want of sensitiveness for very weak signals is due to the slight hissing sound which is normally present in all such imperfect contacts, with mercury especially, though it is on a reduced scale as compared with the Italian Navy coherer.

An examination of the tantalum detector by the resistance substitution method shows that in the receptive condition this has a fairly low resistance, 1,200 to 1,800 ohms (as compared with the filings coherer, 100,000 ohms or so; and the electrolytic detector, 30,000 to 50,000 ohms.). This low resistance should prove beneficial to the tuning in certain cases. When oscillations are acting, the resistance drops to anything from 250 ohms. for strong, to 70 ohms., say, for very strong signals. The great loudness of the signals obtainable with the tantalum detector is due to the large change in the current through the telephones. For this detector the ratio of the current when oscillations are acting to that in the normal condition ranges from 3 : 1 to 8 : 1, and can amount to 30 : 1 without reaching the maximum sound obtainable; the normal current, using 580-ohm telephones, is about 1/20 to 1/10 milliampere. For the purpose of comparison the same ratio has been measured for a coherer of the Italian Navy type. This gave a current ratio of 3 : 1 (about) as a maximum, above which it cohered permanently; it was more usually 3 : 2, at least in the author's experiments. The results with an electrolytic detector were not satisfactory, so that it is preferred to quote Reich's statement,* that this ratio can easily reach 10 : 1. It will thus be seen that the electrical behaviour of the tantalum detector approximates more to that of the electrolytic detector, as also does the sound. Although the resistance of the tantalum detector is low, there is little likelihood of the point being damaged, for unlike the case of a solid metal-to-metal contact, a welding of the contacts is excluded, and no case has been observed in which it has been possible, with very powerful oscillations, to prevent the spontaneous return to the decohered state.

In spite of the fact that, as shown, the tantalum detector is a sensitive, useful, and long-lived receiver for wireless telegraphy, it is, in the author's opinion, not so specially suited for this purpose as for the closely related branch of signalling—wireless telephony. For this more recent application of electric wave propagation the use of microscopically weak signals—such as are at present so favourably regarded in some quarters, for the purpose of covering long distances with a minimum amount of power and, probably, of enhancing the possibility of tuning out—is obviously out of the question, and here it is that the superiority in loudness of the tantalum detector for moderately strong oscillations comes in. This is particularly the case owing to the fact that the electrolytic detector, which has been most generally used for wireless telephonic purposes up to the present time, cannot claim to be quite satisfactory as regards tone, reproduction of speech being rather harsh and metallic. It further, as Tissot has lately shown,* very soon, with quite moderately weak oscillations, reaches its maximum of loudness, and beyond this all additional energy is wasted, since it contributes nothing to the loudness. The harshness has been referred to by de Forest, who now uses for wireless telephony his adaptation of Fleming's "oscillation valve," which he has for some reason renamed the "Audion." The life of such a detector is, however, very limited, being determined by that of the lamp filament employed; it is unlikely that this will amount on the average to more than 800 hours.

The form of detector just described, while serving very well for use in fixed stations where a firm support can be obtained, is not so satisfactory when the detector is liable to be subjected to shaking or mechanical shocks during the reception of messages. Of existing forms of detector there are several which are rather sensitive in this way, and since a detector capable of withstanding rough usage may be useful in certain cases, it was thought desirable to find some method of immobilising the mercury while not interfering unduly with the sensitiveness to electrical stimuli or with the loudness of tone. Various devices have been tried without success, but one satisfactory solution is arrived at by constructing the detector in the following manner:—The tantalum wire is fastened in a platinum clip and the end of the tantalum encased in glass by a special method, necessitated by the impossibility of sealing-in tantalum in the ordinary way as is done with platinum. The platinum wire is sealed into a minute glass bulb B (see Fig. 2) blown on one end of a glass tube; the other end of the tube is connected to an air pump and the interior exhausted. The glass tube is next heated, when the vacuum causes it to collapse on to the tantalum wire. The end of the glass-sheathed wire can then be ground down so that the tantalum surface is just flush with the glass (simply breaking off the glass end usually suffices). The mercury is contained in a glass tube G, having a bore of 5/32 inch. A larger tube would be better, but the sensitiveness to shaking then reappears; a smaller tube gives a less sensitive and more variable detector. An ivory plug I, through which a platinum or nickel wire passes and projects, is placed at one end of a length of a few inches of such glass tube with thick walls. A few drops of mercury—enough to form a pellet (M) about 5/16 inch long—are then put in and a second ivory plug I_1, this one with the sheathed tantalum wire passing through it and projecting about 1/20 inch, inserted so that the tantalum glass surface just dips into or under the mercury surface. The best (most sensitive) position is that shown in Fig. 2, with the glass tube vertical and the tantalum electrode at the top, and this gives a detector which may be roughly shaken or tapped during the reception of signals, without affecting their sound in any way. For sealing up, the whole arrangement is encased in an ebonite tube E, and the ends filled in with insulating compound. The device is then permanent, though experience (time) is wanted to decide whether it is as inalterable as the first form.

As it seemed somewhat remarkable that such exceedingly good results should be obtainable with tantalum, the first metal tried, a series of experiments was carried out, using mercury in conjunction with other metals hitherto untried by the author, especially those which are most resistant to the action of mercury. In the case of the metals, iron, steel, nickel, and tungsten, and "Eureka" resistance alloy, the metal was obtainable in the form of fine wire, and was used as a point just impinging on the mercury surface in exactly the same way as with the tantalum point. But with all these metals it was quite impossible to obtain anything but a "perfect" contact, even when the mercury was reduced to a quite small globule and the applied potential difference was reduced to a very low value, 0·1 volt or less. The tungsten here was not, perhaps, perfectly metallic, being that taken from an "Osram" and from a tungsten-zirconium lamp. Trials were also made with the so-called "high-resistance" tantalum wire, *i.e.*, wire which has been nitrogen treated after the method described by the General Electric Co. of America—a matter which has formed the subject of a previous note by the author.† In this case, also, no imperfect contact effect was observable, although the resistivity of the material was four times as great as that of the pure metallic tantalum. The other metals tried were only available in the massive form, but were used with as fine a point as it was possible to get, dipping into mercury as before. No effect was obtained with vanadium, molybdenum, cobalt, manganese, tellurium, zirconium, ferro-silicon, ferro-manganese, ferronickel, nor with antimony or bismuth all these metals, except possibly molybdenum and zirconium, give a "perfect" contact.

* 'Physikal. Zeitschr.,' Vol. V., p. 338, 1904.

* 'Comptes Rendus,' Vol. CXLV., p. 226, 1907.

† *The Electrician*, Vol. LX., p. 199.

Trying pure tantalum with different solid metals, it was found that a sensitive and moderately loud spontaneously restoring detector can be made by placing a tantalum point so that it bears on an iron surface (best oxidised). An equally sensitive but not quite so loud detector is obtained with a similar arrangement, but using tantalum and tellurium. Since both these latter metals are unaffected by the atmosphere, such a device might prove of value in the laboratory, for intermittent use, for instance. A very weak effect was observed with cobalt, antimony, manganese, and bismuth in this order of decreasing loudness, while with molybdenum and vanadium there was no effect whatever. But with all these coherers one has only to compare them with the tantalum point dipping into mercury to realise that they are hopeless as practical competitors.

It will thus be seen that, so far from this property of imperfect contact and spontaneous decoherence with mercury being common to several metals, the behaviour of tantalum is apparently unique, while the effect obtained greatly surpasses that observed with iron. This latter has hitherto been considered the only possible metal for use in this connection; but it has been shown above that the property possessed by iron has to be artifically aided before it can even begin to serve the purpose which can now be more effectively carried out by a noble and inalterable metal. In conclusion, it is interesting to note that, by a suitable choice of material, the primitive simplicity of the single point contact between two metals can be reverted to and yet practically all the attributes—speed, positive decoherence, loudness, long life, and non-exposed parts—which are required of the modern detector, be retained.

A SATISFACTORY FORM OF HIGH RESISTANCE.*

BY G. W. STEWART.

The low conductivity of carbon has naturally attracted the attention of those looking for satisfactory forms of high resistances, but the lack of constancy has always been a very great disadvantage. Longden † has published several methods of making carbon resistances which proved to be quite satisfactory, but, as he states, all the resistances increase with time. Smoke films deposited on glass, hardened by exposure to alcohol vapour, and then covered with shellac varnish, indiarubber varnish or paraffin wax, proved to be the most satisfactory.

The use of a transparent lacquer called "Zapon" in the shop of the laboratory, directed my attention to its possible combination with carbon in the formation of a permanent high resistance. The lacquer consists of soluble cotton dissolved in certain mixed solvents, the chief ingredient of which is amyl acetate. When dry, there is left a film of pyroxyline, which is elastic, is not subject to ordinary changes in temperature, does not evaporate, does not crack, and is a good insulator.‡ These characteristics are extremely important. It occurred to me that if lampblack were mixed with this lacquer and spread with a brush upon an insulator, a permanent and yet high resistance might be obtained. Experiment has proved this to be the case. The commercial "Germantown" lampblack and the lacquer known as "Zapon L" § were used in the experiments.

Convenience.—The resistance is obtained by spreading the mixture of lampblack and zapon upon an insulating surface. The conductivity of the films thus produced can be easily regulated by the amount of lampblack used and the thickness to which the lacquer is spread with the brush. By trial, I secured a variation in resistance from 3,000 ohms to 3,000,000 ohms with a film approximately 3 mm. long and 2 mm. wide. In order to control the range in constructing high resistances, mixtures with varying proportions of lampblack can be kept on hand. In some experiments, resistances as high as 40,000 megohms are desired. With a film similar to the one just mentioned, it would be possible to secure this enormous resistance by a strip 0·2 mm. wide and 4 metres long. Doubtless films of less conductivity can be secured readily, thus making the length required more easily obtainable.

A further convenience is that the process of making the films is simple and easy of execution, requiring no special apparatus whatever. The forms in which the resistances can be made are unlimited, and can be determined by the purpose for which the resistance is intended. So far, I have experimented only with hard rubber as a base for the lacquer, and the different forms in which the rubber is readily obtainable means great convenience in the construction of such resistances. It should be stated that the sample of Zapon I have used will not cling very satisfactorily to a very smooth surface, unroughened glass for example.

Permanency.—Films of shellac, indiarubber varnish, paraffin, and no doubt other substances have been proposed as binders for the carbon particles, the object being to make the resistance as permanent as possible. A film of pyroxyline has a decided advantage from the standpoint of permanency, for it will neither crack readily nor deteriorate. In securing permanency care must be taken to eliminate changes in the contact between the terminals and the film. This is done by making the terminals a part of the base itself. In some of the experiments, this condition was secured by making the terminals of copper plugs screwed into the rubber plate. Longden solved this difficulty by making the terminals of deposited silver films.

Experiments were made to test the variation of such resistances with time. Two resistances made in January were found to have varied but 3 per cent. five months later. Films of less conductivity do not age so quickly. For example, one of very much less conductivity had a value of 4·13 megohms on May 11, the day following the manufacture; on May 13 a value of 3·61 megohms; on May 15, a value of 3·45 megohms, on May 20, a value of 3·35 megohms. These figures show a variation which is at first quite large, but which grows smaller quite rapidly.

Doubtless a process of ageing by baking would bring such films to a practically steady value at once. Of course a resistance which is composed of carbon particles held in position by a hardened film could in no case be as constant as a metallic resistance. It would therefore be necessary to calibrate constructed resistances from time to time, but with such occasional calibration they would remain sufficiently constant for fairly accurate work.

A variation of the resistance with the impressed voltage would not be surprising. In my first experiments, I found that the resistance decreased with increase of voltage. However, after making the terminals more a part of the base itself, as already suggested, I found the variation to be less than one-half of 1 per cent. with a variation of voltage of 1,000 per cent. In fact, I did not detect any regular variation with voltage at all, for the sensitiveness of the apparatus would permit the detection of a variation no less than that already stated. The observations were made by connecting the resistances in series with a source of voltage and a galvanometer. The resistance consisted of a film about 3 mm. long and 2 mm. wide. Readings were taken with films ranging from 100,000 ohms to 3 megohms. In each case the voltage was varied at least 1,000 per cent., the actual values used depending upon the sensitiveness of the galvanometer.

The question as to the variation with voltage is an important one, in as much as in the electrometer method of measuring ionisation currents, the voltage employed varies with the current to be measured. The experiments I have performed do not prove that these carbon resistances remain constant at small voltages (0·01 of a volt is sometimes used with a resistance of 30,000 megohms). From general considerations, however, it would seem highly probable that there would be less, instead of greater, variation at lower voltages. Doubtless this form of resistance would therefore be satisfactory in the measurements of ionisation currents.

As would be expected there is a variation in these carbon resistances with the temperature. A number of observations were made through small ranges of temperature, and the results show a variation of from 0·1 to 0·15 per cent. per degree Centigrade. Of course this figure will depend somewhat upon the base employed for the film, and consequently must be determined for each arrangement.

The permanence of the film of pyroxyline, the fact that it can be subjected to ordinary ranges of temperature without cracking or deteriorating, would indicate that properly constructed resistances would give satisfaction for an indefinite time. Furthermore, resistances of a few megohms might easily be enclosed in sealed tubes in order to obviate any variations due to moisture.* It is believed, therefore, that this note suggests a form of high resistance which is both convenient and reasonably permanent, subjected only to very slow changes in resistance with time, and which will prove especially satisfactory where very high resistances of thousands of megohms are desired.

* From the *Physical Review*, slightly abbreviated.

† Longden, *Physical Review*, 15, 1902, p. 355.

‡ The General Electric Co. (U.S.A.) controls a patent (No. 687,517) for the use of pyroxyline dissolved in a solution containing amyl acetate as applied to electrical conductors as an insulating material. This method of insulating wire is now in commercial use.

§ "Zapon L" is the trade name given by the manufacturers, the Celluloid Zapon Co., Stamford, Conn.

* Since writing the above, I have found that these resistances increase somewhat with increase in humidity. Whether this is due to the occulsion of water vapour by the carbon or to the swelling of the pyroxyline film has not been ascertained.

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BULK SUPPLY OF POWER.

An examination of the conditions of bulk supply of electric power in this country at the present time reveals a somewhat contradictory state of affairs. Originally the power-in-bulk companies obtained Parliamentary powers to generate electrical energy in large central stations and distribute it over wide areas. The principal argument advanced in favour of these schemes was the low operating costs which were realisable in power houses in which were concentrated a small number of units of large output. An important principle was enunciated, and the stations were started in due course to give it practical effect. Isolated power plants for the generation of electric power were henceforth to be abandoned, and the power in bulk supply was to be taken from the company operating in the particular area.

Theoretically, the ultimate result of the logical pursuit of this policy would be the removal of steam, oil and gas plants in industrial establishments within the area of bulk supply and their displacement by electric motors. Also, it would follow as a natural consequence that no further business in the sale of such engines, &c., could be obtained in those districts covered by the mains of a power company. In a word, there would be ultimately no room for isolated plants in the supply area of a power in bulk company. No other conclusion can be drawn, unless it be framed to make an exception of plants which cannot, for special reasons, be supplied with power from an outside source. From the point of view of the manufacturers of boilers, steam, oil and gas engines and the numerous accessories connected therewith, there is or should have been nothing more to interest them in a power supply area.

Power supply companies have fully established a claim to reliability and economic service. They have made great numbers of factories, mills and workshops dependent upon them for power, and have demonstrated in practice that there is practically no need for the manufacturer to generate his own power. In certain industries there are specialists in the production of particular parts, which are supplied finished for the maker of the complete article, to be included with parts he himself produces. The recognised maker finds it does not pay him to turn out these parts, because another has experimented with the necessary machinery, has designed and erected it, and can supply him with each required item at a price much below his own cost for the same part. Power in bulk supply may be ranked with the specialist manufactures among those industries which have no exceptional facilities for the production of cheap power. The user of power may reasonably be told that he is not in business to generate power now that he can buy it outside, any more than he is in business to produce parts of articles which, for the reason given above, he is not specially equipped for producing economically. Power production is a specialist business and requires the attention of specialists. The power user will sooner or later recognise this, but the sooner he does so the better it will be for power supply.

We notice at the present time what we may term a heterodox movement in favour of isolated plants even in the areas of power in bulk companies. This is a "reversion to type" which we regard as most unwelcome. It indicates a lack of confidence in plant concentration which strikes heavily at the very principle of power supply. What happens outside the power area does not affect the argument. Within the area it is a reflection on the power supply if prime movers other than those at the various generating stations are laid down for the driving of dynamo-electric machinery. The problem is, of course, one of competition between the power in bulk concerns and isolated power plants, it being a question whether the particular power consumers can make their own electrical energy more cheaply than they can purchase it.

One is compelled to ask, in the face of this condition of things, if there is any real economy in the concentrated plant, with its ramifications of feeder lines, about a large industrial area. The state of the various companies in different parts of the country presents striking contrasts. In the Newcastle and Durham coal fields there is distinct evidence of the decline of isolated power plants and a strengthening of the situation for power in bulk supply. Collieries in particular have come to place reliance on purchased power, even though the generating station is a score or more miles from the pit. In South Wales the tendency is in the opposite direction. For reasons which at the moment do not concern us the power supply company started indifferently, and private installations have sprung up for the supply of individual pits or groups with power. Similarly in Lancashire, textile factories have been persuaded to put in turbine plant and make their own energy for the supply of the mill, regardless of the proximity of the mains of the county power company. We must not overlook the fact, however, that many of the newer mills have been electrified under conditions which would probably exclude the power company at the outset. We allude to the placing of contracts for plant in which "counters" figure largely in the transaction. This is a form of competition which a power supply company will find difficult to meet. In Yorkshire, as far as we can gather, the textile and other industries have made an encouraging response to the offers of cheap power held out by the county company.

In due time, no doubt, this question of competition will be solved in a manner satisfactory to the power companies, as, indeed, it is already around Newcastle. The early years of such undertakings, however, are necessarily lean years in which probable loss of business through an insufficiently favourable tariff on the one hand has to be weighed against a still unsatisfactory balance-sheet on the other. But when with expansion of business the balance-sheet once oscillates to the right side the isolated installation becomes of less and less importance, and the power company is able to show to consumers the advantages of bulk supply.

REVIEWS.

(Copies of the undermentioned works can be had from *The Electrician* Office, post free, on receipt of published price, adding 3d. for books published under 2s. Add 10 per cent. for abroad or for foreign books.)

The Hughes and Baudot Telegraphs. By ARTHUR CROTCH. (London: S. Rentell & Co.) Pp. 83. 1s. 6d. net.

An interesting paper upon the Baudot Printing Telegraph System, by Mr. A. C. Booth, was read at the St. Bride's Foundation Institute on March 11, 1907, and the Hughes Printing Instrument is described at length in the Post Office Technical Instructions. Mr. Arthur Crotch has now, within a small compass, and in a volume of handy size, given a clear and excellent account of these two systems, which will be of use to the student and to the operator. The book is amply illustrated, and contains all that is necessary to know about the systems preparatory to the practical operation of them. The Hughes is found on the London Continental lines, and is largely used on the Continent and in Russia, the number of apparatus in actual operation being over 3,000. The Baudot has not so far secured a wide field. It is extensively employed in France and Algeria, some 300 sets being in use. England, Germany, Austria, Holland, and Switzerland operate a few, and India has lately taken up the system. There is no doubt that great scope exists for the use of the Baudot, even in competition with other printers, and it would not be surprising to learn that other countries besides France are taking it up, in the near future, on a larger scale than at present.

Both the Hughes and the Baudot systems have been described in the technical journals, and it is not necessary to occupy space in giving extracts from Mr. Crotch's book to illustrate its character. It will suffice to say that the author is evidently accomplished in his own subject, and has the skill of making technical matters clear to a beginner. The book can be recommended to all who have to do with the systems described.

Handbuch der Physik. Edited by Dr. A. WINKELMANN. 2nd edition. Vol. V., part 2. "Elektrizitat und Magnetismus." (Leipzig: J. A. Barth.) Pp. XIV. -519 to 956. M. 16.

This is a further volume of the series of works which will, when completed, form an encyclopædia covering the whole of physical science, several volumes of which have already been referred to by us in a previous review.

The present volume contains four main sections.

The first, by Waitz, entitled "Electrodynamics," refers principally to the theory of oscillating circuits, their interaction and the production and propagation of electromagnetic oscillations, and furnishes a very complete survey of the principles upon which wireless telegraphy and telephony are based, although very little space is given to a description of the apparatus actually used for such work.

This section is followed by a short chapter on Absolute

Measurements, written originally by Oberbeck, but revised for the purposes of this edition by Steinwehr, containing definitions of the technical electrical units and descriptions of methods employed for their reproduction and absolute determination.

The technical applications of induction form the subject of the third section, which is sub-divided into two chapters on dynamo electric machinery and transmission of power by Des Coudres and telephony by Kellstab.

The concluding section, entitled "The Theory of Electric Phenomena," written by Graetz, is, perhaps, the most fascinating in the book. In it the principal theories of the nature of electricity and the mechanism of electrical effects from the early two-fluid and single-fluid theories, and including the later ones of Maxwell for stationary bodies, and Maxwell and Hertz for bodies in motion, electron and vortex theories are treated in turn and compared critically with one another.

The study of the subjects treated will be greatly facilitated by the copious references to the bibliography given in footnotes and at the ends of the chapters.

Some Quick and Easy Methods of Calculating. By R. G. BLAINE. 3rd edition. (London: E. & F. N. Spon.) Pp. xii. 145. 2s. 6d. net.

There is not much difference between the third edition of this little book and the original, which appeared in 1898. Logarithmic tables have been inserted at the end, and some new matter, dealing with cube roots, new cursors, &c., has been added. It is, of course, extremely difficult to add anything fresh to a book of this kind, which, in its original edition, was as complete as necessary. Perhaps the Stanley-Boucher "pocket calculator," described on p. 89, no longer warrants the use of the term "recent."

The B.I. Handbook. (Prescot: British Insulated & Helsby Cables, Ltd.) 7s. 6d.

Notwithstanding the fact that this handbook has been brought out by one of the leading cable companies it comprises much more than a catalogue of the productions of one firm. It is divided into two sections, each with a separate index. The first section deals with the principal manufactures of British Insulated & Helsby Cables, Ltd., and gives detailed information and specifications for all classes of cables, joint boxes, feeder pillars, tramway poles and fittings, telephone instruments and apparatus for line equipment, and numerous other specialities. The second half of the book is entitled "General Information," and contains a large amount of matter likely to be of great service to electrical engineers. Whilst most of this information has already been published, some very valuable original technical matter is given.

Some idea of the ground covered by this section can be obtained from a summary of its contents. These include a diagram for obtaining the most economical section of a cable by means of Kelvin's law, particulars of the induction and capacity of overhead lines and underground mains, some interesting vector diagrams for ascertaining the losses in single-phase and three-phase circuits, and curves enabling the requisite horse-power of motors for operating cars under given conditions of speed and gradient to be ascertained. After a description of the systems of laying and jointing paper insulated lead-covered cables and of the Merz-Price patent protective system for high-tension feeders and apparatus, a large number of very useful reference tables are given. These comprise the usual tables of areas, resistances, weights, &c., of copper conductors, thickness of insulation and lead in cables, melting points, specific gravities and specific heats of metals and alloys, fusing currents of wires, conversion tables for Centigrade and Fahrenheit temperatures, and for converting C.G.S. into English units, and *vice versa*, the latter table being reprinted from *The Electrician* Electrical Trades Directory, as are also tables in connection with the hours of lighting and illumination data. The remainder of this section contains a digest of the new Patent Act, the 1907 wiring rules of the Institution of Electrical Engineers, the Board of Trade regulations for electricity supply and electric power on tramways and railways, and the Home Office rules for mining installations. It will therefore be seen that this handbook is a valuable book of reference, and as it is excellently got up it should prove a welcome addition to any electrical engineer's library.

THE MEASUREMENT OF POWER FACTOR AND FREQUENCY IN SINGLE-PHASE ALTERNATING CURRENT CIRCUITS.

BY DR. W. LULOFS.

In most alternating current measurements the determination of the power factor is of great importance.

In three-phase alternating current circuits the power factor is easily determined, not only because the three-phase phase-

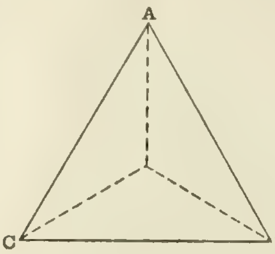


FIG. 1.

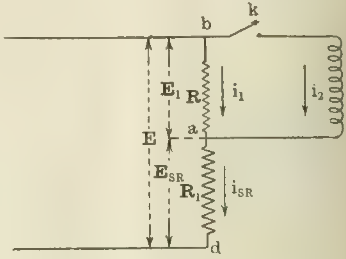


FIG. 2.

meters are of simple construction and accurate in their indications, but also because the well-known "tangent formula," $\tan\phi = \sqrt{3}\frac{W_1 - W_2}{W_1 + W_2}$, from which the tangent of the angle of lag or lead is calculated, is easy in its application, W_1 and W_2 being two wattmeter readings when the pressure circuit of the wattmeter is connected—first across AB and, secondly, across AC, in which case AB and AC have a phase difference of 60 deg. (Fig. 1).

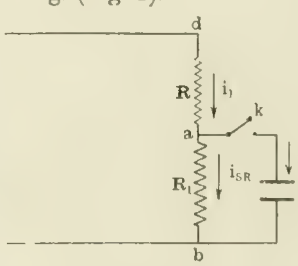


FIG. 3.

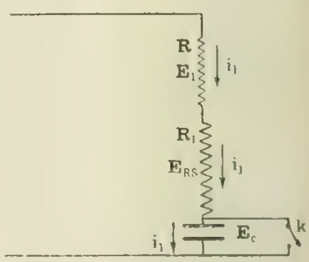


FIG. 4.

In single-phase circuits the phase difference between pressure and current can be found in a somewhat similar way.

It can again be calculated from two wattmeter readings,* the first giving the true watts and the second a value obtained when, by means of a known self-induction or capacity, a definite phase difference has been obtained between pressure and current in the pressure coil, which can be calculated when the resistance of the pressure circuit is known.

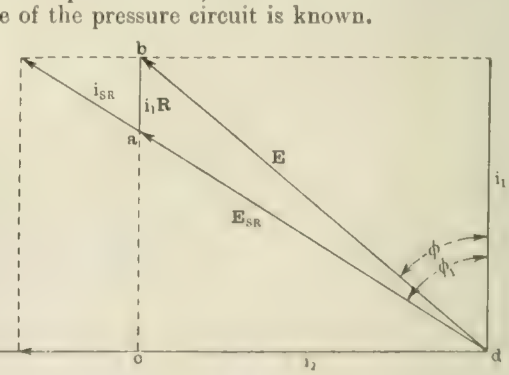


FIG. 5.

As this resistance is comparatively high the most suitable arrangement for obtaining the phase difference in the pressure circuit mentioned above is :—

1. To shunt the pressure coil by a self-induction.
2. To shunt the series resistance of the pressure circuit by a capacity.
3. To connect a capacity in series with the pressure circuit.

* The wattmeter used must have a small capacity, self induction and mutual induction.

Figs. 2, 3 and 4 show the corresponding diagrams of connection of the wattmeter pressure circuits. Figs. 5, 6 and 7 are the corresponding vector diagrams from which at a glance can be seen how far the above-mentioned connections affect the phase difference between pressure and current in pressure circuit.

1. *The Pressure Coil Shunted by a Self-Induction the Ohmic Resistance of which can be Neglected.*—This method is especially accurate in cases when the load current lags behind the pressure. By making pL about equal or twice the value of R a suitable difference in the two wattmeter readings may be obtained, these two wattmeter readings being :—

$$W_1 = c i i_L \cos\theta,$$

in which i_L = load current,
i = pressure circuit current,
θ = phase difference in degrees between load and pressure current,
c = wattmeter constant,

and
$$W_2 = c i_1 i_L \cos(\theta+\phi),$$

in which i_1 = current in moving coil after the same has been shunted by a self-induction,
ϕ = angle of lead in the moving coil.

$$\frac{W_1}{W_2} = \frac{i}{i_1}\,\frac{\cos\theta}{\cos(\theta+\phi)},$$

$$\cos(\theta+\phi) = \cos\theta\cos\phi - \sin\theta\sin\phi.$$

$$\frac{W_1}{W_2} = \frac{i}{i_1}\,\frac{1}{\cos\phi - \sin\phi\tan\theta},$$

$$\cos\phi - \sin\phi\tan\theta = \frac{i}{i_1}\,\frac{W_2}{W_1},$$

$$\sin\phi\tan\theta = \cos\phi - \frac{i}{i_1}\,\frac{W_2}{W_1},$$

$$\tan\theta = \cot\phi - \frac{i}{i_1}\,\frac{W_2}{W_1\sin\phi} \quad . \quad . \quad . \quad . \quad (1)$$

The value of $\sin\phi$ $\cos\phi$ and i/i_1 should now be expressed in terms of p, L and R (*see* Figs. 2 and 5).

$$i_1 : i_2 = pL : R,$$

say, $i_1 = fpL$, in which f = a certain value : then $i_2 = fR$, and $i_{sR} = f\sqrt{R^2+p^2L^2}$, the vectorial sum of i_1 and i_2 being i_{sR}. Also the vectorial sum of i_1R (in phase with i_1) and $i_{sR} \times R_1$ (in phase with i_{sR}) is equal to E, therefore

$$i_1R = fpL \times R \text{ and } ad \text{ (Fig. 5) } = i_{sR} \cdot R_1 = f\sqrt{R^2+p^2L^2} \times R_1$$

$$ac = ad\cos\phi_1, \quad \cos\phi_1 = \frac{i_1}{i_{sR}} = \frac{pL}{\sqrt{p^2L^2+R^2}},$$

$$\therefore \quad ac = f\sqrt{R^2+p^2L^2}\,R_1 \times \frac{pL}{\sqrt{R^2+p^2L^2}} = fR_1pL,$$

$$ab = fRpL, \qquad cb = fpL(R_1+R),$$

$$cd = ad\sin\phi_1 = f\sqrt{R^2+p^2L^2}\,R_1\frac{R}{\sqrt{p^2L^2+R^2}} = fRR_1\,;$$

$$\cot\phi = \frac{bc}{cd} = \frac{pL(R_1+R)}{R_1R}, \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (2)$$

$$\therefore \quad bd = f\sqrt{R_1^2R^2+p^2L^2(R_1+R)^2},$$

and from this

$$\sin\phi = \frac{R_1R}{\sqrt{R_1^2R^2+p^2L^2(R_1+R)^2}}, \quad . \quad . \quad . \quad . \quad (3)$$

$$\cos\phi = \frac{pL(R_1+R)}{\sqrt{R_1^2R^2+p^2L^2(R_1+R)^2}},$$

$$i = \frac{cd}{R+R_1} = f\,\frac{\sqrt{R_1^2R^2+p^2L^2(R_1+R)^2}}{R+R_1},$$

$$i_1 = fpL,$$

$$\frac{i}{i_1} = \frac{\dfrac{\sqrt{R_1^2R^2+p^2L^2(R_1+R)^2}}{R+R_1}}{pL} \quad . \quad . \quad . \quad . \quad . \quad . \quad (4)$$

(2), (3) and (4) filled in in formula (1) enable us to work out the value of $\tan\theta$ when W_1 and W_2 are known.

This formula, however, would be too complicated to be of practical use. Making use of vector diagram, however, the values of ϕ and i/i_1 are easily obtained (Fig. 5).

The following example may show the values which θ and i/i_1 obtain for a certain wattmeter and self-induction.

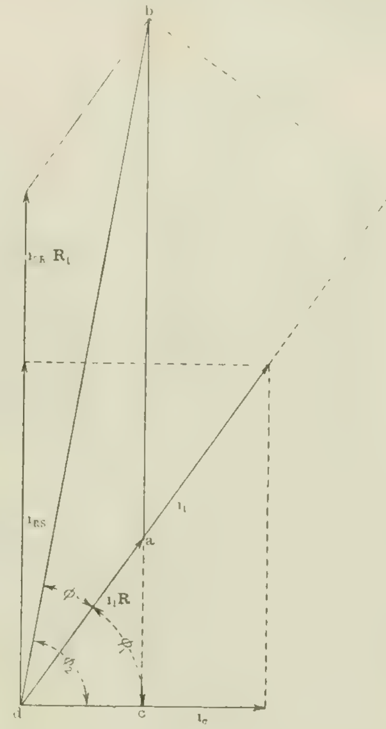


Fig. 6.

A Siemens & Halske wattmeter suitable for 30 volts pressure was found to have

250 ohms for the moving coil = R and
750 ohms for the series resistance = R_1.

Say a self-induction coil of 0·5 henry is used, and the frequency of the circuit is 50 cycles per second.

$$pL = 314 \times 0{\cdot}5 = 157.$$

The relation between i_1, i_2 and i_{sR}
$$= 157 : 250 : 284{\cdot}4 \text{ (from Fig. 5).}$$

$i_{sR} \times 750$ is the voltage drop over the series resistance,

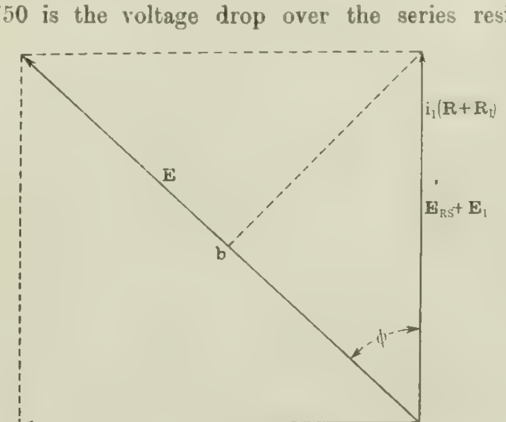


Fig. 7

whereas $i_1 \times 250$ is the voltage drop over the moving coil, the vectorial sum of which two is the impressed voltage.

The ratio of F_1 and E_{sR} (Fig. 2) is, therefore,

$$\frac{157 \times 250}{284{\cdot}4 \times 750} = \frac{39{,}250}{213{,}300},$$

so $E : E_{sR} : F_1 = 24{\cdot}4 : 21{\cdot}95 : 3{\cdot}925$ (from Fig. 5).

In case $E = 23{\cdot}5$, $F_1 = 3{\cdot}925$,

$$i_1 = \frac{3{\cdot}925}{250} = 0{\cdot}0157,$$

and $$i = \frac{24 \cdot 4}{1{,}000} = 0 \cdot 0244,$$

so that $$\frac{i}{i_1} = 1 \cdot 556,$$

$$\cos\phi = 0 \cdot 642 \text{ (from Fig. 5)},$$
$$\sin\phi = 0 \cdot 767 \quad ,,$$

so that formula (1) becomes

$$\tan\theta = 0 \cdot 837 - \frac{1 \cdot 556 \, W_2}{0 \cdot 767 \, W_1},$$

or $$\tan\theta = 0 \cdot 837 - 2 \cdot 03 \frac{W_2}{W_1}.$$

Though the derivation of this formula is somewhat lengthy, it is clear that the figures (0·837 and 2·03), once determined, make the formula itself very simple in its application.

A different frequency naturally involves different constants.

2. *Condenser in Parallel with the Series Winding* R_1.—In this case the formula works out as follows:—

$$i_{sR} : i_c = \frac{1}{pc} : R_1 \text{ (see Figs. 3 and 6)},$$

say $$i_{sR} = i \frac{1}{pc}$$

$$i_c = i R_1$$

$$i_1 = i \sqrt{\frac{1}{p^2c^2} + R_1^2},$$

$$i_1 R = i \sqrt{\frac{1}{p^2c^2} + R_1^2} \, R = ad,$$

$$\sin\phi_1 = \frac{i_{sR}}{i_1} = \frac{\frac{1}{pc}}{\sqrt{\frac{1}{p^2c^2} + R_1^2}},$$

$$\cos\phi = \frac{i_c}{i_1} = \frac{R_1}{\sqrt{\frac{1}{p^2c^2} + R_1^2}},$$

$$ac = ad \sin\phi_1 = i \sqrt{\frac{1}{p^2c^2} + R_1^2} \, R \cdot \frac{\frac{1}{pc}}{\sqrt{\frac{1}{p^2c^2} + R_1^2}} = i \frac{R}{pc},$$

$$ab = i \frac{R_1}{pc}, \quad bc = i \frac{R + R_1}{pc},$$

$$cd = ad \cos\phi_1 = i R R_1, \quad bd = i \sqrt{R R_1 + \left(\frac{R + R_1}{pc}\right)^2}.$$

$$\tan\phi_2 = \frac{bc}{dc} = \frac{R + R_1}{pc(RR_1)}, \quad \tan\phi_1 = \frac{ac}{dc} = \frac{R}{pc(RR_1)}.$$

From these two equations ϕ which is $\phi_2 - \phi_1$ is easily calculated, and from this sin ϕ and cos ϕ

$$\frac{i_1}{i} = \frac{\sqrt{RR_1 + \left(\frac{R + R_1}{pc}\right)}}{R + R_1},$$

$$\ldots = i \sqrt{\frac{1}{p^2c^2}} + R_1$$

$$\ldots \frac{\sqrt{RR_1 + \left(\frac{R + R_1}{pc}\right)}}{R + R_1} \ldots \sqrt{\frac{1}{p^2c^2}} \ldots R_1$$

Again $$\tan\theta = \cos\phi - \frac{i \, W_2}{i_1 \, W_1} \frac{1}{\sin\phi}.$$

The above values substituted in this equation give the relation between θ and W_2/W_1 for given ϕ, C, R and R_1.

Again, the formula is complicated, and following example may show that making use of vector diagram, the values of ϕ and i/i_1 are easily obtained. Say, a capacity of 3 mfd. is used, the frequency being as before, 50 cycles per second.

$$\frac{1}{pc} = \frac{10^6}{314 \times 3} = 1{,}062,$$

$$i_{sR} : i_c = 1{,}062 : 750,$$

$$i_{sR} : i_c : i_1 = 1{,}062 : 750 : 1{,}300 \text{ (see Fig. 6)}.$$

$$\frac{E_1}{E_{sR}} = \frac{1{,}300 \cdot 250}{750 \cdot 1{,}062} = \frac{1{,}300}{3{,}185}.$$

E_1 is in phase with i_1, E_{sR} is in phase with i_{sR}, and E is obtained from Fig. 6 in the same ratio$=4{,}260$, so $E_1 : E_{sR} : E = 1{,}300 : 3{,}185 : 4{,}260$.

In case $E = 42 \cdot 6$ volts, $E_1 = 13$ volts

$$i_1 = \frac{13}{250} = 0 \cdot 052, \quad i = \frac{426}{1{,}000} = 0 \cdot 0426,$$

$$i/i_1 = 0 \cdot 817,$$

$$\left.\begin{array}{l} \cos\phi = 0 \cdot 907 \\ \sin\phi = 0 \cdot 4275 \end{array}\right\} \text{(obtained from Fig. 6)}$$

$$\tan\phi \text{ being } \frac{\cos\phi}{\sin\phi} - \frac{i}{i_1} \frac{W_2}{W_1} \frac{1}{\sin\phi},$$

$$\tan\phi = 2 \cdot 12 - 1 \cdot 911 \frac{W_2}{W_1}.$$

The third method—namely, a condenser in series with the pressure circuit, is the simplest in calculation.

$$i = \frac{E}{R} \text{ (see Figs. 4 and 7)}.$$

$$i_1 = \frac{E}{\sqrt{R^2 + \frac{1}{p^2c^2}}} \qquad \frac{i}{i_1} = \frac{\sqrt{R^2 + \frac{1}{p^2c^2}}}{R}.$$

$$\cos\phi = \frac{R}{\sqrt{R^2 + \frac{1}{p^2c^2}}} \qquad \sin\phi = \frac{\frac{1}{pc}}{\sqrt{R^2 + \frac{1}{p^2c^2}}},$$

$$\tan\theta \text{ being again } \frac{\cos\phi}{\sin\phi} - \frac{i}{i_1} \frac{W_2}{W_1} \frac{1}{\sin\phi},$$

$$R/pc - \frac{W_2}{W_1} \times \frac{R^2 + \frac{1}{p^2c^2}}{R \frac{1}{pc}},$$

$$R/pc - \frac{W_2}{W_1}\left(R/pc + \frac{1}{R/pc}\right),$$

for $c = 3$ microfarad and frequency of 50 as in above example.

$$\tan\phi = 0 \cdot 94 - 2 \frac{W_2}{W_1}.$$

The above mentioned methods have, as compared with the "tangent formula" method applied in three-phase work, the disadvantage of being dependent on the frequency, and are only possible provided the frequency is known.

The "tangent formula" method, however, has the disadvantage of being only correct for perfect balanced load, therefore this method is only possible when a perfect balanced load exists.

But the frequency can always be found, either by counting the speed or number of poles of the generator, by a frequency meter, or, as I shall show later on in this Paper, making use either of the same wattmeter, a voltmeter, or even an ampere meter.

As it is always a great advantage in laboratory work, to cut down the number of measuring instruments required, it might prove of interest to point out how, with the same wattmeter which measured the watts and power factor, the frequency can also be determined.

In most cases the easiest way of proceeding is as follows (*see* Fig. 8).

The current coil is connected in series with a non-inductive resistance (a lamp, or liquid resistance is very suitable for this

purposes, allowing a current to flow of about the maximum value for which the wattmeter is designed.

By means of a key a condenser of known capacity, which is connected in series with the pressure coil, can be short circuited if necessary. With depressed key the wattmeter reads the true watts W_1.

The key being open and the non inductive current remaining

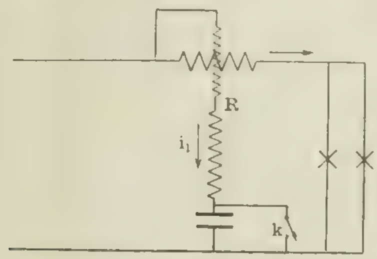


FIG. 8.

unaltered the pressure current alters its value as well as its phase and a second reading, W_2, is obtained.

From these two values the frequency can be calculated as follows :—

In the first case the pressure current i being in phase with the non-inductive load i_n (Fig. 8) $W_1 = ei_n$, whereas $W_2 = i_1 i_n \cos\phi$, in which ϕ = angle obtained between the pressure current i_1

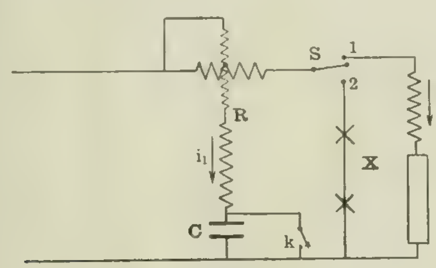


FIG. 9.

and the non-inductive load current i_n, by connecting the condenser in series with the pressure circuit.

$$i_1 = \frac{E_1}{\sqrt{R^2 + \frac{1}{p^2c^2}}} \qquad R = R_{ex} + R_1 \quad (see\ Fig.\ 8)$$

$i_1 \cos\phi = ab$ (*see* Fig. 7).

$$ab = i_1 \frac{R}{\sqrt{R^2 + \frac{1}{p^2c^2}}} \qquad ab = \frac{ER}{R^2 + \frac{1}{p^2c^2}}.$$

$$i = \frac{E}{R},$$

$$\frac{ab}{i} = \frac{R^2}{R^2 + \frac{1}{p^2c^2}} = \frac{i_1 \cos\phi}{i} = \frac{W_2}{W_1},$$

$$\frac{1}{p^2c^2} = \left(\frac{W_1}{W_2} - 1\right)R^2,$$

$$p = \frac{1}{CR\sqrt{\left(\frac{W_1}{W_2} - 1\right)}} \text{ and } N = \frac{1}{2\pi CR\sqrt{\left(\frac{W_1}{W_2} - 1\right)}}$$

where n = the frequency.

The following example may show how far the values of the frequency calculated from this formula compare with the values obtained by measuring the same with a frequency meter.*

In single-phase alternating current testing where, besides the watts, also the phase difference and the frequency have to be measured, I propose the use of only one wattmeter, using the following connections (Fig. 9) :—

* A Frahm type frequency meter was used, constructed by Messrs. Hartmann and Braun.

Table.

W_1	W_2	$\frac{W_1}{W_2}$	$\sqrt{\left(\frac{W_1}{W_2} - 1\right)}$	Frequency cal.	Frequency meas'r'd.	Remarks.
84·1	39·8	2·118	1·056	44·5	45	...
62·0	29·3	,,	,,	,,	,,	Lamp load altered
66·0	31·2	,,	,,	,,	,,	Supply volts altered
83·9	44·6	1·88	0·88	0·50	50	
66·8	35·6	,,	,,	,,	,,	Lamp load altered
61·0	32·5	,,	,,	,,	,,	Supply volts altered
59·9	34·8	1·72			55	...
76·8	44·8	1·714	average 0·847	ave. 55·3	,,	Lamp load altered
77·2	45·0	1·714			,,	
52·2	30·3	1·723			,,	Supply volts altered
63·5	39·5	1·61			60	...
52·0	32·5	1·60	average 1·783	ave. 59·6	,,	...
65·5	40·9	1·60			,,	Lamp load altered
73·9	46·1	1·60			,,	...
73·2	45·5	1·608			,,	Supply volts altered

C = 3·4 mfd. R = 1,070.

1. Switch S being in position 2, X being a non inductive load, the frequency is calculated from the formula

$$n = \frac{1}{2\pi CR\sqrt{\left(\frac{W_1'}{W_2'} - 1\right)}},$$

W_1' = wattmeter reading with depressed key,
W_2' = ,, ,, open key.

2. Switch S in position 1 and key k depressed gives the true watts W.

3. From this value W and a second reading, W', obtained when key k is opened, tan θ can be calculated from the formula,

$$\tan\theta = Rpc - \frac{W'}{W}\left(Rpc + \frac{1}{Rpc}\right).$$

It is clear that, if only the frequency is required, a voltmeter* may be used in the same connections as the pressure coil of the wattmeter shown in Figs. 2, 3 and 4.

Even a moving-coil ammeter may be used. For this purpose, when the connection between the moving coil and field coil can be easily interrupted, a non-inductive load in series with the field coil, and also the moving coil in series with a known self-induction, are connected across the supply.

In this case a self-induction is necessary, as a relativly big current is required to obtain a suitable deflection of the ammeter.

CORRESPONDENCE.

SYMBOLS FOR PHYSICAL QUANTITIES.

TO THE EDITOR OF THE ELECTRICIAN.

SIR : I have great pleasure in seeing that an international committee is drawing up a code of symbols for physical quantities. Nobody will question its utility, but, unfortunately, many will think it to be impracticable.

After reading different books on a subject our minds are often thrown into a state of chaos by the many signs for the same quantity. This, combined with the absence of a reference to a symbol (which sometimes occurs), makes some generally accepted system necessary.

I think that the symbols should be carefully limited to those quantities which often occur in equations, because, even if we have signs for everything, a writer would probably not trouble to look up the approved one. It is also very desirable not to duplicate unnecessarily the symbols. For instance, if we had d (or any other sign) = diameter, we do not need another for radius, since it is $\frac{1}{2}d$, but I would prefer r = radius and $2r$ = diameter.

I think it would lead to a good result if Mr. Walker was to communicate with that most active body, "La Internacia

* The frequency may be calculated by measuring the volt drop over a high non-inductive resistance and over a condenser (both of known value) connected in series across the supply, provided a static voltmeter is used.

F

Scienca Asscio," which is always ready to consider and work on an international movement. The address is 8, Rue Borg-Lysberg, Geneva, and it is desirable to write in Esperanto. I should be pleased to translate a short article for their journal, if Mr. Walker would like one inserted.

Since the roots of Esperanto are truly international, it would in many cases be desirable to adopt the initial letter of that root for the symbol.

Wishing the proposal an extended and rapid application.—I am, &c.,

Hampton Wick, Aug. 10. F. PEAKE SEXTON.

KIEBITZ'S DIRECTIVE ARRANGEMENT FOR ELECTRIC WAVES.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: I shall be pleased if you will allow me to criticise one point in the article on the system of directive wireless telegraphy due to Dr. F. Kiebitz, which I notice in your issue of July 31st. It states that, "The arrangement shown in Fig. 1 consists of a solenoid whose ends, *mm*, are connected to two metal surfaces, *ee*. When such a system is excited . . . its electromagnetic field, which is set up, consists of a magnetic doublet oscillating in the direction *mm*, and an electric doublet oscillating between *ee*. The electromagnetic field thus has a minimum in the plane of the paper and a maximum at right angles to this. Nothing is changed if the whole arrangement is turned in its plane through 90 deg. and one of the metal plates is replaced by the earth." In Fig. 1 the doublet *ee* is supposed horizontal and the doublet *mm* vertical, and as the doublet *mm* must evidently radiate uniformly in the horizontal direction, the dissymmetry of radiation in the Kiebitz system will be due only to the doublet *ee*. In fact, the doublet *mm* will have a rather unfavourable influence in the direction of radiation.—I am, &c.,

Rome, Aug. 3. A. MONTEL.

Prof. Montel criticises one point in the article when he is, in fact, calling into question Dr. Kiebitz's own explanation. The radiation should certainly take place in the manner suggested by Prof. Montel. Perhaps Dr. Kiebitz will see his way to explain more clearly the part played by the doublet *mm*?—THE WRITER OF THE ARTICLE.

EXPERIMENTS ON A DIRECTIVE SYSTEM OF WIRELESS TELEGRAPHY.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: In your issue of July 24th I notice a letter from Prof. F. Braun which concerns myself. To this I beg to reply that at the Physical Society meeting of June 12th last I said that the method employed by Prof. Braun for the purpose of obtaining curves of radiation of cardioid form had given no practical results. And I said this because it is precisely from reading what Prof. Braun has published in *The Electrician* of May 25 and June 1, 1906, and in the *Jahrbuch der drahtlosen Telegraphie und Telephonie* that one arrives at this conclusion.

As a matter of fact, Prof. Braun, in the said publications, shows that on his system the diagram should have the form of a cardioid. But in the same articles he records also his experiments, and these demonstrate clearly that he has not succeeded in obtaining the cardioid diagram.

This detail does not, of course, detract in any way from the admiration of Prof. Braun and his work which I share with all those who make a study of wireless telegraphy.—I am, &c.,

Dieppe, Aug. 10. ALEXANDER TOSI.

BOOKS RECEIVED.

(Copies of the undermentioned works can be had from *The Electrician* office, post free on receipt of [illegible] price, adding 4d. for books published under 2s. Add 10 per cent. [illegible])

"High Speed Dynamo Electric Machinery." By H. M. Hobart and A. G. Ellis. (New York: Wiley & Sons.) 25s. 6d. net.

"Proceedings of the Royal Society." Mathematical and Physical Sciences, A511. (London: Harrison & Sons.) 3s.

"Die Selbsttätige Regulierung der Elektrischen Generatoren." By Dr. F. Natalis. (Brunswick: Fr. Viewig & Sons.) M.4.

"Die Telegraphen Messkunde." By H. Dreisbach. (Brunswick: Fr. Viewig & Sons.) M. 6.

HIGH-TENSION CABLES AND HIGH-TENSION POWER TRANSMISSION.*

BY R. APT.

Summary.—The dangers to which overhead wires are exposed and the increasing use of single-phase current for traction have rather altered the question of power transmission, while the employment of underground cables in many cases offers decided advantages over pole lines. Single core are preferable to three-core or concentric cables for a number of reasons, especially as regards the grading of the insulation. The eddy current losses in the armouring may be avoided by using unarmoured cables laid on the solid system, and losses in the lead may be neglected. These theoretical statements are borne out in practice, the case of the County of Durham Company's network being specially noteworthy.

A close study of the power transmission problem shows that among the most important questions is the possibility of supplying through long lengths of underground cable or the retention of the prevailing overhead system. In many cases a breakdown of the regular power supply would cause such material damage to the user that the possibility of such an accident has prevented many consumers from connecting their factories to the network. Continuity of supply is, therefore, most important, and the engineer should design a system, without regard to the cost, in which all safety regulations are observed, so that an efficient transmission of power is obtained.

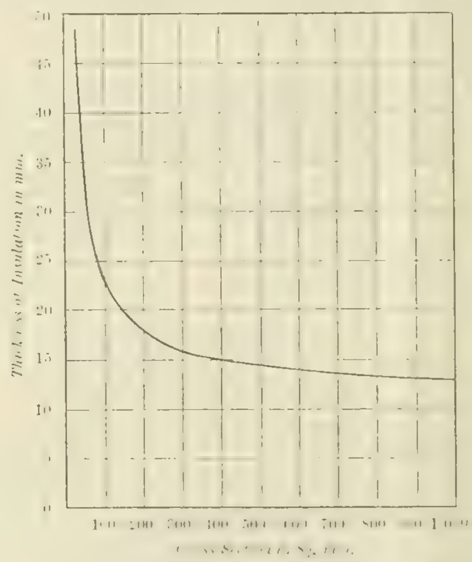


FIG. 1.—THE DEPENDENCE OF INSULATION THICKNESS ON THE CROSS-SECTION OF A SINGLE-CORE CABLE.

The most dangerous enemies of overhead wires are storms and lightning. The use of iron towers, as supports for the conductors, has reduced danger from lightning, but with our present knowledge of the subject no method is known whereby it can be avoided with certainty, and even when duplicate feeders are provided there is still a certain amount of risk.

In thickly populated districts the erection of high tension overhead wires is a matter of difficulty on account of public safety. There are also difficulties with landowners, with which anybody who has had anything to do with the subject is well acquainted. All these reasons make for the use of underground cables for high tension voltages, especially over long distances. Prohibition on account of wayleaves need not then be taken into account, and neither do dangers from lightning or atmospheric disturbances cause any anxiety. The use of underground cables would, therefore, be an ideal system if it were not for technical difficulties and its high cost. During the last few years the situation has, however, rather altered; cables for very high voltages have been made, and more perfect methods of manufacture have considerably reduced their price.

The author then discusses the historical developments of transmission through underground cables and of the insulating material used. He gives reasons why paper has been preferred to vulcanised rubber. A knowledge that breaking down strength and insulation resistance are not as a rule dependent on one another, as well as the circumstance that for high insulations paper becomes very hard and brittle, especially at low temperatures, has rather led to an alteration of opinion which is shown in the rules of the Verband Deutscher Elektrotechniker, where a minimum insulation is no longer insisted upon.

For long distance power transmission three phase current has up to the present been exclusively used. The development of the com

* Abstract of a Paper read before the Elektrotechnischer Verein

mutator motor has, however, brought single phase current to the fore, and the saving upon the network obtained with three-phase current, when overhead wires are used, is no longer of importance but is rather a negative quantity when insulated cables are employed. In every case the prevailing use of three-phase current has led to the almost exclusive employment of three-core cable. Concentric cable, which was much used in earlier years, has quite died out because of the difficulty of manufacture at high voltages. Besides, dissymmetry in the geometrical conditions of the conductors lead to differences in the capacity and self-induction, and the rules of the Verband Deutscher Elektrotechniker expressly forbid the use of concentric cables for voltages above 3,000. Consideration of the design of a three-core cable shows that both on account of the insulation and of the cross-section of conductor a limit is soon reached. If the diameter of the lead is more than 85 to 90 mm. the cable will become very heavy and stiff, and if the insulation thickness under these circumstances is more than 20 mm., the copper has to be kept within narrow limits in order that the maximum overall diameter shall not be exceeded.

The cooling conditions of a three-core cable are inefficient, and become worse with increasing thickness of insulation. The permissible load on a certain cross-section also decreases with increasing voltage. For these reasons the author is of the opinion that, in general, it is not desirable to use three-core cable on working voltages from 20,000 to 30,000 when they are employed for long feeders. As regards the use of high voltages, the single-core cable seems to be the cable with a future. In this connection the author then gives a short summary of the theory of this cable, referring specially to the work of O'Gorman on the subject. Fig. 1 shows the variation of the insulation thickness with the cross-section for a special type of cable, taking into consideration a maximum permissible specific stress of insulating material. A reference to Fig. 2 shows the extraordinary differences in insulation thickness from this point of view for different cross-sections. It is obvious that for a certain relation the voltage

Fig. 2.—Single-Core 50 Sq. mm. and 500 Sq. mm. Cables with Equal Specific Stress of Insulating Material.

gradient will be a minimum, from which the most suitable construction of the cable can be deduced. The circumstance that with increasing cross-section a smaller thickness of insulation is needed to obtain an equal factor of safety leads to the result that a minimum price exists for a certain cross-section of cable; the practical outcome of which is that it is technically and economically unsuitable to use a smaller cross-section. To lay a 4 sq. mm. cable for 20,000 volts for the purpose of saving copper would, for instance, be a very bad beginning. Fig. 3 shows for different working voltages the cost of material as a function of the voltage. The full lines are for copper cable while the dotted lines indicate aluminium. In the latter case the minimum is more towards the left, showing that by the use of this metal sections become rational, which for copper are in the inefficient parts of the curve. In plotting these curves the lower conductivity of aluminium has been taken into account in obtaining the equivalent cross-section—that is, a cross-section of aluminium, shown in the curve as 16 sq. mm., has really a section of 16 × 1·7 or 27·2 sq. mm. The diagrams show that, exclusive of differences in price, there are special grounds for using aluminium in single-core cable with high insulation.

Different ways and means have been proposed for obtaining an equal division of the voltage. O'Gorman suggested the use of layers of materials with different dielectric constants, so that the voltage gradient was made practically straight. This method has also been proposed by Jona. The manufacture of such cables is naturally not very simple, but it may be improved by the use of metallic layers between the insulating material to which auxiliary capacities are connected, so that the total capacity of the single layers are equal. Another method is to connect these metal layers to different voltage terminals of a transformer in the inverse proportion to their capacity. All the above methods labour under the disadvantage that the insulation layers are separated by metal, an inconvenience which is very great in the manufacture of high-tension cables. For these reasons the above arrangements need not be taken into account in practice.

The efficiency of a cable network, besides the costs of manufacture and laying, depend on the working losses. When an alternating current is sent through a single-cored lead-covered cable, losses occur in the lead.* It must also be noted that for the distribution of alternating currents only lead-covered cables without iron armouring can be used, or else hysteresis and eddy current losses will be serious. If two cables are placed at a certain distance apart and their cores and leads connected together the latter may be considered

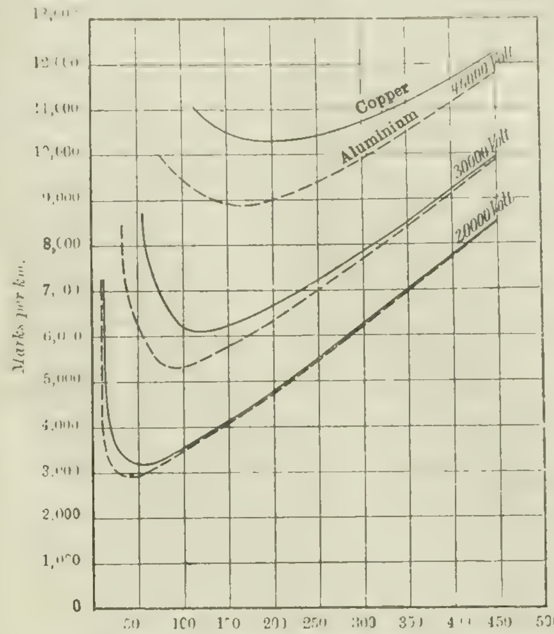


Fig. 3.—Cost of Single Core Cables of Different Diameters.

as the secondary of the transformer whose primary winding is the cable core. For this reason the lead must be considered as laid in sections, a condition which is naturally very seldom fulfilled, and the calculated results, therefore, show a maximum value, which is never quite reached in practice.

The author then discusses the losses in the lead and deduces a mathematical formula for the same which shows that they are greatly dependent on the frequency and the distance apart at which the cables are laid. Fig. 4 gives a comparison of the losses in the lead as a percentage of the total ohmic losses under different conditions. The cables used had a cross-section of 150 sq. mm., the insulation

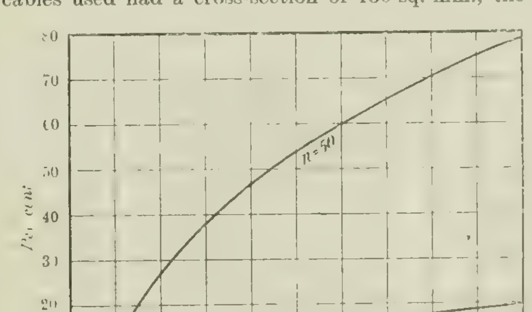


Fig. 4.—Eddy Current Losses in the Lead of Single Core Cables, as a percentage of the Ohmic Losses.

was 10 mm. and the lead 2·5 mm. thick. With low frequencies, such as have to be reckoned with on long feeders, and with the cables not too far apart, the eddy current losses may be neglected in comparison with the ohmic losses. It must also be noted that these losses, unlike the dielectric losses or the no-load losses in transformers, are not the same all the time, but vary with the square of the current.

With armoured cables the losses caused by hysteresis and eddy currents have to be added to the lead losses, and the armouring

* Cf. M. B. Field, The Electrician, Vol. LII., p. 1019.

causes a considerable negative drop in voltage. The effects produced by the magnetic properties of iron can be diminished considerably by breaking the continuity of the iron armouring with neutral material such as bronze wire. In general the discussion on the influence of armouring on long lengths of cable is not of importance, for the most suitable method of laying is to use unarmoured cable placed in troughs filled up with asphalt or pitch. This method, which is looked upon with considerable favour in England, is known as the solid system, and offers considerable advantages on account of the protection it affords against mechanical and chemical damage, so that where the question of land is of no great moment, as on large municipal networks, its use can be recommended. The harmful effect of earth currents is naturally avoided with cable laid on this system. The cost of such troughs are at the present time considerably higher in Germany than in England, but it is to be hoped that German manufacturers, when there is a demand for it, will be able to place this material on the market at cheaper prices, so that the cost of cable laid on the solid system will not be higher than that of armoured cable laid direct in the ground.

The losses from so-called hysteresis are, as recent researches have shown, so long as the insulation material is not overstressed, dependent on the square of the voltage and on the capacity of the cable. These losses are not of much importance, and it is sufficient to know that they are present. The dielectric loss with a working voltage of 11,000 and a frequency of 50 is given for a three-phase network by the formula VH=0·19 kw. per km. In general the loss in the dielectric, even with high voltages and long conductors, is not so great as to exert any harmful effect on the efficiency of the system.

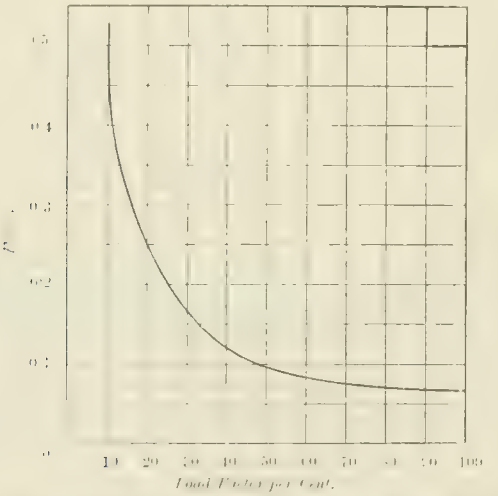


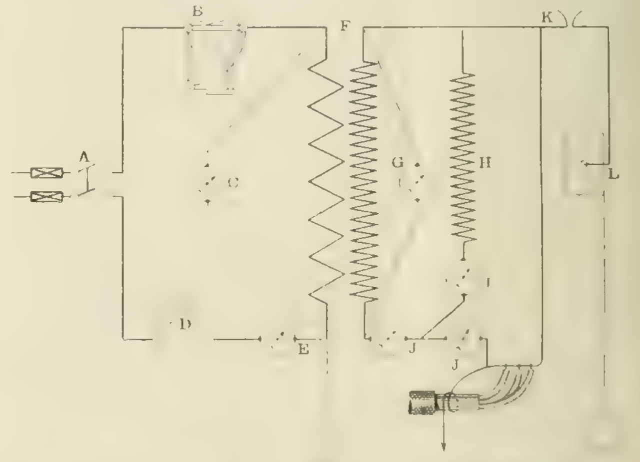
Fig. 5. Transmission Costs per Kw. Hour with 140 Km. Cables for 70,000 Kw. at 40,000 V.

A further loss which occurs in long lengths of cable is the loss due to the charging current. The charging current in a long cable varies from point to point, being a maximum at the beginning of the length and decreasing proportionally to nothing at the end. The loss is given by $V_l = W\frac{I^2}{3}$, where W is the resistance of the cable and I the current. When the resistance and the voltage are high this loss cannot be neglected. Small cable sections are therefore unsuitable for long feeders, a result which is also deducible from the calculations of Rössler.

The development of the single phase series motor and its close connection with the electrical working of main lines has brought single-phase power transmission to the front. The advantages of this system over the three phase system are, where high voltages are concerned, that single cables can be used, and therefore the distribution costs are reduced. The relations of the losses are clearly shown in the following example: It was required to transmit 10,000 kw. with either single phase or three phase current at 30,000 volts to a distance of 62 miles. Taking the power factor as 0·85 and a voltage drop of 10 per cent., conductors of 160 sq. mm. are required for single phase current, while 230 sq. mm. are needed for the three phase cable. On account of the high working voltage single cables had to be used, and as it was permissible to earth the middle or neutral point of the system, cable for 15,000 volts on the single phase and 17,300 volts on the three phase had to be provided, while a calculation of the cost for similar cables under the same conditions showed that the single phase system was cheaper by 8 per cent. In order to show the practical use of the foregoing results a calculation for a network designed for three phase current to transmit 70,000 kw. over 90 miles at a voltage of 40,000 is given. The results show that the employment of cables for such a network is by no means utopian. As three-core cables of 40,000 volts are not to be recommended the neutral point was earthed and the cables were designed for a voltage of 23,000. With a voltage drop of 13 per cent. the necessary cross-section per phase was 1,170 sq. mm. This was divided into three parts, so that nine cables, each with a cross-section of 390 sq. mm., were necessary. Another cable was put in as a reserve, so that the total was 10, and the total cost, including putting to work, was about £1,200,000. Taking the interest as 4½ per cent., the sinking fund as 3 per cent., and repairs and renewals as £12,000 per annum, the total necessary standing charges per annum works out at £102,000. The cost (k) required to transmit one unit can easily be calculated, and the values obtained are indicated graphically in Fig. 5, which shows that with high power factors the standing charges are only about 0·075d. per unit.

A further example of these methods is given by consideration of the network of the County of Durham Electric Power Distribution Co. in which, for the first time, a total length of 62½ miles of cable have been laid down for a working voltage of 20,000. The cables used are three core, each consisting of a cross-section of copper $\frac{1}{10}$th sq. in. The single cores are insulated with paper, and the whole is covered with a common paper covering and with a lead casing. The laying was carried out in accordance with the methods used in England, the cable being placed in troughs and asphalt compound run in. The total length was tested with a voltage of 40,000 between phases for half an hour.

On this system there are two main transformer stations, at Gateshead and Jarrow, which are fed from the central station at Carville.



A D.P. Switch.	E Ammeter.	J Ammeter.
B Liquid Starting Resistance.	F Transformer.	K Lightning Arrester.
C Voltmeter	G Voltmeter.	L Liquid Resistance for Above.
D Regulating Resistance.	H Choking Coil.	

Fig. 6.—Arrangement for Testing Long Lengths of Cable.

The incoming current is stepped up to 20 000 volts. Each of these sub-stations can be fed in two different ways, so that the cable between two stations can be cut out without the working being affected. As the longest section is over 7½ miles, which at 40,000 vo ts with a frequency of 40 requires a charging current of about 5 amperes per mile, the testing is effected by means of a choking coil. A diagram of the arrangement is shown in Fig. 6. The leading current of the cable is compensated by the lagging current given out by the choking coil, so that the testing transformer has only to provide for the losses, and therefore is only lightly loaded. This method has worked well in all cases where the testing of long lengths of cable at high voltages has been required. In the sub-stations automatic switches are provided, so that when a short-circuit occurs on a section this section is automatically cut out at both ends, so that the working of the system can still proceed.

R. D. Mershon has treated the problem of power transmission analytically, and found that it would not be possible to transmit to distances over 500 miles. His premises as well as his results have been much decried, and the author himself is of the opinion that the question cannot be solved in this manner. The choice of a system, the generating costs, the conditions under which current is consumed and the economical situation of the district are factors which have such different effects on the ultimate result that a general solution of the problem is impossible. It may be that under certain circumstances the use of cables in place of overhead wires, in spite of their high first cost, is a financial advantage, for instance where the upkeep of a long pole line would be a serious item of expense. The development of several power schemes is being delayed and in many cases, no doubt, the use of underground cable would make their evolution possible.

FIRST INTERNATIONAL CONGRESS OF CONTINENTAL TELEGRAPH AND TELEPHONE ENGINEERS.

(COMMUNICATED.)

An old standing desire of Continental telegraph and telephone engineers is to be realised on September 21 next, when the first International Technical Congress is to be opened at Budapest. Hitherto it has been recognised by leading men of science, as well as by the practical man in every profession, that periodical meetings effectually promote their joint endeavours for the public welfare. Strange to say, it is the technical staffs of Continental telegraph and telephone administrations, who are day by day in close touch with each other by means of the wires encircling the globe, who have missed the advantages of such periodical gatherings. Yet in the United States of America the technical officers of the numerous telegraph and telephone companies have long ago organised yearly meetings to discuss live questions and to advance in every possible way the interests of the telegraphing and telephoning public. The excellent results obtained from such reunions are not to be denied, for it is generally admitted that nowhere in the world has the land telegraph and telephone service been better regulated, from the technical point of view, than in America.

It is largely owing to this view of the results of such fraternal gatherings in America that the French Administration came forward some time ago with the proposition to hold, from time to time, such meetings, to which proposition the Hungarian Administration also adhered. Subsequently the usefulness of such meetings was recognised from various quarters, until at last the technical staff of the Hungarian Administration succeeded, with the encouraging support of their Minister and their Director-General, to rouse the interest of the technical members of other Administrations, and this has resulted in the summoning of the first Congress for September 21, 1908, at Budapest. From nearly everywhere well-known technical authorities have announced their intention to be present. Up to date the following Administrations have given due notice of sending delegates to the Congress: England, France, Germany, Bavaria, Austria, Italy, Belgium, Holland, Denmark, Sweden, Roumania, Bulgaria and Servia. Other Administrations have not yet definitely declared their participation.

The organisers have announced a series of highly interesting lectures and Papers on professional topics. These lectures will be printed and distributed to the members before the opening of the Congress, so as to enable them to acquaint themselves with the text of such lectures and Papers in view of subsequent discussion. It is hoped and anticipated that this will contribute greatly to the exhaustiveness of the debates. Lectures may be given in English, French or German, and the discussions will take place in these languages.

The Hungarian technical staff, with the ready support of the Minister and Director-General, have provided that the members of Congress shall not only be afforded an opportunity of inspecting the Hungarian technical installations at Budapest, but also the large electric plants and manufactories where telegraph and telephone apparatus and material is produced.

The sittings of Congress will be held in the building of the Hungarian Engineers' and Architects' Association, who have kindly offered their newly adapted premises for the occasion. The Hungarian committee entrusted with the arrangement of the Congress will shortly distribute a detailed programme of the Congress, and will give any information that may be desired. A list of the hotels recommended by the committee will be distributed, setting out the terms of accommodation. The committee will be glad to advise any member requiring rooms.

Those interested in the Congress are requested to apply for information to Mr. Endre Kolossváry, Chief of the Technical Department, Direction Générale des Postes et des Télégraphes, II. Albrecht ut 3, Budapest, Hungary.

ON THE UTILISATION OF THE ATMOSPHERIC NITROGEN IN THE PRODUCTION OF CALCIUM CYANAMIDE, AND ITS USE IN AGRICULTURE AND CHEMISTRY.*

BY DR. A. FRANK.

As a result of the successes achieved about the middle of the last century in agriculture by Liebig's mineral theory, observant investigators, and amongst the first of these Liebig himself, could not in the long run ignore the fact that, by the addition of bodies containing nitrogen to the mineral manures, an essential requirement of plant life was met, and at the same time an improvement in the financial condition of the manure trade must ensue. In consequence an immediate demand for manures containing nitrogen, most of them of organic origin—*e.g.*, bones, blood, offal and fish guano—arose. These, however, only partially supplied requirements, while at the same time the Peruvian deposits of animal guanos were being very rapidly depleted by an ever-increasing demand. It became necessary, therefore, to turn to those inorganic compounds of nitrogen which had definitely been proved by scientific research to be suitable for plant food. Of these the two most important were the salts of ammonia, especially ammonium sulphate, the manufacture of which on a large scale from the gas liquors was first carried out in England in the early sixties, and the nitrates, of which an extensive deposit in the form of sodium nitrate, was discovered on the rainless plateaus of Peru and Chili as early as 1830. Their application to agriculture, however, dates from 1860. Since ammonium salts have up till now only been profitably obtained as a by-product in the manufacture of coal, gas, and coke, their production, in spite of the great increase from 10,000 tons in 1860 to about 600,000 tons last year (of which England uses up some 316,000 tons), is limited and dependent on other factors than agricultural demand.

It was these circumstances which placed sodium nitrate in the front rank of nitrogenous manures, and which caused the world's demand for these substances to rise from 935 tons in 1830 to about 1,740,000 in 1907. Of this amount Europe absorbs about 340,000 tons, 20·25 per cent. of this being employed in the manufacture of chemicals and explosives, while the rest is used for agricultural purposes. Germany, which on account of the uncertain climate of its northern provinces, and because of its extensive beet sugar industries specially needs manures, is the largest consumer, importing over 500,000 tons yearly, about 400,000 of which are utilised in agriculture. The guano deposits which at first were considered inexhaustible have now practically come to an end, and the same remark applies to the strictly limited nitrate deposits in the rainless region of Western South America. Agriculturists and political economists naturally regard with considerable anxiety the approaching disappearance of the deposits, while the demand for nitrates is steadily increasing year by year. Whether the date of exhaustion will be 20 or 40 years hence is, on account of the vast importance of the question, of little consequence, seeing that even last year the price of sodium nitrate rose 35 to 40 per cent. (in Germany), an increase due less to speculators than to higher working expenses and growing difficulty of production. It is also manifest that the chemical industries can afford to pay for the nitrate—which they consume in the production of nitrogenous compounds, nitric acid, and explosives—higher prices than the agriculturist is able to give. The price of sodium nitrate reveals, in addition, the state of the market for other nitrogenous manures. Ammonia and ammonium salts have likewise shown a marked advance, and agriculturists who have urgent need of these manures, not only for producing their present average crops, but also for securing the increased output made necessary by the growth of population, an urgent necessity pointed out some years ago by Sir William Crookes, were threatened with a serious nitrogen famine.

It is well known to all that the atmosphere surrounding our earth contains a diffused and practically inexhaustible supply of nitrogen, totalling about 4,041,200,000,000,000 tons. This works out at 31,000 tons of nitrogen over each acre of the surface of the globe, or the still air over every 9 acres contains about 280,000 tons—*i.e.*, the same amount which is contained in the 1,740,000 tons of Chile saltpetre exported from that country in 1907. We know, further, that uncultivated plants, partly through certain organs which exist in them, as well as in leguminous plants, and partly by the aid of bacteria inhabiting the soil, are able to absorb the nitrogen they require from the air diffused through the soil. Furthermore, in 1775, Priestley showed that atmospheric nitrogen under the influence of the electric spark combined with atmospheric oxygen to form nitric acid, the latter being conveyed by moisture to the soil and then to the plants. But all this accumulated experimental knowledge, important though its results undoubtedly were, did not afford any clue to the possibility of producing nitrogen compounds in considerable masses, nor was it freely at the disposal of agriculturist or chemist. The method devised by Townes and Young last century, and experimentally applied by Bunsen and Playfair, showed that by passing atmospheric nitrogen over carbon and the alkalies or alkaline earths, the carbon compound cyanogen could be formed from which by further treatment ammonia could be obtained. This method, in spite of its extensive application and the many improvements which Marguerite and Sourdeval and later Ludwig Mond introduced in its technical details, produced no practical result, on account of the difficulty of attaining the requisite temperature. It was further complicated by the fact that the construction and maintenance of the apparatus, owing to the materials used in the furnaces, gave rise to what were then insuperable difficulties. The first successful advance was made through the discovery and application of the dynamo, which rendered it possible for electricity to be supplied in considerable quantities. By this means a hitherto unattainable temperature could be produced in quite a restricted space. Up to this time, now some few years ago, the necessary energy had to be obtained, except in so far as it was produced by reaction from the molecular energy of the elements by means of the chemical process of "combustion." With the application of the dynamo and the invention of the electric furnace

* Paper read before the Faraday Society, slightly abbreviated.

by Siemens, this process was greatly modified, as by means of electric energy thus applied heat could be produced by means of the electric arc or of an electrical resistance, and could be brought to bear directly on to the chemically reacting mixture.

Subsequent to 1894, when Thomas L. Willson and Moissan carried on the manufacture of carbide on a large scale in the electric furnace, Prof. A. Frank, in a Paper published in February, 1895, opposed Moissan's views as regards the possible use of this carbide combined with atmospheric nitrogen, for the preparation of cyanides and amides. Tests carried out in conjunction with Dr. N. Caro on this point established the truth of his hypotheses and further led to the invention of a method for the preparation of cyanides, cyanamides, ammonia, and other nitrogen compounds.

The other way of fixing nitrogen, on which much successful work has been accomplished, by oxidising it and turning it into nitric and nitrous acid by means of the electric spark, was soon established on practical lines, firstly with unsatisfactory technical results at Niagara Falls by Bradely and Lovejoy, and then by the magnificent discovery of Birkeland and Eyde, as well as by the improvements which are now being perfected due to Schönhen and the Badische Anilin & Soda Fabrik. Prof. Birkeland, in his Paper before the Faraday Society in July, 1906, made some highly interesting remarks on the oxidation of atmospheric nitrogen, in amplification of which the author may add that the production of calcium nitrate by the Birkeland-Eyde process seems to be developing exceedingly well in Norway, and that the factory mentioned by Prof. Birkeland is actually established at Notodden and is producing this substance. It should, however, be noticed that this industry has not made much progress in any other land save Norway, but it should not be forgotten that it is only in this northern clime that electrical energy can be as cheaply obtained, on account of its unrivalled resources of water power. It would, therefore, seem probable that Norwegian saltpetre is destined to remain the only direct competitor of the Chilian variety.

The two methods of nitrogen fixation differ greatly as regards their chemistry. Physically they are similar, for, properly speaking, they are not electrical, but should be considered purely thermal processes. They do, however, differ in that the fixation of nitrogen by carbide is an exothermic process, in which heat is given out, while the combination of oxygen and nitrogen is endothermic—*i.e.*, it absorbs a large amount of heat, and for the fixation of an equally quantity of nitrogen requires at least three times the energy that the former process calls for.

The researches instituted by Frank and Caro in 1895 were first carried out on calcium carbide mixed with sodium carbonate. But as the yield of cyanide obtained in this way proved unsatisfactory, they soon substituted carbide of barium therefor, a substance which at that time could be more easily obtained, and this they found absorbed nitrogen isolated from the air with great avidity at a temperature of between 700°C. and 800°C. Frank and Caro were then contemplating the transformation of barium cyanide by treatment with carbonate of sodium or potassium into cyanide of potassium, which at that time commanded a very high price, with a considerably increasing demand. The first experimental plant was constructed with the object of perfecting as far as possible the process for obtaining cyanide of potassium and yellow prussiate. They soon found that the nitrogen absorbed by barium carbide was not merely in the form of cyanide ($Ba(CN)_2$), but that it was also present in the form of a more complex compound. The latter was found, on examination, to be cyanamide of barium $BaCN_2$, from which they inferred that the reaction had taken place according to the following equation:

$$BaC_2 + 2N = BaCN_2 + C.$$

Thus it appeared that in the action of carbide on nitrogen half the carbon contained in the carbide was set free. The proportion of cyanide and cyanamide of barium in the reacting mass was on an average as two to three, the product containing 30 per cent. of barium cyanide and 45 per cent. of barium cyanamide, the remainder consisting of barium oxide and carbon. The transformation of the barium cyanamide into barium cyanide can be easily brought about by melting the mass containing both cyanamide and cyanide, with a flux such as potash or soda according to the following equation:—

$$Ba(CN)_2 + BaCN_2 + C + 2K_2CO_3 = 4KCN + 2BaCO_3.$$

The great progress which had meanwhile been made in manufacturing carbide of calcium on an industrial scale gave rise to an attempt to try again the method of treating carbide of calcium with nitrogen, which had been previously abandoned owing to initial difficulties. It was then discovered that the small yield of cyanide obtained in using carbide of calcium without an additional flux could be further reduced, and that no cyanide need be formed at all, but that the reaction would proceed in accordance with the following equation:—

$$CaC_2 + 2N = CaCN_2 + C,$$

and result in the formation of cyanamide of calcium alone.

About this time the patentees, Messrs. Frank and Caro, together with the well known electrical firm, Siemens & Halske, and the Deutsche Bank of Berlin, founded the Cyanid Gesellschaft of Berlin, for the further development of the process. The primary object of the new company in taking up these inventions was to turn cyanamide of calcium into cyanide of potassium, for which there was an extensive and increasing demand for the purposes of gold extraction in South Africa and the United States. It is common knowledge that this object was successfully accomplished.

The low atomic weight of calcium carbide compared with barium carbide, owing to which 64 parts in weight of calcium carbide sufficed to bind about 28 parts of nitrogen, seemed to point to the conclusion that by using calcium carbide it might prove feasible to produce those nitrogenous compounds in which the nitrogen would only command a low price, such as fertilisers, &c. Further research in this direction was started with calcium cyanamide as the raw material for producing ammonia, and it was found that the total nitrogen contents of the calcium cyanamide could by treatment with hot water easily be turned into ammonia. The process is effected according to the following equation—

$$CaCN_2 + 3H_2O = CaCO_3 + 2(NH_3).$$

In spite of the fact that this reaction requires an excess of water and a high temperature, and that acknowledged authorities on agricultural subjects passed unfavourable opinions in view of the presence of the poisonous cyanide group in the product, in consequence of a proposal made by me, an attempt was made to utilise crude calcium cyanamide directly as a fertiliser, burying it in the ground like any other manure. These experiments were first carried out in pots only. The results were satisfactory enough to indicate that the doubts entertained as to the applicability of the product as a fertiliser were groundless. Thereupon field experiments were arranged on an adequate scale at a large number of agricultural experimental stations in most countries possessing agricultural interests, and in connection with almost every class of agricultural produce, and these have been continued for the last six years without intermission.

(To be concluded.)

THE REASON MFG. CO.'S TIME SWITCHES.

There can be no doubt that in very many cases the employment of some sort of time switch is an absolute necessity. In these days of publicity the shop-owner is glad to be able to display his goods after closing hours, and at the same time to be certain that he can shut off his show-window lighting at a time when its attractions will no longer draw a crowd. This is where the time switch comes in; but, unfortunately, some patterns are by no means reliable, and the confusion which arises when the lights are switched off before, or left on after, the required time can be better imagined than described.

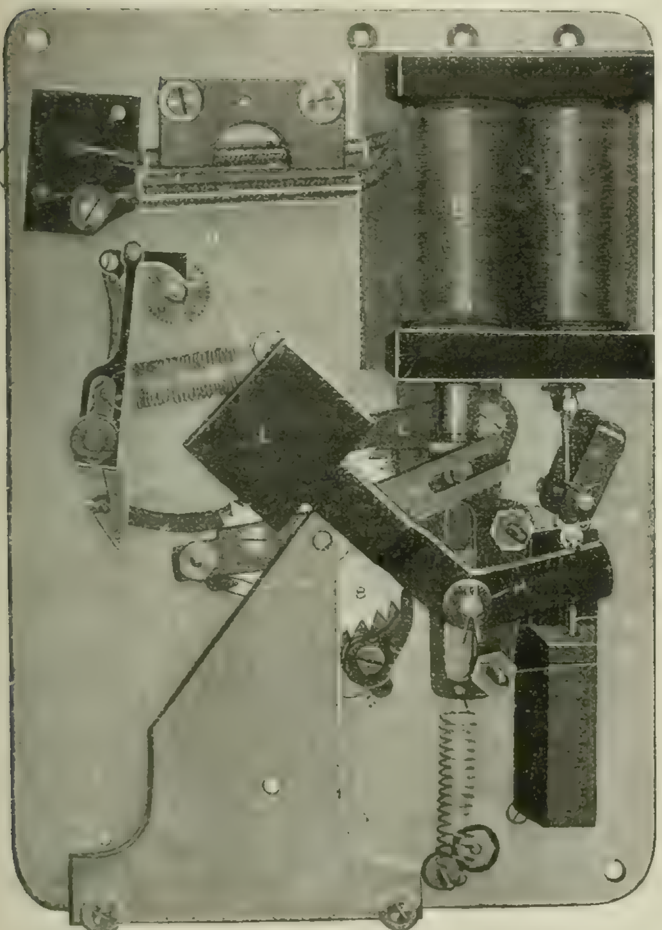
The Reason Mfg. Co., of Brighton, have lately placed on the market a type of electrical time switch suitable for both direct and alternating current which, it is claimed, leaves nothing to be desired as regards sturdiness and certainty in working. A "typewriter" construction for all wearing parts has been adopted. These consist essentially of an electrically wound clock of new construction and of a separate powerful spring, also automatically wound, for operating the switch or switches. An interesting detail is the method of releasing the switch spring when it is required to operate the switch, so that no variable work is put on the clock train.

A view of the clock mechanism is given in the accompanying illustration. It is driven by a spring which when fully wound will work the clock for 12 hours. Every 2½ minutes this clock energises a shunt coil, and this winds the operating spring one-fifteenth of a turn. When the spring is fully wound a slipping attachment comes into play, so that the spring is kept at the same tension while working. This arrangement is said to be very beneficial for timekeeping purposes. The spring is wound through the ratchet arm A, the main end of the spring being attached to the arbor of the ratchet wheel B. A plunger, C, in a shunt coil, D, moves A through a pin. As the plunger is sucked into the coil it winds the spring two teeth, and at the same time picks up lever E by means of a pin. The end of the lever carries a pin, G, which is caught in the click H, when the plunger reaches the end of its stroke. It will be seen from the shape of lever E, that the plunger cannot return so long as the pin G is held by the click. The contact for energising the coil is made between two carbons, the lower fixed, the upper movable. The rod to which the upper is fixed passes to the back of the plate J, and is normally held up by a click, K, so that the shunt circuit is broken. A lever and weight, L, is pivoted at M, and the plunger carries on a plate two pins N and O. If now the click H is released, the lever E falls, and allows the plunger to fall. The pin N catches on lever L and pulls it over, and when the plunger reaches its lowest point the weight end of L throws off click K, allowing the upper carbon to fall on the lower.

Contact is thus made through the shunt coil, the plunger is drawn up, winding the spring through the ratchet arm A; when it has nearly reached the top of its stroke, the pin O pulls back the lever L, which throws up the rod J by catching a projecting pin, separating the carbon contacts with a quick break; the lever E is also caught up, and pin G catches in click H. The clock throws off the click H by a wheel P, which carries four pins. The pawl Q is pressed outwards by one of these pins, and thus releases the pin G, which in returning throws the pawl Q off the pin on P.

The actual switch mechanism is worked by a spring contained in the same barrel as is that working the clock and is wound up by the revolution of the barrel. This spring operates the switch at the appropriate time through an ingenious system of lever and link motion which subjects the clock to a constant light load, except during the actual motion of the switch. This, it is claimed, enables a far better adjustment of the spring strength to be made. The switch itself is of laminated copper with double carbon break. The actual actions of making and breaking are extremely quick.

As a result of tests made on this switch it has been decided to



Winding Gear of Reason Time Switch in Normal Position.

rate it at 15 amperes and 230 volts. This is said to be an absolutely safe load, while it will also be satisfactory at lower currents on higher voltages, or vice versa.

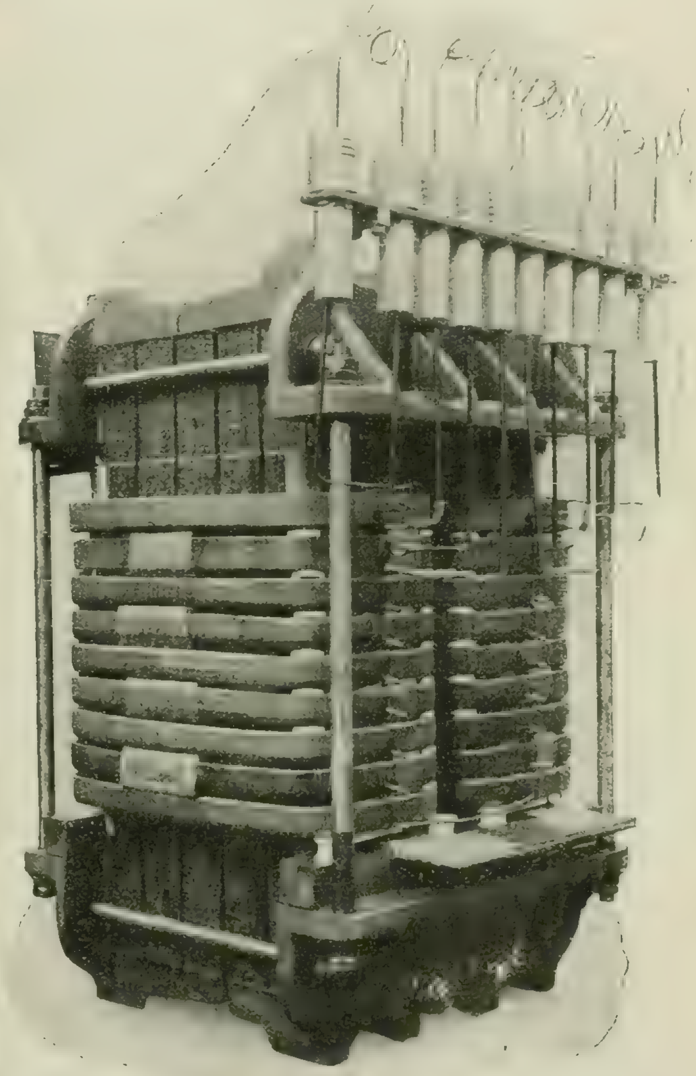
The Reason Mfg. Co. also make a "Cantie" time switch suitable for larger currents, which, in construction, is very similar to that described above, but with two slight differences. These are that the switch is a change-over switch without a carbon break, and suitable for small currents, and a magnetic blow-out is also fitted. This switch is arranged to give a quick "make" as well as a quick "break."

A similar switch allows street lighting to be changed over from incandescent to arcs at a certain time, while another patent arrangement is arranged for controlling an incandescent from an arc lamp circuit. It is, therefore, possible to switch the arc lamps on by hand and to operate the incandescent lamps through the arc lamp circuit. Thus, when the arc lamps are switched on at night, the incandescents do not light up; when the arcs are switched off, the incandescents light up; at daylight the arcs are again switched on momentarily, when the incandescents are switched off automatically. The cycle is repeated when the arcs are again switched on the following evening.

JOHNSON & PHILLIPS' TRANSFORMER.

The accompanying illustration shows a 400 k.v.a. 11,000 volt transformer (the case of which is removed) recently supplied by Messrs. Johnson & Phillips in connection with an important hydro-electric installation in Norway. It is of the oil-cooled pattern and is intended to be used on a 50-cycle single-phase circuit, so as to deliver current at 60 to 80 volts pressure at its low-tension terminals.

It will be seen that the core is of the "butt joint" type, and that the yoke is fixed to the core by clamping bolts passing through the clamping plates at the top and bottom. As these are the only con-



11,000-volt Johnson & Phillips' Transformer.

nections between the core and yoke, it is a matter of only a few minutes to remove the yoke and get at the coils, should this be at any time necessary owing to a breakdown or short circuit. It should be noted that each sheet is doubly insulated from those adjacent to it, and also that there are no clamping bolts through the parts which carry the magnetic flux, so that there can be no short-circuiting of the plates or increased iron losses due to eddy currents after the transformers have been in use for some time.

Instead of the usual barrel construction separating the high and low-tension coils, the high tension windings are carried on porcelain insulators, which separate them from the low-tension side, and in that way allow free circulation of the oil between the two sets of coils. This is of considerable importance for ensuring that the rise of temperature of all parts shall not be unduly high. In the transformer referred to, this rise of temperature after 24 hours at full load only amounted to 50°F., the temperature of the cooling water being about 10°F. above that of the air. The oil used in these transformers is a pure hydro-carbon mineral oil with a flash point of 365°F. and a specific gravity at 60°F. of 0·857. As it is a thin oil it circulates rapidly through the transformer, and so enables the heat generated to be quickly carried away.

The insulation of this transformer was tested by applying 15,000 volts between the primary and secondary windings for a period of half-an-hour, and finally a pressure of 15,000 volts was applied between the terminals of the primary winding, the normal voltage being, as above mentioned, 11,000, in order to ensure that there were no short-circuits.

We understand that at the present time Messrs. Johnson & Phillips are supplying a large number of transformers with outputs ranging from 200 kw. to 700 kw.

MUNICIPAL, FOREIGN & GENERAL NOTES.

APPOINTMENTS VACANT AND FILLED.

Applications are invited for the positions of assistant masters in the physics and electrical engineering and the chemistry and natural science departments of Portsmouth Municipal Technical College. Salary £125, increasing after approved service by £5 per annum to £150. In the physics department qualification in electrical engineering will be a recommendation. Applications (on forms to be obtained from the Secretary, Offices for Higher Education, the Municipal College, Portsmouth) by Aug. 22. See an advertisement.

There are vacancies in the electrical engineer's department, Devonport Dockyard, for three sub station attendants having good experience in batteries and automatic boosters. Applications to the Electrical Engineer, H.M. Dockyard (North), Devonport. See an advertisement.

A foreman is required by the Ceylon Government for telephone line construction. Salary 2,400 rupees per annum. Applications to the Crown Agen's for the Colonies, Whitehall-gardens, S.W., by Aug. 24. See also an advertisement.

The Institute of Metals requires a secretary; commencing salary £200 per annum. Applications to Mr. W. H. Johnson, hon. sec., Woodleigh, Altrincham, Cheshire.

Mr. T. W. Hudson, of Idle, has been appointed works engineer at the Lancaster Electricity Works.

EDUCATIONAL NOTICES.

University of London (University College).—The courses of instruction in mechanical, civil, municipal and electrical engineering begin on Monday, Oct. 5. The fee for the full three-year diploma course in engineering, including the course for graduation (B.Sc.) in the faculty of engineering, is 120 guineas. The college contains spacious mechanical and electrical engineering laboratories, workshops, drawing office, &c., and the extension to the engineering school will be ready for students entering in October.

University of Birmingham.—The full courses in engineering extend over four years, and students who enter after matriculation and who pass successfully the examination at the end of each year will be entitled to the degree of B.Sc. in the branch of engineering to which they have devoted themselves.

The technical engineering classes include lectures on the strength of materials, theory of steam, gas and other heat engines, hydraulics, machine design, strength of structures and distribution of power. In drawing, the design of tools, prime movers, dynamos and other forms of machinery. The courses in civil engineering include constructional work in masonry and steel, railway work, dams, bridges and water engineering. In the engineering laboratory the work will include the determination of the strength of materials, including compressive, bending, tensile and torsion tests, experimental study of the steam engine and boiler, frictional efficiency tests, flow of water over weirs and through orifices, &c. There are lectures and demonstrations on all branches of electrical engineering, and in the electrical laboratory the work will include the testing of continuous and alternate current machinery, electrical instruments, meters, lamps and batteries, insulation and magnetic testing.

The session 1908-9 commences on Oct. 5. Detailed syllabuses, &c., from the secretary.

University of Manchester.—Complete theoretical and practical training is given in this university to students preparing for the higher positions in the electrical engineering profession. Electrical engineering may be taken as part of the courses preparing for the B.Sc. degree in both the honours schools of engineering and physics. A special course has also been arranged extending over three years and preparing for a certificate in electrical engineering. The John Hopkinson laboratories and dynamo house are fitted with modern machinery and excellent facilities are offered for educational and research work. The session begins on Oct. 6. Prospectuses from the Registrar.

University of Leeds.—The next session begins on Oct. 5, and the large new building, completely equipped for instruction in electrical engineering, will then be available. The courses include lectures, design and practical work, and provide systematic training for students preparing for the profession of an electrical engineer with or without the degree of B.Sc. in electrical engineering. Prospectuses from the Registrar.

Armstrong College (Newcastle-on-Tyne).—The session 1908-9 will commence on Sept. 28. There are complete courses of instruction in mechanical, civil, electrical and marine engineering, naval architecture, mining, metallurgy, &c. Particulars from the secretary (Mr. F. H. Pruen).

Glasgow & West of Scotland Technical College.—The next session begins on Sept. 21 in the new building recently erected for the college. The diploma of the college is granted in civil, mechanical, and electrical engineering, mining, naval architecture, chemistry, metallurgy, mathematics and physics. The courses of study for the diploma usually extend over three sessions, and holders of the diploma are eligible for the degree of B.Sc. in engineering of the University of Glasgow after attendance for at least one session. New and well equipped laboratories have been provided in the departments of physics, chemistry, technical chemistry, electrical engineering, motive power engineering, mechanics and metallurgy, and facilities for research are afforded. Preliminary examination for candidates for the diploma begins on Sept. 14. Prospectus gratis from the secretary of the College.

Northampton Polytechnic Institute (London).—The full day courses in the theory and practice of mechanical and electrical engineering will commence on Monday, Oct. 5. Entrance examination on Sept. 30 and Oct. 1. The courses include periods spent in commercial workshops and extend over four years; they also prepare for the degree of B.Sc. in Engineering at the University of London. Three entrance scholarships of the value of £52 each will be offered for competition at the entrance examinations in September. In the technical optics department there are full and part time day courses. Full particulars as to fees, &c., can be obtained at the Institute or on application to the Principal, Dr. R. Mullineux Walmsley.

Amble.—Councillor Wanless has induced the Council to take into consideration the question of the erection of electricity works.

At the meeting of the Council on Wednesday he said that a suction gas generating plant could be put down for £5,500, the annual expenditure would be £900 and the income would be £1,000. They could supply current at such a rate that consumers would save about 50 per cent. on the price they were now paying for gas.

It was agreed that the entire Council should form a committee to go into the matter fully.

Bangor.—The Council have applied for sanction to a loan of £2,000 for slot meters, mains, &c.

Belfast.—The Queen's-road tramway route has been opened for traffic

Bridgend.—On Tuesday the Electric Light committee recommended that application be made for sanction to a loan of £8,250 for the purchase of the South Wales Electrical Power Co.'s generating station. The cost of the station, it was pointed out, was £5,000, and the balance (£3,250) was required for various items, including extension of mains, laying down apparatus for pumping water from the river, refuse destructors and an hydraulic tip for coal trucks. The recommendation was agreed to.

Burton-on Trent.—The Gas and Electricity committee have decided to reduce the charge for current for outside arc lighting from 5d to 4d. per unit.

The reduction applies only to arc lamps which overhang the public footway, and are on the exterior of the building when closed, and the only stipulation is that the wiring which supplies the arc lamps shall be continued to the supply point—*i.e.*, the cutout, so that the Corporation may fix a meter there which will be done free of charge and meter rent. This reduction has been conceded because the use of arc lamps, particularly flame arc lamps, assists in the illumination of the streets and generally benefits the town. These lamps also prove a very good advertisement for the electricity department.

Eccles.—The salary of the borough electrical engineer (Mr. H. W. Angus) has been increased to £300 per annum, to be further increased to £350 by two annual instalments.

Carmarthen.—Messrs. Gibbings & Chauntler have offered to advise the Council in regard to electricity supply.

Chippenham.—The Council have agreed to grant a 75 years' lease of the old gas works to Messrs. Edwards & Armstrong, of Bristol, who propose to form a local company for the erection of electricity works.

Derby.—An unopposed inquiry has been held here into the application of the Council for sanction to a loan of £7,500 for extensions of the electricity undertaking.

Domestic Lighting.—Practical demonstrations of modern methods of lighting and heating will be an attractive section of the Ideal Home Exhibition at Olympia in October. The latest electric

devices will be shown side by side with their rival gas. Cooking and heating by electricity will vie with gas ovens and asbestos fires.

Electric Haulage on Canals.—The Weaver Navigation Trustees recently celebrated the opening of the new Anderton electric lift.

After the ceremony the power room and the overhead machinery were inspected. It was explained by Sir J. Verdin that the lift, which was originally erected in 1875, was designed to work by hydraulic power, and until lately had worked satisfactorily. Four years ago extensive renewals were necessary, and the trustees adopted the suggestion of their engineer (Mr. J. A. Saner) that, instead of renewing the hydraulic rams, which were the most important part requiring attention, and were underground, the caissons should be suspended and counterweighted from an overhead structure and worked by electric power. This conversion has now been completed after two and a half years' work at a cost of some £25,000, and with but very brief interruptions in the service. The lift in its new form is the first of its kind in the world, and will doubtless be inspected by engineers from near and far and copied in many lands. The construction of a canal between Manchester and Bristol, with electric haulage, was advocated by some of the speakers.

Electric Traction in Norway.—The Thamshavn-Svorkmo electric railway, nearly 20 miles in length, was recently opened for traffic. Water power from the Skjenald Fall is used for generating electric current (three phase, at 1,000 volts), and the capacity of the power station is about 2,700 kw.

Fire.—A fire broke out on Friday morning last at Messrs. Wenham & Waters' engineering department at Waddon, Croydon, causing damage estimated at between £10,000 and £12,000.

Glasgow.—The sub-committee has been asked to report upon the application of the London Electrobus Co. for a licence to start a service of electric omnibuses on certain routes in the city.

Halifax.—The salaries of the assistant electrical engineer (Mr. E. G. Love) and the station superintendent (Mr. E. Priestley) have been increased.

Hornsey.—Various extensions of the electric supply mains have been authorised by the Council.

Inquest.—An inquest was held at Ince (Lancs.) on Wednesday into the death of John M'Cormick, a coke-oven attendant at the works of the Wigan Coal & Iron Co. It was found that death was due to deceased falling across "live" wires attached to an electric coal stamper.

A fireman said verbal instructions were given that deceased was not to oil the machinery whilst current was on. The jury recommended that a shield should be placed in front of the wires, as suggested by the Government inspector, and that each person should receive printed rules.

Johannesburg. — The "British and South African Export Gazette" states that the Municipal Council have decided to commence an action against D. Stewart & Co. and their sureties (W. & J. Beardmore) for recovery of £115,134 named in their bond. The proceedings are in connection with the alleged failure of the gas-producer plant supplied by the contractors. Meanwhile the Corporation's existing direct current plant, with the 200 kw. dynamo recently purchased from the Victoria Falls Power Co., will enable the service for town lighting and tramways to continue, but provides no margin for additional consumers or in the event of a breakdown, and therefore the Victoria Falls Co. has been approached as to the continuance of the present supply of 400 kw. d.c. for one year from July 1, 1908. The terms were considered too onerous, and it has therefore been decided to call for tenders for an additional 1,000 kw. d.c. set, with condenser and boiler, to be erected in December. The cost is estimated at about £21,000.

Light Railways.—The Board of Trade have confirmed the Llandilo and Lampeter Light Railway Order, 1906.

Lowestoft.—In future all "free" wiring agreements are to contain a clause providing for a minimum payment for current in all cases.

There are now 950 consumers, representing the equivalent of over 46,200 8 c.p. lamps connected.

Obituary.—We regret to record the death of Mr. Harry S. Parton, secretary to the Sheffield Corporation Electric Lighting committee, who recently died suddenly while bathing at Sutton, Lincs.

"Patents and Designs."—A new illustrated weekly journal, entitled "Patents and Designs," is to be published at 5, Tavistock-street, Strand, W.C., on 22nd inst., by Mr. F. H. Pedgrift, price 2d.

Pembroke (co. Dublin.)—The Electricity committee have been discussing means of developing the electricity department and of increasing the demand for electric current. Some members favoured the organisation of a publicity department, but the majority considered active canvassing the most desirable means of bringing the subject before likely consumers.

Plymouth.— At the meeting of the Council on Tuesday the chairman of the Electricity and Street Lighting committee (Mr. Anthony) said

The annual report of the electrical engineer was entirely satisfactory, and reflected great credit upon Mr. Okell and his staff. They possessed a very handsome asset in the electricity undertaking. In spite of the increased price of coal, the charge for electric current had remained as before. The reserve fund was over £9,000, and it was thought the time had arrived when this fund should be invested and the interest used as a contribution towards sinking fund charges. He thought the Corn Exchange, the Meat Market and other public buildings should be lighted electrically. A petition from the residents of Treville-street suggested that electric light should be used in lieu of gas, but the committee were unable to accede to the request owing to the estimates having been cut down.

Presentation.—The Torquay electricity works staff have presented a gold-mounted fountain pen to Mr. A. G. Pratt, who is leaving to take up an appointment at Wadebridge.

Reading.—The salary of the tramways manager (Mr. W. Binns) has been increased to £600 per annum.

Rochester.—The Borstal tramway extensions have been opened to traffic.

Rotherham.—Sanction has been received to a loan of £3,820 for additional plant at the electricity works.

St. Anne's-on-the-Sea.—Sanction has been received to a loan of £3,500 for cable extensions.

Salford.—An inquiry was held on Tuesday into the application of the Corporation for sanction to borrow £15,281 for extensions of the electricity undertaking. The deputy town clerk (Mr. J. W. Jackson) said that £11,707 was needed for water cooling plant, £575 for expenditure on turbo-generating sets at the works and £3,000 for extension of the supply mains in Prestwich.

Smart Electrical Work.—Messrs. Mavor & Coulson, of Glasgow, have recently executed a piece of engineering work which reflects great credit upon them. Owing to a serious defect in a boiler at the sawmills of Messrs. Anderson & Henderson, at Kinning Park, the mills were thrown idle shortly after resuming work at the end of the holidays. As the repair of the boiler would occupy a considerable time, the firm resolved to have electric plant installed, and Messrs. Mavor & Coulson were entrusted with the work. A 100 H.P. electric motor was fitted up, while Glasgow Corporation electricity department gave every facility for the making of connections, &c., so that the sawmills were running up to their full output with a break of only two working days.

Stalybridge.—The Joint Tramways and Electricity Board have received sanction to a loan of £32,178 for extensions of the electricity undertaking.

Strood.—The Board of Trade have deferred for six months the question of the revocation of the Strood and Dartford (Rural District) electric lighting order, 1903.

Sunderland.—On Wednesday the chairman of the Electricity committee (Ald. Bruce) replied to criticisms of the electricity undertaking.

He said that in 1893 the Council appointed Sir Alex. Kennedy to advise them; that gentleman went thoroughly into the whole subject, and they had acted under his advice. The last extension of plant, at a cost of £40,000, was justified in view of the great demand. They were in as sound a position as any mercantile firm in Sunderland. The balance-sheet had been put into the customary form by chartered accountants, and the undertaking had made more profit than the Water Co. or the Newcastle-upon-Tyne Power Co. The total capital of the undertaking was £403,295, and the expenditure on revenue account amounted to £35,225, against an income of £58,203, leaving gross profit £22,978. The percentage of gross profit to capital came out at 5·69 per cent., whereas the Newcastle Power Co. had made a profit upon capital of 5·08 for the year. This year they had had deplorable depression in the shipbuilding industry, which had come suddenly.

Taunton.—A fresh agreement has been entered into by the Council and the Taunton Electric Traction Co. for the supply of electric current to the tramways, and the company has also agreed to construct the Rowbarton extension within six months.

ELECTRICITY SUPPLY AND TRAMWAY ACCOUNTS.

Belfast.—The total revenue of the tramways department for the past year was £193,013.

Traffic expenses were £59,727, general expenses £13,513, general repairs and maintenance £25,423 and power £21,160, total £119,823. Gross profit was £73,990, and after paying interest, sinking fund, &c., there was a profit of £4,306. 35,233,122 passengers were carried and 5,808,901 car-miles were run.

Dundee.—The annual report of the tramways department gives the receipts as £60,572, and the expenses £39,879. The balance (£20,692) has been applied to meet capital charges, depreciation, renewals, &c. The passengers carried numbered 16,176,134, increase 621,229, and the mileage run 1,281,552, increase 118,760.

Eccles.—The income of the electricity department for the year ended March 31 was £6,875. 8s. 5d. Expenses were £3,850. 4s 8d. and gross profit £3,024. 18s. 9d. Interest and sinking fund charges came to £2,581 and the net profit was £444. The net capital expended is £33,638.

Glasgow.—The 16th annual report of the electricity supply department states that the gross revenue for the year ended May 31 was £255,402, compared with £224,84[illegible] in 1906-7.

Expenses were £115,316. 19s. 3d., against £106,235. 10s. 8d. Interest required £54,714. 17s. 3d.; sinking fund £32,308. 6s. 8d. leaving a profit of £51,061. 15s. 7d., compared with £44,824. 4s. 7d. It is proposed to deduct £50,151. 5s. 11d. depreciation written off capital account, against £41,754. 18s. 7d., leaving £910. 9s. 8d. to be placed to reserve, which now amounts to £22,124. 14s. 9d. Revenue increased by £28,557, while expenditure only increased £9,081. Capital expenditure for the year was £147,798. 18s. 3d., and the total expenditure (less depreciation written off) stands at £1,685,083. 14s. 2d.

The Electricity committee point out that the result of the year's operations and the fact that coal contracts for the coming year have been fixed at rates considerably less than for those of the previous year, justify them in proposing a reduction in the charges for current for private and public lighting. They accordingly recommend that from June 1 to May 31, 1909, the rebate price for private lighting (shops, warehouses, offices, theatres, halls and places of entertainment) should be reduced from 1d. to ¾d. per unit. To domestic consumers, who have hitherto been charged at a uniform rate of 3½d. it is proposed to charge 3d. per unit. It is also proposed to reduce the price charged to the Watching and Lighting committee for the public lamps by £2 per lamp per annum. The charges for stair lighting, motive power, heating and private lighting remain unaltered. The quantity of electricity sold to private consumers was 31,087,322 units, an increase of 25·97 per cent. on the previous year. There are 16,926 consumers (increase 1,429, or 9·22 per cent.) and motors number 3,853, with a total H.P. of 23,743, compared with 3,302 with a H.P. of 19,805. The number of street arcs is 837. For street and stair lighting 1,707,485 units were supplied, against 1,655,005. The equivalent of 1,551,997 8 c.p. lamps is connected to the mains, an increase of 147,444 8 c.p. The maximum load occurred on Dec. 16, when it was 22,186 kw., compared with 19,646 kw., an increase of 12·93 per cent.

Greenock.—For the past year there was a net profit of £700 on the working of the electricity supply department, after paying sinking fund, interest, &c.

Hastings.—For the year ended March 31 the total income of the electricity department was £17,833. 7s. 10d.

Expenses were £9,790. 9s. 1d., leaving gross profit £8,042. 18s. 9d. to meet interest, &c. (£5,032. 4s. 4d.), sinking fund (£5,943. 0s. 10d.) and bad debts (£49. 18s. 3d.), so that there was a deficit of £2,982. 4s. 8d., against a profit of £199 in 1906-7. 936,657 units were generated; 138,026 were supplied to public lamps (against 231,725) and 683,645 to private consumers (against 726,307). The total maximum supply demanded was 615 kw. (against 700½ kw.). The total capital expended is £165,240.

The chief features of the year are (1) a considerable drop in the number of units sold for public lighting owing to all the public lamps being changed to flame arc lamps, thereby reducing consumption considerably; (2) a decrease in units sold for private lighting due to the extended use of metal filament lamps. As Hastings has not got a motor load, the department felt the drop very acutely, but the borough electrical engineer (Mr. Russell Ferguson) considers the consumers are far more satisfied, and so his department will no doubt ultimately feel the benefit by getting more new consumers. Consumers who have changed from gas to electricity agree that they are getting better lighting at a less cost; (3) interest and sinking fund charges are up, on account of the scrapping of some of the old inefficient plant (such as rope-driven, etc.) and the installation of a new turbine in their place.

Manchester.—The traffic revenue of the tramways department for the year ended March 31 was £760,994, miscellaneous revenue £6,859, and parcels receipts £1,220, total £769,073.

Traffic expenses were £215,217, general expenses £70,115, general repairs and maintenance £71,812 and power expenses £142,879, leaving a gross profit of £26[illegible] to meet interest (£[illegible]), income tax (£6,197), rent of leased lines (£21,195), leaseholds (£1,232), expenses of 1907 act £[illegible], leaving £16[illegible],647 to be carried to appropriation account. Sinking fund and loan instalment come to £41,7[illegible], reserve, renewal and depreciation absorbed £[illegible], £55,000 was contributed in aid of rates and £3,10[illegible] applied to street improvements. The total capital outlay is £1,776,629, an increase of £50,784 during the year. 151,477,138 passengers were carried, against 143,264,501 in 1906-7, and 16,974,955 car-miles were run against 15,523,459. 29,955,070 units of electrical energy were consumed (against 25,072,7[illegible]), or 1·76 per car-mile (against 1·61). The percentage of working expenses to receipts was 66, against 65·15. The aggregate length of single track opened for traffic is 176 miles 1,557 yds., an increase of 7 miles [illegible] yds. over 1907. There are 666 electric cars—291 without and 340 with covered tops—and [illegible] combination cars.

Salford.—The traffic receipts of the tramways department for the year ended March 31 was £239,118 17s. 9d., and the total income £239,563.

Working expenses were £147,9[illegible] (6·15d. per car-mile), leaving a balance of £[illegible] (4·03d. per car-mile). After paying interest and sinking fund (£41,971), rents of lines (£25,893), applying £10,806 to depreciation, &c., the balance (£18,000) was transferred to the borough fund. The total length of line worked is 75 miles, of which 36¾ miles are owned by the Corporation. 45,771,611 passengers were carried during the year (an increase of £2,157,488) and 5,416,948 car-miles run; 8,575,959 units of electrical energy (1·58 units per car-mile) were used.

Wallasey.—The traffic revenue of the tramways department for the year ended March 31 was £42,947, and the total income £43,824.

Working expenses were £28,693, leaving a gross profit of £15,131. After paying interest (£4,799), sinking fund (£3,009), placing £4,000 to reserve, £1,000 to insurance reserve fund, and transferring £4,340 to district fund in aid of the rates, the balance (£26) was carried forward. Capital expenditure is £150,021. 8,331,038 passengers were carried, increase of 335,587, and 891,540 car-miles were run, increase 29,416.

Wimbledon.—Although receipts were considerably more than in previous years, there was a decrease of £150 in the net profit of the electricity department, due to increased price of coal, increased rates and taxes, and to nearly £1,200 more being paid in repayment of loans.

TRADE NOTES AND NOTICES.

TENDERS INVITED.

Manchester Tramways committee invite tenders for the supply and delivery of tramcar trucks. Specifications and forms of tender from the general manager (Mr. J. M. McElroy), and tenders to the Chairman of the Tramways committee, 55, Piccadilly, Manchester, by 10 a.m. Tuesday, Sept. 1. See also an advertisement.

The Electric Lighting committee of the *Hull* Corporation invite tenders for the supply and erection of the necessary pipework, &c., in connection with one 500 kw. high-tension steam dynamo. Forms of tenders and specifications may be obtained on depositing 1 guinea with the city treasurer (Mr. T. G. Milner), and tenders, addressed to the Chairman of the Committee, Town Hall, Hull, by first post, Wednesday, Aug. 26. See also an advertisement.

Kingston-upon-Hull Council are prepared to receive tenders for the supply of air space telephone cable and telephone instruments. Copies of specifications, &c., from the town clerk (Mr. E. Laverack), Town Hall, Hull, and tenders by 10 a.m. Aug. 27. See also an advertisement.

Sheffield Electric Light committee invite tenders for foundations for new boiler, ashes and dust chambers, pipe trenches, retaining walls, &c. Tenders to Corporation electric supply department, Commercial-street, Sheffield, by 10 a.m. Aug 31.

The *Metropolitan Asylums Board* invite tenders for the installation of electric storage battery, motor-driven booster and switchboard and connections on the training ship "Exmouth," Grays, Essex, in accordance with drawings and specifications prepared by the engineer-in-chief of the Board (Mr. W. J. Hatch, M.Inst.C.E., M.I.M.E.). Forms of tender from the offices of the Board, Embankment, E.C. Tenders by 10 a.m. Sept. 1.

Brumby and Frodingham Council want tenders by Aug. 24 for supply of sewage disposal plant, including electric motor, switchboard, 600 yds. electric cable, oil or petrol engine, &c. Specifications from Messrs. Strachan & Weekes.

ELECTRICITY SUPPLY TABLES AND DATA.

The *Postmaster-General* invites tenders, until noon Sept. 7, for creosoting telegraph poles. Forms of tender from the controller of stores (Mr. G. Morgan), Stores Department, G.P.O., Bedford-street, Strand, London, W.C.

Galashiels Corporation invite tenders for providing and erecting sewage distributors, gas producer plant, dynamos, motors, pumps, air compressors, &c. Tenders to Town Clerk by 1 p.m. Aug. 24.

Edmonton Guardians want tenders by 9 a.m. Aug. 26 for electric lighting at the nurse's home, Upper Edmonton. Specifications, &c. from Messrs. May & Hawes.

Stretford Council invite tenders for supply and erection of steam boilers and accessories, economisers and mechanical stokers. Tenders to the Clerk by Aug. 24.

Antwerp Municipal Council invite tenders for supply and erection of four electric bollards on the quays of the Royers Lock, Antwerp. A deposit of Fr. 5,000 will be required to qualify a tender. Tenders to M. Le Bourgmestre de la Ville d'Anvers, Hôtel de Ville, Antwerp, by Aug. 31. Copy of specification may be consulted at 73, Basinghall-street, London, E.C.

TENDERS RECEIVED AND ACCEPTED.

Lowestoft Corporation have accepted the following tenders: Parrish & Durrant, free wiring work, at 7s. 6d. per point (the lowest tender received); J. W. Brooke & Co., 50 lamp-posts, at 33s. 6d. per post; and Melloine & Goulder, Bestwood nutty slack, 10s. 9d. per ton up to 1,500 tons, E. Foster & Co., 1,000 tons Ibstock large steam coal, at 14s. 5d. per ton, and Bradbury & Co, 500 tons cobbles, at 14s. 11d. per ton.

Bolton Corporation have accepted the tender of the Triumph Stoker (Ltd.) for supply of six Triumph stokers to replace coking stokers now in use at the electricity works. This is the sixth repeat order by the Corporation.

Salford Council have accepted the tender of the Blasberg Engineering Co., at £11,457, for the supply and erection of a water-cooling plant, and that of Waring & Gillow, at £344, for re-wiring portion of the Royal Technical Institute.

Hertford Council have accepted the offer of the North Metropolitan Electrical Power Distribution Co. for erecting and maintaining for five years nine arc lamps at £14. 10s. each per annum, less 5 per cent.

Walsall Electricity committee have placed an order with Geo. Kent (Ltd.) for a 3 in. Venturi water meter at £70, and with Jesse Tildesley (Ltd.) for steel girders for cooling tower foundation, &c., at £18. 10s.

Hull Corporation have accepted the tender of Siemens Bros. Dynamo Works for supply and erection of a 900 kw. d.c. electric generator with Belliss engine at the Osborne-street power station at £5,926.

Burnley Corporation have accepted the tender of Dick, Kerr & Co. for a 750 kw. steam dynamo at £3,925, and that of Mullin & Durkin for extensions of the station buildings at £3,258.

Wimbledon Council have accepted the offer of the British Electric Transformer Co. for the supply of two 50 kw. transformers for £66 and the return of five disused transformers.

Thirsk Council have accepted the tender of the local electric supply company for public lighting for three years at £205 per annum.

Rotherham Council have accepted the tender of the Worthington Pump Co. for an electrically driven pump at £283.

Finchley Council have accepted the tender of A. E. Faulks for extending the engine house at £964.

Messrs. E. Nuttall & Co. have secured the contract for the construction of the Lampeter to Aberayron light railway.

The "British and South African Export Gazette" states that a new 1,500 kw. turbine generating set has been ordered for the East Rand electricity supply works.

The New Modderfontein Gold Mining Co. have placed an order for two 300 kw. generators with Messrs. H. Davis & Co.

Contracts on behalf of the Geldenhuis Deep have recently been placed with the A.E.G. Electrical Co. of South Africa for two 30 H.P. motors; with the South African General Electric Co., for six motors and panels for pumps; with Siemens (Ltd.), for three 40 kw. transformers; with G. L. Kustner, for one 15 H.P. motor; and with Rintoul & Davies, for 12 transformers.

Sale by Auction.—Messrs. Horne & Co., 8, Delahay-street, Storey's-gate, Westminster, S.W., will sell by public auction at the Royal Arsenal, Woolwich, on Tuesday, 25th inst., unserviceable and obsolete stores, including quantities of iron and steel, brass, copper, gunmetal, lead, zinc, aluminium, &c., dynamos, electric cable, telegraph instruments, porcelain insulators, pressure indicators, electric lamps, cutouts, tools, machinery, &c. The lots may be viewed at the Royal Arsenal, Woolwich, on Friday and Monday previous to and morning of sale. Catalogues at the War Office, Whitehall; the Ordnance Office, Tower; and the Ordnance Office, Royal Arsenal, Woolwich. See also an advertisement.

Patents Development.—The proprietors of the following patents are desirous of entering into arrangements, by way of licence or otherwise, for exploiting same and ensuring their full development and practical working in this country.

Patent No. 23,878/1900, "For Improvements in Process of and Mechanism for Separation of Conductors from Non conductors." Applications to Messrs. Haseltine, Lake & Co., 7 and 8, Southampton-buildings, Chancery-lane, London, W.C.

Patents Nos. 11,933 1900, "For Improvements relating to the Regulation of Electric Motors"; 19,899/05, "For Improvements relating to Alternating Current Electric Motors"; and 26,808/05, "For Improvements relating to Alternating Current Electric Motors." Applications to Messrs. Haseltine, Lake & Co., 7 and 8, Southampton-buildings, Chancery-lane, London, W.C.

Patents Nos. 13,287/02, "For Improvements relating to Apparatus for the Transmission of Sound for Submarine Purposes"; 13,288/02, "For Improvements relating to the Transmission of Sound for Submarine Purposes and to Apparatus therefor"; 3,266/03, "For Improvements in Apparatus for Producing Sound Vibrations in Water"; 10,463/04, "For Improved Means for Producing Sound Vibrations in Water applicable for Marine Signalling"; 10,477/04, "For Improvements in Apparatus for Receiving Submarine Signals"; and 14,230/04, "For Improvements relating to Submarine Signalling and to Apparatus therefor." Applications to Messrs. Haseltine, Lake & Co., 7 and 8, Southampton-buildings, Chancery-lane, London, W.C.

Patents Nos. 23,501/1899, "For Improvements in Vacuum Tube Lighting," and 12,382 02 relating to "An Improved System of Electric Lighting." Applications to Messrs. Lloyd Wise & Co., 46, Lincoln's Inn-fields, London, W.C.

Patent No. 28,820/02, relating to "Improvements in Electrodes for Primary Batteries." Apply to Messrs. Lloyd Wise & Co., 46, Lincoln's Inn-fields, London, W.C.

Patents Nos. 15,215/95, 8,180/97, 21,548/96, 14,637/1900, 20,682 02, 20,683/02 and 20,684/02, all relating to "Improvements in and Pertaining to Telegraphic Printing Apparatus, Typewriters, Apparatus for Punching Strips of Paper," &c. Apply to Messrs. Lloyd Wise & Co., 46, Lincoln's Inn-fields, London, W.C.

Patents Nos. 7,585/03 and 3,913/05, "Relating to Apparatus for enabling Telephonic and Telegraphic Messages to be Transmitted over the same Line"; and No. 12,691/01, "Relating to Apparatus for the Simultaneous Transmission of Telephonic and Telegraphic or other Currents over the same Line." Applications to Messrs. Lloyd Wise & Co., 46, Lincoln's Inn-fields, London, W.C.

Patent No. 8,975/05, "For Improvements in Automatic Telephone Exchange Systems." Applications to Messrs. Abel & Imray, Birkbeck Bank-chambers, Southampton-buildings, London, W.C.

Patents Nos. 1,307 and 1,308/1904, "Relating to Electric Condensers." Applications to Messrs. Wheatley & Mackenzie, 40, Chancery-lane, London, W.C.

Patents Nos. 4,622/1900, "For Improvements in and Mechanism for Reversing Electromotors"; and 1,617/1900, "For Improvements in or connected with Carbon Contacts for Electrical Switches and the like." Applications to Messrs. Brewer & Son, 33, Chancery-lane, London, W.C.

Patent No. 226/1904 relating to "Improvements in Electrical Conductors for Illuminating Purposes, such as Lamp Pencils or Filaments"; No. 2,461/1901 relating to "Casings or Conduits for Electric Conductors." Applications to Messrs. Hyde & Hyde, 3, Broad-street-buildings, London, E.C.

Further particulars of the above patents are given in advertisements on another page.

Railway Signalling Apparatus.—The proprietors of British Letters Patent No. 20,132/01, "Relating to Railway Signalling Apparatus," desire to license British manufacturers to make in Great Britain railway signalling apparatus, or they would consider propositions for the sale of same. Further particulars of the patent are given in an advertisement, and applications should be made to Messrs. Boult, Wade & Tennant, 111-112, Hatton garden, London, E.C.

Mallins' Magnetic Ticket Punch.—In reference to the description of the Prescot ticket punch (Mallins' patent), which appeared

on p 645 of our last issue, we should have stated that the British Insulated & Helsby Cables, Prescot, are sole manufacturers of this punch.

Engineering and Technical Literature.—Messrs. Crosby Lockwood & Son send us the first number of a quarterly circular of engineering and technical literature (classified under subjects) published by them at their recently-opened technical book room, 121A, Victoria-street, S.W. The circular contains all the most important works in engineering science and technology published during the past three months in England and in America.

CATALOGUES, &c.

Osram Lamps.—In these days of vigorous publicity methods among makers of electric lamps, it is most difficult to strike "a good thing" in show cards. The General Electric Co., however, have "touched the spot" with an idea in show cards for Osram lamps. It is a day and night sign, being seen to equal advantage at any portion of the 24 hours. In the centre of a bold shaded border of blue appears the words OSRAM LAMPS. The letters have no visible means of support, being held up by a backing of chiffon. Apart from the advertisement, the average passer-by, seeing the sign, would be curious to know how the centre letters are kept in place. At night, with a light behind the design, much the same effect would be produced. We congratulate the company's publicity manager on the acquisition of a really effective method of attracting attention to Osram lamps.

BANKRUPTCIES, LIQUIDATIONS, &c.

The examination took place at Leeds on Tuesday of Alfred W. Bennett, electrical engineer, lately carrying on business at 32, Park Cross-street, Leeds, as Bennett & Co. Liabilities estimated at £1,124. 13s. 4d. No assets.

Debtor, who was formerly a telegraph engineer, took over a general electrical business in 1887. Five years later he made a deed of assignment, and a dividend of 3s. 5½d. was paid. He was then four years in Leeds, five years in London, again in Leeds four years, and did a general dealing and jobbing business in electrical appliances.—Examination was closed.

Claims against Joseph Richmond & Co. (Ltd.) must be received by Mr. Robert James Ward, 2, Clement's Inn, London, W.C., by Aug. 27.

It has been decided to wind up voluntarily the Pantelegraphy Publishing Co. (Ltd.), and Mr. J. B. Wandless, 13, Old Jewry-chambers, London, E.C., is liquidator. A meeting of the creditors will be held at the office of the liquidator to-day (Friday) at 12 noon.

PATENT RECORD.

APPLICATIONS FOR PATENTS.

NOTE.—*The undermentioned Applications (except those marked †) are not open to public inspection until after acceptance of Complete Specifications. Those marked † are open for inspection 12 months after the date attached to them, if they have not been published previously in the ordinary course. Names within parentheses are those of communicators of inventions. When Complete Specification accompanies application, an asterisk is affixed.*

April 6, 1908.

7,569 HUNGERBUHLER. Accumulators or secondary batteries.
7,571 BROOKES. (Cushman Electric Co., U.S.) Field magnets for dynamo-electric machines.*
7,586 JONES. Electric signals for railroads. (Date applied for, 13/5/07.)*†
7,593 BYNG & GUNNER. Watertight holders for incandescent lamps.
7,614 BERRY. Re-wirable enclosed bridge fuses.
7,621 ATELIERS THOMSON-HOUSTON. Alternating current electric motors of the repulsion type. (Date applied for, 6/4/07.)*†
7,631 CARUS-WILSON. Railway or tramway vehicles.

April 7, 1908.

7,644 FENNELL & PERRY. Apparatus for restricting the maximum current passing in electric circuit.
7,645 FENNELL & PERRY. Charging for electricity supplied.
7,646 FENNELL & PERRY. Electricity meters for limiting the amount of energy which may pass through a circuit to a predetermined quantity.
7,668 PARKER. Electrical methods of transmitting power in a variable and flexible manner.
7,670 DIXON. Safety cutout for overhead wires.
7,671 DAWSON. Attaching shades and reflectors to incandescent lamps.
7,711 SARNEY. Conduits for leads or cables.
7,720 & 7,721 BRUSH ELECTRICAL ENGINEERING CO., CHILTON & NEWTON. Tubines.
7,730 B.T.-H. Co. (G.E. Co., U.S.) Telephone relays.
7,740 MUNDLER. Globe galleries, electric lamps and the like.
7,747 CHAMBERS MOTORS, LTD., & PATTON. High-tension magneto-ignition apparatus for internal combustion engines.*
7,750 KETCHUM. Electric locomotives.*

April 8, 1908.

7,792 SEXTON & SEXTON. Sand-distributing apparatus.*
7,800 CARVER. Electric reciprocating tools.*
7,811 SIR W. G. ARMSTRONG, WHITWORTH & CO. & HARLAW. Controlling electric motors.
7,822 HANDCOCK, DYKES, STEARN & TOPHAM. Electric lamps and their circuits.
7,844 B.T.-H. Co., HASTINGS & WISE. Electric motor controllers.
7,845 B.T.-H. Co. (G.E. Co., U.S.) Alternating current motors.*

April 9, 1908.

7,853 MORGAN. Conductors.
7,854 HALL. Electrical machines.
7,865 HARRISON. Incandescent lamp wrapper.
7,886 NALDER BROS. & THOMPSON, HANDCOCK & DYKES. Electricity meter systems.
7,905 GOVER. (Robinson, Transvaal.) Attaching telegraph, telephone and other wires to insulators or other supports.
7,910 SIEMENS BROS. & CO. (Siemens & Halske A.-G., Germany.) Pyrometers or thermometers of the thermo-electric or electrical resistance type.*
7,916 SMITH & AICHHOLZ. Automatic switch.
7,923 NATHUSIUS & THOMASPHOSPHATWERKE GESELLSCHAFT MIT BESCHRANKTER HAFTUNG. Electric furnaces. (Application for Patent of addition to No. 7,188/08.)*
7,930 EBNER. Electrical ignition devices. (Application for Patent of Addition to No. 28,738/07.)*
7,941 TURNER. Electric brakes.
7,943 B.T.-H. Co. (G.E. Co., U.S.) Dynamo-electric machines.*

April 10, 1908.

7,944 GRAY. Automatic frog for overhead trolleys.
7,954 WISEMAN. Covering and fireproofing of electric wires.
7,961 SORENSEN. Telephone bridge for measurements of ohmic resistances, not affected by the inductance of such resistances.
7,934 BAKER. Rendering sanitary telephone compartments.
8,013 SIEMENS BROS. & CO. (Siemens & Halske A.-G. Germany.) Telegraphically transmitting signals by a perforated strip.*
8,017 BRANCO & GUMPERT. Manufacture of an insulating material.*
8,018 MEYERLING. Ampere-hour meters. (Date applied for, 7/8/07.)*†
8,019 BENNETT & BULL. Clips for haulage cables and the like.

April 11, 1908.

8,065 CROMPTON & CO., MACFARLANE & BURGE. Dynamo-electric machines.*
8,093 MARKS. (Roberts, Natal.) Electrical heating.
8,097 ARTOM. Wireless telegraphy. (Date applied for, 11/4/07.)*†
8,101 SIEMENS BROS. & CO. & TOPLIS. Cooling the commutator of a dynamo-electric machine. (Application for Patent of Addition to No. 7,255/06.)*

April 13, 1908.

8,135 BERJONNEAU. Telephotographic apparatus.
8,148 KRUGER. Electric foot-warmer.*
8,176 LATHAM. Antiseptic coverings for mouthpieces of telephones.
8,190 BOSCH. Interrupters for electrical ignition. (Date applied for, 23/3/08.)*†
8,206 ELEKTRIZITATS GES. ALIOTH. Electrical devices for the measurement of speeds. (Date applied for, 2/5/07.)*†
8,209 BASTIAN. Manufacturing certain electric appliances and apparatus therefor.

April 14, 1908.

8,232 LYNN. Point shifting mechanism.
8,255 DICKINSON. Brake operating mechanism.
8,266 BOOTH & BROOKES, LTD., BOOTH & BROOKES. Means for ascertaining the magnetic bearings of a distant object.
8,277 SCHELLER. Production of high frequency electrical oscillations (Date applied for, 13/8/07.)*†
8,283 SMITH. Switches.
8,289 LAMKIN, CROFTS, & BEAZLEY. Circuit tester, fault and spark locator for induction coils.
8,298 LANGWORTHY. Choking coils for use with arc lamps.*
8,308 DAVY. Arc lamps.

April 15, 1908.

8,375 JONES. Arc lamps.
8,377 PECK. Alternating current distribution systems.
8,386 A.-G. BROWN, BOVERI, & CIE. Thrust balancing in steam or gas turbines using reversible propellers. (Date applied for, 24/8/07.)*†
8,414 ALLGEMEINE ELEKTRICITATS GES. Alternating current motors of the commutator type. (Date applied for, 17/4/07.)*†
8,415 NOGGERATH. Dynamo electric machines. (Date applied for, 25/4/07.)*†
8,416 & 8,421 WOLFRAM LAMPEN A.-G. Filament for incandescent lamps. (Date applied for, 26/4/07.)*†
8,425 EVANS. (Elektrochemische Werke, Germany.) Production of electrical discharge.*

SPECIAL NOTICE.

NOW READY. Vol. LX of "THE ELECTRICIAN," 1,016 pages, bound in strong cloth. Price 17s. 6d.; post free, 18s. 6d. Also ready Cases for Binding. Price 2s.; post free, 2s. 3d.

A complete set of "THE ELECTRICIAN" (1861-1863, 1878-1908) can be supplied. A number of odd volumes and some odd old back numbers, to help in making up complete sets, are also now available.

SPECIFICATIONS PUBLISHED.

1906 SPECIFICATIONS.

26,569A BURNS. Electrically-operated locks and fastenings. (Date applied for, 21/5/07.)

1907 SPECIFICATIONS.

539 RUHMER. Production and maintenance of interrupted arcs of high frequency.
3,215 RUHMER. Hertzian telephony and apparatus therefor.
5,194 POSTANS. Electrical ignition apparatus.
6,034 CRAMP. Single phase alternating-current motors.
7,687 WEBB. Radio-telegraphy and radio-telephony.
7,941 BEVIS & ANGOLD. Arc lamps.
7,941A BEVIS & ANGOLD. Arc lamps. (Date applied for, 5/4/07.)
8,183 MERSHON. Alternating-current dynamo-electric machines.
8,364 GES. FUR DRAHTLOSE TELEGRAPHIE. Receivers for wireless telegraphy. (Date applied for, 10/4/06.)
8,376 VANDERVELL. Switches.
8,471 KESSLER & JELICH. Electric alarm bells.
8,504 BROOK & HIRST. Multiple switch controlling apparatus for electric circuits, specially applicable to motor starters.
8,563 DEUTSCHE GASGLUHLICHT AKT.-GES. (AUER GES.). Manufacture of metallic illuminating bodies for incandescence lamps. (Date applied for, 30/8/06.)
8,641 B.T.-H. Co. (G.E. Co., U.S.) Joints between incandescent lamp filaments and leading-in wires or supports.
8,841 ALLGEMEINE ELEKTRICITATS GES. Incandescence bodies for electric lighting and heating purposes. (Date applied for, 17/4/06.)
8,903 DAVIS. Electric lamp-holder applicable for motor carriages.
9,684 B.T.-H. Co. (G.E. Co., U.S.). Machines for insulating conductors.
9,868 ELECTRIC & ORDNANCE ACCESSORIES CO. & HALL. Electromagnetic circuit breakers.
10,931 CAMPBELL. Incandescent lamp bulbs.
10,972 PORZELLANFABRIK KAHLA, FILIALE HERMSDORF KLOSTERLAUSNITZ. Insulators. (Date applied for, 14/5/06.)
11,044 TANNER & CLAREMONT. Cables and the bonding thereof.
11,381 SIEMENS BROS. & CO. & GRIMSTON. Electrical messenger call and order installations.
11,850 BOTTING & BOTTING. Electric sign switches.

COMPANIES' MEETINGS AND REPORTS.

BAKER STREET & WATERLOO RAILWAY CO.—Sir Geo. S. Gibb at the meeting on Monday stated that for the first time they entered the ranks of dividend-paying railways, being able to pay not only the full 4 per cent. on the preference stock, but also, out of their own resources, a dividend at the rate of ¾ per cent. per annum on the whole of the ordinary shares. He believed that in the four half-years since the railway was opened it had shown a larger percentage growth in business than any tube railway. During the past six months they had carried nearly 13,000,000 passengers, an increase of 3,000,000 (over 30 per cent.) compared with the corresponding period of 1907. The increase included 1,871,140 passengers carried at workmen's fares, about 14 per cent. of the total number carried, but yielding an average of only 1d. per passenger. The explanation of the relatively good growth in traffic was, he thought, to be found in the location of the railway. The "Bakerloo" railway had created entirely new facilities in travel, and did not depend, as did so many new lines, on the diversion of traffic from any other railway route. The development of through traffic was especially satisfactory. They had through bookings with nine different companies, and out of a total traffic of about 13,000,C00 passengers about 4,750,000, or 36 per cent., had been passengers travelling with through tickets. The through traffic exchanged with the Central London Railway had been specially satisfactory, amounting to 40,0C0 passengers per week, with the Piccadilly tube had been 55.000 per week, and with the City & South London about 30,000 per week. Their average receipt from their proportion of through traffic was 1·36d. per passenger, their average receipt from all traffic (through and local) being 1·48d. per passenger. The Paddington extension was still under consideration, and hoped to be able to make a recommendation on the subject at the next meeting.

CHATHAM & DISTRICT LIGHT RAILWAYS CO.—The receipts for the half-year ended June were £19,061. 11s. 7d. and expenses £12,433. 4s. After payment of rent of Rochester Corporation lines (£990. 18s. 3d.), debenture interest £1,234, &c., and crediting balance forward £347. 14s. 4d.) there is £4,434. 8s. 3d. available. The directors recommend payment of the due preference dividend, leaving £1,494.8s.3d. to be carried to revenue new account. Owing to continued trade depression in the Chatham district, the revenue for the half-year has been disappointing. Rochester Corporation extension lines to Strood Hill and Frindsbury were opened at Easter and leased to the company. Satisfactory arrangements were made for supply of current for these extensions from the Kent Electric Power Co.

CHILIAN ELECTRIC TRAMWAYS & LIGHT CO. (LTD.)—The report for 1907, presented at the meeting on Monday, stated that the result of the year's operations, after deducting interest, &c., shows a credit balance of £14,160. A debit balance from last year of £2,447 leaves a net balance of £11,712. £10,000 has been transferred to renewals reserve, leaving £1,712 to be carried forward. The tramway returns show a total of 61,451,234 passengers carried, against 50,998,903 in 1906. The business of the electric lighting department showed a gratifying development, the profit for 1907 amounting to $470,928.81, against $310,448.89. Sir Julius Wernher said there had been satisfactory developments both in the tramway and in the lighting departments. They had carried 10,000,000 more passengers than in 1906, and had earned increased profits in the light and power departments. They were not in a position to pay any dividend, and it was greatly to be regretted that the larger part of the capital remained unremunerative. Negotiations for a revision of the tariff were being continued, and he had no doubt a satisfactory arrangement would be finally arrived at.

CHLORIDE ELECTRICAL STORAGE CO. (LTD.)—For the year ended June 30 the accounts show a profit on trading of £24,945. The directors recommend a dividend of 10 per cent. and the transfer of £2,000 to reserve, carrying forward £10,612.

EDMUNDSON'S ELECTRICITY CORPN. (LTD.)—At the meeting last week Mr. P. Dobell Tuckett said the reduction in trading profit was accounted for by the smaller turnover, consequent upon the completion of various works, and by the fact that the local authority losses had been charged directly against profit instead of to reserve, as formerly. Investments and advances to subsidiary companies stood at £1,409,774, against £1,450 700. The reserves had been increased from £182,073 to £183,564. There was nothing to warrant the impression abroad that the electric supply industry was retrograding. The profitable character of the business had not realised the extravagant hopes which were once entertained of it, but he found it difficult to conceive a business offering a more stable source of income or a more adequate security for its mortgage obligations.

GREAT NORTHERN, PICCADILLY & BROMPTON RAILWAY CO.—Sir Geo. S. Gibb stated at the meeting on Tuesday that the development of the Piccadilly line had been unusually rapid. The company had carried 17,500,00C passengers during the past half-year, an increase of 5,500,000 over the corresponding period of last year. Their through traffic had well developed. They had carried 4,500,000 people with through tickets, which was 25½ per cent. of their total. There was a slight decrease in expenditure, and they found the equipment of the railway was lasting exceedingly well. The directors proposed to declare a dividend of ¾ per cent. on the whole of the paid-up capital of the company—not a large dividend, but the most satisfactory result they were able to show.

LANARKSHIRE TRAMWAYS CO.—The receipts for the half year ended June 30 were £33,960. 14s. 1d., and the expenses £18,992. 0s. 6d. After providing contributions to local authorities (£1,117. 15s.), debenture interest (£608), &c., and crediting balance forward with £894. 17s. 4d. there is a balance of £14,020. 1s. The directors recommend payment of dividends at the rate of 6 per cent. for the half-year (against 5½ per cent. last June half-year). £5,155. 1s. 10d. is carried to revenue new account. Traffic receipts have again been very satisfactory, exceeding by over £4,C00 those for the corresponding half of 1907. The proceeds have been utilised in constructing two extensions and the purchase of seven additional cars. Owing to delays in passing the plans and late delivery of certain materials, the lines were not opened as early as anticipated. The B. of T. inspection of these extensions took place on Aug. 7 inst. As the company's plant is already working at full load, negotiations are pending for a supply of current which will obviate for the present further capital expenditure on power station plant.

LIVERPOOL OVERHEAD RAILWAY CO.—At the meeting on Tuesday, Sir Wm. B. Forwood said there had been a slight improvement in their earnings which enabled them to pay a small dividend upon the ordinary shares. Compared with the same half of last year, first-class travel showed a falling off of 17,769, and third-class a decrease of 116,953; but in the cheap workmen's return tickets there was an increase of 92,000. Their net railway passenger traffic showed a decrease of 42,148 passengers, representing £477. The gross revenue was £37,868, and the working expenses £30,511. A dividend of 5 per cent. was recommended on the 1892 preference shares, absorbing £3,000, and leaving £4,207 to carry forward. They had effected a saving in rates, and their appeal to Quarter Sessions was largely successful. The working of the tramways had been satisfactory, and they had materially contributed to the gross profits The number of passengers carried by the tramways showed an increase of 14,161. Through bookings with the L. & Y. Railway were still disappointing. The renewal fund had now reached £35,913. Referring to the origin of the Overhead Railway, Sir William said that if they could have foreseen the introduction of the telephone and the establishment of electric tramways, the Overhead Railway would certainly not have been built without substantial assistance from the Dock Board, which had greatly benefited from the railway. It was somewhat remarkable that even with the serious competition of the Corporation tramways and the electrical service on the L. & Y. Railway they had been able to hold their traffic so well. In 1902 the total traffic was 8,315,C00; last year it was 8,915,000, but in consequence of the reduction made in the fares these 600,000 more passengers were carried for £722 less money. The revenue had fallen from £68,179 to £67,457, chiefly due to the workmen's traffic. The revenue per passenger went down from 1·66d. to 1·29d. He was doubtful if the workmen's traffic paid the actual cost of conveyance, to say nothing of cost of maintenance and interest on capital.

METROPOLITAN DISTRICT RAILWAY CO.—At the meeting on Wednesday Sir Geo. S. Gibb said the company was now in a sounder financial position than formerly. The capital expenditure during the half-year had been £59,499. The estimated expenditure for the current

half year was £75,000 for a number of improvements of the railway property, rolling stock, &c. They had a good half year, they had carried 29,500,000 passengers, a slightly larger number than the number carried in any previous half-year, and 4,000,000 more than in the corresponding period of 1907. In money the increase was £27,433. Their traffic was derived as to 8½ per cent. from first-class, 10¾ from workmen, and 81 from third-class. Season ticket revenue showed an increase of £8,326. The average receipt per passenger had been 1·86d. The chief item of increase in expenditure was in train working, which showed an increase of £18,185. The whole of that increase was in the cost of electric current, but not in the price of current. The price paid for current had gone down by about 1½ per cent. in comparison with the corresponding half-year. The cost of train working in the first half of 1907 was shown as £56,486. That was the cost of electric current, including the sub-stations. Of that sum £55,642 represented payment for current. The car-miles run in the half-year for which the current was used were 8,145,790. In the past half-year the item for train working was £74,824. Of that £73,167 represented payment for current. The car-miles corresponding to that item were 9,509,527. The increase in car mileage run was, therefore, 12 per cent. The cost per car-mile was 1·847d., compared with 1·639d., and, allowing for the reduction in the actual price per unit paid for current worked out at an increase in consumption per car-mile of 14 per cent. That had been due to the increase which had taken place since the first half of 1907 in the acceleration of trains and a few other causes. The increase in train-miles had been 23 per cent. on the District Railway and 16¾ per cent. in the mileage run by the District cars altogether. The car-mile receipts during the last half-year had been 9·27d., compared with 9·24d. The net result of the half-year was a debit balance, after payment of all debenture interest, of £8,951, compared with £18,035 deficiency in the first half of 1907. He had no doubt those deficiencies would before long entirely disappear from the District accounts. Their railway was in good condition to earn revenue. Their fares were slightly higher, and therefore they got the benefit from any increased traffic.

LOCH LEVEN WATER & ELECTRIC POWER CO.—At the meeting on Wednesday Mr. J. D. Bonner said that the British Aluminium Co. held the whole of the issued capital, and they had now agreed to subscribe for the balance authorised (£750,000) and thus place itself in a position to provide all the funds necessary for carrying out that important scheme. He had just returned from the works at Loch Leven, where he had been amazed at the great progress made in bringing the works to the operating stage, and he was convinced they would be in a position to produce aluminium at Leven several months earlier than they had recently been contemplating.

NEW COMPANIES, STATUTORY RETURNS, MORTGAGES AND CHARGES, &c.

NEW COMPANIES.

BENJAMIN ELECTRIC (LTD.). (99,126.)—Reg. Aug. 7, capital £1,000 in £1 shares, to acquire from the Benjamin Electric Mfg. Co. (Chicago, Ill.) the benefit of certain inventions relating to electrical clusters and lighting specialities, and to carry on the business of electricians, producers and workers of and dealers in electricity, &c. Private company. First directors, R. B. Benjamin, W. D. Steele, W. C. Jones, K. H. Addington and B. J. Grigsby.

ELECTRICITY (LTD.). (99,119.)—Reg. Aug. 6, capital £1,000 in £1 shares, to acquire from C. A. F. Duranty the benefit of certain inventions relating to the production of electricity, and to carry on the business of electricians, engineers, suppliers of electricity, &c. First directors, C. A. F. Duranty and C. E. De Wolf, and the following nominees of C. E. De Wolf—viz., W. C. Bacon, N. Dunn and T. F Harrison (all permanent).

MERSHON INSULATOR (HIGH TENSION) SYND. (LTD.) (99,143.)—Reg. Aug. 8, capital £20,000 in £1 shares, to acquire certain rights in connection with an invention relating to improved high-tension insulators, and to carry on the business of an electric power and supply company. Private company. First directors, R. D. Mershon (permanent, subject to holding 500 shares), H. W. Fox, M. F. Armstrong, W. A Wills, W. Praeger and S. Scott. So long as Earl Dysart is a shareholder he may nominate one director, W. Praeger being his first nominee.

SOLIUM ELECTRICAL CO. (LTD.) (99,009.)—Reg. July 28, capital £12,000 in 40,000 shares of £1 each and 40,000 shares of 1s. each, to carry on the business of manufacturers of and dealers in electrical, incandescent filament lamps, electrical engineers and contractors, manufacturers of and dealers in electrical apparatus, &c. First directors, T. A. Hill, J. McConnell and E. Jardine.

STATUTORY RETURNS.

BARNSLEY & DISTRICT ELECTRIC TRACTION CO. (LTD.)—The return to May 30 gives capital as £50,000, in 5,000 ordinary and 5,000 preference shares of £5 each, of which 4,007 ordinary and 4,400 preference have been taken up. £42,[illegible] has been received. Mortgages and charges, £21,000.

CALCUTTA TRAMWAYS CO. (LTD.)—According to return to April 23 capital is £[illegible] in 140,000 ordinary and 51,000 preference shares of £5 each, of which 1[illegible]7,610 ordinary and 44,027 preference have been taken up. £2 per share has been called up on 4,300 ordinary, £3. 10s. per share on 8,000 ordinary, £3. 10s. per share on 22,000 ordinary, £5 per share on £79,430 ordinary, and £5 per share on £44,027 preference. £723,085 has been received. £185,100 is considered as paid, being £5 per share on 23,780 ordinary, £3 per share on 4,400 ordinary, £2. 10s. per share on 8,000 ordinary and £1. 10s. per share on £22,000 ordinary. Mortgages and charges, £350,000.

EASTERN & SOUTH AFRICAN TELEGRAPH CO. (LTD.)—The return to May 28 gives capital as £600,000 in £10 shares, all of which have been taken up and paid for in full. Mortgages and charges, £449,500.

EVERSHED & VIGNOLES (LTD.)—Return to July 6 gives capital as £30,000 in £10 shares, all of which have been taken up and paid for in full. Mortgages and charges, £11,400.

FRINTON-ON-SEA & DISTRICT ELECTRIC LIGHT & POWER CO. (LTD.)—According to return to July 21, capital is £6,500 in 5,000 ordinary and 1,500 preference shares of £1 each, of which 751 ordinary and 1,500 preference have been taken up. £1 per share has been called up and £2,251 has been received. Mortgages and charges, £6,100.

GLOBE TELEGRAPH & TRUST CO. (LTD.)—The capital in return to July 14 is £5,000,000, in 250,000 preference and 250,000 ordinary shares of £10 each, of which 181,127 preference and 181,127 ordinary have been taken up. £10 per share has been nominally called up. £438,115. 5s. has been received in cash, and £3,167,450 is considered as paid on 316,745 shares. Mortgages and charges, nil.

HINDHEAD & DISTRICT ELECTRIC LIGHT CO. (LTD.)—In return to June 16 capital is £15,000 in £1 shares, of which 12,706 have been taken up. £1 per share has been called up and paid on 2,206 and £10,500 is considered as paid on the remainder. Mortgages and charges, nil.

LOWNE ELECTRIC CLOCK & APPLIANCES CO. (LTD.)—Return to June 16 gives capital as £8,000 in £1 shares, of which 6,507 have been taken up. £1 per share has been called up on 1,007 and £1,000 has been received, leaving £7 in arrears. £5,500 is considered as paid. Mortgages and charges, £475.

POTTERIES ELECTRIC TRACTION CO. (LTD.)—The capital in return to May 26 is £600,000 in 300,000 ordinary and 300,000 preference shares of £1 each, of which 245,000 ordinary and 245,000 preference have been taken up. £1 per share has been called up on 178,340 ordinary and 245,000 preference and £423,340 has been received. 66,660 shares are considered as fully paid. Mortgages and charges, £245,000.

WEST AFRICAN TELEGRAPH CO. (LTD.)—In return to June 11 capital is £400,000 in £10 shares, of which 23,109 have been taken up. £231,090 has been received. Mortgages and charges, nil.

WESTERN TELEGRAPH CO. (LTD.)—Return to May 27 gives capital as £2,500,000 in £10 shares, of which 207,930 have been taken up. £10 per share has been called up on 130,000, and £1,300,000 has been received. £779,300 is considered as paid on 77,930. Mortgages and charges, £800,000.

MORTGAGES AND CHARGES.

MOUNTAIN & GIBSON (LTD.)—Issue on July 28 of £3,500 debentures, part of a series of which particulars have already been filed.

APPOINTMENT OF RECEIVERS, &c.

UNITED ELECTRIC LIGHT & POWER SUPPLY CO. (LTD.)—Notice of the appointment of J. K. Hollingbery, C.A., 6, Howard-street, Glossop, as receiver, on March 25, 1903, under powers contained in debenture dated March 25, 1903, has been filed pursuant to sec. 11 (3) of the Companies' Act, 1907.

CITY NOTES.

MEMORANDA (Aug. 13).—Bank rate 2½ per cent. (since May 28, 1908). Price of silver, 24 1/16d. per oz. Consols 86[illegible]—86[illegible] for money and 86⅝—86¾ account. Consols Pay Day, Sept. 1; Stock and Shares Continuation Day, Aug. 25; Ticket Day, Aug. 26; Pay Day, Aug. 27.

Prices of Metals (London).—*Copper*, cash, 60[illegible]—60[illegible]; three months, 60[illegible]—61[illegible]. *Lead*, English, 13[illegible]; foreign, 13. *Spelter*, foreign, 19[illegible]—20[illegible]. *Tin*, English, 136—137[illegible]; foreign, cash, 13[illegible]—138[illegible], three months, 139—139[illegible]. *Iron*, Cleveland, cash, 51/[illegible]—51/3; three months, 50/7.

MATHER & PLATT (LTD.)—The directors announce an interim dividend on the ordinary shares of 5 per cent. (tax free) for the half year ended June 30, being at the rate of 10 per cent. per annum.

OLDHAM, ASHTON & HYDE ELECTRIC TRAMWAY (LTD.)—An interim dividend of 5 per cent. per annum (5s. per share), less tax, on the ordinary shares for the past half year has been declared.

OXFORD ELECTRIC CO. (LTD.)—The directors have declared an interim dividend at the rate of 5 per cent. (2s. 6d. per share), tax free, on the ordinary shares for the past half year.

RANGOON ELECTRIC TRAMWAY & SUPPLY CO. (LTD.)—This company is inviting applications for an issue of 10,000 6 per cent. £5 cumulative preference shares at a premium of 2s. 6d. per share.

TYNESIDE TRAMWAYS & TRAMROADS CO.—The divisible balance for the past year is £2,4[illegible]. After paying preference dividend, placing £900 to reserve, and applying £55[illegible] to reduction of formation expenses, the carry forward is £[illegible].

ELECTRIC TRAMWAY AND RAILWAY TRAFFIC RECEIPTS.

Line	Week ended.	Amount.	Inc. or Dec. (a)	Aggregate: No. of weeks.	Aggregate: Amount.	Aggregate: Inc. or Dec. (a)
		£	£		£	£
Aberdeen Corporation	Aug 5	1,638	+ 57	9	15,319	+ 10
Airdrie	July 31	180	- 20	30	6,735	+ 89
Anglo-Argentine	Aug. 5	23,383	+ 6,628	31	599,659	+ 88,238
Ayr Corporation	" 8	555	+ 85	12	5,036	- 78
Baker St. & Waterloo Ry.	" 8	2,650	+ 535	6	17,450	+ 2,910
Barnsley	July 31	185	+ 11	30	5,260	+ 352
Barrow	" 31	361	+ 41	30	7,338	- 171
Bath Electric Trams, Ltd.	Aug 5	1,290	+ 384	31	22,562	- 1,008
Birkenhead Corporation	...	...	...	...	...	...
Birmingham Corporation	" 8	6,762	82	19	120,741	+ 5,450
Birmingham & Mid.	July 24	830	+ 1	29	23,998	+ 940
Blackburn Corporation	Aug. 5	1,198	- 19	19	22,182	+ 1,182
Blackpool Corporation	" 6	3,144	- 215	18	23,539	+ 1,004
Blackpool and Fleetwood	...	...	...	...	...	...
Bolton Corporation	" 9	2,537	- 123	19	45,516	+ 1,156
Bombay	July 15	R32,519	+ R5,344	28	R1,003,240	+ R195,194
Bournemouth Corporation.	Aug. 5	2,693	- 156	18	31,065	- 1,661
Bradford Corporation	" 8	5,570	+ 189	18	90,353	+ 1,080
Brighton Corporation	" 9	2,142	+ 329	19	18,569	+ 623
Bristol Trams & Carriage	" 7	6,894	+ 19	37	159,245	+ 1,250
Burnley Corporation	" 8	1,425	+ 70	19	23,519	+ 1,103
Burton Corporation	" 9	343	- 23	19	5,280	- 413
Bury Corporation	" 11	1,254	+ 25	19	23,087	+ 1,920
Calcutta Tramways Co.	" 8	R47,768	+ R234	6	R276,264	- R18,510
Cardiff Corporation	...	...	...	...	...	...
Cavehill	July 31	116	+ 9	30	2,721	+ 158
Central London Railway	Aug. 8	6,648	+ 2,381	6	42,958	+ 12,072
Charing X, Euston & H'stead	" 8	3,515	+ 560	6	19,915	+ 4,110
Chatham & Dist. Lt. Rys.	" 6	1,220	+ 10	31	23,454	+ 753
City & South London Rly.	" 9	2,975	- 133	6	17,542	- 1,245
City of Birmingham	July 31	2,850	+ 73	30	84,016	+ 210
Colchester Corporation	...	...	...	...	...	...
Cork Electric Trams Co.	Aug. 6	586	+ 49	31	14,210	- 481
Croydon Corporation	" 7	1,898	+ 19	19	287,047	+ 244
Devonport & Dist. Trams.	July 31	511	+ 86	30	13,622	- 1
Dover Corporation	Aug. 8	345	- 5	19	4,486	- 89
Dublin & Lucan Railway	" 7	212	+ 6	5	873	- 35
Dublin United	" 7	6,901	- 1,592	5	32,465	- 8,514
Dudley-Stourbridge	July 31	879	+ 26	30	24,383	- 1,085
Dundee Corporation	Aug. 5	1,220	+ 126	‡12	14,615	+ 1,114
East Ham Council	" 8	1,116	- 48	19	17,485	- 928
Exeter Corporation	" 7	462	+ 16	19	6,160	- 131
Falkirk and District	...	...	...	...	...	...
Gateshead & Dist. Trams	July 31	1,033	- 9	30	30,354	+ 281
Glasgow Corporation	Aug. 8	17,279	+ 21	10	170,232	+ 1,447
Glossop	" 8	138	- 5	32	4,954	- 258
Gravesend—Northfleet	July 31	252	- 16	30	6,269	- 895
Great Northern & City Rly.	Aug. 8	1,221	- 213	[illegible]	7,948	- 1,830
Gt. Northern, Piccadilly, &c	" 8	4,180	+ 560	6	30,470	+ 5,910
Greenock & Port Glasgow	July 31	600	- 93	30	15,894	- 4,085
Hartlepool Tramways	" 31	396	+ 43	30	7,133	- 1,315
Hastings Elec. Trams Co.	Aug 6	1,977	- 89	6	7,898	- 407
Hong Kong	...	...	...	...	...	...
Huddersfield Corpn.	" 8	1,889	+ 47	19	31,197	+ 407
Hull Corporation	" 8	2,773	+ 88	19	45,811	+ 201
Ilford District Council	" 8	634	+ 2	19	8,813	- 489
Ilkeston District Council	" 5	190	- 7	18	2,668	+ 49
Ipswich Corporation	" 8	609	- 43	19	7,835	- 100
Isle of Thanet Co.	" 8	2,103	+ 42	45	21,239	+ 252
Jarrow	July 31	125	- 15	30	3,193	- 128
Keighley Corporation	Aug. 6	170	- 7	5	921	+ 1
Kidderminster & District	July 31	163	+ 27	30	3,280	- 122
Kilmarnock Corporation	Aug. 8	165	+ 20	12	1,998	- 138
Lanarkshire Trams Co.	" 6	1,271	+ 39	31	40,266	+ 3,726
Lancashire United	" 5	1,734	- 74	31	41,204	+ 2,023
Leamington	July 31	215	+ 32	30	4,889	+ 318
Leeds Corporation	Aug. 1	6,853	- 35	18	121,628	+ 5,604
Leicester Corporation	" 8	2,715	- 89	6	14,587	+ 298
Leith Corporation	...	...	...	...	...	...
Lincoln Corporation	...	...	...	...	...	...
Liverpool Corporation	" 1	11,033	- 688	31	328,841	- 3,278
Liverpool Overhead Rly.	" 9	1,640	- 528	6	8,990	- 1,660
*London County Council	" 1	36,876	+ 5,617	‡18	617,580	+ 68,664
London United	" 8	10,767	+ 274	31	208,973	+ 3,818
Lowestoft	...	...	...	...	...	...
Maidstone Corporation	" 8	283	...	19	3,613	
Manchester Corporation	" 8	17,428	+ 1,141	19	290,314	+ 12,832
Mersey Railway	" 8	1,927	+ 43	6	11,141	+ 85
Merthyr	July 31	209	+ 3	30	6,301	+ 77
Metropolitan Dist. Railway	Aug. 8	8,140	+ 1,506	6	53,913	+ 7,731
Metropolitan Elec. Trams	July 31	6,809	+ 1,683	20	167,962	+ 33,573
Middleton	" 31	377	- 22	30	10,916	+ 388
Nelson Corporation	Aug. 8	158	- 1	§18	2,740	- 136
Newcastle-on-Tyne Corp.	" 8	3,956	- 305	19	70,602	- 4,958
Newport (Mon.)	...	...	...	...	...	...
Northampton Corporation.	" 7	739	+ 77	§18	9,128	+ 130
Oldham, Ashton & Hyde	July 31	603	- 17	30	17,907	- 85
Oldham Corporation	Aug. 9	2,037	+ 16	20	39,701	+ 721
Perth (N.B.) Corporation	" 5	192	+ 13	12	1,956	- 16
Perth (W.A.) Elec. Trams	" 7	1,314	- 32	32	44,403	- 876
Peterborough	July 31	152	+ 7	30	3,754	+ 91
Portsmouth Corporation	Aug 8	3,338	+ 195	19	39,997	+ 400
Potteries	July 31	1,736	- 121	30	54,968	- 193
Preston Corporation	Aug. 5	781	- 32	5	3,874	- 151
Rotherham Corporation	" 6	712	- 36	18	11,383	+ 187
Rothesay	July 31	572	+ 165	30	5,813	- 287
Salford Corporation	Aug. 10	4,731	+ 43	19	91,576	+ 1,063
Sheerness	July 29	74	+ 8	30	1,657	- 6
Sheffield Corporation	Aug. 9	5,888	- 162	†20	111,294	+ 3
Singapore Trams	...	...	...	...	...	...
South Metropolitan	July 31	937	+ 162	30	23,637	+ 681
South Staffs	" 31	922	+ 53	30	26,396	- 249
Southend Corporation	Aug. 5	929	+ 31	19	8,368	+ 553
Southport Tramways	July 31	371	- 26	30	8,245	- 378
Stalybridge, Hyde, &c., Jt. Bd.	Aug 8	851	- 35	†19	15,203	- 186
Sunderland Corporation	" 9	1,6[illegible]2	- 119	19	23,184	- 4,712
Sunderland District	" 5	754	+ 193	40	19,089	+ 1,580
Swansea Trams	July 31	1,029	+ 22	30	27,637	+ 1,856
Taunton	" 31	47	- 6	30	1,208	- 58
Tynemouth and District	" 31	405	+ 17	30	6,114	- 494
Tyneside Trams Co.	Aug. 5	566	- 31	5	2,284	- 211
Wallasey District Council	" 8	1,219	- 95	18	17,531	+ 813
Walsall Corpn	" 8	655	- 27	32	17,015	+ 1,374
Warrington Corpn.	...	...	...	...	...	...
West Ham Corporation	July 30	2,552	+ 8	18	40,421	- 2,455
Weston-super-Mare	" 29	325	- 14	30	3,269	- 14
Wolverhampton Co.	" 31	461	- 1	30	13,687	- 366
Wolverhampton Corpn.	Aug. 5	1,035	- 57	9	8,319	+ 254
Worcester	July 31	315	- 2	30	8,224	+ 33
Wrexham	" 31	107	- 1	30	3,030	+ 13
Yorkshire W.R. Trams	Aug. 9	1,919	+ 225	32	39,153	...
Yorkshire Woollen District	July 31	1,198	+ 263	30	27,617	- 1,148

(a) These comparisons are with the corresponding period last year. § Plus 3 days. ‖ Plus 2 days. * Partly electrical. † Minus 3 days. ‡ Minus 2 days.

ELECTRICAL COMPANIES' SHARE LIST.

Shares	Last Dividend	Name.	Price Wed., Aug. 12.	Rate % Yielded. £ s. d.	Dividend Due.	Business Week to Aug. 12: Highest.	Business Week to Aug. 12: Lowest.
		ELECTRICITY SUPPLY.					
10	9 0	Bournemouth & Poole Elec. Sup. Ord.	10½-11	6 7 0	Mar, Sept.	–	..
10	4 6	Do. 4½ per Cent. Cum. Pref.	9½-10½	4 7 0	Feb, Aug		..
10	6 0	Do. 6 per Cent. Cum. Second Pref.	10½-11½	5 11 6	Feb, Aug		
St.	4½%	Do. 4½ per Cent. Deb. Stock (red.)	100-103	4 7 6	Jan, July	..	..
5	3 6	Bromley (Kent) El. Lt. & Power Shares	4½-5	5 10 0	April, Oct	..	..
St.	4½%	Do. Do. 1st Debs.	94-97	4 12 9	Mar, Nov	.	..
5	5 6	Brompton & Kensington Elec. Sup. Ord.	7-8	6 6 6	March	..	..
5	3 6	Do. 7 per Cent. Pref.	6¾-7¾	4 10 0	Mar, Sept	..	..
St.	4%	Central Elec. Sup. Co. 4% Guar. Db. Stock	98-101	4 0 0	June, Dec	..	..
5	2 6	Charing Cross (W. End & City) El. Sup. Co.	3¾-4	6 5 0	Feb, Aug	.	..
5	2 3	Do. 4½ per Cent. Pref.	4-4½	5 0 0	Feb, Aug	4¼	..
St.	4%	Do. 4 per Cent. Deb. Stock (red.)	95-98	4 2 6	Jan, July	96½	..
5	2 3	Do. City Undertaking 4½% Cm. Pref.	3¾-4½	5 11 0	Jan, July	3¾	..
5	2/6	Chelsea Electric Supply Ord.	3-3½	6 8 9	March ..	..	..
St.	4½%	* Do. 4½ per Cent. Deb. Stock (red.)	100-103	4 7 6	June, Dec	..	..
10	5 0	†City of London Electric Lighting Ord.	9¾-10½	5 17 0	Feb, Aug	..	..
10	6/0	† Do. 6 per Cent. Cum. Pref.	11½-12½	4 16 0	Jan, July	..	..
St.	5%	Do. 5 per Cent. Deb. Stock (red.)	122-126	4 0 0	June, Dec	..	..
St.	4½%	Do. 4½ per Cent. 2nd Deb. Stock (red.)	101-104	4 6 6	Jan, July	..	..
5	2%	County of Durham Elec. P.D. Ord.	2¾-3	3 9 7	April, Oct	..	..
5	5%	Do. 5 per Cent. non Cum. Pref.	3¾-4¼	6 5 0	April, Oct	..	..
10	4 0	†County of London Elec. Supply Ord.	7¾-8¼	4 17 9	Feb, Aug		.
10	6 0	† Do. 6 per Cent. Cum. Pref.	10¼-10¾	5 11 6	Mar, Sept		.
St.	4½%	Do. 4½% Deb. Stock (red.)	106-109	4 1 0	Jan, July	..	..
St.	4½%	Do. Second Deb. Stock	98-101	4 9 9	May, Nov	100	..
5	3 6	Folkestone Electricity Supply Co. Ord.	4¾-5¼	5 7 0	April, Oct	5¼	5¼
5	2 6	Do. 5 per Cent. Cum. Pref.	5-5½	4 11 0	Mar, Sept	..	..
St.	4½%	† Do. 4½ 1st Deb. Stock (red)	97-100	4 10 0	Feb, Aug	..	..
5	4 6	Hove Electric Lighting Ord.	6-6½	6 11 0	April, Oct	..	..
5	5 0	Kensington & Knightsbridge Ord.	8-9	5 11 0	Feb, Aug	..	..
5	6%	Do. 6 per Cent. 1st Pref.	6-6½	4 12 0	Jan, July	..	–
St.	4%	† Do. 4 per Cent. Deb. Stock (red.)	94-97	4 2 6	..	..	..
St.	4%	Kensingtn. & Kngtbg. Co. & Notting Hill Co. (Joint Station) 4% Deb. Stock (red.)	97-101	3 19 0	April, Oct	–	..
St.	4½%	Kent Elec. Power Co.	86-90	5 0 0	Jan, July		..
3	1 6	London Electric Supply Ord.	1¼-1½	5 8 0	Mar, Sept	..	..
5	3 0	Do. 6 per Cent. Pref.	4½-5	6 0 0	Mar, Sept	..	–
St.	4%	Do. 4 per Cent. 1st Mort. Deb.	89-92	4 7 0	Jan, July	90½	..
5	2 6	†Metropolitan Electric Sup. Ord.	4¾-5¼	6 4 0	April, Oct	..	..
5	2 3	Do. 4½ per Cent. Cum. Pref.	4¼-4¾	4 12 6	Jan, July	..	..
St.	4½%	Do. 4½ per Cent. Deb. Stock 1st Mort.	106-109	4 1 6	June, Dec	..	..
St.	3½%	Do. 3½ per Cent. Mrt. Deb. Stock (red.)	84-89	3 19 0	Jan, July	..	..
100	4½%	Midland Elec. Corp. for P.D. 1st Mort. Db.	94-97	4 12 6	June, Dec	..	–
10	4%	Newcastle & Dist. Elec. Ltg. Ord.	7½-8	5 3 2	Feb, Aug	..	–
100	4½%	Do. 4½ per Cent. Deb.	94-97	4 13 0	Jan, July	..	..
5	8%	Newcastle Elec. Supply Ord.	5⅛-5⅜	7 12 4	Feb, Aug	..	..
5	5%	Do. 5 per Cent. non Cum. Pref.	5¼-5¾	4 15 8	Feb, Aug	..	..
100	4%	Do. 4 per Cent. Mort. Deb. red. 1907.	95-97	4 3 4	Jan, July	..	..
1	3%	Northern Counties Elec. Sup.	—	..	Mar, Aug	–	..
100	4½%	Do. 4½ per Cent. Deb.	93-95	4 15 9	Jan, July	..	..
10	6 0	Notting Hill Electric Ord.	12-13	5 8 0	March ..	..	..
5	4 6	Oxford Electric Ord.	5¾-6¼	5 12 0	March ..	..	..
St.	4%	Do. 4 per Cent. Deb. Stock	95-98	4 2 0	Jan, July	..	..
5	5 0	†St. James' & Pall Mall Elec. Ord.	7-8	6 1 6	Feb, Aug	7⅛	..
5	3 6	† Do. 7 per Cent. Pref.	6½-7¼	4 16 6	Feb, Aug	..	..
St.	3½%	Do. 3½ per Cent. Deb. Stock (red.)	86-90	3 18 0	Jan, July	..	..
5	..	Smithfield Markets Electric Sup. Ord.	¼-¾	..	Feb	..	..
St.	4%	† Do. 4 per Cent. Deb. Stock	68-72	5 11 0	Feb, Aug	..	..
5	4 0	South London Electric Supply Ord.	2¼-2¾	5 19 0	April	..	..
1	0/6	South Metrop'n Elec. Lt. & Power Ord.	½-⅝	4 0 0	..	..	..
1	0 8⅔	Do. 7 per Cent. Cum. Pref.	1-1½	5 12 0	Feb, Aug	..	..
St.	4½%	Do. 4½ 1st Db. Stk. Red.	100-103	4 7 6	April, Oct	..	..
5	2 6	Urban Electric Supply Ord.	½-1½	16 12 0	April, Oct	–	..
5	2 6	Do. 5 per Cent. Cum. Pref.	1⅛-2¼	10 12 0	April, Oct	..	..
St.	4½%	Do. 4½ per Cent. 1st Mort. Deb.	82-85	5 6 0	April, Oct	..	..
5	5 0	†Westminster Elec. Sup. Ord.	7½-8½	5 17 6	Mar, Sept	.	..
5	2/3	Do. 4½ per Cent. Cum. Pref.	5-5½	4 2 0	Jan, July	..	..
		ELECTRIC RAILWAYS, TRAMWAYS, &c.					
St.	4%	Baker St. & Waterloo 4% Perp. Db. St	91-93	4 6 0	Jan, July	92	91¾
1	..	Bath Elec. Trams Pref. Ord.	¼-½	10 13 0	April	..	..
1	0/6	Do. 5 per Cent. Cum. Pref.	⅝-⅞	5 14 0	Jan, July	..	..
St.	4½%	Do. 4½ 1st Mort. Deb. Stock (red.)	88-91	4 19 0	April, Oct	87½	..
St.	4½%	B'ham & Midland Trams 4½ 1st Db. Stk.	91-94	4 17 0	Jan, July	..	..
10	9%	†Bristol Tramways & Carriage Ord.	10¾-11¼	8 0 0	Feb, Aug	..	..
10	4%	Do. Cum. Pref. (fully paid)	8¾-9¼	4 6 6	..	..	..
St.	4%	Do. 4 per Cent. Debs.	93-98	4 2 0	Feb, Aug	..	..
10	..	British Electric Traction Ord.	1⅜-1⅝	..	June, Dec	1½	..
10	1/5	Do. 6 per Cent. Cum. Pref.	4¼-4¾	..	Feb, Aug		.
St.	5%	Do. 5 per Cent. Perpetual Debs.	95-93	..	April, Oct	97	95¾
St.	4½%	Do. 4½ per Cent. 2nd Deb. Stock	76-78	5 15 0	May, Nov	..	..
St.	3%	Central London Ordinary Stock	69-71	4 4 6	Feb, Aug	69¾	..
St.	4%	Do. 4 per Cent. Pref. Stock	87-89	4 10 0	Feb, Aug	95	..
St.	2%	Do. Deferred Stock	52-55	3 11 3	Feb	..	..
100	4%	Do. 4 per Cent. Debs.	101-104	3 17 0	Jan, July	..	..
St.	4%	Charing X, Euston & Hmpstd Per Db. Stk.	81-84	4 15 0	Jan, July	83¼	..
5	2/6	City of Birmingham Trams. 5% Cm. Pref.	4¼-4¾	5 5 0	April, Oct	..	..
100	4%	Do. 4 per Cent. 1st Mort. Debs.	97-100	4 0 0	April, Oct	..	..
St.	1½%	†City & South London Rly. Con. Ord.	32½-33½	4 17 6	Feb, Aug	32¼	..
St.	5%	† Do. 5 per Cent. Perp. Pref. (1891)	111-114	4 7 6	Feb, Aug	.	..
St.	5%	† Do. (1896)	109-112	4 9 3	Feb, Aug	..	..
St.	5%	† Do. (1901)	107-110	4 11 0	Feb, Aug	..	..
St.	5%	† Do. (1903)	102-105	4 15 3	Feb, Aug	102¾	..
St.	4%	Do. 4 per Cent. Perpetual Debs.	100-103	3 17 6	May, Nov	..	..
10	6/0	†Dublin United Trams. Ord	12-13	5 0 0	Feb, Aug	..	..
10	6/0	† Do. 6 per Cent. Pref.	12½-13¼	4 19 6	Feb, Aug	..	..
10	..	Gt. Northern & City Rly. Pref. Ord. (4%)	½-1	..	Feb, Aug		
10	4/0	G. Northern, Piccadilly & Brompton Ord	7¼-7¾	5 6 0	Feb, Aug		..
St.	4%	Do. 4 per Cent. Deb. Stock	90-92	4 7 0	Jan, July	91½	90¾
5	4/0	Hastings & Dist. Elec. Trams. 6% Cm. Pf.	3¼-3¾	8 0 0	Mar, Sept	..	..
St.	4½%	Do. 4½ Db. St.	93-96	4 13 9	April, Oct	..	..
10	9%	†‡Imperial Tramways Ord.	10-11	7 7 3	Mar, Sept	..	..
10	6%	‡Do. 6 per Cent. Pref.	9½-10	6 0 0	Mar, Sept	..	..
St.	4½%	‡Do. 4½ per Cent. Debs.	90-92	4 18 0	Jan, July	..	..
5	..	I. of Thanet E. T. & Lt. 5 per Cent. Pref.	⅞-1⅜	..	Mar, Sept	..	..
St.	4%	Do. 4 per Cent. Deb. Stock	59-61	6 11 0	Jan, July	..	–
10	6/0	Lanarkshire Tramways	9⅞-10⅛	5 9 0	Feb, Aug	..	..
St.	5%	Lancs. Utd. Trams 5% Prior Lien Db. St.	91-93	5 7 6	Jan, July	..	..
10	..	Liverpool Overhead Railway Ord.	1¼-1¾	..	Feb, Aug	..	–
10	5%	Do. 5 per Cent. Pref.	5¾-6¼	8 0 0	Feb, Aug	..	..
St.	4%	Do. 4 per Cent. Deb.	81-85	4 13 0	Jan, July	..	..
10	5,0	London United Trams. 5% Cum. Pref.	6¾-7¼	6 13 0	Jan, July	..	..
St.	4%	Do. 4 per Cent. 1st Mort. Deb. Stock	79-81	4 15 0	Jan, July		..
St.	..	Mersey Con. Ord. Stock	1-3	—	Feb, Aug.	..	..
St.	..	Do. 3 per Cent. Perp. Pref.	3-6	—	..	..	..
1	..	Metropolitan Elec. Tramways Def.	⅛-¼	—	April.. .	..	..
1	0/6	Do. 5 per Cent. Cum. Pref.	1⅛-1⅜	6 3 6	Feb, Aug	–	..
St.	4½%	Do. 4½ per Cent. Deb. Stock	93-96	4 13 9	Jan, July	.	..
St.	½%	Metropolitan Railway Consolidated	35-36	1 7 9	Feb, Aug	35¾	35¼
St.	2¾%	Do. Surplus Lands Stocks	67-69	4 0 0	Feb, Aug	68¾	67
St.	3½%	Do. 3½ per Cent. Preference	86-89	3 19 9	Feb, Aug	..	..
St.	3½%	Do. 3½ per Cent. "A" Preference	76-79	4 8 6	Feb, Aug	..	..
St.	3½%	Do. 3½ per Cent. Convertible Pref.	73-76	4 12 0	Feb, Aug	..	..
St.	3½%	Do. 3½ per Cent. Debenture Stock	90-93	3 15 3	Jan, July	91½	91½
St.	3½%	Do. 3½ per Cent. "A" Ditto	88-91	3 17 0	Jan, July	88½	..

* In calculating the yield allowance has been made for accrued interest but *not* for redemption

† Ex Dividend

ELECTRICAL COMPANIES' SHARE LIST.—*Continued.*

ELECTRIC RAILWAYS & TRAMWAYS—*Continued.*

Share	Last Dividend	Name	Price Wed., Aug. 12.	Rate % Yield-ed.	Dividend Due.	Business Week to Aug. 12. Highest.	Lowest.
St.	..	Metropolitan District Railway Ord.	11 —12	..	Feb, Aug	..	..
St	..	Do. Extension Pref (5 per Cent.)	21 —26	..	Feb, Aug	..	..
St	3½	† Do. Assented Ext. Pref. (Int. Guar. by Und. Elec Rlys. Co. of London, Ltd.)	45 —49	7 2 6	Feb, Aug	..	..
St	3½	Do. 3 per Cent. Consltd. Rent-charge	73 —76	3 19 0	Jan, July	..	..
St.	4%	Do. 4 per Cent. Midland Rent-charge	98 —102	3 18 0	Jan, July	..	..
St	1½	Do. Guar Stock 4 per Cent.	46 —50	3 8 6	Mar, Sept	48	46
St.	6%	Do. 6 per Cent Perp. Deb. Stock	113 —118	5 2 0	Jan, July	..	..
St.	4	Do. 4 per Cent. Ditto	71 —76	5 5 0	Jan, July	73½	..
5	..	New Gen. Trust 6 per Cent. Cum. Pref.	½—¾	..	May	..	..
1	0/9⅞	Potteries Electric Traction Ord.	½—¾	8 0 0	April, Oct	..	..
1	0/6	Do. 5 per Cent. Cum. Pref.	⅜—⅝	6 13 0	Feb, Aug	..	..
St.	4½%	Do. 4½ per Cent. Deb Stock	93 —96	4 14 6	May, Nov	..	..
1	0 7½	†S. Met. Elec. Trams. & Ltg. 6% Cm. Pref.	⅞—1	6 0 0	Feb, Aug	..	..
St.	4%	Do. 4 per Cent Deb. Stock	76 —80	5 0 0	Jan, July	..	..
100	5%	Sunderland Dist. Elec.Trms.5% 1st Mt.Db.	75 —80	6 5 0	Jan, July	..	..
..	5%	Underground Elec. Rys. Co. of London	39 —43	11 12 0	June, Dec	..	..
5	..	Yorkshire (W.R.) Elec. Trams. Ord.	⅞ —1⅛	—	March ..	..	..
5	..	Do. 6 per Cent. Cum. Pref.	3⅛—3⅝	..	..	..	..
St.	4½	Do. 4½ per Cent. 1st Debs.	83 —86	5 5 0	Jan, July	..	..

ELECTRIC MANUFACTURING, &c.

Share	Last Dividend	Name	Price Wed., Aug. 12.	Rate % Yield-ed.	Dividend Due.	Business Week to Aug. 12. Highest.	Lowest.
1	..	Aron Electricity Meter Ord.	⅞—1⅛	..	..	..	..
1	1 4½	Do. 6% Cum. Pf. ex cn a/c arrears)	1⅛—1¼	7 12 0	April, Oct	..	..
1	2/4½	Babcock & Wilcox Ord.	3⅛—3⅜	4 16 3	April, Oct	..	..
1	0/7½	Do. Pref.	1⅞—1⅞	3 16 9	..	..	..
5	6/0	British Insulated & Helsby Cables Ord.	6¼—6¾	7 4 0	July, Feb	6⅛	..
5	3/0	† Do. 6 per Cent. Pref.	6 —6⅜	4 12 0	Jan, July	..	..
St.	4½%	Do. 4½ per Cent. 1st Mort. Deb. (red.)	102 —105	4 5 8	Jan, July	..	..
St.	4½%	British Thoms'n-Houst'n 4½% 1st Mt.Db.	93 —98	4 12 0	Mar, Sept	..	..
5	..	British Westinghouse 6 per Cent. Pref.	⅜—⅝	..	Feb, Aug	..	..
St.	4%	Do. 4 per Cent. Mort. Deb. Stock	45 —48	8 8 0	Jan, July	..	..
2	..	Brush Electrical Engineering	⅛	—	March ..	..	..
2	..	Do. 6 per Cent. Pref. non-Cum.	⅛—2	..	Mar, Sept	..	..
St.	4½%	Do. 4½ per Cent. Prep. 1st Deb. Stock	70 —75	6 0 0	Mar, Sept	..	..
St.	4½%	Do. Perpetual 2nd Deb. Stock	53 —58	7 14 0	Jan, July	..	..
5	16 0	Callender's Cable Con. Ord.	9½—10½	7 1 0	Jan, July	9⅞	..
5	2/6	Do. 5 per Cent. Cum. Pref.	5¼—5¾	4 7 0	Jan, July	..	..
St.	4½%	Do. 4½ per Cent. 1st Mort Debs. (red.)	106 —108	4 3 6	Nov, May	..	..
1	1/0	Castner-Kellner Alkali Co.	1⅛—1¼	8 14 0	May, Nov	1⅛	..
St.	4½%	† Do. 4½ per Cent. 1st Mort. Deb. (red.).	101 —104	4 6 6	Feb. Aug	103	..
1	0/9⅜	Chadburn's (Ship) Telegraph Ord.	1⅛—1⅜	8 8 0	March	..	..
1	0/7½	Do. 6 per Cent. Cum. Pref.	1 —1⅛	5 6 6	April, Oct	..	..
1	0/8⅜	Consolidated Electrical Co.	⅞—1⅛	7 0 0	August ...	..	..
1	1/0	Consolidated Signal Co.	1⅛—1⅛	10 9 0	April, Oct	..	..
1	0/7½	Do. 6 per Cent. Cum. Pref.	⅞—1⅛	6 4 0	April, Oct	..	..
3	3/0	†*Crompton & Co. (Nos. 1 to 86,000)	1½—1⅞	8 11 0	Jan, July	..	..
100	5%	Do. 5 per Cent. 1st Mort. Debs. (red.)	90 —93	5 7 0	Jan, July	..	..
1	0/7½	Davis & Timmins	⅞—1⅛	..	Mar, Sept	..	..
5	2/0	Dick, Kerr & Co. Ord.	1⅛—1⅜	7 11 0	Sept	..	..
5	0/7½	Do. 6 per Cent. Cum. Pref.	1 —1⅛	4 16 0	Sept	..	..
St.	4½%	Do. 4½ per Cent. Deb. Stock	99 —102	4 8 6	Jan, July	..	..
5	2/6	Edison & Swan United ("A" Sh.)(£3 pd.)	⅛—¾	..	Feb, Aug	..	..
5	4/2	Do. (£5 paid)	1½—2½	5 0 0	Feb, Aug	..	..
St.	4%	Do. 4 per Cent. Mort. Deb. Stock (rd.)	76 —79	5 2 6	June, Dec	..	..
St.	5%	Do. 5 per Cent. 2nd Deb. Stock	85 —87	5 15 0	Mar, Sept	—	..
5	..	Edmundson's Elec Corp. Ord.	⅛—⅜	..	Jan, July	..	..
5	..	Do. 6 per Cent. Cum Pref.	⅜—1	..	May, Nov	..	..
St.	4½%	Do. 4½ per cent. 1st Mort. Deb. (red.)	58 —65	6 18 0	Jan, July	..	..
2	..	Electric Construction Co.	⅛—⅜	..	Jan, July	..	..
2	..	† Do. 7 per Cent. Cum. Pref.	1⅜—1⅞	..	July	..	..
St.	4%	Do. 4 per Cent. Perp. 1st Mort. Debs.	66 —71	5 13 0	Jan, July	..	..
10	5/0	General Electric (1900) 5% Cum. Pref.	7½—8	6 5 0	June, Dec	..	..
St.	4%	Do. 4 per Cent. 1st Mort. Debs.	84 —87	4 12 0	Mar, Sept	..	..
5	10/0	Henley's Telegraph Works Ord.	10½—11½	6 10 0	Feb, Aug	..	..
5	2/3	Do. 4½ per Cent. Pref.	5 —5½	4 2 0	Feb, Aug	..	..
St	4½%	Do. 4½ per Cent. 1st Mort. Deb. Stock	106 —108	4 3 6	Mar, Sept	..	..
10	5/0	India Rubber, Gutta Percha, &c., Wrks.	16½—16¾	6 2 0	Feb, Aug	..	..
100	4%	Do. 4 per Cent. Debs. (red.)	98½—100½	3 19 6	April, Oct	..	..
1	..	National Elec. Construction Co.	⅛—⅜	..	April	..	..
1	0/9⅜	Richardsons, Westgarth & Co., Ltd. Ord.	1⅛—1⅜	7 2 0	Nov	..	..
1	0/7½	Do. 6 per Cent. Cum. Pref.	⅞—⅞	6 17 0	May, Nov	..	..
St	4½%	Do. 4½ per Cent. Perp. Deb. Stock	87 —90	5 0 0	Jan, July	..	..
1	..	Simplex Conduits Ord.	1½	..	..	..	..
1	..	Do. 6 per Cent. Cum. Pref.	5¼	..	..	..	..
12	12/0	Telegraph Construction & Maintenance	31 —33	6 8 0	Mar, July	32½	..
100	4%	Do. 4 per Cent Deb. Bonds (1909)	100 —102	3 18 0	Jan, July	..	..
1	2 0	Vickers, Sons & Maxim, Ltd, Ord.	1⅛—1⅜	8 12 0	..	..	..
1	0/6	Do. 5 per Cent. non-Cum. Preference	1 —1⅛	4 9 0	..	..	..
St	5%	Do. 5 per Cent. non-Cum. Preferred	102 —106	4 14 6	..	..	..
St.	4%	Do. 4 per Cent. 1st Mort. Db. Sk. (red)	104 —105	3 16 3	June, Dec	..	..
100	4½%	Do. 4½ per Cent. 2nd Mort. Deb. (red.)	104 —106	4 5 0	June, Dec	105½	104½
100	15/6	Do. 5 per Cent. 2nd Mort. Debs. Ecnp.	102 —104	..	..	102½	102½
1	0/9	J. G. White & Co. 6 Cum. Pref	8½—9½	8 17 9	..	..	..
5	1/9	Willans & Robinson Ord.	1 —1½	4 0 0	Apr, Oct	..	..
5	1/0	Do. 6 per Cent. Cum. Pref.	2½ —3	8 11 6	Apr, Oct	2⅝	..
100	4%	Do. 4 per Cent. 1st. Mort. Debs.	72 —76	5 5 6	May, Nov	..	..

TELEGRAPHS.

Share	Last Dividend	Name	Price Wed., Aug. 12.	Rate % Yield-ed.	Dividend Due.	Business Week to Aug. 12. Highest.	Lowest.
10	..	Amazon Telegraph	2 —3	—	June, Dec	..	..
100	5%	Do. 5 per Cent. Debs. (red.)	87 —89	5 12 0	June, Dec	..	..
St.	15/0	† Anglo-American	57 —60	5 17 0	F,My,Ag,N	59	17½
St.	30 0	† Do. Preferred	102½—103½	3 17 0	F,My,Ag,N	103½	102½
St.	1%	Do. Deferred	15½—16½	6 7 0	F,My,Ag,N	16½	16½
St.	4%	Commercial Cable 4 per Cent. Deb. Stk.	84 —87	4 12 0	Jn,Ap,Jy,O	86½	..
10	5/0	Cuba Submarine Ord.	7¾—8½	7 0 0	Feb, Aug	..	..
10	10/0	Do. Preference 10 per Cent.	16½—16½	6 1 6	Feb, Aug	..	..
5	2/0	Direct Spanish Ord.	3 —3½	6 4 0	April, Oct	..	..
5	5/0	Do. 10 per Cent Cum. Pref.	8 —9	5 11 0	April, Oct	..	..
100	4½%	Do. 4½ per Cent Deb.	100 —103½	4 7 6	Jan, July	..	..
20	4/0	Direct United States Cable £d & bonus	13½—13½	6 5 0	Ja,Ap,Jy,O	13½	..
100	4½%	Direct West India Cable 4½% Rg. Db. (rd.	98 —100	4 10 0	June, Dec	..	..
St	3/0	Eastern Ordinary	134 —137	5 2 0	Ja,Ap,Jy,O	136	135½
St	17/6	Do. 3½ per Cent Perp. Stock	84 —86	4 1 6	Ja,Ap,Jy,O	85	84½
St	4	Do. 4 per Cent. Mort. Deb. Stk. (red.)	101½—103½	3 17 6	May, Nov	102½	102½
10	2/6	Eastern Extension	13½—13½	5 7 0	Ja,Ap,Jy,O	13	12½
St	4%	Do. 4 per Cent. Deb. Stock	102 —104½	3 18 6	Feb, Aug	—	..
St	4%	Eastern & S. African 4% Mort. Deb. 1900	99 —101	3 19 0	Feb, Aug	..	..
100	4%	Do. 4% Mauritius Sub. Debs. red.	100 —102½	3 18 6	May, Nov	..	..
10	..	G. N. of Copenhagen, with Coupon 74	27 —29	6 16 0	Jan, July	..	..
100	4½	Halifax & Bermuda 4½% 1st Mt. Db. (red.)	99 —101	4 9 0	June, Dec	..	..
..	2/6	Indo-European	56 —59	5 12 0	May, Nov	..	..
10	81	Mackay Companies Common	69 —73	5 10 0	Ja,Ap,Jy,O	..	..
10	81	Do. Preferred	69 —73	5 10 0	Ja,Ap,Jy,O	..	..
1	..	Marconi's Wireless Teleg. Co.	⅞—⅞	..	April	..	..
1	..	India & Europe 5% Tel 4% Guar Dbs. red	97 —100	4 0 0	June, Dec	..	..
1	1/6	West Coast of America	1⅛—1⅞	4 5 0	May	..	..
1	..	Do. 4 per Cent. Debs.	98 —101	3 19 6	Jan, July	..	..
1	..	West India & Panama	[illegible]	..	May, Nov	..	..
10	6	Do. 6 per Cent. 1st Pref.	5 —7¼	7 1 0	May, Nov	8	8
10	..	Do. 6 per Cent. 2nd Pref.	[illegible]	..	May, Nov	..	..
100	..	Do. 5 per Cent Debs.	100 —102	4 18 0	Jan, July	..	..
10	5/0	Western Telegraph	11 —11½	4 18 0	Mr,Jn,S,D	11	11½
St	4	Do. 4 per Cent. Deb. Stock (red.)	100 —102	3 18 0	June, Dec	101½	..
..	4	W. [illegible] 4½% Debs.	100 —84	4 14 0	..	..	..

TELEPHONES.

Share	Last Dividend	Name	Price Wed., Aug. 12.	Rate % Yield-ed.	Dividend Due.	Business Week to Aug. 12. Highest.	Lowest.
100	28	Amer. Telephn. & Telegh. Cap. St.	124 —128	6 5 0	..	..	..
..	4%	Do. Coll. Trust $1,000 4 per Cent. Bds	89 —92	4 7 0	Jan, July	..	..
St.	5%	Anglo-Portug'se Tel. 5% 1st Mt. Db. Stk.	101 —104	4 16 0	Mar, Sept	..	—
5	5 0	†Chili Telephone	7¾—8¼	4 17 0	August ..	..	..
1	0/7½	Monte Video Telephone Ord.	1⅛—1⅛	6 11 0	Nov	..	..
1	0/6	Do. 5 per Cent. Pref.	1⅛—1⅛	5 6 0	May, Nov	..	..
St.	6%	†National Co. Pref. Stock	106½—108½	5 10 6	Feb, Aug	107½	107½
St.	6%	† Do. Def. Stock	116½—117½	5 2 6	Feb. Aug	117½	11⅛
10	6/0	† Do. 6 per Cent. Cum. 1st Pref.	10 —12	5 0 0	Feb, Aug	..	..
10	6/0	† Do. 6 per Cent. Cum. 2nd Pref.	10 —12	5 0 0	Feb, Aug	..	..
5	2/6	† Do. 5 per Cent. non-Cum. 3rd Pref.	5⅛—6⅜	4 7 0	Feb, Aug	6⅜	6⅜
St.	3½%	* Do. Deb. Stock 3½ per Cent. (red.)	98½—100½	3 9 6	June, Dec	98½	..
St.	4%	Do 4 per Cent. Deb. Stock (red.)	102½—104½	3 16 6	Jan, July	104½	103½
1	1/0	Oriental	1⅛—1⅛	5 6 8	April, Oct	..	..
1	0 7½	Do. 6 per Cent. Cum. Pref.	1⅛—1½	4 16 0	April, Oct	..	..
St.	4%	Do. 4 per Cent. Red. Deb. Stock	88 —93	4 7 0	Jan, July	..	..
St.	4½%	Telephone Co. of Egypt 4½% Db.Stk.(red.)	98 —101	4 11 0	Jan, July	..	..
5	5/0	†United River Plate	6¾—7	5 14 0	July	6⅞	6⅞
5	2/6	Do. 5 per Cent. Cum. Pref.	5 —5½	4 11 0	June, Dec	..	..
St.	4½%	Do. 4½ Deb. St. Red.	100 —102	4 8 0	Jan, July	..	..

FINANCIAL, INVESTMENT, &c.

Share	Last Dividend	Name	Price Wed., Aug. 12.	Rate % Yield-ed.	Dividend Due.	Business Week to Aug. 12. Highest.	Lowest.
5	8/0	Elec. & Gen. Investment 6% Cum. Pref.	3½—4	7 10 0	Jan, July	..	..
10	5 9	Globe Telegraph & Trust	10¼—10⅞	6 10 0	SpDcMrJu	10½	10⅞
10	3/0	Do. 6 per Cent. Pref.	13½—13⅞	4 7 6	SpDcMrJu	13⅞	13⅛
10	6%	Submarine Cables Trust (Cert.)	127 —130	4 12 0	April, Oct	..	..

COLONIAL AND FOREIGN ELECTRIC RAILWAYS, TRAMWAYS, &c.

Share	Last Dividend	Name	Price Wed., Aug. 12.	Rate % Yield-ed.	Dividend Due.	Business Week to Aug. 12. Highest.	Lowest.
5	3/0	Anglo-Argentine 6% Cum. 1st Pref.	6½—6¾	4 8 9	April, Oct	6⅝	..
5	5/0	Do. 10% Non-cum. 2nd Pref.	8⅜—8⅝	5 13 0	Jan, July	8⅝	..
St.	6%	Do. Permanent 6% Deb. Stock	141 —146	4 2 0	June, Dec	..	..
St.	5%	Auckland Elec. Trams. 5% Deb. (red.)	103 —106	4 14 3	Jan, July	..	..
5	4/0	Brisbane Electric Trams. Invest. Ord.	4⅛—4⅜	4 8 6	May	4⅜	..
5	2 6	Do. 5 per Cent. Cum. Pref.	4⅞—5⅛	4 17 6	May, Nov	..	..
St.	4½%	Do. 4½ per Cent. Db. Prov. Certs.	98 —102	4 8 0	Jan, July	..	..
St.	8%	British Columbia El.Ry.Df. Ord.	122 —127	6 6 0	Mar, Sept	..	..
St.	30 0	† Do. Pref. Ord. Stock	109 —113	5 6 0	May, Nov	..	..
St.	5%	Do. 5% Cum. Perp. Pref. Stock	104 —108	4 12 6	Jan, July	..	..
40	4½%	Do. 4½ per Cent. 1st Mort. Debs.	101 —104	4 6 6	April, Oct	..	—
100	4½%	Do. Vancouver Power Debs.	100 —103	4 7 6	Jan, July	..	—
St.	4½%	Do. 4½% Perp Con. Deb. St.	101 - 104	4 1 6	—	..	..
St.	5%	Buenos Ayres Elec. Trams (1901) Ltd. Deb. St.	93 —97	5 2 6	Ja, Jul ..	..	..
5	..	Buenos Ayres Grand National Ord.	2 —2½	..	..	..	..
5	2/6	Do. 5 per Cent. Cum. Pref.	3½—4½	..	Feb, Aug	..	..
100	5½%	Do. 5½ per Cent. Pref. Debs.	99 —103	5 7 6	Jan, July	..	..
100	6%	Do. 6 per Cent. 1st Deb. Bonds.	100 —104	5 14 0	April, Oct	..	..
St.	5%	Buenos Ayres Lacroze Trams 1st Mt. Db.	94 —97	5 2 6	Mar, Sept	..	..
St.	6%	†Buenos Ayres Port & City Tram. 1st Mt. Deb. Stock £75 Paid	61 —65	6 12 0	Feb, Aug	..	..
5	2/6	Calcutta Tramways (1 to 137,610)	5 —5½	5 9 0	Mar, Sept	..	..
100	2/6	Do. 5 per Cent. Cum. Pref.	4⅞—5⅛	4 13 0	Jan, July	—	..
1	4½%	Do. 4½% 1st Deb. Stock (red.)	101 —104	4 6 6	Jan, July	..	..
St.	..	Cape Electric Tram Shares	..—⅞	..	..	..	..
5	1/3	City of Buenos Ayres Trams Co. (1904) Sh.	5⅛—5⅛	4 5 0	F,My,A,N	5⅛	..
St.	4%	Do. 4 per Cent. Deb. Stock	97 —101	3 19 0	June, Dec	..	..
..	5%	Colombo Tr. & Ltg. 5% 1st Mt. Db.	89 —92	5 8 6	May, Nov	..	..
100	5½	Electric Traction Co. of Hong Kong 5 per Cent. 1st Mort. Debs.	85 —90	5 10 0	June, Dec	..	..
1	5%	Havana Elec. Ry. Con. Mt. 5% $1,000 50 year Coup. Bds.	80 — 85	5 9 6	Feb, Aug	..	..
1	..	Kalgoorlie Elec. Trams Sh.	..—..	..	..	..	..
100	5%	Do. 5 per Cent. "A" Deb. Stock	85 — 89	5 12 0	Jan, July	..	..
5	6%	Do. 6 per Cent. "B" Ditto	69 — 73	8 4 0	Jan, July	..	..
5	1/0	Lisbon Elec. Trams. Ord.	1 —1¼	4 0 0	July	..	..
100	0/7½	Do. 6 per Cent. Cum. Pref.	1 —1¼	4 16 0	Jan, July	..	—
St.	5%	Do. 5 per Cent. Reg. Mort. Debs	92 —97	5 3 0	Jan, July	..	..
St.	5%	Madras Elec. Trams. 5% Deb. Stk.	93 —96	5 4 0	Jan, July	..	..
..	5%	Manila Elec. Ry. $1,000 Gold Bonds	86 —90	5 11 8	Feb, Aug	..	..
100	4/ ½	†Mexico Trams Co. Com. St.	118 —120	3 6 9	..	..	..
500	5%	Do. Gen. Con. 1st Mort. 5% Gold Bds.	93½—94½	5 6 0	..	..	..
St.	4½%	†Montreal St. Ry. Sterling 4½ per Cent. Debs. (1922)	100 —102	4 8 0	Feb, Aug	..	..
1	1/0	Perth Elec. Trams Ord	..	7 3 6	May	..	..
St.	5%	Do. 1st Mt. Db. Stock	101 —104	4 16 0	Jan, July	..	..
5	3/0	Rangoon Elec. Trams & Supply Co. 6 Cum Pf.	5⅛—5⅜	5 6 6	..	..	..
St.	4½	Do. 4½% 1st Mort. Deb. Stk.	90 - 92	4 10 6	..	..	..
..	$2½	Sao Paulo Tramway, Light & Power Co. $100 Stock	143 —150	6 0 0	..	..	..
..	5%	Do. 5 per Cent. 1st Mt. $500 Db.	98½—99½	5 0 6	June, Dec	99	..
100	4½%	Toronto Ry Co. 1st Mt. 4½% Ster Bonds	99 — 101	4 9 0	Feb, Aug	..	..

COLONIAL AND FOREIGN ELECTRICITY SUPPLY &c.

Share	Last Dividend	Name	Price Wed., Aug. 12.	Rate % Yield-ed.	Dividend Due.	Business Week to Aug. 12. Highest.	Lowest.
5	3/0	Adelaide Elec. S'ply Co. 6% Cu. Pr.	4½—5½	5 14 0	Mar, Sept	..	..
10	6/0	†Bombay E. S. & T. 6% Cm. Pf.	10 —10	5 14 0	..	..	..
St.	4½	Do. 4½ per Cent. Deb. Stk. (red.)	94 —96	4 18 9	Jan, July	..	..
5	4/9	Calcutta Elec. Supply Ord.	5¼—6¼	5 17 0	April, Oct	6¼	5⅞
100	7/2	Canadian Gen. Elec. Co. Com. St.	101 —105	6 17 0	..	104½	104
100	5%	Castner Electrolytic Alkali Co. (of U.S.A.) 1st Mort Stl. Debs.	92 — 97	5 2 6	Jan, July	..	..
500	5	Elect. Development Co of Ontario	81 — 83½	6 1 0	..	..	..
5	..	Elec. Ltg. & Trac. Co. of Aust. 6 per Cent. Cum. Pref.	2 — 2½	..	Feb, Aug	..	..
St.	5%	Do. 5 per Cent. Deb Stock	85 —90	5 9 0	Jan, July	..	..
St.	6%	Elec. Supply Co. of Victoria 6 per Cent. 1st Mort. Deb. St.	90 —93	5 7 6	Jan, July	..	..
St.	6%	Indian Elec. Sup. & Trac. Co. Constn Deb St. Rd.	30 — 40	15 0 0	Jan, July	..	..
100	0/3	Kalgoorlie Elec. Power & Ltg. Ord.	.. — ..	..	..	..	..
1	0/7½	Do. 6 per Cent. Cum. Pref	⅞ — 1	8 0 0	April, Oct	..	..
St.	6%	Madras E. S. Corp. 6 per Cent. Constn Deb. St	85 —90	6 11 0	April, Oct	..	..
500	6%	Mexican Elec. Light Co. 6% 1st Mort. Gold Bonds	84½—85½	6 1 6	..	..	85
St.	$1	Mexican Lt. & Power Co. Cap. St.	72 — 75	..	..	72	72½
100	5%	Do. 5% 1st Mt. Gold Bnds.	85½— 89½	5 8 0	..	89	89½
100	6/2	†Montreal Lt. Ht. & Power Co, Cap. St.	93 —101	6 19 0	F,My,A,N	..	..
1	1/7½	River Plate Electricity Co. Ord.	1 —1	6 0 0	April	..	..
1	1 2½	Do. 6 per Cent. non-Cum. Pref	⅞ —1	6 0 0	May	..	..
St.	6%	Do. 6 per Cent Deb. Stock	96 —98	5 3 6	Jan. July	..	..
5	3/0	Rosario Elec. Co. 6 Pref. (1-20,000)	4⅛—5¼	5 17 6	April, Oct	..	..
100	$1	Shawinigan Water & Power Co. Cap. St.	73 —75	5 6 6	..	..	..
..	5%	Do. 5 per Cent. Bds.	102 —104	4 16 6	Jan, July	104	..
..	6d	Victoria Falls Power Co. Pref.	⅞ — ⅛	—	Jan, July	..	..

* In calculating the yield ... accruing has been made for accrued interest but not for redemption. † Ex dividend. ‡ The London Stock Exchange Committee have declined to quote these.

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CONTENTS OF THE CURRENT NUMBER.

NOTES.

Railway Electrification.

AT the half-yearly meeting of the Midland Railway Co., last Friday, the Chairman, Sir ERNEST PAGET, referred to the electrification of the Heysham-Morecambe section, recently described in *The Electrician.* He said that although the line was working exceedingly well, and the experiment was of great interest, yet it was not such as to induce the directors to extend it to the main line. It is not that the electrical working is unsatisfactory or untrustworthy from an engineering point of view; the fact is that the experiment has cost the company far more than was anticipated, and hence the faint praise which the directors have accorded it. This, it will be remembered, is exactly the state of affairs which we foreshadowed in our leading article appearing with the description of the line on June 19th. This decision is to be regretted for its effect upon other railways than the Midland. For example, the Chairman of the North London Railway Co. informed the shareholders that the electrification of that line would involve the expenditure of £1,000,000, and that "such a project would be nothing more nor less than a reckless gamble." We hope that the experience of the London, Brighton and South Coast Railway Co. will prove more fortunate, and that the results of this scheme will encourage the electrification of other local and suburban railways.

Electric Power in the Colonies.

AT a time of almost unparalleled depression of the electrical industry in the Mother Country, it is particularly interesting to observe the condition of affairs in the Colonies. In Canada, for instance, a contract has just been awarded for the construction of no less than 293 miles of transmission lines from Niagara to St. Thomas in the west and Toronto in the east. Steel towers and aluminium conductors will be employed, and the contract price is £254,000. This venture is due, it appears, to the enterprise of the government, which is doing all in its power to secure a cheap and plentiful power supply in the Ontario province. Since the outlook is so black in Great Britain it is conceivable that British manufacturers might do worse than devote very special attention to affairs beyond the seas. There are, undoubtedly, great opportunities for electrical developments in the Colonies, and it would be regrettable if the greater part of the work were secured by foreign manufacturers, as appears probable.

Enclosed Motors.

PERHAPS one of the best proofs of the reliability of an electric motor, and the practically insignificant amount of attention it requires, even when running continuously for weeks, and sometimes months, is the fact that a more or less enclosed type of machine has been evolved as the standard, whilst totally enclosed motors are adopted in a large number of cases. As Mr. W. HARTNELL points out, however, in his Paper read before the Leeds Local Section of the Institution of Electrical Engineers, an abstract of which appears elsewhere in this issue, the process of completely enclosing a motor considerably reduces its output, if the motor is to run for several hours at or near full load, and the author believes that in many instances such totally-enclosed motors are not necessitated by the conditions under which they have to run. A method which is frequently adopted

is to install a well-ventilated motor and to protect it by means of a wooden or, if necessary, sheet-iron housing, this being found to give perfectly satisfactory results in practice.

Symbols in Engineering Literature.

An interesting contribution to the discussion on this subject appears in our Correspondence columns this week. The author, M. F. Galliot, makes the suggestion, of which we do not remember having heard before, that the symbols should be merely the initial letters of the C.G.S. units concerned. M. Galliot does not explain how he proposes to distinguish between two or more different quantities of the same physical nature occurring in the same formula. We may state, as an instance, the simple formula connecting the distances between object, image and principal focus of a lens, which would involve the unit of length three times. It seems to us that this difficulty could only be overcome by the employment of suffixes, which is a serious argument against the proposal.

Wireless Telephony.

As is usual at this time of year, the daily papers devote a great deal of space to happenings of a doubtful or sensational nature; just at present it is wireless telephony. Our readers are, of course, aware that for years past attempts have been made to transmit speech and other sounds by Hertzian waves, but hitherto limited success has attended these efforts. Now, the lay Press affirms that this feat has been accomplished over distances varying from 30 to 300 miles, no two journals being exactly in agreement. Apparently these experiments have been conducted in France and in Italy, but so far, it is said, the Frenchmen are ahead of their rivals. As a matter of fact, some extremely useful and interesting experiments in this direction are being made in England, where the Patent Office offers eloquent testimony of the time and attention which has been devoted to the subject by British inventors.

The Efficiency of the High-Frequency Arc.—The *Elektrotechnische Zeitschrift* gives a few notes on this subject due to C. Schapira. The high-frequency arc burns between a hollow copper electrode, which is water-cooled, and a homogeneous carbon rod. A number of these arcs are usually burned in series, 6 burning on 220 and 12 on 440 volt circuits. Each lamp can be short-circuited independently of the others. The cooling water is heated to boiling point after 15 to 30 minutes run, and during working is kept at this constant temperature. The cooling water has to be renewed after about five hours run. Measurements of energy consumption were undertaken, and attempts were made to discover a law showing how the efficiency of the arrangement varied with the direct current voltage, the number of arcs and the capacity of the oscillatory circuit. A new method whereby small capacity antennæ, or those with too great damping, can be indirectly set in oscillation is described. This is effected by connecting an auxiliary oscillatory circuit, whose wave-length is an exact multiple of that of the main circuit, in parallel with the latter and with the antennae.

Cable Interruptions.

	Date of Interruption.
Las Palmas—Arecife	May 13, 1908
Jeddah—Suakin	July 27, 1908
[illegible]	July 28, 1908
Kwandang—Menado	Aug. [illegible], 1908
Cadiz—Teneriffe	Aug. 17, 1908

The c.s. "Patrol."—We regret to learn that this vessel, the property of the Eastern Extension Australasia & China Telegraph Co., while on her way on charter from Singapore to Kwandang Menado, to effect a repair to one of the Netherlands Government's cables in those waters, went ashore on a sandbank, and has not yet been refloated. The Netherlands Government courteously placed an ironclad at the disposition of the Company. The c.s. "Recorder," of the Extension Company's fleet, has left Singapore to relieve the "Patrol" of her cable, and it is considered probable that this will lighten her sufficiently to enable her to refloat at the next spring tide. In the meantime the ship is on an even keel, and fine weather prevails.

Improved Method of Electric Welding.—A process which makes possible the substitution of steel for malleable iron in many articles of light hardware has been invented by Mr. L. S. Lachman, and is described in the *Engineering and Mining Journal*. The method is founded primarily upon the idea that as two pieces of metal of unequal section do not unite readily to form a good weld, two points, or a point and a ridge must be raised on the pieces to be united. These raised contacts are forced together under hydraulic pressure and, forming the link of lowest conductivity in an electric circuit, are heated by the current to a temperature at or near fusion; the two projections are thus quickly united and form a bond or rivet which is even stronger than an ordinary rivet, because it is in one piece with the body of the metal.

Electrolytic Copper.—According to the *Electrical World* some interesting remarks on electrolytic copper were made recently in a litigation by Col. T. L. Livemore, of the Calumet & Hecla Mining Co., a great producer of lake copper. He said: "Nearly all the copper produced in the United States, other than lake, is marketed in the form of electrolytic copper, and besides that produced in the United States there is a great deal of electrolytic copper produced and marketed in other countries. In 1906 about 330,000 tons were produced in other countries, of which a large part was marketed as electrolytic copper. In the years following 1892 the proportion of wire bars sold by the Calumet & Hecla Mining Co. diminished gradually, although not with absolute regularity, until within the last three years the sale of them has not exceeded 10 per cent. of the whole marketed by the Calumet & Hecla. Electrolytic wire bars, during this period of diminution above mentioned, have increased gradually until during the last three years much more electrolytic copper has been sold in competition with the Calumet copper in that shape than the Calumet itself has sold, and, as I have every reason to believe, more than all lake copper in the shape of wire bars."

Steam Omnibuses in London.—A note in *The Times* Engineering Supplement announces that the London General Omnibus Co. has in contemplation the conversion of a considerable number of its petrol 'buses to steam working. The Clarkson system will be employed, in which the boiler consists of a central steel shell forged out of a solid ingot in a 1,000 ton press, this shell being machined inside and out and fitted on its outside with generator tubes in the form of a horse shoe, the top of the shell being enclosed in a removable cover. The whole arrangement of shell and tubes is placed within a casing. The control of the paraffin burner is achieved automatically, as is also the case with the feed water, the driver being left free for the management of the car in traffic. It is claimed that a considerable reduction in weight of the engine has been obtained, and a feature, from the point of view of public service, is the comparative silence in working. It is claimed that under traffic conditions in London the steam omnibus of this type will work at a cost of 8·5d. per car mile, an appreciable economy in fuel consumption having been achieved on tests extending over many hundreds of miles. It will be remembered that the Electrobus is estimated to cost 9d. per car-mile.

Wireless Telephony.—It is announced from Paris that very successful wireless telephone experiments have been carried on by three naval officers from the Eiffel Tower station. The first achievement was getting into communication with the station at Dieppe. It is stated that bugle calls and music were clearly heard, while some conversation was attempted with a fair

measure of success. The distance from the Eiffel Tower to Dieppe, as the crow flies, is about 90 miles. In the course of further experiments communication has, it is said, been established with Cape Raz in Brittany, a distance of 310 miles from Paris. But with regard to this latter achievement the reports give only very meagre particulars and no technical details. Further information is awaited with interest.

On p. 779 of our issue of August 30, 1907, we referred to a system of wireless telephony due to Prof. Quirino Majorana, head of the science section of the Italian Ministry of Posts and Telegraphs, which differed from the better-known Poulsen system, chiefly in the use of an "hydraulic" microphone. It is now announced from Rome that, by means of this system, speech has been transmitted from Monte Mario to the semaphore station at Porto d'Anzio lighthouse (Sardinia), a distance of about 37 miles. The results obtained are said to have been excellent.

Comparative Cost of Overland Telegraph Services.—The *Electrical World* gives some statistics concerning the extent and cost of the telegraphic service in the most important countries of the world. These figures, which are due to G. A. Bucklin, are summarised below :—

——	No. of messages in millions.	Av. cost per message in pence.	Total receipts.	Miles of line.	Av. income per mile.
United States ...	65·5	21	£5,597,000	1,155,480	£4·84
United Kingdom..	94·0	8	3,049,400	384,109	7·94
France	58·0	6	1,466,800	389,002	3·76
Germany	52·5	7½	1,659,800	458,358	2·02
Austria	19·0	7	540,400	133,549	4·04
Italy	16·0	9½	694,400	128,582	5·40
Spain	5·0	16	368,100	47,923	6·84

Statistics of Russia, Japan and other countries are incomplete. The German telegraph system charges are 6d. for messages of 10 words, or under, to any part of Germany. For each additional word ½d. is charged. Thus, 13 words were paid for in the average German message in 1906. The higher average cost for the United States is partly due, of course, to the much greater distances over which messages are transmitted.

Electric Supply in Italy.—A recent publication emanating from the Ministry of Agriculture, Industry and Commerce gives the following list of concessions granted during last year for electric installations in various parts of Italy.

Region.	New generating stations.	Extension of already existing installations.	Total.
Piedmont	14	24	38
Liguria	3	5	8
Lombardy	5	40	45
Venetia	11	17	28
Emilia and Romagna	8	5	13
Tuscany	10	5	15
Marches	8	12	20
Umbria	1	1	2
Lazio	1	4	5
Abruzzo and Molise	2	3	5
Campania and Terra di Lavoro...	5	5	10
Basilicata	...	...	...
Apulia	6	...	6
Calabria	4	...	4
Sicily	5	...	5
Sardinia	1	...	1
Installations authorised by Ministry.	4	17	21
Total	88	138	226

Of the above 88 new installations 50 will employ water power and the rest will use gas or steam.

Voltage Regulator for A.C. Converters.—A patent recently issued in the U.S.A. to Prof. F. B. Crocker, gives a description of a device for supplying a voltage varying with the load to an alternating current synchronous converter. The delivered alternating E.M.F. differs from the supplied E.M.F. by a certain amount, which is caused to vary automatically both in value and in phase with the direct current. The variable E.M.F. introduced into the supply circuit is obtained from the secondary coil of a transformer whose primary is connected across the generator terminals and the reluctance of whose core is made to vary with the direct current. When the reluctance is low the current in the primary coil produces a large flux in the core and hence the E.M.F. generated in the secondary coil is large. This E.M.F. opposes the generator E.M.F. when the direct current is zero. The direct current is passed through coils, and thus saturates the core of the transformer, thereby increasing its reluctance. With increased reluctance, the primary current, although slightly increased in value and changed in time-phase, is unable to maintain the former flux, and the secondary E.M.F. is decreased. Hence the E.M.F. delivered to the converter increases with increase of load.

2,000 h.p. Direct Current Motor.—*La Lumière Electrique* gives an account of a motor of this output which has recently been erected at the Peiner Walzwerk. Besides its size it is interesting from the fact that it is said to be the first motor used for supplying the blast in a steel works. For this reason the speed has to be adjustable between wide limits, and this decided the Felten Guilleaume-Lahmeyerwerke, who are the makers, in favour of direct current. It is of the shunt type, the supply voltage being 500 volts, and it develops 2,000 H.P. when running at speeds between 50 and 80 revs. per min. The field system contains 20 poles of circular section and 18½ in. in diameter. Between these are placed auxiliary poles, which prevent sparking at all loads. The armature is built up of soft iron stampings, 12 in. wide, and has an external diameter of 18½ ft. and a length of 3 ft. The current is supplied through 20 brush sets, each containing seven brushes, the commutator being 10½ ft. in diameter and having 11½ in. effective breadth. The regulating resistance allows the speed to be varied between 22 and 50 revs. per min., though in practice such regulation will seldom be required. The starting resistance is specially large and is provided with an arrangement so that the current does not "jump" in passing from one notch to the next. On test this motor developed 2,630 H.P., corresponding to a current of 4,100 amperes, without sparking. In ordinary working, however, this is not likely to be reached. The motor will be on load for about 13 minutes and will then run light for about 18 minutes at a speed of 40 revs. per min.

The Electrical Resistance of Silicon at Various Temperatures.—In *The Electrician* for December 27, 1907, we summarised some results obtained by Miss F. G. Wick on the thermo-electric behaviour of metallic silicon. A recent number of the *Physical Review* contains some further data by the same author on the electrical resistance of silicon at various temperatures. Experiments were conducted over a range of 600 deg., the resistance of a number of rods at room temperature being first measured by finding the voltage drop along a known length of rod and comparing this with the drop across a known resistance. The end connections to the silicon rods were iron wires fused in the oxyhydrogen flame. Potential contacts were made by brass springs. The results obtained for various rods differed considerably, but the mean specific resistance was found to be $58{,}036\times10^{-6}$, as against $1{\cdot}3\times10^{-6}$ for copper and $4{,}000\times10^{-6}$ for carbon obtained from an incandescent lamp. In temperature measurements trouble was experienced in making satisfactory connections partly owing to the large thermal E.M.F. between silicon and other metals and partly from the fact that the rods were thick and very brittle. The contact finally chosen was that noted above. The silicon rod was heated to any desired temperature by being enclosed in an iron wire heating coil wound on a porcelain tube. P.D. measurements were taken as above and the temperature determined by previously calibrated copper-constantan junctions placed near the ends of the rod. For low temperatures, the rod was immersed in carbon dioxide, ether or liquid air. The results obtained vary very greatly, the rods appearing to fall into two groups, in one of which the temperature coefficient of resistance is negative. In the other the temperature coefficient is negative until 200 deg. is reached, when it becomes positive. These differences indicate that the resistance of silicon is very sensitive to changes in purity, physical constitution or crystalline structure.

ALTERNATING CURRENT COMMUTATOR MOTORS.*

BY DR. RUDOLF GOLDSCHMIDT.

(*Continued from page 673.*)

Summary.—In this article the author discusses the theory of the single-phase commutator motor. The production of the field is first considered, and then the shunt and series methods of excitation, it being shown that the simple shunt is an impossible method. The characteristics of the ideal series motor are then given in some detail, after which the complications and difficulties encountered in the real motor are considered, including commutation and the circulating currents in the short-circuited coils. Finally, the various losses are considered.

7. The Circulating Currents in the Short-circuited Coil.

Looking at Fig. 26 we notice that the coil, short-circuited by the brush, though entirely out of the range of the poles, is under the inductive influence of the whole of the flux issuing from the pole. The coil under short-circuit actually surrounds the flux entering the armature, and in our case, this flux being an alternating one, induces an E.M.F., and, consequently, a current in this coil. If the short-circuit was perfect and the resistance and self-induction of the coil and the resistance of the brush contact very small, this "circulating current" would be extremely heavy. It would not only be sufficient to cause considerable ohmic loss, but would also load up the contact surface of the brush, in most cases up to the glowing point; and, besides, its demagnetising action on the field itself would be seriously felt. If there was practically no leakage and resistance, the current in the single armature coil would assume such a value that it would almost neutralise the action of the field coils and prevent any flux from passing through the armature. The amount of current flowing in the coil might, under these conditions, be more than *ten* times the current it is supposed to carry ordinarily. The effect on the brushes would not only be glowing but also sparking, due to the circuit being broken. We see, therefore, that this current must be checked. It must be reduced to a reasonable amount, say less than normal current, to prevent any of its bad effects. The most natural way to do this is the introduction of ohmic resistance in the circuit formed by the brush, commutator segments and the connection between both—*i.e.*, the commutator lugs or connectors, as they are generally called (Figs. 27, 27A and 28). These connections are generally used as a resistance, either by having a great length or by being made out of a metal of low conductivity. It would be undesirable to give the coils or the brush a higher resistance than we can help, as these parts have to carry continually the main current. The lugs are particularly suited for serving as resistance, as they have to carry the main current only for a very short time, when the brushes are in contact with their commutator segments; otherwise they are idle. Naturally, even in this favourable case, the reduction of the circulating current must be bought by a certain amount of loss, for a higher resistance giving a very small circulating current indeed will also cause quite an appreciable loss, due to its carrying the main current. A simple calculation will give us an idea of these relations. We will call the voltage induced in the coil under commutation by the alternations of the main field ϵ, the resistance of each connector s, and assume that s is so big that the resistance of the main coil is practically negligible compared with it. In s shall be included the average contact resistance the current finds when passing from the brush to the segment, due account being taken—as far as possible—of the contact resistance being smaller the higher the current density.

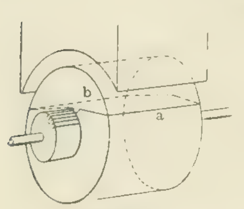


FIG. 26.

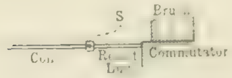


FIG. 27.

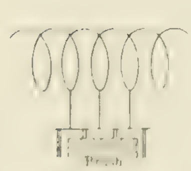


FIG. 27A.

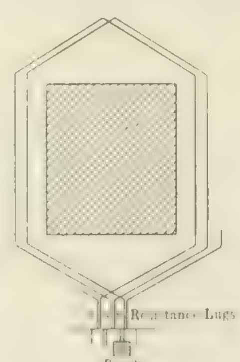


FIG. 28.

It is evident that the self-induction of the coil which might reduce the current and cause phase displacement is comparatively small, the current of the coil being more than 10 times the normal* if s is zero. We will assume that the brush had the exact width of one segment (Fig. 29), thus short-circuiting only one coil at a time. The circulating current would then be $i_c = \epsilon/2s$, and would cause a loss, $p_c = \epsilon^2/2s$, in the lugs under one brush or $p_c = \epsilon^2/s$ for a pair of (plus and minus) brushes. The main current I flowing through the lugs in parallel causes the loss $p_m = I^2 \times \frac{s}{2} \times 2 = I^2 \times s$ per set of brushes. Therefore, the total loss in the lugs through circulating and main current

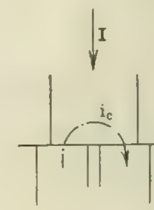


FIG. 29.

$$p_c + p_m = \frac{\epsilon^2}{s} + I^2 \times s.$$

A simple differentiation shows that the total loss is the smallest if p_c and p_m are equal—*i.e.*, if $\epsilon^2/s = I^2 . s$; $s_{min.} = \epsilon/I$, and the circulating current i_c equal to the main current.

If the brush width is equal to that of two commutator segments, it short-circuits mostly two coils at a time; then

$$p_c = 4 . \frac{\epsilon^2}{s} \text{ per pair of brushes,}$$

$$p_m = \tfrac{2}{3} . I^2 . s \text{ per pair of brushes.}$$

The minimum of the total loss is reached if $p_c = p_m$ or $4 . \frac{\epsilon^2}{s} = \frac{2}{3} . I^2 . s$; that is

$$s_{min} = 2{\cdot}45 . \frac{\epsilon}{I},$$

$$(p_c + p_m)_{min} = 3{\cdot}25 \times \epsilon \times I; \; i_{circ} = 0{\cdot}41 \times I.$$

For a brush, short-circuiting x coils, we find

$$p_c = x^2 . \epsilon^2/s;$$

$$p_m = 2 \times \frac{I^2 \times s}{x + 1};$$

and the condition for the minimum of loss

$$s_{min} = \frac{\epsilon}{I} \times x\sqrt{\frac{x+1}{2}},$$

$$(p_c + p_m)_{min} = \epsilon \times I \times \frac{2{\cdot}82}{\sqrt{\frac{1}{x} + \frac{1}{x^2}}}; \; i_{circ} = \frac{I}{\sqrt{2(x+1)}}.$$

The greater the number of segments covered by the brush the greater the losses in the lugs, the higher the resistance of the lugs must be and the smaller the circulating current compared with the main current.

These calculations are naturally only approximate, the distribution of the main current over the segments being made non-uniform by the commutation process itself, the current tending to pass chiefly through the segment about to leave the brush. But the high lug resistance itself counteracts this tendency and makes our assumption of uniform distribution more correct.

We have found in a general way the condition for making the losses in the lugs as small as possible. Naturally this minimum does not entirely settle the amount of lug and brush resistance; other considerations come in as well—for instance, mechanical ones and the current density in the brush. The latter will be satisfactory since, with the brush covering three or

* Thinking of an alternator with a short-circuit current equal to 10 times the normal current, one will understand this statement.

two segments, the circulating current is only 35 to 42 per cent. of the main current, if we comply with the condition for the minimum losses. We can, however, make the resistance somewhat larger or smaller, as the losses up to a certain point change only very slowly provided that we do not depart too far from s_{min} If $s = 1{\cdot}75 \times s_{min}$, the circulating current is only about 20 to 23 per cent. of the main current, and the losses are only 15 per cent. more than the theoretical minimum. This will be seen from Fig. 30, representing the losses and the ratio $\frac{\text{circulating current}}{\text{main current}}$ for different lug resistances, the brushes being taken as covering two segments.

We can easily form an idea of the loss in the resistance lugs expressed as a percentage of the useful electrical energy, the latter being $P = E \times I$. With a parallel armature and two commutator segments covered by the brush

$$(p_c + p_m)_{min.} = 3{\cdot}25 \times \epsilon \times I = 3{\cdot}25 \times P \times \frac{\epsilon}{E}.$$

This formula holds good whatever the number of poles and number of sets of brushes, as, by introducing I, the total current, the number of brush sets has been taken account of.

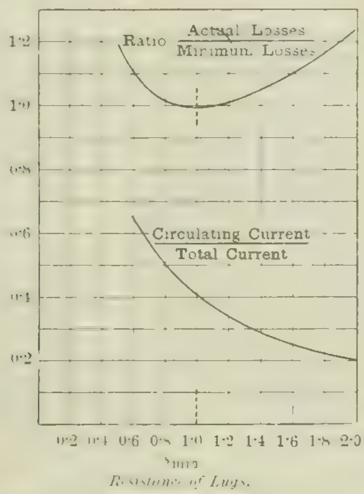


FIG. 30.—LOSSES IN RESISTANCE LUGS.

To find the ratio between ϵ and the E.M.F. E of the armature we put $AT_a = \frac{AT_f}{\gamma}$, and for the series motor (series armature) $s_a = 4 \times \frac{z_f}{\gamma} \times \frac{p}{2}$.

If m = number of commutator segments, $s_a/2m$ = number of turns per coil, we used to call E_L the E.M.F. induced by the main flux plus leakage flux in the z_f turns of the field; therefore, the E.M.F. induced by the main flux into the $s_a/2m$ turns of an armature coil is

$$\epsilon = \frac{2}{p} \times E_L \times \frac{s_a}{2m \times z_f} \times \frac{p}{2} \times \frac{1}{c} = E_L \times \frac{2}{c \cdot \gamma \cdot m}.$$

Formula (8) gives the relation between E_L and E

$$R = \frac{E_L}{E} = \frac{\pi}{2} \times c \times \gamma \times \frac{n_s}{n},$$

or, if the brushes cover two segments,

$$\frac{\text{Loss in resistance lugs}}{\text{Useful energy}} = \frac{10}{m} \times \frac{n_s}{n}$$

$$= \frac{10}{\text{number of commutator segments}} \times \frac{\text{synchronous speed}}{\text{normal speed}} \cdot (16)$$

This formula enables us to estimate the losses in the resistance lugs and brushes, if only speed, number of poles, frequency and number of segments are given. A motor for 25 cycles, four poles (synchronous speed 750 revs. per min.), 1,000 revolutions and 250 commutator segments has a minimum loss in the resistance lugs and brushes equal to $\frac{10}{250} \times \frac{750}{1000} \times 100 = 3$ per cent. of the useful energy of the machine. The condition for the minimum loss was equality of losses due to equalising current and main current. The main current, therefore, must cause $1\frac{1}{2}$ per cent. loss; in other words, the drop in voltage over brush and resistance must be about $1\frac{1}{2}$ per cent. of the voltage in the armature. If the latter is 200 volts, and we have selected brushes giving 2×1 volts $= 2$ volts over the brushes, the drop over the resistance ought to be $[\frac{1.5}{100} \times 200] - 2 = 1$ volt. Allowing for the resistance being higher than required for the minimum, the total loss will go up to about $3\frac{1}{2}$ per cent. and the drop in the lugs alone to about 2 volts. If the machine has approximately 80 per cent. efficiency, the losses in the lugs will affect the efficiency $3\frac{1}{2} \times 0{\cdot}80 = 2\frac{3}{4}$ per cent. With 125 commutator segments (small machines) the loss would be double.

A fact which we can derive from this example is that the resistance in the brush contact is very nearly sufficient to keep the circulating current down to a moderate amount. In fact, if the voltage of the motor is kept low enough, and a carbon brush is selected having high contact resistance, the resistance lugs can be dispensed with altogether. Though through this expedient the size of the commutator becomes rather large, it has been applied in actual practice with quite large machines

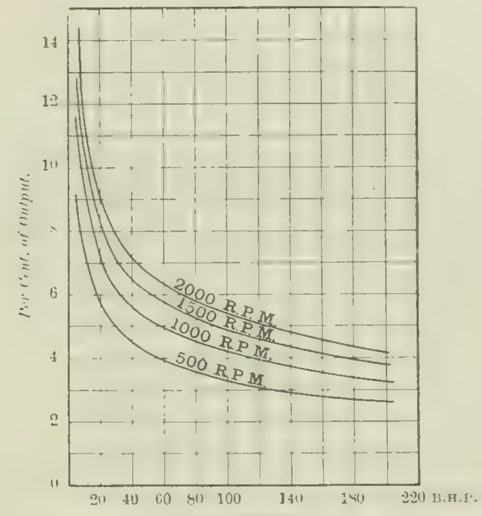


FIG. 31. – LOSSES IN LUGS AND CARBONS AT SYNCHRONOUS SPEED FOR TWO SETS OF BRUSHES.

for traction work. It is certainly desirable not to use resistance lugs as far as the starting of the motor is concerned. The resistance lugs are being designed for intermittent use at full load when they have to carry current only as long as the brushes touch their respective segments. Therefore, there is some danger of their burning out when the motor is stationary or moving slowly.

A given machine, say, for 25 cycles, having its resistance lugs adjusted to give the minimum loss has, as we found, a circulating current approximately equal to the normal current. If we were to increase the frequency to 50, the circulating current would double $\left(\frac{n_{synchr.}}{n_{normal}} \text{ or } \epsilon \text{ double}\right)$ and the machine would spark. The resistance ought to have a different value for each frequency. In the example we just calculated for 25 periods the minimum loss in the resistance would be 6 to 7 per cent. at 50 periods instead of 3 to $3\frac{1}{2}$ per cent. at 25. *High frequency, therefore, affects the efficiency unfavourably as well as the power factor.*

For approximate estimating it is desirable to eliminate construction details, in our case the number of commutator segments, out of formula (16).

This can be done by going into the design in a general way, determining the armature diameter from the output, and assuming the commutator diameter to be as large, and the number of commutator segments as high, as practicable.

Plotting the loss in the lugs and brushes for the ratio $\frac{\text{synchronous speed}}{\text{running speed}} = 1$, we obtain approximate curves (Fig. 31), giving the loss in the lugs as the percentage of the output. These figures are to be multiplied by the ratio $\frac{\text{synchronous speed}}{\text{normal speed}}$.

To show how the character of the current in the coil under commutation is affected by the circulating current, we draw an ordinary commutation curve for direct current (Fig. 32). Up to the moment where the coil is short-circuited the current has the value $+I'$, when it is leaving the short-circuit the current is reversed to $-I''$.

Without the effect of self-induction the change would follow a linear law (A); through the delaying influence of the reactance, however, the current will be deformed into B. The time of commutation being very short generally, compared with

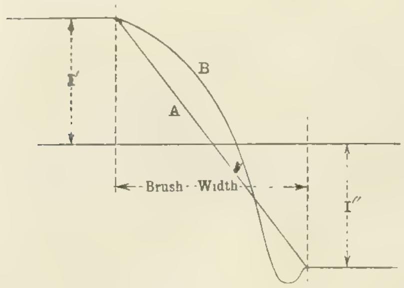


Fig. 32.

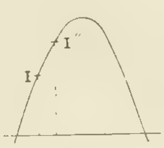


Fig. 33.

the time of one period of the alternating current, I'' is practically equal to I' (Fig. 33). It is actually slightly larger for the rising half of a half-period and slightly smaller for the dropping half. The circulating current, being due to a voltage induced by the main flux, is zero when the main current is a maximum (2, Fig. 34), and, therefore, does not interfere with the commutation of the maximum current. It is opposing the initial armature current when the latter rises $(1-2)$ and helping the

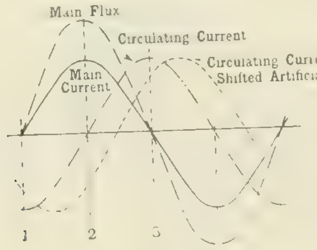


Fig. 34.

initial armature current when it falls $(2-3)$. In Fig. 35, drawn for a period $1-2$, B is the original commutation curve, C the circulating current and D the total current resulting from both. Fig. 36 shows the corresponding curve for the period $2-3$. We see that during the falling of the

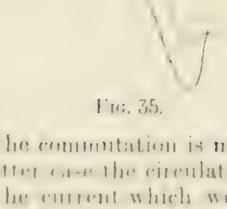


Fig. 35.

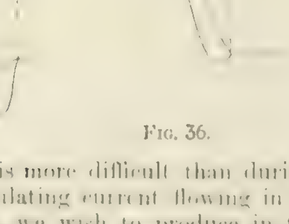


Fig. 36.

current the commutation is more difficult than during rising, in the latter case the circulating current flowing in the direction of the current which we wish to produce in the short circuited coil. The correctness of our investigation, especially the relative direction of the currents, can be easily verified by looking at Fig. 37, direction of rotation and current having been found by applying the curtain rule. We have to remember that the circulating current magnetises when the flux tries to disappear (direction of i_{circ} being the same as that of I).

The fact that during the period $1-2$ the circulating current tends to improve the commutation prompts us to artificially lengthen this period and thus make the otherwise harmful circulating currents do useful service. The circulating current must for this purpose have a component in phase with, but opposite to, the armature current. The circulating current is thus shifted into the dotted position in Fig. 34. This can be achieved by placing an inductive branch (choking coil) across the armature terminals. This causes a current, i_s, to flow in the field besides the armature current, thus shifting the field current, and with it the main flux and the circulating current, in the desired direction (Figs. 38 and 39).

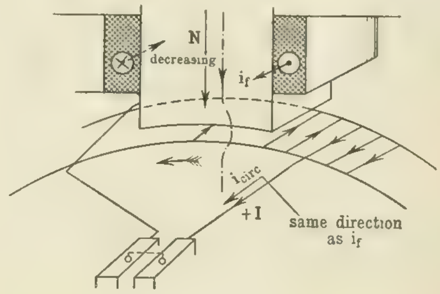


Fig. 37.

The same object is attained by placing a non-inductive resistance in parallel with the field winding, in this case the armature current composed of i_f and i_r being shifted as intended (Figs. 40 and 41).

It is evident that the method is not perfect, the bulk of the circulating current remaining in quarter-phase with the main current, thus being partly beneficial, partly harmful.

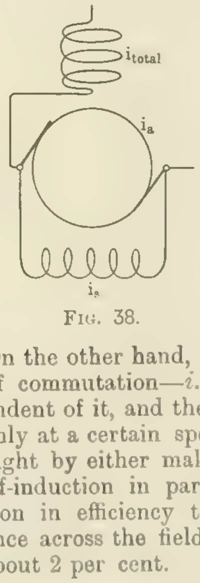


Fig. 38.

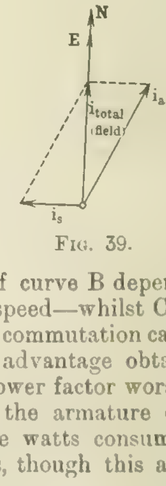


Fig. 39.

On the other hand, the form of curve B depends on the time of commutation—*i.e.*, on the speed—whilst C is almost independent of it, and therefore the commutation can be made good only at a certain speed. The advantage obtained must be bought by either making the power factor worse through the self-induction in parallel with the armature or by the reduction in efficiency through the watts consumed in the resistance across the field terminals, though this amounts to only about 2 per cent.

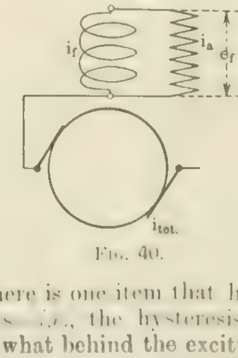


Fig. 40.

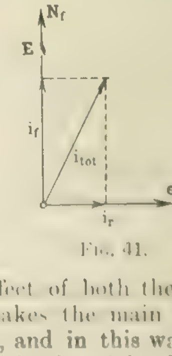


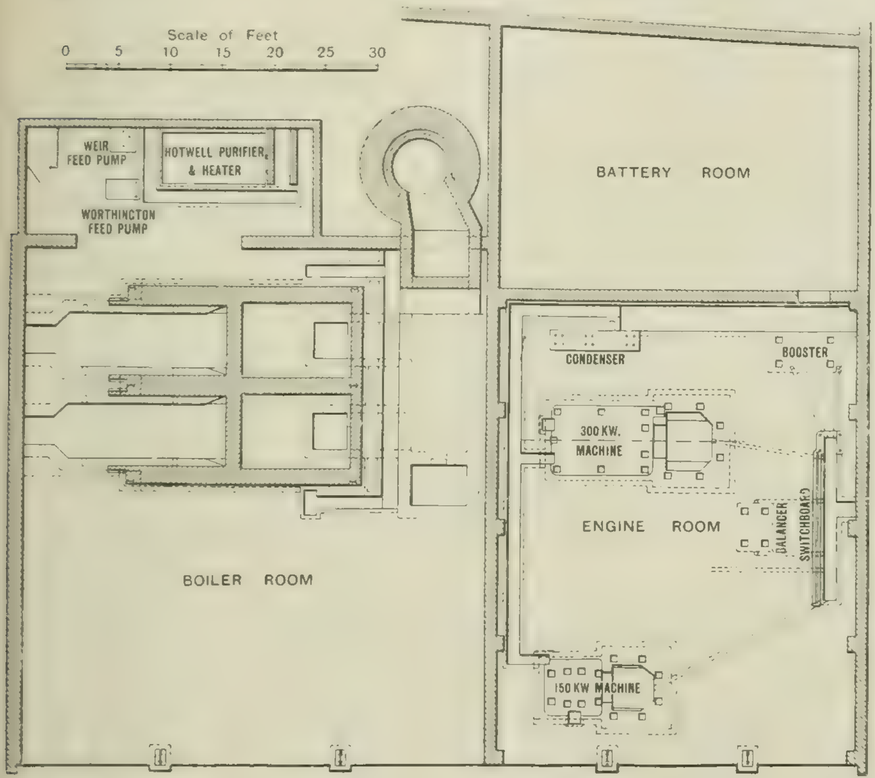
Fig. 41.

There is one item that helps the effect of both these expedients—*i.e.*, the hysteresis, which makes the main flux lag somewhat behind the exciting current, and in this way shifts the phase of the circulating current in the right direction. The hysteresis lag amounts to 10 deg. or 15 deg. Also the self-induction of the short-circuited coil—which is, however, as pointed out, only small compared with the resistance, the latter being large to check the absolute value of the circulating current—tends to shift the phase of i_{circ} so that it helps commutation.

(To be continued).

ARBROATH ELECTRICITY WORKS.

The Royal Burgh of Arbroath, with a resident population of about 23,000, is one of the few large towns of Scotland that has hitherto been without an electricity supply works, and those firms that have desired to use electricity for lighting or power purposes have had to adopt the unsatisfactory and costly expedient of installing plant for their own requirements. Perhaps this is one reason why the town has not progressed during the last decade, large mills, which in previous years were hives of industry, having had to remain idle, while their more fortunately placed competitors in other districts, where better facilities were afforded, have had their full share of prosperity. Now, however, a change for the better may be looked for, and already some of the largest mill-owners, recognising the importance of the change brought about by the advent of electrical power, have begun to make use of it to drive and light their works.



Foundation Plan of the Arbroath Electricity Supply Station.

The history of the introduction of electricity to Arbroath is one of hopes and disappointments, concluding, however, with well-merited success, let us hope, for those who have had the pluck to come forward and carry out the scheme. So long ago as 1899 a provisional order for electric lighting was granted to the Corporation, who a year or two later considered the advisability of themselves carrying it into effect. A scheme was prepared, but was not proceeded with, and at a later stage, namely, in 1904, an agreement was entered into for the transfer of the order to the Empire Electric Light & Power Co. The failure of this company threw the matter back once more, and in the following year the order was revoked by the Board of Trade, who would not allow it to remain in force any longer.

At this dismal period Mr. George Balfour came forward and made an offer to the Corporation to obtain a new order under certain conditions; an agreement was concluded and the order was obtained at the end of July, 1907. Two years was allowed for the construction of the works, but although Mr. Balfour had given no promise of early commencement, now, only one year from the Royal Assent being given to the order, the works are in full operation.

A far more extensive system of mains has been provided than was obligatory under the order, and the substantially built and well-equipped works are sufficient evidence of the thoroughness with which the enterprise has been entered upon. It is interesting to note that the horse-power of the works erected by the company is exactly three times what was contemplated by the Corporation under the proposed scheme referred to above. The company have provided space in the works sufficient to accommodate double the plant already installed, and that they were well advised in so doing is shown by the fact that already the desirability of extensions is being talked about.

General Arrangement of the Works.—The works are situated in South Grimsby-street, adjoining the dock branch of the Caledonian Railway, from which a siding will ultimately be constructed, and in close proximity to the harbour. The site, held on feu from the Corporation, affords ample room for extension of the works, which, owing to their central position within a short distance of the principal factories and main business thoroughfares, and to the facilities they possess for obtaining coal and water, are eminently adapted for the economical production and distribution of electrical energy.

The contract for the whole of the works with equipment, including underground mains and public arc lamps, has been carried out by Messrs. J. G. White & Co., as sub-contractors to Mr. George Balfour, in accordance with plans and specifications prepared by and under the supervision of Messrs. Hawtayne & Zeden, the company's consulting engineers, Mr. J. Cathcart Christie acting as resident engineer.

Buildings.—The buildings are of plain design and have been erected by local firms. The engine house is 45 ft long by 35 ft. wide, and the boiler house 50 ft. long by 45 ft. wide, and an idea of their general arrangement can be obtained from the diagram herewith. The buildings also comprise a battery room and pump room, office accommodation being arranged for in an existing building on the site. Space has been provided for additional machinery, and, with a view to further extensions, the south-west ends of the engine and boiler houses have been constructed of corrugated iron sheeting on a steel framework. The engine house is built in bays with brick piers supporting a gantry running the full length of the house and carrying a travelling crane of 10 tons lifting capacity, supplied by Mr. J. Williams, of Cardiff.

Chimney.—The chimney shaft is of brick and is lined for 47 ft. above ground level, the total height being 125 ft. and the inside diameter 5 ft. 6 in. The work has been carried out by the Alphons Custodis Chimney Co., of London. The main flue has been arranged to allow of the erection of a fuel economiser when required, space being left behind the boilers for this purpose.

Boilers.—The boilers, which have been supplied by Messrs. Babcock & Wilcox, are two in number, each being capable of evaporating 7,500 lb. of water per hour into steam at 160 lb. pressure, and superheated to 480°F. They are fitted with chain-grate stokers and the usual mountings, including duplicate feed valves. The same firm have also been entrusted with the pipe work, the steam pipes being of mild steel with wrought flanges, and the exhaust and circulating pipes of cast iron. The circulating water is drawn from the Brothock Burn through a 8 in. main, and returned to it lower down stream through a 9 in. main. The feed piping is arranged as a complete ring main.

The boilers are fed by means of two steam pumps, the main feed pump being supplied by Messrs. J. G. Weir, of Glasgow, and the auxiliary pump being a Worthington horizontal duplex pump, the capacity of each being 1,800 gallons per hour. To ensure the water reaching the boilers in good condition, it is passed through a purifying plant of the Paterson Engineering Co.'s make, the pump exhaust being utilised for heating

the supply. A hot-well tank of 1,000 gallons capacity is combined with the plant.

Engine Room Plant.—This has been supplied by Messrs. Thomas Parker, of Wolverhampton, who have also supplied a two-machine balancer of 15 kw. and a reversible booster of 28 kw. capacity, together with a Tilney regulator and a switch panel for the booster. The generators comprise one 150 kw. continuous current dynamo, direct-coupled to a Belliss & Morcom compound engine running at 435 revs. per min., and a 300 kw. continuous current dynamo, direct-coupled to a triple-expansion engine, by the same makers, fitted with automatic expansion gear and running at 375 revs. per min. The machines are compound wound, and are fitted with auxiliary poles and equalising switches for the series winding. They give the required output at a pressure ranging between 480 and 560 volts and are capable of giving 10 and 20 per cent. overload respectively, for a period of two hours, without injury.

Battery.—The storage battery consists of 260 E.P.S. cells in lead-lined boxes carried on two-tier stands. It has a capacity of 600 ampere-hours and can give an output of 400 amperes for one hour.

Switchboard.—The machines, battery and feeders are controlled from a handsome white marble switchboard, supplied by the British Thomson-Houston Co., which carries all the necessary instruments, switches and meters. Circuit-breakers are provided on each pole of the machines, and there are two sets of 'bus bars with selector switches, by means of which the supply can be given at two different voltages if desired.

Mains.—The underground mains, manufactured and laid by Messrs. Callender's Cable & Construction Co., consist of vulcanised bitumen and paper-insulated cables laid on the solid system, except at Brothock Bridge, where they are drawn into conduits, provided when the bridge was recently reconstructed. The feeder cables are triple concentric and the distributors are single conductors, the aggregate length of cables being about 10 miles. Distribution is on the three-wire continuous current system with 500 volts across the outers, the supply to consumers being at 250 volts for lighting purposes and 500 volts for power.

Street Lighting.—The main thoroughfares are lighted by means of 20 Crompton-Blondel flame arc lamps of about 1,500 c.p. each, carried on handsome, ornamental cast-iron columns, supplied by Messrs. W. Macfarlane & Co., of Glasgow. Each post also carries a pair of 50 c.p. osram lamps, for use when the arcs are switched off. The lamps are arranged in four groups, controlled from switching points in the bases of the arc lamp columns.

The very gratifying manner in which the supply has been taken up in Arbroath should be a great encouragement to the directors of the company, and there is every indication of the new venture being strongly supported.

BRIGHTON CORPORATION ELECTRICITY ACCOUNTS.

In analysing the accounts of the Brighton Corporation last year we had a sorry tale to tell. The deficit on the year's working was in the neighbourhood of £10,000, and the number of units sold had decreased in an unsatisfactory manner. This unfortunate state of affairs was attributed to several causes, which were fully discussed by us at the time and into which we need not again enter. We are, however, pleased to see that the undertaking has been doing much better during the past financial year, and we hope that it has now touched bottom and will speedily begin to mend.

As mentioned above, the deficit during 1966-07 was £10,000, and although there was again a deficit on last year's working, it was the smaller sum of £3,657 15s. 8d.; in 1905-06 the deficit was [illegible], while in 1904 a profit of £5,831 was realised. During the year under notice the undertaking has not been without its vicissitudes. It was, for example, saddled with a sum of £1,393 for law costs as a result of an action brought for nuisance. This action was fully reported in *The Electrician* at the time, and was, as will be remembered, successfully defended by the Corporation.

The engineer and manager (Mr. J. Christie), in his report to the Lighting Committee, states that a considerable portion of the capital outlay on the Southwick station was incurred to meet future development, and has not yet been as remunerative as was at first hoped. Great economy has been effected in the works costs during the past few years, for in 1904-5 these worked out as 1·17d. per unit sold, this being in 1907-8 reduced to 0·89d. This is specially satisfactory, as in 1904 Welsh coal was abnormally low in price, while, as is well known, last year the opposite was the case.

The increase in units sold was 153,182, while the maximum load was 145 kw. less than last year, this reduction being principally due to the increasing use of high-efficiency lamps. The load factor, however, was improved by 3 per cent., and this materially aided in reducing the works costs. During the year the net increase in the number of consumers has been 23 only, equivalent to 12,024 8 c.p. lamps. This small advance is thought to be due to the depression of trade prevailing in the town and country generally. Things, however, now seem to be improving, and since April 1st a net gain of no less than 52 services has been recorded. It is also satisfactory to note that the power load is improving, for at the end of the financial year 364 motors, equivalent to 1,423 H.P., were connected to the mains, an increase during the year of 31 motors and 132 H.P. Of the above, 130 motors, representing 703 H.P., are hired from the Corporation. This portion of the business is said to be most satisfactory, and its benefits are much appreciated by the smaller power users.

Mr. Christie recommends that steps should be taken as soon as possible to rebuild an adequate reserve fund, as this has become rather depleted owing to the deficits of the past three years.

We give below an analysis of the expenditure during the past year, together with the cost per unit sold, for the past year and for the year 1906-07 :—

	£ s. d.	1907-8.	1906-7.
GENERATING COSTS.			
Coal, &c.	£18,266 0 9	0·55d.	0·61d.
Oil, waste, &c.	522 12 2	0·02d.	0·05d.
Wages and salaries	5,700 15 11	0·17d.	0·23d.
Repairs and maintenance	2,980 16 3	0·09d.	0·12d.
Total Generating Costs	**£27,470 5 1**	**0·83d.**	**1·01d.**
DISTRIBUTION COSTS.			
Repairs and maintenance	£2,228 6 3	0·07d.	0·09d.
Other expenses	768 5 11	0·02d.	0·02d.
Attending public lamps, &c.	3,568 4 1	0·10d.	0·11d.
Total Distribution Costs	**£6,564 16 3**	**0·19d**	**0·22d.**
RATES AND TAXES.			
Local rates	£3,962 6 5	0·12d.	0·11d.
Income tax	314 9 3	0·01d.	0·01d.
Total	**£4,276 15 8**	**0·13d.**	**0·12d.**
MANAGEMENT EXPENSES.			
Salaries	£4,938 18 4	0·14d.	0·17d.
Stamp duty, &c.	510 0 6	0·02d.	0·01d.
Stationary and printing	177 11 7	0·005d.	0·005d.
Establishment charges	486 5 1	0·015d.	0·015d.
Insurance, law expenses, &c.	1,908 13 5	0·06d.	—
Total Management Expenses	**£8,021 8 11**	**0·24d.**	**0·20d.**
TOTAL WORKING EXPENSES (excluding capital charges)	**£46,333 5 11**	**1·39d.**	**1·55d.**
Capital Charges, &c.			
Interest on capital	£21,321 15 10	0·63d.	0·65d.
Sinking funds	23,665 3 11	0·71d.	0·67d.
Stores		—	0·02d.
Bad debts	420 0 11	0·02d.	0·02d.
	£45,407 0 8	**1·36d.**	**1·36d.**
TOTAL EXPENSES (including capital charges)	**£91,740 6 7**	**2·75d.**	**2·91d.**
TOTAL INCOME	**88,082 10 11**	**2·64d.**	**2·62d.**
DEFICIT	**3,657 15 8**	**0·11d.**	**0·29d.**

The capital spent during the year amounts to £16,194.11s.10d., which includes £14,175 for machinery and plant, £1,233 on mains and £581 on the hire of motors. We give below details of the total capital expenditure to date, together with the amount in £ per kilowatt expended on the various items.

Capital Account.				£ per kw.	Per cent.
Lands acquired	£17,918	16	3	1·86d.	2·32
Buildings	149.433	14	1	15·84d.	19·81
Machinery and plant	301,782	8	11	30·68d.	38·96
Mains	243,978	0	7	24·80d.	30·43
Meters and terminal boxes	39,707	9	1	4·23d.	5·80
Motors for hire	6,329	11	11	0·65d.	0·81
Change of voltage	4,263	7	3	0·47d.	0·59
Purchase of patent rights	1,337	3	0	0·12d.	0·15
Engineer's commission	1,496	17	9	0·13d.	0·16
Office furniture	550	1	9	0·06d.	0·07
General expenses	1,126	11	6	0·11d.	0·14
Purchase of Brighton Electric Light Co.'s undertaking	5,000	0	0	0·47d.	0·59
Parliamentary expenses	1,550	0	0	0·14d.	0·17
TOTAL	**£774,474**	**2**	**1**	**79·56d.**	**100·00**

The total units generated were 10,230,119, of which 1,023,767 were absorbed in public lighting, 1,889,871 in tramways, and 23,612 in bulk supply, while 5,065,126 were used by private consumers. The total units sold were 8,002,376. The corresponding figures in 1906-07 were 8,618,335, 1,011,253, 1,798,905, 18,407 and 5,020,629, the total sold amounting to 7,849,194. It will thus be seen that the increase is, in general, satisfactory. The maximum load on the feeders has dropped from 4,789 kw. to 4,644 kw., a decrease of 145 kw., the corresponding drop in the previous financial year was 230 kw. The load factor has increased from 16·6 to 19·6 per cent. The generator capacity remains the same as last year.

The average price per unit sold was for private supply 2·91d., for public lighting 1·56d., for traction 1·50d., for bulk supply 1·98d., and on the whole supply 2·40d. The corresponding figures last year were 2·88d., 1·56d., 1·50d., 2·29d. and 2·39d.

BURTON-ON-TRENT CORPORATION TRAMWAYS.

The results of a year's working on this system are given in the report recently submitted by the engineer to the Public Works and Tramways committee. The deficit is only slightly larger than last year, amounting to rather over £1,121.

The car-mileage run during 1907-8 was 430,913, compared with 421,317 in 1906-7, an increase of 9,596 car-miles. This increase is said to be principally due to a short extension to one of the routes. The current consumption per car-mile, including the Burton and Ashby Light Railway, was 1·22 units, compared with 1·187 last year; this amount is rather greater than that consumed by the Corporation cars alone, owing to the fact that the Burton and Ashby Light Railway, which has running powers into Burton, works over a very hilly route. The revenue per car-mile for the Burton traffic has dropped from 8·6d. per car-mile to 8·03d., a result which is attributed by the manager both to the wet summer of last year and the trade depression. In spite of this, however, the operating expenses have been reduced from 6·14d. to 5·85d. per car-mile, this being at a slower rate than that at which the receipts have fallen. The passengers carried decreased from 3,383,527 to 3,221,595 during the past year.

It is satisfactory to note that the number of accidents has been exceedingly small, a result which speaks well for the working of the tramway when the numerous level crossings and narrow streets in Burton-on-Trent are taken into account.

The parcels traffic has also shown a satisfactory increase, the number carried being 46,859, against 43,955 in 1906-7. An arrangement has been made whereby parcels up to 14 lb. are delivered within half a mile of the tramway at a charge of 1½d. per parcel. The total number delivered in this manner during the year was 4,779, an increase of 1,170. The total revenue from parcels traffic amounted to £205, while the expenditure was only about £20.

The various items of expenditure during the past year are set out in full below together with the cost per car-mile during the same period and in 1906-7.

				Cost per car-mile.	
Traffic Expenses.				1907-8.	1906-7.
Salaries and wages	£3,926	14	8	2·19d.	2·24d.
Oil, grease, waste	76	15	2	0·04d.	0·04d.
Uniforms	119	0	8	0·06d.	0·06d.
Bags, punches, boxes	57	17	9	0·03d.	0·06d.
Fuel, light and water	28	16	4	0·02d.	0·02d.
Cleaning and salting track	111	19	8	0·06d.	0·08d.
Licences for cars	15	0	0	0·01d.	0·01d.
Cleaning cars	342	5	3	0·19d.	0·18d.
Miscellaneous	13	5	2	0·01d.	0·01d.
Total Traffic Expenses	**£4,691**	**14**	**8**	**2·61d.**	**2·70d.**
Repairs and Maintenance.					
Cars	£886	18	0	0·50d.	0·59d.
Overhead work	212	7	8	0·12d.	0·18d.
Permanent way	445	16	1	0·25d.	0·20d.
Cables	38	13	0	0·02d.	0·02d.
Machinery and tools	20	18	11	0·01d.	—
Depot and buildings	4	11	2	—	—
Fuel, light and water	34	15	2	0·02d.	0·02d.
Miscellaneous	7	2	2	-	—
Total Repairs & Maintenance	**£1,651**	**2**	**2**	**0·92d.**	**1·01d.**
Management Expenses, &c					
Salaries and wages	£345	6	7	0·19d.	0·19d.
Printing and stationery	44	14	7	0·02d.	0·03d.
Loan and stock expenses	44	10	1	0·02d.	0·10d.
Fuel, light	49	14	8	0·03d.	0·03d.
Miscellaneous	113	16	9	0·06d.	0·06d.
Rents, rates, taxes & insurance	650	19	7	0·36d.	0·37d.
Third party insurance	181	10	3	0·10d.	0·15d.
Total Management Expenses	**£1,430**	**12**	**6**	**0·78d.**	**0·93d.**
Power Expenses.					
Power—Corporation	£2,949	0	4	1·64d.	1·62d.
,, Midland Railway	454	1	10	0·25d.	0·20d.
Total Power Expenses	**£3,403**	**2**	**2**	**1·89d.**	**1·82d.**
TOTAL OPERATING EXPENDITURE	**£11,176**	**11**	**6**	**6·20d.**	**6·46d.**
Capital Charges.					
Interest on 3 % Stock	£1,523	15	2	0·85d.	0·89d.
,, ,, Loans	1,226	11	1	0·70d.	0·77d.
Bank Interest	49	2	0	0·03d.	—
Contribution to Redemption Fund	1,282	11	5	0·71d.	0·71d.
Contribution to Sinking Fund	784	10	10	0·44d.	0·41d.
,, ,, Renewals Fund	1,000	0	0	0·56d.	0·57d.
TOTAL CAPITAL CHARGES	**£5,866**	**10**	**6**	**3·29d.**	**3·35d.**
Balance brought forward	—			--	0·13d.
TOTAL EXPENDITURE	**£17,043**	**2**	**0**	**9·49d.**	**9·94d.**
TOTAL RECEIPTS	**£15,921**	**18**	**5**	**8·86d.**	**9·30d.**
DEFICIT	**1,121**	**3**	**7**	**0·63d.**	**0·64d.**

The gross revenue account for the 12 months shows a surplus of income over expenditure of £4,745, compared with £5,012 last year and represents 5·1 per cent. on the capital expenditure. The repayment of debt and interest charges amounts to £4,866, compared with £4,889 last year. In spite of the financial situation, £1,000 has again been allotted to the reserve fund. This fund now stands at £3,990. The trading account shows a deficit of £121, compared with a surplus of £123 last year, and this amount, when added to the reserve fund contribution, brings the total deficit up to £1,121. The capital expenditure to date is £105,629, but no details of this are given in the report. Taking into account the conditions under which the system has operated during the past year, the manager considers the result given above as satisfactory.

The mileage of single track now open is practically 9¾ miles, no extensions having been made during the year. As stated above, the total number of passengers carried was 3,221,595, and in this connection it is interesting to note that 1d. fare passengers formed 74·7 per cent. of the whole, workmen coming next with 19 per cent.

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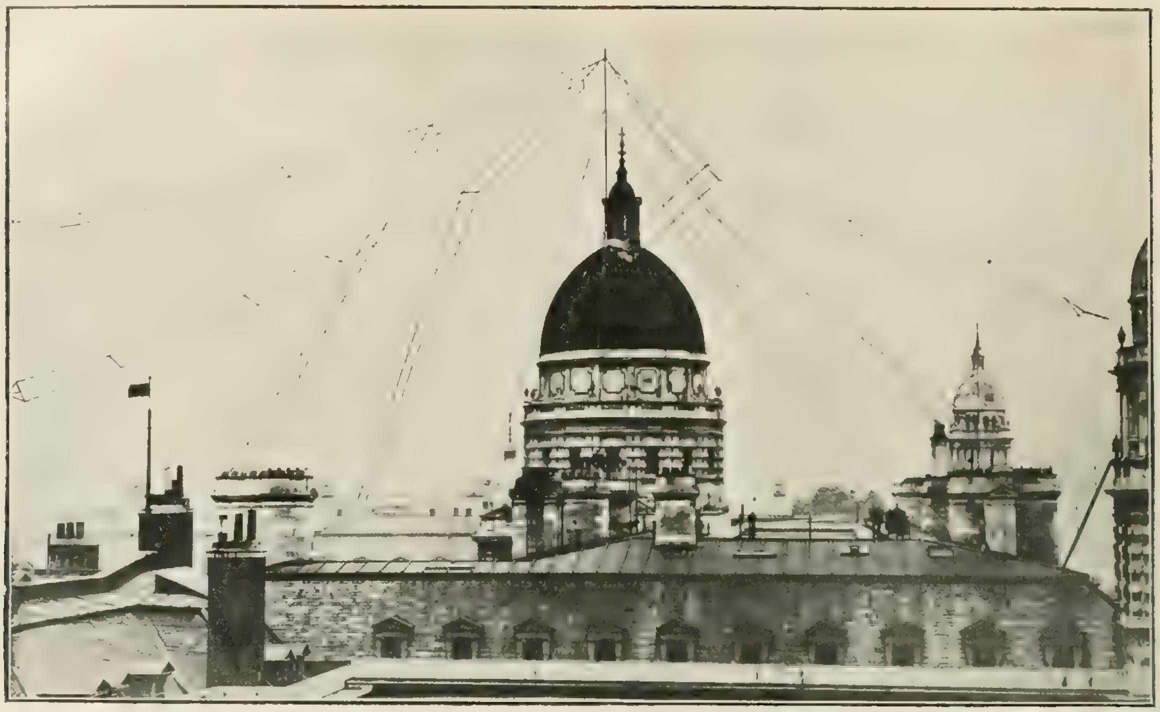

Photo Topical Press.

WIRELESS TELEGRAPH NETWORK ON THE ADMIRALTY BUILDING, WHITEHALL, LONDON.

The Electrician for July 10th contained some particulars relating to an installation of wireless telegraph apparatus at the new Admiralty, Whitehall, and we are now able to supply an excellent photo of the network, which, it is stated, enables the Naval Authorities to keep in constant communication with the Home Fleet. Great developments of this installation are promised in the near future, and it is believed that the authorities will be able greatly to extend the range of the apparatus without materially increasing the network. The photograph was taken from the top of an adjacent building.

ACYCLIC DYNAMOS.

BY PROF. C. FELDMANN.

Summary. In this article the author deals with acyclic dynamos from a practical point of view, describing the main features in the design of actual machines manufactured by the General Electric Co.

Somewhat over three years ago, at a meeting of the American Institute of Electrical Engineers, J. E. Noeggerath presented a Paper* dealing mainly with the general theoretical aspects of acyclic dynamos. In the present article it is intended to treat the subject from a practical point of view, giving the general aspects of the mechanical design, as far as they are specific to the type, with a few notes on operation, postponing further expositions of a theoretical nature to a future date.

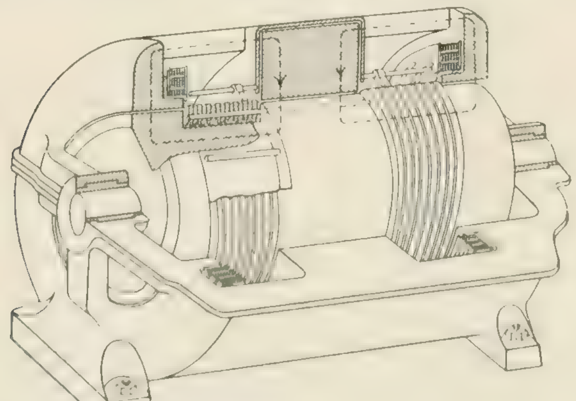

FIG. 1.—DIAGRAM SHOWING THE PRINCIPLE OF AN ACYCLIC DYNAMO.

The Paper, referred to above, was supported by the performance of a 300 k.w. experimental generator, whilst the features here discussed relate to machines, built by the General Electric Co., that have been in commercial operation for some considerable time, the shortest period being eight months.

* Abstracted in *The Electrician*, April 28, 1905, p. 59.

The principle underlying these dynamos may be supposed to be known from previous publications, and is shown in diagrammatic form in Fig. 1, herewith, whilst Fig. 2 illustrates a type of 500 kw. to 2,000 kw. acyclic turbo-generator for operating on electrolytic, power and lighting loads, this type being designed for supplying current at pressures ranging from 50 to 600 volts.

There has also been built one experimental acyclic compensator, capable of transforming continuous current at 125 volts into continuous current at 6·25 volts and multiples thereof, and vice versa. The latter dynamo is probably the first acyclic machine that ran as a motor and the first continuous current compensator.

The design is arranged for high peripherial speeds, and while this may appear on the first glance to be a great disadvantage, embodying such problems as the collection of current from surfaces moving at speeds up to 20,000 ft. per minute, and even above, high centrifugal stresses, &c., an attempt has been made to benefit rather than lose by these extreme conditions.

Noeggerath showed in his Paper how at high speeds the losses due to the collection of current do not increase at all, or only slowly, with increasing speeds, provided that the windage is kept within limits, while, on the other hand, the excellent ventilating facilities reduce the cooling surfaces required—that is to say, the weight of material employed. Further, the high speeds permit of very simple connections to the revolving conductors, where excellent contacts are guaranteed by the centrifugal strains, making it possible to do away entirely with soldered contacts on revolving parts.

Considering first the stationary parts, the frame consists of solid steel castings of a cylindrical shape, as shown in Fig. 3, having two rows of large openings and two rows of small openings; the large openings are used for the inspection of the collecting system and the small ones carry off the hot air which is thrown out between the collector rings. The air is guided from the collector rings to these small openings by means of air deflectors.

The size of the large openings is determined, on the one hand, by the current capacity of the unit, (that is, the size of the brushes), and, on the other hand, by the core losses. The stationary conductors (Fig. 1) are fastened on the outside of the frame, and the whole winding is so arranged that by changing these few frame conductors the rating of the generator as to voltage can be changed without affecting the kilowatt output. Of course, the generators can be operated at any current, from zero to full voltage, without change in connections, but the advantage of having the winding arranged in this flexible way lies in the fact that a generator of, say,

500 kw. and 600 volts, can be changed to a generator of 500 kw. and 300 or 150 volts, &c., by simply re-connecting the frame conductors.

The efficiency of the material of the field coils is high, because of the excellent ventilating facilities at hand. Fig. 5 shows how the copper of the main coils is cooled by receiving fresh air from the armature direct. The spools on the vertical machines are suspended from keys inserted in the frame. Another type of coil is used in the bearing. It serves the purpose of counteracting the stray fields which tend to convert the shaft into a small acyclic generator armature. The heavy currents produced therein are short-circuited in the bearings and have a tendency to destroy them. This action is effectively neutralised by auxiliary coils.

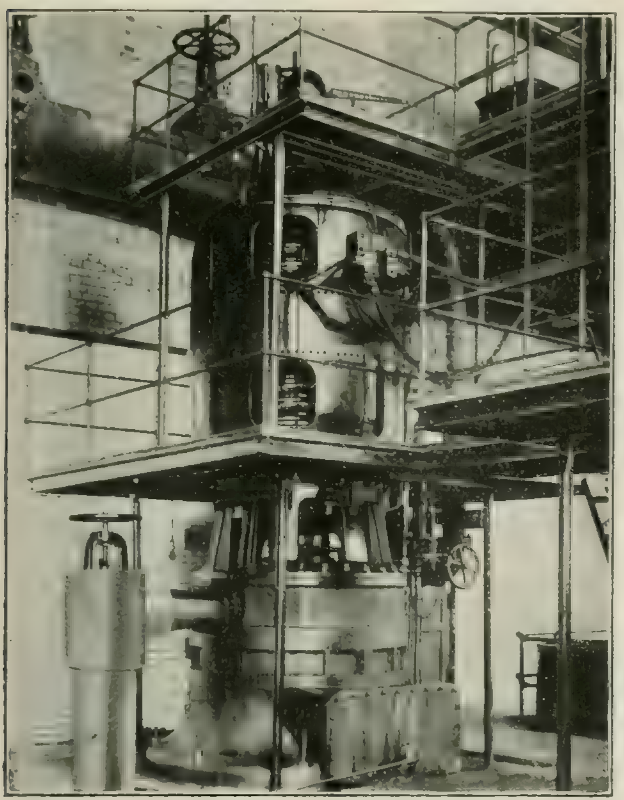

Fig. 2.—500 kw. Acyclic Turbo-Generator, for 300-600 Volts. Running at 2,000 Revs. per Min.

The main features of the armature spider are that all its material is flux-carrying. It is well ventilated, strong (being made of solid castings) and simple. It carries no binding wires or bands of any kind.

Fig. 3.—Frame of a 500 kw. Generator.

Fig. 6 shows the course of the air, for which the collector rings and slots in the armature furnish the propelling power. The air enters through openings at the ends (a) and is led into a cylindrical chamber (c) from which it emerges through slots (b) or openings. The cylindrical reservoir is formed by a division of the armature spider into two castings which are supported for a distance under the collector rings. Another form of armature is shown in Fig. 7.

On horizontal machines an adjustable ring (Fig. 7) is assembled on the outside of the armature spider, and arranged so that the gap between this ring and the stationary part can be adjusted, thereby obtaining a perfect balance of the magnetic side pull. Instead of this arrangement a stationary ring can be used.

From the point of view of an armature winding department, conductors do not exist. If the importance of electrical design with regard to core losses and armature reaction is properly taken into account, especially the distance between the conductors and the distance between the conductors and the air-gap, studs can be used as armature conductors insulated by a tube of suitable material. In some instances the armature conductors form part of the collector studs as in Fig. 8, whilst in others they are separate.

As mentioned above, centrifugal stresses allow of a very simple connection between the armature conductors. The studs extending from the end of one collector through the armature to the end of the other collector are very long, and the problem of different expansions due to heat is prominently present. In Fig. 8 will be noticed a movable contact of great simplicity. It may at a first glance appear hazardous to employ a loose connection in a generator, but the high centrifugal strains maintain a good contact. A year of operation has proved the reliability of this design. The collector rings consist usually of a continuous ring Two of the more important ways of supporting them are shown in Figs. 5 and 8.

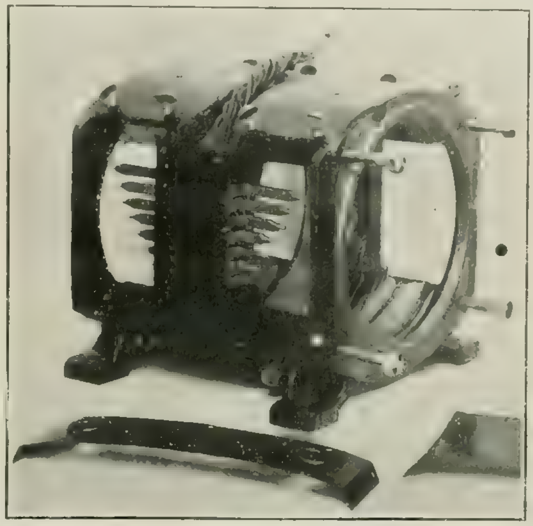

Fig. 4.—Magnet Frame and Stationary Conductors.

Fig. 8 also shows the use of spacing rings of a taper design between the collector rings. The end rings of the collectors are forced together under a pressure and a temperature higher than occurring under operating conditions, the taper forcing the collector rings outward into a concentric position. In larger machines where the axial expansion of the collector rings comes more prominently into action the design shown in Fig. 5 is used.

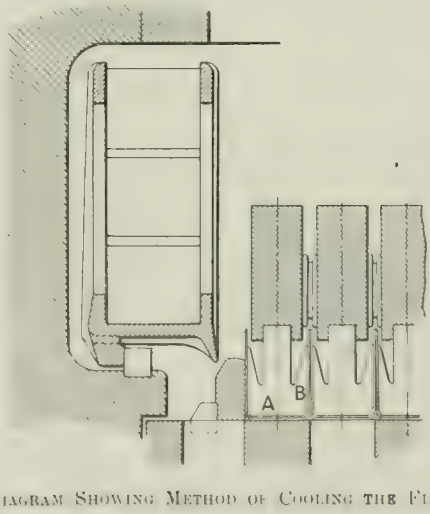

Fig. 5.—Diagram Showing Method of Cooling the Field Coils.

The supports A (Fig. 5) have flanges B which are elastic and of such proportions that they give rigid support to the weight of the collector rings, but at the same time are sufficiently flexible to allow of bending when put under the strain which occurs through the fact that, when operating, the axial expansion of the collector rings is

greater than that of the shell on which the collectors are mounted. The collector rings form one unit with the collector shell and the collector studs, which, as mentioned above, sometimes include the armature conductors.

Though these machines have no commutator they possess a rather complicated system of collector rings and brushes spaced suitably so as to compensate for armature reaction due to the currents in these collectors.

If a copper brush is employed for surface speeds of 25,000 ft. per minute, with a high current density and under the necessarily high temperatures prevailing, it will wear at the rate of from ½ in. to 3 in. in 24 hours. Leaving a complete discussion of this feature for a future article, I will say that the life of the brush has been increased to many times its former value, and it has been put on a commercial basis. This is due to the fact that the brushes consist of two different metals.

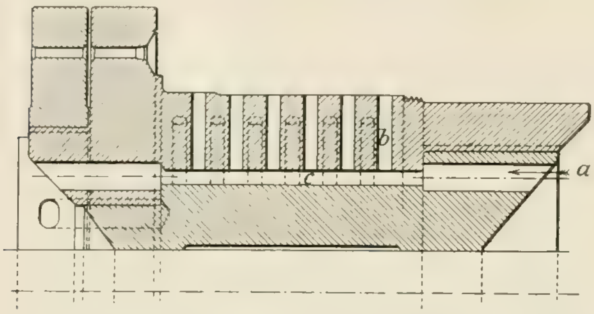

FIG. 6.—SECTION OF ARMATURE, SHOWING PATH OF AIR FOR COOLING.

A typical brush-holder design for small units is shown in Fig. 9, and it will be seen that the number of brushes is small. At the present time there is in operation a 2,000 kw. generator, at 300 volts and 6,670 amperes, which carries only 96 brushes.

As to operating features, the following facts have been established. Heavy short-circuits in the external load have in no case caused any damage to the generator. The danger limit under short-circuits and overloads consists in the heating alone, not in flash-over, distortion of the winding, &c., and the duration of a short-circuit is generally so short that no part of the generator becomes dangerously overheated For the same reason overloads of 200 per cent. and more were carried without affecting the working. This does not mean that the machines were under-rated, but that, when running at normal or even at high temperatures, the generators readily took sudden overloads.

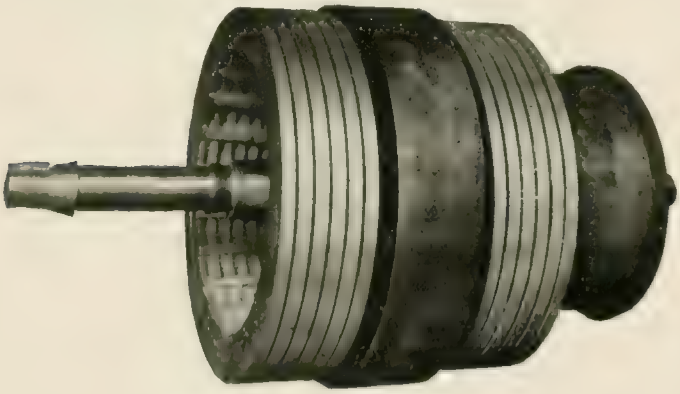

FIG. 7.—ARMATURE FOR ACYCLIC DYNAMO.

In one installation two 500 kw. acyclic generators are operating in parallel with each other and with other generators, and the load is divided equally. These machines are running as three-wire generators, with the neutral tapped off at the half-voltage point, and without any auxiliary apparatus on the generators. All machines that have been in commercial operation up to the present time are shunt wound, although a compound wound set is now being built. The voltage regulation of the shunt wound acyclic generator operating under power and lighting load compares very favourably with that of a compound wound generator of the usual type. The reason for this good performance lies in the fact that both the armature and frames are solid castings, and the variation of the magnetic field is sluggish, so that any change in voltage under sudden fluctuations of load is very little affected by the change in armature reaction. It is also interesting to note that one of these acyclic generators operated for an extended period at 200, 250 and 300 volts, which may be occasionally an advantage for electrolytic plants.

Finally it may be said that the field of application is in a general way governed more by the drive and the voltage than by the character of the service—*i.e.*, very small units can be built commercially only for low voltages, while, for large units, voltages higher than usual continuous current practice prescribes can readily be obtained.

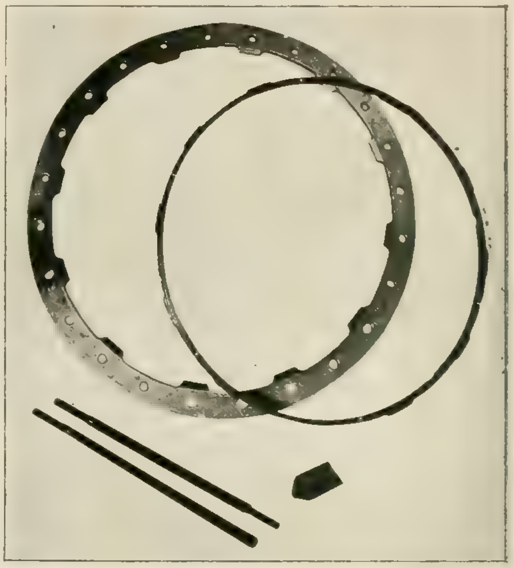

FIG. 8.—COLLECTOR RING, CLAMP RING, CONDUCTORS AND INSULATOR FOR 300-600 VOLT GENERATOR

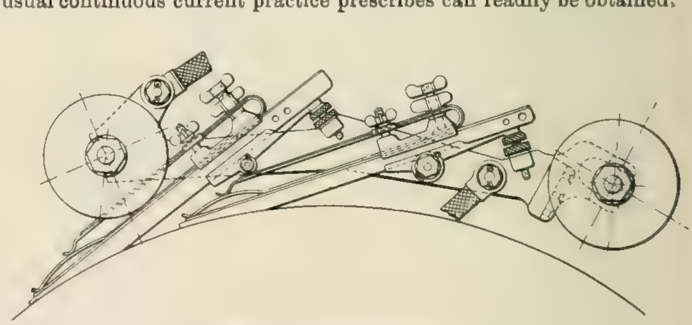

FIG. 9.—BRUSH-HOLDER.

There are, however, other conditions which may be favourable to the design, such as the necessity for a wide range in voltage, &c., or a high flywheel effect, &c. As to the prime mover, high speed is essential, be it steam turbine, water wheel, or motor.

THE VARIATION OF APPARENT CAPACITY OF A CONDENSER WITH THE TIME OF DISCHARGE AND THE VARIATION OF CAPACITY WITH FREQUENCY IN ALTERNATING CURRENT MEASUREMENTS.*

BY B. V. HILL.

Summary.—The author describes some tests, made on a number of condensers of various patterns, showing the amount by which their capacities fall when used with alternating current of high frequency. Details of the apparatus employed are given, and also particulars of tests showing how the apparent capacity of a condenser varies with the length of time it is allowed to discharge.

It has been known that the impedance offered by a condenser to the passage of an alternating current depends upon the frequency of the current. The capacity is larger for low frequencies than for high, but the amount of this variation was not so generally known. A writer in the *American Telephone Journal* for September 29, 1906, stated that the paper condensers ordinarily used in telephone circuits often fall 50 per cent. below their rated capacity, and that the capacity varies greatly with the frequency of the current applied. The manufacturing companies only guarantee an accuracy of 10 per cent. for apparatus of this kind, so a slight change of

* From the *Physical Review*, slightly abbreviated.

electrical constants with frequency is not a very serious matter—a dirty plug or a bent spring might make more difference in speech transmission than a small change in inductance or capacity in the circuit. Several months ago Mr. A. Zeleny showed that the apparent capacity of a condenser, determined by the ballistic method, depended upon the period of the galvanometer—that is, upon the time during which the discharge of the condenser affects the needle or coil of the instrument. I decided to study the behaviour of several condensers both with reference to their straight discharge and their capacity when a part of an alternating current.

For this purpose there were at hand six condensers of different kinds. They were as follows:—(1) A Leeds and Northrup standard mica condenser of 1 mfd. capacity; (2) a Queen & Company's paper condenser of 1 mfd. capacity; (3) and (4) telephone condensers of one firm rated at 2 mfd. capacity; (5) a telephone condenser of another firm rated at 2 mfd. capacity, and a sixth made by the same firm as (3) and (4) but of so low insulation resistance that no results could be obtained with it.

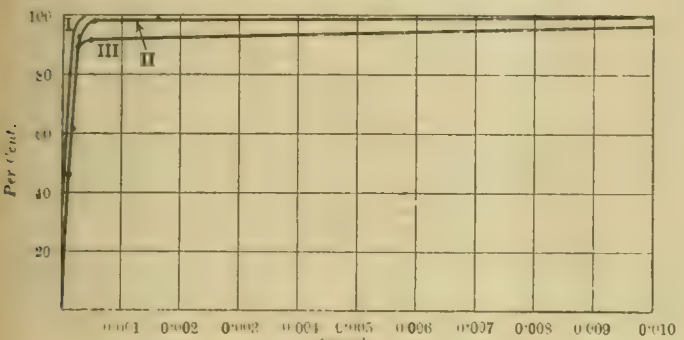

Fig. 1.

The straight discharge was first studied, the method being to charge the condenser for 20 seconds, and then, after a period of insulation of about 0·07 second to connect to the ballistic galvanometer for times varying from 0·0001 second to 11 seconds, the quarter period of the galvanometer. To measure the times of connection with the galvanometer, two pairs of keys, a make and a break-circuit key in each pair, were made and mounted on heavy maple blocks faced with ebonite. These keys were very similar to those ordinarily used in such experiments and need not be described in detail here. Instead of the heavy pendulum ordinarily employed to release the keys, I mounted a $\frac{7}{8}$ in. cold drawn steel rod in a vertical position near a strip, also vertical, upon which the keys were mounted. A weight sliding upon this rod struck the triggers and released the keys. The positions of the triggers were determined by means of a fine cathetometer. The friction of the weight upon

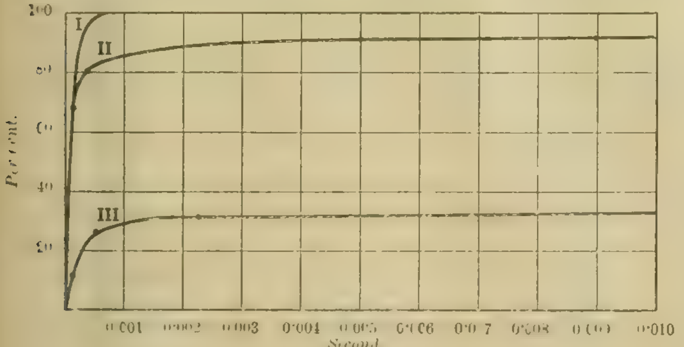

Fig. 2.

the rod was first carefully determined and taken into account in computing the time between the setting off of the two triggers. The break-circuit key on each block was provided with a screw by which it could be moved with reference to the make-circuit key by very small amounts. The zero setting was approximated by finding a place where there was no throw of the galvanometer when the weight was released, but, if the breaking key was moved downward by the smallest possible amount, a throw was observed. Settings agreeing to 1/6,000 of a second could thus be made. This does not represent the accuracy of the apparatus but the smallest distance through which the fingers could turn the screw. A series of readings was now taken. The condenser was first allowed to charge for 20 seconds. The weight was then released, and in its fall, broke the charging circuit, and, after 0·067 second struck the triggers, first connecting and then disconnecting the condenser and the galvanometer. The times of connection were plotted as abscissæ and the corresponding throws of the galvanometer as ordinates. The curve thus obtained was produced back across the axis of time and the point where it cut this line was taken as the true zero point. The galvanometer was a Leeds and Northrup, type P, d'Arsonval. It had a resistance of 127 ohms and an inductance of 0·0014 henry. The coil was loaded with two small bullets, so that its period was 43·08 seconds.

The behaviour of the four condensers which were tested is here shown for times up to 0·01 second. Curve I. in Fig. 1 is the theoretical discharge curve for the capacity of 1 mfd., and the corresponding curve in Fig. 2 is the theoretical curve for the capacity of 2 mfd. Curves II. and III., Fig. I, refer to the Leeds and Northrup mica condenser and the Queen paper condenser respectively. With the former the effect of absorption is over in a very short time but, even here, the galvanometer must have a period of at least 5 seconds if the complete charge is to be liberated. Using a Kemp's key with the ballastic galvanometer, the calculated capacity of this condenser was 1·0328 mfd. With the paper condenser the throw, after 8 seconds connection, is still 2 per cent. below that obtained with the Kemp's key, and the capacity calculated from this full throw was 1·0519. These values may seem absurdly high, especially for so fine a piece of apparatus as the mica condenser; but these same condensers have been used repeatedly for the determination of the earth's horizontal component, H, and the value of this constant was uniformly lower than that obtained by Gauss' method, by an amount corresponding to the excess of capacity just shown in the condensers. From the results obtained in the alternating current measurements the mica condenser appears to be very accurate, and the fault is with the ballistic method of measuring the capacity.

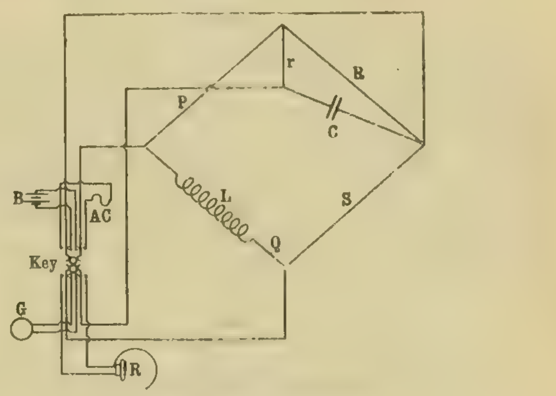

Fig. 3.

Curves II. and III. of Fig. 2 refer to condensers (3) and (4) both being 2 mfd. paper telephone condensers. The capacity of a given condenser of this type increases, of course, with the amount of pressure applied in the making, while the insulation resistance decreases. That designated as (3) is of high resistance, and is what they rate as a "hard" condenser; (4) is a medium, while the sixth one referred to in the beginning of this Paper as giving no proper result at all is called "soft." No. 3 appears to be a very good condenser of its class, but (4) has parted with only about half of its charge at the end of 0·01 second and is found to continue discharging for two minutes or more.

For determining the capacity of the condensers by means of alternating currents, it seemed best to use some method of comparing their impedance with that caused by self-induction; for, even if there should be a small error in the value assumed for the latter, the data sought—namely, the variation of capacity with frequency—will be as valuable as ever. The coil used as a standard of inductance was of No. 23 copper wire, insulated with silk and wound upon a marble cylinder. Its inductance was 0·011316 henry. For such a coil the effect of frequency upon resistance and inductance, for frequencies up to 3,000, is too small to be taken into account here. After trying several of the standard arrangements for comparing a capacity to an inductance a modification of Anderson's method was used. This involved the fewest assumptions and will allow a large number of measurements to be made in rapid succession. The arrangement shown in Fig 3 is the common one, except that, by means of a double key, each half having six points, a battery and a galvanometer, or a source of alternating current and a receiver, may be connected to the points of the bridge by merely throwing over the lever. Leaving the key in the normal position, as shown in the figure, one may adjust the arms of the bridge for a direct current balance, and then, throwing the key into the other position, adjust the resistance r till the sound in the receiver is a minimum. The capacity is now given by the equation

$$C = \frac{L}{r(Q+S)+PS}.$$

To secure alternating current of varying frequencies up to 3,000, which was sufficiently high to represent ordinary voice currents, a

small inductor-alternator was constructed. It consisted of an ebonite disc having about its circumference 60 soft iron, cylindrical inductors, 0·25 in. in diameter, rotating between the poles of the field magnet. The armature coils were wound upon these poles. As the whole effect found was small, no account was taken of wave form. For the very low frequencies (16 and 66) the currents from a pole-changer were used.

The results thus obtained are shown in the following table :—

Condenser.	Capacity(Ball).	Frequency.	Capacity.	Per cent. loss.
1	1·0328	66	0·9961	
		125	0·9970	
		1,450	0·9951	
		2,945	0·9931	0·4
2	1·0519	16	0·9985	
		125	1·0005	
		1,360	0·9965	
		3,020	0·9901	0·8
3	2·170	16	2·0328	
		125	2·0367	
		990	2·0245	
		3,040	2·0064	1·49
4	2·170	16	1·8519	
		125	1·8519	
		1,350	1·8379	
		3,050	1·8046	2·55
5	...	16	2·3448	
		125	2·3420	
		1,350	2·3231	
		3,000	2·3066	1·10

It will be seen by comparing the discharge curves of the several condensers with their alternating current capacities as given in the table, that the latter cannot be inferred from the former. Taking condenser No. 4, as an example, it will be seen that, up to 0·01 second, the capacity is only about 37 per cent. of that obtained when the condenser was allowed to discharge for the whole quarter period of the galvanometer. With an alternating current, however, in which the period of charge—that is, the quarter-period of the complete oscillation—was only 0·00008 second, the capacity was still 80 per cent. of that obtained by the ballistic method and the complete quarter period of the galvano meter.

MODERN DEVELOPMENT IN SINGLE-PHASE GENERATORS.*

BY W. L. WATERS.

Single-phase alternators have been used in the past almost exclusively for lighting work, and in units of comparatively small output and low speed. Recently, on account of the adoption of single-phase current for traction work, an important demand has arisen for large, high speed, low-frequency, single-phase generators. It is in the design and manufacture of such units that the engineer has had to overcome new difficulties. In large, high-speed, single-phase generators for 15 and 25 cycles the difficulties met with are due almost entirely to the large pole-pitch and high armature reaction which it is necessary to adopt. A 500 kw., 60 cycle, 72 pole, single-phase generator would have a pole-pitch of about 7 in., while a 6,000 kw. 15 cycle 2 pole machine would have one of about 120 in. It is easily seen that the design of these will be radically different.

These difficulties in single-phase generators of large pole-pitch are the result of (1) pulsation of the armature reaction ; (2) mechanical stresses on the end connections of the armature coils. The former causes hysteresis and eddy-current losses throughout the machine, often resulting in dangerous heating and low efficiency, whilst the latter results in vibration and distortion of the windings, and often in damage to the insulation or complete destruction of the coils, these stresses being particularly serious in single-phase railway generators, on account of the sudden variations in load and numerous short-circuits to which these machines are subjected. As the above effects practically increase proportionally to the square of the pole-pitch in generators of standard design, it is easily seen why these effects which were negligible in the old single-phase alternators of small pole-pitch have become quite serious in the modern turbine-driven generator. The seriousness of these difficulties when they were first met with was so great that even within the last two years responsible engineers have stated it was impossible to build satisfactory low-frequency high-speed single-phase generators of large capacity, and it is only by careful study and experimenting that the modern machine of this type has been developed.

Losses Due to Pulsation of Armature Reaction. In a polyphase generator the armature current produces a magnetic flux which rotates synchronously with the field magnet. This magnetic flux being of practically constant magnitude. causes very little loss in the iron of the magnetic circuit. On the other hand, the armature current in a single-phase generator produces a pulsating magnetic flux which is stationary in space, causing hysteresis and eddy-current losses throughout the whole magnetic circuit. The exact effect depends, of course, on the power factor of the load on the generator. When the power factor is unity, and the armature current is in phase with the E.M.F., the armature reaction flux is a cross magnetisation; when the power factor is zero, and the armature current is 90 deg. out of phase with the E.M.F., the armature reaction flux is a demagnetisation. In the special case in which the rotating field magnet is cylindrical, without projecting poles, the effect of the armature reaction flux on the magnets is more nearly independent of the power factor of the armature current. But in any case this flux is a pulsating one, and there are important losses in the field magnets, due to their rotation through this pulsating cross flux or demagnetisation flux.

An estimate of the combined losses in the armature and field magnets due to the pulsating armature reaction can be obtained in a number of ways. We can measure the increase of the power required to rotate the field magnets due to normal root mean-square current in the armature coils, with : (1) direct current in the armature ; (2) alternating current of synchronous frequency in the armature; (3) armature short-circuited and field excited. Or with the magnets stationary we can : (4) send normal frequency alternating current through the armature and measure the losses by a wattmeter. The only exact methods of measuring the losses are : (1) as unknown losses in a motor-generator-method efficiency test; or (2) from a comparison of the temperature rise obtained on full load with that obtained with known losses. Both of these tests are difficult to make accurately, especially on a large machine, and probably in practice they do not give results which are any more accurate than the other methods.

Pole-face Dampers. Losses caused by a pulsating flux in the magnetic circuits are due to hysteresis and eddy currents, and the relative magnitudes of the two depend on the amount of solid metal in the path of the flux. If the whole magnetic circuit is laminated, then the losses are practically all due to hysteresis. On the other hand, if we have solid cast-steel poles there will be eddy currents in these poles which will partly choke back the pulsation of the flux and the hysteresis loss will be reduced, but there will be also eddy-current losses. If now we place a heavy copper damper in the path of the pulsating flux, this will provide a low-resistance path for the eddy currents, and the pulsating flux, and consequent hysteresis loss, will be reduced practically to zero, while on account of the low resistance of the damper circuit the eddy loss will not be appreciable. It is usually found that the losses are greatest with heavy laminations or solid poles; that they are less for thin laminations, and practically zero when heavy low-resistance dampers are used either with solid or laminated poles. Tests on a 500 kw., single-phase, 20-pole generator, as determined by means of search-coils wound on the pole-faces, with (1) laminated poles (No. 29 gauge), (2) solid poles, and (3) the same solid pole faces covered with a ⅜-in. copper plate, showed the magnitude of the armature reaction flux pulsations in the three cases to be about in the ratio of 30 to 15 to 1. In practice, a copper damper usually takes a form similar to the squirrel-cage secondary of an induction motor. Heavy copper bars are dovetailed into the pole faces and short-circuited at the ends by copper rings or discs.

To show how serious this matter of losses becomes in two-pole, single-phase machines without dampers, the following table is given, showing the losses and full load temperature rises on three turbo-generators, both with and without dampers. Tests on larger generators up to 6,000 kw. capacity show that the improvement due to heavy copper dampers is even more striking in large machines than it is in small. So far as experience goes at the present time, it may be said that the use of such dampers is the complete solution of the difficulties due to pulsating armature reaction met with in large, low-frequency, two-pole, single-phase generators.

Mechanical Stresses on Armature Coils. That it was necessary mechnically to brace the end connections of the armature coils on a direct current machine subjected to sudden loads and short-

Two-pole, [illegible]-cycle Generators. Same Current per Armature Conductor, One and Three Phase, under all Conditions, and all Losses in per cent. of Single-phase Rating.

Size.	Type field.	Three phase. Without dampers.		Single phase. Without dampers.		Single phase. With dampers.	
		Loss.	Temp. rise.	Loss.	Temp. rise.	Loss.	Temp. rise.
750 kw...	Solid	0·[illegible]	27 C.	3·75	95 C.	0·8	34 C.
1,000 kw...	Solid	0·3	31 C.	[illegible]	[illegible]	[illegible]	[illegible]
1,000 kw...	Laminated	0·2	19 C.	[illegible]	[illegible]	0·3	18 C.

* Abstract of a Paper read at the recent Convention of the American Institute of Electrical Engineers.

circuits has been known for many years. But until quite recently additional supports for alternator armature coils were seldom provided, as the continuous short-circuit current of an alternator being only about two or three times normal, it was not considered that the mechanical stresses on the ends of the small pole-pitch coils generally in use were sufficiently great to cause any trouble. Only during the last few years has it been demonstrated by experience that coil supports on large pole-pitch alternators are not only advisable, but necessary, and that on account of the numerous short circuits, they are particularly necessary on single-phase machines operating on traction circuits, since the stresses on the end connections on sudden short circuits are found to be 2 to 10 tons. It is evident that the coil supports must be of metal of heavy cross-section. The objections to metal are, of course, those of insulation, but though coil supports of wood, porcelain, and similar insulating materials have been tried, it is easily understood that they have proved unsatisfactory on machines of large pole-pitch. The author finally describes a form of coil support which has been developed and proved satisfactory. It is of bronze, of heavy girder section, and insulated for the full generator voltage; it can be placed in position after the machine is wound and is removable in a few minutes at any time.

In conclusion, the use of heavy copper dampers on the pole faces, and heavy bronze coil supports applied to the ends of the armature coils in such a way as to take directly the mechanical stresses which develop on short circuits have now made large, low-frequency high-speed, single-phase generators, a practical success.

ON THE HYSTERESIS LOSS AND OTHER PROPERTIES OF IRON ALLOYS UNDER VERY SMALL MAGNETIC FORCES.*

BY PROF. E. WILSON, V. H. WINSON, AND G. F. O'DELL.

The materials chosen for these experiments, carried out at King's College, are the invention of Mr. R. A. Hadfield, and were supplied by Messrs. Sankey & Sons. They are an alloy of iron called "Stalloy,"† and a sample of transformer iron called "Lobys." The specimens for the magnetic tests are in the form of rings composed of stampings wound with a primary and secondary coil, the secondary next to the core. The Stalloy stampings are separated

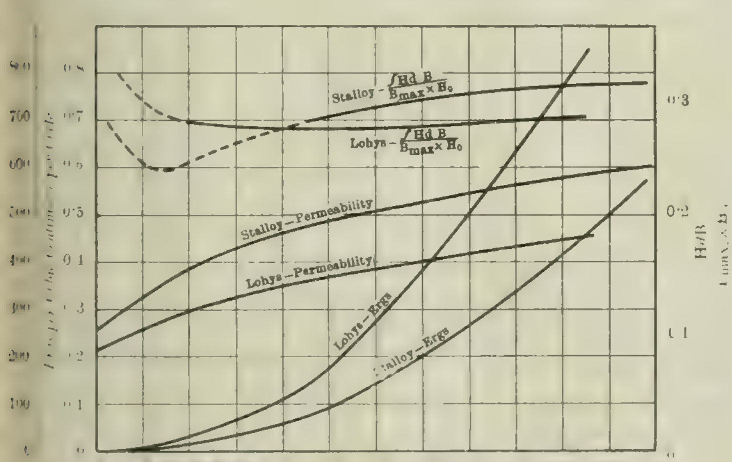

FIG. 1.

by a thin coating of "insuline," and the Lobys stampings have paper insulation between every 10 stampings. The magnetic properties have been found by the ballistic galvanometer method, and a table of results is given in the Paper. Figs. 1 and 2 show the various quantities plotted in terms of the maximum value of the magnetic induction B. Curves of permeability are also given in Fig. 2, for a very pure iron specimen and a piece of transformer plate rolled from Swedish iron. They show that the permeability of Stalloy is high for comparatively small values of the magnetic induction B, but rapidly diminishes as B is increased. The hysteresis loss for each of these specimens lies about midway between those for Stalloy and Lobys. It is interesting to note that the curves of permeability for values of the magnetic induction B varying from 15,000 to 22,000* continue the curves of permeability given in Fig. 2, the change of the slope of the curve between the two being, however, somewhat abrupt in each case.

The Stalloy material requires careful attention in order that a

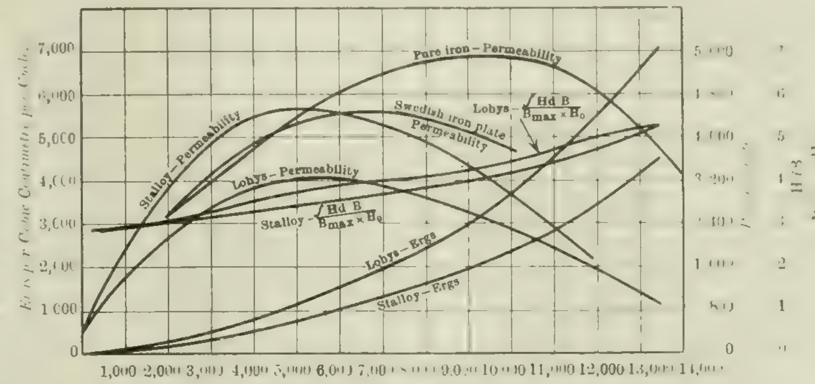

FIG. 2.

truly symmetrical hysteresis loop may be obtained, more especially when the maximum induction B varies from about 200 to 8,000. For instance, in an extreme case, after reducing the force H from about 63 to 0·712 without subjecting the specimen to a series of reversals of the magnetic force as it was reduced, a complete hysteresis loop was obtained. This loop is unsymmetrical, in the sense that if the axis of H be so placed that the coercive forces are equal, the positive and negative values of the maximum induction B are not equal, but the positive and negative values of the residual magnetism B_0 are equal. The value of the permeability, defined as the ratio of half the total change of magnetic induction to the maximum value of H, was less than was obtained when the loop was truly symmetrical. This effect persisted in spite of some hundreds of reversals of the magnetising force, and was only removed by re-applying the larger force and subjecting the specimen to magnetic reversals during the reduction of the magnetic force to the required value.

A matter which has received further attention is the value of $\int H dB / H_0 B_{max.}$, where H_0 is the coercive force corresponding to the particular maximum value of the magnetic induction B. Dr. Sumpner † has pointed out that this quantity is accurately represented by a linear function of the maximum induction B over a large range. It will be seen from Figs. 1 and 2 that this law ceases to hold for very small values of B.

The Steinmetz coefficients have been found between the values of the induction B shown in the table herewith, the law being ergs per cubic centimetre per cycle $= \alpha B^{\beta}$. It will be seen that β varies between wide limits in the case of each of the materials.

Stalloy.

Range of B.	β.	α.
0·937 — 8·25	2·69	0·0000133
8·25 — 94·1	2·[illegible]5	0·0000505
94·1 — 629·0	1·92	0·0000938
629·0 — 6,050·0	1·71	0·000363
6,050·0 — 11,500·0	1·72	0·000321
11,500·0 — 13,480·0	2·37	0·0000000752

Lobys.

Range of B.	β.	α.
4·25 — 37·4	2·45	0·0000207
37·4 — 568·0	1·97	0·000122
568·0 — 3,780·0	1·64	0·000960
3,780·0 — 7,970·0	1·59	0·00148
7,970·0 — 13,440·0	2·08	0·0000179

A table in the Paper gives the results of tests on the specific resistance and temperature coefficients, the mean specific resistance at 15°C. for Stalloy being $49{\cdot}63 \times 10^{-6}$, and for Lobys $14{\cdot}25 \times 10^{-6}$; whilst the mean temperature coefficients between 0°C. and 50°C. were 0·000975 and 0·00424, and between 0°C. and 100°C., 0·00103 and 0·00446 respectively.

It is interesting to note that the eddy current loss calculated by aid of the ordinary formula, when added to the hysteresis loss, gives a curve of total energy loss in close agreement with that published by the manufacturers. As would naturally be expected, the high specific resistance of Stalloy results in a very low eddy current loss.

* Abstract of a Paper read before the Royal Society.

† Mr. Hadfield states that the distinguishing feature of this alloy is that it contains about 3 per cent. of silicon.

* *The Electrician*, October 18, 1907.

† Inst. Elec. Eng. *Journ.*, Vol. XXXVI., p. 465.

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"THE ELECTRICIAN" INDUSTRIAL SUPPLEMENT.

With "THE ELECTRICIAN" for Sept. 14, 1906, was issued the first of a series of "Industrial Supplements," to be published from time to time with "THE ELECTRICIAN." The twenty-sixth issue of the Supplement is issued (Gratis) with the current number of "THE ELECTRICIAN."

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THE UNAUTHORISED SUPPLIER.

It is a curious fact that, although the Board of Trade can authorise the giving of a supply, it cannot protect the authorised supplier from competition on the part of electricity suppliers without Parliamentary powers. This point does not seem to have received much attention hitherto, presumably on the assumption that the unauthorised supplier is not worth consideration; and, as far as electric lighting is concerned, it may indeed be said that there is not much inducement for a company to give supply without statutory authority. The practicability of such a supply depends entirely upon wayleaves, and the obtaining of such wayleaves is always a troublesome matter. For example, the National Telephone Co. has found this to be one of its greatest difficulties in the way of development. There would be similar trouble if an attempt were made to give an unauthorised supply for electric lighting. Consequently, although there have been a few instances, notably those of Hampstead, Finchley, Brighton, Leamington, Carlow and Inverness, a supply of this kind has never assumed serious proportions in industrial areas, and in most cases it has been bought out by the authorised supplier in the district. There are, however, some instances of non-statutory undertakings in small towns in remote provincial districts, and in Ireland and Scotland. In these cases it was considered that, as the probable demand for electrical energy would not be great, it was not worth while incurring the expense of obtaining a provisional order, and so supply came to be established in an unauthorised manner.

The case of power supply, however, is somewhat different. Wayleaves are not so numerous as those necessary for electric lighting, and the revenue obtainable from a single wayleave would generally be very much greater. Moreover, in such a case, wayleaves would probably be

more easily obtained. The district would be a manufacturing one rather than residential, and an arrangement migh very possibly be effected with, say, a railway without much difficulty, and a number of valuable wayleaves would be obtained as the result of a single successful negotiation. A syndicate in the Clyde Valley has recently been working on these lines, and it is said that negotiations for wayleaves have been carried on with a railway, the basis of the arrangement being that a certain sum was to be paid by way of rental and a further sum dependent upon the amount of energy transmitted over the railway company's property. Since large factories usually have sidings, and are largely dependent on railway facilities, such a scheme has the great advantage that the business of electric power supply would run somewhat on co-operative lines. Canals would also afford suitable routes for such wayleaves.

It will be admitted that competition, generally, is an undoubted advantage, and we can quite imagine that a sound business might be started by a few adjacent factories co-operating in a combined electricity supply, this being subsequently extended to give an unauthorised supply to other factories. Generally speaking, however, such an unauthorised supply would not be calculated to inspire confidence among manufacturers, and would not induce them to take a supply in preference to taking one from an authorised supplier unless the advantages were very obvious. Probably, the most serious objection to unauthorised supply of this kind, on the part of those whose duty it is to give a statutory supply in the same district, is that the unauthorised supplier has the great advantage of being able to pick and choose consumers instead of being bound to supply all who may require electrical energy. The authorised supplier is, therefore, submitted to competition of the most unfair kind. Valuable consumers may be lost to the authorised supplier, whereas its competitor is free from any kind of restriction. At the best of times the authorised supplier labours under many disadvantages, especially in the early years of an undertaking, and as cheap power can only be expected from large undertakings, we think there is no question that what may be termed illegitimate competition of this kind should be stopped, and that the assistance of Parliament should be invoked for this purpose if necessary.

REVIEWS.

(Copies of the undermentioned works can be had from *The Electrician* Office, post free on receipt of published price, adding 3d. for books published under 2/. Add 10 per cent. for abroad or for foreign books.)

Thermo-Chemistry. By Julius Thomsen. Translated from the Danish by Katharine A. Burke. (London: Longmans, Green & Co.) Pp. xv.+474. 9s.

It would appear that Sir William Ramsay intends to make the series of text-books on physical chemistry a complete library, which will shortly become a classic, and which no one who wishes to be up-to-date in this branch of the subject will be able to afford to neglect. The latest book, on Thermo-Chemistry, by Julius Thomsen, will be of very great use to metallurgical and electro chemists.

Of course we need scarcely say that anyone who studies chemistry purely from the scientific point will also find it of great value. We would, however, here look at it more from the point of view which may be of interest and of value to those engaged in technical subjects. To begin with, a very thorough description is given of calorimetric methods as employed by Thomsen that is to say the apparatus which is used, and the methods of using it. Then there are extremely useful tables which give the heats of combination of the elements with each other, the heats of solution of their compounds, and it is shown how, having got one series of data, it is possible by calculation to find out other thermochemical quantities. The electro-chemist knows that, given the heat of formation of a substance, he can calculate the heat of decomposition; and given the heat of decomposition, he is able to calculate the electrical voltage necessary to decompose that substance. He wishes, for example, to electrolyse zinc chloride, and to obtain, upon the one hand, metallic zinc, and on the other hand chloride. If he knows the heat of formation of zinc chloride, he has no difficulty in finding out the theoretical amount of energy required to decompose a given quantity of the substance. Of course, this is not all, because we know perfectly well that, in practice, theoretical considerations generally appear to be only approximately correct. Of course, this does not mean that our theory is wrong, but that in practice there are so many details to be taken into consideration which it is almost impossible to take into account from a theoretical point of view, even if we knew exactly what caused them all. The metallurgist also requires, or should require, to know the heat of decomposition of metallic oxides, or other compounds, which he desires to reduce by furnace or other methods. Otherwise, he is hardly in a position to design plant successfully, and make sure that he can, at any rate, give an approximate estimate of what the cost of a process will be.

This book is not altogether what one may call readable. The subject hardly admits of this. One has to read a little way and then examine the tables of data, which are profusely given, in order to understand the book thoroughly. This, of course, requires careful study, and unless readers are particularly interested in this branch of chemistry, probably they will not find it of very great interest. It is, however, a magnificent reference book, and all laboratories, also all technical libraries, should have a copy of it. It gives us great pleasure to recommend heartily this latest addition to the extremely useful series which is being edited by Sir William Ramsay.

Etat Actuel de la Science Electrique: Phénomènes, Applications, Théorie. By Devaux-Charbonnel, Professor at the Ecole Professionnelle Supérieure des Postes et Télégraphes. With a Preface by H. Poincaré, Membre de l'Institut. (Paris: Dunod and Pinat, 49, Quai des Grands-Augustins.) 1908. Pp. x.+(5). Fr. 20.

Here we have an exceptionally good combination of practical and theoretical instruction, written primarily from the point of view, and to meet the necessities of, the telegraph engineer. The plan of the book is distinctly original. In the first part, which comprises 248 pages, the chief phenomena of magnetism and electricity are admirably and lucidly summarised, beginning, as is now usual, with the magnetic field, and proceeding through thermal, chemical, and induction phenomena to electrostatics. The second part deals with "applications." Without saying much about dynamos or motors, the author plunges into the theory and construction of telegraph lines, bringing his list of apparatus down to the Pollak-Virag system of transmission. Under "Alternating Currents" he chiefly deals with telephones and the singing arc. Wireless telegraphy and telephony are dealt with in separate chapters, and the part winds up with a discussion of high-frequency currents and their medical applications. In Part III. we find the fullest exposition of the electron theory that has yet appeared in French, and even here the treatment is eminently practical. New facts, which were left unexplained by the older theories, are introduced one by one, and their interpretation is then given in terms of the modern atomistic conception of electricity. Thus we have cathode, Röntgen, and Becquerel rays, and the various forms of ionisation, condensation, and gaseous conductivity. The ionic theory of the arc, of the Zeeman effect, and of the laws of Ohm and Joule is given in some detail, but the ideas adopted differ somewhat from the prevalent ones in assuming the existence of positive as well as negative electrons. This assumption, which is not

without its own difficulties, appears to have received some experimental basis through the recent researches of the younger Becquerel. The theory of magnetism adopted is that of the author's colleague, Langevin, and a very interesting and fruitful one it is. The book is an almost ideal text-book for the young telegraph engineer. The only criticism we can make would deal with the illustrations, which are occasionally somewhat rough and ready. E. E. F.

Mesures Electriques. By Eric Gerard. 3rd edition. (Paris: Gauthier Villars.) Pp. ix 686. Fr. 12.

This book has now reached its third edition, and has been largely re-written and brought up to date. The author is to be congratulated upon the thoroughness with which his task has been performed and the unbiassed manner in which he has described the many different forms of instruments. As it stands, the volume probably contains the most complete account of electrical instruments yet published, and theory and description are well blended together, which is unfortunately rarely the case in books of this class.

A valuable portion of the book is the introductory chapter, which is devoted to a general consideration of the methods of making and recording observations, and the estimation of their probable accuracy. Few things are more useful in an experimentalist than the ability to rapidly estimate the order of accuracy of a test, or to appreciate the conditions necessary to secure a given degree of accuracy. Nothing is more common or irritating than to find a test spoilt owing to one of the devices being of insufficient sensitiveness or having some constant error, and such information as is given in Prof. Gerard's book should prove the greatest safeguard against such mistakes.

The succeeding chapters deal with length and angular measurements, speed and torque, and photometry. Transmission dynamometers, as is usual on the Continent, receive considerable attention. A somewhat notable omission is that cf the vibrating reed type of speed indicator which has been so much in evidence of late. Photometry, though necessarily kept within limits, receives sound treatment, and the various forms of standard electrical instruments are well explained, with the necessary relations between the various national values. Galvanometers and electro-dynamometers are extremely well treated, but one could have wished to see more space devoted to the potentiometer, in view of its ever-increasing importance and many modifications. Resistance, capacity and inductance measurements are very fully gone into, as well as those concerning iron. The work terminates with some instruction in technical measurements on electrical machinery, which, though compressed, are of considerable value, and with some interesting and original tables and forms, containing useful information.

The author has certainly carried out his purpose in a very thorough manner, and the size and get-up of the work is remarkable, considering its low price. A special feature of the book is its international character, the best devices of various countries being brought together with the most complete impartiality. We can thoroughly recommend the work, and should be glad to see an English version of it. C. V. D.

ON THE ELECTROLYSIS OF SOLUTIONS OF PURE HYDROCHLORIC ACID.*

BY E. DOUMER.

At first sight it would appear that the electrolysis of a solution of pure hydrochloric acid should be a very simple phenomenon, consisting simply in the separation of H and Cl ions, which polymerise respectively at the cathode and the anode, and giving off, with current capable of electrolysing an equivalent of HCl, an equivalent of hydrogen at the negative pole, and an equivalent of chlorine at the positive pole. The phenomenon, however, is rather more complex, for if the theoretical weight of pure hydrogen is collected from the negative pole the gas which is given off at the positive pole is never pure chlorine, but is always mixed with oxygen when inert electrodes are used. The volume of oxygen collected varies with the normality of the solution. It increases as the normality decreases, and may become quite a large fraction of the theoretical value of chlorine which should be obtained. The results of a series of experiments made with solutions of different strengths but practically the same scurrent are given in the Paper and show this fact quite well. The electrodes used were platinum wires 0·5 mm. in diameter and 6 cm. long. Before reading the volume of oxygen given off, this gas was carefully washed several times with distilled water.

It was important to discover whether this generation of oxygen was due to a secondary action of the nascent chlorine on the water or whether it could be attributed to direct electrolysis of the aqueous solution. In the first case, if the experimental conditions are so modified that the chlorine liberated is fixed directly it is given off, the generation of the oxygen will be stopped, or at least, considerably diminished. To fix the chlorine anodes of silver or mercury were used. These have the advantage of possessing a great affinity for chlorine, and the result is compounds which are very slightly soluble. Under these conditions, even with quite small currents, it seemed as if all the chlorine was fixed, for the gas and liquid surrounding the anode gave off no odour of this gas, and a volume of oxygen considerably greater than with platinum electrodes was collected. For instance, with a silver anode a 0·072 per cent. solution through which a current of 0·122 amp. flowed for an hour gave 13·36 cc. of oxygen, and 52·4 cc. of hydrogen. Under the same conditions, but with platinum anodes, only 11·2 cc. of oxygen were given off.

The generation of the oxygen observed should not be attributed to the action of chlorine on the water. It is, on the contrary, quite possible that the chlorine fixes a certain quantity of oxygen giving rise to oxychlorides, for these are constantly noted in the neighbourhood of the anode. This ought to explain why a greater volume of oxygen is obtained when mercury or silver anodes are used. It would appear, therefore, that in the electrolysis of pure solutions of hydrochloric acid electrolytic decomposition of both the acid and the water takes place. If all the oxygen electrolysed could be collected it would be easy to find out the ratio of the number of ions proceeding from the water to the total number in solution. If v represents the volume of the oxygen and V the volume of the hydrogen $2v/V$ will be equal to this ratio, while $(V - 2v)/V$ would be the ratio of the number of ions proceeding from the hydrochloric acid to the total number in solution. These ratios may be called ionisation factors, and it would be important to discover them. Certain figures were obtained in the experiments made, but were not exact, for an unknown volume of oxygen was fixed by the chlorine and was, therefore, not measured. However that may be, in the electrolysis of solutions of hydrochloric acid a part of the current, which is by no means negligible, is used for electrolysing the water, and this phenomenon must be taken into account both in determining the factors of transport of the ions of hydrogen and chlorine, in measuring the conductivity of the solutions, and perhaps also in determining their acidity.

* Abstracted from the *Comptes Rendus.*

HEATING OF VENTILATED AND ENCLOSED MOTORS.*

BY W. HARTNELL.

Summary.—The author deals with motors of eight types, classified according to their system of ventilation. He arrives at the conclusion that totally enclosed motors are under a great disadvantage, and that, in general, their use can be avoided. He gives particulars of tests in support of this view. Interesting figures regarding cooling surface are also tabulated and the results are plotted as curves.

Reference is first made to the reduction in size of motors during the last 15 years. The modern four-pole motor is at a disadvantage, compared with the old two-pole motors with copper brushes, in respect of dissipating the heat produced in working. The heat produced in the armature and shunt winding is no greater than before. The heat produced by losses in the teeth and armature discs is serious, with a dense magnetic flux in the air gap, and can only be kept within reasonable bounds by a moderate surface speed of armature. The heat due to the carbon brushes is considerable with low voltages. With a surface speed of 1,500 ft. per minute, the loss due to friction, and the loss in volts between the carbon and copper, may easily be equal to from 1⅛ to 1¼ watts per ampere per brush. The heat thus produced can only be dissipated: (1) By heating the motor itself, (2) by radiation, and (3) by conduction to a flow of cool air—that is, by ventilation.

It is impossible to separate these cooling effects by ordinary observation, but the author gives a table which shows for a series of motors an assumed average weight, cooling surface and loss of

* Abstract of a Paper read before the Leeds Local Section of the Institution of Electrical Engineers.

watts, the data being based on an actual set of standard motors. Some of the particulars are plotted in Fig. 1, and from this it may be inferred that the heating of the motor itself is of practical value, when a motor works intermittently, as in a crane or a hoist, say, not running more than 20 minutes per hour fully loaded.

Radiation.—It will be seen that the cooling surface per watt of motors under 5 H.P. is nearly double that of motors over 50 H.P. The difference in the effectiveness of the cooling surface is far greater. For the hotter air inside the larger enclosed motor is near the top, the bottom of the motor remaining markedly cooler and, therefore, the radiating surface less active. Also the magnet case may be three or four times as thick in the larger motor, rendering the escape of heat from the metal proportionately less. Thus, although 2·5 sq. in. to 2 sq. in. of radiating surface per watt lost may suffice for small enclosed motors, considerably more would be necessary to keep, say, a 50 H.P. enclosed motor equally cool. In order that radiating surfaces may be most efficient they must be opposite to cool surfaces. If there be a steam or gas engine or wall of a boiler house near the motor the effective radiation on that side of the motor will be partly neutralised although the intermediate air may be cool.

When an enclosed motor is required of more than, say, 3 H.P., the usual means of obtaining the requisite cooling surface is to take a motor of larger size and reduce the output, the armature current being reduced—and therefore the armature reaction—and also the flux density in the air space and ampere turns in the poles. This, however, makes a costly motor for continuous working, even for moderate powers; a 20 H.P. motor wholly enclosed may give 10 H.P. at a passable temperature, but a 30 H.P. motor would scarcely give 15 H.P. for the same temperature rise. A more economical arrangement than an enclosed motor is to place an open motor that may be fully loaded under a thin sheet-iron cover with ample inspection doors. This has been found convenient and satisfactory in flour mills, the case, though merely resting on the floor, being practically

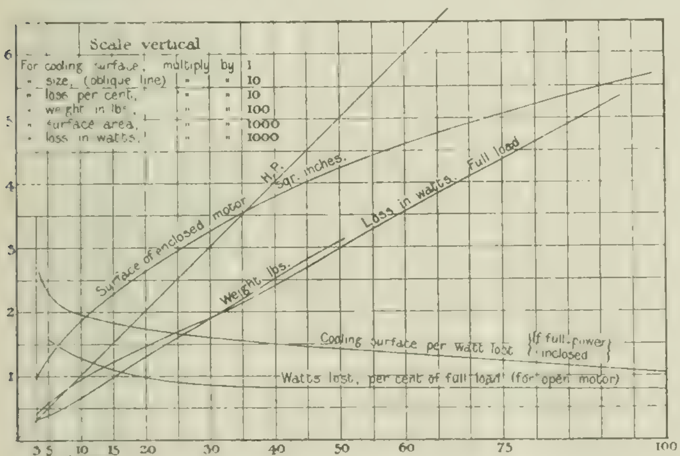


FIG. 1.—AVERAGED PARTICULARS OF A SET OF MOTORS.

dust-proof and inexpensive. Examples of open motors working satisfactorily fully loaded, placed in large covered recesses below the ground floor, and also enclosed in what might be compared to large, roomy wooden cupboards, are to be found in clothing factories.

Ventilation.—A table shows that the cubic feet of air required to keep the temperature rise below 72 deg. is about 9 cubic ft. per horse-power per minute for the smaller motors under 10 H.P., and about 5 cubic ft. per horse-power per minute for motors over 30 H.P. Experience shows that large open motors working to their full load can, by the aid of ventilation and radiation, be kept within the limits of 72 deg. But when wholly enclosed they can only be kept cool by forced draught. From a rough estimation it seems that at least double the quantity of air per minute is then required.

Electric motors, viewed in regard to their means of cooling, may be divided into eight classes: (1) Entirely open, having their bearings usually on a bed plate which carries the magnets. Suitable for large motors, say, over 100 H.P. (2) Protected open, the bearings carried by open covers at each end of the magnet case. This is the ordinary modern motor, say, from 100 H.P. to 2 H.P. (3) Enclosed ventilated. The same as No. 2, but with the openings covered by wire net or perforated metal. If the mesh be not less than four per inch the ventilation is not much interfered with, but if the mesh be much less not only is the ventilation much impeded, but the wire-work is apt to become choked with dust and fluff, and the safety of the motor endangered. (4) Same as No. 2 or No. 3, but with a forced ventilation by means of a fan on the armature, and a diaphragm, or its equivalent, to divide the fan suction from the delivery. This is necessary in an exceptionally warm place. (5) Totally enclosed. These are required for special purposes, and usually necessitate a considerable reduction in the output. (6) Covered motors. The same as No. 2 fully loaded, but covered by a roomy thin sheet-iron case, practically dust-proof, with openings for oiling and inspecting the brushes, the pulley standing outside the case. (7) Open-covered motors. The same as No. 6, but with a smaller cover made wholly or in parts of fine wire netting. The large area of wire-work prevents the tendency of any draught to cause the fine mesh to get clogged, and the motor fully loaded would be as cool as if unenclosed. This is specially adapted to textile mills where floating fluff is found. (8) Totally enclosed, but with forced ventilation like No. 4. This is necessary when the motor is (*a*) working in fumes, fresh air being sucked into the motor from a pure source through a pipe and discharged near the motor, (*b*) surrounded by inflammable gases, as sometimes in mines, the same air being circulated again and again through a cooler.

Standard.		As tested.					Rise of temp. Deg. F.			
H.P.	Revs.	H.P.	Revs.	O = open. E = enclosed.	Volts.	Hours on continuous test.	Air.	Field coils.	Armature	Commutator.
3	1,250	3·00	1,080	O	220	6	68	24	25	20
3	1,250	2·25	800	E	220	6	65	45	47	48
3	1,250	2·20	780	E	220	10	64	56	75	71
5	1 100	5·00	800	O	220	6	70	53	56	46
10	900	10·40	925	O	220	5½	55	58	54	51
	...	5·00	760	E	120	6	70	59	56	51
20	800	20·00	800	O	220	9½	63	49	47	25
...	...	10·50	695	E	120	6	71	86	74	73
50	600	59·00	1,090	O	120	8	66	48	69	46
...	...	20·50	455	E	120	6	70	40	56	65

The accompanying table shows the rise of temperature in motors, open and enclosed, from ordinary tests in the workshop. The motors were of the usual four-pole type with decarbonised steel cases and laminated poles, the induction in the poles being from 13,500 to 14,500. It shows the reduced power permissible, if a motor be totally enclosed and continuously loaded. In short, whilst

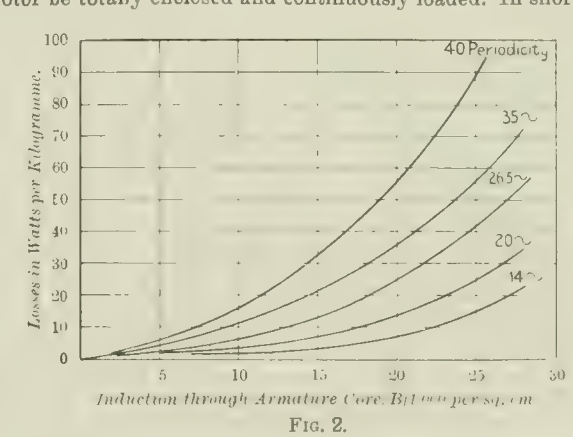


FIG. 2.

the power of a modern open motor is chiefly a function of its magnetic flux, when totally enclosed the power becomes a function of the area of its casing, considerably influenced, however, by its environment—that is, by the exchange of radiated heat with its surroundings, or the motion of the surrounding air.

The increased heating due to totally enclosing a large open-type motor is strikingly shown by the following experiments and incidentally the increased iron losses due to high speed. The motor was designed for 60 H.P. at 1,000 revs. per min. in the magnet case of a 50 H.P. motor at 600 revs. per min. The ventilating slots around the periphery of the end covers were at first closed. The armature was open, the usual type, diameter 410 mm., weight of core 81 kg., and of teeth 21 kg. Slots 48, size 12 mm. by 30 mm. The discs 26 S.W.G. (which had the usual core holes) rested on the shaft 4 in. diameter. The magnetic flux was reduced about 15 per cent. as compared with the standard for 600 revs. per min. The armature was at first driven by belt from another smaller motor and the amperes noted. On running the amature, fully wound, but with the magnets only excited, it was at once noticed that the increase of current on the small motor due to exciting the magnets of the 60 H.P. was much more than anticipated and that the armature rapidly heated. A series of progressive tests was then made to determine the iron losses. The results are shown in Fig 2. These curves can only be approximate representations of the true iron losses as they include other losses which could not be measured. A similar armature, but unwound, was substituted and the tests for heating repeated with the same results. The stampings were by Messrs. Sankey with "Insuline" paint on them.

The unwound armature was stripped and rebuilt, the stampings equally spaced by 10 sheets of tracing paper. On again testing,

there was no noticeable improvement. The armature discs were again removed, bored and fixed on a gun-metal bush—the end plates for supporting the end winding were turned thinner and the cylindrical part for supporting ends of the windings were made shorter and thinner. The end plates were also separated from the stampings by paper discs. This made a slight improvement; after two hours' run with air at 60°F. the rise of temperature in the slots was 54 deg. and in the centre of the core 66 deg.

The heating being evidently due to the discs themselves, Messrs. Sankey were written to and they sent their curves for the iron losses which gave no calculated agreement with facts. Finally the armature was rebuilt with Stalloy stampings and tested unwound, but with the slots filled with wood and the magnets excited. The results are given, and show that the rise of temperature in two hours was 8°F. less than before, showing a slight advantage over ordinary stampings. The armature was wound and a fan fitted to the end of the armature to circulate the air inside. It was then tested as a totally enclosed motor, with a load of 58 H.P. for three hours, with the following results: Rise of temperature of commutator 111 deg., field coils 88 deg. It was again tested totally enclosed for eight hours, but with a stop of 8 to 10 minutes every hour (after the first four hours) to take temperatures. Load 59 H.P. The final temperature rises were (air at 70°F.): Commutator 170 deg., armature 149 deg., field coils 125 deg., air inside 105 deg. There was not much increase of temperature after the first four hours, but the temperatures then were impracticable. The fan was then removed and the motor ran at 59 H.P. as an open motor for eight hours with the ventilating slots on the periphery of the end covers also opened; the final temperature rise with the air at 62 deg. to 69 deg. was: Commutator 58 deg., field coils 48 deg., armature 68°F.

The convex curve (Fig. 3) shows the gradual rise to a maximum temperature of an overloaded field coil of a dynamo (without an armature) and the concave curve the shorter interval of time to reduce the higher temperature after the current is cut off. Thus, in this curve if any line, ABCD, be drawn, AB represents the time required to rise to a particular temperature, BE (measured outside the

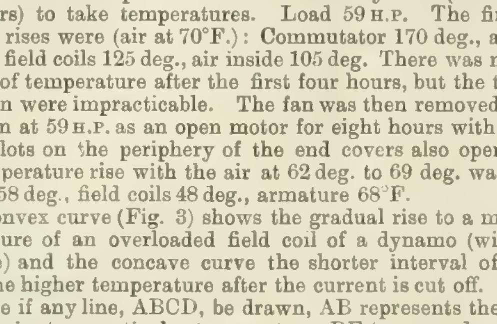


Fig. 3. Heating and Cooling of a Magnet Coil.

coil) and CD the time to cool. For the higher temperature, which illustrates practical work, CD is small compared with AB. The dotted line shows the average internal temperature calculated from the reduced current as the temperature rose.

A diagram is given in the Paper to show the great advantage of intervals of light or no load in the cooling of loaded motors, and explains why heavy overload can be borne with intermittent work without undue heating, as in crane motors. This advantageous cooling with intermittent loads can only be obtained when there is a considerable difference of temperature between that of the air and the highest permissible in the motor. If the air be very warm, so that this difference is comparatively small, the motor gets hot in less time than it cools. It will be seen in Fig. 3 that GH is less than KL.

It has often been noticed how a comparatively small opening in a metal cover (class 6) enclosing an open motor would reduce the temperature. If the escaping air had a temperature of 72°F., only one-sixth the quantity given in the table would suffice to carry off one-third of the heat, and if the velocity were only 2 ft. per second, a moderate opening would suffice.

It may be noticed that there is no such thing as a gas tight motor, even if the shaft worked through a stuffing box. The expulsion of, say, 15 per cent. of the enclosed atmosphere when it was heated and the entry of the same amount of gaseous air from the outside on cooling would cause the average condition of the atmosphere outside and inside soon to be similar. To enclose a motor tightly to keep out noxious gases is a delusion. In an explosive atmosphere they must be totally enclosed and strong enough to withstand an internal explosion as made by the author for a mine some 18 years ago.

Experience with open motors exposed to various noxious chemical fumes shows that, although the motor's appearance may be spoiled and soldered joints affected, yet the motors last so long that it is better to let them wear out and buy new ones rather than put up with the troubles from enclosing them. In the author's opinion the reasons given for totally enclosing any but very small motors [illegible] are usually mistaken. In the case of insurance risk they tend to defeat the object in view. In nearly every place where power is required for manufacturing, open motors may be used and easily protected against the real or supposed dangers of its particular environment. Enclosed motors with a current of air forced through them either by means of a fan or chimney may be considered as open motors so far as heating is concerned. In order that a continuous current motor may give the least trouble it is important that the arrangement be such as to keep the commutator as cool as possible (and vice versa). The conclusion is that totally enclosed motors (class 5) are under great disadvantages, and in general their use can be avoided.

DISCUSSION.

Mr. T. H. Churton, after some remarks concerning the general principles of the heating of motors, said that it was a simple matter to calculate through how many degrees of temperature a given mass of material of given specific heat would be raised by the application of a definite quantity of heat in a given time. But the essence of the matter under discussion was really as to the rate at which the heat of the motor was got rid of under various conditions which commonly obtained in practice. With regard to the ratio of horse-power and area of enclosed motor surface, this was not only a matter of design but was largely dependent upon the speeds of the motors; the slower the speed the larger must be the motor, and consequently the greater area per horse power and generally per watt lost. The figures given for the radiating surface per watt lost in small enclosed motors were confirmed by results he had obtained from a 5 H.P. two-phase induction motor, 50 frequency at 200 volts, 6 poles short-circuited rotor; run at 5 H.P., as an open motor, the temperature rise was 64°F. The motor was then run at the same power totally enclosed when the temperature rose 75°F. in one hour and reached 120°F. rise in four hours, at which it remained constant. In this case the radiating surface was equal to 1·65 sq. in. per watt lost, or at this temperature rise, heat was being given off at the rate of 5 B.T.U. per sq. ft. per min. The motor was then run at 3·25 H.P., a reduction in power of 35 per cent., the radiating surface being 2·35 sq. in. per watt, which resulted in a rise of 82°F., the heat dissipated being 3·49 B.T.U. per sq. ft. per min. But the results which he had obtained in larger motors did not accord with the author's. In the case of a three-phase induction motor, 25 ~, 500 volts, which, as an open machine, gave 60 H.P. at 480 revs. per min., and run at 34 H.P., totally enclosed, at the same speed, the radiating surface was 1·45 sq. in. per watt, and the resulting temperature rise on a six hour test was 72°F. It seemed to him that if an enclosed motor was run long enough at constant load the entire surface would, in the absence of any disturbing cause, arrive at the same, or nearly the same, temperature, and that with a given increase of temperature, other things being equal, heat would be radiated at the same rate, irrespective of the actual size of the surface. For this reason he could not endorse the author's statement that a larger motor required a greater area per watt lost than did a smaller motor for the same temperature rise. With regard to the relation between the capacity of a motor when open and enclosed, it was stated by the author that a motor that could be run at 20 H.P. open could not, on account of heating, be run continuously at more than about 10 H.P. when enclosed. But in making this general statement the effect of the speed of the motor upon the comparison had not been taken into account. As already pointed out, usually the area per watt lost increased as the speed was reduced, consequently the difference which was made in the effective power for continuous work by enclosing was much less in slow than in high speed motors. He should remark that whereas the tests from which he had taken his figures had been on A.C. motors, those from which Mr. Hartnell had obtained his had been D.C. machines; and, though, of course, the same general principles applied equally to each, there were certain differences which might affect the results in practice—for instance, in D.C. motors the heat was generated chiefly in the armature or near the centre of the machine, while in the A.C. motor the heat was mostly generated in the stator or outer part of the motor, part of which was often directly exposed on the outside to the air. This was, in fact, usually the hottest accessible part, and where the temperature was taken; whereas in the D.C. motor it was necessarily taken inside the motor. He quite agreed with the author that motors were often enclosed unnecessarily, but in many cases enclosed motors were of undoubted service, and the only thing possible on cranes, punching machines and similar jobs of low load factor, frequently in positions exposed to the weather or damp.

Mr. F. T. Chapman entirely agreed with the author's conclusion as regards the enclosing of motors. He thought that by "protecting" them in various ways, one protected them more from the attendant than from anything else. The method of cooling given in S (b) in the Paper would appear to be under the same disadvantage with respect to gradually drawing in the surrounding gases as was pointed out later in the Paper in the case of an ordinary totally enclosed motor. An attempt had recently been made to solve this problem by the use of the safety lamp principle. The gases were allowed to circulate through the motor, but the openings through which they were drawn in and expelled consisted of tortuous passages exposing a large amount of cool conducting surface and thus preventing an explosion occurring in the motor from igniting the gas outside. He did not know to what extent the method had been applied in practice. The curves given in Fig. 2 emphasised the impossibility of getting accurate results by that method; for instance, at [illegible] the difference between the loss at 20 cycles and that at 25 [illegible] was greater than that between 25 and 35. The losses at these high densities appeared to be practically proportional to the square of the density and to the square of the frequency, and must be almost entirely due to eddy currents.

Mr. W. B. Woodhouse said that the author's conclusions were ones that could be predicted, thus the amount of cooling surface per watt lost for a totally enclosed motor was of the same order as that required for a transformer. The tests recorded suggested the unsuitability of a standard open type motor for conversion to an enclosed type. With an open type motor certain parts of the motor were kept down to their working temperature by the windage. When the motor was enclosed that windage no longer had effect and those parts of the motor would get unduly hot, and eventually the whole motor would heat up to a higher temperature. One was inclined to agree strongly with the latest practice in dynamos—in the larger ones at any rate—where the machine was completely enclosed, but provided with forced ventilation, the air being drawn in from outside through an air duct and delivered through another air duct to the outside again. This was treating the problem of ventilation scientifically; the older method was a somewhat haphazard one. He was interested to notice recently a description of an installation in a textile factory where a large number of spinning frames were driven by totally enclosed motors. The motors drew air from a ventilating duct in the floor in direct communication with the outside of the mill and discharged the heated air into another duct. The design struck him as being a very good one, as the fluff and dust flying about did not get to the motors which got properly and uniformly cooled. The suggestion of putting a large iron cover over the motor seemed an excellent one; it was of value to know that this did not seriously affect the motor rating, and it must be a good deal cheaper than totally enclosing the motor itself. The fire insurance companies some time ago issued regulations as to the enclosing of motors in textile factories, insisting that the open type D.C. motor was dangerous and should be totally enclosed, but the A.C. motor need only be enclosed by wire netting or perforated sheets with ¼ in. openings. His own experience was that such perforated sheets did not alter the rating or heating of the motor at all.

Mr. G. D. A. Parr referred to the statement of the author, that in recent motors the magnetic leakage had been reduced to from one-quarter to one-fifth of that in the old ring-wound motors. He thought that the old ring-wound motors had a leakage coefficient of 1·35 or 1·4 and he was not aware that the present-day motor could be made with any smaller leakage coefficient than 1·15. The author stated that although 2·5 to 2 sq. in. of radiating surface per watt lost might suffice for small enclosed motors considerably more would be necessary to keep, say, a 50 H.P. enclosed motor equally cool. He (the speaker) thought this must be a mistake because it was in direct contradiction to a figure in one of the tables, and it was possibly meant that the total amount of surface must be more. He also inquired regarding the Stalloy stampings, as the tests did not seem to confirm the supposed good results.

Mr. A. J. Cridge mentioned an unusual instance of the heating of an A.C. motor. The manufacturer—from motives of economy of space, perhaps, or of material—had covered the stator stampings with a thin sheet of iron, held in position by grooves in the end castings. The outside of the motor became very hot, and it was found that the temperature of the sheet varied considerably at different points, and further, that the temperature of the windings was much less than that of the outside. They therefore assumed, although they had no direct evidence, that the heating of the cover was due to eddy currents in the thin sheet. He did not think this solution occurred to the manufacturer, for he put in a fan at one end of the motor, which had the effect of cooling one side, and leaving the other as hot as ever. It also had the effect of drawing the oil out of the bearings, and throwing it into the stator windings.

Mr. H. C. Jenkins remarked that during his experience with motors in mines he found the tendency among many mining people to totally enclose motors was becoming more or less revised, and in many cases they were using open-type motors, making arrangements so that contact with gases was obviated. The question of putting very fine wire gauze over the motor on the principle of the Davy lamp might be a good idea for mills, but was hardly an ideal thing for a colliery, as the coal dust would choke up the small apertures and the motor would be running, therefore, as a totally enclosed machine, unless the gauze was cleaned frequently. He knew of one instance of an electric haulage where the haulage house was situated near to the upcast shaft, and there was a good deal of gas present at various times. They had arranged to have the front of the haulage house enclosed, with a window, so that the man could see the roadway, and the only opening to the return air shaft, by means of which gas could enter, was two slots where the ropes went through. A pipe brought from the upcast shaft allowed the fresh air to play directly on the resistance and the motor, and as there was a certain amount of air pressure in the haulage house there was no chance for the gas to get in.

Mr. W. F. Mylans said that the author had made a remarkable statement, namely, "In order that the radiating surfaces may be most efficient they must be opposite to cool surfaces, as all surfaces radiate heat in all directions." He (the speaker) was always of the opinion that the radiation of surfaces depended entirely on the temperature difference and the state of the surfaces; whether they were polished, white or dark had a great deal to do with it. He was glad to notice the remarks with regard to gas tight motors, with which he agreed, and he felt certain that when these machines were installed they did not receive the attention that was necessary, and consequently they were allowed to run under unsatisfactory conditions.

Mr. F. M. Moody (communicated) agreed that the enclosed motor was not advisable, but in spite of its defects it was the best of the various types for direct coupling, all the working parts which were liable to injury being enclosed, the motor being practically fool-proof. For driving line shafting or steady loads through the medium of a belt, he certainly favoured the entirely open type in preference to any of the others. The author had taken the heating due to the eddy currents, but had given no information on the higher temperature of the windings due to the heavier insulation used in the modern machines. The heat produced was no greater, but was the dissipation of the heat so produced so good? The question with enclosed motors was, Does the higher temperature cause the insulating material to deteriorate more than with the lower temperature obtained with the open type motor? Personally, he objected to these high temperatures, although Mr. Raworth, at a meeting in 1906, had put the limit at 212°F. A great deal could be done to ensure cool running by the design of the commutator and armature end connections so as to produce a draught through the armature, apart from the addition of a fan. The use of interpoles tended to reduce the cooling effect in the armature. If high temperatures were bad for the motor the remedy was in the maker's hands. Fix the temperature rise, and, if the machine was required enclosed, quote for the larger motor which would give the load for the same temperature rise. This was one of the points where the maker could standardise.

Mr. W. Hartnell, in reply, agreed with Mr. Churton's remarks concerning a slow-speed motor having a greater cooling surface than one of the same power of a higher speed, and the loss of power on enclosing a slow-speed motor being proportionately less. The author made no reference to this effect of speed in order not to wander from the title of the Paper, which had no direct bearing on the increased cost of low-speed motors. It was necessary for the sake of comparison to take standard speeds, and as the speeds of the motors taken were nearly in accordance with those recommended by the Standardising Committee it might be assumed for the purposes of the Paper that they were about the most advantageous for D.C. ventilated motors. The reason why a large D.C. motor required greater cooling surface than a smaller one, and a D.C. motor more than an A.C. motor, was because of the difference in the thickness of the case. The A.C. motor was placed in a case as thin as could be conveniently cast, it might have been ⅜ in. in the A.C. motors with which Mr. Churton experimented. The case of a D.C. motor was its yoke. That of the 3 B.H.P. motor alluded to in the Paper was ⅝ in. thick, and that of the 50 B.H.P. motor 1⅞ in. thick, *i.e.*, from two to five times the thickness of the A.C. motor. That an A.C. motor case should radiate one watt for 1·65 sq. in., with the internal air temperature at 120°F., agreed with his experience, but that a watt should be radiated from 1·45 sq. in., with a difference of temperature of only 72 deg., was surprising. Experiments were needed as regards the highest permissible temperature of magnet windings. The temperature of boiling water could not hurt the cotton, the only inconvenience being that the speed was much higher than when the motor started cold. The sparking limit became reduced when the temperature rose, say, above 130°F. If the temperature rose above 150 deg. it was likely to give trouble. The fan effect of connectors on the commutator, although most useful in an open motor, was not of much assistance if the motor was enclosed. It appeared to him that only those who had attempted the design of totally enclosed motors of large power had any idea of the difficulties to be overcome: in fact, they seemed almost insuperable without forced ventilation. The instance which Mr. Woodhouse referred to, wherein the motors were enclosed but fixed over an air duct was, he considered, the true way of dealing with enclosed motors. In reply to Mr. Parr, the Stalloy stampings appeared to be of small advantage for D.C. motors. The sheet-iron case was applicable to A.C. motors, provided it was made sufficiently roomy.

CORRESPONDENCE.

SYMBOLS FOR PHYSICAL QUANTITIES.

TO THE EDITOR OF THE ELECTRICIAN.

Sir: I fail to realise what convenience Mr. Miles Walker expects from his Chinese symbols for physical quantities.

The best way to get uniformity seems to me to be a quite different one. I summarise it as follows: That an international congress should settle a complete system of physical units, and that writers use the initials of these units to designate quantities of the same kind.

I am aware that such a complete set of international units is not yet established, and I think a long time will elapse before such an international agreement is arrived at; but the C.G.S. system is already adopted by all scientists, and my suggestion is that writers should use the initials of the C.G.S. units to designate the quantities measured in these units. Thus, C would stand for a length, G for a mass, S for a time, D (dyne) for a force, E (erg) for a work, V (volt) for a P.D., A (ampere) for a current, O (ohm) for a resistance, H (henry) for an induction, F (farad) for a capacity, and so on.

Ohm's law should be written V=O.A and the general law of a.c. should be written $V = O.A + H\frac{dA}{dS} + \frac{1}{F}\int A.dS$.

Such formulæ marking out not only the kinds of the quantities, but the units in which they were measured, would

F

prove very convenient to both writer and reader, avoiding mistakes by the former and misunderstandings by the latter in calculations.

Every nation will, for a long time, if not for ever, remain attached to its peculiar measures, as it sticks to its own language, but scientists cannot do so.

Through their frequent and extensive intercourse they will be compelled to adopt identical units and symbols.

The adoption of the C.G.S. system has been the first step; many others will soon succeed, more and more rapidly. This will result in uniformity of units; uniformity of symbols will follow.—I am, &c.,

Dijon, August 16. F. GALLIOT.

ALTERNATING CURRENT COMMUTATOR MOTORS.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: Would you kindly explain the following seeming contradiction in Dr. Goldschmidt's article in your issue of July 31st. On p. 591 he gives the formula

$$P_{L_f} = 7\cdot8 \times \left(\frac{i_r \times z_r}{R}\right)^2 \times v \times 10^{-8},$$

and immediately afterwards advocates a small air gap to reduce the reluctance, in order to reduce the wattless current.—I am, &c.,

Glasgow, Aug. 8. A. J. GILL.

We have submitted our correspondent's query to Dr. R. Goldschmidt, and have received the following reply:—

[I would draw your correspondent's attention to the formula $P_{L_f} = 2\cdot5 \times 10^{-8} \times N^2_{f\,max.} \times R \times v$, which confirms directly my statement in italics on p. 591: "The wattless power to produce the magnetic field is proportional to the periodicity and the reluctance of the motor, and proportional to the square of the magnetic flux." If your correspondent wishes to read this law from formula (5), he must remember that the ampere turns themselves are proportional to the reluctance, the flux (*i.e.*, speed, voltage, &c.) naturally being fixed with a certain machine.—R. GOLDSCHMIDT.]

WORKING RESULTS FROM GAS-ELECTRIC POWER PLANT.*

BY J. R. BIBBINS.

Summary.—Particulars are here given of a 30 day test on a gas engine driven plant at the Richmond works of the American Locomotive Co., showing the cost and efficiency of working, and an instructive comparison is also made with steam turbine working.

The equipment consists of a 23·5 by 33 horizontal tandem gas engine, with a direct-connected direct current generator, operating on producer gas generated by a pair of 9 ft. (shells) bituminous producers. The gas is purified by means of wooden slat scrubbers and centrifugal tar extractor, motor driven. A 15,000 cubic ft. holder serves to equalise the quality of the gas and to start the engine, which is necessary to bring the motor-driven auxiliaries into service. The engine is of the modern double-acting type, giving two impulses per revolution, and is governed by a sensitive oil relay system designed to relieve the governor of all valve work. An important feature of the producer is that it is designed for continuous operation, having a water-sealed bottom instead of a closed ash pit, to permit the removal of ash at any time. It generates its own steam, requiring no auxiliary boilers, so that the only auxiliaries required for the entire plant are a motor-driven fan, tar extractor and igniter set. In the aggregate these auxiliaries absorb about 5 per cent. of the station capacity. The plant is called upon for continuous 24 hour service, except on Sundays and holidays.

Owing to the comparatively long period required for 1 lb. of fresh coal to work through a fuel bed several feet deep, a long test is necessary for any degree of accuracy. With the rapid combustion on a boiler grate, this is a different matter, and an eight or ten hour test will suffice. But in producer work 24 hours or 48 hours is the minimum. In this case the test was continued for practically four weeks, half of the time on a full load run and the remaining two weeks on three-fourths and one-half load respectively, with a rate of gasification of 0·25 tons per hour. A continuous run of 223 hours' duration evidently provides an excellent guarantee of accurate results.

The electrical output was measured by recording wattmeters calibrated from a laboratory standard previous to the test. The water consumption was also metered, no great accuracy being desired. The coal was weighed by scales checked from time to time by standard weights. Samples from such weighings, accumulated during a day's run, were quartered down and sealed for analysis. It should be noted that at full load, 312 kw., the engine was running somewhat below full rating, but the true full-load coal consumption may readily be found by plotting the data in the form of curves, showing at a 400 kw. load a coal consumption of about 1·5 lb. per kilowatt-hour. The data of the tests are as follows:—

—	Full load.	¾ load.	½ load.
Length of run, hours	223	125	136
Average load, kw.	312·3	228·3	159·6
Load per cent., engine rating	91·0	67·6	47·5
Load per cent., generator rating	104·0	77·2	53·2
*Coal, gasified, lb.	115,289	54,143	47,775
Coal gasified, per hour	517·0	433·0	351·0
Output, kw.-hours	69,650	28,540	21,710
Lb. coal per kw.-hour	1·654	1·697	2·20
Ave. heat value of coal, B.Th.U.	14,392	14,393	14,393
B.Th.U. per kw.-hour	23,700	27,280	31,650
Per cent. thermal efficiency, brake	15·51	13·6	11·75
Per cent. thermal efficiency, elec.	14·35	12·65	10·78

* *Coal.*—Pocohontas Run-of-mine; avg. heat value dry sample, 14,703, as fired, 14,392; volatile matter, 22·8%, ash 4·5%, sulphur 1%.

The characteristic of constantly increasing economy shown by the gas engine plant up to the point of max. load illustrates an essential difference from steam-engine economy, which usually is best at loads 70 to 80 per cent. rating according to the cylinder ratios employed. Although the gas economy curve is quite flat beyond half-load, yet the plant evidently does its best work well loaded. By projecting backward the line of total coal gasified, we find that it requires over one-third of the full load coal to run the plant unloaded. Excluding this constant loss, the plant would be capable of generating power at the rate of 1 lb. of coal per kilowatt-hour.

During the four weeks' test, there were several days during which the plant was allowed to stand idle, as the works are not operated on Sundays. During this period, some coal was required to keep the producer fires at their normal level and in good condition, and according to the judgment of the producer operator, an average of 1,700 lb. of coal were required to compensate for stand-by losses from 6 p.m. Saturday until 7 a.m. Monday, a period of 37 hours. Herein lies a remarkable feature of the producer plant—the low rate of stand-by losses, averaging only 46 lb. per hour, or 2·5 per cent. of the weekly coal consumption.

During the two weeks' run at full load, comprising 223 hours' operation, the average rate of cylinder oil consumption was 0·09 gallons per hour, or, on the basis of a 10 hour working day, 4·9 gallons per week. This confirms to a considerable degree the experience at the Norton works, where an engine of the same size uses 3·5 to 4 gallons per week, 10 hour day—a rate so low as to have excited suspicion of its correctness. The high economy of oil is, however, due to the system of timed, forced circulation employed.

The average quantity of cooling water used was about 11 gallons per kilowatt hour at heavy load, with inlet temperature varying from 75 F. to 80 F., and outlet from 140 F. to 150 F. This quantity is quite reasonable for the temperature rise. Inasmuch as a definite quantity of heat must be removed from the engine at a given load, the volume of water necessary evidently varies with the rise, so that in winter even less cooling water would be required. Economy of water may be carried to any reasonable point provided the outlet temperature of any part does not exceed 150° F. The upper limit only is important.

From the preceding data and the other items of cost, the cost of power may be estimated at various load-factors. Owing to the

Cost per Kilowatt hour for Gas Plant.

—	Pence per kilowatt hour.	
	Full load.	Half load.
Coal (at 4s.)	0·0405	0·0545
Wages	0·0605	0·1[illegible]1
Supplies	0·038	0·0715
Fixed charges	0·1[illegible]1	0·242
Total costs with coal at 4s.	0·26	[illegible]
" " " 8s.	0·3	0·543
" " " 10s. 10d. Richmond	0·329	0·591
" " " 16s. " "	0·381	0·651
" " " 24s. " "	0·46[illegible]	0·76[illegible]
Saving, gas over steam:		
Coal at 4s.	−5 % loss	−8·5 % loss
" 8s.	+3 % gain	+0·9 % gain
" 10s. 10d.	12·9 "	4·7 % "
" 16s.	19·6 "	12·4 "
" 24s.	33·7 "	19·0 "

* Abstract of a Paper read at the Annual Convention of the American Institute of Electrical Engineers.

fact that the present power plant was made to accommodate a two unit plant, the cost has been computed upon this basis; and in view of the excellent results that have been obtained the electrical rating of the plant has been placed at 700 kw., or 1,000 H.P., at which rating the investment cost becomes about £28 per kilowatt, including machinery, buildings, foundation, piping, erection—in fact, all items except the value of the land occupied. Considering the limited size of the plant, this does not represent an excessive cost, which in large plants would probably be as low as £20 to £25 per kilowatt.

Assumptions with 700 kw. Gas Power Plant.

Equipment Cost.—Building and machinery, cost per kilowatt, £28.

Fixed Charges.—Interest 5 per cent., taxes and insurance 1·5 per cent., depreciation (sinking fund 15 years 5 per cent.), 4·63 per cent., running repairs 1·5 per cent. on investment. Total 12·63 per cent. per year.

Operation. 300 days, 7,200 hours per year, 5,040,000 kw.-hour. Input to auxiliaries, 5·4 per cent. full, 10·8 per cent. half load. Standby losses, producer plant, 1,600 lb. per week, 2·1 per cent. full, 3·1 per cent. half load. Fuel rate, full load, 1·59 lb. + 2·1 per cent. = 1·62 lb. per kilowatt-hour; half load 2·1 lb. + 3·1 per cent. = 2·17 lb. per kilowatt-hour

Assumptions with 700 kw. Turbine Plant.

Equipment Cost.—Building and machinery, £20 per kilowatt.

Fixed Charges.—Interest 5 per cent., taxes and insurance 1·5 per cent., depreciation (sinking fund $16\frac{2}{3}$ years at 5 per cent.) 4 per cent., repairs 1 per cent. Total 11·5 per cent.

Operation.—300-day year, 7,200 hours. Average water rate, full load 21·5 lb. per kilowatt-hour; one half load 25·5 lb. per kilowatt-hour. Gross evaporation, 7·5 lb. to 8 lb. Standby, banking, 10 to 15 per cent. Gross coal consumption, full, 2·95 lb. per kilowatt-hour; half, 3·9 lb. per kilowatt-hour.

Wages and Supplies.—Same as gas.

The costs calculated for several different prices of coal are given in the above table, the price at Richmond being 10s. 10d., showing that power can be delivered at the switchboard at Richmond at a cost of ½d. per kilowatt hour for a fully loaded plant operating 7,200 hours per year, or 0·58d. operating at half load, and this taking into account fixed charges, which are about 40 per cent. of the total cost. Even with coal as high as 24s. per ton, the total cost of power would be under ½d. per kilowatt hour, obviously an excellent result.

Relative Cost of Gas and Steam Power.—A comparison has been drawn up in the above table for a steam turbine plant operating under the same load. This comparison covers only two variable factors, coal cost and loading. And, while not intended to be of more than tentative interest, it will serves to how the general range of working in which the gas and the turbine plant will respectively predominate.

Owing to the handicap of higher fixed charges, the turbine plant shows a lower power cost with low-priced coal; that is, where freight rates are low. Also with light loads or fluctuating loads averaging but a fraction of the generating capacity, the gas plant is evidently at a disadvantage. And for this reason the turbine plant still finds exclusive application in all service subject to extreme overloads or variations. In fact, with the extension of a large electric power system, such as at the Richmond works, it is possible that a combined gas engine turbine plant may best meet load requirements with the highest resultant economy, the turbine unit carrying fluctuating peaks and the gas engines the uniform load, as suggested by Mr. H. G. Stott.

At present hot gas engine jacket water is utilised directly for boiler feed in an auxiliary air-compressing plant, although charged for in the cost table. This arrangement would, of course, be even more applicable to the combined plant, permitting most of auxiliaries to be motor-driven without loss of heat for feed water.

AN ALTERNATING CURRENT MOTOR WITH TWO MOVABLE PARTS FOR USE ON RAILWAYS AND FOR HAULAGE PURPOSES.*

BY DR. J. SAHULKA.

This system consists essentially of a motor, known as the main motor, whose "field" and "armature" are both movable. The inner part of this motor is mechanically connected to the road axle, while the outer part drives a direct current shunt dynamo. This latter, in turn, feeds a direct current series motor, the auxiliary motor, which is also coupled to the road axle.

The system is used in the following way. The circuit between dynamo and auxiliary motor is broken so that the main motor can be brought up to speed unloaded. Only the outer part of the motor and the dynamo is then in motion, while the inner part and the axle connected thereto remain stationary, for the no-load torque is small. The exciting circuit of the dynamo is closed through a high resistance so that its voltage is low in spite of the high speed. In order to start the road-axle the circuit between dynamo and auxiliary motor is closed and the excitation gradually increased. The dynamo exerts a braking action on the outer part of the main motor, while

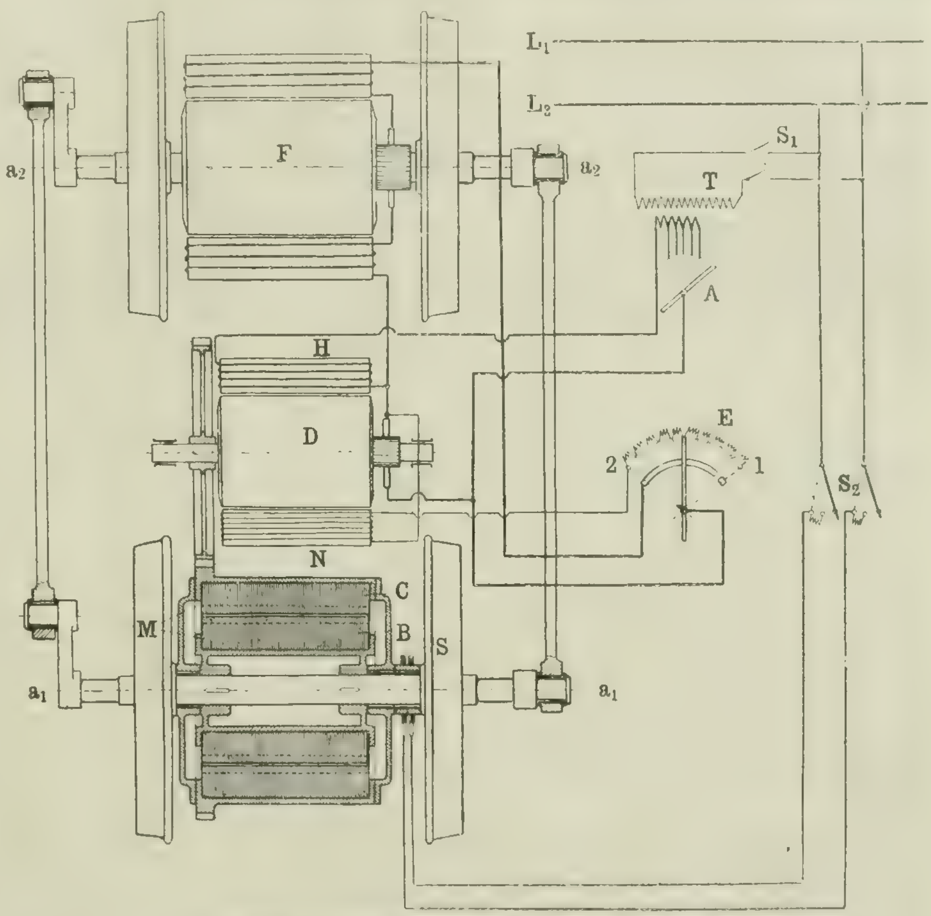


DIAGRAM OF SYSTEM APPLIED TO TRACTION PURPOSES.

the inner part is acted upon by a torque of the same value, but in the opposite direction, to that exerted on the outer part. The road-axle is, therefore, driven both by the inner half of the main motor and the auxiliary motor, which is so arranged that it works in conjunction with the main motor. By increasing the excitation of the dynamo its braking effect is also increased, so that the speed of the outer part of the main motor and the dynamo decreases while that of the inner part and the road-axle increases. Speed regulation is effected by a resistance in the field circuit of the dynamo.

When the main motor is of the induction type the relative speed of its two parts is practically constant, the slip being small. If the main motor is synchronous the relative speed of the two parts is practically constant. The main motor may be of the continuous-current type, while the field winding of the dynamo should be so arranged that with a short-circuited regulating resistance both parts of the main motor turn in opposite directions with equal speed—*i.e.*, with half the speed with which the outer part moves at no load. Under these conditions the main motor exerts half its mechanical power directly on the road axle, the rest being supplied to the dynamo.

* Abstracted from the *Elektrotechnik und Maschinenbau.*

To bring the axle to rest it is only necessary to break the circuit between the dynamo and the auxiliary motor. The dynamo and the outer part of the main motor being no longer loaded, attain their maximum speed, and the inner part of the main motor only exerting a small torque and the auxiliary motor none at all on the road axle, the car soon comes to rest. It is only necessary to start up the main motor once, for it runs at full speed while the car is stationary. To change the direction of rotation the main motor must be stopped, the dynamo and motor reversed and the main motor restarted as described above. But it now revolves in the opposite direction.

This arrangement is shown applied to railway working in the accompanying diagram, the main current being supposed high-tension single-phase. L_1 and L_2 are the mains, M_2 the main motor, B and C its inner and outer parts. B is mechanically connected to the dynamo D and this electrically to the auxiliary motor F. B drives the axle a_1 and F the axle a_2. These two axles may be coupled together. The dynamo D may be provided with both a shunt and series winding, and can then be employed as a direct current shunt dynamo or a single-phase series motor. To start this set, in the latter case, a transformer T with adjustable secondary winding is used. This transformer need only be small, as both D and c are started at no load. The operation is carried out by closing the switch S_1 and turning A, so that D receives current at gradually increasing voltages. It then runs as a single phase motor. When D and c are running at full speed, S_2 is closed, and the main motor started up. S_1 is then opened and A moved back. Current is conveyed to c through slip-rings, while B is provided with a short-circuited winding. In position I of the regulating switch, E, the connection between D and F is broken, and the whole regulating resistance is inserted. By means of this resistance the speed is regulated, while D operates as a direct current shunt dynamo.

The following advantages are claimed by the author for this arrangement: The torque supplied to the road axle by the main motor is the same as would be developed by a motor of the same size with stationary outer part, while in this case the torque of the auxiliary motor has to be added. Further, at starting, the kinetic energy of the moving parts is of great advantage, and the motor can be of smaller size, as the power at starting is not greater than when running. The power factor is always high as the main motor has but little slip. Owing to the arrangement described above the speed regulation is easily effected by small increments. Current of double the frequency which it is now possible to use for traction purposes can be employed, as both parts of the main motor only turn at half synchronous speed. The output of the main motor is increased by raising the frequency. This makes for economy both as regard transformer stations and the employment of traction current for lighting purposes. The losses are smaller at all speeds than in the ordinary system, as there are no series starting resistances or harmful short-circuit currents. The starting current is relatively small, both owing to the arrangements devised for this purpose and owing to the fact that the line losses are small and the power factor high. Power can be returned to the system on down-hill sections. Several motor cars can be used on each train. All the main motors would, in that case, first be started up and then the dynamo circuits controlled from a master position. If three-phase current is used one trolley wire need only be taken over crossings and points as the main motor will run on single phase circuits.

The only disadvantage of this system is the greater cost caused by the employment of three machines instead of one.

The author concludes his Paper by showing that taking the line frequency at 48, the output of the main motor can be increased in the ratio of 1·56 to 1 by using this method.

ON THE UTILISATION OF THE ATMOSPHERIC NITROGEN IN THE PRODUCTION OF CALCIUM CYANAMIDE, AND ITS USE IN AGRICULTURE AND CHEMISTRY.*

BY DR. A. FRANK.

(Concluded from page 696.)

As has been the case with many other artificial manures, a great outcry was, and still is, made warning farmers against the use of calcium cyanamide, popularly known as nitrolim, or at least advising that it should be employed with the utmost caution. This outcry originated in the fact that not only farmers but even agriculturists are saturated with intense conservatism, and that initial failures did here and there occur when first using calcium cyanamide. It is, however, certain that manufacturers must in the first instance determine the most suitable form for every new manure, as a string of well-known instances in the case of other manures abundantly proves. The storm raised against calcium cyanamide has been lulled, and recently Prof. Wagner, of Darmstadt, one of the greatest authorities on agricultural chemistry, summed up his exhaustive researches on the nitrogenous manuring of plants with Chili saltpetre, salts of ammonia and calcium cyanamide as follows: "The prospects for an advantageous use of calcium cyanamide are very bright, especially as regards its use for winter fruits. Calcium cyanamide can only be harmful in agricultural practice when it is submitted to abnormal decomposition by unfavourable circumstances. Such conditions are especially present in the cultivation of poor lands, such as high moorland and sandy soils which are inclined to be acid, and though rich in vegetable properties are poor in lime. It is, however, well known that this soil behaves in an abnormal manner to other nitrogenous manures. In order to prevent the unsuitable conditions of acid soil previous liming is necessary."

It was, besides, only natural that the manufacturers who were not in a position to turn out manure in bulk complying with all these demands should not have been very favourable. To day, however, things are very different. A product is actually manufactured containing 20 per cent. and upwards of nitrogen—that is, considerably more than did the earlier products—which recently has further been submitted to a successful dust-removing process, is packed in air-tight sacks, and its efficacy appreciably increased thereby; there can be no longer any doubt that calcium cyanamide is in a position to compete industrially with any other nitrogenous manure. In this connection the question of price is of the highest importance. Now, as the cyanamide industry has been perfected in the course of the last few years, it must be considered to form, on the basis of the percentage of available nitrogen, the cheapest, and therefore for agriculturists the most economical, manure of the present time. When the first consignments of calcium cyanamide were placed on the market the question of packing and storing was not fully understood. The result was that the product absorbed a large amount of free lime which, under the influence of atmospheric moisture was naturally converted into calcium hydrate. This caused such a large increase in the volume of the material that the jute sacks containing it burst. The theoretical proportion of nitrogen showed a decrease which was not ascribed, as it should have been, to the increase in total weight but was thought to be due to the fact that nitrolim lost nitrogen in some form or other when stored. Scientific research has shown conclusively, however, that calcium cyanamide may be kept stable for years without losing its nitrogen. The technical authorities have also taken notice of this fault, as mentioned above, and calcium cyanamide is now supplied by the manufacturers practically free from the influence of atmospheric moisture and packed in double paper and jute sacks.

It has a further merit, which is of great importance in agricultural operations where elaborate appliances are wanting; calcium cyanamide can be mixed with most widely different manures without loss. For instance, mixed manures of cyanamide and potassium salts, basic slag, &c., may be mentioned which have been found eminently successful in practice. Some difficulty is met in mixing cyanamide with superphosphate, as the free phosphoric acid combines with the free lime of the cyanamide, and is changed from the water soluble to the citric soluble form. To a certain extent this is not preventable, but the interesting and exhaustive work of Prof. Hall, the well-known agricultural chemist and director of the Rothamsted agricultural farm, on this subject has proved that by observing certain conditions the mixing of superphosphate with cyanamide can be easily accomplished, and is both successful and economical.

What makes cyanamide especially valuable as a manure is its after effects. It is generally decomposed by the chemical and bacteriological constituents of the soil into ammonia, which becomes fixed by the vegetable mould, and is not, as with Chili saltpetre, liable to be washed into the drains and so practically lost. For this reason cyanamide which has not been used during the first harvest is always available for the second. Researches on this subject show that the after effects of cyanamide can be very considerable according to circumstances, a property possessed by no other nitrogenous manure.

As regards the part which cyanamide or nitrolim plays in the soil various theories have been propounded. It appears that when brought in contact with the ground calcium cyanamide is first decomposed through the action of the moisture and of the carbonic acid in the soil into free cyanamide and carbonate of lime according to the formula

$$CaCN_2 + H_2O + CO_2 = H_2CN_2 + CaCO_3.$$

The free cyanamide will then, by absorbing water, probably be further decomposed into urea

$$H_2CN_2 + H_2O = CO\begin{matrix}NH_2\\NH_2\end{matrix}.$$

The final product of this decomposition has been found to be ammonia, but later nitrate is produced through the nitrification of the ammonia. Special experiments have demonstrated that the process of transformation of calcium cyanamide or nitrolim is assisted

* Paper read before the Faraday Society, slightly abbreviated.

by a host of microbes which are to be found in almost all cultivated soil. On this point very important and interesting investigation has been carried out quite recently by Dr. Lohnis and Sabaschnikoff,* of Leipzig, and Dr. R. Perotti, of Rome.†

It is, however, not only to the production of fertilisers that the scope of the new calcium cyanamide industry has been limited, for it has been also successfully extended to the production from nitrolim of a number of chemical substances to a great extent by utilising derivative forms of reaction long known to science. Although calcium cyanamide does not display the typical character of the cyanamides, it can, by melting with fluxes, be turned into calcium cyanide, which product can then be treated by well-known methods to yield pure cyanide of potassium or sodium. The molten mass obtained by melting nitrolim with a flux contains approximately an amount of cyanide corresponding to 25 per cent. KCN., the cost of the said molten mixture, to which the name of "surrogate" has been given, being much less than that of an equivalent amount of pure cyanide of potassium, and the material having been shown by the investigations of English experts to be of equal efficiency with pure cyanide of potassium for the extraction of gold and silver. It appears particularly suited to the requirements of the countries where gold and silver are mined, as it can be produced with difficulty at the mine itself where it is to be used.

The production of ammonia and ammoniacal salts from nitrogen, to which I have made reference previously, has also been further worked out and perfected on an industrial scale. You will readily understand that the ammonia obtained by heating $CaCN_2$ with water is very pure and free of empyreuma. It is therefore particularly suitable for the production of pure ammoniacal salts as well as liquid ammonia.

Further, the author would point out that a number of complex organic nitrogenous compounds have been derived from calcium

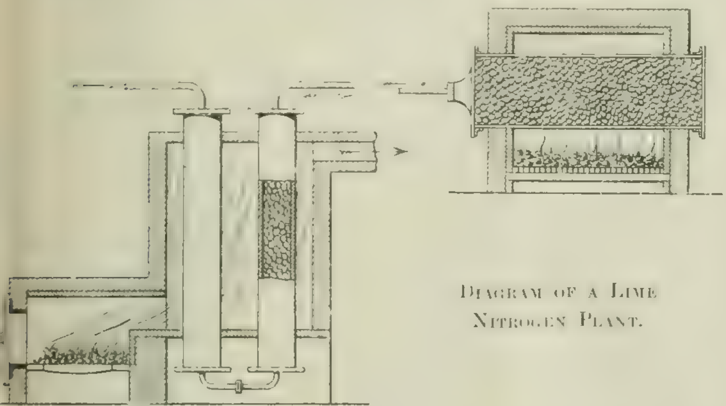


Diagram of a Lime Nitrogen Plant.

cyanamide, and are already being produced on a manufacturing scale. Out of the great number of these I will only mention dicyandiamide ($CNNH_2$), $(—)_2$, for which there is an increasing demand in Germany for the manufacture of organic dyes, besides which there are urea $CONH_2$ and sulphourea $CSNH_2NH_2$.

The author would also mention that one of the German companies is producing from nitrolim the salts of guanidine, such as carbonate and nitrate of guanidine, nitro-guanidine and other salts, all of which should now gradually come into use on an increasing scale in the industries of organic chemistry, as the cost of production will be considerably lower when starting from calcium cyanamide than by the methods of manufacture hitherto employed. Recently attention has been paid to the use of nitrate of guanidine, nitro-guanidine and dicyandiamide as a "deterrent" for reducing the temperature of combustion with explosives and gunpowder. In consequence of the high content of inert nitrogen in dicyandiamide (66 6 per cent.) it evolves a strong pressure when burnt in a gun, and in contradistinction to the other constituents of the explosive which contain more carbon and hydrogen, its decomposition produces but little heat. This peculiarity is of great importance in powder used with ordnance, such as cordite and filite, which, because of the high temperature of combustion, rapidly destroy the rifling of the barrels. With many powder mixtures the cooling action of dicyandiamide is shown by the disappearance of the flash at the muzzle, so that on discharge both powder smoke and powder flash are done away with.

The composition of the crude cyanamide of calcium made it appear likely that it would lend itself quite as well as yellow prussiate and potassium cyanide for use in case-hardening and tempering of iron and steel. Tests carried out to this end have confirmed this impression. It has been shown that by adding certain fluxes to the crude cyanamide of calcium a very high hardening effect can be produced. This new hardening mixture, under the name "ferrodur," has been introduced on the market in Germany, England and other countries, and its property of producing an extraordinary depth of the hardened surface without the material being at all deteriorated has already secured it a great number of friends.

The carbide coming from the electric furnaces is ground, charged into retorts made of fireproof material which are mounted in a furnace similar to gas-house furnaces (*see* Fig.). The nitrogen is then passed over the carbide at a temperature of from 800°C. to 1,000°C. The carbide used is of the same quality and percentage as that employed for lighting purposes, and the nitrogen consumed is obtained by fractional distillation of liquefied air by the Linde system, or the so-called "copper" process, in which air has passed through heated copper particles. The copper takes up the oxygen and the free nitrogen passes to the furnaces. The resulting copper oxide is reduced in the same apparatus by treatment with reducing gases or vapours, and the copper which is recovered is then ready for a new cycle. In the Linde process the oxygen remaining after separation of the nitrogen may be utilised for any purposes. As soon as the carbide in the retorts is saturated with nitrogen, a fact which will be made apparent by the controlling gas meter coming to a standstill, the calcium cyanamide is extracted from the retorts in the form of a hard cake and cooled while the air is excluded. It is then ground into a fine powder and is ready for use. During the last year a new electric furnace has been developed for treating carbide with nitrogen, and is being universally adopted by all the new cyanamide factories in preference to the older retorts. This process is cheaper to instal and to operate where the cost of power is lower than the retort furnaces just described; and notwithstanding that the average life of the retorts has been greatly prolonged, the new electric furnace is cheaper to maintain, possessing practically an unlimited life.

Crude nitrolim contains about 57·63 per cent of the pure cyanamide of calcium, so that its total contents in nitrogen will amount to roundly 20 to 22 per cent., the same as sulphate of ammonia. The material contains besides this about 20 per cent. of calcium oxide, 7 to 8 per cent. of silicious acid, iron oxide and alumina and 14 per cent. of carbon, which imparts to the product its characteristic slate-black colour.

Most carbide works obtain at the present time a yield of 2 tons of carbide per kilowatt year, and 2 tons of carbide will combine with practically 500 kg. of nitrogen in the form of nitrolim; a power of 2 kw. or $2\frac{2}{3}$ H.P. is required per year for fixing 1 ton of nitrogen by the Frank-Caro process. In addition thereto, about $\frac{1}{3}$ H.P. is required for grinding and all other operations. If, therefore, it were proposed to substitute nitrolim for the nitrate of soda at present consumed in the world, it would require plants disposing of no less than 800,000 H.P. to do so.

It goes without saying that before the process of making nitrolim could be developed on an industrial scale, its value as a fertiliser had first to be ascertained. And as it naturally took a number of years to complete the exhaustive agricultural researches instituted for this purpose sufficiently to make them conclusive, it will not surprise you, gentlemen, that it was only about three years ago that the question of putting up industrial works was attacked.

About that time the Cyanid-Gesellschaft, in conjunction with two important Italian companies chiefly interested in the manufacture of calcium carbide, promoted, under the management of Cav-Morani, the founder of the Italian Carbide Industry, the Societa Generale per la Cianamide in Rome.

The first plant on a large industrial scale was started about $2\frac{1}{2}$ years ago at Piano d'Orta in Central Italy near the Adriatic Sea, for a yearly production of 4,000 tons of lime nitrogen, and is just now being enlarged to a capacity of 10,000 tons. In addition to this, the Societa Generale is also about to appropriate a large water power it owns in Italy for the erection of other works. One is ready to start in Terni in connection with the large carbide factories there, and another factory is in course of erection in San Michel in the Val d'Aosta. There are at present in Austria-Hungary important cyanamide works in course of erection, all promoted by the Societa Generale of Rome. In Sebenico, in Dalmatia, at the carbide works one is being built for an initial yearly production of 4,000 tons. At Fiume, in Istria, works are also in construction for a similar output. At the present time a water power installation of at least 50,000 H.P. is being erected at Almissa, also in Dalmatia, for the manufacture of this new artificial manure. The market for the products of these works will be the Balkans, Asia Minor, and Egypt, where, owing to the practice of irrigation, nitrolim will be of special value to agriculture. In France the Société Francaise des Produits Azotés installed works a few months ago at Nôtre Dame de Briançon (Haute Savoie), for the manufacture of cyanamide, with an output of about 4,000 tons per annum. In the Rhone Valley in Switzerland the Société Suisse des Produits Azotés has just opened equally important works. In Germany, the works at Westeregeln and Brühl on the Rhine are manufacturing 10,000 tons of nitrolim annually. It is interesting to mention that the works at Brühl for the preparation of

* "Untersuchungen uber Kalkstickstoff und Stickstoffkalk," von Dr. Alers Sabaschnikoff. Berlin, 1908, Verlag von Paul Pavey.

† Dottore Renato Perotti, "Su i bacteri della diciandiamide." Roma Typographia Enriev Voghera, 1908.

carbide do not employ water-power, but produce the power required in the works themselves, using cheap coal in large quantities for this purpose. Another installation is that of the Brandenburgischer Carbidwerke for the preparation of nitrolim with an output of 2,500 tons per annum, near Bromberg, in North Germany, which is also completed, while the large works of the Cyanid Gesellschaft for an output of over 15,000 tons of nitrolim at Alz-Fluss, in Bavaria, are at present in construction. In the United States of North America the American Cyanamide Co. has taken up the manufacture of nitrolim, and are constructing on the Canadian side of the Niagara Falls works of a present capacity of from 5,000 to 6,000 tons per annum, to be enlarged later to an output of 40,000 tons. It is quite natural that English enterprise should have given this new artificial fertiliser considerable attention. The North-Western Cyanamide Co. (Ltd.) with a capital of £120,000, was incorporated in the middle of 1906 to acquire from the Societa Generale and work licences for the manufacture and sale of cyanamide in a vast territory comprising the United Kingdom, the colonies, protectorates and dependencies (excepting Canada and Egypt) and a large portion of the North-West of Europe—viz., Norway, Sweden and Belgium—with 30 per cent. of the consumption of Denmark, Germany and Holland. The Sun Gas Company, now widely known as the Alby United Carbide Factories (Ltd.), and their able board of directors, Mr. Albert Vickers, Sir Vincent Caillard, Mr. A. E. Barton, and others, took a leading part, with the co operation and assistance of the Societa Generale, of Rome, in the promotion of the North-Western Cyanamide Co., the Alby Company undertaking the erection of a new factory adjoining to that of the North-Western Company to supply them with the requisite carbide. These works, erected at Odda, which is situated at the head of the beautiful Hardanjer Fjord you will see in the accompanying picture, which shows the carbide works and the adjoining nitrolim works, which are the largest at present constructed. The capacity of the cyanamide works at present is 12,500 tons of nitrolim, and is laid out so as to be eventually enlarged to 50,000 tons. The nitrogen is produced by the largest Linde pump ever erected, with a capacity of 375 cubic metres per hour, and the latest electrical furnaces are there installed. The author wishes to point out here that the works at Odda, which produce 2,500 tons of nitrogen, only employ from 5,000 to 6,000 kw., whereas from the statement of Mr. Eyde, it appears that in the works at Notodden, in Norway, for the preparation of an equivalent amount of nitrogen in the form of nitrate of calcium, 25,000 kw. are required.

In order to complete the review which the author has made of the works already erected for the preparation of nitrogenous fertilisers, it should be stated that the British allies in the Far East, the Japanese, are erecting in the south of the Kinskzu Island a works capable of producing 4,000 tons per annum, so that the manufacture of the new fertiliser will soon be localised all over the world. At the end of the present year works for a total production of over 45,000 tons of nitrogen will be in full swing, and in the course of next year there wi l be a correspondingly large increase in the means of production of this product. Though these figures may appear relatively high, they are quite diminutive in comparison with the continual increase in the demand for nitrogenous food for our agriculture, which in Germany alone at the present time shows an annual increase of 15,000 tons of nitrogen. It would be an error to assume that the competition of calcium cyanamide on the fertiliser market with Chili saltpetre, sulphate of ammonia, or Norwegian saltpetre can take on the character of a war of annihilation, as was the case with artificial indigo in respect to the natural product. On the contrary, industry and agriculture will welcome increasingly large quantities of nitrogen, tending to prevent the rising in the prices of the nitrogenous foods required for the development of plant life.

The Question of Supply Voltage.—In a recent number of the *Elektrotechnische Zeitschrift* C. Heim discusses this question from a German point of view, taking as the basis of his arguments the way in which the majority of stations built at any one time fall into one or other of two distinct classes. The electricity works statistics for 1907 show that in stations, both small and great, erected since 1900 the supply has been more often nearer to 220 than to 110 volts. This tendency to higher voltages is still going on, even in villages and small towns where there is no special reason therefor. The author considers that this result is probably due to attempts to develop electricity for power purposes. In fact, in some cases this has been carried to such an extent that it is used for works driving, while gas is still employed for lighting. It is said that the long expected development in metallic filament lamps can only take place in those districts where a voltage not exceeding 110 volts is supplied to consumers. For the purposes required an alternating current system possesses the most advantages.

MANCHESTER ELECTRICAL EXHIBITION, 1908.

We have received the following list of exhibitors to date at the forthcoming electrical exhibition at Manchester :—

Adams Mfg. Co.
Aerators Limited
Allen Clement
Arcalia Elec. Mfg. Co.
Areo Auto. Fire Alarm Co.
Aron Electricity Meter
Ashton, H.
Babcock & Wilcox
Bailey, W. H., & Co.
Bates, W. J., & Co.
Batty, W., & Sons
Beanland, Perkin & Co.
Berry, Skinner & Co.
Blackwell, R. W., & Co.
Boddy, G. M., & Co.
Brady, G., & Co.
Bray, Markham & Reiss
British Insulated & Helsby Cables
Brit. Westinghouse Co.
Broadbent, T. W. (Ltd.)
Browett, Lindley & Co.
Brown, Boveri & Co.
Brown, F. V., & Co.
Bruce Peebles & Co.
Bullers Limited
Bullough's Adjustable Rail Joint Support Co.
Calmon Asb. & Rubber Works
Carbone, Le [ham
Chamberlain & Hook-
Chorlton & Knowles
Churchill, Chas., & Co.
Climax Fire Ex. Co.
Clipper Belt Hook Co.
Collier, J., & Co.
Concordia Elec. Wire Co
Congdon & Muir
Consolidated Pneumatic Tool Co.
Crossley Bros.
Crypto Electrical Co.
Cunliffe & Croom
Cutler, Wardle & Co.
Daniels, T. H. & J.
Dey Time Registers
Diesel Engine Co.
D.P. Battery Co.
Drake & Gorham
Dryden & Co.
Dugdill, John & Co.
Ebenestos Mfg. Co.
Eckstein, Heap & Co.
Edison & Swan Co.
"Electric Journal"
Electric & Ord Accessories Co.
"Electrical Engineer"
"Electrical Field"
"Electrical Magazine"
Elec Power Storage Co.
Electrical Press
"Electrical Review"
"Electrical Times"
Electrician Printing & Publishing Co.
Electromotors Limited
Elliott Bros.
Emmott & Co.
"Engineer"
Ernst, F., & Co.
Evans, E. M., & Son
Evershed & Vignoles
Falk, Stadelman & Co.
Faulkner, John
Ferranti Limited
Galloways Limited
General Electric Co.
Gilbert Arc Lamp Co.
Glyco Metal Co
Goodalls
Green, E., & Son
Grevener, J. & H.
Hacking & Co
Hall, J. P., & Co.
Hans Renold (Ltd.)
Harland, G. Bowden, & Co.
Hart Accumulator Co.
Heatley Gresham Eng. Co.
Hebblewaite Bros.
Herbert, Alfred (Ltd.)
Heyde, J. B. von der
Hodgkinson, Jas. (Ltd.)
Hoffman Mfg. Co.
Hopkinson, J., & Co
Howard Asphalt Co.
Howden, J., & Co.
Howell, W. R., & Co.
Int. Electric Co.
Int. Time Recording Co.
Kendal, J. Lomax & Co.
Kennedy Bending Machine Co.
Kent, Geo. (Ltd.)
Kenyon, Alex., & Co.
Kerr, J., & Co.
Key Engineering Co.
Kilowatt Publishing Co.
Kirkpatrick & Rastall
Lancashire Dynamo & Motor Co.
Lancashire Elec. Power
Lea, J. E. [Co.
Liverpool Elec. Cable Co.
Loewe, Ludw., & Co
Luke & Spencer
Lyle Trading & Mfg. Co.
McDermott, R. W.
Manchester Corporation (Elec. Dept.)
Marshall, Percival & Co.
Massey, B. & S
Matthews & Yates
Mayer & Schmidt [Day
Mirrlees, Bickerton &
Mirrlees, Watson Co
Mitcham Elec. Fan Co.
Morgan Crucible Co
Morton & Co
Musgrave, J., & Sons
Nalder Bros. & Thompson
National Gas Engine Co
National Telephone Co.
New Gutta Percha Co.
Naremburg Engine Co.
O'Brien & Co.
Oliver Arc Lamp
Oliver Machinery Co.
Parmiter, Hope & Sugden
Parsons, C. A., & Co.
Pearn, F., & Co.
Pearson & Co.
Phillips Commutator Grinder Co.
Pinchin, Johnson & Co.
Pollock & McNab
Post Office
Power Plant Co. [Co.
Premier Accumulator
Premier Elec. Lamp Co.
Price, Chas., & Son
Price's Patent Candle Co
Proctor, Jas. (Ltd.)
Rapid Mag. Machine Co
Reyrolle, A., & Co
Rhodes, J., & Sons
Richards, G., & Co.
Ripolin Limited
Robertson Elec. Lamps
Robinson, Thos., & Son
Ronald Mfg. Co.
Ross, A., Hotchkiss & Co
Sanders, Rehders & Co.
Schaffer & Budenberg
Shaw, J., & Son [Wks.
Siemens Bros. Dynamo
Sisson, W., & Co.
Small Power Dynamo & Motor Co.
Smith, F., & Co.
Standard Machine Wks
Steinthall & Boydell
Stubbs J., & Co
Sub-station—
Brit. Westinghouse Co.
Bruce Peebles & Co.
Ferranti Limited
General Electric Co
Sunbeam Lamp Co.
Supplies Limited
Synchronome Co.
Taylor, Garnett & Evans & Co.
Taylor, Tunnicliffe & Co.
Thomas, Bertram
Traun, Dr. Heinr., & Sons
Union Electric Co
Union Standard Machine Co
U.S. Metallic Packing Co
Wallwork, H., & Co.
Walsall Hardware Mfg.
Whipp & Bourne [Co.
Wilson, L. E., & Co
Worthington Pump Co.

MUNICIPAL, FOREIGN & GENERAL NOTES.

APPOINTMENTS VACANT AND FILLED.

The position of Principal of the Durban (Natal) Technical Institute is vacant. Applicants for the post must be graduates in science, with experience of the work of technical institutions. Three years' engagement. Salary £25 per month, advancing by increments of £24 per annum for second and third years. Applications to the chairman of the Council (Dr. S. G. Campbell), Durban, Natal, by Sept. 15.

There are vacancies in the electrical engineer's department, Devonport Dockyard, for three sub station attendants having good experience in batteries and automatic boosters. Applications to the Electrical Engineer, H.M. Dockyard (North), Devonport.

A foreman is required by the Ceylon Government for telephone line construction. Salary 2,400 rupees per annum. Applications to the Crown Agents for the Colonies, Whitehall-gardens, S.W., by Aug. 24.

A sub-inspector of scientific supplies, preferably with some electrical training, is required for the India Store Depot, Belvedere-road, London, S.E. Salary 18s., rising to 24s. per week. Particulars from the Director General of Stores, India Office, Whitehall, London, S.W., until Aug. 31.

Mr. A. R. Howden, of Dundee, has been appointed station superintendent at Dumbarton.

Mr. W. J. Horne, lecturer in physics at the South African College, Capetown, has been appointed inspector of technical education by the Transvaal Department of Public Education.

EDUCATIONAL NOTICES.

University of Leeds.—The next session begins on Oct. 5, and the large new building, completely equipped for instruction in electrical engineering, will then be available. The courses include lectures, design and practical work, and provide systematic training for students preparing for the profession of an electrical engineer with or without the degree of B.Sc. in electrical engineering. Prospectuses from the Registrar.

University of Glasgow.—The session commences on Oct. 12 and ends on March 18, 1909. There are courses of instruction in engineering, mining, naval architecture, &c., and students usually spend the summer months in practical work, thus receiving their training on the sandwich system. Prospectuses of the courses for the degrees of B.Sc. and D.Sc. in engineering, and a syllabus of courses will be forwarded on application to the Assistant Clerk, Matriculation Office, The University, Glasgow.

Armstrong College (Newcastle-on-Tyne).—The session 1908-9 will commence on Sept. 28. There are complete courses of instruction in mechanical, civil, electrical and marine engineering, naval architecture, mining, metallurgy, &c. Particulars from the secretary (Mr. F. H. Pruen).

Glasgow & West of Scotland Technical College.—The next session begins on Sept. 21 in the new building recently erected for the college. The diploma of the college is granted in civil, mechanical, and electrical engineering, mining, naval architecture, chemistry, metallurgy, mathematics and physics. The courses of study for the diploma usually extend over three sessions, and holders of the diploma are eligible for the degree of B.Sc. in engineering of the University of Glasgow after attendance for at least one session. New and well equipped laboratories have been provided in the departments of physics, chemistry, technical chemistry, electrical engineering, motive power engineering, mechanics and metallurgy, and facilities for research are afforded. Preliminary examination for candidates for the diploma begins on Sept. 14. Prospectus gratis from the secretary of the College.

We have received a copy of the calendar of the college for the 112th session (1908-9). Full particulars are given of the courses of instruction, classes (day and evening), diplomas, examinations, bursaries, &c. Special attention is devoted to engineering (electrical, civil and mechanical), mining, naval architecture, &c., but general commercial subjects are also well catered for.

Merchant Venturers' Technical College (Bristol.)—The Calendar for the 53rd session (1908-9) contains particulars of the courses of instruction in engineering, physics, chemistry, &c. The engineering courses extend over four years and cover the requirements of the B.Sc. degree in engineering of the University of London. There are day and evening classes in all science and commercial subjects. Copies of the Calendar may be obtained from the College, price 6d.

Battersea Polytechnic (London, S.W.)—At this polytechnic there are day and evening courses of instruction. The day courses include preparation for the B.Sc. in engineering of the University of London and the polytechnic diploma in (*a*) mechanical, (*b*) electrical and (*c*) civil engineering. The entrance examination begins on Sept. 15. The evening classes include preparation for the B.Sc. in engineering, associateship examination of the I.C.E., &c. Prospectus on application to the Secretary.

Hackney Technical Institute, London, N.E.—The next session commences on Sept. 21. There will be evening lecture and laboratory courses in electrical engineering subjects, including electrical measurements, dynamos and motors, alternating currents, electrical design, &c. Prospectuses from the Principal.

South-Western Polytechnic (Chelsea, London, S.W.)—A complete three years' course in electrical engineering is held during the day and a four years' course in the evening. There are courses of lectures and practical work in elementary, intermediate and advanced electrical engineering, electrical design, instruments and lamps, alternating and polyphase currents, electric wiring and fitting, calculus for engineers, &c.

University College, Dundee.—The work of erecting the Peters electrical laboratory is being proceeded with.

The laboratory is being erected by Mrs. Garden and Miss Peters as a memorial to their brother, the late Lord Dean of Guild Peters and £4,000 is to be spent in erecting and equipping it. The new building will occupy a site to the north of the physics laboratory. The ground floor will comprise the battery room, high tension instruments room, alternating current room and accommodation for dynamos and motors. The first floor will be divided into lecture, photometric and testing rooms. The building is estimated to cost £2,792, the remainder of the £4,000 being expended on equipment.

Aberdeen.—In March last Mr. R. S. Pilcher made an application for an increase of salary, but the Tramways committee decided, by 7 votes to 3, to recommend that, as Mr. Pilcher had been connected with Aberdeen tramways less than 2½ years, the increase of salary should not be granted. Mr. Pilcher, in view of this decision, has withdrawn his application.

The Electrobus.—The Council have referred to the magistrates an application by the London Electrobus Co. for a licence to start a service of electrobuses on suitable routes in Aberdeen—where the city is not served by the electric tramway service. The vehicle the company proposed to run would be identical with the London type, except that a more suitable type of body would be provided, consisting of a single decker with separate smoker and non-smoker compartments.

Aberdeen District committee are disposed to accept the Council's terms for supply of electrical energy for lighting Culter. Following are the heads of agreement suggested by the municipal electricity department:—

The agreement to be for five years; at least 50 lamps to be erected; the electricity department to light and extinguish lamps; the hours of lighting to be approximately 1,318·5 hours per annum; each public lamp to be 50 c.p.; the District committee to pay for the installation of each lamp, £2. 5s.; supply for the above hours per annum to be given at the rate of 25s. per lamp per annum; rentals of cables and renewals to be given at the rate of 10s. per lamp per annum; all lamp posts on the main road to be of cast iron of the pattern used at Cults, and in side roads brackets to be fitted on wooden poles, the same poles also to be used for carrying overhead cables for supply purposes, and the District committee to grant the privilege of erecting the poles without rental.

The capital outlay for 50 lamps (at £2. 5s. each) would be £112. 10s., the annual charge for current £62. 10s., and the rental of cables £25.

Argentina.—A review of the trade and commerce of Rosario for 1907 by Mr. Consul H. M. Mallet describes the commercial outlook of that city as decidedly favourable, and statistics prove that the demand for British manufactured goods show steady development, especially in regard to machinery and tools. In the supply of rolling stock for railways and electric tramways, the United Kingdom ranks first. Particulars are given of a contract recently completed by a locally-formed joint stock company for a grain elevator, said to be one of the largest and best fitted in South America, at a cost of 5,000,000 fr.

4,000 tons of iron have been used in its construction, and the main building is 47 metres (154 ft.) high and is almost fireproof. 1,000 tons can be loaded per hour and eight large vessels can be berthed alongside to receive grain in bulk or bag. Grain can be received off railway wagon at the rate of 500 tons per hour. All facilities, worked by machinery of the most modern type, have been provided for handling, classifying, cleaning, drying and weighing of grain in bulk or bag. Attached to the works at the port is an up-to-date generating and distributing plant for supplying electric current to the elevator, winches, bands, lighting, &c. The machinery consists of five sets of 1,500 H.P. each.

Tramways.—The electric tramway service of the Rosario Tramways Co. (a Belgian company) is nearing completion and several sections were opened during 1907. The length of track when completed will be 75 miles, and the total cost 18,000,000 fr.

Electricity Supply.—The important undertaking of the Rosario Electric Co., whose head offices are at 52, Moorgate-street, London, E.C., supplies electric current for public and private lighting and power, &c. During the year a powerful engine has been added to the works and other important improvements are being carried out to meet the increasing demands for energy.

Australasia.—"The Australian Mining Standard" states that the work of placing the telephone wires underground in *Melbourne* is proceeding rapidly. When completed, the total length of tunnels will be about 2½ miles.

The tunnels will be from 25 ft. to 30 ft. from the surface, and when floors and walls have been formed with concrete, and the brick arch built over the top, the inside measurements will be 6 ft. 6 in. in height and 4 ft. 6 in. wide. The cables will be carried along the walls on hooks and packs, the whole being enclosed in lead covering. Access to the tunnels will be by manholes, ventilation being provided for 9 in. pipes, which will reach the footways. The underground operations are being carried out by electric light, and electric power is employed for the winding gear at the top of the shafts. A new common battery switch board is being constructed by the Western Electric Co., and tenders are to be invited for 74 miles of underground cable.

Cottesloe (W.A.) Electric Light & Gas Co. (Messrs. Splatt, Wall & Co.) have offered to provide and erect 100 lamps and to reduce the charge for electric lighting by 5s. per lamp per month, provided the Council enter into a five years' contract for public lighting.

Tenders are to be invited for the supply of electricity for public and private lighting in *Terang* and *Camperdown* (Victoria).

The directors of the *Korumburra* (Victoria) co-operative butter factory have submitted to the councillors of Korumburra riding a scheme for electric lighting the streets of the town.

The Victorian Executive Council have empowered the Councils of *Malvern* and *Prahran* to proceed with the construction of the Malvern-Prahran electric tramway. The lines will be constructed on the standard gauge, and the maximum speed for cars equipped with hand-brakes is to be 15 miles an hour, those having magnetic, air or other approved power brake extending to 20 miles. The first portion of the new line must be completed and ready for opening within two years of the payment of £13,000 to the Railway Commissioners in respect to the necessary regrading work, and the line on other routes within 10 years.

For the year ended June there was a deficit of £5,450 on the working of the *St. Kilda-Brighton* (Victoria) electric tramway. The result would have been different but for extraordinary expenditure incurred in consequence of the fire at the power house in March, 1907.

Bendigo (Victoria) City Council are considering a report by the city surveyor (Mr. Richardson) recommending the utilisation of the water power available in the Coliban water race, between Sedgwick and the Crusoe reservoir, for generating electricity for public lighting in the city and suburbs. Mr. Richardson estimates the cost of supplying and erecting water turbines and electric generators, including a transmission line to the city boundary, at £10,260.

Banbridge (Ireland).—A committee of the Council is to be formed to collect information as to the practicability of an electricity supply scheme.

Barnes.—The Council have authorised the laying of distributing cables to supply electric current in two districts, where 50 and 20 houses respectively are being wired.

The electrical engineer (Mr. C. S. Davidson) has been instructed to instal a Lea recorder at a cost of 60 guineas.

Belfast.—The Queen's-road electric tramway route is now open for traffic.

Benwell and Fenham.—Residents are becoming impatient of the long delay in introducing electricity supply into this district, and last week a meeting of protest was held.

The chairman (Mr. H. Shaw) explained that in 1901 Benwell and Fenham Council obtained an electric lighting order, and in 1904 an arrangement was made with Newcastle & District Electric Supply Co. by which the Council would lay mains and the company supply current. Soon after the district was merged in the city, and no attempt was made to carry out the agreement. The Corporation subsequently decided to carry out the agreement, and applied to the L G. Board for £6,000 loan for laying mains. The application was refused. Further schemes were prepared by the Corporation, but so far nothing had been done.

Sir B. C. Browne said it was a minor question whether the Corporation or the company supplied current. Electric light was as great a necessity to a town as water.

A motion was passed calling upon the Corporation to supply an efficient electric light service without delay, and appointing a deputation to urge the Corporation to allow the company to do so until a satisfactory solution of the matter was arrived at.

Blandford.—The members of the local Council are very dissatisfied with the present system of gas lighting, and at a recent meeting the following resolution was passed :—

> That owing to the unsatisfactory lighting of the town by the gas company steps be taken to inquire under what terms and conditions an electric light company would undertake the public lighting.

Bulk Supply by Electricity Consumers.—Recently the Empire Palace (Ealing), Ltd., were summoned by Ealing Corporation for supplying current in bulk to a restaurant on the theatre premises occupied by Liptons Limited, but the Brentford magistrates, who heard the case, dismissed the information under the provisions of sec. 1 (3) of the Probation of Offenders' Act, 1907, but ordered defendants to pay £2. 2s. costs, as a technical offence had been committed. An appeal against the latter part of the decision has been lodged.

Burnley.—Mr. J. M. Grey, chairman of the Electricity committee, has been elected an alderman.

Chalfont St. Peter (Middlesex).—The Parish Council have called for tenders for lighting the public lamps by electricity or gas.

Country House Lighting. Electric lighting has been introduced at Tanderagee Castle, the Irish seat of the Duke of Manchester. The wiring and installation work was carried out by Messrs. Mavor & Coulson, Glasgow.

The plant consists of a dry back boiler supplying steam at 100 lb. pressure to a single acting automatic engine, developing 25 B.H.P. The engine is direct coupled to and mounted on the same bedplate with a shunt wound dynamo, supplying current to charge a 54 cell accumulator, capable of supplying the lamps in use at the castle. The switch board is arranged for any combination connection between the dynamo and the accumulator and lamp circuits. The cables and wiring are all on the firm's "C.C." system of concentric wiring, and the generating plant was also manufactured by the firm.

The Duke of Atholl has adopted electric lighting at Blair Castle, and the village of Blair Atholl is also now lighted electrically. The water power of the Slannchaidh Burn is used in generating electrical energy. The power available has met all requirements, and there is sufficient reserve to permit of an extension of the service to Glentilt. The wiring work was executed by Mr. Massey, of Kendal, and the electrical fittings were supplied by Messrs. Bell, Shaw & Co., of Glasgow.

Crayford.—A committee of the Parish Council has been formed to consider the question of introducing electricity supply. Councillor Hopper, who is the leading advocate of electric lighting in the district, is confident that the public lighting could be effected much better and cheaper by electricity than by gas.

Doncaster.—The salary of the assistant electrical engineer (Mr. G. A. Roberts) is to be increased from £150 to £200 by annual increments of £12. 10s.

Dundee.—During the interval in which His Majesty's Theatre has been closed a complete electrical equipment has been installed. Not a single gas jet is now to be found behind the scenes, while electric light has given the inside of the building a beautifully bright and wholesome appearance. The work has been carried out by the chief electrician of the theatre, while Mr. Richardson, the City electrical engineer, has also given his advice and assistance in the carrying out of the work.

The Tramways committee recommend that the salary of the tramways manager (Mr. P. Fisher) be increased from £500 to £600 per annum.

Dunfermline.—On Tuesday the Council disposed of the electric lighting question, which has been before the Council for upwards of three years.

It was decided to accept the offer of the Fife Electric Power Co. to take a transfer of the Dunfermline provisional order, and to establish and maintain electricity works for 30 years, after which the Corporation reserve the right of purchase. The company also pay the expenses of the Corporation in obtaining the order.

Electricity in the Home.—The City of London Electric Lighting Co. is issuing a card inviting visitors to the Franco-British Exhibition to inspect the capital display of electric lighting, heating and cooking appliances shown in operation by the electric supply companies of London.

Finland.—The electric railway from Hyvinge station to the Nääs estate in Helsingfors, 9 3 miles in length, built at a cost of about £16,000, has been in operation since Jan., 1908, and was recently officially inaugurated. The line may probably be extended to the towns of Hangö and Forssa.

The Helsingfors telephone service already exceeds 7,000 subscribers out of a population of 160,000 persons. The telephone is not a Government monopoly, and the subscription in no case exceeds £3. 3s. per annum.

Fire.—A fire broke out on Monday at the works of the Portpatrick Electric Supply Co., at Craigoch Glen, which resulted in considerable damage to the buildings and machinery.

Folkestone, Sandgate and Hythe Tramways.—Hythe Council have acquiesced in the proposal of the National Electric Construction Co. to substitute the overhead for the Dolter surface contact system of traction on these lines.

Foreign Contracts.—The "Glasgow Herald" of the 15th inst. contains the following, presumably communicated by the Board of Trade :—

> The Glasgow Chamber of Commerce notifies its members and others interested that information of a confidential nature has been received from the Commercial Intelligence Branch of the Board of Trade relating to tenders for steel rails, railway bridges, telegraph wire, &c., for *a certain foreign country*; also tenders for the supply of coal and bed plates for *a certain foreign country*, particulars of which may be obtained by members of the Chamber or by any other persons or firms of British nationality on application at the Chamber.

Why this secrecy? Is not the inquiry of general trade interest?

Glasgow.—At last week's meeting of the Corporation Mr. Jas. M'Farlane, chairman of the Tramways committee, referred to the contract for steel rails which had been placed with the Lorain Steel Co. of America.

Objection had (he said) been taken to the order going out of the country at a time when work was very scarce in the district. But the difference between the lowest British offer and the offer of the American company was £650. They had been dealing with the Lorain Co. for the past seven years, and the quality of their material was first rate and their work above reproach. When the matter was considered in committee they agreed, with one exception, that the order should go to the American company.

The minutes were confirmed.

Gravesend. Application has been made for sanction to a loan of £6,000 for extensions of the electricity undertaking.

Greenock.—On Tuesday Bailie Shankland presented the accounts of the electricity department for the past year, and said that though the actual profit on the year's working was not so large as on the two previous occasions, when the special difficulties were considered the result might be taken as the best since the undertaking commenced.

The price of coal had been high, and the preliminary expenses of the new works at Dellingburn were borne by revenue. There was an increase of output to private consumers of 41 per cent. Income from private lighting and power increased from £13,011 to £16,374. Gross profit was 6.3 per cent. on the average capital employed during the year. After paying interest (£5,415) there was a net balance of £384. For the coming year a net balance of fully £1,300 was expected.

Hindley.—The provisional electric lighting order (1901) has been extended for a year.

Hospital Lighting.—The L.G. Board have sanctioned a loan of £1,500 for the electric lighting of Lodgemoor hospital, Sheffield.

Kingston-on-Thames.—An unopposed inquiry was held on Tuesday into the application of the Corporation for sanction to borrow £12,600 for extending the electrical undertaking.

The Town Clerk (Mr H. A. Winser) stated that the total loans raised in connection with the undertaking amounted to £99,860, of which £71,840 remained to be paid. The undertaking was started in 1904, and last year there were 920 consumers for lighting and 104 for power. The revenue for the year ended March 31 was £11,190, and the expenditure (including redemption of loans) £12,074, showing a deficit of £884.

Kirkby-in-Ashfield.—The Council have decided to take no further steps to carry out the terms of their provisional electric lighting order.

L.C.C. Tramways.—The Board of Trade have asked St. Pancras Council for observations on the proposals of London County Council for electrifying the local tramways and connecting Hampstead-road with the Holborn lines by a new line. The conduit system is to be adopted, and it is proposed to construct a bridge at King's Cross to afford direct access from Gray's Inn road to Caledonian-road.

The route between King's Cross, via Caledonian-road, to Finsbury Park is now open for traffic.

Niagara Electric Power.—The Ontario Government has awarded a contract to Mr. F. H. McGingan for the construction of an electric power transmission line at £254,000. The line, which will be of aluminium, will be used to transmit cheap electric power generated at the Niagara Falls power station to many municipalities, especially in Western Ontario.

Presentations.—On Friday last Mr. A. R. Howden was, on the occasion of his leaving to take up the position of station superintendent at Dumbarton, presented by his colleagues in the electricity department with a case of compasses. Mr. C. Lamb, distribution engineer, made the presentation.

On the 10th inst. Mr. Jan Roothaan, head of the drawing office of Messrs. Ferranti Limited, was presented with a canteen by the staff of the company on the occasion of his marriage.

Reserve Funds of Electricity Undertakings.—The Secretary for Scotland has recently sanctioned a further loan of £7,000 for the Bo'ness electricity undertaking, increasing the total sum sanctioned to £36,000. In forwarding the sanction the Under-Secretary wrote as follows:—

On the question of forming a reserve fund I am to say that the Secretary for Scotland is unable to accept the view that the redemption of the loans in 30 years renders the formation of such a fund unnecessary. He understands that under their present working agreement with the National Electric Construction Co. the Town Council receive 6 per cent. annually from the company on the amount of capital borrowed for the undertaking, and that this is applied in paying interest on and redeeming the loans. The rate of interest (4 per cent.) at which the existing loads have been raised—having regard to the rates at which loans for burgh general purposes have been obtained in the same years, and to the fact that the burgh general assessment is assigned as security for the electricity loans along with revenues of the undertaking—seems to be high; but, even so, there will be a small margin left out of the 6 per cent. received from the company after paying debt charges, and this margin, as well as any profits received at a later stage under the agreement, should, in the Secretary's view, be carried to reserve account until the limit mentioned in clause 7 of the Electric Lighting Clauses Act, 1899, is reached. This matter should receive the special consideration of the Council, in view of application being made on some future occasion for a further extension of borrowing powers.

Ship Lighting.—Every modern passenger steamer is now provided with an elaborate electric lighting and power installation, and the Pacific Steam Navigation Co.'s new mail steamship is no exception to this rule. The ship was built by W. Beardmore & Co., and, in addition to the ordinary lighting fittings, there are on board an electric laundry, an electric potato peeler, electric crockery washer and electric knife-cleaning machines. There are also electric lifts, an electric bell and telephone installation, and, in fact, a very complete electrical equipment.

Southend.—The new tramway route between the Kursaal to Bryant-avenue has been opened for traffic.

Stirling.—The Council have applied for sanction to a loan of £3,000 for new feeder cable.

Thetford.—Owing to a dispute with the local gas company the Council threaten to return to oil lamps for public lighting! Thetford is a town of nearly 5,000 inhabitants.

Toulon (France).—Owing to the Municipal Council not having paid a debt owing to the local electric lighting company the latter has cut off the supply of electricity, and the town is (it is reported) now half lighted by gas. The Council are considering the floating of a loan to enable them to pay off the company.

Tramways Transfer.—Rhondda Urban Council give notice of intention to lease to the Rhondda Tramways Co. (Ltd.) certain tramways authorised by their 1902 Act for 42 years at an annual rent of £2,250.

Turkey.—In reviewing the trade of Damascus for 1907 Mr. Consul Devey notifies that an electric tramway $3\frac{1}{3}$ miles in length was opened for traffic in February, the lines being the property of a local company, which also owns an electricity supply undertaking, which was completed in July last year. Electric lighting is being adopted by private consumers slowly, but the hotels cafés, and theatres, as well as the great mosque and the principal thoroughfares of the city, are already nearly all lighted electrically.

West London Tramways.—The following Councils have been invited to attend a conference to consider the present condition of the permanent way of the London United Tramways, with the view to united course of action to obtain improvements: Ealing, Hammersmith, Twickenham, Chiswick, Acton, Brentford, Southall-Norwood, Teddington, Hampton Wick and Hounslow.

London United Tramways (Ltd.) have informed Hampton Council that they propose to continue the work of repairing the permanent way within the district until everything needing attention has been completed, and also that they propose to place a new type of silencer to certain spring points.

Wolverhampton.—The salary of the assistant engineer (Mr. H. A. Howie) has been increased to £200 per annum.

Workhouse Lighting.—The negotiations between Haslingden Guardians and Rawtenstall Corporation for supply of electrical energy for lighting the workhouse are likely to fall through.

In connection with the electric lighting installation at the new Hammersmith (London) workhouse, three of the guardians have been surcharged by the L.G. Board auditor a sum of £93. 16s. 3d.

Sports.—At the meeting of Leeds City Tramways Employés' Social and Athletic Society at Headingley on Wednesday the event which excited the greatest interest was the tug of war, open to all tramway employés in the United Kingdom. This was won by the London United Tramways team, who defeated Glasgow by two successive pulls. Leeds and Hull were beaten in the second round, and Sheffield, Wakefield and Halifax in the first.

Other open events were won by Hull (quarter mile handicap), Leeds (half-mile bicycle handicap), Leeds (100 yds. and 220 yds. handicap), Wakefield (obstacle race), Leeds (1 mile bicycle handicap), and Leeds (mile handicap).

On the 9th inst. teams representing the staffs of the West Ham generating station and head office of the electricity department played a cricket match at Chingford, head office eleven winning by 89 runs. The generating station team were unable to cope with the excellent bowling of Messrs. Hellaby and Gibbs, and were dismissed for 22 runs. The station staff are determined to effectively rehabilitate themselves when the annual football matches between the two branches of the department come to be played.

ELECTRICITY SUPPLY AND TRAMWAY ACCOUNTS.

Belfast.—The total income of the electricity department for the year ended March 31 was £57,004, including £34,783 from the sale of current for private lighting.

The cost of generation, repairs and maintenance was £26,752 (fuel being £17,647), and the total expenses were £34,174, leaving a gross profit of £22,830. After paying dividends on stock, redemption of stock, &c., there was a net profit of £8,199. 10,883,658 units of electrical energy were sold; the cost of production per unit was 0·753d., the total cost (including interest and sinking fund) 1·076d., and the average price obtained per unit was 1·257d. The capital expenditure is £293,329, a sum of £12,806 having been spent in 1907-8.

Bridlington.—The accounts of the electricity department for the year ended March 31 show total income £4,462, including £4,338 from the sale of current for public and private lighting.

The total working expenses were £2,287, leaving a gross profit of £2,175, which, with balance from last account (£428) made £2,603. Interest required £1,322 and sinking fund £1,129, leaving £152 to be carried forward. The capital expended is £35,119, an increase of £2,316 during the year. 303,262 units were generated; 116,433 units were sold to private consumers and 140,150 were supplied to the public lamps (39 arcs, 21 nernsts, 78 120 watt, 221 90-watt and 118 60 watt lamps). The total maximum supply demanded was 600 kw.

Hammersmith (London).—The total income of the electricity department for the year ended March 31 was £40,428.

Working expenses came to £21,896. Gross profit was £18,532. After allowing for interest on bank balances and paying interest (£7,879) and sinking fund (£10,389), placing £153 to reserve for redemption of capital overdraft and writing off £153 for bad debts, the net profit for the year was £13. 16s. 10d. Total capital expenditure is £290,221, an increase of £15,026. Owing to fluctuations in the lamps connected at the Franco-British Exhibition and Olympia the number of equivalent 8 c.-p. lamps connected is not given, but there are 317 motors of 2,430 H.P. connected and 2,160 consumers, and the maximum load reached was 4,100 k.w.

In the interesting report of the borough electrical engineer (Mr. G. G. Bell) which accompanies the accounts, particulars are given of the work carried out during the year, the progress made, &c. The extended use of metallic filament lamps has adversely affected consumption of current, and in this respect it is pointed out that Hammersmith

is particularly favourably situated from the consumers' point of view, as the pressure is just right for these lamps; therefore, the department has suffered more than many other districts from decreased sales. The limit of consumers' economy has about been reached, so that Mr. Bell anticipates having more satisfactory progress to report next year. The metal filament lamps were also a splendid inducement for new consumers to come on to the mains, and he considers that they should do as much for electric lighting as gas mantles did for the gas companies some years back.

Perth.—In submitting the accounts of the electricity department for the year ended May the convener of the Electric Light committee (Councillor Macnab) stated that they had experienced a fairly satisfactory year.

On the year's working the net profit was £108. 12s. 1d. The estimated revenue for the current year was put at £7,864, a decrease of £192 compared with 1907-8. The estimated expenditure was £4,946, or £186 more than last year. Special facilities were to be given to shopkeepers and other users of current, and there would be a general reduction in charges.

Portsmouth.—The total income of the electricity department for the year ended March 31 was £48,372 (against £51,157).

Expenses were £26,639 (against £23,445), leaving gross profit £21,738 (against £28,712). Interest required £9,253 and sinking fund £8,995 leaving a net profit of £3,486. 4,159,160 units were generated; 2,645,259 were sold to private consumers and 648,791 to public lamps (265 large and 58 small arcs and 464 incandescents). The total maximum supply demanded was 2,680 kw. The capital expenditure is £313,939, an increase of £11,939.

The accounts were approved at the meeting of the Council last week. Mr. Hemingway explained that the income showed a decrease owing to the loss of the contract for lighting the Naval Barracks. They had also made considerable concessions to consumers in the price of current. Coal had cost an additional £1,955. They had also paid out of revenue for several things which should have been classed as extraordinary expenditure, such as £430 for a new economiser and £650 for spare parts. Other increases were £167 in rates and taxes, and £333 in initial outlay in placing new street lamps. Under these circumstances he thought the balance-sheet was satisfactory. They were giving £2,000 to relief of rates.

The total income of the tramways department for the year ended March was £99,341 (against £102,015).

Working expenses were £48,015 (against £45,755), leaving gross profit £51,325. After paying interest (£20,242), sinking fund (£17,000), income tax (£1,014) and rent of leased lines (£301), there was a net profit of £13,132, out of which £373 was contributed to capital account, £2,500 placed to reserve and insurance and £9,351 to renewals, leaving £908 to be carried forward. 21,247,048 passengers were carried (against 20,668,825) and 2,309,439 car-miles run (against 2,199,823). The gross capital expenditure is £678,931.

Southwark (London.)—The total income of the electricity department for the year ended March 31, after deducting £226 for discounts and allowances and £122 for bad and doubtful debts, was £14,933, an increase of £1,221 over 1906 7.

The total working expenses were £9,668, an increase of £1,233, leaving a gross profit of £5,265, a decrease of £12. After paying interest, sinking fund, &c., there was a net profit of £185, against £473. During the year £3,725 was expended on capital account, making the total net capital outlay £79,000. 1,539,800 units of electrical energy were generated; 350,960 units were supplied to the public lamps (99 arcs, 162 Nernsts and 4 incandescents) and 1,050,885 to private consumers. The total maximum supply demanded was 820 kw.

West Ham.—The total income of the tramways department for the year ended March 31 was £120,072.

Total working expenses were £76,718, and after deducting £477, proportion of cost of through running to East Ham, there was a gross profit of £43,831. After paying interest and income tax the balance was £25,946. Crediting the balance of £4,322 from 1907 and paying sinking fund, expenses of the 1907 provisional order, cost of 20 top covers, &c., the balance of £7,437 was placed to reserve or renewals fund. Total capital expenditure is £513,538, increase £6,900. No additions were made to the rolling stock during the year, but 20 cars were fitted with top covers at the Greengate-street depot at a cost of £1,649. 4,195,93[illegible] units (or 1·53d. per car mile) were used for traction and shed and car repair works. 34,712,220 passengers were carried and 2,516,723 car miles run, average receipts per car mile being 10·41d.

TRADE NOTES AND NOTICES.

TENDERS INVITED.

The Lighting committee of *Dublin* Corporation invite tenders for supply of 500 a.c. meters single phase, and 100 a.c. meters, three phase. Specifications, forms of tender, &c., may be inspected at and obtained from the office of the city electrical engineer (Mr. Mark Ruddle), Fleet-street, Dublin. Tenders, addressed to the Chairman of the Lighting committee, 3, Cork hill, Dublin, by noon Sept. 1. See also an advertisement.

The Guardians of *Hackney* (London) Union invite tenders for the provision and fixing of electric light and power fittings and electric bell and telephone installation at Pavilion D now in course of erection at the infirmary at High street, Homerton, N.E. Specification, &c., from the clerk to the Guardians (Mr. Frank R. Coles), Sidney-road, Homerton, N.E., to whom tenders by 10 a.m. Aug 31. See also an advertisement.

London County Council invite tenders for supply and delivery of about 3,600 tons steel girder tramway track rails and fastenings and about 1,550 tons of steel slot rails, and about 590 tons of conductor tee rails; and also the road work and plate laying required for the electrification (on the conduit system) of the existing tramways in Wandsworth-road, Lavender-hill and East-hill, Wandsworth. The total length of tramway is about 6¾ miles of single line. Tenders by 11 a.m. Sept. 8.

The *Metropolitan Asylums Board* invite tenders for the installation of electric storage battery, motor-driven booster and switchboard and connections on the training ship "Exmouth," Grays, Essex, in accordance with drawings and specifications prepared by the engineer-in-chief of the Board (Mr. W. J. Hatch, M.Inst.C.E., M.I.M.E.). Forms of tender from the offices of the Board, Embankment, E.C. Tenders by 10 a.m. Sept. 1.

The Electric Lighting committee of the *Hull* Corporation invite tenders for the supply and erection of the necessary pipework, &c., in connection with one 500 kw. high-tension steam dynamo. Forms of tenders and specifications may be obtained on depositing 1 guinea with the city treasurer (Mr. T. G. Milner), and tenders, addressed to the Chairman of the Committee, Town Hall, Hull, by first post, Wednesday, Aug. 26.

Manchester Tramways committee invite tenders for the supply and delivery of tramcar trucks. Specifications and forms of tender from the general manager (Mr. J. M. McElroy), and tenders to the Chairman of the Tramways committee, 55, Piccadilly, Manchester, by 10 a.m. Tuesday, Sept. 1.

Kingston-upon-Hull Council are prepared to receive tenders for the supply of air space telephone cable and telephone instruments. Copies of specifications, &c., from the town clerk (Mr. E. Laverack), Town Hall, Hull, and tenders by 10 a.m. Aug. 27.

Sheffield Electric Light committee invite tenders for foundations for new boiler, ashes and dust chambers, pipe trenches, retaining walls, &c. Tenders to Corporation electric supply department, Commercial-street, Sheffield, by 10 a.m. Aug 31.

Farnworth Council invite tenders (by 10 a.m. Aug. 27) for supply of motor generators, rotor converters, switchgear, transformers and removal and re-erection of accumulators.

Stretford Electricity committee invite tenders, by Aug. 31, for extending the electricity station buildings.

Hackney (London) Council want tenders by 7 p.m. Sept. 10 for coal for the electricity department. Specifications, &c., from the Town Clerk.

Antwerp Municipal Council invite tenders for supply and erection of four electric bollards on the quays of Royers Lock. A deposit of 5,000 fr. (about £200) is required. Tenders to M. Le Bourgmestre de la Ville d'Anvers, Hotel de Ville, Antwerp, by Aug. 31. Specification may be seen by British contractors at 73, Basinghall street, London, E.C.

The Ministry of Public Works, Posts and Telegraphs, *Paris*, require tenders for supply of the following submarine cable material: 50 km. of submarine cable core (telegraphic); 100 km. of same; 50,000 kg. of homogeneous iron wire, 2½ mm. diameter; 2,000 kg. jute thread, 1½ mm. diameter; 8,000 sq. metres tarred jute bandage. Tenders to Sous Secretariat d'Etat des Postes et des Telegraphes by

Aug. 25. The contract will be adjudicated at 10 a.m. on Sept. 4 at 103, Rue de Grenelle, Paris, where specification may be seen.

Tenders will be received until 11 a.m. Sept. 2 by the Société Nationale des Chemins de Fer Vicinaux, 14, Rue de la Science, *Brussels*, for supply of electric cables and laying of conduits for the Brussels-Grimberghen section of the Brussels-Humbeek electric railway. Plans, &c., from the Bureau des Adjudications, 15, Rue des Augustins, Brussels

Extension of Time.—The date for sending in tenders for the construction of an electric power station at *Pernik* (Bulgaria) has been postponed to Aug. 29. Specification (in German), with drawings, may be examined by British contractors at 73, Basinghall-street, London, E C.

TENDERS RECEIVED AND ACCEPTED.

The Postmaster-General, Melbourne, has placed an order with Sydney branch of the Western Electric Co. for the manufacture and supply of a common battery switchboard for the new Lonsdale-street exchange at £43,641. There were nine tenders examined by the chief electrical engineer (Mr. Hesketh) and the State engineer (Mr. Jenvey), and that of the Western Co. was the lowest, the highest being £58,240. The board is to be completed by July, 1909. The ultimate capacity of the board will be 11,700 subscribers' lines, but the initial equipment will be for only 9,000. There are at present about 5,000 subscribers.

Glasgow Electricity committee recommend acceptance of the following tenders.—

Temperley Transporter Co., coal transporter for Port Dundas station, at £2,520; Donald Clerk & Son, coal tank, £550; G. & J. Weir, a feed pump for St. Andrew's Cross station, at £280; British Westinghouse Co., rotary converter, with transformers and spares, £851; Siemens Bros. Dynamo Works, induction motors and transformers, £1,565; A. Reyrolle & Co., switch gear, £284. 1s. 6d.; British Thomson-Houston Co., two Tirrill regulators, one for Port-Dundas station and one for the St. Andrew's Cross station, £163. 10s.

Bradninch (Devon) Parochial committee have accepted the tender of the Bradninch & District Electric Supply Co. for supply, erecting and maintaining 22 public electric lamps of at least 32 c.p. at £20 per annum.

An order has been placed with Crompton & Co. for the supply and erection of an electrical installation at Nassau, the capital of the Bahamas. It is stated that this is the first instance of an electric lighting and power installation in the islands.

The Mirrlees Watson Co. have received orders for a surface condensing plant for Southport Corporation and for two surface plants for Kobe (Japan) electric railway (the latter through Messrs. Mitsui & Co.).

Sunderland Corporation have accepted the tender of the British Westinghouse Co. for extra high-tension switchgear for the Hylton-road station.

Mossley Council have accepted the tender of Morrison & Roebuck for wiring the Mechanics' Institution.

Dewsbury Infirmary Board have accepted the tender of A. Hirst & Son for an electric motor.

The G.P.O. have accepted the tender of Siemens Bros. Dynamo Works for the supply of tantalum lamps.

Condensing and Cooling Plants.—The Midland Engineering Co., 12, Victoria-square, Birmingham, have recently received the following orders for Zylberlast condensing and cooling plants:—

Dewsbury Corporation, cooling tower to deal with 50,000 gallons of water per hour; Aston Corporation, to deal with 250,000 gallons of water per hour; Wednesbury Corporation, to deal with 5,000 gallons of water per hour; River Plate Electricity Co. (through Messrs. W. H. Allen, Sons & Co.), cooling tower to deal with 110,000 gallons of water per hour; Sherwood Colliery, Mansfield, to deal with 110,000 gallons of water per hour; Islington (London) Council, to deal with 370,000 gallons of water per hour; Bayliss, Jones & Bayliss, to deal with 20,000 gallons of water per hour; Worthing Corporation, condensing plant o deal with 17,500 lb. of steam per hour.

BUSINESS NOTICES.

Edward C. Thompson and Herbert Vanstone, electrical engineers, &c., Exchange-street, Norwich, have dissolved partnership. Debts by Mr. Vanstone, who continues, in partnership with Ernest Roper, as Thompson, Vanstone & Roper.

The goodwill of the business of E. & C. Braby has been acquired by Bingley, Son & Follitt (Ltd.), Millbank Slate Wharf, Westminster, S.W., who are taking over the major portion of Messrs. Braby's stock, a number of the employés, &c. Mr. Clement Braby has also joined the company.

The Newcastle-on-Tyne offices of the General Electric Co. have been removed to Gallowgate House, 30, Gallowgate.

Warner Tramway Truck.—The manufacture of the M. G. Warner Truck (Warner non-parallel axle truck) has been taken over, and standard types will be supplied by Messrs. Mountain & Gibson, Elton Fold Works, Bury, Lancs. Trials of this truck, extending over three years running in regular service, have shown that the life of tyres is considerably greater with this type of truck than that obtainable with any type of parallel axle or rigid truck or with any type of radial truck at present on the market, with a corresponding saving in track wear, while the maintenance is lower and vibration and oscillation are practically eliminated. The conversion of existing trucks will be undertaken either by the Warner Engineering Co. or by Messrs. Mountain & Gibson.

Patents Development.—The proprietors of the following patents are desirous of entering into arrangements, by way of licence or otherwise, for exploiting same and ensuring their full development and practical working in this country.

Patent No. 23,878/1900. "For Improvements in Process of and Mechanism for Separation of Conductors from Non-conductors." Applications to Messrs. Haseltine, Lake & Co., 7 and 8, Southampton-buildings, Chancery-lane, London, W.C.

Patents Nos. 11,933 1900, "For Improvements relating to the Regulation of Electric Motors"; 19,899/05, "For Improvements relating to Alternating Current Electric Motors"; and 26,808/05, "For Improvements relating to Alternating Current Electric Motors." Applications to Messrs. Haseltine, Lake & Co., 7 and 8, Southampton-buildings, Chancery-lane, London, W.C.

Patents Nos. 13,287/02, "For Improvements relating to Apparatus for the Transmission of Sound for Submarine Purposes"; 13,288/02, "For Improvements relating to the Transmission of Sound for Submarine Purposes and to Apparatus therefor"; 3,265/03, "For Improvements in Apparatus for Producing Sound Vibrations in Water"; 10,463/04, "For Improved Means for Producing Sound Vibrations in Water applicable for Marine Signalling"; 10,477/04, "For Improvements in Apparatus for Receiving Submarine Signals"; and 14,230/04, "For Improvements relating to Submarine Signalling and to Apparatus therefor." Applications to Messrs. Haseltine, Lake & Co., 7 and 8, Southampton-buildings, Chancery-lane, London, W.C.

Patent No. 18,909/1905, for "Improved Method of Electric Welding Sheet Metal." Applications to Messrs. Haseltine, Lake & Co., 7 and 8, Southampton-buildings, Chancery-lane, London, W.C.

Patent No. 2,067/1903, for "Improvements in Electric Controllers." Applications to Messrs. Haseltine, Lake & Co., 7 and 8, Southampton buildings, Chancery-lane, W.C.

Patents Nos. 2,700/1902 and 2,701/1902, for "Telephone Exchange Circuit" and "Improvements in Telephone Line Jacks." Applications to Messrs. Haseltine, Lake & Co., 7 and 8, Southampton-buildings, Chancery-lane, W.C.

Patent No. 28,805/1903, for "Improvements relating to Electric Furnaces." Apply to Messrs. Haseltine, Lake & Co., 7 and 8, Southampton-buildings, Chancery-lane, W.C.

Patents Nos. 26,673/1902 and 3,891/1904, for "Improvements relating to Devices for the Measurement of Electrical Energy" and "Improvements in and relating to Electrical Energy Matters." Apply to Messrs. Haseltine, Lake & Co., 7 and 8, Southampton-buildings, Chancery-lane, W.C.

Patents Nos. 23,501/1899, "For Improvements in Vacuum Tube Lighting," and 12,382/02 relating to "An Improved System of Electric Lighting." Applications to Messrs. Lloyd Wise & Co., 46, Lincoln's Inn-fields, London, W.C.

Patent No. 28,820/02, relating to "Improvements in Electrodes for Primary Batteries." Apply to Messrs. Lloyd Wise & Co., 46, Lincoln's Inn-fields, London, W.C.

Patents Nos. 15,215/95, 8,180/97, 21,548/96, 14,637/1900, 20,682/02, 20,683/02 and 20,684/02, all relating to "Improvements in and Pertaining to Telegraphic Printing Apparatus, Typewriters, Apparatus for Punching Strips of Paper," &c. Apply to Messrs. Lloyd Wise & Co., 46, Lincoln's Inn-fields, London, W.C.

Patents Nos. 7,585/03 and 3,913/05, "Relating to Apparatus for enabling Telephonic and Telegraphic Messages to be Transmitted over the same Line"; and No. 12,691/01, "Relating to Apparatus for the Simultaneous Transmission of Telephonic and Telegraphic or other Currents over the same Line." Applications to Messrs. Lloyd Wise & Co., 46, Lincoln's Inn-fields, London, W.C.

Patents Nos. 4,622/1900, "For Improvements in and Mechanism for Reversing Electromotors"; and 1,617/1900, "For Improvements in or connected with Carbon Contacts for Electrical Switches and the like." Applications to Messrs. Brewer & Son, 33, Chancery-lane, London, W.C.

Patent No. 226/1904 relating to "Improvements in Electrical Conductors for Illuminating Purposes, such as Lamp Pencils or Filaments"; No. 2,461/1901 relating to "Casings or Conduits for Electric Conductors." Applications to Messrs. Hyde & Heide, 3, Broad-street-buildings, London, E.C.

Patent No. 12,629/1903 for "Improvements Relating to Electric Alarms." Applications to Mr. J. S. Withers, Gamage-building, 118, Holborn, London, E.C.

Patent No. 11,262/1904 for "A Method for the Transmission of Sound to Long Distances and Telephonic Apparatus therefor." Applications to Mr. J. S. Withers, Gamage-building, 118, Holborn, London, E.C.

Poulsen's patent No. 8,961 1899 for "Methods of and Apparatus for Effecting the Storing up of Speech or Signals by Magnetically Influencing Magnetisable Bodies"; Pedersen's patent No. 23,738/1901 for "Improvements in Magnetisable Bodies for use in Telegraphones"; Poulsen's patent No. 541/1903 for "Improvements in Apparatus for Storing and Reproducing Audible Messages and Signals"; and Poulsen-Pedersen and Schou's patent No. 7,292/1903 for "Apparatus for Receiving and Storing up Messages, Signals and the like." Applications to Messrs. W. E. Heys & Son, 51, Deansgate-arcade, Manchester.

Heys' patent (communicated by Scott, Varley & Anderson) No. 1,863/1900 for "Improvements in Coils or Helices for Electrical Apparatus," No. 1,864/1900 for "Improvements in and relating to the Method of Winding Coils or Helices for Electrical Purposes," and No. 5,257/1900 for "Improvements in Apparatus for Winding or Producing Coils, Bobbins, Helices or the like for Electrical and other Purposes." Applications to Messrs. W. E. Heys & Son, 51, Deansgate-arcade, Manchester.

Dale's patents Nos. 6,873 and 9,397/1904 for "Improvements in and relating to 'Clusters' for Incandescence Electric Lamps." Applications to Messrs. W. E. Heys & Son, 51, Deansgate-arcade, Manchester.

Patent No. 21,890/1903, relating to "Apparatus for Extracting Rubber, Gums, &c." Inquiries to Messrs. Cruikshank & Fairweather (Ltd.), 65 & 66, Chancery-lane, London, W.C.

Patents Nos. 2,453 and 2,451/1901, relating to "Alarm Systems." Applications to Messrs. Fell & James, 1, Queen Victoria-street, London, E.C.

Further particulars of the above patents are given in advertisements on another page.

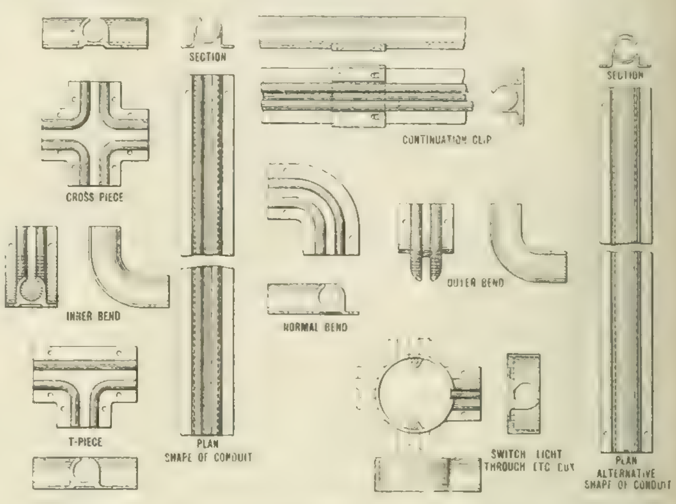
Railway Signalling Apparatus.—The proprietors of British Letters Patent No. 20,152/01, "Relating to Railway Signalling Apparatus," desire to license British manufacturers to make in Great Britain railway signalling apparatus, or they would consider propositions for the sale of same. Further particulars of the patent are given in an advertisement, and applications should be made to Messrs. Boult, Wade & Tennant, 111-112, Hatton garden, London, E.C.

Building Sites.—The facilities offered for the acquisition of eligible building sites for the erection and operation of large trading concerns is a subject just now of considerable interest. There are certain industrial centres where natural facilities are added to other material advantages. The City of Dundee is one of these favourably-situated localities, and the action of the City authorities in calling attention to the advantages offered is one to be commended. Situated on the River Tay, cheap water carriage to ports in Great Britain and the European Continent is available, and the City is directly connected with all the principal railway lines by the Caledonian and North British Railways. Land is available in abundance and water is good and plentiful. The municipal authorities offer liberal terms to those who are disposed to establish new industries in the City, and when we add that the Corporation are in a position to give an unlimited supply of electrical energy, that male labour is to be obtained plentifully, that there is a good and cheap tramway service, and, finally, that the local rates, compared with other seaport districts, are low, it will be agreed that Dundee has established its claim to be regarded as one of the best industrial centres in the United Kingdom.

Partner Wanted.—A partner is wanted in a small electrical manufacturing business, to bring in at least £2,000 for developing several patents. See an advertisement.

Electrical Workshop Wanted.—An amateur electrician requires the temporary use of a workshop. See advertisement.

Electric Conduit for Surface Work.—The accompanying illustration shows details of a new form of conduit that has been protected by Mr. G. Gladman Sarney, of 16, Chaucer road, London, S.E., for use more especially for interior surface wiring. Briefly, the conduit consists of a gapped tube, the gap being smaller than the maximum internal diameter of the tube, with flanges for fixing purposes. The wires are laid in the conduit and held within by the natural twist in the wires "taking up" within the conduit. The conduit is made continuous by means of one type of clip only, which is also used to attach tees, bends, inspection boxes, &c. The conduit is fixed by screws or nails through the flanges, which are punched where required. The back of the tube is kept clear of surfaces by the flanges, which allow air to pass freely all round the conduit and thus prevent unequal temperature within the tube, the cause of most condensation and corrosion troubles. Sudden changes in temperature, which set up condensation, &c., will also quickly disperse the same, the gap acting as a natural ventilator. Alterations and additions can also be easily carried out, because it is only necessary



Sarney's Electric Conduit for Surface Work.

to pull out wires from any length of conduit at the point of alteration or addition, and after inserting the necessary box, tee, or bend all wires can be replaced quickly at a great saving of time and labour.

A Converted Lyre.—We learn that to Mr. J. K. Brydges, borough electrical engineer of Eastbourne, belongs the credit of being the first to adopt the most modern methods of trimming for the whole of his street lamps, comprising swan necks, street spanning and centre pole varieties, thus reducing to a minimum the difficulties and dangers besetting their trimming and cleaning. The contact and suspension device of the method adopted, which is supplied by the London Electric Firm, Croydon, is fixed in the hood of the carrier. A cross arm is fitted right through the hood, and a wire rope, working over pulleys, unlocks the suspension device, draws the lamp out horizontally clear of the pole, and then lowers it vertically, a single winch fitted in the base of the pole (operated in the same direction all the while) doing the whole of these operations, and conversely re-hoisting and taking the weight of the lamp off the rope. The contact-suspension device is positive in action, does not depend on the operation of springs, levers, balls, clutches or other similar contrivances, and, being on the concentric principle, does not require to be manœuvred to ensure correct polarity. The winch is self-sustaining in all positions without ratchets, pawls or gear wheels, and will not run back.

Lamp Trimming at Hastings.

CATALOGUES, &c.

"*Aegma*" *Lamps.*—We have received from The Electrical Co. an attractive pamphlet setting out the advantages of the "Aegma" lamp, together with a piece of apparatus which is best described as a "sort of ready reckoner." Its purpose is to show the saving effected by using "Aegma" instead of ordinary "carbon" lamps. We cannot give this arrangement higher praise than to say it fulfils this object. The costs of burning "Aegma" and "carbon" lamps of 25 c.p. and 50 c.p. respectively are arranged in opposite halves of a movable disc. By moving the appropriate section up into place

the cost for 25, 50, 100, 500 and 1,000 hours, with power at 3½d., 4d. or 5d. per unit, is easily read off.

Prescot House Fuse Boxes.—It will not require any great effort of retrospection on the part of *The Electrician* readers to recall house fuse boxes, which were, to put it mildly, scarcely up to their work. These inefficient apparati are gradually being replaced, and with full confidence we can recommend "Prescot" boxes for this purpose. From the very nature of its work the house fuse box often finds its resting place in a more or less damp cellar, and seldom does it rise above basement quarters. It is, therefore, necessary that it should be designed on perfect damp-proof lines, while care should be taken that no tampering can be indulged in. These conditions are admirably fulfilled by the boxes of the British Insulated & Helsby Cables. They are made in a number of varying sizes and designs suitable for all usual types of cables. Some examples shown in a recently issued list are specially adapted for non-hygroscopic cables, while others are provided with sealing boxes for the paper insulated type. In our glance through the catalogue we notice a description of the Prescot switch cutout, which consists of a double or triple pole quick-break switch, the same number of single-pole fuses, and a sealing chamber. The whole is remarkably compact, and should find useful application on both power and lighting circuits. Engineers and contractors will be amply repaid by a close study of this catalogue.

"*Simplexity*" *in Cooking.*—The receipt of the tempting lists of the Simplex Co. make us yearn for the opportunity to rent a flat and therein experiment with a large number of the Simplex electric cooking and heating apparatus. The new Simplex catalogue contains a large variety of kettles for afternoon tea and other domestic purposes, which will doubtless be appreciated during the too quickly approaching winter. Mere man is catered for by a number of tasteful hot water jugs and shaving pots, while the secrets of the ladies' dressing-room are disclosed by a curling tongs heater. It is hardly necessary to call attention to other "Simplexities," for they must be already well known; we can but recommend those who are starting in flat life to give electric cooking a trial, they will not be disappointed.

"*Fool-Proof*" *Switches.*—We are not certain that Messrs. Berry, Skinner & Co. are to be credited with the extremely expressive adjective "fool-proof." But if they are not the original inventors they have certainly applied it with good effect to the switches which they manufacture. We have just received a descriptive pamphlet on these switches and from a close study it appears that by using them not only is water and dust tightness ensured but the electrical details have been designed to meet all requirements both as regards current carrying capacity and reliability. Further, it is impossible to take "off" the cover with the switch on or to leave the switch in any intermediate position between "on" and "off."

"*Electrical Bulletin.*"—An interesting number of the "Electrical Bulletin" is that just issued, which is called an "Exhibition" number. There is a good article on the domestic side of electricity supply, which is exemplified by the heating and cooking exhibits at the Franco-British Exhibition. Reference is made to the interesting metal filament cluster lamp of the Stearn Electric Lamp Co. Various cleanly labour-saving electrical devices, with which our readers are familiar, are also illustrated and described. The striking difference between the electrical and gas exhibits at the exhibition is humorously described in a short article, wherein the value of gas as a heating agent (in the wrong place) is very well shown. We are not impressed by the pictures showing the "Swallow's" return, but here again the heating effect of gas must have been proved in a malapropos way, for there must have been as much heat outside as inside the "Swallow."

Steam Fittings.—We have received from Messrs. Joseph Shaw & Son, Huddersfield, a copy of their new catalogue, which contains illustrated particulars and prices of a number of specialities in steam fittings, including the improved "Shaw" valves, water gauges, water level indicators, pressure gauges, steam traps, gunmetal steam fittings, lubricators, cocks, castings, &c. The firm specialise in valves for superheated steam, and all valves and fittings are put to steam or hydraulic tests to double their working pressure.

Imports.—The following are official values of electrical machinery, material, and apparatus imported into this country (*a*) during July, 1908, and (*b*) during the current year from Jan. 1 to July 31, with the increases or decreases compared with the corresponding periods of 1907:—

Electrical machinery (*a*) £70,920 (decrease £26,852); (*b*) £397,929 (increase £60,403); telegraph and telephone cables (*a*) £10,801 (decrease £10,950), (*b*) £75,312 (decrease £97,513); telegraph and telephone apparatus (*a*) £14,796 (decrease £6,066), (*b*) £114,423 (decrease £36,713); other electrical wires and cables, rubber insulated (*a*) £6,478 (increase £3,453), (*b*) £45,729 (decrease £2,301); with other insulations (*a*) £8,063 (increase £1,982), (*b*) £65,096 (increase £18,120). The following were not separately enumerated last year: Carbons (*a*) £11,388, (*b*) £98,159; glow lamps (*a*) £20,330, (*b*) £144,552; arc lamps and electric searchlights (*a*) £531, (*b*) £2,374; parts of arc lamps and searchlights (other than carbons) (*a*) £4,851, (*b*) £30,765; primary and secondary batteries (*a*) £5,049, (*b*) £29,697. Total of electrical goods and apparatus, other than machinery and telegraph and telephone wire (*a*) £93,242 (decrease £14,667), (*b*) £675,918 (decrease £64,223).

Exports.—The exports of electrical machinery, material, &c. (*a*) during July, 1908, and (*b*) during the current year from Jan. 1 to July 31, and the increases or decreases compared with the corresponding periods of 1907, are as follows:—

Electrical machinery (*a*) £126,466 (increase £30,692), (*b*) £768,408 (increase £219,701); telegraph and telephone cables (*a*) £78,553 (increase £36,391), (*b*) £315,811 (decrease £280,520); telegraph and telephone apparatus (*a*) £13,569 (decrease £5,438), (*b*) £93,561 (decrease £11,453); other electrical wires and cables, rubber insulated (*a*) £21,432 (decrease £1,393), (*b*) £159,062 (increase £3,067); with other insulations (*a*) £27,859 (increase £12,949), (*b*) £162,440 (increase £33,827). The following were not separately enumerated last year: Carbons (*a*) £1,160, (*b*) £5,013; glow lamps (*a*) £6,989, (*b*) £31,770; arc lamps and searchlights (*a*) £2,301, (*b*) £12,954; parts of arc lamps and searchlights (other than carbons) (*a*) £1,107, (*b*) £9,308; primary and secondary batteries (*a*) £8,069, (*b*) £39,978. Total of electrical goods and apparatus, other than machinery and telegraph and telephone wire (*a*) £189,347 (increase £52,528), (*b*) £1,031,332 (decrease £238,453).

BANKRUPTCIES, LIQUIDATIONS, &c.

The summary of affairs in the matter of Illuminated Signs (Ltd.) shows debts and liabilities £788. 3s. 3d., against assets nil, when preferential creditors and debenture holders have been satisfied. The total deficiency as to contributors is £4,175. 3s. 3d.

The company was incorporated Oct. 10, 1905, with a nominal capital of £3,000 in £1 shares, and took over certain inventions and patents for producing coloured and ornamental light effects in facias, signs, &c. The company was promoted by the vendor, Mr. Sidney T. Mowbray. No prospectus was issued or invitation for public subscriptions. The first directors were S. T. Mowbray, managing director, at £7 per week; F. H. Mowbray and Charles W. Langford. The latter resigned on Nov. 8, 1906. Mr. S. T. Mowbray resigned Nov. 21, 1907, and Mr. Horace S. Imber, who was managing director at £10 per week, resigned Dec. 9, 1907, when Mr. A. F. Durlacher joined the board. The total capital issued is £3,387, £2,000 of which was paid to the vendor for the inventions and patents taken over as above-mentioned. £500 was issued to Mr. H. S. Imber for obtaining orders and in consideration of his becoming managing director, and £887 was subscribed in cash. First mortgage debentures for £350, at 7½ per cent., were issued on Dec. 2, 1907, in favour of A. F. Durlacher, in consideration, it is stated, of cash advanced and to be advanced to the company. On Dec. 17, 1907, £125 of debentures, at 7½ per cent., were issued to C. W. Langford for cash also said to have been advanced by him. The business of the company appears to have been carried on at a loss from the start. On July 3 last Mr. C. F. Farmery, secretary of the company, was appointed receiver for the debenture holders and is now in possession. Failure attributed to "loss on withdrawal of illuminated sign at Camberwell Palace of Varieties by order of London County Council and defective material supplied by an electrical company, thereby occasioning loss and cancellation of orders, lack of working capital and bad debts." Unsecured liabilities, amounting to £788. 3s. 3d., are chiefly in respect of goods supplied, law costs and the estimated unsecured balance due upon debentures.

W. Terrell Garnett (trading as W. T. Garnett's Cable Co.), Barkerend Mills, Bradford, has been adjudicated bankrupt. First meeting of creditors Aug. 26 at 12, Duke-street, Bradford, and the public examination on Oct. 7 at the County Court, Bradford.

It is expected that the total liabilities will amount to about £94,000, liabilities expected to rank £35,000, and assets estimated at £10,000. Debtor, formerly a worsted spinner, in 1895 started business as a manufacturer of electric cables.

A meeting of the creditors of the Private Telephone Co. (Ltd.) will be held at 27, Chancery-lane, London, W.C., on Aug. 25.

Claims against the Empire Electric Light & Power Co. (Ltd.) by Aug. 31 to Mr. W. Allnutt, 5, Lime street, London, E.C.

The Blackpool Electric Tramways (South), Ltd., is being wound up voluntarily. Messrs. Andrew McGowan and T. McWilliam, 43, Castle-street, Liverpool, are liquidators. A meeting of creditors will be held on Aug. 28 at the above address.

On July 30 an order was made by the High Court appointing Mr. F. Taussig, 67, Aldersgate-street, London, E.C., and Mr. F. J. Tiffin, 3, Great Winchester-street, London, E.C., a committee of inspection to act with the liquidator (Mr. H. Brougham) in the winding up of the Kevan Electric Co. (Ltd.).

BOOKS RECEIVED.

(Copies of the undermentioned works can be had from *The Electrician* office, post free, on receipt of published price, adding 3d. for books published under 2s. Add 10 per cent. for abroad or for foreign books.)

"Die Entwickelung der Telegraphie und Telephonie." By Dr. Richard Hennig. (Leipzig: Johann Ambrosius Barth.) M. 4.

"Electric Lighting and Power Distribution." By W. Perren Maycock. Vol. I. 7th edition. (London: Whittaker & Co.) 6s. net.

COMPANIES' MEETINGS AND REPORTS.

Willans & Robinson (Ltd.)

A debenture holders' meeting was held in London on Friday last, at which a resolution with reference to the proposed sale of the company's works at Queen's Ferry was considered. Mr. MARK ROBINSON presided.

The SECRETARY (Mr. C. S. Essex) read the notice convening the meeting, and the chairman briefly reviewed the history of the company's Queen's Ferry undertaking. He said that, thanks mainly to the large reserve fund which was accumulated in the company's prosperous days, they had been able to tide over the difficult position which the diminished profitableness in the company's main business carried on at Rugby had brought about. Despite all that had occurred, they had never had an overdraft at the bank, nor had they missed a cash discount which might have been obtained by prompt payment. They had left no stone unturned to make the Queen's Ferry works a profit-earning undertaking, and with the view of assisting a private sale as a going concern they had kept the works going for some years. This had involved them in a considerable annual loss, and the directors had now come to the conclusion that the works must be discontinued and be offered for sale by auction. This opinion had been confirmed and supported by the trustees for the debenture holders. He would like to add that at the end of 1907 the valuation of their freehold premises, plant and machinery at Rugby and Thames Ditton, probably a very conservative valuation, was £315,641, taking no account of Queen's Ferry, whatever the value of these works might be, or of the other items which made up £749,443, the total on the credit side of their balance sheet. As the entire debenture debt was but £246,154, and as the trustees held investments costing £28,983 (the fire insurance fund), it would be agreed that the debenture holders were well covered, whatever might happen to Queen's Ferry. He then moved the adoption of the resolution approving the sale of the company's leasehold interest in Ferry Works, Queen's Ferry, according to the terms of the resolution, which had been distributed amongst the debenture holders.

Mr. H. LASKEY seconded the resolution, which, after a brief discussion, was carried.

It was arranged to take a poll, and at the close the chairman said the meeting represented the amount of £144,921 of debentures in person or by proxy, and the votes were £136,585 in favour of the resolution, and none against. He, therefore, declared the resolution carried, and the proceedings terminated.

LONDON & NORTH-WESTERN RAILWAY CO.—At the meeting of the shareholders last week a motion was almost unanimously adopted for providing for the capital expenditure of £3,051,334 for the Euston-Watford electric line.

MIDLAND RAILWAY CO.—At the meeting last week the chairman (Sir E. Paget) referred to the electrification of their railway between Lancaster, Morecambe and Heysham, and said it was an experiment of very great interest, but he was not yet able to say that it would be safe to extend it to the main line. All he could say now was that the electrified line was used for local traffic and was working exceedingly well.

NORTH LONDON RAILWAY CO.—At the meeting last week Lord Rathmore had a doleful tale to tell of reduced passenger receipts and increasing competition by electric tramways, &c. This competition could not very well be increased, for the body of their unfortunate railway had been so effectually blistered on every side by electrical competition that there was no more space left to apply further unpleasant plasters of a like kind. As to remedies, there was the expensive one of a reduction in fares, and they had also been recommended to proceed with the work of electrification. They had within the last few months been appoached by two of the greatest electrical engineering companies in England with a view to making an investigation into the cost and desirability of electrifying the line, but those companies had not gone far in their investigation when they found that it would be useless to go further until the G.N., L. & N.W., G.E. and other companies over whose lines the North London trains ran electrified parts of their systems. Including rolling stock, the expenditure on electrification could not come to much less than £1,000,000.

SOUTH AMERICAN LIGHT & POWER CO. (LTD.)—The report for the year ended March states that the net amount at credit of profit and loss is £2,399 and the directors recommend a dividend of 2 per cent. on the £160,000 capital issued. The Bahia Blanca & North Western Railway Co. are about to erect a large power station at Bahia Blanca, which the directors consider will enable them to meet the future considerable increase in the company's business.

NEW COMPANIES, STATUTORY RETURNS, RECEIVERS AND MANAGERS, &c.

NEW COMPANIES.

GENERAL RAILWAY SIGNAL CO. (LTD.) (99,155.)—Reg. Aug. 10, capital £100 in £1 shares, to carry on the business of railway signalling engineers, manufacturers and installers of and dealers in signal [illegible] engineers and contractors, electricians, electro-pneumatic engineers, &c.

W. SEYMOUR (LTD.) (99,208.)—Reg. Aug. 14, capital £1,050 in 1,000 preference shares of £1 each and 1,000 ordinary shares of 1s. each, to adopt an agreement with W. Seymour and to carry on the business of electrical, mechanical, sanitary and motor engineers, &c. Private company. Reg. office, 1, Ellis-street, Sloane-street, London, S.W.

SPARKS (SHEFFIELD) (LTD.) (99,170.)—Reg. with capital £1,000 in £1 shares, to carry on the business of electrical and mechanical engineers, manufacturers of and dealers in electric, magnetic, telephonic, telegraphic and other appliances and apparatus, &c. Private company. First directors, Mrs. M. J. Horton, E. C. Clayton and B. Lake. Reg. office, 11, Broomhall-street, Sheffield.

THORPE METER SYND. (LTD.) (99,191.)—Reg. Aug. 13, capital £9,000 in £1 shares (3,000 founders'), to acquire from W. B. Thorpe an invention relating to an electricity meter and to turn same to account. Private company. The first directors, J. M. Gatti, H. P. Miles and E. A. de Paiva, J.P. Reg. office, 11, Victoria-street, London, S.W.

STATUTORY RETURNS.

BRITISH ACCUMULATOR CO. (LTD.)—Return to June 24 gives capital as £5,000 in £1 shares, all of which have been taken up. £2,500 has been received and £2,500 is considered as paid. Mortgages and charges, nil.

ILFRACOMBE ELECTRIC LIGHT & POWER CO. (LTD.)—In return to June 15th capital is £15,000 in £5 shares, of which 67 have been taken up. £335 has been received. Mortgages and charges, nil.

NORTHWOOD ELECTRIC LIGHT & POWER CO. (LTD.)—The capital in return to July 23 is £30,000 in 15,000 ordinary and 15,000 preference shares of £1 each, of which 12,357 ordinary and 6,730 preference have been taken up. £1 per share has been called up on 8,132 ordinary and 6,730 preference, and £14,862 has been received. £4,225 is considered as paid on 4,225 ordinary. Mortgages and charges nil.

WOLVERHAMPTON DISTRICT ELECTRIC TRAMWAYS (LTD.)—Return May 7th gives capital as £200,000 in £5 shares, of which 32,200 have been taken up. £5 per share has been called up on 31,950 and 5s. per share on 252 shares and £159,812. 10s. has been received. Mortgages and charges, £100,000.

RECEIVERS AND MANAGERS.

BIRMINGHAM ELECTRICAL CASE CO. (LTD.)—Notice of the appointment of P. T. Thompson, 21, Salisbury-road, Handsworth, as receiver, on June 18, 1908, under powers contained in an instrument dated April 10, 1908, has been filed pursuant to sec. 11 (2) of the Companies' Act, 1907.

HEADLAND'S PATENT ELECTRIC STORAGE BATTERY CO. (LTD.)—Notice of the appointment of G. D. Price, Finsbury House, Blomfield-street, E.C., as receiver or manager, on Feb. 25, 1900, under powers contained in mortgage debentures dated Nov. 8, 1895, has been filed pursuant to sec. 11 (2) of the Companies Act, 1907.

PRIVATE WIRE & TELEPHONE INSTALLATION CO. (LTD.)—Notice of appointment of J. E. Ward, C.A., 122, Cannon-street, E.C., as receiver and manager, by order of Court, dated July 29, 1908, has been filed pursuant to sec. 11 (2) of the Companies Act, 1907.

X ELECTRIC ACCUMULATOR CO. (LTD.)—Notice of appointment of F. H. Kingham, C.A., 9, Fenchurch-street, E.C., as receiver and manager, by order of Court, dated March 7, 1908, has been filed pursuant to sec. 11 (2) of the Companies Act, 1907.

CITY NOTES.

MEMORANDA (Aug. 20).—Bank rate 2½ per cent. (since May 28, 1908). Price of silver, 23⅝d. per oz. Consols 86¼—86⅜ for money and 86 5/16—86 7/16 account. Consols Pay Day, Sept. 1; Stock and Shares Continuation Days, Aug. 25 and Sept. 9; Ticket Days, Aug. 26 and Sept. 10; Pay Days, Aug. 27 and Sept. 11.

PRICES OF METALS (London).—*Copper*, cash, 60¼—60½; three months, 60⅝—61⅛. *Lead*, English, 13¾—14; foreign, 13 7/16—13½. *Spelter*, foreign, 19⅝—19¾. *Tin*, English, 132½—133½; foreign, cash, 132⅞—133⅜, three months, 133⅝—134⅛. *Iron*, Cleveland, cash, 51/6—51/9, three months, 50/9—50/10.

HADFIELD'S STEEL FOUNDRY (LTD.)—The directors have declared an interim dividend at the rate of 5 per cent. (1s. per share) on the ordinary shares for the past half year.

HUDSON & BOWRING (LTD.)—The directors have declared a dividend of 2s. per share on the ordinary shares for the half year ended June 30.

NORTHAMPTON ELECTRIC LIGHT & POWER CO. (LTD.)—The directors have declared an interim dividend at the rate of 4½ per cent. (less tax) on the B ordinary shares for the past half year.

SOUTH AMERICAN LIGHT & POWER CO. (LTD.)—The directors recommend a dividend of 2 per cent. on the ordinary shares for the past year.

STOCK EXCHANGE NOTICES.—The Stock Exchange committee have granted quotations to 67,200 £5 fully paid ordinary and 70,000 £5 fully paid 6 per cent. cumulative preference shares of the [illegible] Tramways of Monte Video (Ltd.), and £1,000,000 5 per cent. third mortgage debentures of [illegible] (Ltd.). The committee have been asked to allow $150,000 additional 30 year 5 per cent. $100 and $500 gold bonds of the *Rio de Janeiro Tramway, Light & Power Co. (Ltd.)* to be quoted.

TORONTO POWER CO.—This is the title of a new company formed to take over the undertaking of the Electrical Development Co. of Toronto. The new company is controlled by the Toronto Street Railway Co.

ELECTRIC TRAMWAY AND RAILWAY TRAFFIC RECEIPTS.

Line	Week ended.	Amount.	Inc. or Dec. (a)	Aggregate: No. of weeks.	Aggregate: Amount.	Aggregate: Inc. or Dec. (a)
		£	£		£	£
Aberdeen Corporation	Aug. 12	1,705	+ 45	11	17,025	+ 55
Airdrie	,, 7	212	+ 1	31	6,947	+ 90
Anglo-Argentine	,, 12	23,712	+ 7,326	32	622,802	+ 95,564
Ayr Corporation	,, 15	514	− 9	13	5,550	− 88
Baker St. & Waterloo Ry.	,, 15	2,580	+ 570	7	29,020	+ 3,490
Barnsley	,, 7	197	− 4	31	5,456	+ 328
Barrow	,, 7	361	− 57	31	7,699	− 231
Bath Electric Trams, Ltd.	,, 12	917	− 385	32	23,476	− 1,393
Birkenhead Corporation	,, 16	1,088	...	...	...	...
Birmingham Corporation	,, 15	5,727	− 200	20	125,770	+ 5,251
Birmingham & Mid.	July 31	853	+ 6	20	24,881	+ 946
Blackburn Corporation	Aug. 12	1,215	+ 19	20	23,697	+ 1,164
Blackpool Corporation	,, 13	2,988	− 330	19	26,527	+ 537
Blackpool and Fleetwood	,, 15	2,205	+ 154	...	...	...
Bolton Corporation	,, 15	2,165	+ 113	20	47,981	+ 1,269
Bombay	July 23	R33,808	+ R9,012	29	R1,037,048	+ R204,506
Bournemouth Corporation.	Aug. 12	2,423	+ 74	19	33,488	− 1,587
Bradford Corporation.	,, 15	4,845	+ 12	19	95,799	+ 1,092
Brighton Corporation	,, 16	1,365	+ 210	20	19,934	+ 833
Bristol Trams & Carriage	,, 11	5,033	− 121	38	164,278	+ 1,109
Burnley Corporation	,, 15	1,379	+ 61	20	24,894	+ 1,164
Burton Corporation	,, 16	284	− 31	29	[illegible]	− 117
Bury Corporation	,, 16	1,271	+ 9	‡20	24,358	+ 1,938
Calcutta Tramways Co.	,, 15	R19,152	+ R582	7	R325,116	− R7,958
Cardiff Corporation	,, 8	2,838	+ 100	19	42,426	− 597
Cavehill	,, 7	148	+ 44	31	2,869	+ 182
Central London Railway	,, 15	6,531	+ 2,266	7	49,489	+ 14,338
Charing C., Euston & H'stead	,, 15	2,980	+ 660	7	22,895	+ 4,800
Chatham & Dist. Lt. Rys.	,, 13	923	+ 77	32	24,377	+ 829
City & South London Rly.	,, 16	2,874	+ 59	7	20,416	− 1,186
City of Birmingham	,, 7	2,980	− 156	31	86,996	+ 54
Colchester Corporation	,, 5	329	− 21	5	1,246	− 52
Cork Electric Trams Co.	,, 13	520	− 16	32	14,730	− 496
Croydon Corporation	,, 14	1,422	− 36	20	29,466	+ 208
Devonport & Dist. Trams	,, 7	646	+ 78	31	14,268	+ 77
Dover Corporation	,, 15	308	− 20	20	4,795	− 108
Dublin & Lucan Railway	,, 14	162	− 4	6	1,035	− 39
Dublin United	,, 14	5,640	− 1,965	6	38,105	− 10,223
Dudley-Stourbridge	,, 7	1,565	− 93	31	25,954	− 1,179
East Ham Council	,, 15	924	− 15	20	18,405	− 824
Exeter Corporation	,, 14	364	− 7	20	6,524	− 137
Falkirk and District	...	...	...	...	...	...
Gateshead & Dist. Trams	,, 7	1,115	− 48	31	31,470	+ 233
Glasgow Corporation	,, 15	17,061	− 405	11	187,293	+ 968
Glossop	...	...	...	...	...	...
Gravesend—Northfleet	,, 7	311	− 53	31	6,610	− 947
Great Northern & City Rly.	,, 15	1,213	− 235	7	9,161	− 2,065
Gt. Northern, Piccadilly, &c	,, 15	4,290	+ 865	7	34,760	+ 6,795
Greenock & Port Glasgow	,, 7	655	− 21	31	16,549	− 4,106
Hartlepool Tramways	,, 7	395	− 74	31	7,447	− 1,470
Hastings Elec. Trams Co.	,, 13	1,762	− 1	7	9,660	− 608
Hong Kong	,, 15	$8,325	+ $166	33	$260,612	− $6,818
Huddersfield Corpn.	,, 15	1,737	− 102	20	32,935	+ 205
Hull Corporation	,, 15	2,280	+ 145	20	48,192	+ 55
Ilford District Council	,, 15	465	− 8	20	9,278	− 494
Ilkeston District Council	,, 11	144	− 2	19	2,813	+ 48
Ipswich Corporation	,, 15	490	− 45	20	8,325	− 151
Isle of Thanet Co.	,, 15	1,908	− 23	46	23,147	− 275
Jarrow	,, 7	159	− 13	31	3,352	− 441
Keighley Corporation	...	...	...	...	...	...
Kidderminster & District	,, 7	310	− 13	31	3,590	− 135
Kilmarnock Corporation	,, 15	134	− 21	13	2,132	− 159
Lanarkshire Trams Co.	,, 13	1,278	− 37	32	41,544	+ 3,753
Lancashire United	,, 12	1,427	+ 86	32	42,616	+ 2,081
Leamington	,, 7	323	+ 36	31	5,222	+ 354
Leeds Corporation	,, 8	7,551	− 599	19	129,179	+ 4,746
Leicester Corporation	,, 15	2,018	− 129	7	16,605	+ 169
Leith Corporation	,, 8	580	+ 28	12	7,666	+ 28
Lincoln Corporation	...	...	...	...	...	...
Liverpool Corporation	,, 8	11,893	− 2,909	32	340,734	− 6,187
Liverpool Overhead Rly.	,, 16	1,496	− 114	7	10,486	− 1,774
*London County Council	,, 8	38,216	+ 3,957	†19	655,795	+ 72,621
London United	,, 15	8,171	+ 255	32	217,145	+ 4,104
Lowestoft	,, 15	475	− 9	46	8,758	+ 147
Maidstone Corporation	,, 15	221	+ 111	20	4,034	+ 1,760
Manchester Corporation	,, 15	14,765	− 724	20	305,109	+ 12,665
Mersey Railway	,, 15	1,800	+ 22	7	12,941	+ 107
Merthyr	,, 7	286	+ 5	31	6,587	+ 82
Metropolitan Dist. Railway	,, 15	7,978	+ 1,326	7	61,891	+ 9,060
Metropolitan Elec. Trams	,, 7	8,369	+ 1,598	21	176,332	+ 35,161
Middleton	,, 7	198	+ 71	31	11,404	+ 459
Nelson Corporation	,, 15	152	− 16	§19	2,892	− 152
Newcastle-on-Tyne Corp.	,, 15	3,668	− 341	20	78,269	− 5,170
Newport (Mon.)	...	...	...	...	...	...
Northampton Corporation	,, 11	451	− 1	§19	9,852	+ 629
Oldham, Ashton & Hyde	,, 7	655	− 12	31	18,562	− 99
Oldham Corporation	,, 16	2,089	+ 15	21	41,790	+ 742
Perth (N.B.) Corporation	,, 12	172	5	13	2,139	− 92
Perth (W.A.) Elec. Trams	,, 14	1,287	− 6	33	45,693	− 828
Peterborough	,, 7	217	− 20	31	3,971	+ 71
Portsmouth Corporation	,, 15	2,867	+ 205	20	42,861	+ 668
Potteries	,, 7	2,095	− 143	31	57,064	− 635
Preston Corporation	...	...	...	...	...	...
Rotherham Corporation	,, 13	617	− 22	19	12,901	+ 166
Rothesay	,, 7	639	+ 93	31	6,182	− 191
Salford Corporation	,, 17	4,861	− 34	20	96,136	+ 2,412
Sheerness	,, 5	96	− 3	31	1,753	− 9
Sheffield Corporation	,, 15	5,306	− 339	†21	116,600	− 3,46
Singapore Trams	,, 15	$9,704	+ $111	...	...	...
South Metropolitan	,, 7	1,294	+ 40	31	24,931	+ 721
South Staffs.	,, 7	1,172	− 111	31	27,668	− 360
Southend Corporation	,, 12	825	+ 66	20	9,193	+ 619
Southport Tramways	,, 7	516	− 39	31	8,761	− 417
Stalybridge, Hyde &c., Jt Bd.	,, 15	806	− 132	‡20	16,001	− 318
Sunderland Corporation	,, 16	1,288	− 183	20	24,473	− 4,894
Sunderland District	,, 12	517	− 133	41	19,606	+ 1,452
Swansea Trams	,, 7	1,631	+ 139	31	29,268	+ 1,995
Swindon Corporation	,, 12	181	− 24	...	...	...
Taunton	,, 7	61	− 5	31	1,268	− 61
Tynemouth and District	,, 7	628	+ 11	31	7,042	− 481
Tyneside Trams Co.	,, 12	446	− 34	6	2,730	− 246
Wallasey District Council	,, 15	1,027	+ 43	§19	18,558	+ 851
Walsall Corpn.	,, 15	500	− 40	33	17,515	+ 1,334
Warrington Corpn.	,, 13	365	− 21	19	1,396	− 98
West Ham Corporation	,, 8	2,753	− 42	19	43,175	− 2,500
Weston-super-Mare	,, 5	651	+ 36	31	3,923	+ 21
Wolverhampton Co.	,, 7	667	− 90	31	14,354	− 458
Wolverhampton Corpn.	,, 12	817	+ 20	10	9,166	+ 274
Worcester	,, 7	488	− 16	31	8,712	+ 18
Wrexham	,, 7	140	− 5	31	3,170	+ 9
Yorkshire W.R. Trams	,, 16	1,292	− 40	33	40,445	...
Yorkshire Woollen District.	,, 7	1,015	− 67	31	28,631	− 1,215

(a) These comparisons are with the corresponding period last year. § Plus 3 days. Plus 2 days. * Partly electrical. † Minus 3 days. ‡ Minus 2 days.

ELECTRICAL COMPANIES' SHARE LIST.

Share	Last Dividend	Name.	Price Wed., Aug. 19.	Rate % Yield-ed. £	s.	d.	Dividend Due.	Business Week to Aug. 19: Highest.	Lowest.
		ELECTRICITY SUPPLY.							
10	9 0	†Bournemouth & Poole Elec. Sup. Ord.	10½–10¾	6	10	0	Mar, Sept.	10⅝	..
10	4 6	† Do. 4½ per Cent. Cum. Pref.	9½–10	4	10	0	Feb, Aug		–
10	6 0	† Do. 6 per Cent. Cum. Second Pref.	10½–10¾	5	6	6	Feb, Aug	10½	
St.	4½%	Do. 4½ per Cent. Deb. Stock (red.)	100–103	4	7	6	Jan, July	..	..
5	3 6	Bromley (Kent) El. Lt. & Power Shares	4½–5	5	10	0	April, Oct	..	..
St.	4½%	Do. Do. 1st Debs.	94–97	4	12	9	May, Nov	.	..
5	4 6	†Brompton & Kensington Elec. Sup. Ord.	6¾–7¾	6	9	0	March....	..	..
5	3 6	† Do. 7 per Cent. Pref.	6½–7½	4	13	6	Mar, Sept	..	..
St.	4%	Central Elec. Sup. Co. 4% Guar. Db. Stock	99–102	3	18	6	June, Dec	..	..
5	2 6	Charing Cross (W. End & City) El. Sup. Co.	3½–4	6	5	0	Feb, Aug	[illegible]	..
5	2 3	Do. 4½ per Cent. Pref.	4–4½	5	0	0	Feb, Aug	–	..
St.	4%	Do. 4 per Cent. Deb. Stock (red.)	95–98	4	2	0	Jan, July		..
5	2/3	Do. City Undertaking 4½% Cm. Pref.	3½–4	5	12	0	Jan, July	[illegible]	..
5	2/6	Chelsea Electric Supply Ord.	3–3½	6	8	9	March ..	..	..
St.	4½%	* Do. 4½ per Cent. Deb. Stock (red.)	100–103	4	7	6	June, Dec	..	..
10	5 0	City of London Electric Lighting Ord.	9½–10½	5	17	0	Feb, Aug	10[illegible]	9[illegible]
10	6/0	Do. 6 per Cent. Cum. Pref.	11½–12½	4	16	0	Jan, July	12[illegible]	..
St.	5%	Do. 5 per Cent. Deb. Stock (red.)	122–126	4	0	0	June, Dec	123	..
St.	4½%	Do. 4½ per Cent. 2nd Deb. Stock (red.)	101–104	4	6	6	Jan, July	..	..
5	2%	County of Durham Elec. P.D. Ord.	2¾–3	3	9	7	April, Oct	..	..
5	5%	Do. 5 per Cent. non Cum. Pref.	3⅞–4¼	6	5	0	April, Oct	..	–
10	4/0	County of London Elec. Supply Ord.	7½–8½	5	17	6	Feb, Aug		..
10	6 0	Do. 6 per Cent. Cum. Pref.	10¼–10¾	5	11	6	Mar, Sept	10½	10½
St.	4½%	Do. 4½% Deb. Stock (red.)	106–109	4	1	0	Jan, July	..	..
St.	4½%	Do. Second Deb. Stock	98–101	4	9	9	May, Nov	98	..
5	3 6	Folkestone Electricity Supply Co. Ord.	4¾–5¼	5	7	0	April, Oct		..
5	2 6	Do. 5 per Cent. Cum. Pref.	5–5½	4	11	0	Mar, Sept	..	..
St.	4½%	Do. 4½ 1st Deb. Stock (red)	97–100	4	10	0	Feb, Aug	..	..
5	4/6	Hove Electric Lighting Ord.	6–6½	6	11	0	April, Oct	..	..
5	4/0	†Kensington & Knightsbridge Ord.	7¾–8¼	5	14	0	Feb, Aug	..	..
5	6%	Do. 6 per Cent. 1st Pref.	6–6½	4	12	0	Jan, July	..	–
St.	4%	Do. 4 per Cent. Deb. Stock (red.)	94–97	4	2	6	..	..	..
St.	4%	Kensingtn. & Kngtbg. Co. & Notting Hill Co. (Joint Station) 4% Deb. Stock (red.)	97–101	3	19	0	April, Oct	–	..
St.	4½%	Kent Elec. Power Co.	86–90	5	0	0	Jan, July	..	..
3	1 6	London Electric Supply Ord.	⅞–1⅛	5	8	0	Mar, Sept	..	..
5	3,0	Do. 6 per Cent. Pref.	4½–5	6	0	0	Mar, Sept	..	–
St.	4%	Do. 4 per Cent. 1st Mort. Deb.	89–92	4	7	0	Jan, July	89½	..
5	2,6	Metropolitan Electric Sup. Ord.	4½–5	6	10	0	April, Oct	4½	4⅝
5	2.3	Do. 4½ per Cent. Cum. Pref.	4½–5	4	10	6	Jan, July	4⅝	4⅝
St.	4½%	Do. 4½ per Cent. Deb. Stock 1st Mort.	105–109	4	1	6	June, Dec	105½	..
St.	3½%	Do. 3½ per Cent. Mrt. Deb. Stock (red.)	84–89	3	19	0	Jan, July	..	..
100	4½%	Midland Elec. Corp. for P.D. 1st Mort. Db.	94–97	4	12	6	June, Dec	..	–
10	4%	Newcastle & Dist. Elec. Ltg. Ord.	7½–8	5	3	2	Feb, Aug	–	–
100	4½%	Do. 4½ per Cent. Deb.	94–96	4	14	9	Jan, July	..	..
5	8%	Newcastle Elec. Supply Ord.	5⅛–5⅜	7	12	4	Feb, Aug	..	..
5	5%	Do. 5 per Cent. non Cum. Pref.	5¼–5⅜	4	15	8	Feb, Aug	..	..
100	4%	Do. 4 per Cent. Mort. Deb. red. 1907.	95–97	4	3	4	Jan, July	..	..
1	3%	Northern Counties Elec. Sup.	—	..			Mar, Aug	–	..
100	4½%	Do. 4½ per Cent. Deb.	93–95	4	15	9	Jan, July	..	..
10	6,0	Notting Hill Electric Ord.	12–13	5	8	0	March ..	..	..
5	2/6	†Oxford Electric Ord.	5⅝–6⅛	5	14	0	March ..	..	..
St.	4%	Do. 4 per Cent. Deb. Stock	95–98	4	2	0	Jan, July	..	..
5	5,0	St. James' & Pall Mall Elec. Ord.	7–8	6	1	6	Feb, Aug	..	..
5	3/6	Do. 7 per Cent. Pref.	6½–7½	4	16	6	Feb, Aug	..	..
St.	3½%	Do. 3½ per Cent. Deb. Stock (red.)	86–90	3	18	0	Jan, July	8[illegible]	86
5	..	Smithfield Markets Electric Sup. Ord.	¼–¾	..			Feb	..	..
St.	4%	Do. 4 per Cent. Deb. Stock	68–72	5	11	0	Feb, Aug	..	..
5	4 0	South London Electric Supply Ord.	2⅝–2⅞	5	19	0	April....	..	..
1	0/6	South Metrop'n Elec. Lt. & Power Ord.	⅜–⅝	4	0	0	..	..	–
1	0 8⅖	Do. 7 per Cent. Cum. Pref.	1–1¼	5	12	0	Feb, Aug	..	..
St.	4½%	Do. 4½ 1st Db. Stk. Red	100–103	4	7	6	April, Oct	..	–
5	2/6	Urban Electric Supply Ord.	½–1½	16	12	0	April, Oct	–	..
5	2,6	Do. 5 per Cent. Cum. Pref.	1⅞–2⅜	10	12	0	April, Oct	..	..
St.	4½%	Do. 4½ per Cent. 1st Mort. Deb.	82–85	5	6	0	April, Oct	..	..
5	5,0	Westminster Elec. Sup. Ord.	7½–8½	5	17	6	Mar, Sept	8[illegible]	..
5	2,3	Do. 4½ per Cent. Cum. Pref.	5–5½	4	2	0	Jan, July	[illegible]	5¼
		ELECTRIC RAILWAYS, TRAMWAYS, &c.							
St.	4%	Baker St. & Waterloo 4% Perp. Db. St	93–94	4	5	0	Jan, July	92¾	92¾
1	..	Bath Elec. Trams Pref. Ord.	½–¾	10	13	0	April....	..	–
1	0/6	Do. 5 per Cent. Cum. Pref.	⅝–⅞	5	14	0	Jan, July	..	–
St.	4½%	Do. 4½ 1st Mort. Deb. Stock (red.)	86–91	4	19	0	April, Oct	..	..
St.	4½%	B'ham & Midland Trams 4½ 1st Db. Stk.	91–94	4	17	0	Jan, July	..	..
10	9%	Bristol Tramways & Carriage Ord.	10¾–11¼	8	0	0	Feb, Aug	..	..
10	4%	Do. Cum. Pref. (fully paid)	8¾–9¼	4	6	6	..	..	..
St.	4%	Do. 4 per Cent. Debs.	93–98	4	2	0	Feb, Aug	..	..
10	..	British Electric Traction Ord.	1⅛–1⅜	..			June, Dec	..	..
10	3,0	† Do. 6 per Cent. Cum. Pref.	4¼–4½	..			Feb, Aug	4¼	..
St.	5%	Do. 5 per Cent. Perpetual Debs.	95–98	..			April, Oct	97	95¾
St.	4½%	Do. 4½ per Cent. 2nd Deb. Stock	76–78	5	15	0	May, Nov	..	..
St.	3%	†Central London Ordinary Stock	79–81	3	14	0	Feb, Aug	69½	68½
St.	4%	† Do. 4 per Cent. Pref. Stock	85–87	4	12	0	Feb, Aug	85¼	.
St.	2%	Do. Deferred Stock	51–54	3	14	0	Feb	52¼	..
100	4%	Do. 4 per Cent. Debs.	101–104	3	17	0	Jan, July	..	..
St.	4%	Charing X, Euston & Hmpstd Per. Db. Stk.	82–84	4	15	0	Jan, July	..	..
5	2/6	City of Birmingham Trams. 5% Cm. Pref.	4¼–4¾	5	5	0	April, Oct	..	..
100	4%	Do. 4 per Cent. 1st Mort. Debs.	97–100	4	0	0	April, Oct	..	..
St.	1½%	City & South London Rly. Con. Ord.	32–33	4	19	0	Feb, Aug	33	32
St.	5%	Do. 5 per Cent. Perp. Pref. (1891)	111–114	4	7	6	Feb, Aug	..	..
St.	5%	Do. (1896)	109–112	4	9	3	Feb, Aug	–	..
St.	5%	Do. (1901)	107–110	4	11	0	Feb, Aug	..	..
St.	5%	Do. (1903)	102–105	4	15	3	Feb, Aug	..	..
St.	4%	Do. 4 per Cent. Perpetual Debs.	100–103	3	17	6	May, Nov	..	..
10	6/0	Dublin United Trams. Ord	12–13	5	0	0	Feb, Aug	..	..
10	6/0	Do. 6 per Cent. Pref.	12½–13½	4	10	6	Feb, Aug	..	–
10	..	Gt. Northern & City Rly. Pref. Ord. (4%)	½–1	..			Feb, Aug	..	
10	0,9	†G. Northern, Piccadilly & Brompton Ord.	7–7½	5	6	9	Feb, Aug		.
St.	4%	Do. 4 per Cent. Deb. Stock	91–93	4	6	0	Jan, July	92¼	91
5	4/0	Hastings & Dist. Elec. Trams. 6% Cm. Pf.	3½–3¾	8	0	0	Mar, Sept	..	..
St.	4½%	Do. 4½ Db. St.	93–96	4	13	9	April, Oct	..	..
10	9%	‡Imperial Tramways Ord.	10–11	7	7	3	Mar, Sept	..	..
10	6%	‡Do. 6 per Cent. Pref.	9½–10	6	0	0	Mar, Sept	..	..
St.	4½%	‡Do. 4½ per Cent. Debs.	90–92	4	18	0	Jan, July	..	..
5	..	I. of Thanet E. T. & Lt. 5 per Cent. Pref.	⅞–1⅜	..			Mar, Sept	..	–
St.	4%	Do. 4 per Cent. Deb. Stock	59–61	6	11	0	Jan, July	..	–
10	6/0	Lanarkshire Tramways	9⅞–10⅜	5	9	0	Feb, Aug	.	..
St.	5%	Lancs. Utd. Trams 5% Prior Lien Db. St.	92–94	5	6	6	Jan, July	93	..
10	..	Liverpool Overhead Railway Ord.	1¼–1¾	..			Feb, Aug	..	–
10	5%	Do. 5 per Cent. Pref.	5¾–6¼	8	0	0	Feb, Aug	..	..
St.	4%	Do. 4 per Cent. Deb.	84–86	4	13	0	Jan, July	..	..
10	5/0	London United Trams. 5% Cum. Pref.	6¼–7¼	6	13	0	Jan, July	6¾	..
St.	4%	Do. 4 per Cent. 1st Mort. Deb. Stock	79–84	4	15	0	Jan, July	80	..
St.	..	Mersey Con. Ord. Stock	1–3	–			Feb, Aug.	..	..
St.	..	Do. 3 per Cent. Perp. Pref.	3–6	–			..	..	..
1	..	Metropolitan Elec. Tramways Def.	½–[illegible]	–			April..	..	..
1	0/6	† Do. 5 per Cent. Cum. Pref.	13/16–15/16	6	3	6	Feb, Aug	¾	..
St.	4½%	Do. 4½ per Cent. Deb. Stock	93–96	4	13	9	Jan, July	94	93
St.	½%	†Metropolitan Railway Consolidated	35½–36½	1	7	6	Feb, Aug	36½	[illegible]
St.	2½%	† Do. Surplus Lands Stocks	65–67	4	2	0	Feb, Aug	66¼	65¾
St.	3½%	† Do. 3½ per Cent. Preference	84–87	4	0	6	Feb, Aug	84½	84
St.	3½	† Do. 3½ per Cent. "A" Preference	74–77	4	11	[illegible]	Feb, Aug	74	..
St.	3½%	† Do. 3½ per Cent. Convertible Pref.	70–73	4	16	0	Feb, Aug	70	..
St.	3½%	Do. 3½ per Cent. Debenture Stock	90–93	3	15	3	Jan, July	91½	90¾
St.	3½%	Do. 3½ per Cent. "A" Ditto	88–91	3	17	0	Jan, July	89	88

* In calculating the yield allowance has been made for accrued interest but *not* for redemption

† Ex Dividend

ELECTRICAL COMPANIES' SHARE LIST.—*Continued.*

ELECTRIC RAILWAYS & TRAMWAYS—*Continued.*

Share.	Last Dividend	Name.	Price Wed., Aug. 19.	Rate % Yielded. £ s. d.	Dividend Due.	Business Week to Aug. 19. Highest.	Lowest.
St.	..	Metropolitan District Railway Ord.	11 —12	—	Feb, Aug	11 1/2	..
St	..	Do. Extension Pref. (5 per Cent.)	19 —23	..	Feb, Aug	..	..
St	3 1/2	Do. Assented Ext. Pref. (Int. Guar. by Und. Elec. Rlys. Co. of London, Ltd.)	47 —51	6 17 0	Feb, Aug	..	..
St.	3%	Do. 3 per Cent. Consoltd. Rent-charge	73 —76	3 19 0	Jan, July	..	..
St.	4%	Do. 4 per Cent. Midland Rent-charge	98 —102	3 18 0	Jan, July	..	..
St.	1%	† Do. Guar. Stock 4 per Cent.	46 —49	3 9 6	Mar, Sept	..	..
St.	6%	Do. 6 per Cent. Perp. Deb. Stock	113 —118	5 2 0	Jan, July	116 1/2	114 1/2
St.	4%	Do. 4 per Cent. Ditto	71 —76	5 5 0	Jan, July	72 1/2	—
5	..	New Gen. Tract. 6 per Cent. Cum. Pref.	1/4—3/4	..	May	..	—
1	0/9 3/8	Potteries Electric Traction Ord.	1/4—1/2	8 0 0	April, Oct	..	—
1	0/6	† Do. 5 per Cent. Cum. Pref.	5/8—3/4	6 13 0	Feb, Aug	..	..
St.	4 1/2%	Do. 4 1/2 per Cent. Deb. Stock	93 —96	4 14 6	May, Nov	..	..
1	0/7 1/2	S. Met. Elec. Trams. & Ltg. 6% Cm. Pref.	3/4—1	6 0 0	Feb, Aug	..	..
St.	4%	Do. 4 per Cent. Deb. Stock	76 —80	5 0 0	Jan, July	..	..
100	5%	Sunderland Dist. Elec. Trms. 5% 1st Mt. Db.	78 —82	6 2 0	Jan, July	76 1/2	..
..	5%	Underground Elec. Rys. Co. of London	39 —43	11 12 0	June, Dec	38 1/2	..
5	..	Yorkshire (W.R.) Elec. Trams. Ord.	7/8—1 3/8	—	March ..	..	..
5	..	Do. 6 per Cent. Cum. Pref.	2 7/8—3 3/8	—	..	3 1/4	..
St.	4 1/2	Do. 4 1/2 per Cent. 1st Debs.	83 —86	5 5 0	Jan, July	..	..

ELECTRIC MANUFACTURING, &c.

Share.	Last Dividend	Name.	Price Wed., Aug. 19.	Rate % Yielded. £ s. d.	Dividend Due.	Highest.	Lowest.
1	..	Aron Electricity Meter Ord.	7/16—11/16	..	..	..	..
1	1 4 1/2	Do. 6% Cum. Pf. ex (on a/c arrears)	11/16—15/16	7 12 0	April, Oct	..	..
1	2/4 1/2	Babcock & Wilcox Ord.	3 3/4—4	4 7 6	April, Oct	3 13/16	..
1	0/7 1/2	Do. Pref.	1 7/16—1 9/16	3 16 9	..	..	..
5	6/0	British Insulated & Helsby Cables Ord.	6 1/4—6 3/4	7 4 0	July, Feb	6 3/8	6 1/2
5	3/0	Do. 6 per Cent. Pref.	6 —6 1/2	4 12 0	Jan, July	..	..
St.	4 1/2%	Do. 4 1/2 per Cent. 1st Mort. Deb. (red.)	103 —106	4 5 0	Jan, July	..	..
St.	4 1/2%	British Thoms'n-Houst'n 4 1/2% 1st Mt. Db.	93 —98	4 12 0	Mar, Sept	..	..
5	..	British Westinghouse 6 per Cent. Pref.	3/8—5/8	..	Feb, Aug	1/2	[illegible]
St.	4%	Do. 4 per Cent. Mort. Deb. Stock	43 —48	8 8 0	Jan, July	..	..
2	..	Brush Electrical Engineering	1/2	—	March ..	..	..
2	..	Do. 6 per Cent. Pref. non-Cum.	1/8—5/8	..	Mar, Sept	..	..
St.	4 1/2%	Do. 4 1/2 per Cent. Perp. 1st Deb. Stock	70 —75	6 0 0	Mar, Sept	..	..
St.	4 1/2%	Do. Perpetual 2nd Deb. Stock	53 —58	7 14 0	Jan, July	..	..
5	10/0	Callender's Cable Con. Ord.	9 3/4—10 3/4	6 17 6	Jan, July	..	..
5	2/6	Do. 5 per Cent. Cum. Pref.	5 1/4—5 3/4	4 7 0	Jan, July	5 5/8	5 5/8
St.	4 1/2%	Do. 4 1/2 per Cent. 1st Mort Debs. (red.)	106 —108	4 3 6	Nov, May	107 3/4	107 1/2
1	1/0	Castner-Kellner Alkali Co.	1 7/16—1 9/16	8 6 0	May, Nov	1 1/2	1 15/32
St.	4 1/2%	Do. 4 1/2 per Cent. 1st Mort. Deb. (red.)	101 —104	4 6 6	Feb, Aug	..	..
1	0/9 3/8	Chadburn's (Ship) Telegraph Ord.	15/16—1 1/16	7 19 6	March ..	..	..
1	0/7 1/2	Do. 6 per Cent. Cum. Pref.	15/16—1 1/16	5 13 0	April, Oct	..	..
1	0/8 3/4	Consolidated Electrical Co.	3/8—1/2	7 0 0	August ...	7/16	..
1	1/0	Consolidated Signal Co.	1 1/16—1 3/16	10 9 0	April, Oct	..	..
1	0/7 1/2	Do. 6 per Cent. Cum. Pref.	25/32—31/32	6 4 0	April, Oct	29/32	..
3	3/0	*Crompton & Co. (Nos. 1 to 86,000)	1 1/2—1 3/4	8 11 0	Jan, July	1 5/8	..
100	5%	Do. 5 per Cent. 1st Mort. Debs. (red.)	90 —93	5 7 0	Jan, July	..	..
1	0/7 1/2	† Davis & Timmins	7/8—1 1/8	..	Mar, Sept	..	..
5	2/0	Dick, Kerr & Co. Ord.	1 1/8—1 3/8	7 11 0	Sept	..	..
5	0/7 1/2	Do. 6 per Cent. Cum. Pref.	1 —1 1/4	4 16 0	Sept	1 3/16	1 1/8
St.	4 1/2%	Do. 4 1/2 per Cent. Deb. Stock	99 —102	4 8 6	Jan, July	[illegible]	—
5	2/6	Edison & Swan United ("A" Sh.) (£3 pd.)	1/2—3/4	..	Feb, Aug	..	..
5	4/2	Do. (£5 paid)	1 1/2—2 1/2	5 0 0	Feb, Aug	..	—
St	4%	Do. 4 per Cent. Mort. Deb. Stock (rd.)	76 —79	5 [illegible] 6	June, Dec	..	..
St.	5%	Do. 5 per Cent. 2nd Deb. Stock	85 —87	5 15 0	Mar, Sept	—	..
5	..	Edmundson's Elec. Corp. Ord.	1/8—3/8	..	Jan, July	..	..
5	..	Do. 6 per Cent. Cum. Pref.	1/2—1	..	May, Nov	..	..
St.	4 1/2%	Do. 4 1/2 per cent. 1st Mort. Deb. (red.)	58 —65	6 18 0	Jan, July	63	..
2	..	Electric Construction Co.	15/16—1 1/16	..	Jan, July	..	..
2	2/9	Do. 7 per Cent. Cum. Pref.	1 1/8—1 3/8	..	July	—	..
St.	4	Do. 4 per Cent. Perp. 1st Mort. Debs.	66 —71	5 13 0	Jan, July	..	..
10	5/0	General Electric (1900) 5% Cum. Pref.	7 1/2—8	6 5 0	June, Dec	..	..
St	4%	Do. 4 per Cent. 1st Mort. Debs.	84 —87	4 12 0	Mar, Sept	..	—
5	10/0	Henley's Telegraph Works Ord.	10 1/2—11 1/2	6 10 0	Feb, Aug	11 1/4	..
5	2/3	Do. 4 1/2 per Cent. Pref.	5 —5 1/2	4 2 0	Feb, Aug	..	..
St	4 1/2%	Do. 4 1/2 per Cent. 1st Mort. Deb. Stock	106 —108	4 3 6	Mar, Sept	..	..
10	5/0	India Rubber, Gutta Percha, &c., Wrks.	15 1/2—16 1/2	6 2 0	Feb, Aug	..	
100	4%	Do. 4 per Cent. Debs. (red.)	98 1/2—100 1/2	3 19 6	April, Oct	..	..
1	..	National Elec. Construction Co.	3/8—5/8	..	April	..	..
1	0/9	Richardsons, Westgarth & Co., Ltd. Ord.	7/16—9/16	7 2 0	Nov	..	..
1	0/7 1/2	Do. 6 per Cent. Cum. Pref.	3/4—7/8	6 17 0	May, Nov	..	..
St	4 1/2%	Do. 4 1/2 per Cent. Perp. Deb. Stock	87 —90	5 0 0	Jan, July	..	..
1	..	Simplex Conduits Ord.	1 1/2	..	..	—	—
5	..	Do. 6 per Cent. Cum. Pref.	5 1/4	..	..	..	..
12	12/0	Telegraph Construction & Maintenance	31 1/2—32 1/2	6 5 6	Mar, July	32 1/4	32 1/8
100	4%	Do. 4 per Cent. Deb. Bonds (1909)	100 —102	3 18 0	Jan, July	..	..
1	1/0	† Vickers, Sons & Maxim, Ltd. Ord.	1 1/8—1 3/8	8 14 6	..	1 [illegible]	1 1/4
1	1/6	† Do. 5 per Cent. non-Cum. Preference	1 —1 1/16	4 11 6	..	1	..
St.	5%	† Do. 5 per Cent. non-Cum. Preferred	101 —105	4 15 0	..	..	..
St	4%	Do. 4 per Cent. 1st Mort. Db. Sk. (red)	104 —105	3 16 0	June, Dec	105	..
100	4 1/2%	Do. 4 1/2 per Cent. 2nd Mort. Deb. (red.)	104 —106	4 5 0	June, Dec	105 1/4	105
100	15/6	Do. 5 per Cent. 2nd Mort. Debs. Scrip.	102 —104	..	..	102 1/4	102 3/4
10	16/0	J. G. White & Co. 6% Cm. Pref.	8 1/2—9 1/2	8 17 9	..	..	..
5	1/0	Willans & Robinson Ord.	1/2—1 1/4	4 0 0	Apr, Oct	1	..
5	2/0	Do. 6 per Cent. Cum. Pref.	2 1/2—3	8 11 6	Apr, Oct	[illegible]	2 5/8
100	4%	Do. 4 per Cent. 1st Mort. Debs.	72 —76	5 5 6	May, Nov	74	73

TELEGRAPHS.

Share.	Last Dividend	Name.	Price Wed., Aug. 19.	Rate % Yielded. £ s. d.	Dividend Due.	Highest.	Lowest.
10	..	Amazon Telegraph	2 —3	—	June, Dec	..	—
100	5%	Do. 5 per Cent. Debs. (red.)	87 —89	5 12 0	June, Dec	..	..
St.	15/0	Anglo-American	58 —61	5 16 0	F, My, Ag, N	..	..
St	30/0	Do. Preferred	103 1/2—104 1/2	2 16 0	F, My, Ag, N	104 3/8	103 1/4
St.	1%	Do. Deferred	16 —16 1/2	6 1 0	F, My, Ag, N	16 [illegible]	16 1/4
St.	4%	Commercial Cable 4 per Cent. Deb. Stk	84 —87	4 12 0	Jn, Ap, Jy, O	86 1/2	85
10	10/0	Cuba Submarine Ord.	7 1/2—8 1/2	7 0 0	Feb, Aug	..	..
10	10/0	Do. Preference 10 per Cent.	16 1/2—16 1/2	6 1 6	Feb, Aug	16	..
5	2/0	Direct Spanish Ord.	3 —3 1/2	6 4 0	April, Oct	..	..
5	5/0	Do. 10 per Cent. Cum. Pref.	8 —9	5 11 0	April, Oct	..	..
100	4 1/2%	Do. 4 1/2 per Cent. Deb.	100 —103	4 7 6	Jan, July	..	..
20	[illegible]	Direct United States Cable	13 1/2—14 1/2	6 7 6	Ja, Ap, Jy, O	13 [illegible]	13 [illegible]
100	4 1/2%	Direct West India Cable 4 1/2% Rg. Db. (rd.	99 —101	4 9 0	June, Dec	..	..
St.	25/0	Eastern Ordinary	135 —138	5 1 0	Ja, Ap, Jy, O	136 1/4	136 1/2
St.	17/6	Do. 3 1/2 per Cent. Pref. Stock	84 —86	4 [illegible] 6	Ja, Ap, Jy, O	[illegible]	84 [illegible]
St	4%	Do. 4 per Cent. Mort. Deb. Stk. (red.)	101 1/2—103 1/2	3 17 6	May, Nov	1 [illegible]	1 [illegible]
10	2/6	Eastern Extension	12 [illegible]—13 [illegible]	5 7 0	Ja, Ap, Jy, O	12 [illegible]	12 [illegible]
St.	4%	Do. 4 per Cent. Deb. Stock	99 1/2—101 1/2	3 18 6	Feb, Aug	—	..
100	4%	Eastern & S. African 4% Mort. Deb. 1900	99 —101	3 19 0	Feb, Aug	..	..
100	4%	Do. 4% Mauritius Sub. Debs. (red.)	100 1/2—102 1/2	3 17 6	May, Nov	1 [illegible]	..
10	[illegible]	G. N. of Copenhagen with Coupon 74	27 1/2—29 1/2	6 16 0	Jan, July	28 1/4	28 1/2
100	4 1/2	Halifax & Bermuda 4 1/2% 1st Mt. Db. (red.)	99 —101	4 9 0	June, Dec	..	..
[illegible]	[illegible]	Indo-European	56 —59	5 1[illegible] 0	May, Nov	..	..
100	$1	Mackay Companies Common	69 —73	5 10 0	Ja, Ap, Jy, O	..	..
100	$1	Do. Preference	69 —73	5 10 0	Ja, Ap, Jy, O	..	..
1		Marconi's Wireless Teleg. Co.	1/4—1/2	..	April	1/4	..
100	4%	Pacific & European Tel. 4% Guar. Dbs. (red.)	98 —101	3 19 0	June, Dec	98 1/2	—
[illegible]	1/3	West Coast of America	1 1/4—1	4 5 0	May	..	..
100	4	Do. 4 per Cent. Debs.	98 —101	3 19 0	Jan, July	..	..
1		West India & Panama	[illegible]	..	May, Nov	..	..
10	[illegible]	Do. 6 per Cent. 1st Pref.	8 —8 1/2	7 1 0	May, Nov	..	..
10	[illegible]	Do. 6 per Cent. 2nd Pref.	8 1/2—9 1/2	..	May, Nov	..	..
100	[illegible]	Do. [illegible] per Cent. Debs.	100 —103 1/2	4 17 6	Jan, July	..	..
10	[illegible]	Western Telegraph	13 3/4—14 1/4	4 18 0	Mr, Jn, O, D	14 1/2	13 [illegible]
St	4	Do. 4 per Cent. Deb. Stock (red.)	100 —102 1/2	3 17 6	June, Dec	101	..
..	4	Western Union Tel. $1,000 4% Bonds	80 —85	4 14 0	..	..	..

TELEPHONES.

Share.	Last Dividend	Name.	Price Wed., Aug. 19.	Rate % Yielded. £ s. d.	Dividend Due.	Highest.	Lowest.
100	2$	Amer. Telephn. & Telegh. Cap. St.	126 —130	3 17 0	..	130	—
..	4%	Do. Coll. Trust $1,000 4 per Cent. Bds	89 —92	4 7 0	Jan, July	..	..
St.	5%	Anglo-Portug'se Tel. 5% 1st Mt. Db. Stk.	101 —104	4 16 0	Mar, Sept	..	—
5	5/0	Chili Telephone	8 —8 1/2	4 14 0	August ..	8 1/16	8 1/16
1	0/7 1/2	Monte Video Telephone Ord.	1 —1 1/8	6 4 0	Nov	..	..
1	0/6	Do. 5 per Cent. Pref.	27/32—31/32	5 3 0	May, Nov	..	..
St.	6%	National Co. Pref. Stock	107—109	5 10 0	Feb, Aug	108 1/4	107
St.	6%	Do. Def. Stock	119 1/2—121 1/2	4 19 0	Feb, Aug	120	119 1/2
10	6/0	Do. 6 per Cent. Cum. 1st Pref.	10 —12	5 0 0	Feb, Aug	..	..
10	6/0	Do. 6 per Cent. Cum. 2nd Pref.	10 —12	5 0 0	Feb, Aug	..	..
5	2/6	Do. 5 per Cent. non-Cum. 3rd Pref.	5 9/16—5 13/16	4 6 0	Feb, Aug	..	..
St.	3 1/2%	* Do. Deb. Stock 3 1/2 per Cent. (red.)	98 1/2—100 1/2	3 9 6	June, Dec	99	98 1/2
St	4%	Do 4 per Cent. Deb. Stock (red.)	103 —105	3 16 0	Jan, July	103 1/2	..
1	1/0	Oriental	1 3/4—1 7/8	5 16 6	April, Oct	1 13/16	1 3/4
1	0 7 1/2	Do. 6 per Cent. Cum. Pref.	1 9/16—1 11/16	4 11 6	April, Oct	—	..
St.	4%	Do. 4 per Cent. Red. Deb. Stock	89 —92	4 7 0	Jan, July	91	..
St.	4 1/2%	Telephone Co. of Egypt 4 1/2% Db. Stk. (red.)	99 —102	4 12 0	Jan, July	100	—
5	5/0	United River Plate	6 7/8—7 1/8	5 12 0	July	6 7/8	6 3/4
5	2/6	Do. 5 per Cent. Cum. Pref.	5 —5 1/2	4 11 0	June, Dec	5 1/4	..
St.	4 1/2%	Do. 4 1/2 Deb. St. Red.	100 1/2—102 1/2	4 7 6	Jan, July	101 3/4	101 1/2

FINANCIAL, INVESTMENT, &c.

Share.	Last Dividend	Name.	Price Wed., Aug. 19.	Rate % Yielded. £ s. d.	Dividend Due.	Highest.	Lowest.
5	3/0	Elec. & Gen. Investment 6% Cum. Pref.	3 1/2—4	7 10 0	Jan, July	..	..
10	5/9	Globe Telegraph & Trust	10 1/2—11	5 7 0	Sp De Mr Ju	10 3/4	10 1/2
10	3/0	Do. 6 per Cent. Pref.	13 1/2—14	4 5 9	Sp De Mr Ju	13 [illegible]	13 [illegible]
10	6%	Submarine Cables Trust (Cert.)	128 —131	4 11 6	April, Oct	128 1/2	..

COLONIAL AND FOREIGN ELECTRIC RAILWAYS, TRAMWAYS, &c.

Share.	Last Dividend	Name.	Price Wed., Aug. 19.	Rate % Yielded. £ s. d.	Dividend Due.	Highest.	Lowest.
5	3/0	Anglo-Argentine 6% Cum. 1st Pref.	6 1/16—6 5/16	4 12 0	April, Oct	6 3/8	6 1/4
5	5/0	Do. 10% Non-cum. 2nd Pref.	8 3/4—8 3/4	5 13 0	Jan, July	8 3/4	..
St.	6%	Do. Permanent 6% Deb. Stock	141 —146	4 2 0	June, Dec	145	143
St.	5%	Auckland Elec. Trams. 5% Deb. (red.)	103 —106	4 14 3	Jan, July	..	..
5	4 0	Brisbane Electric Trams. Invest. Ord.	4 5/16—4 13/16	4 3 0	May	4 11/16	4
5	2.6	Do. 5 per Cent. Cum. Pref.	4 7/8—5 3/8	4 17 6	May, Nov	5 1/16	5 [illegible]
St.	4 1/2%	Do. 4 1/2 per Cent. Db. Prov. Certs.	98 —102	4 8 0	Jan, July	101	..
St.	8%	British Columbia El. Ry. Df. Ord.	123 —125	6 5 0	Mar, Sept	125	..
St.	30 0	Do. Pref. Ord. Stock	109 —113	5 6 0	May, Nov	111 1/4	111 1/2
St.	5%	Do. 5% Cum. Perp. Pref. Stock	104 —105	4 12 6	Jan, July	..	..
40	4 1/2%	Do. 4 1/2 per Cent. 1st Mort. Debs.	101 —104	4 6 6	April, Oct	..	—
100	4 1/2%	Do. Vancouver Power Debs.	100 —103	4 7 6	Jan, July	..	—
St.	4 1/2%	Do. 4 1/2% Perp. Con. Deb. St.	101—104	4 1 6	—	..	..
St.	5%	Buenos Ayres Elec. Trams (1901) Ltd. Deb. St.	93 —97	5 2 6	Ja, Jul.	..	..
5	..	Buenos Ayres Grand National Ord.	2 —2 1/2	..	..	..	..
5	2/6	Do. 5 per Cent. Cum. Pref.	3 3/4—4 1/4	..	Feb, Aug	4 1/16	..
100	5 1/2%	Do. 5 1/2 per Cent. Pref. Debs.	99 —103	5 7 6	Jan, July	..	..
100	6%	Do. 6 per Cent. 1st Deb. Bonds.	100 —104	5 14 6	April, Oct	..	..
St.	5%	† Buenos Ayres Lacroze Trams 1st Mt. Db	93 —95	5 5 0	Mar, Sept	94	..
St.	6%	Buenos Ayres Port & City Tram. 1st Mt Deb. Stock £75 Paid	61 —65	6 12 0	Feb, Aug	..	..
5	2/6	Calcutta Tramways (1 to 137,610)	5 3/8—5 7/8	5 2 0	Mar, Sept	5 1/2	5 [illegible]
100	2/6	Do. 5 per Cent. Cum. Pref.	4 7/8—5 1/4	4 13 0	Jan, July	—	..
1	4 1/2%	Do. 4 1/2% 1st Deb. Stock (red.)	101 —104	4 6 6	Jan, July	..	..
St.	..	Cape Electric Tram Shares	3/16—7/16	..	..	..	—
5	1/3	† City of Buenos Ayres Trams Co. (1904) Sh.	5 9/16—5 13/16	4 6 0	F, My, A, N	5 5/8	..
St.	4%	Do. 4 per Cent. Deb. Stock	97 —101	3 19 0	June, Dec	..	..
..	5%	Colombo Tr. & Ltg. 5% 1st Mt. Db.	90 —93	5 6 6	May, Nov	92	—
100	5%	Electric Traction Co. of Hong Kong 5 per Cent. 1st Mort. Debs.	85 —90	5 10 0	June, Dec	..	..
1	5%	Havana Elec. Ry. Con. Mt. 5% $1,000 50 year Coup. Bds.	85 —90	5 11 0	Feb, Aug	..	..
1	..	Kalgoorlie Elec. Trams Sh.	[illegible]	..	..	..	..
100	5%	Do. 5 per Cent. "A" Deb. Stock	85 —89	5 12 0	Jan, July	..	—
5	6%	Do. 6 per Cent. "B" Ditto	69 —73	8 1 0	Jan, July	..	..
5	1/0	Lisbon Elec. Trams. Ord.	1 —1 1/4	4 0 0	July	..	..
100	0/7 1/2	Do. 6 per Cent. Cum. Pref.	1 —1 1/4	4 16 0	Jan, July	..	—
St.	5%	Do. 5 per Cent. Reg. Mort. Debs	92 —97	5 3 0	Jan, July	..	..
St.	5%	Madras Elec. Trams. 5% Deb. Stk.	93 —96	5 4 0	Jan, July	..	..
..	5%	† Manila Elec. Ry. $1,000 Gold Bonds	84 —88	5 11 0	Feb, Aug	..	..
100	4/ 1/2	Mexico Trams Co. Com. St.	119 —121	3 6 0	..	120 1/4	119 1/4
500	5%	Do. Gen. Con. 1st Mort. 5% Gold Bds.	93 1/2—94 1/2	5 6 6	..	94 1/4	93 3/4
St.	4 1/2%	Montreal St. Ry. Sterling 4 1/2 per Cent. Debs. (1922)	100 —102	4 8 0	Feb, Aug	..	
1	1/0	Perth Elec. Trams Ord	[illegible]	7 3 6	May	..	..
St.	5%	Do. 1st Mt. Db. Stock	101 —104	4 16 0	Jan, July	..	—
5	3/0	Rangoon Elec. Trams & Supply Co. 6% Cum. Pf.	5 1/4—5 3/4	5 6 6	..	..	—
St.	4 1/2	Do. 4 1/2% 1st Mort. Deb. Stk.	97 1/2—98 1/2	4 10 6	..	..	—
..	8% 1/2	Sao Paulo Tramway, Light & Power Co. $100 Stock	148 —152	5 18 0	..	151 1/2	146
..	5%	Do. 5 per Cent. 1st Mt. $500 Db.	98 1/2—99 1/2	5 0 6	June, Dec	[illegible]	[illegible]
100	4 1/2%	Toronto Ry. Co. 1st Mt. 4 1/2% Ster. Bonds	99 —101	4 9 0	Feb, Aug	..	..

COLONIAL AND FOREIGN ELECTRICITY SUPPLY &c.

Share.	Last Dividend	Name.	Price Wed., Aug. 19.	Rate % Yielded. £ s. d.	Dividend Due.	Highest.	Lowest.
5	8 0	Adelaide Elec. S'ply Co. 6% Cu. Pr.	4 3/4—5 1/4	5 14 0	Mar, Sept	..	..
10	6/0	Bombay E. S. & T. 6% Cm. Pf.	9 3/4—10 1/4	5 14 6	..	..	..
St.	4 1/2	Do. 4 1/2 per Cent. Deb. Stk. (red.)	94 —96	4 13 9	Jan, July	..	..
5	4/9	Calcutta Elec. Supply Ord.	5 3/4—6 1/4	5 17 0	April, Oct	6 1/4	6
100	7/2	Canadian Gen. Elec. Co. Com. St.	101 —103	6 16 0	..	102 3/4	102 1/4
100	5%	Castner Electrolytic Alkali Co. (of U.S.A.) 1st Mort. Stl. Debs.	92 —97	5 2 6	Jan, July	..	..
500	5	Elect. Development Co. of Ontario	83 —86 1/2	5 16 0	..	86	84 1/2
5	..	Elec. Ltg. & Trac. Co. of Aust. 6 per Cent. Cum. Pref.	2 —2 1/2	..	Feb, Aug	..	..
St.	5%	Do. 5 per Cent. Deb. Stock	84 —89	5 12 0	Jan, July	..	..
St.	5%	Elec. Supply Co. of Victoria 5 per Cent. 1st Mort. Deb. St.	90 —93	5 7 6	Jan, July		..
St.	6%	Indian Elec. Sup. & Trac. Co. Constn Deb. St. Rd.	30 —40	15 0 0	Jan, July	..	..
10	0/3	Kalgoorlie Elec. Power & Ltg. Ord.	—	..	..	..	
1	0/7 1/2	Do. 6 per Cent. Cum. Pref.	5/8—1	8 0 0	April, Oct	..	..
St.	5%	Madras E. S. Corp. 5 per Cent. Constn Deb. St.	85 —90	5 11 0	April, Oct	88 1/2	..
500	5%	Mexican Elec. Light Co. 5% 1st Mort. Gold Bonds	85 1/2—86 1/2	5 15 0	..	86 1/4	86
St.	$1	Mexican Lt. & Power Co. Cap. St.	70 1/2—71 1/2	..	..	71 1/4	71
100	5%	Do. 5% 1st Mort. Gold Bnds.	84 —85 1/2	5 19 6	..	85 1/4	84
100	6 2	Montreal Lt. Ht. & Power Co. Cap. St.	95 —101	5 19 0	F, My, A, N	98 1/4	
1	1/3	River Plate Electricity Co. Ord.	3/4—1	6 0 0	April		
1	1 2 1/2	Do. 6 per Cent. non-Cum. Pref.	[illegible]—1	6 0 0	May	..	
St	5%	Do. 5 per Cent. Deb. Stock	96 1/2—98 1/2	5 [illegible] 0	Jan, July		
5	3/0	Rosario Elec. Co. 6% Pref. (1–20,000)	4 [illegible]—5 1/4	5 17 6	April, Oct	..	
100	$1	Shawinigan Water & Power Co. Cap. St.	73 —75	5 6 6	..	74	73
..	5%	Do. 5 per Cent. Bds.	103 —105 1/2	4 15 6	Jan, July	100 1/2	..
..	6%	Victoria Falls Power Co. Pref.	3/4—1	—	Jan, July	..	..

* In calculating the yield allowance has been made for accrued interest but *not* for redemption. † Ex dividend. ‡ The London Stock Exchange Committee have declined to quote them.

CONTENTS.

THE ELECTRICIAN INDUSTRIAL SUPPLEMENT.

Electrician No. 1579.
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Gratis to Subscribers.

AUGUST 21, 1908.

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EXTRA COPIES can be obtained, price 4d. per copy, post free.

Making Power Chains.

The New Works of Messrs. Hans Renold, Ltd.

THE belt has held practically supreme sway as a transmission medium for the driving of industrial machinery since the conduct of factories equipped with productive appliances was undertaken on organised lines. But the belt has been tolerated as a necessary evil particularly with heavy machine tools which made sudden demands on the power source. It has never been really satisfactory, and has been accepted as a stop-gap pending the supply of evidence which might lead to its conviction and condemnation as a power transmission agent. That evidence is now forthcoming as the article below will show, at any rate in so far as it relates to the operation of important and accurate machine tools.

In the new works which they have erected at Burnage, a suburb of Manchester, Messrs. Hans Renold (Ltd.) have clearly demonstrated the futility of attempting to secure accuracy in the product of an automatic machine driven by belt. We need hardly remind our readers that the manufacture of the Renold chain for power, automobile and cycle service is carried on with a degree of accuracy which reaches within $\frac{2}{10000}$ths of size. The whole of the work on such parts as pins and rollers is done on automatic lathes, and tests conducted for the purpose of comparing the work on belt and chain drive have revealed the undeniable superiority of the chain, as we shall show later. We may at this juncture refer our readers to our issue of March, 1907, in which we referred at some length to the Progress Works of Messrs. Hans Renold (Ltd.), at which the bulk of the product in chains has been turned out for many years past, indeed, as far back as 1879.

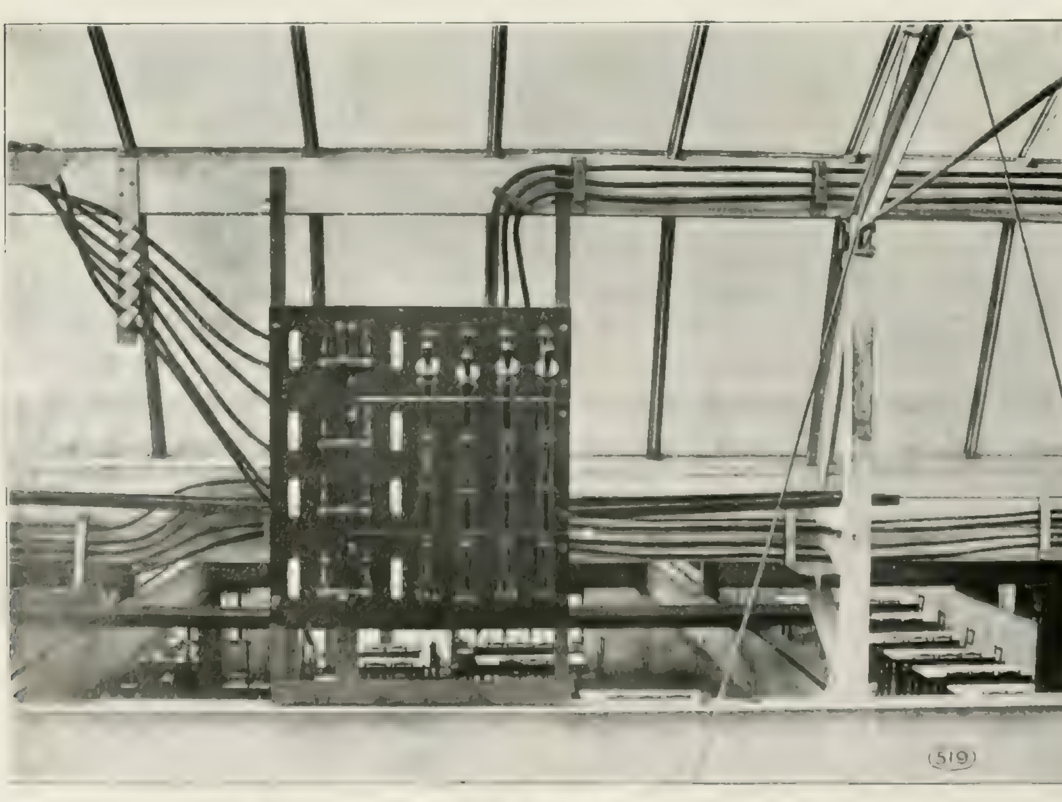


Fig. 1. Power Distribution Board on Gallery under Roof.

The new works at Burnage have been erected primarily for taking over the independent manufacture of power chains for motor traction and industrial power purposes. The various departments are laid out in a single building which is quite open and practically constitutes a huge workshop divided into bays by a number of aisles. This arrangement admits of even illumination and a minimum of trouble in the interchange of parts. The

area covered is about 210,000 sq. ft., and embraces both offices, workshop, sub-station, heating boiler house, fanhouse and hardening shop. As we have previously dealt with the manufacture of the Renold chain, and as our readers will be familiar with the main features of the various chains manufactured, we propose to deal in this article with the main details of the electrical equipment and the tests of chain and belt-driving to which we have already referred.

Fig. 2.—View in one of the Side Aisles, showing position of Motors and Power Cables.

The shop is entirely driven by electric power, energy being purchased from the Manchester Corporation. For the supply of the works a sub-station has been built on the premises, and the transmission voltage of 6,500 is lowered to 400 volts for distribution in the shops. Two sets of British Electric Transformer Co.'s transformers are installed, together with the necessary switchgear. Lighting circuits at 250 volts are obtained by connecting the neutral point of the system with any one of the outer wires. Bare copper conductors are used for the main feeders from the sub-station to the central distribution board, and these are run overhead on a gallery which extends around the main aisles in the shops. The position of the board and gallery will be made clear by a glance at Fig. 1, which depicts the principal feeder board.

The driving is arranged on the group system as most of the machines, except the punches, are comparatively small and light and individual driving would be out of the question. Standard motors, of Bruce Peebles make, each developing 12 B.H.P., are erected on concrete pillars at different parts of the shop, and these drive lengths of line shafting by silent chains. The motors run at 750 revs. per min. and the line shafting at 150, 200 or 300 revs. per min., with centres ranging from 3 ft. to 10 ft. The position of the motors and line shafting is shown in Fig. 2. It should be noted that the motors are all one size and that all parts are strictly interchangeable; we may also recall the fact that the greater part of the installation forms a repeat order. There are 37 motors in all. The lighting of the works is by 50 flame arcs of the Davy "Sunrae" pattern, these being run in series groups across the lighting mains. Fig. 3 is a view in one of the machine bays, and shows the light character of the overhead shafting and the compact arrangement of the automatic lathes.

The drive from the motors to the line shafting is by Renold silent chain, the drive being direct without the use of clutches or spring wheels. The line shaft, in the case of the bays containing the automatic lathes, runs over the centre of the gangway between the machines, and the countershafting above each line of lathes is chain-driven from the central line shaft. This is clearly depicted in Fig. 3, which illustrates a bay containing 63 small automatic machines. Chains are used for the main spindles of many of the larger automatic lathes, belts serving for the smaller machines and for the cam shaft movements. The lathes are thrown in and out of gear by a coil clutch in the case of the smaller drives and a cone clutch for the heavier duties. One of the latter is illustrated in Fig. 4.

The clutch is oil-retaining and is fitted with self-contained thrust bearings. These clutches have been made by Messrs. Renold up to 20 H.P. and we understand that patterns up to 100 H.P. are being developed. We may remark here that the

Fig. 4.—Views of Rollers turned on Belt (on left) and Chain-driven Automatic Lathes.

line shafting and hangers are of uniform length and size, and the simplest possible method of fixing has been adopted. When we state that 163 machines were transferred from the Manchester works to the new shops and re-erected in one month by a gang of five men, our readers may judge of the flexibility of an interchangeable system of shafting. This feat was accomplished without Sunday or night work, and no machine was stopped more than two days. The entire works contain many features of engineering and electrical interest, more especially in respect of the processes employed in the production of the chains themselves. These we must pass over at the moment because we wish to give some details of the remarkable tests made by Messrs. Renold to demonstrate the superiority of chain over belt driving. These particulars have been supplied somewhat fully by the makers, so that we propose devoting the balance of this article to them.

At the outset we may call attention to the fact that Messrs. Renold have experimented with the power chain for a number of years now, and the accumulated experience influenced them in the policy of adopting the chain drive on the machinery in their new works. What follows may therefore, be regarded as no mere piece of pioneering, but the consummation of plans which have been maturing for some time. The principal claims made for the chain drive are two in number—(1) a saving of 20 per cent. in the power bill and (2) an increase in production of 15 to 25 per cent. Other important advantages are silent running, greater top light, due to small size and width of chain wheels and chains, better quality of work and more compact grouping of tools.

From results obtained with a few chain driven lathes at Progress Works it was assumed some time before the tests were made that a great superiority over belt driving would be brought about. In the actual trials which

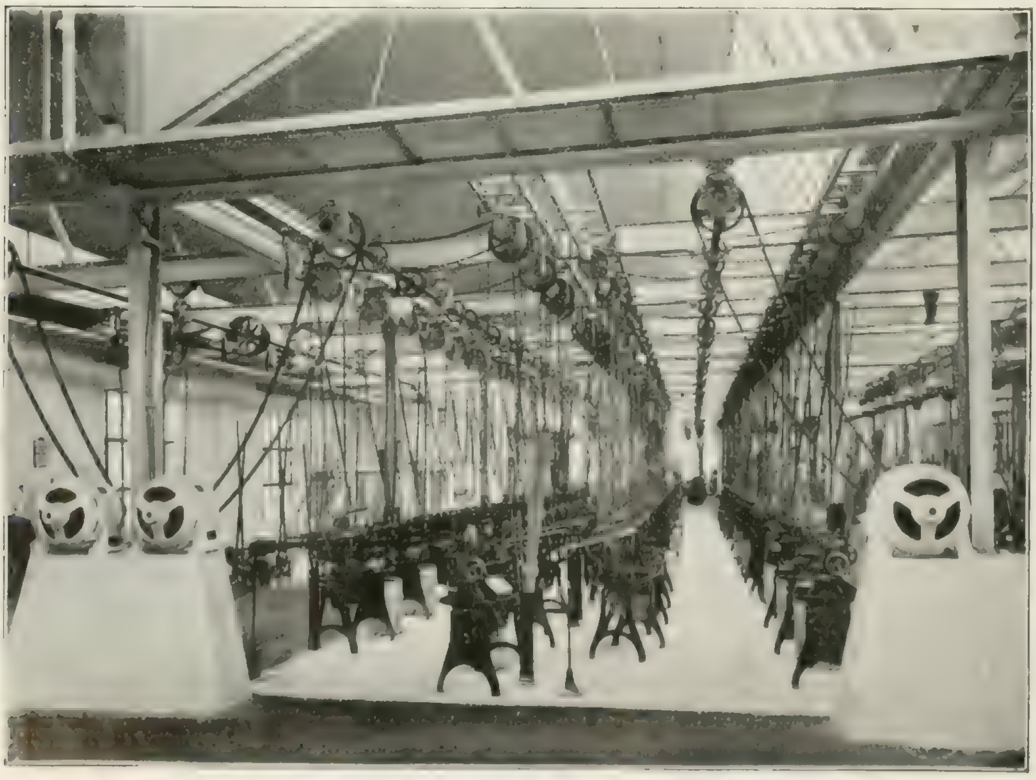


Fig. 3.—View along Line of Machines in one of the Bays, showing Line and Countershafting and Position of Motors.

took place at the new works, two identical Brown & Sharpe automatic lathes were used and each was given the same duty, the only difference between the tools being that one had a chain-driven spindle and the other a belt-driven one. The duty consisted of drilling, rimering and parting from solid steel bars, rollers 1 in. diameter, 1 in. long with $\frac{3}{4}$ in. hole. These rollers represent the utmost capacity of the respective tools. The trials extended over an identical period for each machine, namely, 138 hours. During this time the chain-driven lathe produced 3,074 rollers and the belt-driven 2,485 rollers, making a difference in favour of the former of 589 rollers, or $23\frac{1}{2}$ per cent. These results were verified by changing the feed cams and the parting tools of the respective machines. The marked difference in the finish of the rollers from each machine may be gathered from Fig. 4, which is an enlarged view of the rollers from the chain and belt-driven tools. The greater steadiness of the chain drive is abundantly proved by this illustration. The uneven surface of the roller from the belt-driven machine points to jerky movement of the spindle and a tearing away rather than a cutting of the metal. As much as 230 lb. tension was required on the belt to obtain any result.

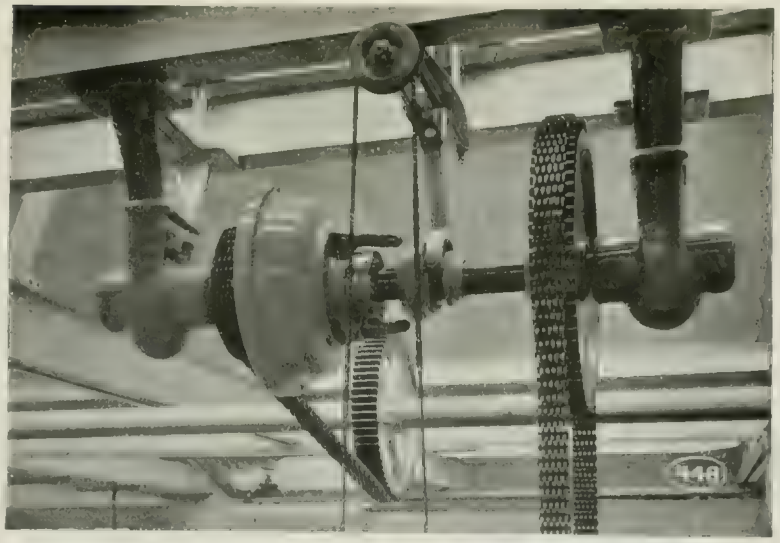


Fig. 6.—Clutch and Striking Gear used on Chain-driven Countershafting.

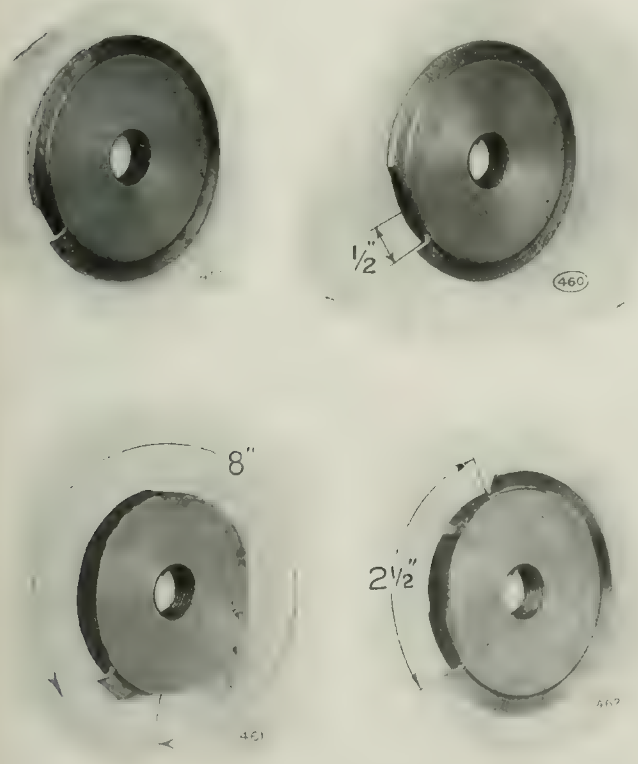


Fig. 5.—Parting Tools used on Chain and Belt-driven Automatic Lathes. (The two lower tools were taken from the belt-driven machines. The upper right-hand tool run through the test on the chain-driven Lathe.)

The effect on the tools of the respective machines presents some striking contrasts. The drilling was done at speeds of 93·75 ft. on the belt-driven machine and 56·25 ft. on the chain, the speed being that at the circumference of a $\frac{3}{4}$ in. drill; the respective feeds per revolution were 0·0028 in. and 0·0046 in. The drill on the belt machine was ground 10 times and two drills were used: a total length of 6 in. was worn off these. The chain-driven machine showed much better results. The drill used was sharpened twice, and only $1\frac{3}{8}$ in. was worn away. The effect on the parting tools was even more extraordinary. The views in Fig. 5 show the unused tool, the same after 138 hours' run on the chain-driven machine and the two worn tools taken from the belt-driven machine. These practically tell their own tale, and substantiate the claim of the chain makers that only 5 per cent. of parting tools are used.

As a direct result of these tests it is claimed that one operator can attend six chain-driven machines as against two belt-driven, that 25 per cent. of grinding tools only are necessary and that the wear on the spindle and countershaft of the tool is greatly reduced. The latter was demonstrated by tests made of the pressure on the bearings, the results being summed up in the table on p. 126.

—	Belt driven.		Chain driven.	
	Counter-shaft.	Machine spindle.	Counter-shaft.	Machine spindle.
Pressure on Bearings.	lb.	lb.	lb.	lb.
When machine is stopped	230	230	32	0
When spindle and cam-shaft on machine are running, but no work is done	230	230	36	4
When going through one working cycle, consisting of				
1st, centering	230	230	68	36
2nd, drilling	230	230	63	31
3rd, rimering	230	230	38	6
4th, cutting off	230	230	40	8
5th, feeding stock forward ...	230	230	38	6

The tests for power consumption were made on 11 belt and 11 chain-driven machines, the former doing light and the latter heavy work. The results showed that 6·95 H.P. was required for the chain-driven machines, as against 8·43 H.P. for the belt driven. If the power required for the line and countershafts is deducted the figures become 5·69 H.P. belt and 4·21 H.P. chain, or a gain of 26 per cent. in favour of the former. Figures have also been got out for the chain and belt driving of the new works at Burnage, and these read 540 H.P. belt and 450 H.P., or 20 per cent. less for chain. The cost of chain is 20 higher than belt, but this may be offset by the fact that a belt installation would require 20 per cent. larger motors, shafting belts, &c. Considering the actual costs based on the charge per horse-power year, which may be taken as about £6 at Messrs. Renold's works, the figures are, for belt driving £3,240 and for chains £2,700 on the above difference in horse-power required. This represents a saving of £540 per annum for electrical energy alone. But, of course, this advantage in favour of chain driving is further enhanced by the increased production due to the use of chains, the improved quality of the output, reduction in cost of labour and a large saving in the matter of tools and floor space. Fig. 6 illustrates the type of clutch and striking gear adopted in the works.

Coming as they do from a firm with the reputation for precision in workmanship which is enjoyed by Messrs. Renold, the above results will be accepted by engineers as a complete justification of the use of chains for the driving of automatic tools. Messrs. Renold have already applied the silent chain to the driving, in conjunction with electric motors, of many large machine tools. In addition to a special selection of grinders, punches, drop-hammers (*see* Fig. 7), &c., in their works, there are also large fans and air compressors driven through the medium of chains. We need hardly state that the particular merits of the chain drive need to be considered in each instance. At the same time it is probable that, having regard to the success achieved with the chain drive so far, its range of commercial and industrial utility will be largely extended. Messrs. Renold have already accumulated an enormous amount of data on the subject of chain driving, and this information is constantly being added to. Needless to say they place it entirely at the disposal of interested engineers who may have the merits of chain driving under consideration.

Fig. 7.—Group of Drop Hammers operated by Chains from Chain-driven Shafting.

We must express our thanks to the company for permission to inspect the new works and particularly to Mr. Charles Renold for his courtesy in conducting us round the various departments.

Problems of Textile Power.

THOSE engineers responsible for the ordering of things in textile circles must soon begin to feel their responsibilities in regard to the power problem. We fear that many mills have been equipped with power plant, as well as textile machinery, which has not come up to present-day standards, but which is introduced simply and solely because the makers of the plant become financially interested in the mill. The share system runs the entire gamut of officials, contractors, manufacturers and operatives, and in itself is no doubt valuable as cementing the interests of those who will be entrusted with the conduct of the mill once it has been started. But when it is held out as an inducement either to contractors or by contractors and manufacturers it is liable to be the cause of much evil. It is bound to be a check on progressive development of both power plant and textile machines. Of course, improvements in engines and textile machinery are introduced from time to time, but assuming that the owners of the patent rights cannot, or will not, take advantage of the share system, the industry must suffer the lack of these advanced types of plant.

There are naturally arguments in favour of the system. For instance, it may be of advantage to foster a species of competition among machinery makers as to which shall become interested to the greatest extent in the financial undertaking of the mill or mills belonging to a company. The promotion of rivalry of this character will no doubt stimulate a desire to secure business in this way, But is there the same anxiety to introduce new and improved plant into a mill as is evinced in the securing of an order for a portion or the whole of the equipment. If the system were nothing more than a form of co-operation between the financial organisations of manufacturers and mill owners respectively, instituted with the object of furthering progress in textile industries little objection might be raised to it. We feel, however, that it operates to the general detriment of the industry, and that a bad feeling against the principle of co-operation is likely to be created.

We realise that the maker of textile power plant, for instance, knowing that he may become financially idenfied with a certain mill company, will also need to fulfil any contract which he may secure by these means to the best of his ability and with the most efficient type of plant his works can produce. But the financial lever with which he may lift his machinery into the mill blunts the edge of his interest in the introduction of an entirely modern equipment which, in competition with his commercial rivals, he would have been compelled to put forward for acceptance.

While this share system may have certain advantages in its relation to the development and utilisation of power plant and textile machinery proper, it hits very hard against an important section of electrical industry—namely, the power in bulk supply company. The problem of electric power supply to textile mills resolves itself practically into two distinct issues: (1) The employment of isolated plant in which electrical energy is generated on the mill premises, and (2) the purchase of power from an independent organisation having stations situated at different points within the supply area. The first mentioned is not seriously influenced by the functions of the share system, though to electrical manufacturers it is undesirable that contracts be concluded on any other than a strictly financial basis. The objection that out-of-date electrical plant may find its way into the mill has also to be raised. Still the maker of electrical plant and apparatus can secure contracts for mill equipment in the same manner as does the manufacturer of machinery and accessories for steam and rope driving. Not so the power company. Its commodity is an intangible one, and is only purchaseable in a specific manner. It can give guarantees under penalty, of reliable service, but it cannot barter in shares. Its weapons against the attacks or for the attack of the isolated plant are, broadly speaking, two only—low tariff and continuity of supply. How then can a company offering electric power for sale meet the blandishments of the sharemonger? It must be some consolation to organisations of this character that they can show this gentleman the door, the while they are content to rest alone upon the merits of their claims to the attention of the textile mill owner. At the same time textile power supply in bulk labours under a serious disability, where the share system is in operation, particularly with new mills, which offer many advantages for the utilisation of the electric drive.

Modern Economical Steam Plants. . .

TO reduce the cost of generating electrical energy in small plants to a minimum is the constant aim of power station engineers. Consequently the selection of an economical and reliable prime mover is of vital importance. Whatever may be the merits of internal combustion engines, many engineers still prefer an equally economical steam plant.

This need seems to be met by the Wolf superheated steam locomobile, which, we understand from figures placed at our disposal, has actually attained a consumption of 1·04 lb. of coal and 8·66 lb. of steam per brake-horse-power per hour on a 100 H.P. unit. These results practically

represent 1 lb. of coal per brake-horse-power per hour, ordinary steam coal of only 13,500 B.Th.U. being used. Taking the price at 10s. per ton, this will reduce the cost of fuel to 0·05d. per brake-horse-power per hour, or 20 H.P. for 1d.

The locomobiles are of the overtype design and are built in various sizes, from 10 H.P. to 600 H.P. Each forms a complete and compact steam plant, occupying little floor space and requiring no special setting in brickwork or extensive foundations. They can be attended by unskilled labour. The furnace and tubes are removable, so that inspection and cleaning of the boiler is an easy matter. By undoing a few nuts, the furnace and tube can be withdrawn and thoroughly scaled in the open. The tubes are wide apart, and even the innermost tube can be scaled without disturbing any of the others. This is a great advantage where the water is impure and the boilers must be regularly examined for scale, deposit, &c.

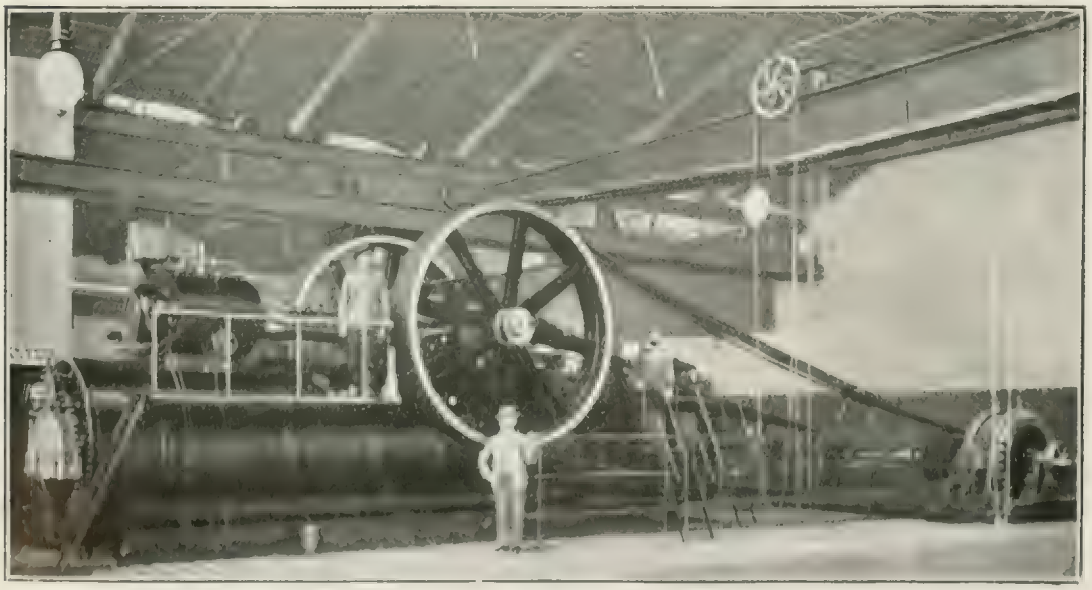
The furnace can be arranged for any kind of fuel, such as inferior coal, lignite, or slurry from coal washeries; woodwaste, sawdust, peat, tan; or liquid fuel, naphtha, petroleum, &c., which will give sufficient heat to generate a steam pressure of 176 lb. per square inch. The superheater is a coil of seamless drawn wrought-iron tubes placed immediately behind the fire tubes, so that it is constantly swept and surrounded by the hot gases immediately they leave the boiler. It is claimed that, by the constant impact of the deflected hot gases against the superheater tubes, and the continued intermixing of the steam particles and their intimate contact with the walls of the tubes in consequence of centrifugal force, the Wolf superheater utilises the full amount of heat.

Special attention has been given to the valve gear in superheated steam engines, since the common slide and poppet valves have proved unsuitable even for moderately superheated steam. The piston valve, introduced by Messrs. Wolf after long experiment, in connection with the shaft governor, has, we understand, been found absolutely reliable and durable even under the highest steam temperature. This is due to the small weight of the valve and its simplicity, combined with the fact that the operating mechanism only consists of three parts. The larger size engines are all equipped with continuous chain lubrication, which ensures a great economy of oil. The bearing bushes are very carefully made and offer a large surface. The bearings are fastened to a heavy bearing saddle, which spans the boiler and gives the shaft a firm bedding.

Views of Wolf Locomobiles in Electric Power Stations, in Steel Works, aggregating 900 H.P.

Boiler expansion is allowed for by the mounting and fitting of all parts while the boiler is under steam. This method has been applied to both the smallest and largest engines for more than 45 years, and has always given the best results.

In order to obtain shorter steam pipes the cylinders of the tandem engines are removed to the rear, the high-pressure cylinder being built into the smokebox, where it is not exposed to loss of heat. The steam from the first superheater having expanded in the high-pressure cylinder, passes through the intermediate superheater into the low-pressure cylinder, the jacket of which serves as the steam dome. The high-pressure cylinder is fitted with balanced piston valves, which are kept steam tight with spring rings; the low-pressure cylinder is working with constant cut-off, and the cut-off of the high-pressure cylinder is automatically controlled by a shaft governor. By placing the two cylinders in tandem the driving gear is simplified, and the substantial construction of the engines ensures great durability, combined with highest capacity.



440 H.P. Wolf Locomobile in Copper Tube Works, driving A.C. and D.C. Generators.

Tests of this tandem locomobile made by Prof Josse showed the following results:—

Capacity in brake-horse-power, 43·2 H.P.; consumption of steam, 10·90 lb. per B.H.P. per hour; consumption of coal 1·10 lb. per B.H.P. per hour. Capacity in brake-horse-

power, 55·1 H.P.; consumption of steam, 10·29 lb.; consumption of coal, 1·23 lb. per B.H.P. per hour.

Prof. Josse—in his book, "The Present Development of Heat Engines and Power Plants"—states that he considers these locomobiles the most favourable heat-power plants of the present time.

Power Station at Salbke with 385 B.H.P. Superheated Compound Locomobile.

The superheated steam locomobiles are used in a large number of electricity generating stations as well as in other industries in all parts of the world. The accompanying illustrations show Wolf engines driving dynamos in some of the largest steel and metal works on the Continent, as well as one unit at their own electricity station at Salbke. In regard to the latter, we may point out that this unit, which develops up to 385 B.H.P., is fitted with automatic underground step-grate firing for using the cheapest grade of lignite as fuel.

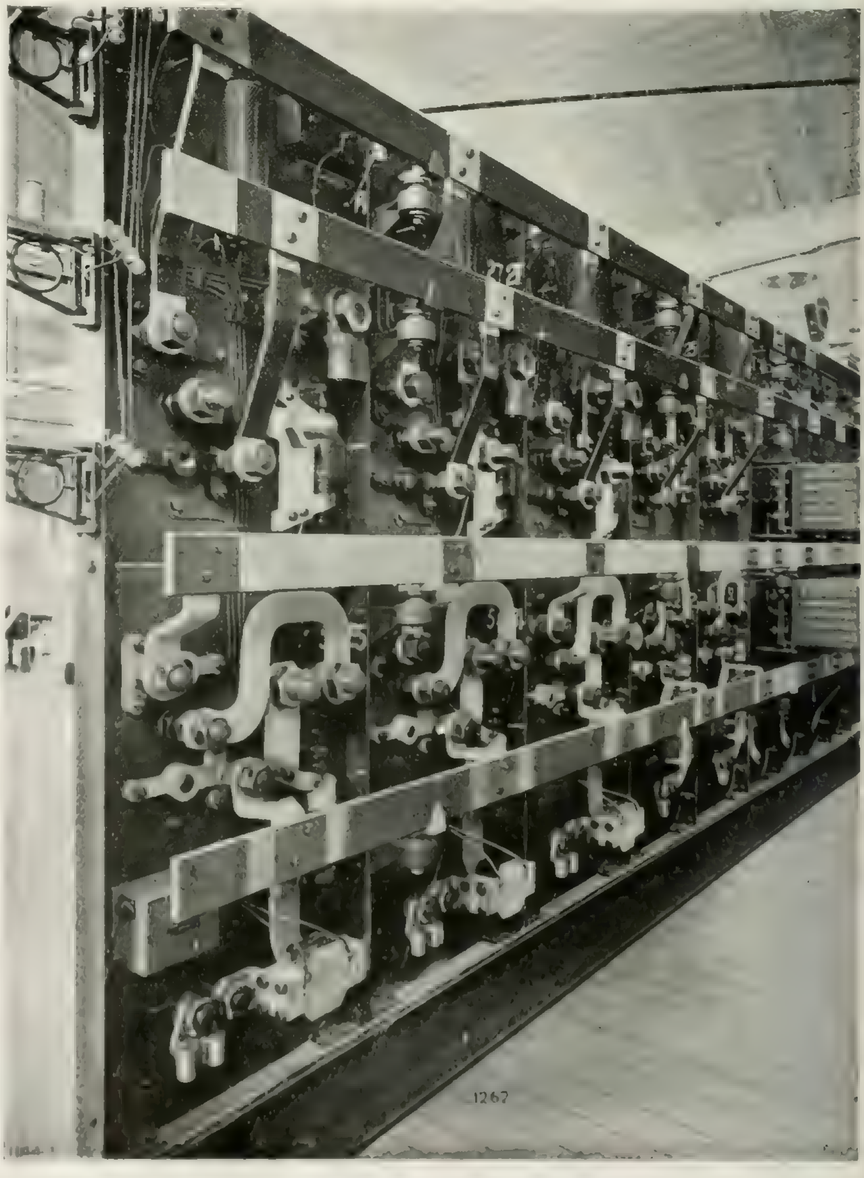
The total output of the firm in locomobiles aggregates up to the present over 600,000 H.P., and of the large number of locomobiles sold over 1,300 were installed in electric lighting and power stations, 1,200 in iron and metal works, 700 in hoisting and mining plants, 1,500 in wood working factories, 1,250 in potteries, cement and brick works, 800 in flour mills, 200 in paper mills and printing works, 250 in textile mills, &c.

Messrs. Wolf were, we understand, the first to apply a high degree of superheat to locomobiles, and to develop a compact steam plant embodying all the latest features of modern engineering practice. The works were established at Magdeburg-Buckau in 1862, making as a speciality locomobiles, and to-day they employ in this branch of manufacturing alone nearly 3,000 hands. Amongst the numerous awards granted to the firm may be mentioned the highest awards at Chicago World's Fair, 1893, two diplomas of honour with medals; Paris 1900 grand prix; Dusseldorf, 1904, gold medal; Moscow, 1905, diploma of honour with medal; Milan, 1906, grand prix; Berlin, 1907, gold medal and diploma of honour, &c. The London address of the company is 7 Laurence Pountney Hill, Cannon-street, E.C.

A Typical Switchboard.

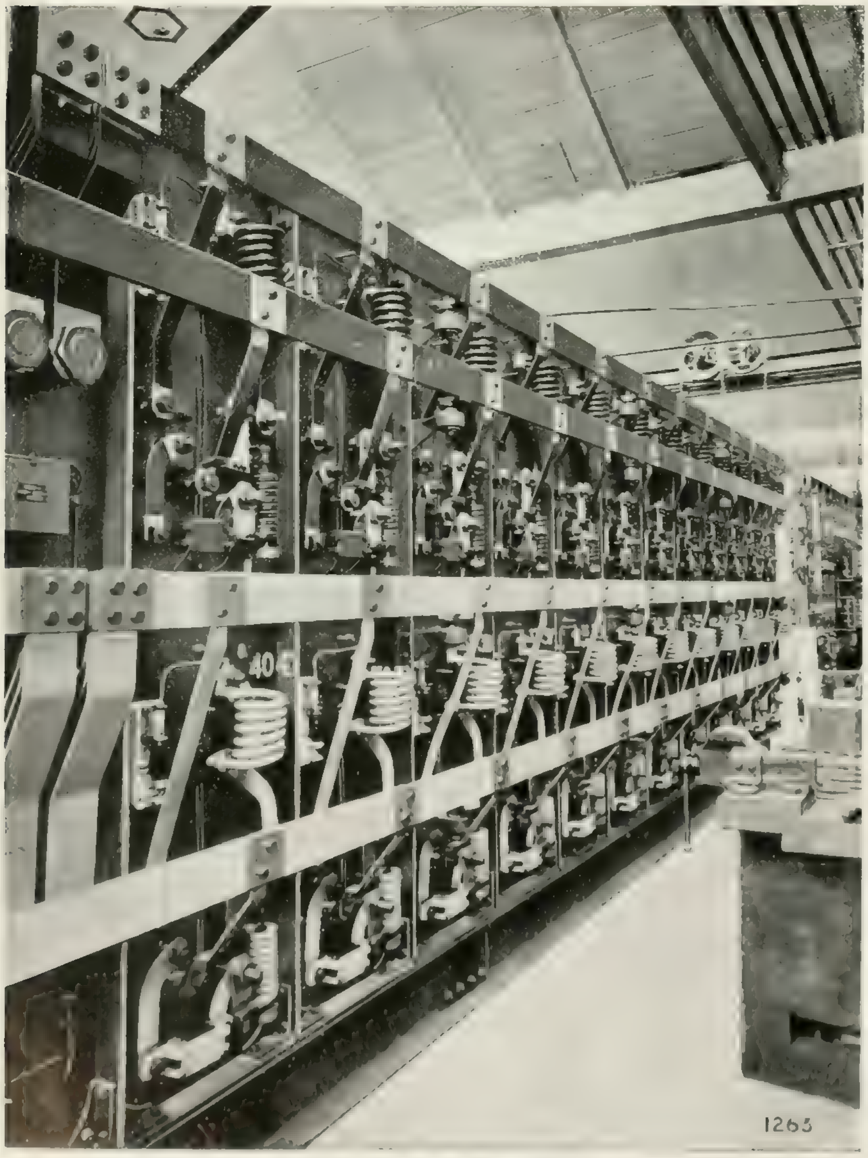
THE modern low-tension switchboard differs considerably from its predecessor of a decade ago in many important respects. Many engineers in charge of large electricity works to-day will recall the fires and burn out which marked the unhappy career of gears fitted with rubber-covered cable connections of opposite polarity which chased each other in bewildering and almost fascinating confusion within a space which would hardly have done justice as a coal closet. The thought of bare conductors at the back of the board in those days would have called forth appreciative remarks from the shift engineers who feared that their profession as rubber-gloved spanner acrobats might become a thing of the past. Yet to-day the low-tension gear rejoices in bare 'bus bars, bare copper connections, bare terminals,—a veritable contrast in all their nakedness to the braided and capped spectacle presented by the "early" switchboard, which may here and there be encountered in the "backwoods" of electricity supply.

The adjoining illustrations depict the class of work which is carried out by Messrs. Crompton & Co. on all the low-



Back View of Board, showing Dynamo Connections.

tension gears made by them at their Chelmsford works. The board illustrated has been supplied to the Madras Electric Supply Corporation, and is made for the control of five generators, two balancers, and a battery of 12 feeders. The general construction is on modern lines, there being an angle iron framework, into which enamelled slate panels are fixed. The selection of the latter material requires some care as metaliferous veins are sometimes met with, and these give rise to short circuits or serious leakage which will ultimately cause trouble. To reduce these risks to a minimum all terminal shanks are ebonite bushed, and the bolts clamping the panel to the frame are ebonized. In the case of the Madras gear this has been carried out The actual arrangement of the parts at the back of the board is well brought out in the illustrations which serve to show that when care is exercised in the lay out of the connections there is absolute safety with a gear of this class.



Back View of Feeder Panels.

The panels making up the Madras board are fitted with the usual complement of instruments, circuit breakers, switches, &c. The generator panels control respectively three 500 kw. and two 250 kw. machines. The instruments are of the dead beat moving coil pattern on the standard lines laid down by Messrs. Crompton many years ago. The circuit breakers are fitted with magnetic blow-out and have quick make and break with free handle movement. This latter dispenses with the necessity for a knife switch in series, and leaves the panel both front and back much freer than if the knife switch is included in the equipment. Maximum and reverse current tripping devices are fitted to the breakers. Watt-hour meters are also included on the generator panels. These serve as a check on the main wattmeters which are placed in the 'bus bars between the generators and feeders. The feeder and balancer panels have the usual equipment of instruments, circuit-breakers and switches.

Two sets of 'bus bars have been provided, one for high voltage or distant feeder supply, and the other for low voltage or local feeder service. By means of suitable plugs any feeder can be connected to either of these bars. The resistances for the generator fields and the boosters are controlled from pillars set back on the switch gallery away from the front of the board.

The entire arrangement of the gear has been worked out with the object of ensuring complete and safe control of the generating plant, and no effort has been spared to achieve this end.

Continental Power Plants.

THE growth of hydro-electric plants on the Continent is not accurately expressed by statistics. It must be seen to be believed. We are not given to travel, like the Americans, and consequently are deprived of the pleasure of actually observing what our neighbours are doing. Dr. Louis Bell has evidently been keeping his eyes open during a recent trip to Europe, judging by the columns of the *Electrical World*, in which he gives his impressions of scenes and events. These are penned in characteristic American and in their references to hydro-electric transmission plants are worth quoting.

"Starting out from Milan one follows for miles the transmission lines that have made northern Italy conspicuous. The constructions are interesting more especially from the very general use of steel lattice poles. Poles they are, not towers, spaced not more than 40 to 50 metres, I should think. There are square lattice poles, some with wooden extension tops, some with steel throughout and wooden cross-arms, some all steel. I noted in particular a very workmanlike slender latticed A-pole bearing only the three-line wires and set in concrete, like most of the poles. The A was set in general with its base in the line of the wires, but every few spans, and at angles, poles were crosswise the line to give lateral stability. At road crossings a simple cage was stretched under the lines, and at railway crossings a more elaborate one. Some lines carried six wires, one circuit being above the other. Wooden poles are used to some extent, but the more flexible lattice seems to be the standard of construction. A little above Viege they are building a large power station, not yet near completion, with a big hydraulic head, to judge from the immense upward sweep of the way cleared for the pipe lines. The Viege is a wild stream hardly held in place by its rock walls and masonry embankments and will ere long prove a splendid source of power. To-day I came down from Zermatt and rode down the Rhone Valley to Martigny, a beautiful and interesting country, rich in power. One would over and over see from the train a pole line with the three tell-tale insulators, and follow it far across the valley until it dodged into the mouth of a canyon, with perhaps a glimpse of the roof of the power station or the last steep plunge of the pipe line. The poles used along here are, with few exceptions, wooden, generally with the porcelain insulators set on the simple steel hook fixtures so familiar in Continental telegraph practice. The whole region is full of water powers rushing down from the high Alps, and it will not be long before hardly a village will lack electric light and power. In fact, the time is pretty near already. Until I reached Strasburg day before yesterday I had practically not been out of sight of a power transmission line for a week. Switzerland seems to be fairly enmeshed with them. Structurally the Swiss line reminds one on the average of some of the earlier American lines. It is designed after the manner of a Continental telegraph line. The Swiss plants, you see, have cheap line construction, and as the hydraulic heads are generally considerable, they are, on the whole, of moderate first cost, and, as a rule, have paid, sometimes very little at first, but steadily more and more as time goes on. They get good prices for light and power—quite as good as we do."

THE ELECTRICIAN INDUSTRIAL SUPPLEMENT.

ISSUED MONTHLY GRATIS

THE ELECTRICIAN

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Telegraphic Address: ELECTRICIAN NEWSPAPER LONDON   Telephone No. 949 HOLBORN

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Manufacturers, Contractors, Central Station Engineers, and those interested in Electrical Industrial Developments are cordially invited to contribute original matter to the SUPPLEMENT, and when suitable this will be inserted as space permits.

Filing Case for "The Electrician" Industrial Supplement.

The INDUSTRIAL SUPPLEMENT is holed for filing, and we are distributing cases which will hold twelve issues. On request a case will be sent to Consulting, Manufacturing, or Contracting firms; to Chief or Resident Engineers of Electricity Supply, Traction or Power Stations; to any firm of Merchants or Agents; to Railway, Tramway, Dock, Harbour, or other companies interested in the applications of Electric Power, &c., to their undertakings; and to other large consumers of electrical energy, either at home, in the Colonies, or abroad.

A portion of each issue of the SUPPLEMENT is reserved for special circulation oversea.

Editorial.

The Chain Drive. In another column will be found a description of a modern factory equipped with automatic machinery and driven by electric motors, for the most part through the medium of power chains. The results of tests of belt-driven and chain-driven machines are so convincing that they cannot be passed lightly over, particularly by the engineer or manufacturer, who has everything to gain by the introduction of highly efficient machinery and perfected methods of production. The tests conducted by Messrs. Hans Renold at their new Manchester works are epoch-making in so far as they relate to machine-tool driving, and particularly to automatic tools. They establish the claims of the chain beyond all doubt as a superior power-transmitting medium compared with the belt, especially in connection with machine tools. The works equipment also shows how a plant intended primarily for highly accurate productive work can be installed in a large factory under practically ideal conditions as regards light, air and general efficiency. The overhead chain drive, in being more compact, lighter and less obtrusive, admits of the best grouping of the machine tools on the floor below, while it interferes but little with the passage of light from above. The remarkable economies in power secured by the chain drive also throw a new light on the wasteful character of belt driving and furnish useful evidence in support of motor operation with a minimum of countershafting. It cannot, of course, be argued from the Burnage Works experiments that the chain drive is the panacea for all the ills which lie athwart the track of all industrial power users. Careful comparison of belt and chain in individual cases can alone provide tangible evidence on which to consider seriously the question of conversion. Still, the results obtained in the present series of tests are encouraging enough to warrant the conduct of further interesting research work in other industries. Even if this is never undertaken there remains enormous scope for the power chain within the wide and varied province of machine-tool operation. The chain-driven lathe, automatic or otherwise, should in itself be a means of cheapening production in the turning of metals, while it will unquestionably increase the accuracy of the work done. A noteworthy feature of these investigations is the reputation which Messrs. Hans Renold have achieved for extreme precision in the manufacture of chain, and a degree of accuracy in chain production which must make their record the envy of the engineering world.

Steam Locomobiles. In the light of the development of which are now termed "locomobiles," one is compelled to wonder what the electricity works of 15 years ago would have looked like had such plants been available at that time. Modern steam locomobiles combine boiler, superheater, engine and condenser in one, and the complete plant forms a compact power unit which might grace any engine room. It will be interesting to follow the development of these plants for the driving of industrial machinery in competition with suction gas and oil. In this country we are probably a little prejudiced in favour of the steam engine, and this circumstance has, no doubt, checked any rapid movement away from steam towards gas and oil engines. We are speaking now of users of power who require an engine at only irregular intervals, or who are beyond the reach of an electricity supply service. There are, of course, great numbers of power users of this class. Considering, now, the figures given by R. Wolf, makers of a compact steam locomobile, we find that, even if allowance is made for the special conditions under which the tests were conducted, a steam locomobile can still comfortably compete with a suction gas plant, and have a good margin in hand. 20 H.P. for one penny is an exceptionally low figure for a small steam plant, and practically halves the records claimed for suction gas. Side by side with this must be considered the fact that the average mechanic understands the steam engine, and knows how to humour it. Gas and oil plants are less familiar objects, and are probably regarded as crankish and difficult to keep in order. The future of the locomobile would appear to be among power users who appreciate the value of the smaller types of steam engine, and have always maintained a lively faith in the possibilities of their economic development. For certain classes of working requiring portable engines it also presents striking advantages. As a prime mover for the driving of dynamos its compact dimensions and remarkable economy compensate for the fact that either a belt or rope-driven generator must be used. The higher speed of the dynamo, of course, reduces the initial cost, while the actual space occupied by boiler, engine and dynamo is less than that required for a separate boiler and direct coupled steam unit. Still the fact remains that in this country, for public electricity supply purposes at any rate, we are practically wedded to the high speed engine, and have brought this type of plant to a degree of perfection which cannot be rivalled elsewhere. The locomobile has, however, an open field among those who favour its installation in conjunction with high-speed dynamos, driven by ropes or belt. The economies of the plant and their capacity for steam under cheap coal might certainly be a recommendation for them as day and night load plants in small or medium sized stations.

London Power Supply.

THE problem of electric power supply in London is like the poor, "always with us." It has recently entered upon a more interesting phase, and one which holds some promise of more activity in the direction of an organised bulk supply in the near future. The record of the efforts made to establish a central source of electricity supply in the London area is an interesting and instructive one, and when it comes to be made into "history" its perusal will furnish many valuable side lights on the subject of electric power in bulk. The hopes and ambitions of some engineers of tying London to the provinces by transmission lines are not likely to be realised in the schemes which may soon receive Parliamentary sanction. Neither by high-tension energy transmitted alongside railway routes nor by gas dynamos fed from colliery centred producers is the metropolis to come nearer the electrical engineer's ideal of a smokeless city. Without dwelling at length on the merits or demerits of the present proposals it is important to recall the fact that during the four years which have elapsed since Mr. C. H. Merz made a bold bid for London supply, the power requirements of the area to be covered have altered considerably. Some large manufacturers have left the Thamesside for the Midlands or the North. Provincial sites near railways, held out temptingly by the railway companies themselves, have attracted and are attracting away from London a class of power consumer who generally proves profitable to electric power supply. We refer to engineers, shipbuilders and mechanics, who run long hours and generally require a large amount of power. These find the industrial centres of the North and North-West better adapted to the carrying on of manufacturing processes.

Still there will always remain a residue of power users who will go to form an important and desirable aggregation of consumers for one or more central sources of electrical energy. In a recent issue of *Engineering* Mr. T. H. Minshall considered generally the characteristics of London power supply and classified into groups the various industries using power. His groupings are based on investigations carried out about the time that the Administrative County of London Co.'s power bill was laid before Parliament some four years ago. These figures present some striking contrasts. For instance, one of the tables shows the character of power agent used in various factories. Steam and gas preponderate, though no doubt a return made now would increase the users of electricity considerably. Woodworking shops, for example, are generally very partial to electric driving, but the return shows that 29 used steam, 22 gas and only 7 electricity. In letterpress printing, however, a different state of things prevailed. Thirteen used steam, 33 gas and 22 electricity. The figures for the last two are most likely reversed now, for no power user has shown such appreciation of the electric power as the printer. This is shown by the return (four years ago) for newspaper printers, of whom 10 used steam, 6 gas and 11 electricity. These also are figures which at the present time would receive considerable adjustment in favour of electric power. Out of a total of 35 selected trades 37 per cent. used steam, 54 per cent. gas and 22 per cent. electricity. For records of four years back these figures speak volumes for the electric drive, and justify the statement that, during the period which has elapsed the turnover of power uses from steam and gas to electricity will have been a larger one.

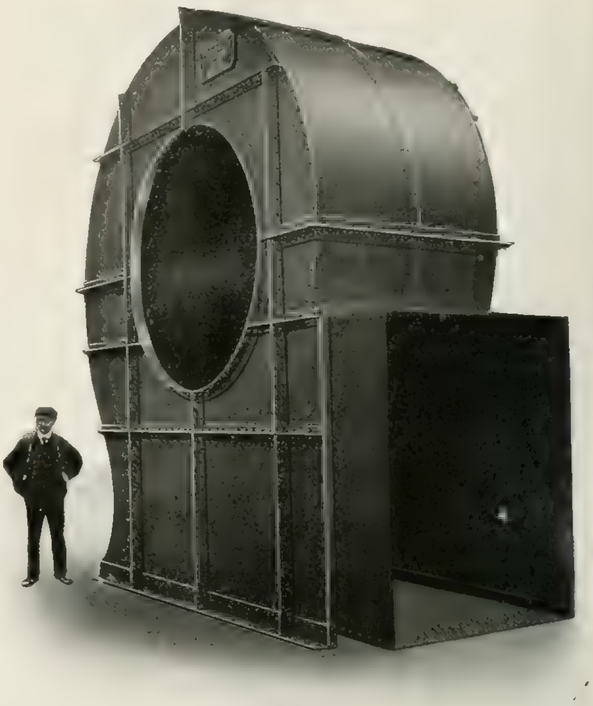
Mr. Minshall complains, in his article, of the lack of reliable statistics on the subject of power users in London, and mildly arraigns the Home Office for not rising to the occasion. He says: "In the colonies, and in many foreign countries, it is the practice to include such figures in the census. Thus the returns for the State of Victoria give not only the number of factories using machinery, but the actual horse-power of the engines used, differentiating always between steam, gas, electricity, oil, and in some cases wind and water. As a further detail, they give the number of independent engines, thus differentiating independent sources of power from those which are supplied from external sources."

Coming to the supply of power of all kinds to London as a whole, Mr. Minshall gives a figure of 500,000 H.P. as utilised in 1904 among 23,744 factories. In dealing with the general electrification of factories, it is pointed out that the amount of power required for steam and gas is likely to be much less for electricity, because of the economies which motor driving invariably introduces. This is a matter which will require the same care and consideration in any district outside London. The difference in power used is, however, offset by the fact that electricity can be applied to many machines and processes which would never figure specially under any other system of driving.

Problems of Induced Draught.

THE introduction of the motor-driven ventilating and blowing fan has undoubtedly given considerable stimulus to the development of mechanical draught equipment for boilers. When electricity supply suffered from the doubts and difficulties of engineers responsible for the station and plant design the question of mechanical draught was an open one, upon which divided opinions were common enough. Now, with the accumulated experience of a decade or more to work upon, there seems to be no room for doubt as to the necessity for induced draught fans where efficiency is the primary object of the management in the operation of the plant.

40 H.P. Motor driving Cyclone Fan at Beckenham Electricity Works.



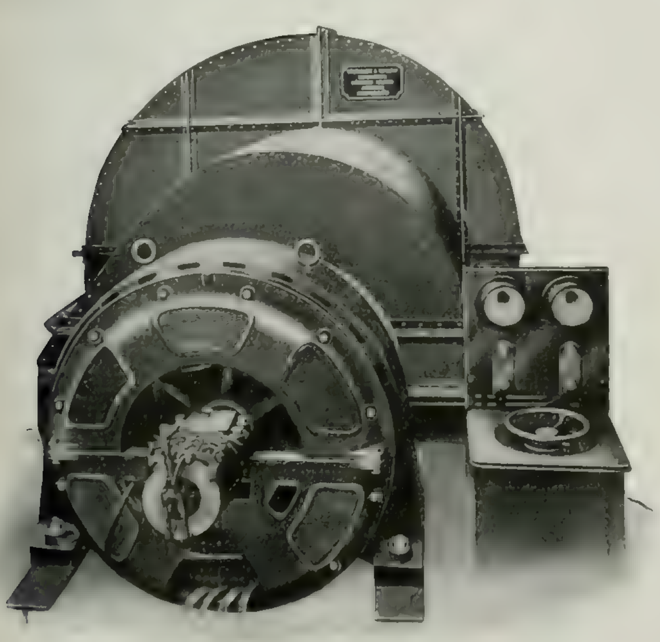
Cyclone Induced Draught Fan as erected at Leeds Lighting Station.

The problem is of sufficient importance to be reviewed briefly here in the light of the experience of a firm who specialise in the production of induced draught apparatus, namely, Messrs. Matthews & Yates, Swinton, Lancs. By the use of a chimney a better draught is obtained when the temperature of the flue gases is high, a greater velocity of draught being thereby given to the air entering the furnaces. This method is obviously wasteful because of the high temperature needed in the chimney to secure a good draught, while the construction of the chimney is likely to work out rather costly. Experience in the combustion of fuel indicates that the amount of air chemically required for coal is 12 lb. or 150 cubic ft. per pound of coal. In practice it is usual to double this amount where chimney draught is used with hand firing. With induced draught this excess of air over that chemically required for perfect combustion of the fuel is not required, 240 cubic ft. per pound of coal being a common figure. It may be noted that an excess of air at the fire causes a serious loss of heat, while an insufficient supply gives rise to black smoke.

It is claimed for induced draught fans that three boilers will do the work of four employing chimney draught. Matthews & Yates claim this result when their Cyclone fans are employed. They state that the necessity for a high temperature in the gases passing to the atmosphere is obviated, the heat in these gases being utilised to better advantage before it leaves the boiler. Further economies

can be effected by introducing more pipes in the economiser, thereby raising the temperature of the feed water. Probably the greatest advantage of an induced draught system resides in the fact that a much cheaper fuel can be employed, the difference in price being as much as 2s. a ton in certain cases, more water being also evaporated from fewer boilers.

The smoke problem for steam users is probably as aggravated a matter as that of boiler efficiency, particularly



250 H.P. A.C. Motor driving Induced Draught Fan at Leeds Lighting Station.

as a close watch is now kept on stacks by district inspectors. The induced draught fan has certainly all the appearance of mitigating, if not entirely solving, the problem of smoke nuisance. It follows that by the drawing through the fire of a correct amount of oxygen and combining this with the carbon at a proper temperature black smoke cannot very well be formed.

The application of the fans to the boiler flues is an extremely simple matter, and when electric power is available, as it is in electricity works, the most economical and compact arrangement is that in which a motor is employed. Through the courtesy of Messrs. Matthews & Yates we are able to illustrate this article with views of their Cyclone fans driven by electric motors.

We may remark here that under favourable conditions an induced draught plant will recover its first cost in a comparatively short time. Certain cases have indicated that this cost can be redeemed in 12 months, on account of the saving in price of fuel and reduced number of boilers in service. The following figures taken from the records of a Yorkshire mill are interesting:—

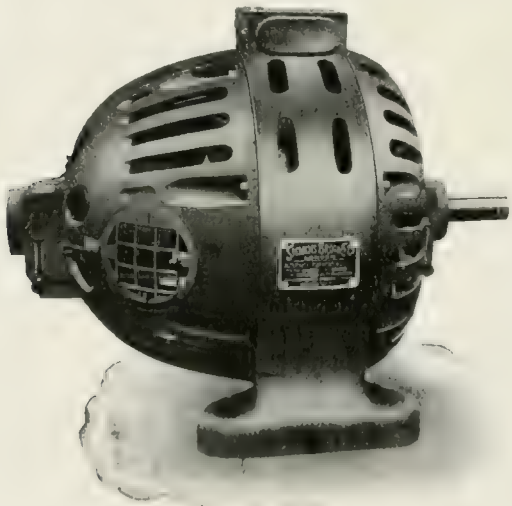
Coal used, Whitdale Smudge.	Tons	cwt.	qr.		£	s.	d.
Fuel used with fan	78	9	1	at 6s. 11d. ton	27	2	9
,, ,, without fan	84	8	1	,, ,, ,,	29	3	9
Gain in favour of fan ...	5	19	0		2	1	0

These figures, culled from operating results, appear to fully justify the claim that induced draught plant is economical to run, and its economies provide a substantial surplus which may be placed to the credit of the fan installation.

In conclusion, we may state that Messrs. Matthews & Yates are prepared to meet any requirements in the nature of induced draught plant and place at the disposal of interested engineers a staff of experts on the subject, quite free of charge.

Induction Motors.

In view of the fact that the method of driving machinery by electricity has come so much to the fore in recent years, and that a considerable proportion of this is carried out by the employment of alternating-current motors, doubtless the following points in connection with induction motors will prove worthy of note. The aim of the manufacturer of electrical machinery has been to produce a machine which can be relied upon to satisfactorily perform the duties for which it has been designed and installed, and in this matter Messrs. Siemens Bros. Dynamo Works (Ltd.) are well known as makers of induction motors. These machines, which are designed for two and three-phase circuits, are made in two types—namely, ventilated and totally enclosed, one of the former being shown in the accompanying illustration.



Siemens Ventilated Induction Motor.

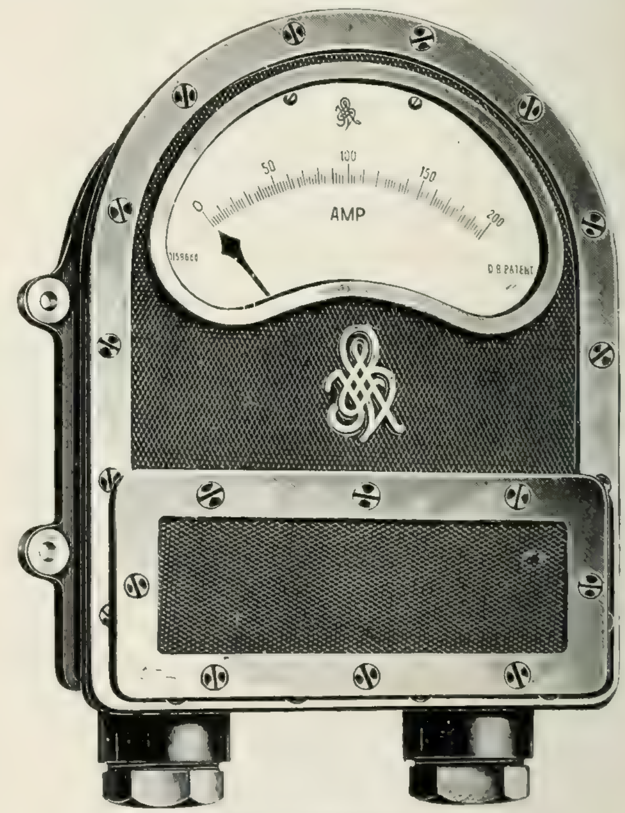
They are constructed for all voltages, speeds and outputs, and are suitable for continuous or intermittent working; in addition they are capable of developing a very large starting torque, their efficiency and power-factor are high, and they will stand heavy overloads for a considerable length of time without injurious heating. Either squirrel cage or slip-ring rotors are fitted to these machines.

Special attention has been paid to such points as good ventilation and efficient lubrication; all working parts are well protected from accidental mechanical injury, but at the same time are easily accessible. The end shields are bolted to circular facings on the stator frame, and can thus be easily rotated to render the motor suitable, without further alteration, for fixing to wall, floor or ceiling.

In conclusion, we may say that many of these machines have already been installed for various purposes and have been found to give complete satisfaction.

Watertight Instruments.

With the advance made into the region of watertight switches and switchgear it becomes important that attention should be paid to the matter of making instruments also impervious to the entrance of water and moisture. Instruments were once thought too much of an elaboration to include with starting switches and switchgear and only within recent years have they been seriously included in the control equipment. The Union Electric Co. is putting on the market a line of watertight instruments which are mainly intended for industrial service. The accompanying illustration shows



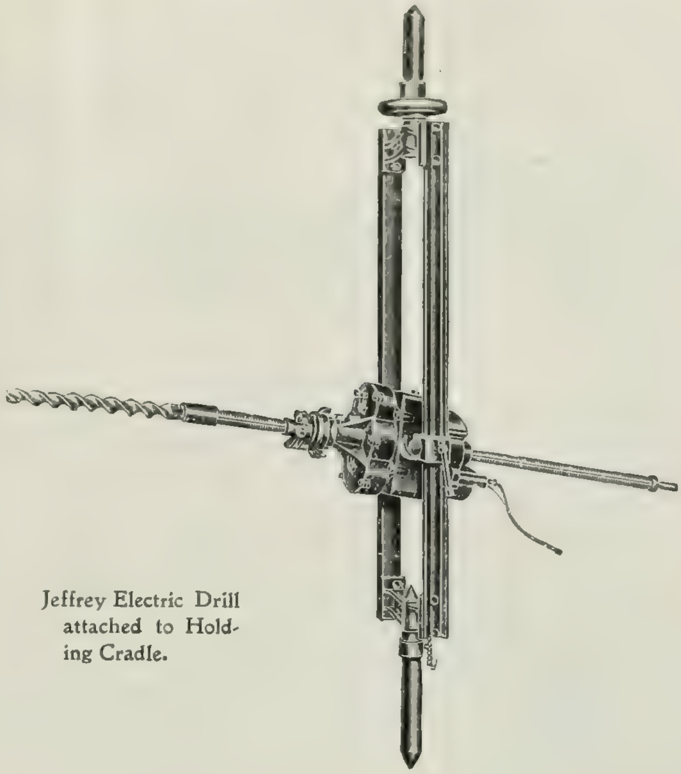
Sector Pattern Watertight Ammeter.

a sector pattern instrument with watertight gunmetal case. This type is intended for wall use, small lugs being fitted for fixing purposes. The front of the case is bedded down on to a machined surface and secured by a number of small screws. A rectangular cover is also fitted below the dial to give access to the interior of the case for adjustment of the movement. The cables enter by carefully-made glands, which exclude all possibility of the entrance of moisture. The instruments can be supplied with electro-magnetic, moving coil or hot-wire movements. The cases are also supplied for a variety of special and ordinary purposes, such as switchboards (projecting and flush patterns), switch boxes, conduit lines, &c. The cases are either of iron or gunmetal, finished black with nickel plated edges. Both kinds of case are tested to 10 lb. pressure. The instruments can be supplied with any desired arrangement of terminals, and the scales can be for wide or narrow range as required.

Davis Electric Mining Plant.

THE recently-closed Mining Exhibition will, we have no doubt, leave behind it many lasting impressions among engineers of the designs of modern plant exposed to critical inspection during the time it was open. Prominent among the machinery exhibits was an interesting collection of mining plant by Messrs. John Davis & Son (Derby) (Ltd.) Some of our readers may recall the fact that this firm has been identified with electrical developments in mining since quite the early days of electric power applications to industry. They introduced the Stokes safety motor with special commutator into mining work, and this m chine rendered yeoman service. The commutator was so arranged that the brushes pressed on the under side of the bars and not on the periphery, as with the modern machine. We recall the introduction of this motor by Messrs. Davis as some indication of their pioneering experience with electric power in mines.

At Olympia the firm showed specimens of the Jeffrey electric header and drill. These are two distinct machines which are well known to colliery and mining engineers. The header is a breast machine which makes its cut straight to the front and is suitable for working in thick or thin seams. It is mounted on a substantial carriage, along which the motor and chain gear advances during the making of a cut. The motors for these machines are supplied for alternating current or direct current circuits up to 500 volts. Two sizes are standardised, one with 21 H.P. and the other with 26 H.P. motor, the machines being for thin and thick seams respectively. The machine is complete with enclosed switch and control gear and flexible connections, leather covered, with plugs. Different rates of feed are available, a cut of



Jeffrey Electric Drill attached to Holding Cradle.

6 ft. under being made in either $3\frac{1}{2}$, 7 or 9 minutes. Four cuts, 6 ft. deep, can be made in undercutting a place 14 ft.

wide within an hour. We may mention that the electrical details have been reconstructed to conform with the Home Office and Colonial mining regulations.

The Jeffrey electric drill has been designed to cope with particularly hard rock, ironstone, shale, &c.

It is claimed that the electrical and mechanical parts will withstand any duty they are called upon to perform.

Jeffrey Electric Header for Coal Cutting.

If the auger point will stand up against its work, the power behind it will take care of itself. The drill frame is of the usual design, and is jacked between the floor and roof of a mine or between timbers in the ordinary manner. The drill may be fixed at any convenient height, and at any desired angle. The design embraces several features of novelty. The armature spindle is hollow, and through it the drill feed-screw passes. By this means a well-balanced drill is provided, hitherto the motor was necessarily above, below or on one side of the feed-screw. The gearing is also remodelled in this drill. A pinion surrounds the hollow armature shaft, and this engages above and below with two driven wheels of uniform size to one another. Mounted on the same shafts with the gears are the pinions of the second reduction set of gearing. These pinions engage the gear which drives the feed-screw. The gear wheels are accessible, and one of the features obtained in the design is the ease by which the gears may be varied.

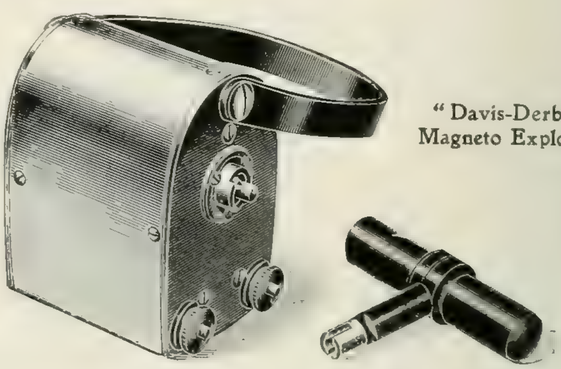
It will be seen by the figures given below that the revolutions per minute of the auger may be varied from 106 to 310, and the forward feed or rate of cutting may be varied from 10·6 in. per minute up to 62 in. per minute, out of a variety of 16 combinations. It will thus be possible to select the most suitable gearing, not only for rate of cutting, but speed of rotation, to suit almost any degree of hardness of material it is desired to drill.

	Descriptive letter.	A	B	C	D
Descriptive letter.	Revs. of feed screw per minute.	106	167	224	310
	Threads per inch of the feed screw.	Forward feed per minute.			
E	5 Acme threads	21·2 in.	33·5 in.	44·75 in.	62·0 in.
F	6 ,, ,, ...	17·9 in.	27·8 in.	37·4 in.	51·6 in.
G	8 ,, ,, ...	13·25 in.	20·9 in.	28 0 in.	38·8 in.
H	10 ,, ,, ...	10·6 in.	16·7 in.	22 4 in.	31·0 in.

A friction band is provided, with a winged nut and bolt for adjusting the pressure, to allow the feed bar to revolve with the auger without progressing, should it encounter any foreign substance in drilling, and so avoid unnecessary strains.

The motor, starting switch and gearing are contained in a case which is both damp and gas tight. The terminal pins are so arranged that when the cable sockets are withdrawn the arc is broken in an enclosed space.

The recent great development in electric shot-firing apparatus in coal mines, due to the introduction of new legislation, has set manufacturers of such apparatus designing a generator which shall produce the necessary firing current with a minimum of weight and bulk. The "Davis-Derby" Exploder consists of a magneto or dynamo generator enclosed in a convenient case, the armature being driven through spur gearing by a ratchet device mounted on a shaft, the end of which is squared to engage with a key or crank. The tedious process of revolving a cranked handle and pressing a button is displaced by a handle which works on a shaft supplied with a ratchet in front of the gear wheels. The gearing is necessary to obtain the high speed required. The armature, commutator and gear wheels must all rotate together, so that when the operating key is smartly turned through about half a revolution they will be driven through the ratchet up to the end of the movement of the operating handle, and they will then overrun the ratchet and rotate by their own momentum for a short time.



"Davis-Derby" Magneto Exploder.

One of the generator brushes is connected to the frame and the other to an insulated terminal and the ratchet shaft, which is in electrical connection with the frame and which carries a projection or arm which at a certain point comes in contact with a fixed metal stop in electrical connection with the other terminal. Thus no current flows through the external circuit until the projection on the ratchet shaft comes against the contact stop, and this is at the end of the stroke of the hand key when the armature is rotating at its highest speed and the output of the generator is at its maximum voltage.

The "Davis-Derby" Exploder is constructed either for high or low tension fuses. It is also made in various sizes of which the following are the leading particulars: The largest will fire up to 20 shots in series, and weighs 15 lb. The smaller size is constructed to fire four shots through 50 yds. twin wire, the weighs being under 4 lb. The latest and the smallest exploder will fire two shots through 50 yds. of twin wire, the size being 3½ in. high by 2½ in. by 2¼ in., and the weight 1 lb. 14½ oz. The last mentioned machine is said to be the smallest and lightest magneto exploder yet produced, and from reports appears to be much appreciated by the shot-firer on account of its extreme portability.

Electric Power in Steel Works.

WE have often remarked that one of the best advertisements for electric power is a satisfied user. Each captain of industry added to the "well pleased" list is an almost certain assurance of further additions to the number in due course. A case in point is a large steel works in Belgium which three years ago possessed a small 400 kw. station have recently completed the equipment of a 1,000 kw. plant for supplying energy to numerous tools, rolling mills, cranes and locomotives about the works. These were previously operated by steam and hydraulic engines. The new motors about the shops are 500 volt machines of the three-phase induction type. A number of direct current motors, operating at 120 volts, have been retained for crane duty, the two older generators being used for the supply of these machines. One of the generators is driven by a 6,300 volt motor operated from the circuits of the new alternator, and the other is still coupled to its original steam engine.

Upwards of 70 motors are supplied with 500 volt energy, the transmitted power being reduced in voltage from 6,300 volts to this pressure. There are five centres of low-tension distribution. The various machine tools in use in the works are employed for dressing rail heads, and rolled iron, punching, drilling and shearing fish-plates, &c. Most of these tools were driven from countershafting or had separate small steam engines mounted on them. The steam consumption of these engines was alarmingly high at times, and frequently the output of the tools was restricted on account of lack of steam.

Several machines were converted from steam to electric drive by removing the steam engine and adapting the gearing for drive by motor. A punching machine, operated by a 15 H.P. motor, was altered in this way. By fixing a toothed wheel on the inside of the flywheel a drive for the motor pinion was obtained. A cast-iron plate, with three brackets, supports the motor, which is at the top of the machine. The steam engine obstructed the operation of the machine a great deal, but this is all altered by the use of the motor drive. Another machine was converted in a somewhat similar way. One of the flywheels was replaced by a disc of equivalent weight having two concentric toothed rims on its inner surface. The motor can be moved so as to engage with either of these rims to allow of different speeds. In another instance a 23 H.P. motor suspended transversely from the roof beams drives a set of milling machines. In the "Haute Campagne" finishing department a 22 H.P. motor drives a six-grooved rolling mill through a triple set of gearing.

Wherever possible the motors have been placed on the top of the machines. A special enclosed motor has also been made with ventilating chimney and ducts which admit air at the bottom of the motor. The motors in the finishing department are blown out once a week to ensure the removal of all dust from the stator windings. The steam engines required much more attention, and also had to be overhauled annually. An interesting motor drive is that of a lathe shop in which the rollers of the mills are turned up. One 40 H.P. and a 22 H.P. motor drive the shafting for eight lathes, and they maintain a constant speed at all times. A steam engine previously drove this shop, and trouble was frequently caused through lack of power and irregularity in speed. The blast for five cupola furnaces is obtained from two 100 H.P. motor-driven blowers which only need to be run 25 minutes for a pour of metal of 12 tons.

Motor-Driving in a Corn Plant.

In this country the products of the wheat and cornfield are employed in more direct fashion than is the custom in America and Canada. There it has been a common practice to treat wheat, barley, rice and other cereals by machinery processes and make up packet foods, which are marketed under special trade names. We have, of course, mills for the rolling of oats, but, quite naturally, they cannot compare with those employed abroad, either on the score of size or amount of output. The use of machinery in mills of this class at once suggests the electric motor, and in many instances it has been installed to meet somewhat trying conditions. A case in point is the plant of the American Maize Products Co., Ind., the electrical equipment of which was recently described in the *Electrical Review*, N.Y.

The corn, before it is available for food or industrial purposes, must pass through a great many operations of weighing, steaming, crushing, grinding, sieving, separating and packaging. Most of the motors are of standard construction, but the motors connected to the buhrstone mills, for grinding the corn very fine, are special machines, having been developed for this purpose. Each is of the vertical belted type, and has a normal rated output of 75 H.P. The stator core is supported in a cast-iron housing provided with projecting lugs resting on the slide rails. The stator core has open slots to allow the coils to be readily removed in case repairs are necessary. The stator has a 14-pole winding, thus giving a synchronous speed of 514 revs. per min., the full-load speed being approximately 490 revs. per min. The rotor spider is mounted on a vertical shaft, which passes through a guide bearing at the top of the motor. A second guide bearing is placed at the bottom, and the weight of the rotating part is carried by a multiple-disc self-aligning thrust-bearing under the lower end of the shaft. A complete oiling system is provided whereby oil is supplied to the upper bearing from a large sight-feed oil cup, and, after passing through this bearing, flows to the lower one. The thrust-bearing is designed so that all parts are thoroughly lubricated. The pulley is at the top of the motor, and the vertical arrangement allows the motor to be belted directly to the mill without the use of a quarter-turn belt.

In addition to the buhr mills, the elevators, conveyors, shaking sieves, and, in fact, all of the moving machinery, is driven by motors of capacities ranging from 5 H.P. to 30 H.P.

Not the least important part of this great plant is the pumping machinery. This comprises the following: Two 12 and 18 by 14 by 18 in. duplex pumping engines of the outside centre-packed plunger type, each having a capacity of 1,400 gallons of water per minute. Three single-stage centrifugal pumps for the steeps, each having a capacity of 200 gallons per minute. These pumps are placed on extended bases and direct connected to $7\frac{1}{2}$ H.P. motors. The shaft coming in contact with the liquor is made of bronze composition. One single-stage centrifugal pump for the shakers, having a capacity of 400 gallons per minute. This is direct connected to a 15 H.P. motor.

One single-stage centrifugal pump for discharging slop from the buhr mills, having a capacity of 400 gallons per minute. The pump is placed on an extended base and direct connected to a $17\frac{1}{2}$ H.P. motor. Four single-stage centrifugal pumps for crushed corn, each direct connected to a 15 H.P. motor. One single-stage centrifugal pump for the starch-breaker, having a capacity of 400 gallons per minute, direct connected to a 15 H.P. motor. One single-stage centrifugal pump for water, having a capacity of 700 gallons per minute, direct connected to a 22 H.P. motor.

The centrifugal pumps are of the balanced type, with single suction opening. The casing is circular and concentric, fitted with discharge flange and with feet for bolting to the foundation. The suction is on the drawing side and admits the water to that side of the casing. It passes through cores in the chute case to the front end of the impeller, so that the impeller has suction on each side and is consequently balanced.

Six 8 and 6 by 10 in. duplex yoke-type pumps for the refinery. Two 12 and 8 by 12 in. duplex outside centre-packed plunger boiler-feed pumps, equipped with chilled-iron plungers, brass-covered plunger rods and brass-bushed plunger glands and boxes.

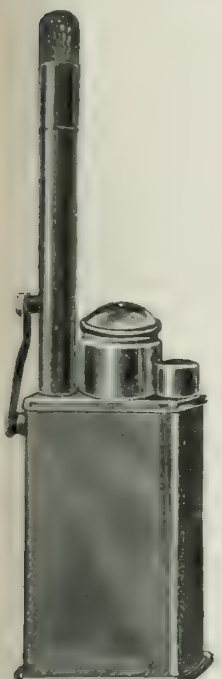
Two 10 and 16 by 10 in. duplex crank and flywheel vacuum pumps, provided with automatic governors.

One 10 and 10 by 12 duplex clapper valve pump, with slide valve steam end, and brass-fitted clapper valve liquid end.

The power plant has been designed in strict accordance with latest practice and possesses many features of special merit. In the engine room there is but one large main unit, which is a 26 and 44 by 48 Allis-Chalmers cross-compound Corliss engine, connected to an alternator of the same company's build and having a normal rating of 800 kw. The generator is a three-phase 60 cycle machine of the revolving field type and was designed to deliver 480 volts pressure at a speed of 90 revs. per min. The rotor of the generator is about 17 ft. in diameter and weighs 17 tons. The load carried by this machine is mostly power, consisting of 150 motors and ranging in capacities from 5 H.P. to 75 H.P.

Thomson Electric Gas Lighter.

THE convenience of the Thomson pocket electric lamp to which we have referred in a previous issue, have prompted Messrs. L. E. Wilson & Co. to fit to a battery a gas-lighting attachment. The adjoining illustration shows the battery with the fitment attached. It consists of a short length of tube with terminals for connection to the battery and with a small burner surrounded by holes in the tube. The illustration shows that the ordinary bullseye lamp is retained with the battery, and the gas lighter is plugged in by the side of it. When the lighter is switched on the lamp also is lighted, so that the location of the gas burner can be observed without the need for groping in the dark. The lighting tubes or "spires," as they are termed, are supplied in two lengths, 4 in. and 12 in. The ordinary lamp case supplied with the pocket lamp can be exchanged for a case which will take the gas lighter spires. The burner itself is renewable at a small cost. We are informed that the current consumption is small and that the lighter will last some time before the battery needs recharging.

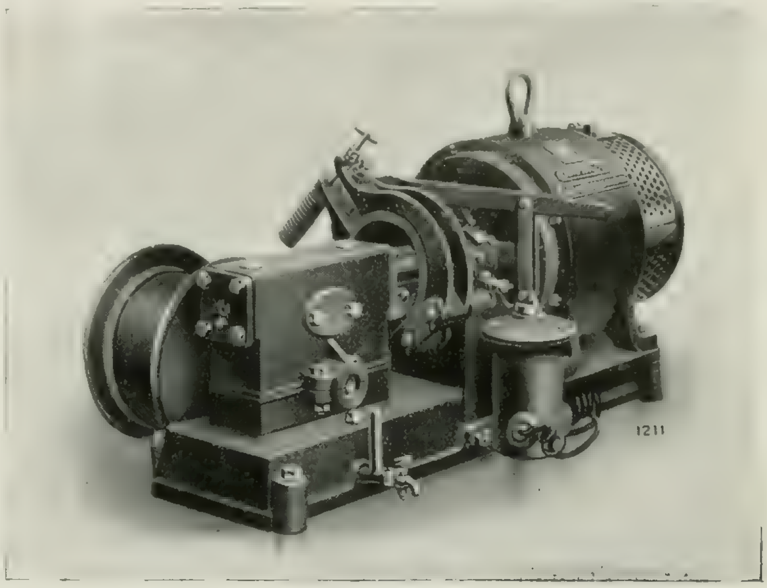


General View of Thomson Gas Lighter with Short Spire.

The entire apparatus is quite light and compact enough to carry in the pocket without inconvenience.

Electric Hoists.

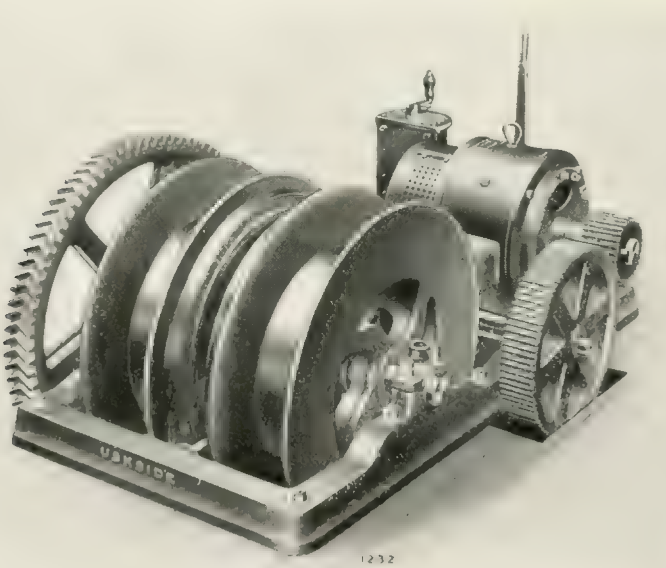
THERE is an ever increasing demand for standard patterns of electric hoists and winches suitable for a variety of requirements. The adjoining illustration shows an electric hoist, of which a great number have been made and are working very successfully. The arrangement being self-contained it is portable and can be used in almost any position and for various purposes. The motor



Standard Crompton Electric Hoist.

is one of Messrs. Crompton & Co.'s ventilated enclosed type, the armature shaft being extended to take the brake which is actuated by a pot magnet bolted to the underbed. The brake-cheeks are of steel and are held "on" by a compression spring, provision being made for adjusting this spring and also for taking up any wear. The worm reducing gear is enclosed in a cast-iron box, the lower half of which forms an oil bath for the worm-wheel. The rim of the worm-wheel is of gunmetal, with machine-cut teeth cut from the solid. Ball-bearings are provided to take the end thrust, the bearings being fitted with self-lubricating rings. The whole apparatus is of very substantial design and will stand a great deal of rough usage.

The same firm also makes a small 10 H.P. main-and-tail hauling gear of the self-contained type, mounted on a cast-iron bedplate, which is a very strong and compact job for small haulages up to 50 H.P. It is fitted with two cast-iron drums worked from the centre of the shaft with a double jaw clutch. Each drum is bushed with gunmetal for running loose on shaft, and is fitted with powerful all-round band brakes worked with foot lever. The main gearing is double helical machine-moulded, the first motion gearing being machine cut with steel or raw hide pinion to go on motor as preferred. The shafts are of best mild steel and the pedestal of heavy pattern adjustable type with gunmetal bearings.



10 H.P. Main and Tail Haulage Plant.

Large Electric Lumber Plant.

THE industry of lumbering is practically confined to Canada and the United States—that is, of course, lumbering on a large scale. The workshops of the Great Southern Lumber Co., Bogalusa, Louisiana, cover so large an area that electric power is the only solution of the problem of driving the machinery located in the various mills. The electrical equipment is probably the largest of its kind for a plant of this description. Something like 1,500 H.P. of plant is installed at a main generating station which supplies energy to upwards of 80 motors in different mills and shops in the area. Many of these motors are direct-coupled to the machines they have to drive, notably a group of 17 planers, each belted to a 35 H.P. motor. The largest motors are 150 H.P., of which there are six, driving blowers for the removal of dust and chips from the shops. About 8 oz. pressure is sufficient to deal with all shavings, &c. There are nine shops in all, and power is distributed to them at 2,300 volts pressure by underground cables.

Index to Advertisers.

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CONTENTS OF THE CURRENT NUMBER.

NOTES.

Patents and Designs Act.

THIS product of Mr. LLOYD GEORGE, which has been so thoroughly discussed in and out of Parliament, comes into force to-day. As a measure of considerable importance to the electrical industry we call our readers' attention to it, but we prefer to add very little to the criticisms which, from time to time, have appeared in *The Electrician* concerning the Act. So far as the intentions of the Act are concerned there is apparently little left to be desired, but it is quite probable that the clauses will be found easy of circumvention in actual practice. For this reason the very persons whom it is designed to benefit may suffer more than before. One effect of the Act is very noticeable—viz., the evident anxiety of foreign inventors to dispose of their patent rights by lease or sale. For some weeks past numerous advertisements to this effect have appeared in our pages. It will be curious to observe the effect the working of the Act will have upon Patent litigation, and its course will, if for this reason alone, be followed with more than ordinary interest.

The Transmutation of Elements.

JUST a year ago Sir WM. RAMSAY made the startling announcement that, after exposing a solution of salts of copper to the radium emanation, he was able to detect the presence of lithium where none had previously existed. This statement was received with a certain amount of scepticism, and coming from a less eminent authority on matters of this kind would probably have been greeted with ridicule. However, Sir WM. RAMSAY's researches were not to be despised, and speculation was rife. Two explanations were offered: one, that the lithium was originally contained in either the vessels or the re-agents; or that lithium was a constituent of copper. Now, however, Mme. CURIE and Mdlle. GLEDITSCH, who have been attempting to verify the experiments, declare that they find no confirmation of Sir WM. RAMSAY's announcement.

THE investigations, which have been of a most careful and painstaking nature, were carried out by means of platinum containing vessels, as the investigators found that glass and quartz vessels contained an appreciable quantity of lithium. As a matter of fact, they go further than merely claiming negative results: they say that the lithium discovered by Sir WM. RAMSAY was present in the re-agents and apparatus that he used, and could have been detected by suitable means. We publish, on another page, an account of the work of Mme. CURIE and Mdlle. GLEDITSCH, which is of absorbing interest in itself. It now remains to be seen whether the lithium phenomenon will share the fate of M. BLONDLOT's claim to the discovery of "N" rays, or whether we have not yet heard the last of what is clearly a wide divergence of opinion between very eminent investigators.

Automatic Telephone Exchanges.

ONE of the most prominent features of modern engineering has been the development of automatic devices designed with the object of reducing manual labour to a minimum. The introduction of such automatic machinery, usually after strenuous opposition on the part of the operators displaced, has in most cases led to considerable economy, although this is not necessarily an assured result. Thus, although increased reliability may be obtained by the removal of the human element, the cost of maintaining the automatic apparatus in an efficient condition may more than offset any saving in actual operation. Mr. W. LEE CAMPBELL

recently read a very interesting Paper before the American Institute of Electrical Engineers, in which he advocates the adoption of automatic telephone exchanges, and preferably the splitting up of large exchanges into a number of smaller units. As will be seen from the abstract of the Paper, which appears elsewhere in this issue, the author makes out a very good case for the system, but we think telephone engineers will hesitate to accept his figures as to the cost of maintenance. This is, of course, an essential consideration in an automatic system which necessarily comprises much complicated apparatus, and whilst appreciating the many good points raised by the author, we must, perforce, be dubious as to the final results until further evidence as to cost of maintenance is before us. It will be remembered that we announced in a recent issue the possibility of the adoption of an automatic exchange at Lyons, in France; this may supply the required data.

Depreciation.

MUCH criticism has been levelled from time to time against the provision made by the various tramway authorities for the renewal of parts of their undertakings, the life of which is admittedly much shorter than was at first anticipated. In this respect, however, the Glasgow Corporation tramways are undoubtedly above criticism. As will be seen from our analysis of last year's accounts relating to this undertaking, the "depreciation and permanent way renewals" fund now amounts to no less than £1,224,051, although the total capital expenditure is only £3,145,576. The contribution to the former sum during the past year was £188,603, of which £88,187 was allowed for permanent way renewals and £100,416 for depreciation of the cars, power station, overhead equipment of the line, &c. It will be remembered that the Glasgow Corporation provide for the future renewal of their track on the basis of £500 per mile per annum, which, when reckoned on car-mileage, probably a better basis for comparison, is at the rate of over 1d. per car-mile during 1907-8; whilst the total allowance for depreciation and renewals of the undertaking is actually 2·18d. per car-mile, a figure in striking contrast with the two-thirds of a penny which is at present considered by the London County Council a reasonable provision for this purpose.

Electrical Development in the Colonies.

ONLY last week we referred to extensive power developments which are taking place in Canada, and now we have to call attention to the possible electrification of the Melbourne suburban railways. A representative of the *Railway Times* has interviewed the Hon. J. A. BOYD, a member of the Government of Victoria, who has been visiting Great Britain and the Continent for the purpose of studying various systems of electric traction, and a report of the interview appears in a recent issue of our contemporary. As announced a short time ago in *The Electrician*, Mr. C. H. MERZ, who has been engaged in the preparation of an exhaustive report concerning the proposed electrification of the Melbourne suburban railways, has now submitted this report together with specifications. In this case, if the report be adopted by the Government, it only remains to call for tenders.

OBVIOUSLY, the report cannot yet be made public, but we learn that Mr. BOYD "confidently predicted" Mr. MERZ's recommendation of the third-rail system. The first instalment which it is proposed to convert consists of about 20 route miles, or about 40 miles of track, while the railways comprise altogether some 149 route miles, most of which is double track. This is, of course, a large undertaking, and it is not to be expected that all the work will be put in hand at once. Even if Mr. MERZ's report be adopted, there is no doubt that a considerable interval of time will be allowed to elapse between the completion of the first 20 miles and the commencement of the next portion, or remainder, as the case may be. Nevertheless, it is highly satisfactory to learn that these great undertakings are being seriously contemplated by the Colonies, since they afford fresh fields for the enterprise of British manufacturers. In this connection it should be borne in mind that American makers of electrical apparatus are fully alive to the possibilities of business in Australia, and for years past have left no stone unturned to secure advantages over their British competitors.

The "G.B." System and the L.C.C.

THE controversy on this subject, the various details of which were summarised in our Editorial Notes on July 31st, has advanced another stage. It will be remembered that the "G.B." Surface Contact Co. offered to put the electrical equipment of the track in an efficient state and to maintain it for 12 months, provided the Council would fit the cars in accordance with their designs. This offer was rejected, and it was then decided that expert advice should be taken. We understand that Mr. W. M. MORDEY has, at the request of the Council, visited Lincoln and reported on the working of the system in that town. It is to be hoped that this step will lead to a speedy settlement of the dispute.

British Association.

PROVISIONAL PROGRAMME OF SECTION G (ENGINEERING).

Thursday, September 3rd.

Address by the President of the Section (Mr. DUGALD CLERK, F.R.S.).

Friday, September 4th.

Report of the Committee on Gaseous Explosions, to be read and discussed in joint meeting with Sections A and B.

Monday, September 7th.

1. GERALD STONEY.—"Recent Advances in Steam Turbines."
2. P. EMERSON DAWSON.—"Producer Gas."
3. P. W. ROBSON.—"Suction Gas Producers."
4. Capt. H. RIALL SANKEY, R.A.—"The Utilisation of Peat for making Gas or Charcoal."

Tuesday, September 8th.

1. F. W. LANCHESTER.—"The Laws of Flight."
2. F. H. ROYCE.—"The Causes of Wear in Motor Vehicle Machinery."
3. W. WORBY BEAUMONT.—"On a Fundamental Error in the Theory of Power Transmission by Belts."

Other Papers to be read.

SIR HOWARD GRUBB, F.R.S.—"A Clock-driving Mechanism for Equatorial Telescopes."

J. BROWN, F.R.S., and MAURICE F. FITZGERALD.—"Experiments on Rotating Discs."

W. E. LILLY.—"Strength of Solid Round-ended Columns."

F. DOUGLAS FOX.—"Railless Traction."

W. ROSENHAIN.—"On the Study of Breakages."

Obituary.—As we go to press, we learn with regret of the death of M. E. Mascart, the distinguished French scientist, at the age of 71. It is matter for great regret, not only for France but for the world, that we should in the same week lose two such leaders as Becquerel and Mascart. We shall give a full notice of M. Mascart's life and work in our next issue.

International Conference on Electrical Units and Standards.—The President of the Board of Trade has appointed Major W. A. J. O'Meara, R.E., C.M.G., to be an additional delegate to this conference, which is to assemble in London on October 12th next.

New Metal Lamp Factory.—A German firm has recently acquired land and buildings at Brimsdown, near Edmonton, London, for the purpose of erecting works for the manufacture of tungsten filament lamps under the Pintsch and the Kuzel patents. The works are to be electrically driven, power being taken from the North Metropolitan Electric Power Supply Co.

The Electrobus.—With recent additions made to this service by the London Electrobus Co. there are now 18 of these 'buses on the streets of London, chiefly plying between Victoria Station and Liverpool-street, and Victoria and Cricklewood. The vehicles seem to have become increasingly popular, and the fares are in many cases lower than those charged on the "Monopoly" 'buses.

The c.s. "Patrol."—We are glad to be able to state that the "Patrol," which, as we announced last week, had struck on a sand bank, was successfully floated on Wednesday evening, and, having received no damage, is in a position to continue the repairs upon which she was engaged. The c.s. "Recorder" had taken the "Patrol's" cable on board, and so was able to materially assist in the work of re-floating.

Iron and Steel Institute.—As previously announced, the autumn meeting of this Institute will take place at Middlesbrough from September 28th to October 2nd. The following are among the Papers down for reading: "On the Scientific Control of Fuel Supply," by Prof. H. E. Armstrong, F.R.S.; "On Metallurgy at the Franco-British Exhibition," by Mr. H. Bauerman; "On Gas Producer Practice," by Prof. W. A. Bone, F.R.S., and Mr. R. V. Wheeler; "On Some Results of Experience with Electrically-driven Rolling Mills," by Messrs. C. Koettgen and C. A. Ablett; and "On Electric Power Supply," by Mr. C. H. Merz.

Electrical Patents.—The *Elektrochemische Zeitschrift* gives a table indicating the number of electrical patents granted in each country from 1904 to 1906. This table is given below:—

America	2,050	Belgium	90
Great Britain and Colonies	785	Sweden	90
Germany	700	Denmark	90
France	400	Spain	35
Austria	180	Norway	30
Italy	130	Portugal	15
Hungary	120		
Switzerland	90	Total	4,805

As a matter of fact many more electrical patents were granted in the various countries, but these were granted to foreigners, and were merely a repetition of those already issued in the native country of the patentee.

Liverpool Tramcar Accident.—Greatly exaggerated reports have appeared in the Press in connection with the tramway accident which occurred on the Liverpool tramway system on 21st inst. The following is the true version of the accident:—

Driver Walsh had commenced to descend Lambeth-road at a slow rate of speed, using the electric brake, and brought the car to the bottom of the hill in perfect safety. It was then necessary to put on the hand brake to hold the car stationary at the compulsory stopping station. In doing so the driver inadvertently failed to put the clutch into the proper position to engage in the teeth of the ratchet wheel at the base of the brake staff, with the result that the hand brake flew off and the staff struck him a heavy blow on the elbow. This disabled his arm for the moment, and allowed the car to go without the brake for a distance of 18 yds. to 20 yds., when it collided with a waggon, thereby causing the accident. Walsh further states that had the waggon not come into the road he would have been able to put the brake on immediately afterwards and have brought the car to rest, thus avoiding the accident. The brakes and other equipment were in perfect condition and the car did not leave the metals.

Wireless Telephone Notes.—Dr. de Forest is stated to have expressed the opinion that New York and Paris will be in wireless telephonic communication within two years. An installation on the De Forest system is to be erected on the tower, nearly 700 ft. high, of the Metropolitan Life Insurance Co.'s new building in Madison-square, New York, with a range of 1,000 miles. It is further stated that the apparatus used in the Eiffel tower experiments, whereby a distance of over 300 miles was bridged for telephonic purposes, consists of a Poulsen arc having one carbon and one copper electrode cooled by a flow of water. This arrangement has a frequency of over 1,000,000 waves a second. Microphones in series are inserted in the circuit, and the stream of waves is modified in accordance with the vibrations produced by the voice. The receiving apparatus includes the usual aerial wire and Capt. Ferrée's electrolytic detector. The power required for telephoning from Paris to Dieppe is said to be less than 4 kw.

Wireless Telegraph Notes.—We take the following interesting notes from the *Zeitschrift für Schwachstromtechnik*, a German journal specially devoted to "weak-current" matters:—

The important part which wireless telegraphy plays in navigation during fog will be seen from the following incident related by the captain of the North German Lloyd liner "Kaiser Wilhelm II." He says that during a recent voyage from New York he encountered fog at the entrance to the English Channel. Neither Scilly nor Wolf Rock could be sighted and no fog signals could be heard. As he could not hear the fog signal on the Lizard, at 1:32 communication with the Marconi station at the Lizard was effected, and he discovered that this station could hear the liner's steam whistle 2 or 3 miles away. The course was now set for Eddystone and the agent at Plymouth was instructed (by "wireless" presumably) to send the tender out. At 3:15 Eddystone's fog signal was heard, at 4:40 answer was received from the tender and the liner anchored; 10 minutes later the tender came alongside, and having landed passengers, mails, luggage and cargo, the liner's journey was continued at 5:35 without Plymouth having been sighted.

Wireless telegraphy is now being used in connection with the German sea fishing industry. The flagship of the fishing fleet, "Zieten," has been fitted with wireless equipment, and messages can be sent from this ship to the German mainland. Special rules have been laid down for the conduct of this traffic.

Direct communication has been opened between the Norddeicher Telefunken station and the Central Telegraph Office in Berlin, and it is now possible to transmit telegrams to the Berlin Telefunken station, whence they are transmitted to the ships.

According to present arrangements the new wireless station at Varna will have a range of action of 385 miles. The Bulgarian Government is in negotiation with the Marconi Company regarding the operation of the station.

As announced in our issue of July 24th, the Great Eastern Railway Co. are equipping the steamers employed on their continental service with "wireless" apparatus. In connection with these arrangements a special station will be erected at Parkeston, capable of transmitting or receiving messages to or from a distance of 300 miles. A motor-driven alternator supplies power, the system used being the Lodge-Muirhead. The installation has been carried out under the superintendence of Mr. H. W. Firth, the company's electrical engineer.

The *Vossische Zeitung* (Berlin) states that the experiments by German officers with wireless telegraphy from airships have been concluded for the present, the results being described as eminently satisfactory.

The Copenhagen correspondent of the London *Daily Telegraph* states that Mr. V. Poulsen has started new and interesting experiments with his wireless system in connection with the forthcoming opening of the Transatlantic telegraph service between the Amalgamated Radio-Telegraph Co.'s stations on the west coast of Ireland and Canada. He is said to have invented new apparatus, similar to the Wheatstone apparatus, for wireless working, which enables much more rapid operation than any other previous wireless equipment. Experiments between Copenhagen and Newcastle will, it is stated, take place in a few days.

Cable Interruptions.	Date of Interruption.
Las Palmas—Arrecife	May 18, 1908
Jedda—Suakim	July 27, 1908
Assab—Massowah	July 28, 1908
Kwandang—Manado	Aug. 5, 1908
Cadiz—Teneriffe	Aug. 17, 1908

GLASGOW CORPORATION TRAMWAYS.

It is to an undertaking such as the Glasgow Corporation tramways that the supporter of municipal trading turns when his arguments require support. And there can be no doubt that the example is a good one. It is true that during 1907-8 the working expenses showed an increase under practically all headings; but in spite of this, after paying all charges, the substantial sum of £38,929 was carried forward to the appropriation fund. Of this balance, £4,061 was employed in writing off the cost of old single-deck cars, the remainder being placed to the general reserve fund.

As will be remembered, the Glasgow system is one of the oldest municipally-owned tramways in the country, having been acquired in 1894. The first section to be converted to electric traction was the Mitchell-street and Springburn route in 1898.

The total mileage worked by the Corporation is 179 miles, of which 109½ miles lie within the City of Glasgow, the remainder being in the counties of Lanark and Renfrew, and in several neighbouring burghs, including Govan, Partick and Clydebank. An extra 3¼ miles of track have been added to the system during the past year.

To meet the increasing demands a 3,000 kw. turbo-generator is on order for the Pinkston power station. During the year extensive renewals have been made to two main engines at this station. The cost of these ordinary repairs and of workshop tools and plant during the year has been charged against revenue.

The total number of cars in stock is 759. During the year 21 old single-deck cars had been written down to a nominal figure and taken out of this account. All cars are now being equipped with side life-guards.

We give below an analysis of the expenses during the past year, together with the cost per car-mile during 1907-8 and 1906-7.

Traffic Expenses.		Per car-mile. 1907-8.	1906-7.
Superintendence	£5,054 16 5	0·058d.	0·059d.
Wages and bonuses	196,423 7 10	2·270d.	2·229d.
Cleaning and oiling cars	26,601 8 0	0·308d.	0 299d.
Fuel, power, light and water for depots	2,839 1 7	0·033d.	0·029d.
Ticket check	10,980 19 0	0·127d.	0·123d.
Uniforms	7,478 3 1	0·085d.	0·064d
Miscellaneous	3,182 4 2	0·037d.	0·036d.
Cleaning track	4,045 5 10	0·047d.	0·051d.
Total Traffic Expenses	**£256,605 5 11**	**2·966d.**	**2·890d.**

General Expenses.			
Salaries and wages	£6,755 16 6	0·078d.	0·083d.
Store expenses	1,064 15 3	0·012d.	0·011d.
Rents, rates and taxes	48,680 16 10	0·562d.	0·550d.
Printing and stationery	1,391 11 3	0·016d.	0·023d.
Fuel, light and water	447 10 0	0·005d.	0·005d.
Law and insurance	24,154 9 3	[illegible]	[illegible]
Parliamentary expenses	2,861 13 1	0·033d.	0·003d.
Travelling expenses	379 6 6	0·004d.	0·004d.
Decorations and expenses in connection with Royal and other visits	–		0·012d.
Miscellaneous	1,827 16 6	0·021d.	0·025d.
Contribution to friendly society	[illegible]	[illegible]	[illegible]
Total General Expenses	**£91,322 16 11**	**1·055d.**	**1·023d.**

General Repairs and Maintenance.			
Permanent way	[illegible]	[illegible]	[illegible]
Electrical equipment of line	[illegible]	0·10[illegible]	[illegible]
[illegible]	[illegible] 1	[illegible]	[illegible]
[illegible]	[illegible] 7	0·025d.	0·022d.
Cars	29,768 17 [illegible]	[illegible]	[illegible]
[illegible]	[illegible] 2 3	0·211d.	0·210d
Other rolling stock	1,290 2 10	0·015d.	0·019d.
Miscellaneous equipment	154 7 6	[illegible]	[illegible]
Total General Repairs and Maintenance	**£122,650 0 10**	**1·418d**	**1·440d.**

Power Expenses.		Per unit. 1907-8.	1906-7.	Per car-mile. 1907-8.	1906-7.
Sal. & wages	£10,194 19 11	0·096d.	0·108d.	0·117d.	0·088d.
Fuel	17,540 10 8	0·166d.	0·161d.	0·203d.	0·131d.
Water	358 18 4	0·003d.	0·004d.	0·004d.	0·003d.
Oil and waste	1,392 5 9	0·013d.	0·015d.	0·016d.	0·013d.
Miscellaneous	391 1 6	0·004d.	0·005d.	0·005d.	0·004d.
Repairs	7,487 16 6	0·071d.	0·076d.	0·086d.	0·062d.
Energy purchased for elec. dep't.	1,951 0 7	1·000d.	—	0·023d.	—
	£39,316 13 3	**1·353d.**	**0·369d.**	**0·454d.**	**0·301d.**

		1907-8.	1906-7.
TOTAL WORKING EXPENSES	**£509,894 16 11**	**5·893d.**	**5·721d.**
Capital Charges, &c.			
Rental of leased lines	£9,861 0 0	0·114d.	0·117d.
Interest and sinking fund	111,956 6 2	1·409d.	1·339d.
Income tax	9,435 11 2	0·109d.	0·117d.
Parliamentary expenses	2,884 12 1	0·033d.	0·082d.
Payment to "common good"	35,000 0 0	0·405d.	0·413d.
Depreciation and renewals	188,603 5 5	2·180d.	1·986d.
TOTAL CAPITAL CHARGES	**£367,740 14 10**	**4·250d.**	**4·054d.**
TOTAL EXPENSES (including Capital Charges)	**£877,635 11 9**	**10·143d.**	**9·775d.**
TOTAL INCOME from all sources	**£916,565 10 10**	**10·593d.**	**10·606d.**
BALANCE carried to Appropriation Account	**£38,929 19 1**	**0·450d.**	**0·831d.**

The balance carried to the net revenue account was £400,423. 11s. 6d., which, together with interest on surplus revenue amounting to £6,247. 2s. 5d., makes up the total of £406,670. 13s. 11d. on the credit side of this account. The traffic revenue amounted to £910,318. 8s. 5d., as against £895,841. 14s. 3d. in 1906-7, the principal items, besides the ordinary traffic, being £404 for use of tramway lines and £494 for energy for the Fairfield Shipbuilding & Engineering Co. The Scottish Office during the year raised the question of the payment of the sinking fund on the sum expended on capital account out of the depreciation and renewals fund. They considered that it was necessary to charge revenue with sinking fund upon this amount. The Committee agreed to this proposal, and considered that the most satisfactory way to carry this out was to create a debt to the "common good" by borrowing the amount which had been temporarily drawn from the depreciation and renewals fund. The amount of sinking fund chargeable against revenue for this year has, therefore, been increased by £17,534. 3s. 3d.

The capital expended during the year amounted to £41,515. 2s. 11d. The amount of capital expenditure temporarily provided out of depreciation, renewal and reserve funds has now been treated in the accounts as having been borrowed on capital account for common good. This increases the gross amount borrowed from £2,044,644 to £2,291,352.

The details of the capital expenditure to date are given below:—

Capital Account.		Percentage.
Permanent way	£994,570 6 1	31·71
Electrical equipment	656,448 18 7	20·93
Ground	136,222 7 4	4·33
Buildings	445,891 2 7	14·18
Power station plant	390,668 1 9	12·42
Tools	28,044 4 11	0·87
Cars	263,628 15 1	8·37
Electrical equipment of cars	189,352 9 5	6·00
Other rolling stock	11,830 1 9	0·34
Miscellaneous equipment	19,016 4 11	0·58
Office furniture	5,246 3 11	0·15
Lease of Govan and Ibrox tramways	4,057 2 4	0·12
Total	**£3,145,575 18 8**	**100·00**

The total units generated during the year were 28,662,621, as against 29,653,678 in 1906-7, the decrease being due to the fact that the electricity department took no power during the year. Of these 1,604,157 were used in car depots, 1,219,128 at the power station and 222,389 at the sub-stations. The total power used in actually driving the cars was 23,600,373, as against 22,487,336 in 1906-7. The maximum load on the station was 8,528 kw. The load factor of the total load was 38·3 per cent. The coal consumed per unit generated was 2·97 lb.

The total number of car-miles run during the year was 20,766,722, against 20,350,367 in 1906-7, an increase of 416,355. The passengers carried during the same periods were 226,948,290 and 224,063,098 respectively, an increase of 2,885,192. The average traffic revenue per car-mile was 10·488d., as against 10·465d. in the previous year.

The population served by the Glasgow Corporation tramways is 1,050,000, the average revenue per head of population served being 17s. 3d., or an increase of 4d. over the corresponding figures in 1906-7. The average working expenses per car mile (excluding power) were 5·439d. and 5·353d., respectively, in the two years under review, while the figures including power works costs were 5·893d. and 5·721d., respectively. The corresponding working expenses per passenger were 0·539d. and 0·520d. It will be seen from the above figures that the expenses were, in general, slightly higher during 1907-8 than during the previous year.

A NEW DIRECT CURRENT AMPERE-HOUR METER.*

BY A. KÖNIGSWERTHER.

As is well known the present day ampere-hour meters are often extremely inaccurate at low loads, and many attempts have been made to overcome this difficulty. For it means that no certainty can be placed on the readings obtained, if one or two lamps only have been in circuit for some considerable time. It is considered that the reason for this alteration, and this has also been borne out by numerous tests, is the variation in contact resistance between brush and commutator, and the friction torque. In this matter the previous treatment of material has a great deal to do with the after effects, and the author describes numerous experiments which go to bear out these statements. It is especially found that the alterations are very great when the commutators are highly polished. In this case, when the error occurs, if the spindle of the moving system is raised a few tenths of a millimetre the meter will become accurate again for at least several hours, and will then once more slow up. In some cases, however, it was noticed that no alteration occurred for a considerable period, and an examination showed that the brushes had worked into the commutator owing to the more than ordinary brush pressure. This method could obviously not be used for altering the defects set out above.

As a result of the observations made on the alteration of the brush position a number of meters were constructed in which a periodic movement was given to the brushes during their operation. The commutators were fixed eccentrically so that the brushes in spite of their vertical movements always moved in the same path. From time to time the brushes were moved in a vertical direction, but only negative results were obtained from a large number of tests of this kind. The best preventative was found to be the treatment of the commutator with emery.

Another theory was that a film of water got between the commutator and brush and set up a back E.M.F. at this point. Numerous tests, however, showed that this was not the case. When a milliammeter was put in circuit it was found that the circuit was periodically broken, and it was also determined that these variations were independent of the current, for a number of tests with different currents and voltages showed that no alteration in the normal readings occurred. Other metals besides silver were tried for making both commutators and brushes, but the differences obtained were so small that they could have had no effect on the result.

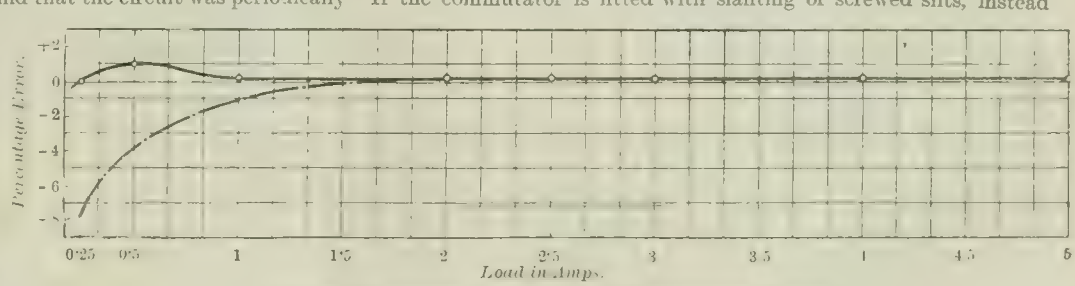


FIG. 2. CALIBRATION CURVE OF A KÖNIGSWERTHER METER.

These defects are claimed by the author to be avoided with the apparatus of which we give a description below, and its readings are said to be correct at all loads. This instrument, which is made by the Allgemeine Elektrizitäts Gesellschaft, is shown diagrammatically in Fig. 1. It consists essentially of a magnet M, an armature A, and a commutator K. The brushes, B and B_1, are fixed to a double-arm lever, H, which turns about D. This lever carries at one end a coil, S, which moves in the stray field of the magnet, M, so that as the current passes through it it is repelled or attracted. This coil is in series with the armature A, while the whole arrangement is connected across the terminals of the shunt, W, which is placed in the main circuit. The connections with W are made by means of spiral springs. A spring, F, also brings back H to its normal position when the current is switched off.

When any alteration in the contact resistance causes the current in the system, and therefore also in the coil, S, to vary, it follows that the position of this coil, and of the brushes, must also be altered. The current then again reaches its normal value, and the brushes thereupon take up their former position, so that the lever is continually making small movements as the contact resistance alters. In order to test this relation under the most unfavourable conditions the commutator was highly polished and the brushes were made of strip. Tests carried out with an ordinary meter arranged in this manner showed that the readings altered even during standardisation, and when put to work the meter came to rest with small loads. When the same meter was fitted with the modification described above its operation was quite satisfactory.

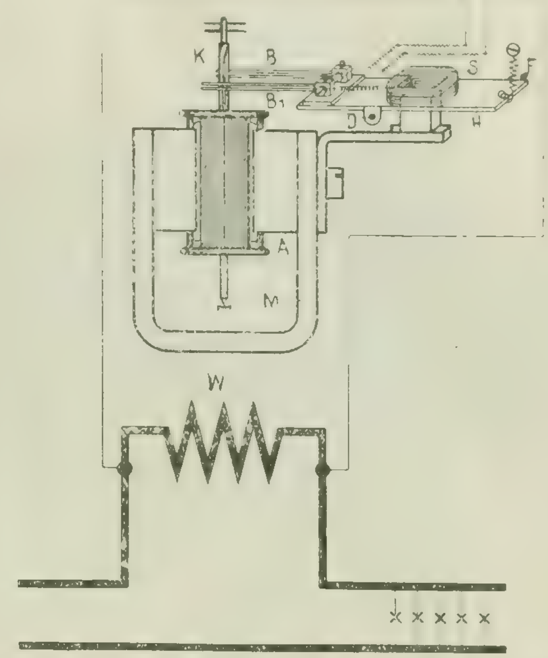


FIG. 1.—DIAGRAM OF THE KÖNIGSWERTHER AMPERE-HOUR METER.

This arrangement possesses the further advantage that the brushes at low loads work on another part of the commutator to what they do when the load is high. The commutator is more worn away in the full load position, while that part at which the brushes are when the load is lower is quite clean, a property which also makes for accurate readings. The percentage error at no load can be further improved by placing the commutating zone at full load, not in the neutral but in some other position by turning the commutator through a small angle, so that the meter does not develop its full torque. If the commutator is fitted with slanting or screwed slits, instead of straight, the brushes at no load approach more nearly to the commutating zone, so that the meter develops a torque which depends both on the load and on the commutation. By arranging these slits in an appropriate manner the calibration curve can be made to take any desired form. Fig. 2 shows such a curve taken from a meter with movable brushes and ordinary commutator slits. The dotted part of the curve shows the difference when the commutator was fitted with straight slits.

The author concludes his paper by describing in considerable detail a number of instruments in which this new arrangement is fitted. The method is also adaptable to watt-hour meters by connecting the movable coil across the supply terminals. At full load the torque of the ampere hour meter is 10-11 gm. cm., and the starting current is about 0·5 per cent. of the full load current.

* Abstract of a lecture delivered before the Verband Deutscher Elektrotechniker. From the *Elektrotechnische Zeitschrift.*

ELECTRIC TRACTION ON RAILWAYS.*

VIII.—MOTOR TRUCKS.

BY PHILIP DAWSON.

(*Continued from page 633.*)

Summary.—In this article the author deals with the design of trucks suitable for geared motors. For railway work bogie trucks are almost universally used, and various types and makes are here described, those with pressed steel side frames being most in favour in this country. The method of suspending the motors and their position are also discussed.

The subject of trucks suitable for use under electric motor cars is an important one, and much trouble has been experienced in the past from the adoption of a wrong design. In

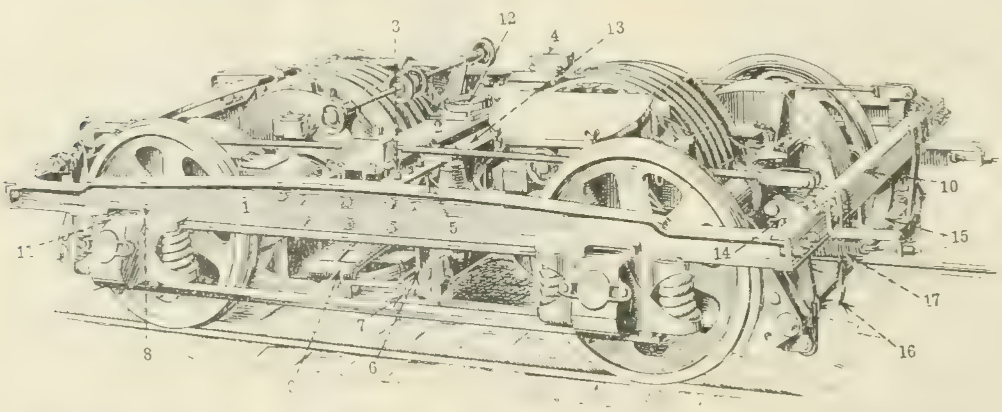


Fig. 1. Motor Truck with Cast Steel Side Frames, fitted with two Ganz Three-phase Continuous Current Motors.

the case of motor cars, owing to want of space, and to the fact that weights must be kept as low as possible, it is only with geared motors that we shall have to deal, and the question of gearless motors and of trucks suitable for use with them, will be discussed in a separate article when electric locomotives are dealt with.

For railway work two types are in use; the rigid four or six-wheeled truck, and the bogie truck, the latter with either four or six wheels, although for the present there are few examples of six-wheeled bogies in connection with electrically-operated rolling stock. Both forms of trucks are made in a variety of designs, and as far as the four or six wheel rigid, or semi-rigid trucks are concerned, they are usually built up and riveted owing to the length of the horizontal members being such as to make it practically impossible to make them either out of pressed sections or cast steel.

As regards the use of rigid wheel base four or six wheel trucks, there are but few instances of their use for motor cars although for locomotives they are largely if not universally used. Among their disadvantages may be mentioned that, owing to the restricted wheel base, they do not permit the use of bodies capable of carrying a large number of passengers, and it is believed that, as far as electric railway work is concerned, the only example of their use is to be found on the Metropolitan Railway in Paris. The bogie truck is that practically in universal use both for motor and trailer cars wherever heavy electric traction is concerned.

Bogies are usually constructed of one of the following materials according to the method indicated:

1. Cast steel side frames.
2. Pressed steel side frames.
3. Riveted side frames, constructed with rolled steel sections.

In the following pages various types and makes of trucks will be discussed belonging to one or other of these three groups. Generally speaking it may be said that as far as this country is concerned pressed steel side frames seem to have secured the preference for electric railway work. The side frames serve to support the motors and brake gear, the car body being pivoted on what is generally known as a swing bolster, the object of which is to give the body as much lateral latitude as possible, and this in its turn is supported from the sideframes usually through several sets of springs.

As regards motor bogies the strains they have to stand are considerably greater than those which have to be borne by bogies under ordinary railway coaches of the same weight which are hauled by a locomotive, and experience has now enabled the electric traction engineer to calculate and design satisfactory electric motor trucks for any given purpose. The reason for this is easily perceived, for whereas with locomotive haulage the trucks are pulled into position by the tractive effort of the locomotive on the front of the train, when they are fitted with motors they may constantly tend to get out of line and there is nothing in the torque exercised by the motors on the axles to tend to bring them back to the direct position except the side thrust of the rails which exerts itself through the side members and cross bearing, and creates a movement tending to distort the truck and at right angles to that produced by the motors.

This action is much more severe than would be the case

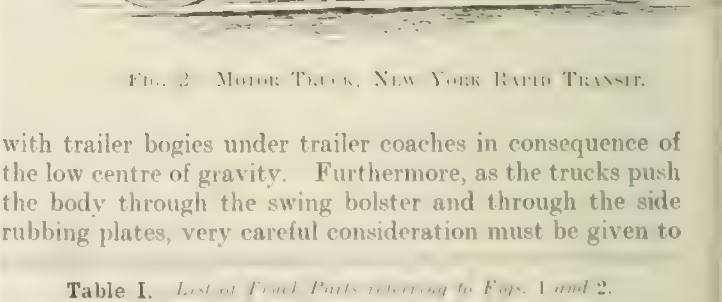


Fig. 2. Motor Truck, New York Rapid Transit.

with trailer bogies under trailer coaches in consequence of the low centre of gravity. Furthermore, as the trucks push the body through the swing bolster and through the side rubbing plates, very careful consideration must be given to

Table I. *List of Truck Parts referring to Figs. 1 and 2.*

1. Side frame or side bar or outside wheel piece plate.
2. Swing bolster.
3. Swing bolster rubbing plates.
4. Swing bolster side bearings.
5. Support for spring plank.
6. Spring plank hanger.
7. Spring plank.
8. Horn block.
9. Bolster spring.
10. End piece of truck frame.
11. Axle box.
12. King pin centre plate.
13. Transom and swing bolster housing plate.
14. Brake beam link.
15. Brake beam.
16. Brake safety strap.
17. Brake beam release spring.
18. Outside equalising bar.
19. Inside equalising bar.

the design of the trucks in consequence of the very special conditions which it is seen obtain in the case of trucks fitted with electric motors.

The car body underframe is supported on what is known as the spring bolster and kept in position by what is called

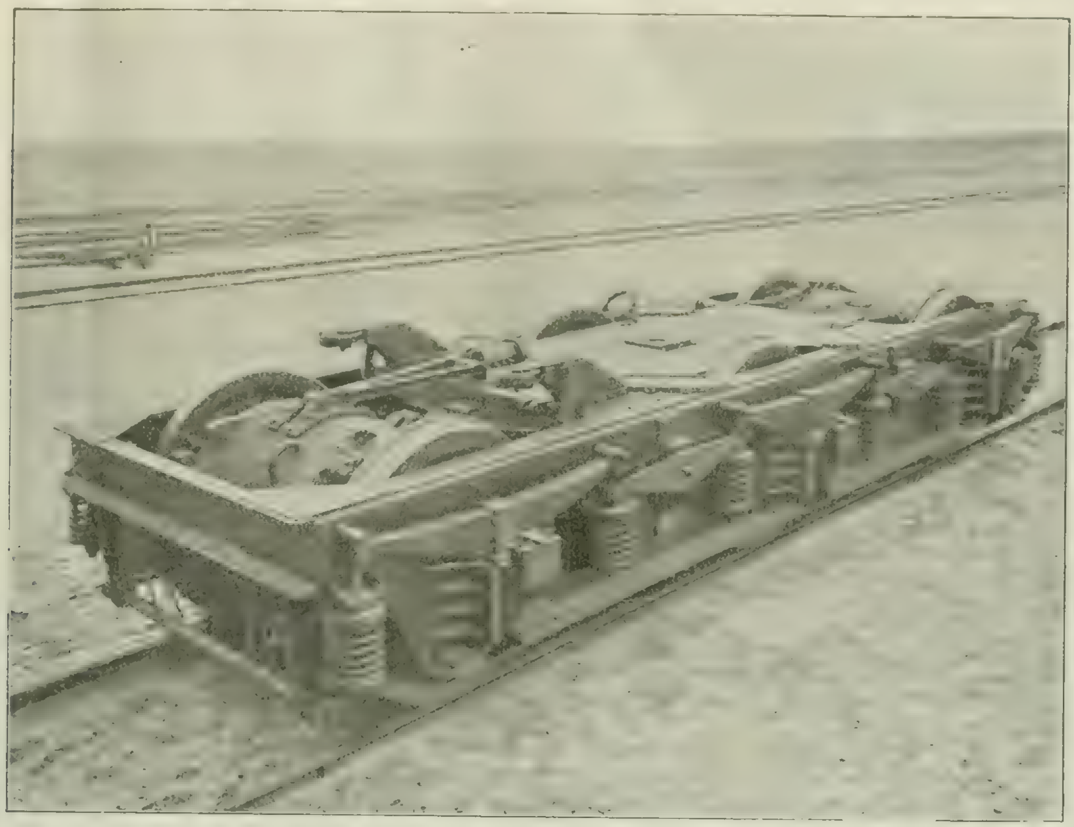


Fig. 3. Truck for Siemens Schuckert Car, Berlin—Zossen High speed Trials

a king pin fitting into a king pin centre plate, and round this pin as centre the truck turns, the body being usually guided by curved plates fixed to it against which fit corresponding plates fixed to the bog e frame. The bolster rests on springs which may be either spiral or elliptical, and which, in turn, rest on wha is known as the spring plate, which is usually swung by means of links from the transoms connecting the side frames or sole bars of the truck. The swing

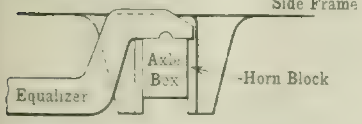


Fig. 4.

bolster can therefore swing sideways, and to guide it in this motion, what are called rubbing plates, are fixed to the inside of the transoms or bolster housing plates.

It is to the side frame that the motors are fixed at one end, by various methods which will be considered hereafter. The side frames can either be carried from springs fixed to the axle boxes in a method similar to that shown in Fig. 1 where special springs are used, or by means of elliptic springs carried on the top of the axle boxes, this latter being the method most generally adopted in this country. The numbers in Fig. 1 refer to the various component parts of a truck, and their names are given in Table I.

When elliptic springs are used, a secondary suspension con isting either of rubber or steel spiral springs is usually added; such springs are clearly shown in Fig. 3, which illustrates one of the motor trucks specially built for the Siemens-Shuckert motor car with which the Berlin-Zossen high speed railway experiments were run.

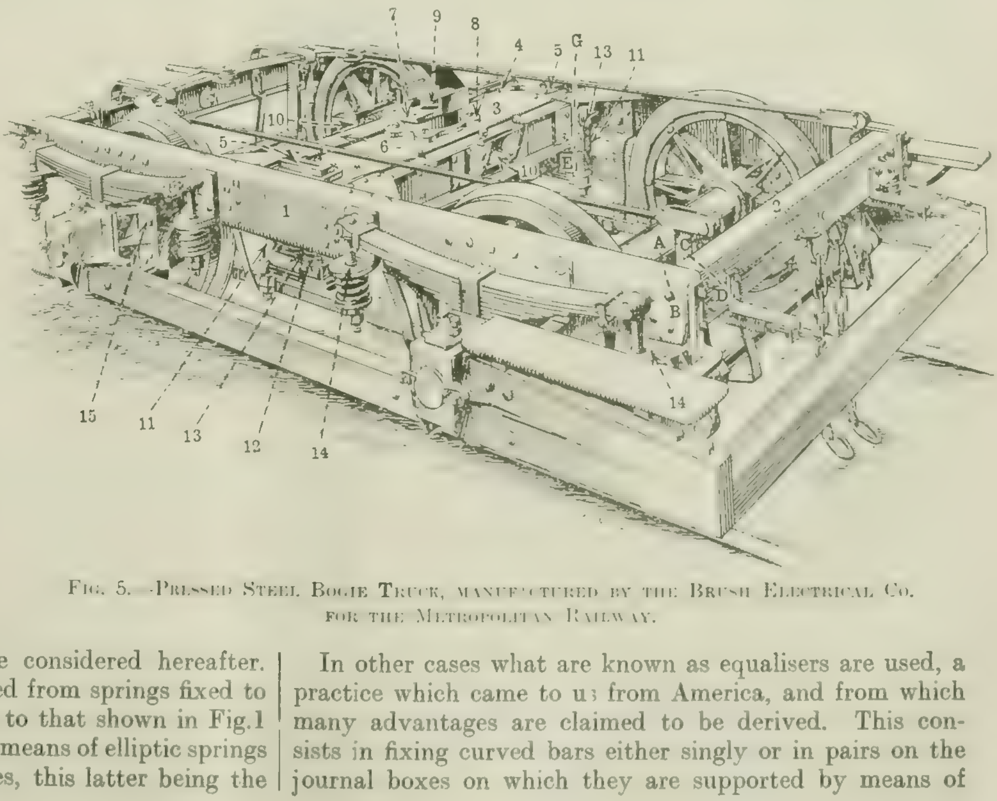
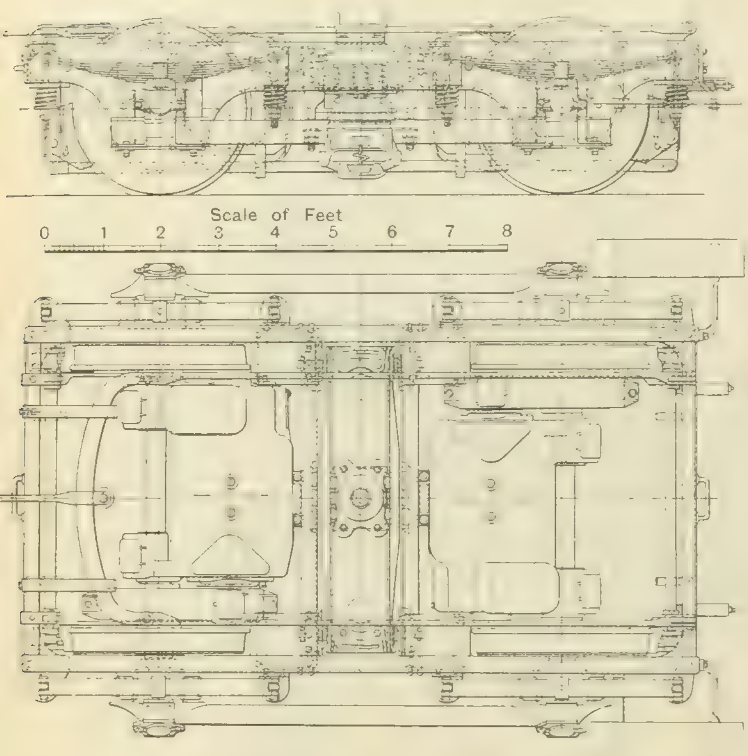


Fig. 5. Pressed Steel Bogie Truck, manufactured by the Brush Electrical Co. for the Metropolitan Railway.

In other cases what are known as equalisers are used, a practice which came to u from America, and from which many advantages are claimed to be derived. This consists in fixing curved bars either singly or in pairs on the journal boxes on which they are supported by means of

knife edges, and on these bars, by means of coil springs, the side frame is supported, as shown in Fig. 2. The numerals on this illustration refer to the same parts as those referred to in Fig. 1. The method generally adopted for the



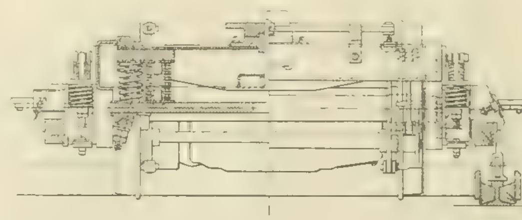


FIG. 6. PRESSED STEEL MOTOR TRUCK OF THE BRUSH COMPANY.

equaliser to rest on this axle box is shown in Fig. 4, and Table I. has been compiled, the numbers of which refer to Figs. 1 and 2 and which give the names by which the various parts comprising a truck are usually known.

Fig. 5 reproduces a form of construction mostly used in English steam railway practice, and which has been adopted with success to electric railway working, both by the North Eastern Railway, the Metropolitan Railway, and the Great Western Railway, and Table II. refers to this illustration.

Table II.—*Reference to Pressed Steel Motor Bogie Truck of Brush Co.'s Manufacture* (*Fig.* 5).

1. Sole bar or side frame made of pressed steel
2. End piece of truck made of pressed steel.
3. Swing bolster.
4. Rubbing plates guiding swing bolster, and between which and swing bolster both lateral and vertical motion takes place.
5. Guides running on corresponding guide plates fixed to bottom of car body underframe.
6. Transom or swing bolster housing plate.
7. Male rubbing plate
8. Female rubbing plate.
9. King pin.
10. Support for motor nose, consisting of cast bracket and strap bolted to transom.
11. Spring plank hanger.
12. Spring plank consisting of wooden plank with steel plate at end on which bolster spring rests.
13. Coil springs resting on spring plank and supporting swing bolster.
14. Brackets supporting springs.
15. Horn blocks.

In this form of construction the side frames, or sole bars, as well as the end pieces consist of pressed steel sections; the transoms are also of pressed steel and are riveted to the sole bars, as shown in Figs. 5 and 6. It will be noticed that in this case there is no equalising bar, the weight of the side frames carrying the transoms, and the motors being supported from single elliptic springs supported on the top of the axle boxes through the intermediary of secondary coil springs resting on brackets riveted to the sole bars. In some cases the place of the coil springs is taken by rubber pads The bolster in this case is also supported from the spring plank through two sets of four-coil springs, one at each end of the spring p'ank, as shown in Fig. 5 and more clearly in Fig. 6. These springs, both as regards position and method of fixing being more clearly seen in the side elevation and cross-section of the truck in Fig. 6. In some cases, instead of using two sets of four springs, sets of three are used, and in some cases, particularly when the coaches are very heavy, and when coil springs and not double elliptics are used, sets of two-coil springs, the centres of which are located on the centre line

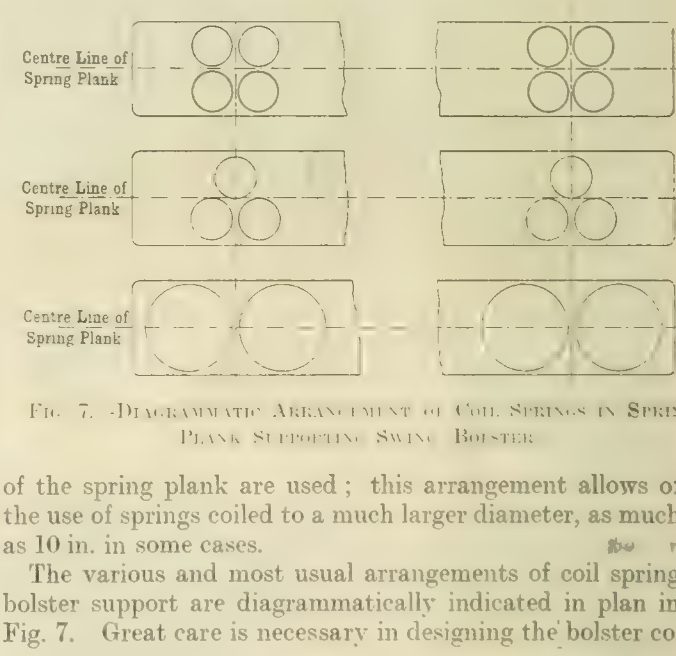


FIG. 7. DIAGRAMMATIC ARRANGEMENT OF COIL SPRINGS IN SPRING PLANK SUPPORTING SWING BOLSTER.

of the spring plank are used; this arrangement allows of the use of springs coiled to a much larger diameter, as much as 10 in. in some cases.

The various and most usual arrangements of coil spring bolster support are diagrammatically indicated in plan in Fig. 7. Great care is necessary in designing the bolster coil

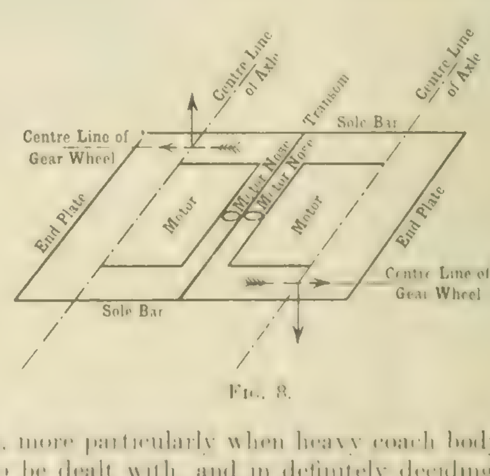


FIG. 8.

springs, more particularly when heavy coach body weights have to be dealt with, and in definitely deciding whether sets of two, three, or four springs shall be used. From the illustration (Fig. 5) it will be clearly seen that the truck transmits the lateral pressure due to the rotation of the axles, which is transmitted to the side frames through the

axle boxes and horn blocks, through the swing bolster and through the swing bolster rubbing plates, and then through the female and male rubbing plates and the king pin to the car

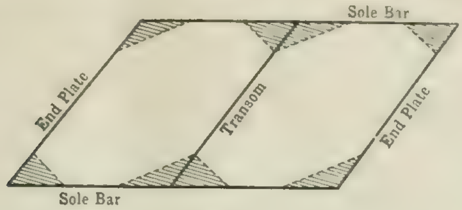


FIG. 9.

underframe and body. Experience in practice has shown that, particularly where the motors are practically rigidly fixed to the transoms by the motor nose resting on a cast- deform and ultimately break the trunk members. Fig. 9 shows diagrammatically the sole bars, transoms and end plates, and the shaded part indicates the portions which particularly require not only strengthening but also stiffening; it is particularly with a view to overcoming these weak points that the author has designed the motor trucks which will be used in connection with the electrification of the London, Brighton & South Coast Railway, and which are being manufactured by the Metropolitan Amalgamated Carriage & Waggon Co., of Birmingham, the detailed description of which will be given in these columns at a later date. There are other points connected with the electrification of the London Brighton & South Coast Railway which will be fully gone into by the author in the columns of *The Electrician* in the future: suffice it here to refer to the matter in

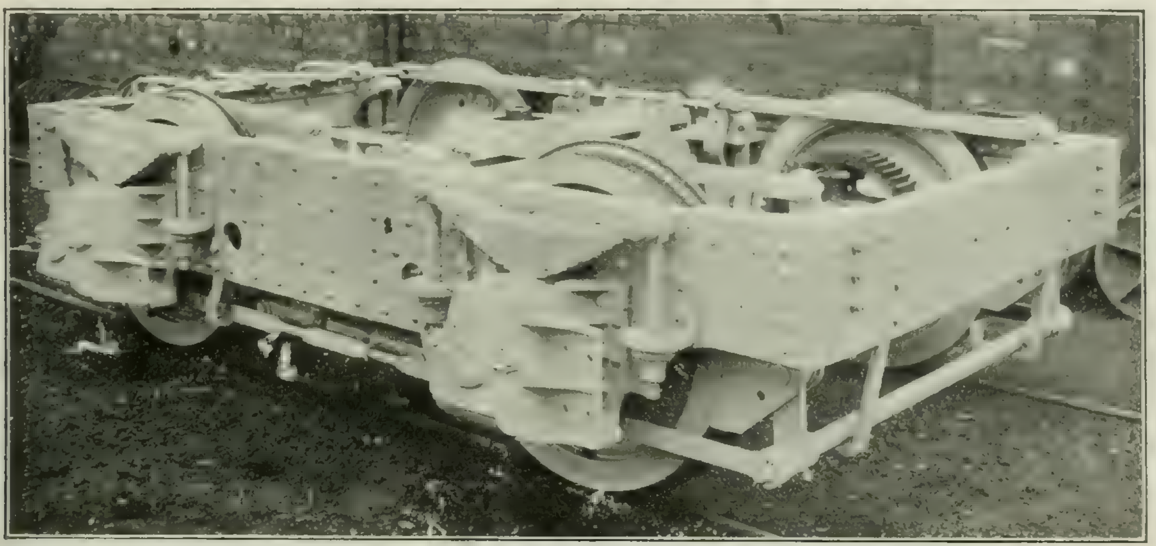


FIG. 10.—ELECTRIC LOCOMOTIVE TRUCK CONSTRUCTED BY THE BRUSH COMPANY.

ing fixed to the transoms, as shown in Fig. 5, one of the weakest spots is where the transom is fixed to the sole bar at section E G, marked on Fig. 5, and that the other weak spot is where the sole plates are joined to the end plates at the sections marked A B and C D in Fig. 5. In this connection the diagram in Fig. 8 has been prepared in which by arrows are shown the direction of stresses which tend to a general way. Another form of truck construction, similar as regards general design to that illustrated in Fig. 5 is shown in the illustration, Fig. 10; the principal difference is that the truck is constructed of rolled steel sections instead of pressed steel sections. This truck is intended for locomotive work.

(To be continued).

THE CONSTRUCTION OF THE PARIS SUBWAY LINES.

BY LOUIS DUBOIS.

Summary.—A description is here given of the extensions which are at present being made to the Paris subways. The river Seine has had to be crossed in two places and a different method has been adopted in each case. The author gives full particulars of the interesting constructional work involved.

At the present time the work which is being carried on in the different sections of the Paris subway presents many points of interest owing to the somewhat original methods adopted in various parts of the line. There are two new sections of subway now under construction, both of which cross the city from north to south. Both these lines have to cross the Seine, and, as the crossing points lie in the central district, the Municipal Council would not permit the building of an iron bridge, as was done in other cases where the line crossed the Seine in the outlying districts, but required that the subway should pass beneath the river.

Considerable engineering work was thus required, and the problem was solved in two different ways. Those responsible for the Metropolitan subway, which crosses the city from the Clignancourt Gate to the Orleans Gate, undertook the construction of the portion lying under the river upon the metallic caisson system, which were built at the surface and then sunk in the river, according to the usual method. These caissons are circular in shape, so that when placed end to end they will constitute the tunnel under the river. Another method was adopted for the second line, which is operated by an independent company, and crosses the town from the Versailles Gate to the Place Jules Joffrin. In this case it was decided to take the line across the river by means of a metallic tube, which was constructed under the river bed and was gradually advanced by means of the compressed air shield system. The work upon both these sections, which we have just mentioned, is going on at present and is now well under way. We shall give a short account of the "Berlier tube" method, as it is called, in the first place, and also a description of the second method.

The present line is independent of the extensive network known as the "Metropolitan," as the concession was granted to a company formed for the purpose, and known as the "Chemin de Fer electrique Nord-Sud." It is intended to serve a district in which the need of a subway has been felt for a long time past, and which has been neglected in the plans of the Metropolitan Company. Starting from the Versailles Gate in

D

the southern part of the town, it passes by the Rue de Vaugirard, the Montparnasse Railway Station, then crosses the Seine at the Place de la Concorde and near the Orsay and Invalides Railway Stations. It thence passes northward past the St. Lazare Station and ends at the Place Jules Joffrin, in the northern part of the town. There is also a branch line which runs from the St. Lazare Station and ends at the St. Ouen Gate. A map of the numerous subways now in existence is given in Fig. 1.

Generally speaking, the new subway will be built on the same engineering lines as those of the Metropolitan subway, both as regards the section of tunnel, which is double-track, and also as concerns the rolling stock. The trains will be made up of two motor cars and a variable number of ordinary passenger cars of the general type now in use. We will pass on to two original features of the present line, namely the "Berlier tube" under the Seine and the construction of some of the underground stations in reinforced concrete. The views here reproduced give a general idea of the "Berlier Tube" portion of the line. As is shown in the diagram, Fig. 1, it starts from a point near the Seine, and after passing for some distance under the street in an easy curve, it then proceeds under the Seine in a nearly straight line. The two tubes, one for each track, lie nearly parallel to each other. Upon reaching the right bank, the tubes pass under the whole extent of the Place de la Concorde and end at a point near the Rue de Rivoli. The total length is 548 metres (0·34 mile).

On the left bank, under the Rue de l'Université, is a large underground station of elliptical section which serves as the junction for the main subway tunnel and the double tube. On the southern side the double track tunnel enters the station in the usual way. At the other end of the station is the starting point of the two metallic tubes, and the ends of the latter are well embedded in masonry and concrete at this point. Generally speaking, both the tubes have the same gradient. The tube descends toward the Seine at a slope of 0·040 per metre, then crosses the river on the nearly level gradient of 0·0015, and then rises up towards the right bank and the Concorde station on a gradient of 0·035 per metre.

The method used in construction is that of the compressed air shield which has been used so extensively in the London tubes, the tunnel being lined with cast-iron rings in sections. The space between the Seine bed and the tube is filled in with concrete, this being effected by forcing the concrete through holes which have been left in the tube for the purpose, these holes being then closed.

The underground station beneath the Rue de l'Université has been fitted up temporarily with compressed air plant to the extent of 1,000 H.P. for the use of the tube. These machines consist of electric motors coupled to Ingersoll air compressors, together with a bank of transformers, which receive high-tension current from the city mains and supply the motors with low-tension current. From the underground station there is a shaft which leads up to a transverse gallery. The latter passes under the street and opens at a point on the bank of the Seine. In this way the earth can be removed, and at the same time the sections of the tube and other material can be taken in.

Another point of interest which may be mentioned before leaving this section of the subway is the method which has been adopted for constructing the underground stations where the line passes under a narrow street. In general the stations along the line are built of masonry and concrete, and have a standard outside width of 55 ft. There is no difficulty in constructing such stations under the wide streets or boulevards, but in some of the narrow streets the space available between the foundation walls of the house is quite limited, and in the case of the Rue de Vaugirard this space is only 11·80 metres. At the same time it is not desirable to cut down the standard inside width of the station, which is 13·50 metres. The problem has been solved very well by the use of reinforced concrete as the material of the station, and the sectional view which is here presented shows how this has been carried out. In this way the contractors were able to reduce the walls of the station to 2 ft. in thickness. The vaulting of the station has the same inside profile as the usual masonry vault, but the thickness is much less. However, it is strengthened at short intervals by heavy ribs, which add greatly to the solidity of the construction. After finishing the vault it is given an

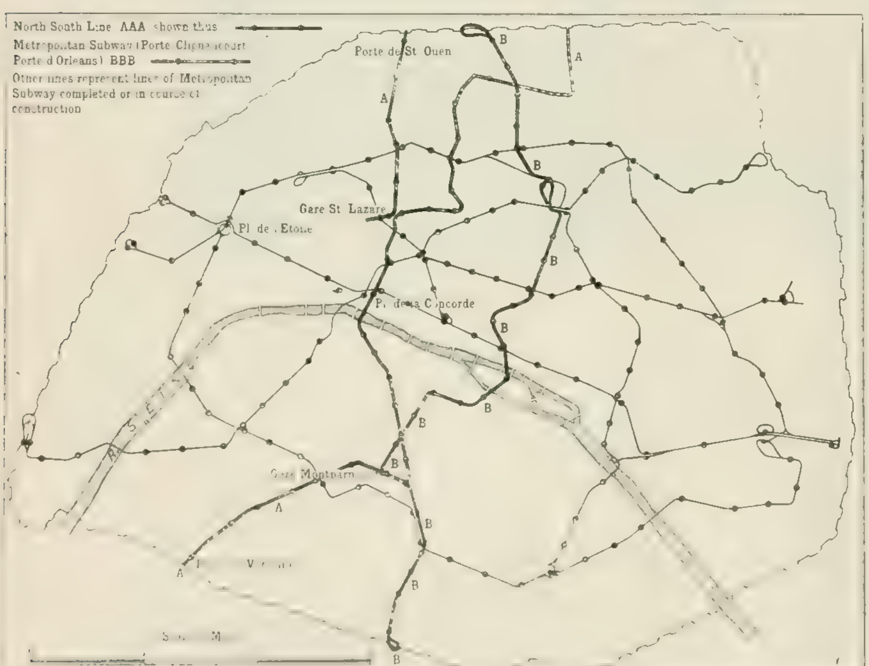


Fig. 1. Diagram of Paris Subways.

Fig. 2. North-South Line Station as constructed in a Narrow Street.

outer coating of concrete, after which the earth is replaced and the street paving laid. A section is shown in Fig. 2.

Of quite another character is the work which is now being carried on at another point in the Seine. At this point one of the important lines of the Metropolitan subway is to be taken across the river, and as, in the preceding case, an iron bridge could not be built, for æsthetic and other reasons. This line runs from north to south across the city, but in a different district from the last-mentioned line. Starting from the Orleans Gate in the southern district it passes north and north-west by the Montparnasse Station (where it meets the former line) then passes north and north-east, crossing the Seine at the Place St. Michel and the City Island, proceeding on the right bank past the Central Market, and thence reaching the East and the North Railroad Depôts, finally ending at the Clignancourt Gate.

Instead of adopting the shield system and tube for crossing the Seine, the present plan, carried out by the Chagniaud firm, provides for the use of metal caissons, having the section of the standard double-track tunnel, and which are sunk directly in the bed of the Seine. By joining a number of such caissons end to end we have a continuous tunnel. This method has one advantage among others, this being that the highest part of the construction lies very near the river bottom, coming within 2 ft. of the latter, so that the road bed is brought to a higher point, and this makes it possible to dispense with heavy gradients. The construction of the present section involves an amount of metal caisson work which is undoubtedly greater than has yet been undertaken in France. Not only are the two arms of the Seine to be crossed, but there are two underground stations to be constructed entirely of metal caissons. One of these stations lies in the City Island and the second at the Place St. Michel. The metal frames of the stations are of unusually large size and represent an enormous mass of iron.

Fig. 3.—Caisson in the Seine

Speaking first of the construction which is carried out in the bed of the Seine, each of the sections which are sunk in the river is composed of a main iron structure which represents the standard section of double-track tunnel. This is a strong iron tube, having a somewhat elliptical section. Each of the rings which form the tube is 2 ft. in width, and the rings are bolted together with water-tight joints formed by interposing strips of creosoted wood. Around the tube is then built a metallic framework covered with iron plate in order to form the caisson. For this purpose there are placed a series of webs or brace-pieces at intervals along the tube, and these are of such a form that when the iron plating is placed on the outside, the whole construction has the appearance of an immense oblong box with flat bottom and a slightly-curved top, being of a nearly square section. The part of the box lying under the tube proper is entirely separated from the remainder by a stout horizontal flooring, and this portion serves as the caisson proper. It is filled with compressed air when placed on the bed of the river, and here the workmen excavate the river bed so as to allow the structure to sink into place. Above this, the

Fig. 4. Middle Caisson of Station—Commencement.

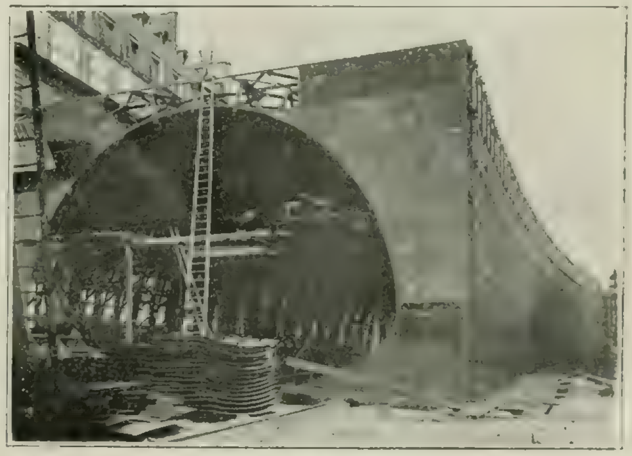


Fig. 5. Middle Caisson of Station—Nearly Finished.

whole space lying between the tube and the sheet-iron walls is filled in with cement béton, thus solidly fixing the framework and making a very compact mass surrounding the tube. One of these caissons in the Seine is shown in Fig. 3.

There are three caissons of the above form used in the wide branch of the Seine and two in the narrow branch. They were constructed at some distance from the working point at the Quai des Tuileries, where a yard had been established for the purpose. After the iron plating was put in place and the whole was quite watertight, the immense box was launched down an inclined track into the Seine, and was then towed to the working point. Care had been taken to dredge the bed of the stream, so as to give a perfectly level surface upon which the caisson should rest. In order that the sinking should be properly carried out, a set of piles was driven in the river bed to serve as guides, and on top of the piles was built a platform connected with the river bank for removing the excavated earth. The men enter the caisson, as usual, by means of vertical shafts, which pass through the structure and have air locks at the top. After placing the structure on the river bed, the concrete filling was poured into the space between the tube and the walls, as mentioned above. The weight of the ironwork is 250 tons.

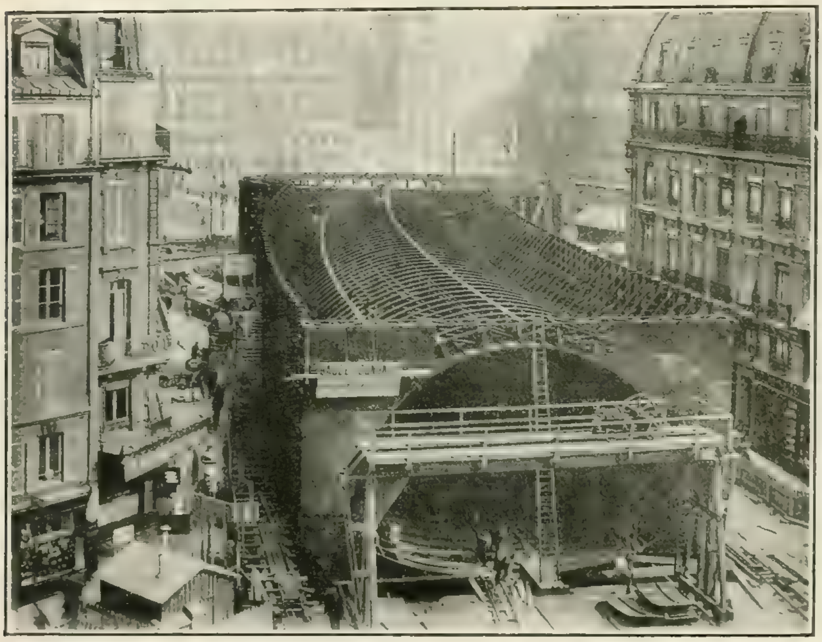


Fig. 6.—Middle and End Caisson.

At the present time all the five caissons have been sunk in place in the river bed. The lower chamber has been filled up with concrete and each caisson cleared of the water which had been admitted to give the necessary ballast when it was lowered into place. After this it remained to join the different sections together in order to make a continuous tunnel. In the meantime, a small caisson had been sunk in order to fill up the space of 5ft. which had been left between the large structures, and a masonry foundation had been built under the ends of the latter so as to keep them at exactly the same level. After this was carried out, the sheet-iron end plating was removed from all the caissons, thus making a continuous tunnel from end to end in each branch of the Seine. The two tunnels are, however, separated by the City Island, in which there is placed the large underground station mentioned below.

At the Place St. Michel and also in the City Island there has been carried out a piece of work which was watched with much interest by Parisians on account of its unusual construction as well as its great size. The total length of the iron structure at the Place St. Michel is nearly 400 ft., with a height of 50 ft., and this immense structure was sunk below the ground to the proper depth by the use of compressed air.

Here it was intended to establish an underground station havingthe same interior section, with a station platform on either side of the double track. The soil, however, is waterlogged at this point, and this made it necessary to adopt a special method of construction. It was accordingly decided to sink a metallic caisson in the ground which should contain a large tube of elliptical section corresponding with the station. At the same time it was necessary to provide for the approach to the station, the staircases and ticket offices, and for this there was sunk a large caisson of elliptical shape at each end of the centre section. The latter are constructed quite differently from the former. Figs. 4, 5 and 6 show this work in progress.

As regards the centre section, it is of great length, measuring about 220 ft. long, and the extreme width is 54 ft. The height is about the same. It is constructed by Baudet, Donon & Co. The inside tubular part which forms the station proper has a semi-circular vaulting of 41 ft. internal width, while the base is formed of a semi-elliptical section. The total height of the interior is 28 ft. Around the main tube is constructed a skeleton framing consisting of metallic trusses spaced about 4 ft. apart surrounding the tube. Additional ironwork is added to this in order to give vertical sides to the entire mass, and iron plating is placed over the whole so as to make it quite watertight. In the lower part of the boxlike structure is the working chamber, separated from the rest by airtight flooring and having a height of about 6 ft. The chamber is divided into two independent parts by a longitudinal partition, and the workmen are thus lodged in two distinct chambers in order to equalise the work. The whole mass weighs 18,000 tons, including 7,000 tons of concrete filling around the central tube. The entire structure is constructed on a curve of 984 ft. radius.

The two end caissons are of elliptical form, with the two axes measuring 60 and 80 ft. respectively, and their depth is 65 ft. They are built in the form of a ring, which is made up of two concentric platings of sheet iron separated by brace pieces, which keep them 5 ft. apart. This inner space is filled in with concrete to the extent of 2,500 tons. When this piece is sunk so as to correspond with the former, it is to be topped with masonry, upon which rests a metallic floor lying below the pavement. At present the middle and the two end pieces have already been sunk into place and the street paving has been relaid. In due course the station will be joined to the tunnel section in the Seine bed, and the tunnel will be continued on the other side by the more ordinary methods.

A STUDY OF MULTI-OFFICE AUTOMATIC SWITCHBOARD TELEPHONE SYSTEMS.*

BY W. LEE CAMPBELL.

Summary.—This Paper deals with (1) The enormous economic waste which the wire, cable and conduit equipment of a telephone system involves. (2) A recapitulation and discussion of reasons which make this waste necessary or expedient in manually operated systems. (3) How this waste can and should be greatly reduced in systems employing automatic switchboards.

The first cost of a telephone plant using switchboards of either type may be divided into three principal items: (1) cost of the apparatus (both central office and subscriber's station); (2) cost of the central office buildings and furnishings; (3) cost of the wire, cable, and conduit plant. In the third item we find the largest factor of the three. It is very variable, but will usually cost more than the two other parts combined; not infrequently it represents two thirds of the entire first cost of the system. It will be incredible to electrical engineers that in the average telephone system containing one central office only, nine tenths of the cable and wire plant is idle—not in use for transmitting conversations, even at the peak of the load; and, too, that on the average during 24 hours' service, 98 per cent. of the wires are not in use. Indeed, from observations made in a large number of automatic plants during the busiest hour, it was found

* Abstract of a Paper read before the American Institute of Electrical Engineers.

that in offices of from 8,000 to 10,000 lines, handling a comparatively heavy traffic, the maximum number of conversations taking place at one time was equal to slightly less than 4 per cent. of the number of lines in service. As each conversation represents two lines, this would indicate a maximum of 8 per cent. of the lines engaged for conversation, operating and signalling at the peak of the load.

Excepting party-line service, which at best is but a partial remedy, there is only one method known to telephone engineers of to-day for materially reducing the great economic waste represented in the 90 per cent. of costly cable, wire, and conduit equipment which is not in use even during the "rush hours." This method is to divide up each plant so that instead of one large central office it will employ a number of smaller offices. For example, in Chicago there are 15 or 16 central offices averaging about 3,000 lines each. But

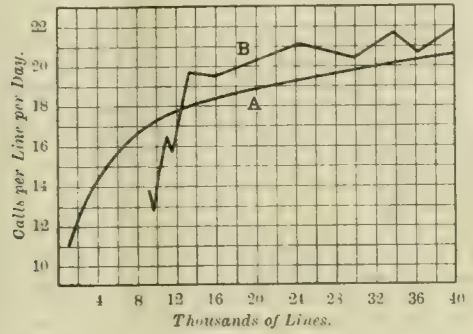


FIG. 1.

Curve A shows assumed number of calls per line per day. Curve B shows average number of calls per line per day in Chicago district from 1893 to 190?.

division of an office of less than 10,000 lines is generally regarded as undesirable and to be avoided wherever possible. It is, therefore, the general practice in smaller cities to carry all or the bulk of the business on one large board, smaller branch boards being installed under suffrance and only for urgent reasons. The writer hopes to demonstrate that while this antipathy toward dividing offices of 10,000 lines or less is reasonable in manual practice, it is not reasonable in automatic practice.

Considering now the factors that govern the first cost of a common-battery system of either type, we find first, that the cost of the ordinary direct-line, flat-rate telephone at the subscriber's station is about the same ($7·25) in all sizes and conditions of modern common battery manual plants, and $12·50 each in automatic plants. The cost of a private branch switchboard at a subscriber's premises is not materially affected by the size, location, or type of the central office

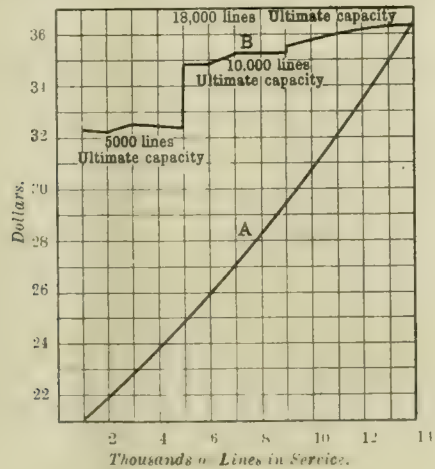


FIG. 2.

Complete cost of central office equipment, except long distance board, plus cost of one telephone per line. Curve A for manual offices. Curve B for automatic offices.

to which it is connected. This, therefore, will not be taken into consideration. The cost of the central office equipment, when all installed in one office, depends upon the number of lines entering the office, and the number of connections demanded during the busy-hour of each day. The writer has drawn, in Fig. 1, an arbitrary curve, A, from which will be taken all figures used on the number of calls made per line per day in plants of different sizes. It will also be taken for granted that the number of calls made during the busy hour of each day is one-eighth of the total day's business. Experience shows that this is an average ratio. The average busy-hour's work of an operator in the small manual plants is about 225 flat-rate connections; in the large manual plants about 250 flat-rate connections when no calls are trunked to other offices.

For the benefit of those not familiar with automatic switchboards, the writer will state that each line terminates in what is generally called a line switch. These line switches are arranged and multiplied together in groups of 100 each. Connections between these groups are made by means of trunking switches called first selectors, second selectors, third selectors, and connectors. In a system having an ultimate capacity of 1,000 lines, first selectors and connectors are the only trunking switches used. When the ultimate capacity is in-

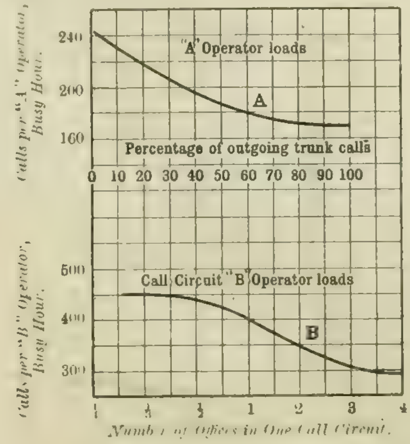


FIG. 3.—OPERATOR'S LOADS.

creased to 10,000 lines, second selectors are required also; and when the ultimate capacity is increased to 100,000 lines, third selectors are added. In a 100,000-line system, then, there is one first selector, one second selector, one third selector, and one connector for each trunk equipped.

In curves A and B, Fig. 2, the respective costs of manual and automatic central office equipment are shown for one telephone per line.

Considering the second item of first cost for single office systems, the author gives curves showing floor space and cubic feet of space required on the average for automatic and manual central office equipments respectively.

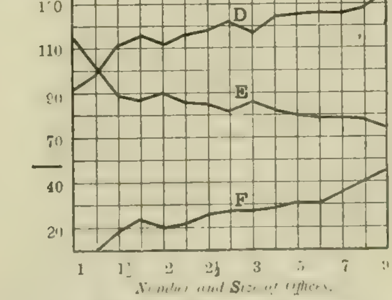


FIG. 4.—MANUAL OFFICES.

Estimated, 173,500 calls per day and 21,687 calls during busy hour.

From these it is seen that the cost of building space for automatic equipment is considerably less than that for manual equipment, and that for offices of over 5,000 lines the automatic occupies about half the space required for the manual. No effort has been made to secure comparative figures on the cost of furnishings, but they are unquestionably more expensive in manual offices. The author next considers what effect dividing up a system so that it employs more than one office, has on these two items of first cost.

In manual systems an operator's daily quota of connections is reduced when part of the calls which she handles must be trunked

to other offices. This effect of trunking on the operator's work is indicated by curve A, Fig. 3, which gives the number of flat-rate busy-hour connections which one of the largest manual operating companies has found that an average "A" operator will make with various petcentages of trunked calls. It is, therefore, necessary in a multi-office manual system to instal and to provide space for more "A" operators' positions, as well as to instal and provide space for "B" operators' positions and to provide increased space for rest rooms, &c.

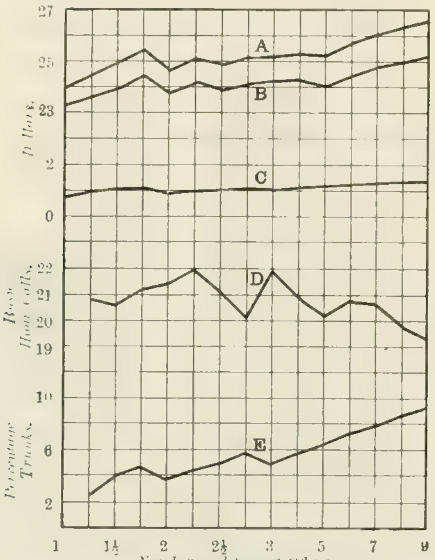


FIG. 5.—AUTOMATIC OFFICES.
Estimated, 173,500 Calls per Day and 21,687 Calls during Busy Hour.

As an illustration, in Fig. 4, curves D, F, and E show respectively the number of "A" operators' positions, the number of "B" operators' positions, and the average number of lines per "A" operators' position for a hypothetical 10,000 line system with different numbers and sizes of offices. The numerals along the bottom of the figure, which indicate the various numbers and sizes of offices, have the following significance: $1\frac{1}{4}$ represents one office of 8,000 lines and one office of 2,000 lines; $1\frac{2}{3}$ represents one office of 6,700 lines and two offices of 1,650 lines each; $2\frac{1}{4}$ represents two offices of 4,450 lines each and one office of 1,100 lines; and so on. It will be noted that the number of "A" and the number of "B" operators' positions increases quite rapidly as the number of offices is increased, while the number of lines per "A" operators' position diminishes. Curve E, Fig. 4, gives the approximate cost per line of the central office equipments installed as derived from the data used in curves D, F, and E previously mentioned. It will be noted that although more positions are necessary than in a single office, the cost of each position is reduced by a decrease in the line equipment and in the number of multiple jacks per position, so that there is not a great variation in the total switchboard cost. Curve C shows the cost per line of the buildings for the various sizes and numbers of offices in the divided system. The cost of space required for executive offices, storage, &c., is not included in these figures, nor do they include the cost of land and furnishings. Curve A shows the combined cost per line of central office equipment and buildings.

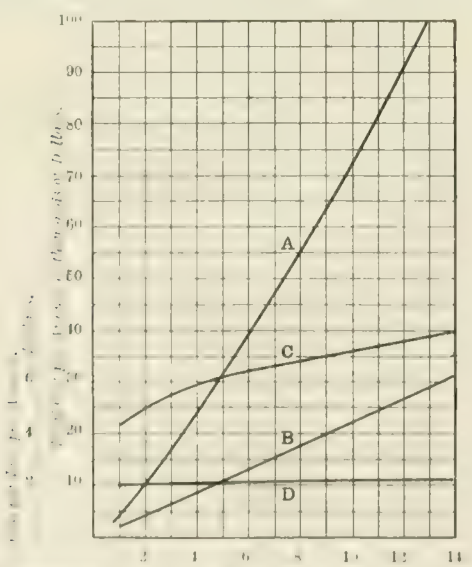


FIG. 6.—COST OF LABOUR FOR OPERATING, REPAIRING, AND MAINTAINING ALL CENTRAL OFFICE EQUIPMENT EXCEPT "LONG DISTANCE BOARD."

Curve A gives total per annum for manual equipment. Curve B gives total per annum for automatic equipment. Curve C gives cost per line per annum for manual offices. Curve D gives cost per line per annum for automatic offices.

Before discussing operating expenses, however, let us see what effect plant division has on the first cost of automatic central office apparatus and buildings. To illustrate the effect, the curves in Fig. 5 have been worked out, using the same 10,000-line system and the same numbers and sizes of offices employed in Fig. 4 for the manual system.

Considering operating expenses, the author directs attention first to curves A and C, Fig. 6, which show average annual operating and maintenance labour cost for manual central offices of from 1,000 to 14,000 lines, doing no trunking and handling the number of calls per line per day indicated by curve A, Fig. 1. Curves B and D, Fig. 6, show respectively the total annual cost and the annual cost per line of all central office labour for automatic offices of from 1,000 to 14,000 lines.

The author next draws attention to curves A and B, Fig. 7, which give the central office labour expense as shown in Fig. 6, plus the cost per line per annum of certain central office equipment and central office building charges that are materially affected by plant division. Curve A is for manual offices of from 1,000 to 14,000 lines, no trunking, and curve B gives similar data for automatic offices. These figures include insurance, taxes, interest and depreciation on central office equipment and buildings, renewals for central office equipment, and the cost of lighting and power.

Insurance of the central office equipment in fire-proof buildings is taken at 1 per cent. per annum. Taxes on both types of equipment are taken at the rate of 1·5 per cent. per annum; interest is taken at

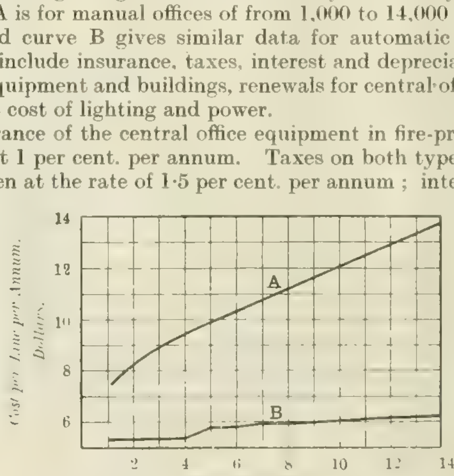


FIG. 7.

Curve A shows cost per line per annum for operating manual central office, as shown by curve C, Fig. 6, plus cost of power, lighting and interest, depreciation, taxes and insurance on central office equipment and on central office building.
Curves B same as A but for automatic equipment (see curve D, Fig. 6).

6 per cent. per annum for both. Depreciation on manual central office equipment is reckoned on an average life of 10 years. Of course, many parts of the switchboard must be replaced in less time; for example, cords in an average time of 1·5 years, plugs in two years, keyboard lamps three years, answering jacks five years, &c. These, however, are believed to be covered by including a 2 per cent. charge for maintenance materials and renewals. Depreciation on automatic equipment is calculated on a life of 12 years. Therefore, 6 per cent. is used in calculating depreciation on automatic central office equipment, while for manual equipment the depreciation charge is taken at 7·5 per cent. (*i.e.*, 10 years' life). Maintenance material or renewals for automatic central office equipment, the author has found amount on the average to 0·2 per cent. per annum on the first cost of the central office equipment. The power plant, main distributing frame, and other parts of the central office equipment, increase the renewals item, however, and in order to cover everything it has been taken at 0·5 per cent. for automatic offices.

The cost of power per originating call handled is about twice as much for automatic switchboards as for most of the manual switchboards used by the "independent companies." The amount of current consumed is almost the same, 0·006 of an ampere hour. Automatic plants generally use a battery of 46 volts, about twice the voltage of the usual manual battery, although in large plants where the lines are long, 40-volt batteries are sometimes employed in manual practice. The manual switchboards generally used by the Bell companies require considerably more current than those used by the independent companies. The amounts used by the independent boards have been taken in working out the curves in this

Paper. Taking the cost of power, transformed and delivered at the switchboards, at 15 cts. per kilowatt-hour gives a cost of $0·0216 per thousand local calls for manual offices and of $0·0432 per thousand local calls for automatic offices. The additional cost per thousand incoming trunk calls received at a manual office would be $0·0144. For automatic offices the additional cost for incoming trunk calls would be $0·004 per thousand, assuming that the number of calls trunked out from an office equals the number incoming. The cost of lighting automatic central office equipment has been taken at $4·00 per thousand lines per month ; and for manual offices the cost of lighting the operators' positions, the switchboard rooms, operators' retiring rooms, terminal room, desks, &c., has been taken at $2·00 per switchboard position per month. The annual charges on the central office buildings have been taken at the same rates for the two systems; that is, insurance on fire-proof central office buildings has been figured at 0·5 per cent. per annum, interest at 6 per cent., taxes at 1 per cent., and depreciation and repairs at 2 per cent. per annum.

In order to illustrate the effect on the annual expenses caused by dividing a system up so that it employs a number of offices instead of one, the writer has constructed the curves in Fig. 8, which show what the expenses would be for the different numbers and sizes of offices in the hypothetical 10,000-line system used in Figs. 4 and 5. Referring to curve A in Fig. 8, it will be noted that the annual cost of central office labour for the nine-office arrangement of the manual system is 80 per cent. greater than for the single office arrangement.

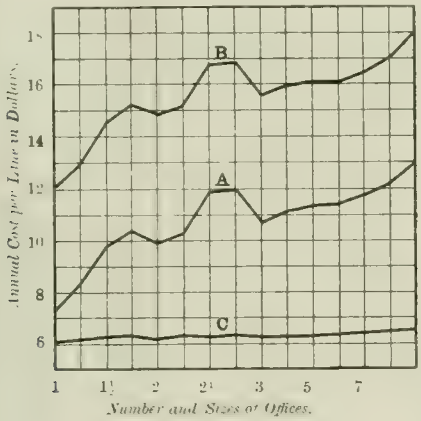


Fig. 8.

Curve A gives annual expense per line of all central office labour for a 10,000 line manual system. Curve B shows labour cost as given by Curve A plus interest, taxes, depreciation, maintenance, insurance and cost of lighting and power. Curve C shows for a 10,000 line automatic system (*see* Fig. 5) the same costs as those given in Curve B for a like manual system.

Curve B shows that the increase in the cost of labour plus the annual charges on equipment and buildings, weighs heavily against the division of manual systems. Roughly speaking, an economical arrangement of the average divided manual system will include offices not much less than two miles apart. Curve C in Fig. 8 shows that division of automatic systems may be profitably carried much further on account of the slow increase in central office expenses resulting from adding to the number of offices.

In calculating depreciation, the life of the telephones for both systems has been taken to be 10 years. The cost of material for repairs and renewals of automatic systems is a little greater than for the manual. It is found that the cost of new parts peculiar to the automatic system amounts to 0·14 per cent. per annum. This difference has, therefore, been noted in comparing maintenance costs of the two systems.

(To be concluded.)

New Electric Baggage Wagon.—According to the *Electric Railway Review*, experiments are being made under commercial conditions in Pittsburg with a 5-ton electric delivery van, which can be propelled either by its own batteries or, when running along tramway routes, by taking current from the overhead line by means of an ordinary trolley. The vehicle is provided with four 2½ H P. motors, which are used in series on the trolley line or in parallel on a 42-cell battery. The gearing permits a speed of 22 miles per hour when on the tramway track, which is fast enough not to interfere with the tramway traffic, and the battery can propel the car at eight miles per hour. A smaller car on the same principle has been in use for parcel delivery for two years.

HIGH-TENSION CONTINUOUS ELECTRICAL OSCILLATIONS.*

BY R. C. GALLETTI.

(Preliminary note.)

To give particulars of the various ways and of the extent to which high-tension direct current is more manageable than alternating current would be a long task and perhaps premature, but Prof. Blondel's recent pronouncement in this journal obliges me to make some statement.

I shall state briefly how I obtained the continuous oscillations at Geneva with the help of a Thury dynamo at 25,000 volts and 114 amperes, courteously placed at my disposal by the Compagnie de l'Industrie Electrique, to whom I wish here to renew my thanks.

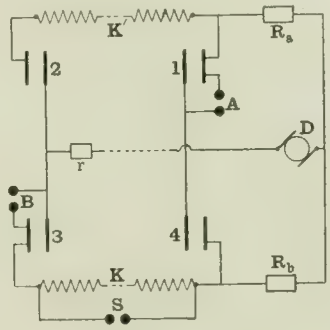
The diagram shows a set of oscillating circuits by means of which I obtained the continuous oscillations. It comprises four identical capacities, 1, 2, 3, 4, and two spark micrometers A and B.

Dicharging the capacity 1 across the spark-gap A produced a series of oscillations in the circuit 1, A and another induced series in the circuit 1, K[1], 2, 3, K, 4 syntonised to the same period. Since the decrement of the latter circuit was very small, the maximum oscillation in it coincided with the final oscillations in 1, A.

The same thing happened on discharging the capacity 3 across B.

Hence at the end of every discharge across either A or B there was a maximum oscillating potential induced on the balls of the opposite spark-gap.

The fixed distance between the balls of the spark-gap was the striking distance of a certain static electric charge at a certain tension produced by the working of the dynamo at a certain interval determined by the capacity in parallel with the gap, the resistance in series with the dynamo, and the tension of the latter.



The presence of an oscillating potential induced on the balls of the spark micrometer gives a striking distance which is virtually smaller. This virtual striking distance was least for B at the termination of the A spark, and least for A at the termination of the B spark.

On increasing the tension of the dynamo and thus providing a sufficient number of sparks per second either at A or B it happens at a certain instant that the partial static charge discharges itself prematurely on account of the lesser virtual striking distance. This was made evident by the diminution of the striking distance of the test-gap S, which measures the charging potential of the capacity of the closed circuit.

On calculating the quantity of electricity which should have passed per second through the circuit 1, K[1], 2, 3, K, 4, while it was the seat of continuous oscillations of the potential indicated by the test-gap, this was found to agree with the quantity measured by means of a fuse inserted in the same circuit. Such a fuse was composed of several lead wires 0·5 mm. in diameter and was tested by comparison with a 0·1 mm. copper wire at high frequency.

The resistance shown in the diagram was introduced in order to direct the path of the oscillations and to facilitate the interpretation of the phenomena observed.

I reserve the quantitative data till after the impending experiments at Lyons with direct current at 40,000 volts and 5 amperes, by agreement with the Société Grénobloise de Force et Lumière.

It is easy to appreciate the practical importance to radio-telegraphy of the above tests, and I shall be well satisfied if I succeed in opening a new field for the industrial applications of high potential direct current, a form of electrical energy specially developed by the Geneva electricians, in contrast with the work of a thousand minds bent upon ensuring the triumph of the alternating current.

* Translated from *L'Elettricista.*

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"THE ELECTRICIAN" INDUSTRIAL SUPPLEMENT.

With "THE ELECTRICIAN" for Sept. 14, 1906, was issued the first of a series of "Industrial Supplements," to be published from time to time with "THE ELECTRICIAN." The twenty-sixth issue of the Supplement was issued (Gratis) with "THE ELECTRICIAN" for August 21.

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SWITCHGEAR ARCHITECTURE.

It is an acknowledged axiom among architects that the first consideration in all their designs must be the capability of each part to do its work. Decoration and elaboration are subordinated to the demands made by this important principle. The application of a somewhat similar principle to switchgear design is a matter worthy of study by electrical engineers at the present time. We cannot help thinking that the engineer would do well to take a page out of the architect's book, to pay more attention to the lay-out of his station than to its "artistic" decoration, and to arrange for more accessibility behind his switchboards, rather than to insist on the degree of polish of their marble and slate panel faces.

The question of proper switchboard design is, in fact, one which should receive immediate attention. Every year Mr. G. SCOTT RAM, in his capacity as Electrical Inspector of Factories, chronicles accidents due to the improper protection of workpeople from "live" parts. There are undoubted signs that the old order is passing, but there still remain boards whose backs are one mass of wires. On such parodies it is impossible to work without crouching down in the most uncomfortable, and often dangerous, position or to perform some awkward adjustment which even broad daylight and plenty of room would make difficult.

These are, unfortunately, not the only faults. In speaking above of insufficient accessibility we had low voltage gear in mind, but some high tension boards err in the other direction by being too accessible. To refer again to Mr. RAM'S reports, instances are constantly cited where accident has occurred owing to insufficient protection of high tension switchgear, with the result that cleaners have unthinkingly moved from "dead" to "live" panels with fatal results.

Such matters may, in these days of Workman's Compensation Acts, be recommended as food for reflection to both designers and users of switchboards. To construct an easily accessible switchboard, and one which may receive attention, when necessary, at the hands of ordinary switchmen, and not professional contortionists, but which when "live" is adequately protected from unauthorised tampering, should be the first consideration of the designer. The modern tendency is, we believe, to keep these points in mind, and if the new Home Office Rules do nothing but make the employment of truly safe switchboards compulsory their promulgation will not have been in vain. It may, therefore, be taken as axiomatic that in the near future all switchboards will be safe, and both accessible and inaccessible under "dead" and "live" conditions respectively.

Some attention has recently been directed to the matter in American electrical engineering circles. It has been viewed rather from an economical than an engineering standpoint, but the two are so closely allied in central station work that separation is well nigh impossible. The feeling in America is rather that too much material is put into modern switchboards. The provision of quick-break knife switches, where the plain type would answer, is one complaint, while the installation of remote control switches where "man-power" control would be as efficient, and at the same time cheaper, is another indictment levelled against the more recently designed gears. The underlying truth of these statements cannot be gainsaid, and they may equally well apply to the practice of this country. An arrangement whereby an expensive switch is connected up with every available cable, however short, is not one which makes for the best or most efficient operation. It increases, rather, the number of weak points, without conferring any corresponding benefit. The number of switches might, in any case, be reduced with advantage without endangering the safety of the plant.

In these days of labour-saving devices it is not unnatural that, where switchgear is concerned, an attempt should be made to make everything automatic. Unfortunately such apparatus is "very human," in being exceedingly liable to err, and at best must be regarded as relatively unreliable. A non-automatic station—*i.e.*, one fitted with simple cut-out devices, unelaborated in any way—requires one man to look after the boards, while stations equipped with a multiplicity of automatic apparatus have, not infrequently, a man on the board and another to look after the automatic gear. Economically, too, the advantages are all on the side of the simpler board. To saddle an undertaking with elaborate switchgear out of all proportion to its needs and capacity is unwise. A switchboard is not essentially a dividend-earning concern, and the less unnecessary capital sunk in it the better for the financial welfare of the station.

The modern engineer is, fortunately, imbued with the financial spirit, and he finds that switchgear simplification, with its consequent reduction in first cost, is obtainable without any danger to the continuity of supply. Elaborate switching arrangements under his *régime* will be things of the past, and this without any attempt at shoddy work. The modern switchboard may then combine the features of utility and simplicity, while protection to life and limb will be ensured, with accessibility as the keynote to all.

It appears to us desirable that in modern switchboard work a return should be made to the equivalent of the "simple life," so that complicated automata will no longer be the daymare and nightmare of the switchman. Finally, we would lay stress on the fact that, in any case, an engineering job is required, and that he who would build well must also build strongly.

OBITUARY.

HENRI BECQUEREL.

We regret to record the death of M. Henri Becquerel, which occurred at Paris on Tuesday last. Henri Becquerel was 56 years of age, having been born at Paris in 1852. He came of scientific stock, both his father and grandfather being of world-wide repute in learned circles. He received his early education at L'Ecole Polytechnique and L'Ecole des Ponts et Chaussées, graduating from the latter in 1877. After this he remained in the Government employ for over 10 years, and on obtaining the degree of Doctor of Science, in 1888, was appointed professor at L'Ecole Polytechnique and the Natural History Museum. The latter post had been held before him by both his father and grandfather, while his son Jean is at present assistant professor there. M. Becquerel also acted as substitute for his father in the Chair of Applied Physics at the Conservatoire des Arts et Métiers. He was elected a member of the Academie des Sciences in 1889, in succession to M. Berthelot when the latter was made permanent secretary. M. Becquerel himself was elected permanent secretary for the Physical Sciences only last month. In 1882 he was created Chevalier, and at the time of his death was Officer of the Legion of Honour. He was awarded the Nobel prize in 1903.

The results of M. Becquerel's researches in the domain of physics are too well known to readers of *The Electrician* to require any long discussion here. He will be best remembered for his investigations on the polarisation of light, researches which led to the discovery of the uranium rays and culminated in the production of radium by M. and Mdme. Curie.

WILLIAM ARNOLD ANTHONY.

We also regret to record the death of Prof. W. A. Anthony, one of the earliest members and a past-president of the American Institute of Electrical Engineers. He was one of the pioneer electrical engineers in the United States, and, as a teacher, did much towards helping numerous, now famous, pupils on their careers.

SIR EYRE MASSEY SHAW, K.C.B.

The death occurred at Folkestone, on Tuesday last, of Sir Eyre Massey Shaw, who was for many years (1861-1891) the popular head of the Metropolitan Fire Brigade. Sir Eyre was the author of many books and pamphlets dealing with fires and fire protection. He was a many-sided man and, among other things, took considerable interest in electricity supply from the earliest date. He had been a director of the Metropolitan Electric Supply Co. for some years. Deceased became C.B. in 1879 and K.C.B. in 1891 on his retirement from the Metropolitan Fire Brigade.

REVIEWS.

(Copies of the undermentioned works can be had from *The Electrician* Office, post free on receipt of published price, adding 3d. for books published under 2s. Add 10 per cent. for abroad or for foreign books.)

Electric Arc Lamps. By J. Zeidler and J. Lustgarten. (London: Harper & Bros.) Pp. xvi.+186. 5s. net.

This book, which is based on one in German by Herr J. Zeidler, is perhaps the fullest modern work that we have in English on this subject. This statement, however, should not be understood as implying that the treatment of the subject is exhaustive. It is written from the practical point of view throughout and should be a useful manual for pupils and apprentices, as the descriptions of actual apparatus are full

and well illustrated. The book commences with a general description of the electric arc and a short historical *résumé* of the development of the arc lamp. This does not dwell too much on prehistoric forms and is well brought up to date. In dealing with the flame arc, reference is made to Mr. Leonard Andrews' valuable Paper on this subject, but attention has not been drawn to the fact, which has a practical bearing and is so clearly brought out there, that, when the pressure at the arc is raised in an inclined carbon lamp, the craters travel down towards the points and are thus less and less obscured by the opposite carbons. The next chapter deals with the electrical principles of arc lamps and, although good in plan, is not uniformly clear, as the translation has not been brought throughout to that stage which our forefathers termed "*done* into English." Some of the editor's additions, moreover, are not perfectly welded in, notably one on p. 28; a few clerical errors have also been missed, *e.g.*, on p. 31 (lever, S^1), p. 95 (ratchet). The next chapter deals with the construction of arc lamps and contains a fairly detailed description of the parts of some lamps made by the A.E.G. and others. A number of modern lamps are then described, including devices for reflecting and diffusing the light. This part of the book is very well done. Chapter IV. deals with light distribution and illumination, and is prefaced by an account of the various standards in practical use. This contains a definition of illuminating power expressed in mathematical form which is based on the assumption that the *solid* angle enclosed by a *sphere* is equal to 2π; this false quantity is, however, dropped in the course of the demonstration and the right result appears at the end. This chapter contains an interesting series of light intensity curves and also some fully worked out examples of outdoor and indoor lighting. The final chapter describes external connections and accessories, and is also thoroughly practical. Three appendixes are given, one a table of photometric quantities, another a table of the cost of the most usual sources of light, due to Dr. Wedding, and the other the standardisation rules on photometry and lamps of the American I.E.E. The book should be found very useful, and only suffers from lack of critical revision at the proof-reading stage. The size of type is good and a marked improvement on the original German, but the illustrations have not all been well reproduced, possibly because the paper chosen is not suitable for printing half-tone blocks. C. K. F.

An Introduction to Electricity. By Bruno Kolbe. Translated from the 2nd edition of "Einfuhrung in die Elektrizitätslehre," with additions, by Joseph Skellon. (London: Kegan Paul, Trench, Trübner & Co.) Pp. xii. + 416. 10s. 6d.

There is a brightness in this work which is very attractive. The basis of the book is a course of lectures delivered by Prof. Kolbe at St. Petersburg; and the translator has succeeded in transmitting the delightful freshness of the original composition.

The first part of the book contains descriptions of an excellent series of experiments on static electricity, and there is an abundance of serviceable and accurate diagrams, generally printed on the page, or opposite the page, containing the account of the apparatus, so that the reading is quite easy. The experiments are so admirably arranged that a teacher will certainly derive considerable benefit from a perusal of the work; but it is doubtful whether the book can be heartily recommended to a solitary English student, if such a person exists.

All teachers recognise the difficulty of the earlier lectures of an elementary course. If too many precise definitions are given the lectures are dry; whilst if too few are given there is a tendency for the terms used to be rather loose in meaning. It is perhaps impossible for a text book not to suffer, more or less, from the defects associated with its good qualities. As an example it may be mentioned that in the book under discussion the term "potential" is not explained until well past the hundredth page; until then the term "degree of electrification" is used where "potential" would commonly be used in a more advanced work; and it is doubtful whether the English beginner would do well to associate the term "degree of electrification" with the special meaning adopted in this introduction.

The second part of the book deals with dynamic electricity and electromagnetism. This is also good, but does not call for special attention like the first part. A. G.

Essais des Machines Électriques; Mesures Mécaniques. By F. Loppé. No. 43 of "Encyclopédie Electrotechnique." (Paris: E. Bernard.) Pp. 109. Fr. 2.

This volume forms part of an electrotechnical encyclopædia which is being prepared by a committee of French engineers, and which, when complete, will consist of 48 volumes, each of 80 to 100 pages, published in paper covers at 2 frs. each. Each volume deals with a special branch of the subject, and the one under review (Vol. XLIII.) is confined to the mechanical measurements which are required in testing electric motors and generators. The material is not arranged alphabetically, but rather in the way one would expect in a text-book on the subject. Moreover, as there is neither a table of contents nor any index whatever, the book is not very suitable for reference. The style of the book is somewhat explained by the statement in the introduction that the volume contains lectures given by the author for some years at the Ecole Supérieure d'Electricité.

The book is divided into three parts; (1) measurements of length, speed and acceleration; (2) force, pressure and torque; and (3) comprising nine pages only, to measurements of power and energy. The taking of indicator diagrams is omitted as belonging rather to the study of the steam engine. Each part is preceded by a table of units, both metric and British, with their relative values. On page 8, angular velocity is expressed in *quadrants* per second, but as we are also told that it is equal to the revolutions per minute multiplied by 0·10472, it is evident that the author's quadrant is our radian.

Part I contains descriptions of revolution counters, recording chronometers, stop watches and various types of tachometers. Ten methods of determining the inequality of rotation of reciprocating engines are described in four pages, and 12 pages are then devoted to its determination from the indicator diagrams because none of the experimental methods are sufficiently accurate. One electrical and four mechanical methods are given for measuring the acceleration of vehicles.

Part II. contains descriptions of a number of transmission dynamometers and brakes, both hydraulic, mechanical and electrical. In Part III. the retardation method of testing motors (suggested by Deprez in 1884) is described, as also the determination of output from measurements made on the brake cooling water.

The worst feature of the book is the almost entire absence of references. The descriptions are mostly too short to be quite satisfactory, and no clue is given as to where fuller information may be obtained. G. W. O. H.

NOTES ON THE PLUG PERMEAMETER.*

BY C. V. DRYSDALE, D.SC.

Summary.—The author describes a number of tests which, he claims, show that the plug permeameter gives as good results as other methods of iron testing.

In 1901 the writer described a permeameter†, devised with the object of enabling permeability tests to be made on castings and forgings for dynamo work. The apparatus consisted of a special drill, which could be employed to bore a hole in the casting or forging, leaving, however, a small piece of metal in the form of a rod or pin standing in the centre of the hole. A split iron plug, arranged to fit both the conical sides of the hole and over the pin, was employed to complete the magnetic circuit; and this plug carried a bobbin wound with magnetising and search coils. A special portable testing set was also designed with the object of making permeability tests by direct readings of H and B.

It was noticed at the time that the magnetisation curves obtained by this method fell below those obtained by measurements on a long bar of the same material. This would naturally be attributed to a

* Abstract of a Paper read before the Physical Society. A short abstract of the discussion following the reading of the Paper appeared in *The Electrician*, April 17, 1908, p. 18.

† *Proc.* I.E.E., Vol. XXXI., p. 283.

bad magnetic joint between the pin and plug; but experiments made at the time seemed to point rather to the effect being due to the reluctance of the return path at the point of entrance of the flux, due to the concentration of the lines of force at these points. This seemed probable from the fact that the readings were remarkably consistent when the plug was removed and replaced.

This hypothesis rendered it probable that there might be a more or less definite relation between the value of the true magnetising force H in the specimen, and the apparent magnetising force $H' = \frac{4\pi}{10}\frac{Cn}{l}$; and arrangements were made to test this relation. The most perfect method was suggested by the double-yoke method

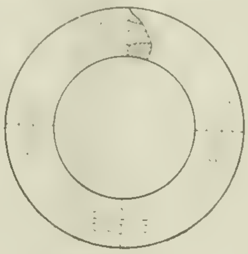

FIG. 1.

of Prof. Ewing. It consisted in finding the relation of the induction density and the magnetising current for the ordinary drilled specimen, and afterwards when the length of the specimen was doubled by drilling to a greater depth with a second drill. The increase of the magnetising current for the same induction should give the true H. A large number of tests were made in this manner, but proved of little value, as, although the first drilling presented no difficulties, it was found impossible to perform the second drilling accurately enough to preserve parallelism of the pin.

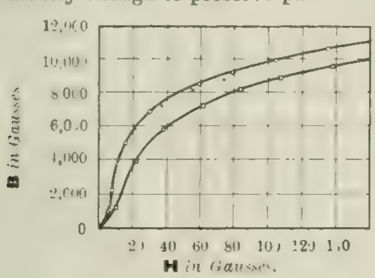

FIG. 2.—ORDINARY CAST IRON.

Recourse was therefore had to the more simple device of obtaining some specimens of cast and wrought iron and mild steel, in the form of rings, testing them by the ordinary ring method and afterwards cutting them up and drilling, for tests by the plug. Two rings of each material were tested, and each ring was cut into four quadrants. Each of these quadrants was drilled in both ends, so that eight drillings were made in each ring. Readings of B were then made with the plug method, at nominal values of H of 30 and 100 on the eight drillings, and the drilling selected for final test, the readings on which corresponded to the mean of the eight. It may be mentioned that the whole of the 64 drillings on the eight rings were made with the same drill, which was none the worse after.

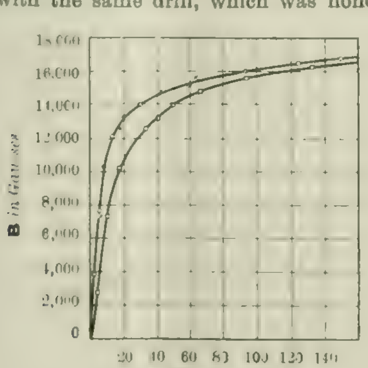

FIG. 3.—WROUGHT IRON.

None of the drillings gave a bad fit with the plug. Fig. 1 shows the form and mode of cutting and drilling the ring, which was 5 in. external diameter and 1 in. square in section, whilst typical readings on the various drillings of a wrought-iron ring and the amount of variation usually found are given in the Paper. The variations shown are not apparently due to variation in the fit of the plug, but rather to actual differences in the magnetic quality of the iron.

Eight diagrams, showing magnetisation curves taken on the ring and by the plug, are included in the Paper, and it is seen that the curves obtained by the plug lie in every case below those by the ring, but there is no evidence to show that this is due to an air-gap. Typical diagrams are reproduced herewith in Figs. 2–4.

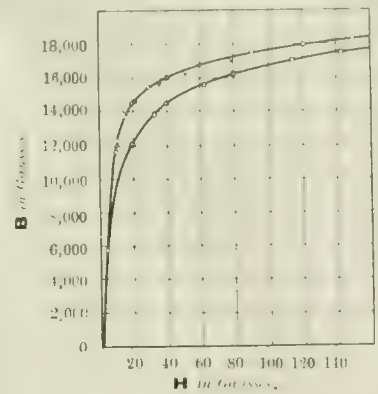

FIG. 4.—MILD STEEL.

By finding from these curves the value of H', the nominal magnetising force in the case of the plug test, for each value of H from the ring test, for a given induction-density, Fig. 5 can be drawn, the curves showing the relation of H' to H for each of the materials

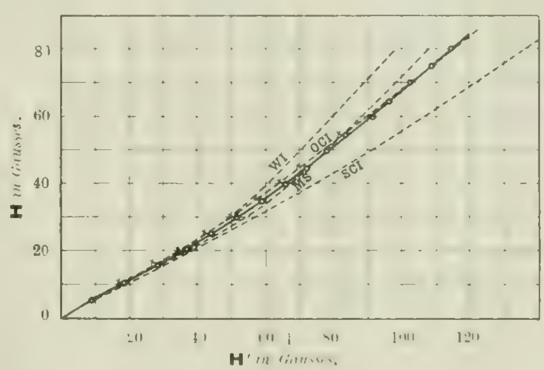

FIG. 5.

and for the mean of all. Although considerable differences were found between the values, they appear to have no relation to the permeability of the specimen, and must therefore be regarded as accidental. In fact, the difference between H and H' is greater in

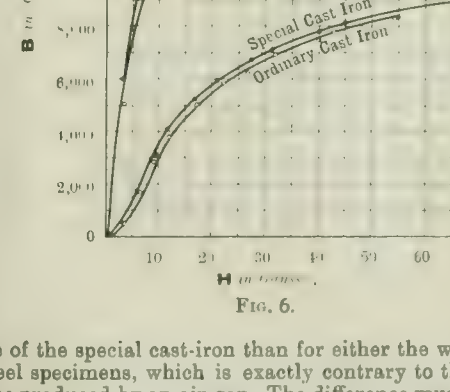

FIG. 6.

the case of the special cast-iron than for either the wrought-iron or mild-steel specimens, which is exactly contrary to the effect which would be produced by an air-gap. The difference must consequently be attributed to the shortness of the specimen; and the results therefore may have some general value in indicating the amount of the end effect in the case of yoke-permeameters, in which the specimen is only five diameters long.

In order to show the result of correcting the indications of the instrument, the diagrams referred to above have points marked by crosses, in which the readings of the plug-permeameter are shifted backwards along the H axis by amounts corresponding to the mean curve in Fig. 5. The agreement with the ring-tests then becomes fairly good, as seen in Figs. 2-4. Fig 6 shows readings taken by one of the portable testing sets, in which the H scale has been marked off in this way. The curves are those given by the ring method, while the points are taken by the testing set. The agreement is as good as in most of the recognised permeameters.

Fig. 7 shows two curves taken by the plug permeameter: one on a cast-steel pole-piece for a large generator, which was sent us by the dynamo-builders under the impression that it was of poor magnetic quality. The test shows the permeability to be very good. The other curve is for another specimen of steel, and indicates the remarkable variations of quality which are found in practice. It should be mentioned that when the plug used in these tests was replaced by a second one, the results agreed within an accuracy of 1½ per cent.

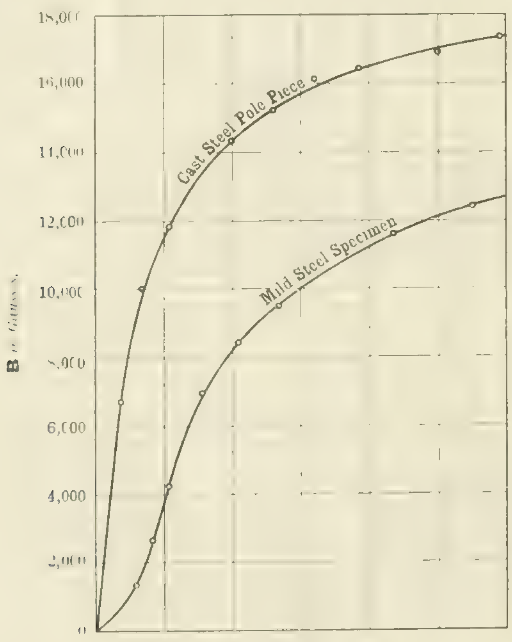

Fig. 7.

The general conclusion to be drawn from these experiments is that the plug permeameter, in reasonably careful hands, gives as good results as any other method of iron testing, so far as permeability tests are concerned. In a recent Paper by Mr. Murdoch * this permeameter was criticised as employing a very small specimen, but this is precisely what has been aimed at in its design. It appears to be of great importance that permeameters for castings or forgings should be capable of being employed on the bulk of the metal itself, without extra machined specimens, and up to the present no other instrument has been devised which meets this requirement.

WIRELESS TELEPHONY.†

BY REGINALD A. FESSENDEN.

Summary.—The author first gives a brief history of the development of wireless signalling, proceeding to describe the method and apparatus used in wireless telephony. He also discusses its possibilities and how its development has been retarded.

The discussion of the theory, practical operation and possibilities of wireless telephony is facilitated by first briefly considering the history of the development of wireless signalling generally. It has been considered best, for the sake of accuracy, to refer to published results, such as scientific articles or theses or patent specifications. For the sake of brevity, references to work done in repetition of previously published work has, as a rule, been omitted. With the exception of Munk's original paper, which could not be obtained, all references have been verified by consulting the original publications.

Period 1838-1897.—Origin and Development of Old or Damped Wave-Train Method.—Joseph Henry, to whose work the development of wire telegraphy owes so much, was the first (1838-1842) to produce high frequency electrical oscillations, and to point out and experimentally demonstrate the fact that the discharge of a condenser is under certain conditions oscillatory, or, as he puts it, consists "of a principal discharge in one direction and then several reflex actions backward and forward, each more feeble than the preceding until equilibrium is attained."[1] This view was also later adopted by Helmholz[2] but the mathematical demonstration of the fact was first given by Lord Kelvin in his Paper on "Transient Electric Currents."[3]

In 1870 Van Bezold discovered and experimentally demonstrated the fact that the advancing and reflected oscillations produced in conductors by a condenser discharge gave rise to interference phenomena.[4] In 1883 Prof. Fitzgerald suggested at a British Association meeting[5] that electromagnetic waves could be generated by the discharge of a condenser, but the suggestion was not followed up, possibly because no means was known for detecting the waves. Hertz[6] discovered a method of detecting such waves by means of a minute spark-gap and before March 30, 1888, had concluded his remarkable series of researches in which, for the first time, electromagnetic waves were actually produced by a spark-gap and radiating conductor and received and detected at a distance by a tuned receiving circuit. Hertz changed the frequency of his radiated waves by altering the inductance or capacity of his radiating conductor or antenna, and reflected and focussed the electromagnetic waves, thus demonstrating the correctness of Maxwell's electromagnetic theory of light. Lodge later in the same year read a Paper on the "Protection of Buildings from Lightning,"[7] before the Society of Arts, London, in which he described a number of interesting experiments on oscillatory discharges.

Great interest was excited by the experiments of Hertz, and it was not long before several eminent scientists perceived that the property possessed by Hertzian waves of passing through fog and material obstacles made them particularly suitable for use for electric signalling. Prof. Elihu Thomson, in a lecture delivered at Lynn, Mass., on "Alternating Currents and Electric Waves," in 1889, suggested this use. Sir William Crookes in the *Fortnightly Review* for February, 1892, discussed the matter in some detail:—

Rays of light will not pierce through a wall, nor, as we know only too well, through a London fog. But the electrical vibrations of a yard or more in wave length of which I have spoken will easily pierce such medium which to them will be transparent. Here, then, is revealed the bewildering possibility of telegraphy without wires, posts, cables, or any of our present costly appliances. Granted a few reasonable postulates, the whole thing comes well within the realms of possible fulfilment. At the present time experimentalists are able to generate electrical waves of any desired wave-length from a few feet upwards, and to keep up a succession of such waves radiating into space in all directions. It is possible, too, with some of these rays, if not with all, to refract them through suitably shaped bodies acting as lenses, and so direct a sheaf of rays in any given direction; enormous lens-shaped masses of pitch and similar bodies have been used for this purpose. Also an experimentalist at a distance can receive some, if not all, of these rays on a properly constituted instrument, and by concerted signals messages in the Morse code can thus pass from one operator to another. What, therefore, remains to be discovered is—firstly, simpler and more certain means of generating electrical rays of any desired wave-length, from the shortest, say of a few feet in length, which will easily pass through buildings and fogs, to those long waves whose lengths are measured by tens, hundreds, and thousands of miles; secondly, more delicate receivers, which will respond to wave-lengths between certain defined limits and be silent to all others; thirdly, means of darting the sheaf of rays in any desired direction, whether by lenses or reflectors, by the help of which the sensitiveness of the receiver (apparently the most difficult of the problems to be solved) would not need to be so delicate as when the rays to be picked up are simply radiating into space in all directions, and fading away according to the law of inverse squares.

I assume here that the progress of discovery would give instruments capable of adjustment by turning a screw or altering the length of a wire, so as to become receptive of wave lengths of any preconcerted length. Thus, when adjusted to 50 yards, the transmitter might emit, and the receiver respond to, rays varying between 45 to 55 yards, and be silent to all others. Considering that there would be the whole range of waves to choose from, varying from a few feet to several thousand miles, there would be sufficient secrecy, for the most inveterate curiosity would surely recoil from the task of passing in review all the millions of possible wave-lengths on the remote chance of ultimately hitting on the particular wave length employed by his friends whose correspondence he wished to tap. By "coding" the message even this remote chance of surreptitious straying could be obviated.

* *The Electrician*, Vol. LX., p. 245.

† Abstract of a Paper presented at the 25th annual Convention of the American Institute of Electrical Engineers, June-July, 1908.

[1] Scientific Writings of Joseph Henry, Smithsonian Institution.

[2] Helmholz, "Erhaltung der Kraft." Berlin, 1847.

[3] Kelvin, *Phil. Mag.*, June, 1853.

[4] Van Bezold, *Poggendorff's Annalen*, CXL., p. 541.

[5] Fitzgerald, "On a Method of Producing Electromagnetic Disturbances of Comparatively Short Wave Lengths." Report of B.A., 1883. Also *The Electrician*, Vol. XI., p. 519.

[6] Hertz's "Electric Waves." [7] Lodge, Society of Arts, 1888.

This is no mere dream of a visionary philosopher. All the requisites needed to bring it within the grasp of daily life are well within the possibilities of discovery, and are so reasonable and so clearly in the path of researches which are now being actively prosecuted in every capital of Europe that we may any day expect to hear that they have emerged from the realms of speculation into those of sober fact. Even now, indeed, telegraphing without wires is possible within a restricted radius of a few hundred yards, and some years ago I assisted at experiments where messages were transmitted from one part of a house to another without an intervening wire by almost the identical means here described.

The statement in the last paragraph of the quotation refers to the work of Prof. D. E. Hughes.[1] Prof. Elihu Thomson and E. J. Houston in 1876 made a number of experiments and observations on high-frequency oscillatory discharges.[2] Prof. Dolbear also suggested the same thing in an article in *Donahoe's Magazine*, March, 1893. In fact the idea of using Hertzian waves for wireless telegraphy seems to have been quite widespread in the years immediately following Hertz's publications.

Fairly efficient means of generating electromagnetic waves of any desired length had been made known by Hertz. Vertical antennae connected with the ground had been previously used for sending and receiving by Dolbear in 1882 in connection with his system for telegraphing by electrostatic induction[3] and also later by Edison and others. Hertz's receiver, the minute spark-gap, was not suited for wireless telegraphy, and before any telegraphic work could be done a suitable receiver had to be found.

The fact that tubes containing conducting powders had their resistance altered by the discharge of a Leyden jar and that the original resistance could be restored by tapping the tube was first noted by Munk in 1835.[4] In 1890 Branly showed that such a tube would respond to sparks produced at a distance from it.[5] In 1892, at the meeting of the British Association at Edinburgh, Prof. G. Forbes suggested that such a tube would respond to Hertzian waves. In 1893 Prof. Minchen demonstrated experimentally that such powders would respond to electromagnetic waves generated at a distance.[6] He used a battery and galvanometer shunted across the powder to detect the effect of the waves.

Sir O. J. Lodge on June 1, 1894, delivered a lecture before the Royal Institution.[7] In this remarkable lecture Lodge described among other things the following:

1. The filings coherer. 2. The filings coherer in hydrogen under reduced pressure (this in a note added July, 1894). 3. The automatic tapper back for the coherer. 4. The metallic reflector for focusing the waves. 5. The connection of the coherer to an earthed conductor; *i.e.*, a gas pipe system. 6. The method of making the coherer so connected respond by setting up oscillations in a separate earthed system, *i.e.*, a hot-water pipe system, in another part of the building. 7. The method of detecting distant thunderstorms by connecting the coherer to an earthed gas pipe system.

In this lecture Prof. Lodge stated that in his estimate the apparatus used would respond to signals at a distance of half a mile.

Early in 1895 Prof. Popoff[8], of Cronstadt, Russia, constructed a very sensitive filings coherer, one form of which was used in some surveying experiments by the Russian Government,[9] consisting of iron filings suspended by a magnet and resting upon a metallic plate or cup. He used early in 1895 the automatic tapping back mechanism, and substituted for the galvanometer an ordinary telegraphic relay. He operated this apparatus at a distance by means of a large Hertzian radiator. One terminal of his coherer was connected to a conductor fastened to a mast about 30 ft. high on the top of the Institute building and the other terminal of the coherer was earthed. At the conclusion of his Paper, which is dated December, 1895, Popoff made the following statement: "In conclusion I can express the hope that my apparatus, with further improvements of same, may be adapted to the transmission of signals at a distance by the aid of quick electric vibrations, as soon as the source of such vibrations, possessing sufficient energy, will be found."

Among other experimenters who were working on this subject at the same time may be mentioned Capt. Jackson, of the British Navy, and Mr. A. C. Brown, of London. Marconi, on June 2, 1896, filed a provisional specification[1] showing two forms of apparatus, one similar to Lodge's 1894 apparatus, using unearthed aerials for both sending and receiving and the other for use "when transmitting through the earth or water," substantially identical with Lodge's 1894 and Popoff's 1895 apparatus, with tapper back, &c., and the receiving antenna only being earthed. Soon after (July, 1896), Marconi arrived in England and made a number of experiments for the English Post Office at Salisbury Plain and elsewhere, using unearthed aerials and parabolic reflectors and succeeded in reaching nearly two miles. On March 2, 1897, Marconi filed the complete specification, in which was included a statement that the transmitting antenna also could be earthed.

Lodge filed a provisional specification[2] showing radiating spheres but no antenna on May 10, 1897. The complete specification filed on Feb. 5, 1898, shows as one form both antennæ earthed and also the use of an inductance wound in the form of a coil for the purpose of diminishing the rate of damping of the waves.

So far as is known little work was done in America during this period. The writer made some experiments in 1896, and in conjunction with two of his students (Messrs. Bennett and Bradshaw), did considerable work on receivers of various types in the winter of 1896 and spring of 1897, the results of which were incorporated in a thesis.

3. 1898. *Return to first Principles and Foundation, on lines Antithetical to Old, of New or Sustained Oscillation-non-microphonic Receiver Method.*—Up to the year 1898, therefore, the development of wireless telegraphy had proceeded along a single line. In that year, however, an entirely new method of wireless telegraphy was developed, characterised by a return to first principles, the abandonment of the previously used methods and by the introduction of methods in almost every respect their exact antithesis. While the coherer is of more or less interest theoretically it is not adapted for use for telegraphic purposes. Responding as it does to voltage rises above a certain limit it does not discriminate between impulses of different characters, and is therefore peculiarly susceptible to interfering signals and atmospheric disturbances, and the operation of coherer systems cannot be guaranteed during the summer months or in the tropics. Roughly speaking, a coherer acts by starting an arc and making a short-circuit on the line every time a signal is received, which short-circuit persists until it is broken by a blow from an additional mechanism, and such a method of operation is obviously far from practical. In addition, it is practically impossible to obtain sharp tuning in a local circuit containing a coherer; its action is always more or less erratic, its electrostatic capacity variable, and it is insensitive.

At the sending end the energy which can be liberated by the discharge of an antenna is limited, and in the form used prior to 1897 the damping is so great that there only a few oscillations per spark. Lodge[4], by placing a coil of large inductance in the antenna throttled down the amount of energy radiated per oscillation and so obtained with the same limited amount of energy derived from the charged antenna, an increase in the time of damping. Braun[5] patented the method of using a local oscillatory circuit connected to an antenna the local oscillatory circuit having a much longer period than the natural period of the antenna and of a different order of magnitude. Such a system, however, does not radiate energy appreciably, and produces a damped wave. This damping, and the limited amount of energy obtainable by charging and discharging the antenna, operates to prevent sharp tuning and working over long distances. The coherer is well adapted for working with damped waves, but the coherer-damped wave method can never be developed into a practical telegraph system. It is a question whether the invention of the coherer has not been on the whole a misfortune, as tending to lead the development of the art astray into impracticable and futile lines and thereby retarding the development of a really practical system.

The fact that no coherer-damped wave system could ever be developed into a practically operative telegraph system, and the fact that it was necessary to return to first principles and initiate a new line of development along engineering rather than laboratory lines, was perceived in America in 1898[6], and a new method was advised which may be called the Sustained Oscillation-non-microphonic receiver method, as opposed to the Damped Oscillation-coherer method previously used.

4. *Fundamental Differences between the Old and New Wireless*

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[1] See *The Electrician*, May 5, 1899.
[2] *Journal* Franklin Institute, April, 1876.
[3] Dolbear, U.S. patent 350,299, March 24, 1882.
[4] Guthe, "Coherer Action," *Transactions* of the International Electrical Congress, St. Louis, 1904, p. 242.
[5] Branley, *Comptes Rendus*, 1890, p. 785, and 1891, p. 90.
[6] Minchen, *Proceedings* Physical Society, 1893, p. 455.
[7] Sir O. J. Lodge, "The Work of Hertz," *Proceedings* Royal Institution, June 1, 1894, p. 321; and *The Electrician*, Vol. XXXIII., p. 153 *et seq.*
[8] *Journal* Russian Physico-Chemical Society, Vol. XXVII., April 25, 1895.
[9] Popoff, "Apparatus for Detection and Registration of Electrical Vibrations," *Journal* Russian Physico-Chemical Society, Vol. XXVIII., December, 1895.

[1] Marconi, Great Britain patent, 12,039 (1896).
[2] Lodge, Great Britain patent, 11,575 (1897).
[3] Western University of Pennsylvania, May, 1897.
[4] Lodge, Great Britain patent, 11,575 (1897).
[5] Braun, German patent 11,578 (1898).
[6] *Proceedings* American Institute of Electrical Engineers, November, 1899, p. 635, and November 20, 1906, p. 781.

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Schools.—The differences between the two methods are shown in tabulated form :—

Damped Oscillation-Coherer Method.	*Sustained Oscillation-non-microphonic Method.*
A1. Damped oscillations are produced at the sending end.	Sustained oscillations are produced at the sending end.
2. The energy transmitted is obtained by charging the antenna and discharging it.	The energy transmitted is derived from a local source and not from the antenna.
3. A spark gap is used for producing the oscillations.	An arc or high frequency dynamo is generally used for producing the oscillations.
B1. Imperfect or microphonic contact receivers are used.	Non-microphonic contact receivers are used.
2. The action of the receiver depends on the voltage rise and is independent of amount of energy received.	The receiver response is determined by the integral amount of energy received.
3. An open tuned circuit is used for receiving.	A closed tuned circuit is used for receiving.
4. The receiving circuit is tuned to the wave frequency only.	The receiving circuit may be tuned to a group frequency as well as to the wave frequency.
C1. In transmitting messages the production of the electromagnetic waves is intermittent.	The waves are preferably generated continuously and transmission accomplished by changing the character of the wave.
2. The wave energy flux is intermittent.	The wave energy flux is constant.
3. A high voltage is used.	A low voltage is used.
4. Comparatively short wave lengths are used.	Comparatively long wave lengths are used.
5. The signals consist of dots and dashes, whose interpretation is fixed.	The signals may consist of dots only, whose interpretation depends on the station sending and receiving.
D1. Antennæ are used, adapted, roughly speaking, to utilise the electrostatic component of the electromagnetic waves.	The antennæ are preferably arranged so as to utilise the other component of the electromagnetic waves instead of the electrostatic component.

The history of these two antithetical lines of development will be treated of separately.

(*To be continued.*)

THE EFFECT OF RADIUM EMANATION ON SOLUTIONS OF COPPER SALTS.*

BY MDME. CURIE AND MDLLE. GLEDITSCH.

About a year ago Ramsay and Cameron announced that they had observed the production of the alkaline metals and lithium in solutions of copper salts, which had been submitted to the action of radium emanation. From this they concluded that metallic copper in the presence of such emanation was degraded to elements of the same family and of lower atomic weight, *e.g.*, potassium, sodium and lithium. These important results attracted widespread attention, and it appeared desirable to reproduce them in laboratories possessing a sufficient quantity of radium.

The experiment was briefly as follows: A solution of copper sulphate or nitrate was submitted to the action of a large quantity of emanation. The copper was separated out, the remaining solution evaporated to dryness and the residue examined. The same operation was carried out with similar salts of copper which were not submitted to the action of the emanation. In the first of these experiments the presence of lithium was detected by means of the spectroscope, while in the second set none was discovered. The authors have endeavoured to reproduce these experiments with as great an accuracy as possible, for they are extremely delicate and many causes of error are present, of which the principal is the use of glass vessels, a fact noted by Ramsay himself.

Preliminary experiments showed that it is extremely difficult to obtain chemicals free from lithium. It is found in distilled water and nearly all the re-agents, while such re-agents as are in the first case free from it soon take it up after being contained for but a short time in glass vessels. The authors proved the above statements by first obtaining water free from lithium by distillation in platinum vessels, and then leaving this water in a glass flask. It was found after 24 hours that the water on evaporation gave a residue consisting principally of sodium salts, but containing also a trace of lithium. It also appeared as objectionable to employ quartz, for this substance also contains lithium, and it was finally decided to use platinum vessels.

Great care was taken to prevent any of the test solutions from coming into contact with glass, and the necessary water and acid for the experiment were re-distilled in a platinum retort and preserved in platinum bottles. To get rid of the lithium, which, as noted above, is present in practically all re-agents, different methods of purification were tried. The method finally employed was to use sulphate of copper which had first been re-crystallised a great many times in a platinum crucible and re-dissolved in pure water. By this means, however, all the lithium present could not be got rid of.

The emanation employed was first condensed in a worm immersed in liquid air and then blown into the apparatus. The exact quantity introduced was determined by measuring the radiation in the apparatus against a known amount of radium. The emanation was introduced in small quantities into a solution of pure sulphate of copper in order that it might be quite dissolved, and the solution was shaken, the apparatus being placed in melting ice. When the experiment was finished the solution was transferred to a platinum crucible and several drops of nitric acid added. An electrode of platinum was placed in the same vessel and the copper deposited on it. The solution, free from copper, was evaporated to dryness and heated to expel the sulphuric acid. The residue was dissolved in a few drops of water and treated with sulphuretted hydrogen to remove any trace of copper still present. The liquid was filtered and collected in a platinum dish and evaporated to dryness at a very low temperature. The residue was weighed. From the results obtained it may be remarked that while the quantity of copper employed was practically the same as that used by Ramsay, and the quantity of emanation also the same, the final residue was much less, and this was principally the result of not using glass.

Spectroscopic examination showed that this residue consisted principally of sodium with a trace of potassium; the presence of lithium was not noticed. An experiment made with a mixture of sulphate of sodium with a very little sulphate of lithium showed that the red line of lithium could be seen when the proportions of the two substances were 10,000 to 1.

To sum up, the authors have not succeeded in confirming the experiments of Ramsay and Cameron. It would be quite incorrect to say that no trace of sodium or lithium was present during the experiments, but the fact of the formation of these elements cannot be considered as established.

* Abstracted from the *Comptes Rendus.*

THE STEADINESS OF THE ALTERNATE CURRENT ARC AS A FUNCTION OF THE ATOMIC WEIGHT OF ITS METAL ELECTRODES.*

BY C. E. GUYE AND A. BRON.

In a preceding note† the authors called attention to the important part played by the period of extinction on the P.D. across an alternate current arc between metals, even when this arc appeared quite steady. These conditions appeared to explain the results of some previous researches which are summarised in the following table. Contrary to the experiments published in the above note these researches have been carried on under conditions in which the period of extinction is by no means negligible. It is, therefore, interesting to compare them with those formerly published where very steady conditions were obtained.

Table. *P.D. across the Arc in Volts, observed by MM. Guye and B. Monasch (L'Eclairage Electrique, 1906).*

Arc length in mm.	C.	Mg.	Fe.	Ni.	Cu.	Ag.	Cd.	Pt.	Au.	Current in amperes.
3	...	...	...	590	650	660	480	770	790	
5	.	.	...	770	825	850	650	920	950	0·05
7			...	960	1,010	1,000	810	1,000		
3 ...	...	500	650	650	690	710	550	830	830	
5	640	700	850	850	870	900	725	1,000	1,070	0·04
7	...	890	1,050	1,050	1,070	1,100	890	1,150	1,270	
3	...	600	690	740	780	790	730	...	1,070	
5	...	830	910	950	980	990	900	...	1,320	0·03
7	...	1,040	1,130	1,170	1,180	1,210	1,080		1,320	
Atomic weight	12	24	56	59	63	108	111	194	197	

It will be noticed that with the exception of cadmium, which emits abundant vapour, the effective P.D. increases with the atomic weight of the metal electrode. The differences are, however, too small, the experiments not sufficiently numerous and the phenomenon too complex for it to be possible to draw from these observations any numerical relation whatsoever.

It may be noticed, however, relying on the conclusions of the former note, that the P.D. for the same length of arc and current strength can be attributed to the greater or less duration of the

* Translated from the *Comptes Rendus.*

† *Comptes Rendus*, May 25, 1908.

period of extinction which should increase as the atomic weight of the metal electrode is raised. In other words, in order that the arc may re-strike every period the P.D. which immediately precedes such re-striking must reach a higher value the greater the atomic weight of the metal. The explanation which appeared the most simple and probable depends on Dulong and Petit's law. The specific heat being inversely proportional to the atomic weight it follows that the decrease in temperature of the cathode which occurs at each extinction is greater the greater the atomic weight of the metal. It is, therefore, obvious that to restrike requires a greater difference of potential, and thus a longer period of extinction.

In the light of present day conceptions of the mechanism of the arc it may be admitted that the electrons projected by the incandescent cathode and which are the necessary condition for the re-establishment of the arc should move at a greater speed as the adjacent metallic vapour, which they have to ionise, has an increased atomic weight. This speed being accurately determined by the difference of potential, the consequence will be a lengthening of the period of extinction.

RECENT DEVELOPMENTS OF THE KJELLIN AND ROCHLING-RODENHAUSER ELECTRIC INDUCTION FURNACES.*

BY J. HARDÉN.

Summary. -The author discusses the rapid development of the electric induction furnace during the last two years, describing the practical improvements in detail, and he also touches upon one or two novel points of a purely physical nature.

Correspondents in the technical papers have discussed the "pinch" effect† of an electric current, and the point has been raised whether this phenomenon can also be observed in the induction furnace. Theoretically it is obvious that it should, for although the induced current is an alternating one, it has for a given moment of time the same direction in each part of the path. We have taken observations under working conditions on a 60 kw. Kjellin furnace erected in London for experimental work. A small charge of pig-iron, consisting of about one-third of the full capacity of the furnace, was placed in the bath, and a power of 20 kw. was employed. As soon as the charge was fully liquid the pinching effect commenced, and the metal was seen to contract at a certain spot, raising the level of the metal on both sides of the "pinch," which was sufficient to break the circuit, causing a flash, immediately after which the metal flowed together again, closing the circuit. The level of the metal immediately on each side of the pinched area rose about 1½ in. above the normal level of the bath. It was found, on examination, that a small piece of slag was burnt into the bottom of the hearth at the point where this phenomenon occurred, thus causing the original reduction of area. Pieces of pig-iron were added to the bath, and as the depth increased the pinching slowly disappeared. It was found that if the original charge was about half of the full charge no pinching effect could be observed.

Another striking feature is the resistance curve of the melt—that is to say, the curve obtained by taking the voltage across the terminals of the furnace during melting. Supposing we are starting the charge by means of a cold ring of welded or cast iron. Putting on full load and keeping the kilowatts constant, we first find that the voltage rises above the normal for full load, and as the ring gets hotter the voltage still gradually rises until the ring becomes a bright red heat. From that point a decided drop in the voltage is noticed, although the power is kept constant and the weight of the charge is kept the same. As soon as the ring begins to melt the voltage again rises, but does not reach the same value as before the ring was red-hot. Let us consider the cause of this result. The furnace is nothing but a transformer with a short-circuited secondary. This latter must be placed some distance from the primary, owing to the thickness of the lining, cooling chamber, &c. We therefore have a certain amount of magnetic leakage, not only around the primary, but also round the secondary. The secondary is of iron, with comparatively high permeability, and we have therefore introduced an easy path for the lines of the stray field, hence the increased inductive voltage across the terminals. This is to a certain extent compensated for by the lower ohmic resistance of the ring; but as the resistive coefficient of the latter is such as to increase with the temperature, the total resistance, measured across the terminals, will increase with the temperature, but the power factor will be lower during this period, which shows that it is not only the ohmic resistance that is increased, but also the inductive resistance. This is due to the fact that the permeability of the iron is also increased to a certain extent with the temperature; in fact, it rises very rapidly up to a temperature of about 840 C., when the permeability begins to drop very quickly, and reaches zero at about 920 C. In this interval between 840 C. and 920 C. the inductive resistance is rapidly decreasing, because the easy path for the stray field is checked, and the voltage across the terminals is consequently lowered. But in the meantime the ohmic resistance is steadily increasing, but more slowly than the change in the permeability; therefore, the voltage will again rise, though slowly, until the temperature is reached at which the loss by radiation and the heat introduced balance each other. It may even increase somewhat above this point, owing to oxidation of the charge, but this increase is very slight. This is the explanation why some people were misled into believing that the increase of resistance in iron due to heat was not a straight line curve. (It may, perhaps, not be so, but the effect shown on the furnace terminal is certainly produced in the way stated which can be proved by the wattmeter readings.)

Considering now the more practical side of the process, a new feature, which is likely to prove a distinct improvement, is the Röchling-Rodenhauser modification of the induction furnace.* In the original Kjellin furnace some disadvantages are experienced when dealing with material which has to be refined and treated in very large quantities. For instance, when a charge of 3 tons or more is to be treated, the section of the bath becomes very large, thus causing a low resistance, whereby the power factor is lowered. If we try to increase the resistance by making the ring wider in diameter and of smaller section, the distance from the primary will be greater and the power factor again lower. Thus it becomes necessary to employ a generator of very low periodicity for such furnaces, which is, of course, undesirable. Also the processes of desulphurisation and dephosphorisation are very tedious, as it is difficult to keep the slag sufficiently liquid for such purposes. Nevertheless, this class of furnace will still hold its own, as it forms an almost ideal crucible steel furnace.

The engineers at the Röchling'sche Iron & Steel Works at Völklingen, Germany, Mr. Rodenhauser and Dr. Schönawa, have introduced the "combined furnace." This consists of a transformer furnace with two ring-shaped baths adjacent and communicating with one another in the case of a single-phase furnace, and three such baths in the case of a three-phase furnace, with a square or rectangular hearth in the centre between the rings, with doors in front and behind, in exterior appearance very much like a Siemens open-hearth furnace; but the principal feature is a heavy secondary winding of copper cables, placed around and coaxial to the primary (one on each leg of the core), surrounded by the rings forming the charge. These copper secondaries, consisting of a few turns only, are connected to conductive plates—they can hardly be called electrodes—built into the furnace wall, two in front and two at the back for a single-phase furnace. These plates consist of corrugated cast steel plates, and a compound of magnesite, dolomite and tar is applied firmly over the corrugation. The plates do not conduct well when cold, but as soon as the furnace is charged with molten raw material they will act as a "conductor of the second class," and readily allow the current to pass. Thus about one-half of the power is transmitted to the charge by induction in the rings and the rest of the power through the side plates. As the copper secondary is placed very close to the primary, the leakage field is very much smaller; in fact, three furnaces for 1 to 1½ tons are now in operation with 50 periods at a power factor of 0·7 to 0·85, a result which could never be obtained with a plain induction furnace of a similar size, in spite of "bifilar" baths and other devices which have been tried. A far more important gain is to be found in the metallurgical possibilities obtained with the new design. We know that for carrying out any refining process in steel we need a sufficiently liquid slag and ways and means of handling the same. In the combined furnace, part of the power is induced in the rings, thus heating the charge, and the rest passes through the side plates, to such an extent only as experience has proved to be necessary in order to obtain a sufficiently liquid slag. The ring-shaped part of the bath is covered with bricks, at a height below the level of the charge in the centre bath. Thus no slag can enter into the rings, and as it is the slag which is injurious to the lining, the rings need hardly any repair during a long run, whereas the rectangular bath in the middle is easily accessible, and can easily be patched out. The lining is simply burnt magnesite or dolomite, mixed with tar, and stamped in hot.

After the lining is stamped in, the tar is burnt out (either by heating a cast-steel ring or pouring a small quantity of pig-iron into the hearth), leaving behind a sintered mass, forming a solid brick of basic lining. The pig-iron is teemed for treatment in the Bessemer converter, and a fresh charge is given, which is tapped direct from the converter. It is more economical to burn out the carbon and the silicon in the converter, before refining from phosphorus and sulphur. The larger furnace at Völklingen will take a charge of 4 tons. Calcined lime is added to form a suitable slag; this slag also contains

* Abstract of a Paper read before the Faraday Society.

† See *The Electrician*, Vol. LIX., p. 562.

* This was illustrated in *The Electrician*, August 7, 1908, p. 648.

about 6 per cent. of magnesia. Sometimes a small quantity of fluorspar is also added, to act as a flux, but this is not always necessary. Plate scale from the rolling mill is added for decarbonising. In this condition the slag will take up the phosphorus very readily, after which it is made more viscous by applying cold lime and drawn off through the slag door by a slight tilting of the furnace.

It is essential for a successful dephosphorisation that the charge should be what is called "hot brittle"—*i.e.*, have an excess of oxygen in order to prevent the phosphorus wandering back into the charge again. After removing the slag which contains phosphorus, ferrosilicon or carbon is added, forming SiO_2 or CO, thus depriving the charge of the oxygen. It has been found that the adding of ferrosilicon will shorten the time of the de-oxidation; thus, if power is cheap, the cheaper carbon may be employed, and in the case of dearer power it is better to use the ferrosilicon.

As soon as the dephosphorising is effected, this first slag is entirely removed, and a fresh slag of lime only is formed, which, when the temperature is raised, acts as a desulphuriser in forming iron sulphide. The oxygen is also driven out in this operation, partly by forming calcium carbide and partly by adding a small quantity of ferrosilicon, and eventually some mill scale. After this, the maximum power is given, in order to drive out the last trace of oxygen, and as soon as no more gas bubbles are seen to leave the charge a test piece is taken out and forged. If too soft for the purpose, some coke powder is thrown in until the right proportions are arrived at. As a rule the charge is finished in $1\frac{1}{2}$ to 2 hours, but if necessary the steel can, without disadvantage, be kept in the furnace for 10 hours or more.

As to the power consumption, if the furnace is charged with molten material from the converter, the consumption is from 125 to 150 kw.-hours per ton of finished material. This, of course, depends upon the quality of the raw material, but 130 kw.-hours may be taken as a good average. The finished product is especially distinguished by its great strength, equality and homogeneity.

The Paper concludes with several tables giving particulars of Kjellin, Röchling, Colby, Héroult and Frick furnaces installed in various countries; the English installations being a 150 kw. Kjellin furnace at Messrs. Vickers, Sons & Maxim's River Don Works, Sheffield, a 60 kw. experimental Kjellin furnace at Messrs. Gröndal Kjellin Co., Nine Elms-lane, London, S.W., and Frick furnaces for Messrs. J. Brown & Co. and Messrs. W. Jessop & Sons, both at Sheffield.

ELECTRICAL EXHIBITS AT THE FRANCO-BRITISH EXHIBITION.—III.*

Both in this country and in America, but more particularly in the latter country, considerable interest has been aroused by vacuum

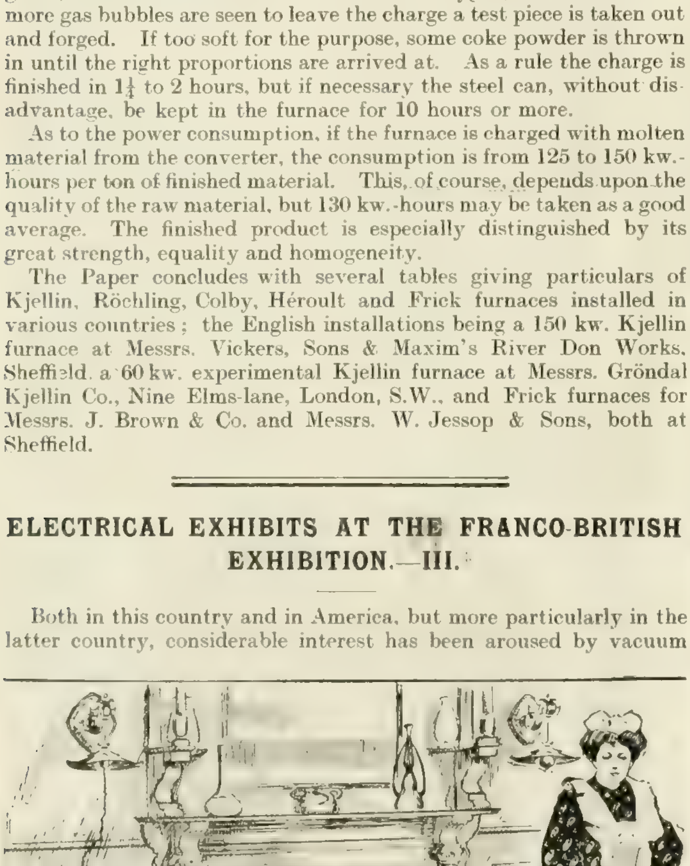

Fig. 1.—Electric "Pulvo" in Use.

methods of removing dust from carpets, walls, curtains, clothes, &c. A recent addition to the exhibits in the reception room of the London electric supply companies is the "Pulvo," a portable air suction dust-lifter, manufactured by The Pulvo Co., of 10, Dane-street, High Holborn, W.C. The apparatus, which is illustrated in Fig. 1 has been designed so as to be of the simplest character and consists of two bellows worked from a shaft having two cranks, and driven by a small electric motor. The whole apparatus is contained in a metal case, with removable lids, and is mounted on rollers so that it can be easily moved about as required for cleaning purposes. Current is conducted to the motor by a flexible cable which is attached to a plug. Visible and audible proof of the great dust removing properties of the "Pulvo" is obtained by noting the rush of dust and grit through the glass attachment connected to the hand tube, and visitors to the reception room cannot fail to be impressed by the ease with which dirt is removed from the carpet

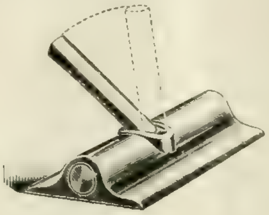

Fig. 2.—Nozzle of "Pulvo."

on the floor of this room. An important feature of the apparatus is the nozzle which is shown in Fig. 2, and we learn that the company have just completed a set of nozzles about 24 in. long, of vulcanised fibre, specially adapted for lifting the dust from electrical apparatus, switchboards, &c. This apparatus is certainly worthy of attention by central station engineers. The electric "Pulvo" is supplied to suit all voltages, and, for both continuous and alternating current, and where electric power is not available, a similar machine is made for use by hand.

The Franco-British Electrical Co., of 99a, Charing Cross-road, W.C., are demonstrating on their stand the advantages of using metallic filament lamps of low voltage in combination with a transformer for alternating current circuits. This combination they term the Weissmann economiser system.

An interesting model of an automatically controlled electric passenger lift is shown on the stand of Messrs. R. Waygood & Co. As is well known, these automatic lifts dispense with the services of an attendant, the pressure on a button sufficing to start the lift, and bring it to the particular floor desired. Also the lift cannot be started from any floor until the door on that floor has been closed, and such door is automatically kept locked except when the lift cage is opposite same. The model is complete in every respect and admirably illustrates the method of working.

Messrs. Hans Renold have a comprehensive display of their driving chains, chain wheels, &c., which form their sole products. The exhibit includes patent silent chains, bush roller chains, block, stud, balance, textile, pipe wrench, and other special chains, as well as cycle chains. In several cases the parts of the chains are displayed separately, so as to show the construction. The complete chain drives shown include sizes for powers ranging from 3 to 40 h.p., and speeds from 400 to 1,300 ft. per min. In the silent chain drive is included a spring wheel, part of the cover of which is cut away to expose one of the springs. This special form of wheel is used for drives where the load is impulsive, as in pumps, compressors, forging machines, &c. Photographs showing a few of the large number of purposes to which Renold chains are put, form an interesting feature of the display.

In our issue of May 22 we referred briefly to the electrical exhibits in the French section of the Machinery Hall. These exhibits are now attracting considerable attention from visitors, but they are not connected to any great extent with heavy electrical engineering.

The principal manufactures of the Société Electro-Metallurgique Française, who exhibit a model of a Héroult oscillating electric furnace, are aluminium ingots, plates, wires, &c., electric steel, ferro-chrome, ferro-silicon, ferro nickel, &c. Specimens of the various products of the Froges, La Praz and St. Michel works of this firm are shown, and it is interesting to learn that Froges aluminium is used to a great extent in the carriages of the London underground railways. There is a good display of electric steel produced by the Froges-Héroult process, by which any desired percentage of carbon, silicon, manganese, tungsten, &c., can be easily obtained. As shown by the model, the two electrodes are at no time in contact with the metallic bath, the latter being protected by a layer of slag.

The firm of Paul Girod show some interesting photographs representing the Girod electric furnace in operation, whilst samples of electro-steel and of alloys made in these furnaces are also exhibited on this stand.

* Previous articles appeared in our issues of July 3 (p. 455) and July 24 (p. 568).

Another electrometallurgical exhibit is that of MONS. GIN who shows a model of his circulating electric induction furnace used for the production of high-class steels, an electric motor being usually employed for tilting the furnace when the latter requires tapping.

The stand occupied by the firm of J. A. GENTEUR is of considerable interest to central station engineers. The exhibit is a fine display of starting switches, regulating switches, D.P. switches up to 1,200 amp. size, lightning arresters and relays, whilst an 800 amp. D.P. automatic switch, a 400 ampere 3,000 volt switch fuse, and a 50,000 volt isolating switch (Oerlikon pattern) are deserving of more than passing attention.

Adjacent to this stand G. AND H. DE LA MATHE ("La Canalisation Electrique") show lead covered and armoured cables with junction boxes, dividing boxes, &c., arranged to display the connections used. Rubber covered cables, flexibles and small wires for winding the coils of instruments are also included in this exhibit.

Primary batteries of the Leclanché, bichromate and dry cell type are exhibited by a number of firms; of those to whom reference has not previously been made, we must mention LECLANCHE & CIE, and P. DELAFON, the exhibits also including such accessories as electric bell pushes, &c. Whilst in addition to dry batteries the attractive stand of LE CARBONE contains an interesting collection of carbon brushes, carbon switch contacts, &c. Brushes of various types are exhibited, and suitable for all patterns of motors or generators.

The most interesting instrument on the stand of the SOCIETE INDUSTRIELLE DES TELEPHONES (English agent, Mr. G. A. Nussbaum 29, Ludgate Hill, E.C.), is the "monophone." This is a microtelephone which, it is claimed, offers absolute immunity against contagion. A special arrangement of the microphone enables the orifice of the tubular mouthpiece to be placed at such an angle that the projection of moisture from the speaker's mouth cannot penetrate it. The "monophone" is said to be eminently suitable for long distance conversation, and it is already in use on some of the longest lines established in Europe, such as Paris-Berlin, Paris-Rome, &c. Other exhibits on this stand are telephone cables, telephone switchboards, and instruments.

A stand of interest to both mechanical and electrical engineers is that of M. SAUTTER HARLE ET CIE. A Diesel oil engine is here shown coupled to a 4 pole 100 kw. continuous current dynamo, fitted with interpoles. The set runs at 450 revs. per min., and generates at full load 900 amperes at 110 volts pressure. The engine is fitted with four cylinders, the cranks being situated at 0°, 180°, 180°, 0°. Since each piston gives one working stroke for every two revolutions of the shaft, it means there are two impulses per revolution, thus tending to prevent large fluctuations in the speed of the generator. At full load the engine is stated to require only 7 ounces of fuel per brake-horse-power per hour, which is, of course, an excellent result.. A set such as that described should prove very convenient for use on board ship.

THE HERMITE ELECTROLYTIC PROCESS AT POPLAR.

In our issue of November 8, 1907, we gave some particulars of the cost of the electrolytic apparatus installed at Poplar for the production of disinfectants. It will be remembered that this apparatus has been working since February, 1906, so that a good idea of its efficiency is now able to be obtained. The medical officer of health for the Metropolitan Borough of Poplar, Dr. F. W. Alexander, in his report for the year 1907, refers to the working of the electrolytic disinfectant plant, and we give below some particulars taken from his report:—

Condition of Plant. The wear and tear has been practically nothing to speak about. The plant after two years is still in good working order, turning out 185 gallons of fluid in eight hours, at an average strength of 4·5 to 5·0 grammes of chlorine per litre. It has not been necessary to renew any of the zinc electrodes, which from their present condition no doubt can be used for a much further period. To prevent the salt from acting upon the iron, the interior of the large supply tank has been coated over with "rosbonite," a preparation which answers admirably. The saturators have been treated in a like manner. There has been introduced a very simple arrangement to insure the mixing of the preservative (hydroxide of magnesia) and a large amount of labour is also saved.

Cost of Plant, &c.—Total cost up to date January 31, 1908, of depot, plant, fittings, alterations, painting, testing apparatus, carboys, syphons, &c., £606. 18s. 3d. Initial outlay, 1906, was £583. 9s. 2d., which shows that £23. 9s. 1d. has been expended during the years 1906 and 1907 for carboys, sundry additional apparatus, repairs to depot, new electric light, paint, "rosbonite" and minor details.

Output.—The electrolytic disinfecting fluid manufactured from February, 1906, to January 31, 1908, a period of two years, amounted to 32,586 gallons, of an average strength of 4·5 grammes to 5·0 grammes of chlorine per litre (4·5 to 5·0 per 1,000). There was supplied, at a charge of 1d. per gallon, to the works department (for watering roads, flushing gullies, sewer manholes and market places), 13,656 gallons; gratis to Guardians' institutions, October, 1906, to January 31, 1908, 1,380 gallons; gratis to Managers of sick asylums, 642 gallons; and distributed to the public from the Council's four depots including fluid supplied to Poplar and Bow Baths, 16,908 gallons; total, 32,586 gallons.

Cost of Manufacturing.—The cost of electricity and materials in the manufacture of the 32,586 gallons of disinfecting fluid from February, 1906, to January 31, 1908 (a period of two years), was: Electricity (4,888 units at 1½d. per unit), £30. 11s; salt (at 24s., 26s. and 32s per ton), £9. 4s.; chloride of magnesium (at £3. 17s. 6d. and £4. 10s. per ton), £14. 9s. 6d.; caustic soda (7s. 2d. per 48 lb.) £7. 2s. 8d; water, £1. 13s.; total, £63. 0s. 2d. Corks, paraffin wax, labels and bottles cost, from February, 1906, to December, 1906, £127. 19s. 2d.; and from January 31, 1907, to January 31, 1903, £22. 17s. 8d., whilst for the same two periods, the testing reagent accounted for £2. 8s. and £2. 16s. respectively.

If carbolic acid disinfectants had been issued in place of electrolytic fluid for the period of two years from February, 1906, to January 31, 1908, based upon the expenditure of 1905, the amount expended would have been £2,015. 3s. 8d., whilst the actual cost of electrolytic fluid for this period was £1,009. 5s. 8d., showing a saving of £1,005. 18s. for disinfectants used in the borough for the period of two years aforementioned, no consideration being taken into account in respect of the 13,656 gallons supplied to the works department for watering roads, &c. Each cart for conveying away sludge from the street gullies is furnished with a 4 gallon jar of fluid, and instead of dusting around the gullies carbolic powder, there is sprinkled electrolytic fluid by means of a small ordinary watering can.

Since the initial outlay of building depot, plant and appliances was £583. 9s. 3d., and repairs to depot, &c., during the years 1906-7 have amounted to £23. 9s. 1d., making a total of £606. 18s. 3d., the initial expenditure has not only been saved, but also a sum of £393. 19s. 9d. Also the rent of manufacturing depot, £30 per annum, is no loss to the borough as the amount is paid into the electricity department's account.

From the above statement it is apparent that in the future there will be a still greater saving in cost of disinfectants to the borough.

THE "AUTO" CO_2 RECORDER.

In these days of dear coal, and when a desire for cheap power is also very general, it behoves the station engineer to get every pennyworth out of his material. It has long been felt that a great deal of waste often goes on in the boiler house, for the extent to which a careful regulation of the air supply affects fuel economy is not always appreciated. It is quite impossible to tell from ocular observation whether combustion is being effected in the best possible manner, though this is often relied upon, and several types of instrument for analysing the furnace gases have lately been designed to overcome these difficulties.

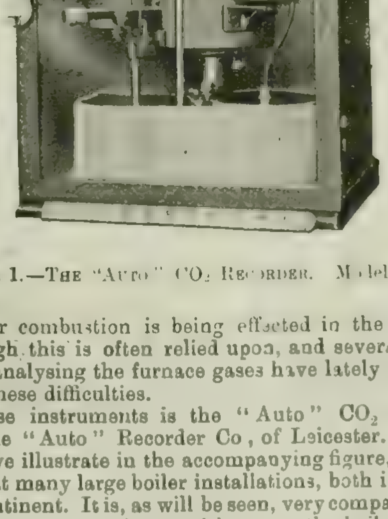

FIG. 1.—THE "AUTO" CO_2 RECORDER. MODEL A.

Among these instruments is the "Auto" CO_2 recorder constructed by the "Auto" Recorder Co, of Leicester. This instrument, which we illustrate in the accompanying figure, is in successful operation at many large boiler installations, both in this country and on the Continent. It is, as will be seen, very compact, and can be easily fixed in some convenient position near the boiler. Its operation is as follows: A small quantity of water is passed into the tank at the left of the instrument, whence it runs through a valve into a special vessel. The gas to be analysed is drawn into the measuring chamber through a water seal by allowing the water in the first vessel, which is in connection with the measuring chamber, to run

out. The gas is then forced into the caustic potash vessel by reversing the flow of the water. After treatment has taken place, the remaining gas is drawn out by the water in again performing the first operation, and this action causes the measuring bell to fall more or less in proportion to the CO_2 absorbed. The movements of this drum are transmitted to a chart, whence a continuous record can be obtained.

Great attention has been paid in this recorder to the efficient filtering of the gas, and for this purpose a special apparatus is provided. This is shown in Fig. 2. It is placed horizontally as near to the flue as possible, so that cleaning is easily effected by simply removing the top. The flue gases on coming in contact with the cool inclined cover deposit a greater part of their moisture, which drops back into the flue. They then pass to the underside of the

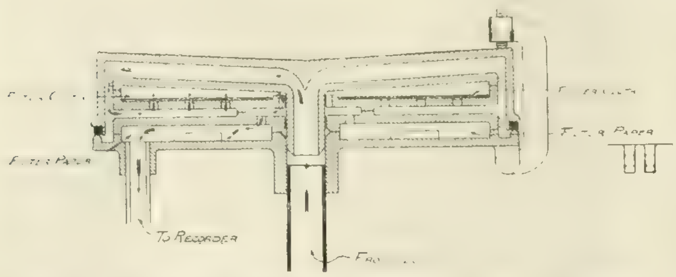

Fig. 2.—Filtering Arrangement used with "Auto" Recorder.

perforated dish a, in the direction shown by the arrows, and through some coarse filter cloth which removes the large dust. Ordinary filter paper, through which the gases next pass, completes the cleansing process.

It is claimed that this recorder only costs 1d. per day for caustic and water, while the attention and cleaning required is very small.

SWITCH AND FUSE PANELS.

We illustrate herewith a combined switch and fuse panel which is now being placed on the market by Messrs. A. Reyrolle & Co., of

Reyrolle Combined Switch and Fuse Panel.

Hebburn-on-Tyne. The combination consists of one of this firm's well known 25 ampere ironclad quick break switches and three house-service fuse boxes of unusual design, the whole mounted on a sheet-iron panel with distance pieces on each corner at the back. In these days of keen competition and cut quality, it is gratifying to find that English firms can produce class accessories at close prices. Messrs. Reyrolle also make these panels in the double-pole type.

LEGAL INTELLIGENCE.

Telephone Agreements.

At Brighton County Court on Friday last the deputy-judge (Mr. C. Cavanagh) delivered a considered judgment in an action by the National Telephone Co. to recover £3 for a year's subscription from a Mr. Leggatt. Under the terms of the agreement plaintiff's had disconnected the service and sued defendant for a full year's subscription. Defendant submitted that he was only liable up to the time the service ceased.

The Deputy-Judge held that, under the contract, defendant was liable for the full year, but on a technical point as to the non-production by plaintiffs of the Postmaster-General's license he decided that the agreement was not enforceable, and, therefore, the claim failed. He gave leave to appeal, on condition that plaintiffs indemnified defendant against costs.

MUNICIPAL, FOREIGN & GENERAL NOTES.

APPOINTMENTS VACANT AND FILLED.

Hammersmith (London) Council require a fourth assistant engineer to act as junior engineer-in-charge at their electricity works. Commencing salary £130, rising by annual increments of £5 to £150 per annum. Applications (by 10 a.m. Sept. 11) on forms to be obtained from the borough electrical engineer (Mr. G. Gilbert Bell), Electricity Department, 88, Fulham Palace-road, W. See also an advertisement.

The directors of the East Indian Railway Co. require an assistant electrical foreman in the electrical department of the company in India. Candidates must be about 28-30 years, have had a good general education, followed by apprenticeship with an electrical or engineering firm of repute, and a thorough knowledge of high and low tension power plant (d.c. and a.c. three phase). Salary 300 rupees per calendar month. Four years' agreement, with 2nd class free passage to India and home on termination of service. Applications to the secretary (Mr. C. W. Young), 23-30, Nicholas-lane, London, E.C., by Sept. 10. See also an advertisement.

A first-class man, with good experience, is wanted to take charge of telephone instrument assembly room. See an advertisement.

The position of Principal of the Durban (Natal) Technical Institute is vacant. Applicants for the post must be graduates in science, with experience of the work of technical institutions. Three years' engagement. Salary £25 per month, advancing by increments of £24 per annum for second and third years. Applications to the chairman of the Council (Dr. S. G. Campbell), Durban, Natal, by Sept. 15.

A sub-inspector of scientific supplies, preferably with some electrical training, is required for the India Store Depot, Belvedere-road, London, S.E. Salary 48s., rising to 54s. per week. Particulars from the Director-General of Stores, India Office, Whitehall, London, S.W., until Aug. 31.

Alexandria (Egypt) Municipality require a permanent chief assistant engineer for the electrical and mechanical departments. Salary about £420 per annum. Applications to L'Administrateur de la Municipalite by Oct. 15.

Mr. W. Galloway Duncan, of Dundee, has been appointed head of the Government engineering school, Dacca, India.

Mr. J. Goodall, of Woolwich, has been appointed charge engineer at Eastbourne electricity works.

EDUCATIONAL NOTICES.

University of Leeds.—The next session begins on Oct. 5, and the large new building, completely equipped for instruction in electrical engineering, will then be available. The courses include lectures, design and practical work, and provide systematic training for students preparing for the profession of an electrical engineer with or without the degree of B.Sc. in electrical engineering. Prospectuses from the Registrar.

University of Glasgow.—The session commences on Oct. 12 and ends on March 18, 1909. There are courses of instruction in engineering, mining, naval architecture, &c., and students usually spend the summer months in practical work, thus receiving their training on the sandwich system. Prospectuses of the courses for the degrees of B.Sc. and D.Sc. in engineering, and a syllabus of

courses will be forwarded on application to the Assistant Clerk, Matriculation Office, The University, Glasgow.

University of Birmingham.—The full courses in engineering extend over four years, and students who enter after matriculation and who pass successfully the examination at the end of each year will be entitled to the degree of B.Sc. in the branch of engineering to which they have devoted themselves.

The technical engineering classes include lectures on the strength of materials, theory of steam, gas and other heat engines, hydraulics, machine design, strength of structures and distribution of power. In drawing, the design of tools, prime movers, dynamos and other forms of machinery. The courses in civil engineering include constructional work in masonry and steel, railway work, dams, bridges and water engineering. In the engineering laboratory the work will include the determination of the strength of materials, including compressive, bending, tensile and torsion tests, experimental study of the steam engine and boiler, frictional efficiency tests, flow of water over weirs and through orifices, &c. There are lectures and demonstrations on all branches of electrical engineering, and in the electrical laboratory the work will include the testing of continuous and alternate current machinery, electrical instruments, meters, lamps and batteries, insulation and magnetic testing.

The session 1908-9 commences on Oct. 5. Detailed syllabuses, &c., from the secretary.

University of Manchester.—Complete theoretical and practical training is given in this university to students preparing for the higher positions in the electrical engineering profession. Electrical engineering may be taken as part of the courses preparing for the B.Sc. degree in both the honours schools of engineering and physics. A special course has also been arranged extending over three years and preparing for a certificate in electrical engineering. The John Hopkinson laboratories and dynamo house are fitted with modern machinery and excellent facilities are offered for educational and research work. The session begins on Oct. 6. Prospectuses from the Registrar.

University College, Bristol.—The session 1908-9 begins on Oct. 1, and in the chemical department the courses of instruction include lectures on inorganic, organic and physical chemistry. The laboratories are fitted with most modern appliances for study and research in chemistry in all its branches. Several scholarships are tenable at the college. Calendar containing full information, price 1s.; post free 1s. 4d. Prospectuses from the registrar and secretary (Mr. James Rafter).

Armstrong College (Newcastle-on-Tyne).—The session 1908-9 will commence on Sept. 28. There are complete courses of instruction in mechanical, civil, electrical and marine engineering, naval architecture, mining, metallurgy, &c. Particulars from the secretary (Mr. F. H. Pruen).

Glasgow and West of Scotland Technical College.—The next session begins on Sept. 21 in the new building recently erected for the college. The diploma of the college is granted in civil, mechanical, and electrical engineering, mining, naval architecture, chemistry, metallurgy, mathematics and physics. The courses of study for the diploma usually extend over three sessions, and holders of the diploma are eligible for the degree of B.Sc. in engineering of the University of Glasgow after attendance for at least one session. New and well equipped laboratories have been provided in the departments of physics, chemistry, technical chemistry, electrical engineering, motive power engineering, mechanics and metallurgy, and facilities for research are afforded. Preliminary examination for candidates for the diploma begins on Sept. 14. Prospectus gratis from the secretary of the College.

Battersea Polytechnic (London, S.W.)—At this polytechnic there are day and evening courses of instruction. The day courses include preparation for the B.Sc. in engineering of the University of London and the polytechnic diploma in (*a*) mechanical, (*b*) electrical and (*c*) civil engineering. The entrance examination begins on Sept. 15. The evening classes include preparation for the B.Sc. in engineering, associateship examination of the I.C.E., &c. Prospectus on application to the Secretary.

Hackney Technical Institute, London, N.E.—The next session commences on Sept. 21. There will be evening lecture and laboratory courses in electrical engineering subjects, including electrical measurements, dynamos and motors, alternating currents, electrical design, &c. Prospectuses from the Principal.

Northampton Polytechnic Institute (London).—The full day courses in the theory and practice of mechanical and electrical engineering will commence on Monday, Oct. 5. Entrance examination on Sept. 30 and Oct. 1. The courses include periods spent in commercial workshops and extend over four years; they also prepare for the degree of B.Sc. in Engineering at the University of London. Three entrance scholarships of the value of £52 each will be offered for competition at the entrance examinations in September. In the technical optics department there are full and part time day courses. Full particulars as to fees, &c., can be obtained at the Institute or on application to the Principal, Dr. R. Mullineux Walmsley.

Argentina.—The "Review of the River Plate" says the concessionaires for an electric railway from Avellaneda to La Plata have asked Congress for leave to enter the city of Buenos Ayres and extend the line to Retiro, Constitucion and the Port.

Messrs. Barrios & Conicelli have applied to Bahia Blanca Municipality for a 20 years' concession for the erection and operation of electricity works at Puerto Militar.

Australasia.—The "Australian Mining Standard" states that Prahran and Malvern (Victoria) Tramways Trust is borrowing £85,000 for the construction and equipment of its lines.

It was recently announced that the purchase of the Strand and Imperial Arcade Electric Lighting Cos.' undertakings by Sydney Council had been completed. The Oxford-street Co.'s works were also recently acquired by the Corporation.

Bowling-green Lighting.—Southport Corporation now light the Crowlands bowling-green electrically.

Copper.—It is stated in copper circles that those interested in copper are basing their hopes for a market revival in that metal on extensive schemes of railway electrification which are shortly to be carried out in the United States. It is further stated that many of these projects have even reached the contract stage.

Cromer.—The Council have applied to the L.G. Board for an extension of the period for repaying the last electric lighting loan to 25 years.

Dockyard Cranes.—A new electric revolving crane has been erected on No. 2 jetty, South Yard, Devonport. It is stated that this crane, which was supplied by Messrs. Marshall, Fleming & Jack, is the first of its type to be erected at Devonport, the motive power being obtained from a Westinghouse motor. The mechanism is arranged to lift the full working load of 30 cwt. 50 ft. in one minute and to revolve the derrick through one complete revolution in less than one minute.

Dublin.—On Friday last the Corporation decided, on the motion of Mr. Altman, chairman of the Lighting committee, to apply for sanction to a further loan for extensions of the electricity supply undertaking.

Mr. CUMMINS moved an amendment that "As soon as the mains are laid the Council do erect arc lamps on the North Circular-road." This was accepted, and the motion as amended was adopted.

In answer to some criticism of the undertaking, Ald. FARRELL said they could not make a profit unless they extended the undertaking and the gas company was wiped out. If there was not such an enormous influence exercised by the gas company they would have no doubt about getting the business of the North and South Unions and the Richmond Asylum. In his opinion, the Committee and their officers had done their work well, and that in the electrical plant Dublin had a valuable and increasing source of revenue. The number of new consumers of electricity every fortnight averaged 20.

Electrical Engineers (R.E.)—The "London Gazette" contains announcements of the following appointments:—

Wm. Arnold to be second lieutenant, Welsh Divisional Telegraph Company, Major A. Bain, to be lieut.-colonel London District Telegraph Companies, Capt E. H. Leat, to be captain and Lieut. S. W. Humphery to be lieutenant London Wireless Telegraph Company; Super. Capt. J. J. F. O'Shaughnessy to be major [(remaining] seconded). Capt. J. E. Pearce to be major, Capt. and Hon. Major G. B. Willi ms to be captain and [hon. major, and Second Lieut. C. W. Zoephel to be lieutenant London Cable Telegraph Company; Capt. J. H. S. Phillips to be major, Capt. H. F. Bigge to be captain, Lieut. E. C. Sheppard to be captain, and Second Lieuts. F. H. Masters and H. C. Gunton to be second lieutenants London Air Line Telegraph Company. Lieut.-Col. and Hon. Col. J. S. Park resigns his commission, and Super. Lieut.-Col. and Hon. Col. D. Laidlaw, junr., is appointed lieut.-colonel to command the Scottish Command Telegraph Companies.

Electricity in Gasworks.—At the meeting of Croydon Gas Co. last week the directors' report stated that No. 2 retort house had been rebuilt and was being fitted with modern coal and coke handling plant. They were erecting and equipping an electric power house (the plant in which would be driven by gas engines) for the supply of current for operating the coal and coke handling plant, &c.

Exhibitions.—The inauguration of the electric lighting of the buildings in the main square of the Scottish National Exhibition (Edinburgh) took place on Monday evening. The convener of the Electricity and Lighting committee (Councillor Wilson) stated that the new lighting completed the scheme so far as the buildings were concerned, and there remained now to be installed only the decorative lighting of the grounds. When the lighting was completed there would be not far short of 20,000 lamps.

The St. Petersburg Exhibition of Arts and Industries was opened by the Grand Duchess Olga on Tuesday.

Fire Brigade Drill.—The "Ediswan" fire brigade were successful in winning the fourth prize in the one man manual drill at the competition at Leyton on Bank Holiday; also first prize in the five men manual drill. The team also tied with Wanstead fire brigade for the "Vincent" challenge shield, but lost it in the re-drill. The "Vincent" shield is held for one year by the brigade making the fastest time in the two men and five men drills.

First International Congress of Telegraph and Telephone Engineers. In *The Electrician* for Aug. 14, p. 695, we detailed particulars regarding the International Congress of Engineers of Continental Telegraph and Telephone Administrations. Mr. Endre, Chief of the Technical Department of Posts and Telegraphs, Budapest, writes asking us to intimate that the congress will be composed of officials of Government administrations solely.

Glasgow.—At a meeting of the Tramways committee last week a statement was submitted showing that additional borrowing powers for £349,536 would have to be asked for in the next provisional order, but if the extension to Coatbridge be not included the amount would only be £313,558.

Haslingden.—The Council have applied for sanction to a loan of £7,200 for the purchase of generating plant for supplying electric energy to the tramways.

Hythe.—A poll of the ratepayers is to be taken on the proposals of the National Electric Construction Co. to substitute the overhead for the Dolter surface contact system on the proposed tramways.

India.—"Indian Engineering" says an independent plant has been put down for supplying electrical energy for lighting, &c., in the Agricultural College and adjoining residences at Pusa.

The "Indian and Eastern Engineer" states that the Jind Government is taking expert advice on the feasibility of generating electrical energy by water power at the Babbanpur Fall of the Sutlej Canal.

Darjeeling Municipal Commissioners are about to add to their electricity generating plant at a cost of about £3,350.

Mussoorie Municipal Commissioners have applied for a licence for electricity supply.

The Nuwara Eliya (Ceylon) Board of Improvement have adopted a scheme, prepared by the Government electrical engineer, for lighting the station electrically.

In recent railway collisions at Ghaziabad and Itola disastrous consequences ensued from the use of gas for carriage lighting, and the Railway Board have sent a le'ter to the Secretary of the Indian Railway Conference Association advocating the general adoption of electric lighting in carriages on Indian railways as early as possible. The Board have been considering what system can best be used in the three State-worked railways, the North-Western, the Eastern Bengal and the Oudh and Rohilkhand. They hope the views of the various railway administrations may be available at the next meeting of the Conference at Simla. The Board consider it necessary to issue actual instructions to State-worked railways before the end of the present year, so as in future to provide all new carriages, as well as some of the existing rolling stock, with the electric light.

The Government have purchased for 10,000 rupees (about £667) the Indian patent rights of the train key block instrument, invented by Mr. C. Theobald, chief telegraph inspector of the Government Railway department.

Inquests.—An inquest was held at Bedworth (Nuneaton) on Saturday on the body of Edward Dale, an employé at Exhall Colliery, whose body was discovered on the 18th inst. in the vicinity of an electric motor at the colliery.

William Randle, assistant electrician, said deceased was acquainted with motors and their working, and the employes were warned to keep clear of the live parts. A doctor who made a post-mortem examination could not say that death was due to an electric shock, of which there was no sign. The jury, however, returned a verdict that death was due to electric shock.

At Bolton on Tuesday an inquest was held on Thos. Brindle, a smith's striker at Messrs. Dobson & Barlow's works, who was killed on Saturday morning.

Deceased was working at an electric welding machine when he fell and died soon afterwards. A doctor said there was no possibility of accounting for death except by electric shock. An apprentice said he noticed deceased standing by the welding machine at the time of the accident. There was a board over some tram lines for him to stand on, but at the time he had one foot on the board and the other on the ground. He could not say if the foot on the ground was in contact with the tram line. He saw deceased fall with a bar of iron in his hand, and he got hold of him, himself receiving an electric shock.

A verdict of "Death from electric shock" was returned.

Littleborough (Lancs.)—The Council, who are in negotiation with Rochdale Corporation for a supply of electricity in bulk, have appointed a deputation, consisting of the Chairman of the Electricity committee (Councillor Hallett), the clerk (Mr. G. H. Wild), and the consulting engineer (Mr. W. C. C. Hawtayne), to arrange terms with Rochdale Electricity committee.

L C C Annual Report.—The report of London County Council for the year 1906-7 has recently been issued, and contains a mass of statistics relating to municipal administration in London.

The total length of the Council's tramways, both electric and horse lines, is 116¼ miles, of which about 23½ miles of electric lines were completed and opened for traffic during the year. The total number of passengers carried was 314,227,090 and the total number of car-miles run 30,130,297. Receipts were £1,414,603. 18s. 2d. and working expenses £1,075,116. 6s. 4d., leaving a balance of £339,487. 11s. 10d. The net debt on tramways outstanding on March 31, 1907, was £6,108,905. 17s. 8d.

Much interesting information is also given about education (including technical instruction, evening classes, &c.), street improvements, rating, &c.

L.C.C. Tramways.—After prolonged negotiations between Battersea Council and the Highways committee of London County Council the difficulties in the way of the electrification of the remaining tramways in Battersea and Wandsworth have been practically removed. The Queen's-road and Chelsea Bridge-road lines will be equipped at once on the conduit system. As to the line from St. John's Hill to Vauxhall a tentative agreement has been arrived at, subject to confirmation by the Councils at their next meetings.

Maidstone.—The Council have decided to experiment on the Tovil route with a demi-car, which has been ordered

Mansfield.—Loans of £2,500 for mains and £500 for meters have been applied for by the Council.

Marriages.—Mr. J. W. Papworth, burgh electrical engineer of Stirling, was married to Miss Mary Frew on 20th inst. The staff presented Mr. Papworth with an inlaid barometer.

Mr. Gordon Bryant, borough electrical engineer of Great Yarmouth, was marrried to Miss Beatrice Hart on 24th in t.

Patents and Designs Act and Factory Property.—Messrs. Leopold Farmer & Sons write to point out the practical and beneficial results which have already accrued through the alterations in the patent law made by the 1907 Patents and Designs Act.

The following important firms have acquired land and factories in England to carry on their businesses:—Elberfelder Farbenfabriken (represented by the Bayer Co.) have acquired 24 acres of land at Port-Sunlight, Cheshire; Hoschlisfarhwerke Co., 7 acres of land at Ellesmere Port, Cheshire; Gillete Razor Co., works at Leicester; Sanatogen Food Co., land in Cornwall; and the Pintsch Suction Gas Plant Co. and the National Cash Register Co., works in London. In addition to the foregoing specific instances of actual movements, Messrs. Farmer & Sons are in negotiation with numerous German and American manufacturers requiring sites and factories in different parts of England, the trades to be carried on consist principally of chemical, engineering and pottery industries. The firm also state that they are certain that the movement is only beginning, and there will be a big development of it, principally amongst German manufacturers, who are makers of numerous chemical products largely used in dyeing, &c. The American industry, being more in machinery, is not so much affected, but from the match, electrical, pottery and other industries, firms may open up works in England. The feeling at present abroad is that the alteration in the Patent and Designs Act is the insertion of "the thin edge of the wedge" to England bringing in a reform in her Fiscal Policy, and in view of this, the foreigner is likely to acquire a property, manufacture enough now to protect his patent, and extend his operations when needed.

Personal.—Mr. Douglas Vickers, managing-director of Vickers, Sons & Maxim (Ltd.) was elected on Tuesday Master Cutler of Hallamshire.

Proposed Tube Railway in Lincoln.—It is reported that a scheme is being prepared for the construction of an electric railway up and down Steep-hill, Lincoln.

The principal promoter of the scheme is the City sheriff (Mr. W. R. Lilly), who has acquired property and secured rights and easements for its promotion. It is his desire that the suggested railway should belong to the city council, and that the cost of the journey up or down the hill should, if possible, be ½d., or not more than 1d. The total length of the line is about 1,000 ft., the rise from the lower to the upper terminus being about 142 ft. There would be a double line.

Provisional Order Revocation.—The Board of Trade have revoked the Workington Electric Lighting Order, 1901, as from Aug. 14.

Ross.—The Rural Council have consented to the local electric light company's application for a provisional electric lighting order.

Ship Lighting.—In our last issue (p. 735) we gave some particulars of the electric lighting installation of the Pacific Steam Navigation Co.'s new steamer "Orcoma." We are now able to supply some further information:—

The generating plant was supplied by Messrs. W. H. Allen, Son & Co., and consists of four high-speed engines coupled direct to compound wound dynamos giving an output of 65 kw. at 100 volts. It is proposed to use one set for power and one for lighting. There are about 1,500 16 c.p. lamps and there are lamps for coaling and general cargo working. In the main dining saloon there are 210 electric lamps and 10 low speed ceiling fans of 4 ft. 6 in. diam., and the second class dining room is similarly provided. The applications of electric power are numerous, e.g., motors drive a patent potato-peeler, a joint-roaster, a knife-cleaner and a dish washing machine. There are two Sirocco fans (supplied by Messrs. Davidson & Co.) for extracting the heated air from the kitchen, and these are driven by separate motors of 1 h.p. each, and there is also an electrical plate for heating dishes. An up-to-date electric laundry contains

a washer driven by a 5 H.P. motor, extractor and wringing machines, and electrically heated ironing machines and hand irons. There is a complete telephone installation and the steam whistle is electrically operated from the bridge. An Admiralty Morse code flash lamp is fitted on the bridge and worked electrically. The ventilation of the stokeholds is effected by two large Sirocco fans driven by an 8 H.P. motor, and the ventilation of store-rooms, lavatories, &c., is similarly effected. A three-speed electric lift by Waygood provides a means of communication between the four passenger decks of the vessel and this is driven by an 8 H.P. motor. Electric hoists are also installed for stores and other purposes. The main switchboard was supplied by the Edison & Swan Co., and carries a total of 15 light and power switches. There are also eight large sub-distributing switchboards.

Tramway Provisional Orders.—The report of the Board of Trade on their proceedings under the Tramways Act, 1870, during the session of 1908 has just been published.

There were only three applications for orders, viz., Liverpool Corporation (extensions), Manchester Corporation, and Potteries and North Staffordshire (Amendment). The first two applications included power to construct extensions of tramways, and the third was to authorise certain doublings which had been effected and to confer the usual power to double or alter existing lines. The aggregate length of the proposed new tramways was 61·5 chains of double line and 27·5 chains of single line, the estimated cost being £14,002. Provisional orders were made in every case, and the bills to confirm the orders were passed and duly received the Royal assent. The Potteries and North Staffordshire Bill was amended by the House of Lords Select Committee to whom it was referred.

ELECTRICITY SUPPLY AND TRAMWAY ACCOUNTS.

Ipswich.—The accounts of the electricity department for the year ended March show capital expenditure £84,662 (increase £1,315).

Revenue was £13,052, working expenses were £8,947, and gross profit £4,105. Interest required £3,110, the instalment of loan £2,679, and instalment of cost of renewal of boiler settings £105. Deficit £927 (against £1,653 at March, 1907). Generation cost 0·924d. (0·830d.) per unit sold. Total expenditure 1·702d. (1·501d.), 1,261,614 (1,167,373) units were sold, 317,417 (259,450) for lighting, 230,712 (187,677) for power, and 713,485 (720,246) for traction. There are 820 (526) H.P. of motors connected and total connections are equivalent to 56,420 (43,390) 8 c.p. lamps. The maximum load on the lighting plant was 565 kw. (455 kw.), and on the traction plant 464 k.w (456 kw.).

The capital expenditure of the tramways department was £114,346 (increase £12). Revenue was £20,578 (£22,043), and working expenses £16,112 (£16,127). Interest required £4,110 (£4,156), and £1,806 (£1,753) has been appropriated for repayment of loan, the deficit being £1,450 (against a profit of £6); 4,979,253 (5,289,006) passengers were carried, 647,744 (654,253) car miles run, and 713,485 (720,246) units of energy used. Revenue per car mile was 7·624d. (8·086d.), and working expenses (including power) 5·970d. (5·916d.).

Maidstone.—The accounts of the electricity department for the year ended March show capital expenditure £71,112, increase £7,370.

Revenue was £11,974 (against £10,585), expenditure £6,474 (£6,063), gross profit £5,500 (£4,522), and after paying interest, sinking fund, &c. the net profit was £1,278 (£14). There are 702 (658) consumers, with the equivalent of 50,001 (42,466) 8 c.p. lamps connected. The load-factor was 21·6 (as in previous year). Total costs were 1·052d. (1·123d.) per unit. 1,504,366 (1,206,317) units were generated, 317,912 (297,211) were sold for lighting, 363,047 (342,115) for power, 27,637 (13,360) for heating, 243,505 (230,501) for street lighting, and 334,824 (206,932) for traction. The maximum lighting load was 517 kw. (500 kw.)

The report of the engineer (Mr. E. E. Hoadley) states that in spite of the introduction of metallic filament lamps the units sold for private lighting have increased by 3·5 per cent. Revenue has increased about £1,400 while costs have only increased £411, and the gross profit is again 8·1 per cent. on the average capital expended. The coal cost has decreased owing to the employment of mechanical stokers and the use of lower grade coal. Mr. Hoadley considers the present position of the electrical industry satisfactory and that incandescent gas can now be successfully fought on the question of price alone. What is required (he considers) is a reduction in the selling price of flame arc and metal filament lamps, and a manufacturer supplying a 30 c.p. metal filament lamp for use on high voltage circuits at 2s. 6d. each would have a difficulty in meeting the demand.

Sheffield.—The capital expenditure on the tramways is £1,220,559 (increase £48,289).

During the year ended March 77,568,686 passengers were carried and 7,065,380 car-miles run. The amount contributed to relief of rates is £22,532 (against £20,667 in previous year). The manager (Mr Fearnley) states in his report that the tramway department pays more in wages in proportion to receipts (8s. 3d. in the £) than such large industries as the cotton trade, railways and mining, the last mentioned coming second with 7s. The tramway department paid £126,245 in wages during the year, employs 1,527 men, and has 268 cars in stock. The income increased £12,807, but the net profit only £ ,776, owing to an increase of £9,531 in expenses, of which £8,679 was for wages. The undertaking has since its inauguration contributed £132,234 to relief of rates, besides contributing £1,000 a year to Sheffield University, and other sums for winter concerts and for music in the parks. The traffic revenue per car-mile was 9·842d., the working expenses 6·045d. and the average fare per car mile 0·38d.

Wimbledon.—The electricity department accounts for the year ended March 31 show capital expenditure £184,030 (increase £14,348).

Revenue was £28,926 (against £24,230 in previous year). Expenditure was £14,858 (£10,627), capital charges £11,364 (£10,149), and net profit £2,704 (£3,454). Coal cost 0·776d. (0·669d.) per unit sold, generation 1·017d. (0·932d.), and total expenditure 1·518d. (1·430d.), or including capital charges 2·681d (2·811d.), 2,819,317 units were generated, 639,440 supplied to public lamps, and 1,706,517 to private consumers. Public lamps equivalent to 6,604 8 c.p., and private lamps equivalent to 143,804 8 c.p. are connected. The maximum supply demanded was 1,548 kw.

TRADE NOTES AND NOTICES.

TENDERS INVITED.

Salford Electricity committee invite tenders for supply and delivery at the Corporation electricity department's mains depot, Frederick-road, Pendleton, of lighting and power feeder and distribution pillars. Specification, &c., from the borough electrical engineer (Mr. Victor A. H. M'Cowen, M.I.E.E.). Tenders to the chairman of the Electricity committee at the office of the Borough Electrical Engineer, Frederick-road, Pendleton, by noon Sept. 14. See also an advertisement.

Dublin Lighting committee invite tenders for supply and erection of boiler plant, &c., at Pigeon House generating station. Specifications, &c., from the city electrical engineer (Mr. Mark Ruddle), Fleet-street, Dublin. Tenders, addressed to Chairman of Lighting committee (3, Cork-hill, Dublin), by noon Sept. 4. See also an advertisement.

Tenders are invited for supply and erection of a power plant for the General Post Office, *Adelaide* (South Australia). Tenders, forms and specifications at the Commonwealth Office, 72, Victoria-street, London, S.W. See also an advertisement.

London County Council invite tenders for supply and delivery of about 3,600 tons steel girder tramway track rails and fastenings and about 1,550 tons of steel slot rails, and about 590 tons of conductor tee rails; and also the road work and plate laying required for the electrification (on the conduit system) of the existing tramways in Wandsworth-road, Lavender-hill and East-hill, Wandsworth. The total length of tramway is about 6¾ miles of single line. Tenders by 11 a.m. Sept. 8.

The *Metropolitan Asylums Board* invite tenders for the installation of electric storage battery, motor-driven booster and switchboard and connections on the training ship "Exmouth," Grays, Essex, in accordance with drawings and specifications prepared by the engineer-in-chief of the Board (Mr. W. J. Hatch, M.Inst.C.E., M.I.M.E.). Forms of tender from the offices of the Board, Embankment, E.C. Tenders by 10 a.m. Sept. 1.

Manchester Tramways committee invite tenders for the supply and delivery of tramcar trucks. Specifications and forms of tender from the general manager (Mr. J. M. McElroy), and tenders to the Chairman of the Tramways committee, 55, Piccadilly, Manchester, by 10 a.m. Tuesday, Sept. 1.

The Guardians of *Hackney* (London) Union invite tenders for the provision and fixing of electric light and power fittings and electric bell and telephone installation at Pavilion D now in course of erection at the infirmary at High-street, Homerton, N.E. Specification, &c., from the clerk to the Guardians (Mr. Frank R. Coles), Sidney-road, Homerton, N.E., to whom tenders by 10 a.m. Aug 31.

The Lighting committee of *Dublin* Corporation invite tenders for supply of 500 a.c. meters single phase, and 100 a.c. meters, three phase. Specifications from the office of the city electrical engineer (Mr. Mark Ruddle), Fleet-street, Dublin. Tenders, addressed to the Chairman of the Lighting committee, 3, Cork-hill, Dublin, by noon Sept. 4.

East Indian Railway Co. want tenders by noon Sept. 16 for supply of a 600 kw. three-phase alternator, gas engine and equipment. Specifications from the Secretary, 23 30, Nicholas lane, London, E.C.

Tenders are wanted by Sept. 15 for electric (or gas) lighting at *Sligo and Leitrim* District Lunatic Asylum. About 450 lights. Particulars from A. Scott & Son, 49, Upper Sackville-street, Dublin.

Perth Corporation invite tenders for the electric lighting and power installation at the new City Hall. Tenders to Town Clerk by Aug. 29.

Stoke-upon-Trent Electricity committee invite tenders for supply and erection of water cooling apparatus. Tenders by Sept. 8.

The Deputy Postmaster-General, *Melbourne*, wants tenders by 3 p.m., Sept. 22, for 8,700 black and 6,250 white telephone plugs. The Deputy Postmaster-General, *Perth* (W. Australia), wants tenders by noon, Oct. 6, for telegraph and telephone material. The Deputy Postmaster-General, *Hobart* (Tasmania) requires tenders by noon, Nov. 2, for material for accumulator equipment. Specifications, &c., from 72, Victoria-street, London, S.W.

The Turkish Ministry of Posts and Telegraphs, *Constantinople*, are inviting tenders for supply of 8,500 kgs. 4 mm. steel wire, machines for cogging wheels, and 15,000 Leclanché and 1,360 other insulators. (The British Consul-General, Mr. H. C. A. Eyres, says British firms cannot hope to do business except through a local agent.)

TENDERS RECEIVED AND ACCEPTED.

Dublin Corporation were recommended by their Lighting committee to accept the tenders of Ferranti Limited for sub-station switchboards, of the British Electric Transformer Co. for transformer plant, and of Richardsons, Westgarth & Co. for boiler plant.

Mr. Altman, Chairman of the committee, moved that the tender of Babcock & Wilcox, which was lower than that of Richardsons, Westgarth & Co., be accepted.

Ald. Farrell asked the Lord Mayor to rule the motion out of order, on the ground that the report recommended the acceptance of Richardsons, Westgarth's tender, and the chairman of the committee was bound to move that instead of the motion he had submitted.

The Town Clerk said he had received a letter from a representative of Richardsons, Westgarth & Co. stating that he understood an opportunity had been afforded Babcock & Wilcox to amend their tender, and he expressed a hope that the Council would extend a like privilege to his firm, on behalf of which he enclosed a revised tender.

Mr. Hutchinson said it was contrary to every principle of fair play to allow tenders after they had been received to be amended. He moved that the matter be referred back and to advertise for fresh tenders.

This amendment was adopted.

The advertisement for fresh tenders for boiler plant appears in another column.

Dartford Council has accepted the tenders of Chamberlain & Hookham for meters required up to June 30, 1909; S. W. Gibson & Co., wiring for condenser pumps and bath pump, £22. 15s. 6d.; Hodgson & Stead, maintaining weighbridge at refuse destructor, £3 per annum.

Siemens Bros. Dynamo Works have supplied electrical plant for the Egmore (Madras) railway station. Steam driving has been adopted temporarily, but suction gas plant is being erected.

Huddersfield Corporation have accepted the tenders of the British Thomson-Houston Co. for meters and high-tension switchgear and Ferranti Limited for a switchboard.

Mr. H. Willoughby Lance has secured the contract for the electric lighting of the new works of the British Aluminium Corpn. at Dolgarrog, Talycafn.

Tiverton Rural Council have accepted the tender of the Bradninch Electric Supply Co. for the public electric lighting of Bradninch at £25 per annum.

Shildon Council have accepted the tender of the Northern Counties Electricity Supply Co. for public lighting.

Eccles Education committee have accepted the tender of Holman & Co. for wiring the Clarendon-road schools at £182.

Watford Guardians have accepted the tender of Rogor & Cowlett for telephone installation at the workhouse.

ELECTRICITY SUPPLY TABLES AND DATA.

The Series of comprehensive Tables of Statistical and Engineering Data relating to Electricity Supply Undertakings of the United Kingdom for Lighting, Power and Traction, are now completed and can be obtained price 6s. 6d., post free 7s.; or printed on hard paper at 8s. 6d. per copy.

The book contains, in addition to the above-mentioned Tables for the United Kingdom, Lighting, Power and Traction Tables of Colonial and some of the important Foreign Electricity Supply and Tramway and Railway Undertakings.

The complete set of Tables forms an exceedingly valuable group of data and statistics in a form specially designed for ready reference and comparison.

An Index to the entire group of Tables precedes the main sheets.

Aldershot Council have placed an order with Babcock & Wilcox for a mechanical chain grate stoker at £155.

Octavius Steel & Co., Calcutta, have in hand a contract for an electric light installation for Indore Residency. A voltage of 50 is to be used and it is stated that this will be the first independent installation in India comprising osram lamps. The same firm have also contracts for installations for Dacca College and Pusa Agricultural Institute.

Melbourne (Victoria) Council have accepted the tender of Johnson & Phillips for cable at £240. The tenders of Laurence & Hanson for motor generator (£1,385) and Dorman, Long & Co. for girders (£113) are recommended for acceptance.

The Victorian Government Railway Department have accepted the tenders of the India Rubber Co. for porcelain battery covers, sheet ebonite, instrument ink, porcelain insulators, shackle insulators, binding screws and Leclanché zincs; of the British Insulated & Helsby Cables for porous pots and copper-covered wire; of Lawrence & Hanson for rod ebonite and office wire; of Zwicker, Tod & Co. for instrument tape, and of E. Duckett & Sons for sheet zinc.

Workshop and Factory Lighting.—The Brockie-Pell Arc Lamp Co., who recently removed their works to Wimbledon, S.W., inform us that they have just executed a large order for workshop lighting in Lancashire, and are engaged on an order for 300 of their well-known standard open-type double-carbon arc lamps for one of the leading railway companies. The company are also doing considerable business in their new high-efficiency auto-transformers for metallic filament lamps.

BUSINESS NOTICES.

Messrs. Kelvin & James White, Glasgow, notify that in future the London address of their electrical department will be 11, Billiter-street, E.C.

Pintsch's Patent Lighting Co. have enlarged their works at Dover Wharf, Limehouse, and after Sept. 7 their city address will be Friar's House, New Broad-street, E.C., where communications should be addressed.

John E. Elliott & Wm. T. Upton (trading as Hill, Upton & Co.), electrical engineers, 22, George-street, Oxford, and 4, Town Hall-buildings, Banbury, have dissolved partnership. Debts by Mr. Upton, who continues.

"**The Journal.**"—Part 191 of "The Journal of the Institution of Electrical Engineers" is now ready, price 5s. Particulars of contents are given in an advertisement.

Patents Development.—The proprietors of the following patents are desirous of entering into arrangements, by way of licence or otherwise, for exploiting same and ensuring their full development and practical working in this country.

Patents Nos. 11,933 1900, "For Improvements relating to the Regulation of Electric Motors"; 19,899,05, "For Improvements relating to Alternating Current Electric Motors"; and 16,898 05, "For Improvements relating to Alternating Current Electric Motors." Applications to Messrs. Haseltine, Lake & Co., 7 and 8, Southampton buildings, Chancery lane, London, W.C.

Patents Nos. 13,287 02, "For Improvements relating to Apparatus for the Transmission of Sound for Submarine Purposes"; 13,183 02, "For Improvements relating to the Transmission of Sound for Submarine Purposes and to Apparatus therefor"; 3,265,03, "For Improvements in Apparatus for Producing Sound Vibrations in Water"; 10,463 04, "For Improved Means for Producing Sound Vibrations in Water applicable for Marine Signalling"; 10,477 04, "For Improvements in Apparatus for Receiving Submarine Signals"; and 11,230 04, "For Improvements relating to Submarine Signalling and to Apparatus therefor." Applications to Messrs. Haseltine, Lake & Co., 7 and 8, Southampton buildings, Chancery lane, London, W.C.

Patent No. 18,909/1905, for "Improved Method of Electric Welding Sheet Metal." Applications to Messrs. Haseltine, Lake & Co., 7 and 8, Southampton buildings, Chancery lane, London, W.C.

Patent No. 2,067 1903, for "Improvements in Electric Controllers." Applications to Messrs. Haseltine, Lake & Co., 7 and 8, Southampton buildings, Chancery lane, W.C.

Patents Nos. 2,700 1902 and 2,701 1902, for "Telephone Exchange Circuit" and "Improvements in Telephone Line Jacks." Applications to Messrs. Haseltine, Lake & Co., 7 and 8, Southampton buildings, Chancery-lane, W.C.

Patent No. 28,805 1903, for "Improvements relating to Electric Furnaces." Apply to Messrs. Haseltine, Lake & Co., 7 and 8, Southampton buildings, Chancery lane, W.C.

Patents Nos. 26,673 1902 and 3,891/1904, for "Improvements relating to Devices for the Measurement of Electrical Energy" and "Improvements in and relating to Electrical Energy Matters." Apply to Messrs. Haseltine, Lake & Co., 7 and 8, Southampton-buildings, Chancery-lane, W.C.

Patent No. 19979 1904 for "Improvements in Magnetic Wheels or Electromagnetic Motors." Applications to Messrs. Haseltine, Lake & Co., 7 and 8, Southampton Buildings, Chancery-lane, London, W.C.

Patent No. 24689 1904 for Improvements in and relating to Electric Storage Batteries. Applications to Messrs. Haseltine, Lake & Co., 7 and 8, Southampton Buildings, London, W.C.

Patents Nos. 23,501 1899, "For Improvements in Vacuum Tube Lighting," and 12,382 02 relating to "An Improved System of Electric Lighting." Applications to Messrs. Lloyd Wise & Co., 46, Lincoln's Inn-fields, London, W.C.

Patent No. 28,820/02, relating to "Improvements in Electrodes for Primary Batteries." Apply to Messrs. Lloyd Wise & Co., 46, Lincoln's Inn-fields, London, W.C.

Patents Nos. 15,215/95, 8,180/97, 21,548/96, 14,637/1900, 20,682 02, 20,683 02 and 20,684 02, all relating to "Improvements in and Pertaining to Telegraphic Printing Apparatus, Typewriters, Apparatus for Punching Strips of Paper," &c. Apply to Messrs. Lloyd Wise & Co., 46, Lincoln's Inn-fields, London, W.C.

Patents Nos. 7,585/03 and 3,913/05, "Relating to Apparatus for enabling Telephonic and Telegraphic Messages to be Transmitted over the same Line"; and No. 12,691 01. "Relating to Apparatus for the Simultaneous Transmission of Telephonic and Telegraphic or other Currents over the same Line." Applications to Messrs. Lloyd Wise & Co., 46, Lincoln's Inn-fields, London, W.C.

Patent No. 10,219 1900, relating to "Improvements in Electric Energy Meters." Applications to Messrs. Lloyd Wise & Co., 46, Lincoln's Inn Fields, London, W.C.

Patents Nos. 4,622/1900, "For Improvements in and Mechanism for Reversing Electromotors"; and 1,617/1900, "For Improvements in or connected with Carbon Contacts for Electrical Switches and the like." Applications to Messrs. Brewer & Son, 33, Chancery-lane, London, W.C.

Patent No. 21,890/1903, relating to "Apparatus for Extracting Rubber, Gums, &c." Inquiries to Messrs. Cruikshank & Fairweather (Ltd.), 65 & 66, Chancery-lane, London, W.C.

Patent No. 13,686/1,900, for "Improvements in Type Writing-Machines." Applications to Messrs. Sloan & Lloyd-Barnes, 34, Castle street, Liverpool.

Patents Nos. 8,725/1,897 & 3,666A, 3,666B and 3,666C 1903, for "Improvements in the Art of and in Apparatus for Generating Music Electrically." Applications to Messrs. Sloan & Lloyd-Barnes, 34, Castle-street, Liverpool.

Patents Nos. 16,578 1904 and 12,994/1904, ralating to electric telegraphs. Applications to Messrs. Wheatley & Mackenzie, 40, Chancery lane, London, W.C.

Further particulars of the above patents are given in advertisements on another page.

Railway Signalling Apparatus.—The proprietors of British Letters Patent No. 20,132/01, "Relating to Railway Signalling Apparatus," desire to license British manufacturers to make in Great Britain railway signalling apparatus, or they would consider propositions for the sale of same. Further particulars of the patent are given in an advertisement, and applications should be made to Messrs. Boult, Wade & Tennant, 111-112, Hatton-garden, London, E.C.

CATALOGUES, &c.

Contact Voltmeters, Signal Lamps, &c.—The Union Electric Co., Park-street, Southwark, London, have issued list No. 8,012, which gives particulars and prices of "Union" contact voltmeters, relays, signal bells and lamps for use on direct and alternating current circuits. The contact voltmeter, with its carefully designed contacts and oil damper fulfils all requirements both for d.c. and a.c. circuits. In order to excite coils, &c., requiring a considerable current it is necessary for the contacts in the voltmeter to be relieved from the full duty, and this is achieved by the use of special relays having very ample contact surfaces, thus permitting heavy currents to flow and be interrupted without harm or loss of reliability. In order to show that the contact voltmeter is either on the maximum or minimum pressure contact a signal bell is desirable, and the illustration shows a pattern with bell and two lamps, each lamp illuminating a different coloured glass.

UNION ELECTRIC CO.'S CONTACT VOLTMETER SIGNAL APPARATUS, WITH TWO LAMPS.

IMPORTANT NOTICE.

Extra Copies of "The Electrician" Special Mining Issue (July 10th, 1908), are obtainable, price 1/- nett (post free U.K., 1/4; abroad 1/6).

Simplex Wires and Cables.—Simplex Conduits (Ltd.) have issued section W of their catalogue, devoted to wires and cables. Particulars and prices are given of a variety of electric light wires and cables, flexible cords, bell wires and telephone cables, jointing material, Leclanché and dry cells, &c. The simplex V.I.R. wires and cables are stated to be British made in accordance with the Engineering Standards committee's specification, and all grades are of guaranteed insulation resistance. The company supply "Association," "Non-Association" and "Competition" quality cables, which are listed in the catalogue.

Electric Hooters.—Messrs. Marples, Leach & Co., Adnil-building, Artillery-lane, E.C., have ready a 4 page illustrated pamphlet giving particulars and prices of the "Adnil" electric hooter, which,

FIG. 1.

it is claimed, is unrivalled as a signalling apparatus for mines, railways, smelting works, foundries, warehouses, motor cars and motor boats and other marine purposes. The hooters are made for battery and machine working at standard voltages, but they can be adapted to all kinds of currents and voltages, and the firm will supply them for any pressure for direct or alternating current circuits. Fig. 1 shows the hooter in gas and water tight cast-iron

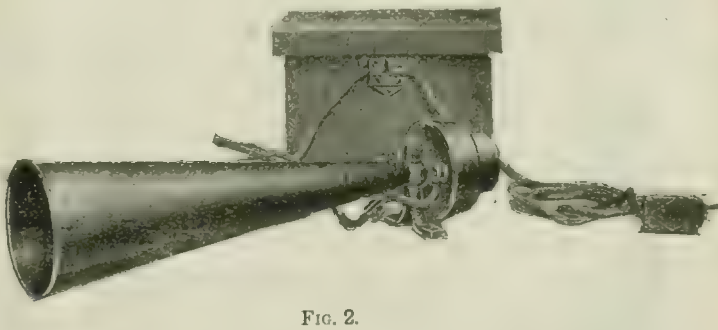

FIG. 2.

casing, and Fig. 2 is a representation of the "Adnil" hooter, complete with accumulator flexible cord and watertight contact switch.

Circuit Breakers.—Messrs. Cecil Hodges & Co. issue a leaflet of particulars and prices of their automatic no-volt circuit breakers, which have been designed for the protection of a.c. motors under the new Board of Trade regulations. These circuit breakers are constructed for all voltages up to 600, and, among other advantages, it is claimed that they are certain in action.

Shippey's Chemical Decarboniser.—Shippey Bros., 13 and 14, King-street, Cheapside, have ready a leaflet giving particulars, prices and directions for using their chemical decarboniser, for which it is claimed that it removes all carbon and resinous matter from petrol and gas engines and increases the power of the engine by 20 to 25 per cent. Particulars are also given of the "Shippey" compound decalcifier for removing and preventing incrustations of lime and other substances from the interior of radiators, water jackets, pipes and connections of petrol and gas engines.

Coal Cutters and Haulage Gear.—Messrs. Mavor & Coulson's monthly card calendar for August contains further data relating to the firm's pick-quick electric coal cutter. A leaflet, giving particulars of electrically-driven haulage gears has also been issued.

Distribution Boards.—The Simplex Progress sheet (publication No. 277) deals with d.p. and s.p. switch distribution boards for 5 ampere circuits. Prices of simplex wood, base and switch blocks and porcelain connectors are included.

Lundberg Ingenuities.—We have received from Messrs. A. P. Lundberg & Sons another of their most interesting pamphlets relating to their specialities. It has always appeared to us that there is something remarkable in the numerous permutations and combinations which can be made with "Lundberg" switches and fittings, and we can only admire without daring to imitate. The improved HV ceiling rose is fitted with a novel type of terminal which allows the fitting to be threaded on to the leads, and in the case of the "loop in" type plenty of slack can be brought in. This enables the end of the wire to be twisted and properly attached without any cutting being necessary. We also notice a "Triflex" ceiling rose shown in Fig. 1

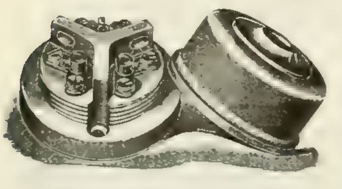

FIG. 1.—LUNDBERG "TRIPLEX" CEILING ROSE.

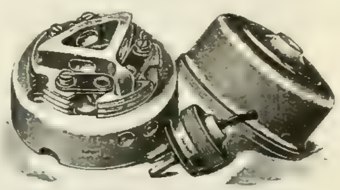

FIG. 2.—LUNDBERG "M.I.P." CEILING ROSE.

which is specially adapted for two-way work and has many "Lundbergian" applications. Another ingenious arrangement is the "Detachable" ceiling rose shown, whose current-carrying parts are protected from leakage or "shorts," while an efficient cord-grip is also provided. The plug is fitted with two split contact pins similar to those in the "Universal" wall connection. Another ceiling rose, the "M.I.P." (see Fig. 2) is fitted with holes for the insertion of a plug, thus greatly increasing its possibilities. The catalogue contains many interesting illustrations and should prove of service to those engaged in wiring work.

Another pamphlet from the same firm deals with wall connections. The special features of these have already been noted by us, and are probably so well known to our readers that they require no further introduction.

Trolley Wire.—The British Insulated & Helsby Cables, Prescot, Lancs., have issued leaflet P77, which deals with the Prescot non-fouling trolley wire, for which the following special advantages are claimed: Non-fouling fittings, no bumping or arcing, no crystallisation of the trolley wire, reduced pressure on the trolley boom, considerable saving in trolley wheels and wire, low cost of maintenance and perfection in running. The illustration shows the trolley wire fitted with a straight line mechanical ear.

SHOWING "PRESCOT" NON-FOULING TROLLEY WIRE.

Telegraph and Telephone Insulators, Tools, &c.—The India Rubber, Gutta Percha & Telegraph Works Co., Silvertown and London, have issued their revised price list, No. 36, of insulators, fittings and tools for telegraph and telephone lines. A variety of insulators, cable reels, brackets for iron and wood poles, tools, &c., is listed. Stock items only are priced, but close quotations will be given by the company for large quantities of any special sizes, and any kind of high-tension insulators, in white or brown porcelain, with or without supports, will also be quoted for on request.

"Adnil" Metallic Filament Lamps.—Yet another metallic filament lamp. We have received from Marples, Leach & Co. particulars of the "Adnil" lamp, which they are placing on the English market. This lamp is made both for high and low voltages in various candle powers ranging from 5 to 100, though the 200 volt lamps are not yet supplied for candle-powers less than 50. Their approximate life is 1,000 hours, and their efficiency is 1·25 watts per English candle-power. They are suitable for both a.c. and d.c. circuits, and the usual rules as to series burning must be observed.

BANKRUPTCIES, LIQUIDATIONS, &c.

In the bankruptcy of William T. Garnett, cable manufacturer, Bradford, the gross liabilities are returned at £94,942, expected to rank £31,330, assets (after deducting preferential creditors) estimated to produce £8,129, leaving the deficiency £23,201. Stock in-trade, which cost £4,802, is valued at £2,868.

Debtor attributes failure to depreciation in value of real estate, heavy bank charges, fluctuation in price of copper, cable and other machinery, &c. He began business in 1883 as a worsted spinner, in which he lost heavily. In September, 1902, he started business as an electric wire and cable manufacturer, but this proved a failure owing to loss on contracts and the heavy fall in copper. There was a loss on trading for 13 months ended March 31 last of £8,000. From June, 1904, to Feb. 14 last he had a partner, but the latter had introduced no capital. At a meeting of the creditors on Wednesday Mr. Edgar Musgrave was appointed trustee, and the following were appointed to act as a committee of inspection: Messrs. Thos. Paton, — Hustler, G. W. Laughton, H. W. Johnson and H. Jowett. Following are the principal creditors:—

C. J. Garnett	£2,805	R. R. Griffin	£60
United Asbestos Co.	583	J. Musgrave & Co.	41
F. Smith & Co.	472	Harrison Bros.	40
S. W. Whaley & Co.	295	Pearsall & Co.	39
McConnell & Co.	267	Britannia Rubber Co.	35
Ramsden, Camm & Co.	260	W. Hinder	30
J. Slater & Co.	256	J. H. Holdsworth	30
L. N. Greenbaum & Sons	180	Martin's Metal Co	29
G. W. Laughton & Co.	179	Cresswells' Asbestos Co.	27
A. Thornton, Son & Co.	168	Beecroft & Wightman	23
I. Frankenburg & Son	123	D. McDougall (jun.) & Co.	21
Ancoats Vale Rubber Co.	70	Clark, Sons & Co	20
T. Paton & Co.	70	Bradford Bobbin Co.	19
Taylor, Jeffery & Jessop	63		

At Kilmarnock Sheriff Court last week Jas. Allan Wilson, electrical engineer, &c., Kilmarnock, was examined. Assets £310, liabilities £2,450.

Debtor started business about five years ago with obligations for borrowed money of between £400 and £500. About £800 of the deficiency was never in the business, part of it having been borrowed to pay accommodation bills. The electrical business had never paid. Debtor's average drawings from the business were £293 per annum. The excess of drawings over profits for the whole period was £822 odd. There was £674 accounted for by the difference between the valuation which had been made in the bankruptcy and his own valuation of the stock. Examination concluded.

The public examination of Richard Paley Gardner and Collinson Hall (carrying on business as Hall & Gardner, at Chobham) took place on Tuesday.

Liabilities are stated at £8,892 and the estimated surplus is £1,061. Debtor Hall stated that in 1902 he became associated with Mr. Gardner in connection with a scheme for the construction of light railways in Surrey, and in the following year they formed the West Surrey Light Railway Co. (Ltd.) to carry through the scheme. They acted as directors of the company, which obtained orders for the construction of light railways from Guildford to Stoughton and from Woking to Bagshot. Failure was brought about by pressure of petitioning creditors. Examination concluded.

Claims against Blackpool Electric Tramways (South) (Ltd.) (in liq.) by Oct. 5 to A. McGowan & J. McWilliam, 43, Castle-street, Liverpool.

Rowland Barnett & Co. (Ltd.) is being wound up voluntarily. Mr. J. W. Pace, Emerson-chambers, Newcastle-on-Tyne, is liquidator.

The Private Telephone Co. (Ltd.) is being wound up voluntarily. Mr. G. H. Rosefield, St. Wilfred's-road, New Barnet, is liquidator. A meeting of creditors will be held Aug. 26 at 27, Chancery-lane, London, W.C.

A meeting will be held on Sept. 30 at Watergate House, York-buildings, Adelphi, London, W.C., to receive an account of the winding up of Sanfil Limited.

Winding-up Petition.—A petition for winding up Electrical Instrument Manufacturers (Ltd.) will be heard at Edmonton County Court on Sept. 14.

PATENT RECORD.

APPLICATIONS FOR PATENTS.

NOTE.—*The undermentioned Applications (except those marked †) are not open to public inspection until after acceptance of Complete Specification. Those marked † are open for inspection 12 months after the date attached to them, if they have not been published previously in the ordinary course. Names within parentheses are those of communicators of inventions. When Complete Specification accompanies application, an asterisk is affixed.*

April 16, 1908.

8,445 BOWRING. Lifeguards for tramcars and the like.
8,449 TODD. Sunk switch box and cover.
8,462 BENJAMIN KEDAR NOY. Side life guards for tramway vehicles.
8,467 JACK. Driving and braking gear for overhead electric cranes.
8,471 VERITYS, Ltd., & SMITH. Electric heating apparatus.*
8,479 HIGGS & STANTON. Magnetically operated ignition plugs.
8,481 BENSTEAD. Electric contact makers, distributors, &c.
8,521 NORTH & PECK. Alternating current distribution systems.
8,522 BERG. Turbo-electric generator systems. (Date applied for, 20/4/07.)*†
8,523 OHLRICHS. Reinforced concrete pole.*
8,543 BERGRATH. Fixing electric punkahs.
8,547 REINHARDT. Field magnets for magnetic inductors. (Date applied for, 16/4/07.)*†
8,558 DICKMANN. Electric order and alarm apparatus.

April 21, 1908.

8,679 POWNALL. Electric kettles, urns, &c.
8,719 MARRIOTT. Pitch compound for use as an insulating cement for assisting in the joining or connecting of electric cable cores or electric wires or for coating electric cable joints or joined electric wires with a ductile flexible insulating and waterproof covering.
8,737 HOPTON. Filaments or bodies for incandescent electric lamps.*
8,739 PRATHER. Wave motors. (Date applied for, 30/4/07.)*
8,746 AUGER. Incandescent filaments.*
8,748 MCNALLY. Electrical cut-outs.

April 22, 1908.

8,752 LILLICRAP. Sparkless surface contact electric motor starter and automatic regulator.
8,769 BLUM. Sparking-plug. (Date applied for, 11/6/07.)*
8,773 BÖHM. Electric lamps.
8,787 POSTANS. Electrical ignition apparatus. (Addition to No. 5194/07.)
8,794 CARPENTER. Storage batteries.

April 23, 1908.

8,848 DICKSON & REESER. Incandescent electric lamps.
8,850 FRY. Utilising waste steam power in connection with the production of electricity by steam.
8,863 GUNNING. Time-controlled electric switches.
8,869 & 8,870 MOUNTAIN & GIBSON (LTD.) & HEAD. Vehicles for tramways and railways.
8,874 LEVY & MEHLHOSE. Electric ventilator.*
8,887 LUTZ. Apparatus for disinfecting telephones.*
8,904 BOUNEAU. Electrical furnaces. (Date applied for, 24/4/07.)*

April 24, 1908.

8,930 KNIGHT. Electrically driven percussive tools.
8,934 EDRIDGE & JUSTINIEN & PRADEL. Electric block system and apparatus.
8,962 BRAY & BRAY, MARKHAM & REISS (LTD.). Insulated electric conductors, and contacts.
8,968 SIEMENS BROS. & CO. (Siemens & Halske Akt.-Ges., Germany.). Installations for electrically controlling railway points.*
8,972 BALSILLIE. Generators for high frequency electric currents.
8,984 HUNTER. Telegraphic instrument.
8,986 BROWN. Electric telegraphy and telephony.
8,991 ELECTRICAL CO., & SCHAEFER. Arc lamps.
8,996 SOCIETE ANONYME L'ELECTRICITE MODERNE. Apparatus for storing the heat furnished by a source of electricity. (Date applied for, 6/4/08.)*

April 25, 1908.

9,023 DENIEPORT. Construction of electric condensers. (Date applied for, 30/9/07.)*
9,033 FYNN. Commutating dynamo-electric machines.
9,042 HOUGHTON. Electrodes for the application of high-frequency electric currents.
9,077 LAKE. (Paul Schroder, Germany.) Insulating wire conductors for electric currents.*
90,80 WARDLE. Secondary batteries or accumulators.

April 27, 1908.

9,090 SIMPSON & BROWN. Insulating machines for electrical apparatus.
9,097 DEUTSCHE GASGLUHLICHT AKT.-GES. (AUER GES.). Holders for tungsten filaments in electric lamps. (Date applied for, 13/2/08.)*
9,099 WERMANN. Trolley for electric railways and tramways.*
9,128 GRIMLER & NEYLAND. Flexible stands for supporting electric lamps.*
9,133 HAWKINS. Electromotor.
9,146 AKT.-GES. BROWN, BOVERI & CIE. Electric transformers. (Date applied for, 26/4/07.)*

April 28, 1908.

9,195 MAJOR, STEVENS, & STEVENS. Electric lifts.
9,203 PRINGLE & GREEN. Signalling apparatus for electric railways and tramways.
9,222 CARPENTER & BANKS. Arc lamps.
9,231 & 9,232 LEWERS. Electric railway signalling systems.
9,237 ALLGEMEINE ELEKTRICITATS GES. Devices for protecting transformers, cables and other electrical apparatus. (Date applied for, 29/4/07.)*
9,241 JONES. Arc lamps. (Addition to No. 3060/07.)

April 29, 1908.

9,254 KENNEDY. Electricity integrating meters
9,257 COCHRAN. Incandescent electric lamps.
9,260 GUY. Electrical contact breakers.
9,288 ARON. Electricity meters.*
9,289 ARON. Multiple tariff electricity meters.*
9,291 KOTYRA. Electromagnets.
9,309 CALLENDAR. Radiation receivers.

April 30, 1908.

9,323 STRATTON & CLAREMONT. Mechanical connectors for electric cables.*
9,324 VIGAR. Arc lamp coupling.
9,335 BROWN & RUDALL. Electrical and attendant arrangements for controlling the locking and unlocking of railway carriage doors.
9,360 MILLARD. Trolley head.*
9,403 PRINGLE. Brakes for tramways and railways. (Addition to No. 15,943/06.)
9,405 MERIGUET. Plates for electrical accumulators.

May 1, 1908.

9,479 SCHAFFER. Hooks for electric glow-lamp filaments. (Date applied for, 3/5/07.)*
9,481 RORKE & RORKE. System of heating by electricity and apparatus for use in connection therewith.*
9,501 BAGGETT. Arc lamps.*
9,502 ALLGEMEINE ELECTRICITATS GES. Arc lamps. (Date applied for, 2/5/07.)*
9,509 MILES. Electric switches.*

May 2, 1908.

9,518 BAKER. Electrical transmission of half-tone or line photographs.
9,537 VAUGHAN & BIRCH. Metallic fittings for electric continuity system.
9,546 WALKER. Alternating electric current induction motors.
9,552 BROWN. Electrical block signalling apparatus for railways. (Date applied for, 8/5/07. An invention comprised in Application No. 10,687/07. Addition to No. 2413/07.)

SPECIFICATIONS PUBLISHED.

1907 SPECIFICATIONS.

12,420 LANCASHIRE DYNAMO & MOTOR CO. & STANSFIELD. Dynamo-electric machinery.
12,871 GORNALL & UNION RUBBER & CHEMICAL CO. Electrically heated vulcanizer.
12,907 NEWITT. Electrical counting and indicating gear.
12,913 IRVING. Reciprocating electric motors
12,960 MARCONI'S WIRELESS TELEGRAPH CO. & FRANKLIN. Receiving apparatus for wireless telegraphy.
13,270 COSSOR. Mercurial thermostatic circuit "closers."
13,342 RICHARDSON & VAUGHAN. Electrical production of ozone.
13,582 JONES. Resistances.
14,150 MOORE & POWLES. Electrical signalling apparatus.
15,169 DICKSON. Combined telegraph and telephone apparatus.
16,383 APPLEYARD & QUIGGIN. Electric light fittings.
16,513 WISE. (Mailloux.) Cooling electric machinery.
16,530 B.T.-H. CO. (G.E. Co., U.S.). Refractory metallic conductors for incandescent lamps.
16,865 BROOKES. (Asbestos Wood Co.). Insulating materials.
16,956 ANGOLD & MAXIM ELECTRICAL CO. Arc lamps.
16,968 MARTIN. Electrical resistance device
17,012 BEVIS & KRAUSE. Wall plugs and sockets,
17,655 HEYS. (Scott Electrical Co.) Arc lamps.
17,686 STONE. Space telegraphy. (Date applied for, 3/8/06.)
17,704 MARZI. Loud speaking telephone apparatus. (Date applied for, 25/4/07)
17,830 ALLISON (Speitschka). Electrical attachment for racking off casks.
18,045 FELTEN & GUILLEAUME-LAHMEYERWERKE A.-G. Inverted repulsion electric motors. (Date applied for 15/8/06.)
18,346 DAWSON. Shade holders and shades.
18,515 B.T.-H. CO. (G.E. Co., U.S.). Protective devices for electric transmission systems.
18,648 BROWN, BOVERI ET CIE. A.-G. Steam turbines. (Date applied for, 20/12/06.)
19,101 RAWSON & SAGER. Electrical water heater.
21,087 COOMBS. Diaphragms for phonographic and telephonic apparatus.
21,408 THOMPSON. (Ges. fur Drahtlose Telegraphie.) Detector for wireless telegraphy.
21,476 BLOXAM (Siemens & Halske A.-G.). Incandescent lamps having metal filaments.
21,811 BENRATHER MASCHINENFABRIK A.-G. Control of electric motors. (Date applied for, 3/10/06.)
22,259 ETCHELLS. Controlling locks for the well-doors of electric lifts.
22,349 ETCHELLS. Switches or controllers.
22,467 PINOT. Rotary transformers for electric current. (Date applied for, 9/11/06.)
22,609 CRAIG. Trolley mechanism for electrically propelled cars.
23,709 UNDERWOOD & SMITH. Dynamo-electric machines. (Date applied for, 27/10/06.)
23,756 DIEHL & BECKER. Electric fans. (Date applied for, 22/4/07.)
24,212 JOHNSON. (Felten & Guilleaume-Lahmeyerwerke A.-G.) Electrical indicating or recording targets.
24,670 ELEKTRIZITATS A.-G. VORM. SCHUCKERT & CO. Arrangements on electricity meters for determining the maximum consumption. (Date applied for, 20/11/06.)
24,702 RENNERT. Automatic electrical fire alarm systems.
25,391 KARNS. Rail bond for rail joint circuits.
25,919 FERGUSON. Electricity generators.
26,530 GES. FUR DRAHTLOSE TELEGRAPHIE. Radio telephony. (Date applied for, 19/12/06.)
26,834 HADDAN (Synchronous Static Co.). Apparatus for producing high frequency discharges.
27,090 GILL. Bracket for supporting or locating cables, pipes, and the like.
27,401 RAWLINGS & SMITH. Fuses.
27,447 SIEMENS BROS. DYNAMO WORKS, & CLIFT. Safety devices for electric winding plants.
28,690 KITSEE. Cable telegraphy.

1908 SPECIFICATIONS.

401 EDISON. Electrolytes for alkaline storage batteries. (Date applied for, 10/5/07.)

559 DRAGER & DRAGER. Electric lamps for miners' helmets.

2,676 LOEBL & BRITISH EVER READY ELECTRICAL CO. Holders for incandescent lamps.

3,465 ANDERSSON. Clutch for arc lamps. (Date applied for, 18/2/07.)

6,157 BOSCH. Electric ignition for large internal-combustion engines. (Date applied for, 16/9/07.)

7,041 RUHMER. Production of powerful interrupted electric impulses of high frequency. (Date applied for, 8/1/07.)

COMPANIES' MEETINGS AND REPORTS.

BRIGHTON & ROTTINGDEAN SEASHORE ELECTRIC TRAMROAD CO.—The report for the year ended Dec. 31 last states that the balance of revenue was £2,132. Sundry creditors absorbed £714, debenture interest £984, and the amount due to capital account was £434.

CIA MARCONI DE TELEGRAFIA SIN HILOS DEL RIO DE LA PLATA.—The annual general meeting of shareholders of this company was held on July 24th. Col. Sir C. Euan-Smith, chairman of the parent Marconi Co. stated that he had received a telegram from Mr. Marconi to the effect that he would come to Buenos Ayres early in 1909, and that he had no doubt of being able to establish direct communication between Argentina and Italy as soon as a similar station to that in Coltano, Italy, is erected in Argentina.

DUBLIN AND LUCAN ELECTRIC RAILWAY CO.—At the meeting last week Mr. Wm. Mooney, J.P., said the working of the line continued satisfactory. Their gross receipts for the half-year were £3,108. 2s., against £2,896. 12s. for the corresponding period of 1907, but expenditure had increased by £247. 3s. 4d. The sum contributed out of revenue for capital purposes since the opening of the new electric line in 1900 had exceeded £3,600. They had also paid their debenture interest and the preference dividend and maintained their permanent way and rolling stock in first-class order. The only payment that remained to be paid out of revenue, beyond the ordinary current outgoings was £750 and interest still due on the electrical equipment account and the temporary indebtedness to their bankers.

LANARKSHIRE TRAMWAYS CO.—At the meeting on Friday last Mr. A. R. Monks said they were in a position to pay a dividend at the rate of 6 per cent. per annum on the share capital. The traffic receipts had exceeded by over £4,000 the corresponding six months of 1907. There had been delays in completing the recent extensions, but negotiations were pending for a supply of current for the extensions so as to obviate for the present further capital expenditure on power station plant.

LIMA RAILWAYS CO. (LTD.)—At the meeting on Wednesday the chairman (Lieut. Col. A. Brooke) explained the position with regard to the Chorillos Electric Tramway Co. and the Santa Rosa Power Co. He hoped that the Associated Electric Co. would soon resume payment of their monthly contributions, as the tramway competition had now ceased.

MERSEY RAILWAY CO.—During the half-year ended June 30 the train-mileage run was 408,134, compared with 411,313 in the corresponding six months of 1907. The number of passengers conveyed was 5,719,572 (against 5,618,462, exclusive of season-ticket holders). The total receipts were £51,783. 14s. 4d., compared with £49,892. 4s. 5d.; working expenses (exclusive of charges for pumping, ventilation and lifts) £33,075. 0s. 1d. (equal to 63·87 per cent.), against £31,418. 8s. 8d. (62·97 per cent.). The charges for pumping, ventilation and hydraulic lifts for the past half-year amounted to £4,070. 0s. 10d. (7·86 per cent.), compared with £4,058. 16s. 11d. (8·13 per cent.).

SOUTH AMERICAN LIGHT & POWER CO. (LTD.)—At the meeting on Friday last Mr. F. H. Jackson congratulated the shareholders on having entered the list of dividend-paying companies. The 50 per cent. of the gross receipts payable to the company under its agreement with the Bahia-Blanca & North-Western Railway Co. for the year ended March 31 last showed an increase of 65½ per cent.

NEW COMPANIES, STATUTORY RETURNS, RECEIVERS AND MANAGERS, &c.

NEW COMPANIES.

G. DAVENPORT & CO. (LTD.) (99,245)—Reg. Aug. 19, capital £7,000 in £1 shares, to adopt an agreement with G. Davenport for the acquisition of the business carried on by him as G. Davenport & Co., and to carry on the business of manufacturers and importers of and agents for goods in connection with motors, motor-cars and carriages, and horological, mechanical and electrical novelties, &c. Private company. G. Davenport is governing director for life. Reg. office, 95, Clerkenwell road, London, E.C.

LIND & CO (LTD.) (99,275.)—Reg. Aug. 21, capital £5,000 in £1 shares, to acquire the business of an electrical manufacturers' agent, general electrician and contractor carried on at Liverpool as Lind & Co. Private company. First directors, A. L. Lind, G. St. J. Wood and J. G. Wilson. Reg. office, 37, Moorfields, Liverpool.

ROSARIO & DISTRICT RAILWAY SYND. (LTD.) (99,284.)—Reg. Aug 21, capital £60,000 in £1 shares, with objects chiefly indicated by the title. Private company. Reg. by Goddard & Co., St. Michael's House, St. Michael's-alley, Cornhill, E.C.

STATUTORY RETURNS.

SUNBEAM LAMP CO. (LTD.)—Particulars of £10,000 debentures, created by resolution of Jan. 28, 1904, have been filed pursuant to sec. 10 (3) of the Companies' Act, 1907, the amount of present issue being £1,200. Property charged: Company's undertaking and property, present and future, including uncalled capital. No trustees.

MORTGAGES AND CHARGES.

"X" SYND. (LTD.)—Particulars of £3,700 debentures, created July 23, have been filed pursuant to sec. 10 (3) of the Companies Act, 1907, the whole amount being issued on same date. Property charged, company's undertaking and property, present and future, including uncalled capital. No trustees.

KEYNSHAM ELECTRIC LIGHT & POWER CO. (LTD.)—Particulars of £1,500 2nd mortgage debentures, created Oct. 9, 1905, have been filed pursuant to sec. 10 (3) of the Companies Act, 1907, the amount of the present issue being £350. Property charged, company's undertaking and property, present and future, including uncalled capital, if any (subject to 1st mortage debentures), and land and premises at Keynsham. No trustees.

NAIROBI ELECTRIC POWER & LIGHTING CO. (LTD.)—Issue on Aug. 12, 1908, of £600 debentures, part of a series of which particulars have already been filed.

CITY NOTES.

MEMORANDA (Aug. 27).—Bank rate 2½ per cent. (since May 28, 1908). Price of silver, 23$\frac{13}{16}$d. per oz. Consols 86$\frac{7}{16}$ 86$\frac{9}{16}$ for money and account. Consols Pay Day, Sept. 1; Stock and Shares Continuation Days, Sept. 9 and 28; Ticket Days, Sept. 10 and 29; Pay Day, Sept. 11.

PRICES OF METALS (London).—*Copper*, cash, 60¾—61; three months, 61½—61¾. *Lead*, English, 13¼—13⅜; foreign, 13⅜—13$\frac{7}{16}$. *Spelter*, foreign, 19⅝—19¾. *Tin*, English, 132½—133; foreign, cash, 133⅜—133⅞, three months, 134⅛—134⅝. *Iron*, Cleveland, cash, 51/7½—51/9, three months, 50/11½—51/1.

ABERDEEN SUBURBAN TRAMWAYS CO.—The report for the half-year ended June states that the profit was £835. A dividend of 2 per cent. for the past year is declared.

ASCOT DISTRICT GAS & ELECTRICITY CO.—The directors have declared an interim dividend at the rate of 5½ per cent. (less tax) for the past half-year.

CALCUTTA ELECTRIC SUPPLY CORPN. (LTD.)—During the five weeks ended July 31 724,011 units were delivered to consumers, compared with 681,826 units in the corresponding five weeks of 1907.

CAMBRIDGE ELECTRIC SUPPLY CO. (LTD.)—An interim dividend at the rate of 5 per cent. (4s. 6d per share) has been declared for the past half-year.

FOREIGN COMPANIES.—By sec. 35 of the Companies Act, 1907, companies incorporated outside, but having a place of business in the United Kingdom, are required within three months from commencement of the Act (July 1, 1908), or within one month from the establishment of a place of business, to file with the Registrar (*a*) a certified copy of the charter, statutes or memorandum and articles of association or other instrument constituting or defining the constitution of the company and a certified translation thereof, (*b*) a list of the directors of the company, and (*c*) the names and addresses of some one or more persons resident in the United Kingdom authorised to accept on behalf of the company service of process and any notices required to be served on the company. Alterations in the instrument or changes in the directorate, &c., must also be filed. The company must also file an annual statement as in the case of British companies. Particulars of the following have already been filed:

Sao Paulo Tramway, Light & Power Co. (Ltd.) (185F.)—Particulars filed Aug. 17. Reg. in Ontario (Canada) in 1899 as the Sao Paulo Railway, Light & Power Co. Re-named in 1899. Capital $7,500,000, in $100 shares. British address, 34, Nicholas lane, E.C., where J. Davidson is authorised to accept service.

Arthur Koppel Aktien Gesellschaft (90 F.)—Particulars filed Aug. 5: reg. in Germany in January, 1905, with capital M. 10,000,000 (£500,000) in shares of M. 1,000 (£50) each, to acquire the business of Arthur Koppel and to carry on the business of manufacturers of railway materials and tools, &c. British address, 27, Clement's lane, E.C., where F. R. Leistekow is authorised to accept service.

STEWARTS & LLOYDS (LTD.)—The directors have declared an interim dividend at the rate of 9 per cent. on the ordinary shares.

STOCK EXCHANGE NOTICES.—The Stock Exchange Committee have appointed Sept. 2 a special settling day in and granted a quotation to £565,000 4 per cent debenture stock of the *Anglo-Argentine Tramways Co. (Ltd.)* and have also ordered 391,337 £1 fully paid ordinary shares of the *Metropolitan Electric Tramways (Ltd.)* to be quoted. The Committee have been asked to grant a quotation to a further issue of $900,000 7 per cent cumulative preference stock of the *Mexican Light and Power Co.*

ELECTRIC TRAMWAY AND RAILWAY TRAFFIC RECEIPTS.

Line	Week ended.	Amount.	Inc. or Dec. (a)	Aggregate No. of weeks.	Aggregate Amount.	Aggregate Inc. or Dec. (a)
		£	£		£	£
Aberdeen Corporation	Aug 19	1,599	− 41	12	18,624	+ 11
Airdrie	,, 14	211	− 13	32	7,159	+ 77
Anglo-Argentine	,, 19	22,180	+ 6,402	33	645,282	+ 101,966
Ayr Corporation	,, 22	487	+ 67	14	6,038	− 20
Baker St. & Waterloo Ry.	,, 22	2,650	+ 580	8	22,680	+ 4,070
Barnsley	,, 14	191	− 32	32	5,647	+ 295
Barrow	,, 14	285	− 37	32	7,984	− 268
Bath Electric Trams, Ltd.	,, 19	914	− 31	33	24,391	− 1,424
Birkenhead Corporation	,, 23	1,067	+ 9	...	...	...
Birmingham Corporation	,, 22	6,134	+ 41	21	131,904	+ 5,292
Birmingham & Mid.	,, 7	1 187	− 75	31	26,069	+ 872
Blackburn Corporation	...	...	...	...	...	...
Blackpool Corporation	,, 20	2,963	− 58	20	29,491	+ 510
Blackpool and Fleetwood	,, 22	1 751	+ 432	...	...	...
Bolton Corporation	,, 23	2,339	− 21	21	50,320	+ 1,248
Bombay	July 30	R29,962	+ R1,669	30	R1,067,010	+ R209,175
Bournemouth Corporation	Aug. 19	2,361	− 311	20	35,849	− 1,898
Bradford Corporation	,, 22	4,983	− 8	20	100,782	+ 1,084
Brighton Corporation	,, 23	1,172	− 69	21	21,106	+ 763
Bristol Trams & Carriage	,, 21	4,545	− 233	39	168,823	+ 876
Burnley Corporation	,, 22	1,267	− 18	21	26,181	+ 1,151
Burton Corporation	,, 23	278	− 62	21	5,843	− 499
Bury Corporation	,, 23	1,185	− 46	‡12	25,544	+ 1 893
Calcutta Tramways Co.	,, 22	R16,734	+ R1,412	8	R372,152	− R6,546
Cardiff Corporation	,, 15	2,2.7	+ 38	20	44,644	− 558
Cavehill	,, 14	118	+ 33	32	2,987	+ 215
Central London Railway	,, 22	6,528	+ 2,223	8	66,017	+ 16,561
Charing C., Euston & H'stead	,, 22	2,995	+ 725	8	25,890	+ 5,525
Chatham & Dist. Lt. Rys.	,, 20	910	+ 140	33	25,288	+ 970
City & South London Rly.	,, 23	2,882	− 187	8	23,298	− 1,373
City of Birmingham	,, 14	2,648	− 162	32	89,644	− 108
Colchester Corporation	,, 19	231	− 12	7	1,711	− 93
Cork Electric Trams Co.	,, 20	554	+ 43	33	15,284	− 453
Croydon Corporation	,, 21	1,439	+ 1	21	30,908	+ 210
Devonport & Dist. Trams	,, 14	538	+ 39	32	14,805	+ 116
Dover Corporation	,, 22	299	− 7	21	6,094	− 116
Dublin & Lucan Railway	,, 21	173	+ 3	7	1,208	− 36
Dublin United	,, 21	5,807	− 1,820	7	43,913	− 12,221
Dudley-Stourbridge	,, 14	1,043	+ 181	32	26,997	− 998
East Ham Council	,, 22	924	...	21	18,405	− 923
Exeter Corporation	,, 21	367	− 3	21	6,891	− 140
Falkirk and District	...	...	...	...	...	...
Gateshead & Dist. Trams	,, 14	1,002	− 43	32	32,471	+ 190
Glasgow Corporation	,, 22	16,799	− 400	12	204,092	+ 509
Glossop	,, 22	145	+ 1	31	5,240	− 263
Gravesend—Northfleet	,, 14	240	− 47	32	6,551	− 994
Great Northern & City Rly.	,, 22	1,166	− 324	8	10,327	− 2,389
Gt. Northern, Piccadilly, &c	,, 22	4,270	+ 760	8	39,030	+ 7,555
Greenock & Port Glasgow	,, 14	606	− 111	32	17,155	− 4,217
Hartlepool Tramways	,, 14	282	− 45	32	7,735	− 1,509
Hastings Elec. Trams Co.	,, 20	1,655	− 78	8	11 315	− 686
Hong Kong	,, 22	$7,189	+ $1,049	34	$268,101	− $14,207
Huddersfield Corpn.	,, 22	1,645	+ 13	21	34,580	+ 319
Hull Corporation	,, 22	2,400	− 5	21	50,592	+ 49
Ilford District Council	,, 22	477	+ 13	21	9,756	− 485
Ilkeston District Council	,, 19	147	...	20	2,960	+ 47
Ipswich Corporation	,, 22	492	− 2	21	8,817	− 162
Isle of Thanet Co.	,, 22	1,970	+ 131	47	25,117	− 144
Jarrow	,, 14	121	− 8	32	3,473	− 449
Keighley Corporation	,, 20	179	+ 7	7	1,280	+ 11
Kidderminster & District	,, 14	144	− 17	32	3 734	− 153
Kilmarnock Corporation	,, 22	143	− 3	14	2,275	− 163
Lanarkshire Trams Co.	,, 20	1,365	+ 34	33	42,908	+ 3,787
Lancashire United	,, 19	1,728	+ 173	33	44,374	+ 2,323
Leamington	,, 14	200	+ 4	32	5,422	+ 358
Leeds Corporation	,, 22	6,672	− 65	21	142,109	+ 4,732
Leicester Corporation	,, 22	2,183	+ 58	8	18,788	+ 227
Leith Corporation	,, 15	595	− 2	13	7,661	+ 26
Lincoln Corporation	...	...	...	...	...	...
Liverpool Corporation	,, 15	16,681	− 472	33	351,415	− 6,600
Liverpool Overhead Rly.	,, 23	1,480	− 93	8	11,966	− 1,867
*London County Council	,, 15	34,790	+ 3,523	†20	690,585	+ 76,144
London United	,, 22	8,121	+ 475	33	225,276	+ 4,579
Lowestoft	,, 22	485	+ 22	47	9,245	+ 168
Maidstone Corporation	,, 22	218	+ 109	21	4,253	+ 1,869
Manchester Corporation	,, 22	15,068	− 204	21	320,177	+ 12,092
Mersey Railway	,, 22	1,798	+ 32	8	14,739	+ 139
Merthyr	,, 14	215	..	32	6 802	+ 81
Metropolitan Dist. Railway	,, 22	8,051	+ 1,357	8	69,942	+ 10,417
Metropolitan Elec. Trams	,, 14	6 212	+ 995	22	182,543	+ 36,155
Middleton	,, 14	390	...	32	11,791	+ 460
Nelson Corporation	,, 22	140	− 14	§20	3,032	− 167
Newcastle-on-Tyne Corp.	,, 22	3,616	− 309	21	81,815	− 5,480
Newport (Mon.)	,, 22	648	− 40	21	14,436	− 910
Northampton Corporation	,, 21	487	+ 32	§20	10,068	+ 661
Oldham, Ashton & Hyde	,, 14	625	− 77	32	19,188	− 176
Oldham Corporation	,, 23	1,957	− 9	22	43,787	+ 733
Perth (N.B.) Corporation	,, 19	177	− 11	14	2,316	− 103
Perth (W.A.) Elec. Trams	,, 21	1,260	− 25	34	46,953	− 902
Peterborough	,, 14	145	− 18	32	4,117	+ 53
Portsmouth Corporation	,, 22	2,739	+ 82	21	45,603	+ 750
Potteries	,, 14	1,565	− 109	32	58,620	− 744
Preston Corporation	,, 12	855	− 91	6	4,729	− 242
Rotherham Corporation	,, 20	642	− 34	10	12,444	+ 133
Rothesay	,, 14	615	− 6	32	7,096	− 157
Salford Corporation	,, 24	4,518	− 76	21	100,954	+ 918
Sheerness	,, 12	83	− 11	32	1,836	− 20
Sheffield Corporation	,, 23	5,550	− 109	‡22	122,180	− 445
Singapore Trams	,, 22	$9,305	+ $127	...	..	..
South Metropolitan	,, 14	1,146	− 72	32	26,077	+ 619
South Staffs	,, 14	805	− 29	32	28,373	− 389
Southend Corporation	,, 19	862	+ 127	21	10,055	+ 745
Southport Tramways	,, 14	455	− 16	32	9,216	− 433
Stalybridge, Hyde, &c., Jt. Bd.	...	...	...	...	.	...
Sunderland Corporation	,, 23	1,232	− 239	21	25,701	− 5,138
Sunderland District	,, 19	521	+ 38	42	20,128	+ 1,480
Swansea Trams	,, 14	1,093	+ 22	32	30,361	+ 2,017
Swindon Corporation		...	...	..	...	.
Taunton	,, 14	62	− 7	32	1,331	− 69
Tynemouth and District	,, 14	416	− 6	32	7,159	− 489
Tyneside Trams Co.	,, 19	457	− 31	7	3,188	− 277
Wallasey District Council	,, 22	1,012	+ 65	§20	19,570	+ 922
Walsall Corpn.	,, 22	582	− 67	34	18,096	+ 1,226
Warrington Corpn.	,, 20	378	− 16	20	7,775	− 112
West Ham Corporation	,, 20	2,199	− 13	21	47,649	− 2,556
Weston-super-Mare	,, 12	491	+ 48	32	4,415	+ 69
Wolverhampton Co.	,, 11	421	− 32	33	14,775	− 490
Wolverhampton Corpn.	,, 19	874	+ 47	11	19,940	+ 321
*Worcester	,, 14	330	− 19	32	9,041	− 1
Wrexham	,, 14	106	− 2	32	3,276	+ 7
Yorkshire W.R. Trams	,, 23	1,206	+ 4	34	41,651	...
Yorkshire Woollen District	,, 14	939	− 36	32	29,570	− 1,251

(a) These comparisons are with the corresponding period last year. § Plus 3 days. ‡ Plus 2 days. * Partly electrical. † Minus 3 days ‡ Minus 2 days.

ELECTRICAL COMPANIES' SHARE LIST.

Share	Last Dividend	Name.	Price Wed., Aug. 26.	Rate % Yielded £ s. d.	Dividend Due.	Business Week to Aug. 26 Highest.	Business Week to Aug. 26 Lowest.
		ELECTRICITY SUPPLY.					
10	5 0	†Bournemouth & Poole Elec. Sup. Ord.	10½ −10¾	6 10 0	Mar, Sept,	..	..
10	4 6	† Do. 4½ per Cent. Cum. Pref.	9½ −10	4 10 0	Feb, Aug	9	—
10	6 0	† Do. 6 per Cent. Cum. Second Pref.	10½ −10⅞	5 6 6	Feb, Aug	..	..
St.	4½%	Do. 4½ per Cent. Deb. Stock (red.)	100 −103	4 7 6	Jan, July	..	..
5	3 6	Bromley (Kent) El. Lt. & Power Shares	4½ −5	5 10 0	April, Oct	..	..
St.	4½%	Do. Do. 1st Debs.	94 −97	4 12 9	May, Nov	..	..
5	4 6	†Brompton & Kensington Elec. Sup. Ord.	6¾ −7¼	6 3 0	March....	..	..
5	3 6	† Do. 7 per Cent. Pref.	6¾ −7¼	4 13 6	Mar, Sept	..	..
St.	4%	Central Elec. Sup. Co. 4% Guar. Db. Stock	99 −102	3 18 6	June, Dec	..	..
5	2 6	Charing Cross (W. End & City) El. Sup. Co.	3¾ −4	6 5 0	Feb, Aug	—	..
5	2 3	Do. 4½ per Cent. Pref.	4 −4½	5 0 0	Feb, Aug	—	..
St.	4%	Do. 4 per Cent. Deb. Stock (red.)	96 −99	4 1 0	Jan, July	..	..
5	2 8	Do. City Undertaking 4½% Cm. Pref.	3½ −4	5 12 0	Jan, July	3⅞	..
5	2/6	Chelsea Electric Supply Ord.	3 −3½	6 8 9	March ..	3 1/16	..
St.	4½%	* Do. 4½ per Cent. Deb. Stock (red.)	100 −103	4 7 6	June, Dec	..	..
10	5/0	City of London Electric Lighting Ord.	9¾ −10¼	5 17 0	Feb, Aug	10	9⅞
10	6/0	Do. 6 per Cent. Cum. Pref.	11¾ −12¾	4 14 0	Jan, July	12½	12 1/16
St.	5%	Do. 5 per Cent. Deb. Stock (red.)	122 −125	4 0 0	June, Dec	..	..
St.	4½%	Do. 4½ per Cent. 2nd Deb. Stock (red.)	101 −104	4 6 6	Jan, July	..	..
5	2%	County of Durham Elec. P.D. Ord.	2¾ −3	3 9 7	April, Oct	..	..
5	5%	Do. 5 per Cent. non Cum. Pref.	3⅞ −4⅛	6 5 0	April, Oct	..	..
10	4/0	County of London Elec. Supply Ord.	7¼ −8¼	5 17 6	Feb, Aug	7¾	..
10	6 0	Do. 6 per Cent. Cum. Pref.	10⅜ −10⅞	5 9 6	Mar, Sept	10¾	10½
St.	4½%	Do. 4½% Deb. Stock (red.)	107 −110	4 2 0	Jan, July	..	..
St.	4½%	Do. Second Deb. Stock	99 −102	4 8 0	May, Nov	..	..
5	3 6	Folkestone Electricity Supply Co. Ord.	4¾ −5¼	5 7 0	April, Oct		..
5	2 6	Do. 5 per Cent. Cum. Pref.	5 −5½	4 11 0	Mar, Sept	..	..
St.	4½%	Do. 4½ 1st Deb. Stock (red)	97 −100	4 10 0	Feb, Aug	..	..
5	4/6	Hove Electric Lighting Ord.	6 −6½	6 11 0	April, Oct	..	..
5	4/0	†Kensington & Knightsbridge Ord.	7¾ −8¼	5 14 0	Feb, Aug	..	..
5	6%	Do. 6 per Cent. 1st Pref.	6 −6½	4 12 0	Jan, July	..	—
St.	4%	Do. 4 per Cent. Deb. Stock (red.)	94 −97	4 2 6	..	94	..
St.	4%	Kensingtn. & Kngtbg. Co. & Notting Hill Co. (Joint Station) 4% Deb. Stock (red.)	97 −101	3 19 0	April, Oct	—	..
St.	4½%	Kent Elec. Power Co.	86 −90	5 0 0	Jan, July	..	..
3	1/6	London Electric Supply Ord.	⅞ −1⅛	5 8 0	Mar, Sept	..	..
5	3 0	Do. 6 per Cent. Pref.	4½ −5	6 0 0	Mar, Sept	4⅝	4½
St.	4%	Do. 4 per Cent. 1st Mort. Deb.	89 −92	4 7 0	Jan, July	..	..
5	2 6	Metropolitan Electric Sup. Ord.	4½ −5	6 10 0	April, Oct	4½	4½
5	2/3	Do. 4½ per Cent. Cum. Pref.	4⅝ −4⅞	4 12 0	Jan, July	4¾	..
St.	4½%	Do. 4½ per Cent. Deb. Stock 1st Mort.	105 −109	4 1 6	June, Dec	.	..
St.	3½%	Do. 3½ per Cent. Mrt. Deb. Stock (red.)	84 −89	3 19 0	Jan, July	84½	..
100	4½%	Midland Elec. Corp. for P.D. 1st Mort. Db.	94 −97	4 12 6	June, Dec	95½	94
10	4%	Newcastle & Dist. Elec. Ltg. Ord.	7½ −8	5 3 2	Feb, Aug	—	—
100	4½%	Do. 4½ per Cent. Deb.	94 −96	4 14 9	Jan, July	..	..
5	8%	Newcastle Elec. Supply Ord.	5⅛ −5⅝	7 12 4	Feb, Aug	..	..
5	5%	Do. 5 per Cent. non Cum. Pref.	5¼ −5⅝	4 15 8	Feb, Aug	..	..
100	4%	Do. 4 per Cent. Mort. Deb. red. 1907.	95 −97	4 3 4	Jan, July	..	..
1	3%	Northern Counties Elec. Sup.	—	..	Mar, Aug	—	..
100	4½%	Do. 4½ per Cent. Deb.	93 −95	4 15 9	Jan, July	..	..
10	6 0	Notting Hill Electric Ord.	11¾ −12¾	5 10 6	March ..	..	..
5	2 6	†Oxford Electric Ord.	5⅝ −6⅛	5 14 0	March ..	..	..
St.	4%	Do. 4 per Cent. Deb. Stock	95 −98	4 2 0	Jan, July	..	..
5	5 0	St. James' & Pall Mall Elec. Ord.	7 −8	6 1 6	Feb, Aug	..	..
5	3 6	Do. 7 per Cent. Pref.	6½ −7½	4 16 6	Feb, Aug	..	—
St.	3½%	Do. 3½ per Cent. Deb. Stock (red.)	86 −90	3 18 0	Jan, July	..	..
5	..	Smithfield Markets Electric Sup. Ord.	¼ −¾	..	Feb	..	..
St.	4%	Do. 4 per Cent. Deb. Stock	68 −72	5 11 0	Feb, Aug	..	..
5	4/0	South London Electric Supply Ord.	2⅝ −2⅞	5 19 0	April	..	..
1	0/6	South Metrop'n Elec. Lt. & Power Ord.	⅜ −⅝	4 0 0	..	..	—
1	0 8⅔	Do. 7 per Cent. Cum. Pref.	1 −1¼	5 12 0	Feb, Aug	1	..
St.	4½%	Do. 4½ 1st Db. Stk. Red.	100 −103	4 7 6	April, Oct	..	—
5	2 6	Urban Electric Supply Ord.	½ −1	..	April, Oct	—	..
5	2 6	Do. 5 per Cent. Cum. Pref.	1⅞ −2⅜	10 12 0	April, Oct	..	..
St.	4½%	Do. 4½ per Cent. 1st Mort. Deb.	82 −85	5 6 0	April, Oct	..	..
5	5 0	Westminster Elec. Sup. Ord.	7½ −8½	5 17 6	Mar, Sept	..	..
5	2/3	Do. 4½ per Cent. Cum. Pref.	5 −5½	4 2 0	Jan, July	..	..
		ELECTRIC RAILWAYS, TRAMWAYS, &c.					
St.	4%	Baker St. & Waterloo 4% Perp. Db. St	92 −94	4 5 0	Jan, July	93½	92¾
1	..	Bath Elec. Trams Pref. Ord.	¼ −⅜	10 13 0	April	—	—
1	0/6	Do. 5 per Cent. Cum. Pref.	⅝ −⅞	5 14 0	Jan, July	..	—
St.	4½%	Do. 4½ 1st Mort. Deb. Stock (red.)	86 −91	4 19 0	April, Oct	..	..
St.	4½%	B'ham & Midland Trams 4½ 1st Db. Stk.	91 −94	4 17 0	Jan, July	..	..
10	9%	Bristol Tramways & Carriage Ord.	10¾ −11¼	8 0 0	Feb, Aug	..	..
10	4%	Do. Cum. Pref. (fully paid)	8¾ −9¼	4 6 6	..	..	..
St.	4%	Do. 4 per Cent. Debs.	93 −98	4 2 0	Feb, Aug	..	..
10	..	British Electric Traction Ord.	1¼ −1½	..	June, Dec	..	..
10	8/0	† Do. 6 per Cent. Cum. Pref.	3⅞ −4⅜	..	Feb, Aug	4 1/16	..
St.	5%	Do. 5 per Cent. Perpetual Debs.	95 −98	..	April, Oct	..	—
St.	4½%	Do. 4½ per Cent. 2nd Deb. Stock	76 −78	5 15 0	May, Nov	..	..
St.	3%	†Central London Ordinary Stock	79 −81	3 14 0	Feb, Aug	68	..
St.	4%	† Do. 4 per Cent. Pref. Stock	85 −87	4 12 0	Feb, Aug	..	..
St.	2%	Do. Deferred Stock	49 −52	3 17 0	Feb	51	..
100	4%	Do. 4 per Cent. Debs.	101 −104	3 17 0	Jan, July	..	..
St.	4%	Charing X, Euston & Hmpstd Per. Db. Stk.	83 −84	4 15 0	Jan, July	83⅜	82¾
5	2/6	City of Birmingham Trams. 5% Cm. Pref.	4¼ −4¾	5 5 0	April, Oct	..	..
100	4%	Do. 4 per Cent. 1st Mort. Debs.	97 −100	4 0 0	April, Oct	..	..
St.	1½%	City & South London Rly. Con. Ord.	32 −33	4 19 0	Feb, Aug	33	..
St.	5%	Do. 5 per Cent. Perp. Pref. (1891)	111 −114	4 7 6	Feb, Aug	..	..
St.	5%	Do. (1896)	109 −112	4 9 3	Feb, Aug	—	..
St.	5%	Do. (1901)	107 −110	4 11 0	Feb, Aug	..	..
St.	5%	Do. (1903)	102 −105	4 15 3	Feb, Aug	..	..
St.	4%	Do. 4 per Cent. Perpetual Debs.	100 −103	3 17 6	May, Nov	..	..
10	6/0	Dublin United Trams. Ord	12 −13	5 0 0	Feb, Aug	..	..
10	6/0	Do. 6 per Cent. Pref.	12½ −13½	4 10 6	Feb, Aug	..	—
10	..	Gt. Northern & City Rly. Pref. Ord. (4%	½ −1	..	Feb, Aug	..	.
10	0/9	†G. Northern, Piccadilly & Brompton Ord.	7 −7½	5 6 9	Feb, Aug		..
St.	4%	Do. 4 per Cent. Deb. Stock	91 −93	4 6 0	Jan, July	92½	91½
5	4/0	Hastings & Dist. Elec. Trams. 6% Cm. Pf.	3¼ −3¾	8 0 0	Mar, Sept	..	..
St.	4½%	Do. 4½ Db. St.	93 −96	4 13 9	April, Oct	..	..
10	9%	‡Imperial Tramways Ord.	10 −11	7 7 3	Mar, Sept	..	..
10	6%	‡Do. 6 per Cent. Pref.	9½ −10	6 0 0	Mar, Sept	..	..
St.	4½%	‡Do. 4½ per Cent. Debs.	90 −92	4 18 0	Jan, July	..	..
5	..	I. of Thanet E. T. & Lt. 5 per Cent. Pref.	⅞ −1⅛	..	Mar, Sept	..	—
St.	4%	Do. 4 per Cent. Deb. Stock	59 −61	6 11 0	Jan, July	..	—
10	6/0	Lanarkshire Tramways	9⅞ −10⅜	5 9 0	Feb, Aug	..	..
St.	5%	Lancs. Utd. Trams 5% Prior Lien Db. St.	92 −94	5 6 6	Jan, July	..	..
10	..	Liverpool Overhead Railway Ord.	1¼ −1¾	..	Feb, Aug	..	—
10	5%	Do. 5 per Cent. Pref.	5¾ −6¼	8 0 0	Feb, Aug	..	..
St.	4%	Do. 4 per Cent. Deb.	84 −86	4 13 0	Jan, July	..	..
10	5/0	London United Trams. 5% Cum. Pref.	5½ −6½	7 14 0	Jan, July	..	..
St.	4%	Do. 4 per Cent. 1st Mort. Deb. Stock	76 −81	4 18 9	Jan, July	..	..
St.	—	Mersey Con. Ord. Stock	1 −3	—	Feb, Aug.	..	..
St.	..	Do. 3 per Cent. Perp. Pref.	8 −6	—	..	..	..
1	..	Metropolitan Elec. Tramways Ord.	⅛ −⅜	—		..	..
1	..	Do. Def.	1/32 −1/16	..	April..	..	..
1	0/6	† Do. 5 per Cent. Cum. Pref.	13/16 −15/16	6 3 6	Feb, Aug	..	..
St.	4½%	Do. 4½ per Cent. Deb. Stock	93 −96	4 13 9	Jan, July	94½	93¼
St.	½%	†Metropolitan Railway Consolidated	36 −37	1 7 0	Feb, Aug	37	35
St.	2½%	† Do. Surplus Lands Stocks	65 −67	4 2 0	Feb, Aug	66½	65
St.	3½%	† Do. 3½ per Cent. Preference	84 −87	4 0 6	Feb, Aug	84	..
St.	3½%	† Do. 3½ per Cent. "A" Preference	73 −76	4 12 0	Feb, Aug	—	..
St.	3½%	† Do. 3½ per Cent. Convertible Pref.	70 −73	4 16 0	Feb, Aug	..	..
St.	3½%	Do. 3½ per Cent. Debenture Stock	90 −93	3 15 3	Jan, July	91½	90½
St.	3½%	Do. 3½ per Cent. "A" Ditto	88 −91	3 17 0	Jan, July	89	88

* In calculating the yield allowance has been made for accrued interest but *not* for redemption
† Ex Dividend

ELECTRICAL COMPANIES' SHARE LIST.—Continued.

Share	Last Dividend	Name	Price Wed., Aug. 26.	Rate % Yielded (£ s. d.)	Dividend Due	Business Week to Aug. 26. Highest	Lowest
		ELECTRIC RAILWAYS & TRAMWAYS *Continued.*					
St	..	Metropolitan District Railway Ord.	11 —12	—	Feb, Aug	11⅛	11
St	..	Do. Extension Pref. (5 per Cent.)	19 —23	..	Feb, Aug	..	..
St.	3½%	Do. Assented Ext. Pref. (Int. Guar. by Und. Elec. Rys. Co. of London, Ltd.)	47 —51	6 17 0	Feb, Aug	..	..
St	3%	Do. 3 per Cent. Consoltd. Rent-charge	73 —76	3 19 0	Jan, July	..	..
St.	4%	Do. 4 per Cent. Midland Rent-charge	98 —102	3 18 0	Jan, July	..	—
St	1½%	† Do. Guar. Stock 4 per Cent.	45 —49	3 9 6	Mar, Sept	..	..
St.	6%	Do. 6 per Cent. Perp. Deb. Stock	113 —118	5 2 0	Jan, July	..	..
St.	4	Do. 4 per Cent. Ditto	71 —76	5 5 0	Jan, July	73½	73
5	..	New Gen. Tract. 6 per Cent. Cum. Pref.	¼—¾	—	May	..	—
1	0/9¾	Potteries Electric Traction Ord.	¼—½	8 0 0	April, Oct	..	..
1	0/6	† Do. 5 per Cent. Cum. Pref.	⅝—¾	6 13 0	Feb, Aug	..	..
St.	4½%	Do. 4½ per Cent. Deb. Stock	93 —96	4 14 6	May, Nov	..	..
1	0 7½	S. Met. Elec. Trams. & Ltg. 6% Cm. Pref.	¾—1	6 0 0	Feb, Aug	..	..
St.	4%	Do. 4 per Cent. Deb. Stock	76 —80	5 0 0	Jan, July	..	..
100	5%	Sunderland Dist. Elec.Trms.5% 1stMt.Db.	78 —82	6 2 0	Jan, July	78½	..
..	5%	Underground Elec. Rys. Co. of London...	39 —43	11 12 0	June, Dec	..	..
5	..	Yorkshire (W.R.) Elec. Trams. Ord.	⅞—1⅛	—	March ..	..	..
5	..	Do. 6 per Cent. Cum. Pref.	3⅛—3⅝	—	..	..	..
St.	4½	Do. 4½ per Cent. 1st Debs.	83 —86	5 5 0	Jan, July	..	..
		ELECTRIC MANUFACTURING, &c.					
1	..	Aron Electricity Meter Ord.	7/16—11/16	..	..	..	..
1	1 4½	Do. 6% Cum. Pf. ex Cn a/c arrears)...	1 1/16—1 1/16	7 12 0	April, Oct	..	..
1	2/4½	Babcock & Wilcox Ord.	3⅞—4⅛	4 9 0	April, Oct	4 1/16	3 15/16
1	0/7½	Do. Pref.	1½—1⅝	3 13 9	..	1⅝	..
5	6,0	British Insulated & Helsby Cables Ord.	6¼—6¾	7 4 0	July, Feb	..	..
5	3,0	Do. 6 per Cent. Pref.	6 —6½	4 12 0	Jan, July	..	..
St.	4½%	Do. 4½ per Cent. 1st Mort. Deb. (red.)	103 —106	4 5 0	Jan, July	..	..
St.	4½%	British Thoms'n Houst'n 4½% 1st Mt.Db.	93 —98	4 12 0	Mar, Sept	..	..
5	..	British Westinghouse 6 per Cent. Pref...	⅜-⅝	..	Feb, Aug	..	..
St.	4%	Do. 4 per Cent. Mort. Deb. Stock	43 —48	8 8 0	Jan, July	45	..
2	..	Brush Electrical Engineering	½	—	March ..	..	..
2	..	Do. 6 per Cent. Pref. non-Cum.	⅛—⅜	..	Mar, Sept	..	..
St.	4½%	Do. 4½ per Cent. Perp. 1st Deb. Stock	70 —75	6 0 0	Mar, Sept	..	..
St.	4½%	Do. Perpetual 2nd Deb. Stock	50 —54	8 6 6	Jan, July	..	..
5	10 0	Callender's Cable Con. Ord.	9¾—10¾	6 17 6	Jan, July	9⅞	10⅛
5	2/6	Do. 5 per Cent. Cum. Pref.	5½—5¾	4 7 0	Jan, July	..	..
St.	4½%	Do. 4½ per Cent. 1st Mort Debs. (red.)	106½—108½	4 4 0	Nov, May	107½	..
1	1/0	Castner-Kellner Alkali Co.	1½ —1⅝	8 0 0	May, Nov	[illegible]	1½
St.	4½%	Do. 4½ per Cent. 1st Mort. Deb. (red.)	102 —105	4 5 9	Feb, Aug	..	..
1	0 9⅜	Chadburn's (Ship) Telegraph Ord.	15/16—1 1/16	7 10 6	March ..	..	..
1	0/7½	Do. 6 per Cent. Cum. Pref.	15/16—1 1/16	5 13 0	April, Oct	..	..
1	[illegible]	Consolidated Electrical Co.	⅜—½	7 0 0	August ...	..	..
1	1/0	Consolidated Signal Co.	1 5/16—1½	10 0 0	April, Oct	1⅜	..
1	0/7½	Do. 6 per Cent. Cum. Pref.	[illegible]	6 4 0	April, Oct	—	..
3	3/0	*Crompton & Co. (Nos. 1 to 86,000)	1 1/16—1 3/16	9 5 0	Jan, July	..	..
100	5%	Do. 5 per Cent. 1st Mort. Debs. (red.)	90 —93	5 7 0	Jan, July	..	..
1	0 7½	Davis & Timmins	⅞—1⅛	..	Mar, Sept	..	..
5	2/0	Dick, Kerr & Co. Ord.	1⅛—1⅜	7 11 0	Sept	1 3/16	..
5	0/7½	Do. 6 per Cent. Cum. Pref.	1 —1¼	4 16 0	Sept	1⅛	[illegible]
St.	4½%	Do. 4½ per Cent. Deb. Stock	99 —102	4 8 6	Jan, July	..	—
5	2/6	Edison & Swan United ("A" Sh.) (£3 pd.)	½—¾	..	Feb, Aug	[illegible]	..
5	4/2	Do. (£5 paid)	1½—2½	5 0 0	Feb, Aug	..	—
St.	4%	Do. 4 per Cent. Mort. Deb. Stock (rd.)	76 —79	5 [illegible] 6	June, Dec	..	..
St.	5%	Do. 5 per Cent. 2nd Deb. Stock	85 —87	5 15 0	Mar, Sept	—	..
5	..	Edmundson's Elec. Corp. Ord.	⅛—⅜	..	Jan, July	..	..
5	..	Do. 6 per Cent. Cum. Pref.	½—1	..	May, Nov	..	..
St.	4½%	Do. 4½ per cent. 1st Mort. Deb. (red.)	59 —66	6 16 0	Jan, July	..	..
2	..	Electric Construction Co.	[illegible]	..	Jan, July	[illegible]	..
2	2/9¾	Do. 7 per Cent. Cum. Pref.	1⅜—1⅝	..	July	—	..
St.	4	Do. 4 per Cent. Perp. 1st Mort. Debs.	66 —71	5 13 0	Jan, July	..	..
10	5,0	General Electric (1900) 5% Cum. Pref.	7½—8	6 5 0	June, Dec	..	..
St.	4%	Do. 4 per Cent. 1st Mort. Debs.	86 —90	4 9 0	Mar, Sept	..	—
5	10,0	Henley's Telegraph Works Ord.	10½—11½	6 10 0	Feb, Aug	11¼	..
5	2/3	Do. 4½ per Cent. Pref.	5 —5½	4 2 0	Feb, Aug	..	..
St	4½%	Do. 4½ per Cent. 1st Mort. Deb. Stock	106½—108½	4 3 0	Mar, Sept	108	..
10	5,0	India Rubber, Gutta Percha, &c., Wrks.	15½—16½	6 2 0	Feb, Aug	16¼	15¾
100	4%	Do. 4 per Cent. Debs. (red.)	99 —101	3 19 0	April, Oct	[illegible]	99
1	..	National Elec. Construction Co.	⅜—⅝	..	April	..	..
1	0/9⅜	Richardsons, Westgarth & Co., Ltd. Ord.	7/16—9/16	7 2 0	Nov	..	..
1	0/7½	Do. 6 per Cent. Cum. Pref.	¾—⅞	6 17 0	May, Nov	..	..
St.	4½%	Do. 4½ per Cent. Perp. Deb. Stock	87 —90	5 0 0	Jan, July	..	..
1	..	Simplex Conduits Ord.	1½	..	..	—	—
5	..	Do. 6 per Cent. Cum. Pref.	5¼	..	..	..	—
12	12/0	Telegraph Construction & Maintenance	31½—32½	6 5 6	Mar, July	—	..
100	4%	Do. 4 per Cent. Deb. Bonds (1909)	100 —102	3 18 0	Jan, July	..	..
1	1 0	†Vickers, Sons & Maxim, Ltd., Ord.	1⅝—1¾	8 9 0	..	[illegible]	1⅝
1	1/6	† Do. 5 per Cent. non-Cum. Preference	[illegible]	4 11 6	..	[illegible]	..
St.	5%	† Do. 5 per Cent. non-Cum. Preferred	101 —105	4 15 0	..	..	..
St.	4%	Do. 4 per Cent. 1st Mort. Db.Sk. red	104 —106	3 15 0	June, Dec	..	..
100	4½%	Do. 4½ per Cent. 2nd Mort. Deb. (red.	104 —106	4 5 0	June, Dec	105½	104¾
100	15 6	Do. 5 per Cent. [illegible] Mort. Debs. Scrip.	102½—104½	..	..	[illegible]	[illegible]
10	10/0	J. G. White & Co. 6% Cm. Pref.	8½—9½	8 17 9	..	[illegible]	..
5	1/0	Willans & Robinson Ord.	[illegible]—1¼	4 0 0	Apr, Oct	..	..
5	2/0	Do. 6 per Cent. Cum. Pref.	2½—3	8 11 6	Apr, Oct	..	..
100	4%	Do. 4 per Cent. 1st Mort. Debs.	72 —76	5 5 6	May, Nov	..	..
		TELEGRAPHS.					
10	..	Amazon Telegraph	2 —3	—	June, Dec	..	—
100	5%	Do. 5 per Cent. Debs. (red.)	89 —92	5 8 6	June, Dec	92	..
St.	15/0	Anglo American	58 —61	5 16 0	F,My,Ag,N	..	..
St.	30 0	Do. Preferred	103½—104½	3 16 0	F,My,Ag,N	104½	[illegible]
St	1%	Do. Deferred	16 —16½	6 1 0	F,My,Ag,N	16⅜	16⅛
St.	4%	Commercial Cable 4 per Cent. Deb. Stk.	84 —87	4 12 0	Jn,Ap,Jy,O	85½	..
10	6 0	Cuba Submarine Ord.	7½—8½	7 0 0	Feb, Aug	..	..
10	10/0	Do. Preference 10 per Cent.	15½—16½	6 1 6	Feb, Aug	..	..
[illegible]	2/0	Direct Spanish Ord	3 —3½	6 4 0	April, Oct	..	..
[illegible]	5 0	Do. 10 per Cent. Cum. Pref.	8 —9	5 11 0	April, Oct	..	..
100	4½%	Do. 4½ per Cent. Deb.	100 —103	4 7 6	Jan, July	..	..
20	[illegible]	Direct United States Cable	13½—14½	6 7 6	Ja,Ap,Jy,O	13¾	..
100	4½%	Direct West India Cable 4½% Rg. Db. (rd.	99 —101	4 9 0	June, Dec	..	..
St	[illegible]	Eastern Ordinary	135 —138	5 1 0	Ja,Ap,Jy,O	137	135½
[illegible]	17/6	Do. [illegible] per Cent. Pref. Stock	84—86	4 [illegible] 6	Ja,Ap,Jy,O	[illegible]	84½
St	4%	Do. 4 per Cent. Mort. Deb. Stk. (red.)	102 —104	3 17 0	May, Nov	[illegible]	102½
10	2/6	Eastern Extension	12¾—13¼	5 5 6	Ja,Ap,Jy,O	13	12¾
St.	4	Do. 4 per Cent. Deb. Stock	100 —102	3 18 0	Feb, Aug	101½	[illegible]
100	4%	Eastern & S. African 4% Mort. Deb. 1909	99 —101	3 19 0	Feb, Aug	..	..
[illegible]	4%	Do. 4% Mauritius Sub. Debs. (red.)	100½—102½	3 17 6	May, Nov	..	..
10	5/0	G. N. of Copenhagen, with Coupon 74	28 —30	6 9 0	Jan, July	28	—
100	4½%	Halifax & Bermudas 4½% 1st Mt. Dbs. red.)	99 —101	4 9 0	June, Dec	..	..
[illegible]	[illegible]	Indo-European	[illegible]	5 1[illegible] 0	May, Nov	[illegible]	..
100	$4	Mackay Companies Common	69 —73	5 10 0	Ja,Ap,Jy,O	..	..
100	$4	Do. Preference	69 —73	5 10 0	Ja,Ap,Jy,O	..	..
[illegible]	..	Marconi's Wireless Telegraph Co.	[illegible]—1	..	April ..	..	..
100	4	Pacific & European Tel. 4% Guar. Dbs. red.	98 —101	3 19 0	June, Dec	99½	—
[illegible]	[illegible]	West Coast of America	[illegible]	4 5 0	May	..	..
[illegible]	[illegible]	Do. 4 per Cent. Debs.	98½—101½	3 18 0	Jan, July	..	..
1	..	West India & Panama	[illegible]	..	May, Nov	..	..
10	[illegible]	Do. 6 per Cent. 1st Pref.	8 —8½	7 1 0	May, Nov	..	..
10	[illegible]	Do. 6 per Cent. 2nd Pref.	8½—9½	..	May, Nov	..	..
100	[illegible]	Do. 5 per Cent. Debs.	100 —103	4 17 6	Jan, July	[illegible]	..
10	[illegible]	Western Telegraph	[illegible]—11¼	4 18 0	Mr,Jn,O,D	14	..
St	4%	Do. 4 per Cent. Deb. Stock (red.	101 —103	3 17 0	June, Dec	..	..
[illegible]	4	Western [illegible]	80 —85	4 14 0	..	[illegible]	..

Share	Last Dividend	Name	Price Wed., Aug. 26.	Rate % Yielded (£ s. d.)	Dividend Due	Business Week to Aug. 26. Highest	Lowest
		TELEPHONES.					
100	2$	Amer. Telephn. & Telegh. Cap. St.	126 —130	3 17 0	..	..	—
..	4%	Do. Coll. Trust $1,000 4 per Cent. Bds	89 —92	4 7 0	Jan, July	..	..
St.	5%	Anglo-Portug'se Tel. 5% 1st Mt. Db. Stk.	101 —104	4 16 0	Mar, Sept	..	—
5	5 0	Chili Telephone	8 —8½	4 14 0	August ..	..	..
1	0/7½	Monte Video Telephone Ord.	1 —1⅛	6 4 0	Nov	1 1/16	..
1	0/6	Do. 5 per Cent. Pref.	[illegible]	5 3 0	May, Nov	..	..
St.	6%	National Co. Pref. Stock	107½—109½	[illegible] 10 6	Feb, Aug	108¾	107¾
St.	6%	Do. Def. Stock	119½—121½	4 19 0	Feb, Aug	121½	120¼
10	6/0	Do. 6 per Cent. Cum. 1st Pref.	10 —12	5 0 0	Feb, Aug	..	..
10	6/0	Do. 6 per Cent. Cum. 2nd Pref.	10 —12	5 0 0	Feb, Aug	..	..
5	2/6	Do. 5 per Cent. non-Cum. 3rd Pref.	[illegible]	4 6 0	Feb, Aug	5⅜	—
St.	3½%	* Do. Deb. Stock 3½ per Cent. (red.)	98½—100½	3 9 6	June, Dec	97½	..
St	4%	Do 4 per Cent. Deb. Stock (red.)	103 —105	3 10 0	Jan, July	103½	[illegible]
1	1/0	Oriental	[illegible]	6 1 0	April, Oct	1¼	..
1	0/7½	Do. 6 per Cent. Cum. Pref.	[illegible]	4 11 6	April, Oct	—	..
St.	4%	Do. 4 per Cent. Red. Deb. Stock	89 —92	4 7 0	Jan, July	..	..
St.	4½%	Telephone Co. of Egypt 4½% Db.Stk.(red.)	99 —102	4 12 0	Jan, July	100½	—
5	5/0	United River Plate	[illegible]—7⅛	5 12 0	July	6¾	..
5	2/6	Do. 5 per Cent. Cum. Pref.	5 —5½	4 11 0	June, Dec	..	..
St.	4½%	Do. 4½ Deb. St. Red.	101½—103½	4 7 0	Jan, July	102¾	[illegible]
		FINANCIAL, INVESTMENT, &c.					
5	3/0	Elec. & Gen. Investment 6% Cum. Pref.	3½—4	7 10 0	Jan, July	..	..
10	5/9	Globe Telegraph & Trust	10½—11	5 7 0	Sp Dc Mr Ju	10¾	[illegible]
10	3/0	Do. 6 per Cent. Pref.	13½—14	4 5 9	Sp Dc Mr Ju	[illegible]	[illegible]
10	6%	Submarine Cables Trust (Cert.)	128 —131	4 11 6	April, Oct	..	..
		COLONIAL AND FOREIGN ELECTRIC RAILWAYS, TRAMWAYS, &c.					
5	3/0	Anglo-Argentine 6% Cum. 1st Pref.	6 1/16—6 5/16	4 12 0	April, Oct	[illegible]	6
5	5 0	Do. 10% Non-cum. 2nd Pref.	8¼—8⅝	5 13 0	Jan, July	8½	[illegible]
St.	6%	Do. Permanent 6% Deb. Stock	141 —146	4 2 0	June, Dec	..	..
St.	5%	Auckland Elec. Trams. 5% Deb. (red.)	103 —106	4 14 3	Jan, July	..	..
5	4 0	Brisbane Electric Trams. Invest. Ord.	4 9/16—4 13/16	4 3 0	May	4¾	[illegible]
5	2 6	Do. 5 per Cent. Cum. Pref.	4⅞—5⅜	4 17 6	May, Nov	[illegible]	.
St.	4½%	Do. 4½ per Cent. Db. Prov. Certs.	98 —102	4 8 0	Jan, July	100½	..
St.	8%	British Columbia El.Ry.Df. Ord.	123 —128	6 5 0	Mar, Sept	..	..
St.	30 0	Do. Pref. Ord. Stock	109 —113	5 6 0	May, Nov	..	..
St.	5%	Do. 5% Cum. Perp. Pref. Stock	104 —108	4 12 6	Jan, July	.	..
40	4½%	Do. 4½ per Cent. 1st Mort. Debs.	101 —104	4 6 6	April, Oct	103½	102½
100	4½%	Do. Vancouver Power Debs.	100 —103	4 7 6	Jan, July	..	—
St.	4½%	Do. 4½% Perp. Con. Deb. St.	101 —104	4 1 6	—	..	..
St.	5%	Buenos Ayres Elec. Trams (1901) Ltd. Deb. St.	93 —97	5 2 6	Ja, Jul ..	..	..
5	..	Buenos Ayres Grand National Ord.	2 —2½	..	..	..	..
5	2/6	Do. 5 per Cent. Cum. Pref.	3¾—4¼	..	Feb, Aug	..	..
100	5½%	Do. 5½ per Cent. Pref. Debs.	99 —103	5 7 6	Jan, July	..	..
100	6%	Do. 6 per Cent. 1st Deb. Bonds.	100 —104	5 14 6	April, Oct	..	..
St.	5%	†Buenos Ayres Lacroze Trams 1st Mt. Db.	93 —95	5 5 0	Mar, Sept	94½	94
St.	6%	Buenos Ayres Port & City Tram. 1st Mt Deb. Stock £75 Paid	61 —65	6 12 0	Feb, Aug	.	..
5	2/6	Calcutta Tramways (1 to 137,610)	5½—6	5 0 0	Mar, Sept	[illegible]	[illegible]
100	2/6	Do. 5 per Cent. Cum. Pref.	4⅛—5⅛	4 13 0	Jan, July	—	..
1	4½%	Do. 4½% 1st Deb. Stock (red.)	101 —104	4 6 6	Jan, July	..	..
St.	..	Cape Electric Tram Shares	3/16—7/16	..	..	..	—
5	1/3	†City of Buenos Ayres Trams Co. (1904) Sh.	5⅛ —5⅜	4 5 3	F,My,A,N	5¼	
St.	4%	Do 4 per Cent. Deb. Stock	97 —101	3 19 0	June, Dec	..	..
.	5%	Colombo Tr. & Ltg. 5% 1st Mt. Db.	90 —93	5 6 6	May, Nov	..	—
100	5%	Electric Traction Co. of Hong Kong 5 per Cent. 1st Mort. Debs.	85 —90	5 10 0	June, Dec	..	..
1	5%	Havana Elec. Ry. Con. Mt. 5% $1,000 50 year Coup. Bds.	85 —90	5 11 0	Feb, Aug	..	..
1	..	Kalgoorlie Elec. Trams Sh.	[illegible]	..	..	..	..
100	5%	Do. 5 per Cent. "A" Deb. Stock	85 —87	5 12 0	Jan, July	..	—
5	6%	Do. 6 per Cent. "B" Ditto	65 —70	8 11 6	Jan, July	65	
5	1,0	Lisbon Elec. Trams. Ord.	1 —1¼	4 0 0	July	..	..
100	0/7½	Do. 6 per Cent. Cum. Pref.	1 —1¼	4 16 0	Jan, July	..	—
St.	5%	Do. 5 per Cent. Reg. Mort. Debs	92 —97	5 3 0	Jan, July	..	..
St.	5%	Madras Elec. Trams. 5% Deb. Stk.	93 —96	5 4 0	Jan, July	..	..
..	5%	†Manila Elec. Ry. $1,000 Gold Bonds	84 —88	5 14 0	Feb, Aug		
100	4/ ½	Mexico Trams Co. Com. St.	[illegible]—127½	3 16 3	..	127	[illegible]
500	5%	Do. Gen. Con. 1st Mort. 5 Gold Bds.	93¼—94¾	5 5 6	..	94½	[illegible]
St.	4½%	Montreal St. Ry. Sterling 4½ per Cent. Debs. (1922) (Nos. 600 to 2,000)	100 —102	4 8 0	Feb, Aug		
1	1/0	Perth Elec. Trams Ord	[illegible]	7 3 6	May	..	..
St.	5%	Do. 1st Mt. Db. Stock	101 —104	4 16 0	Jan, July	..	—
5	3/0	Rangoon Elec. Trams & Supply Co. 6 Cum. Pf.	5½—5⅝	5 6 6	..	.	—
St.	4½	Do. 4½% 1st Mort. Deb. Stk.	95 —100	4 10 0	..	..	—
..	[illegible]	Sao Paulo Tramway, Light & Power Co. $100 Stock	154 —158	5 14 0	..	156	[illegible]
.	5%	Do. 5 per Cent. 1st Mt. $500 Db.	98½—99½	5 0 6	June, Dec	[illegible]	[illegible]
100	4½%	Toronto Ry. Co. 1st Mt. 4½% Ster. Bonds	99 —101	4 9 0	Feb, Aug	99½	.
		COLONIAL AND FOREIGN ELECTRICITY SUPPLY &c.					
5	3 0	Adelaide Elec. S'ply Co. 6% Cu. Pr.	4¾—5¼	5 14 0	Mar, Sept	..	.
10	6/0	Bombay E. S. & T. 6% Cm. Pf.	9¾—10¼	5 14 6	..	..	..
St.	4½	Do. 4½ per Cent. Deb. Stk. (red.)	94 —96	4 13 9	Jan, July	95½	..
5	4,9	Calcutta Elec. Supply Ord.	5¾—6¼	5 17 0	April, Oct	[illegible]	
100	7/2	Canadian Gen. Elec. Co. Com. St.	100 —101	6 18 0	..	105	[illegible]
100	5%	Castner Electrolytic Alkali Co. (of U.S.A.) 1st Mort. Stl. Debs.	92 —97	5 2 6	Jan, July		
500	5%	Elect. Development Co of Ontario	84 —86	5 16 0	..	85	[illegible]
5	..	Elec. Ltg. & Trac. Co. of Aust. 6 per Cent. Cum. Pref.	2 —2½	..	Feb, Aug	..	—
St.	5%	Do. 5 per Cent. Deb Stock	84 —89	5 12 0	Jan, July	..	..
St.	5%	Elec. Supply Co. of Victoria 5 per Cent. 1st Mort. Deb. St.	90 —93	5 7 6	Jan, July		.
St.	6%	Indian Elec. Sup. & Trac. Co. Constn Deb. St. Rd.	30 —40	15 0 0	Jan, July	..	..
100	[illegible]	Kalgoorlie Elec. Power & Ltg. Ord.	[illegible]	..	..	..	..
1	[illegible]	Do. 6 per Cent. Cum. Pref.	[illegible]	8 0 0	April, Oct	..	..
St.	5%	Madras E. S. Corp. 5 per Cent. Constn Deb. St.	85 —90	5 11 0	April, Oct	..	..
500	5%	Mexican Elec. Light Co. 5% 1st Mort. Gold Bonds	[illegible]	5 15 0	..	[illegible]	[illegible]
St.	$1	Mexican Lt. & Power Co. Com. St.	[illegible]	..	..	[illegible]	[illegible]
100	5%	Do. 5% 1st Mort. Gold Bonds	[illegible]	5 [illegible] 0	..	[illegible]	[illegible]
100	[illegible]	Montreal Lt. Ht. & Power Co. Cap. St.	100 —103	5 16 [illegible]	F,My,A,N	103	.
1	1/[illegible]	River Plate Electricity Co. Ord	[illegible]—1	6 0 0	April		.
1	[illegible]	Do. 6 per Cent. non-Cum. Pref	[illegible]—1	6 0 0	May ..		..
St.	5%	Do. 5 per Cent. Deb. Stock	[illegible]	5 1 0	Jan, July		
5	3/0	Rosario Elec. Co. 6% Pref. (1 to 20,000)	[illegible]—5¼	5 14 0	April, Oct	[illegible]	[illegible]
100	$1	Shawinigan Water & Power Co. Cap. St.	[illegible]	4 16 0	..	[illegible]	[illegible]
.	5%	Do. 5 per Cent. Bds.	103 —105½	4 15 6	Jan, July	104	[illegible]
..	[illegible]	Victoria Falls Power Co. Pref.	[illegible]	—	Jan, July		..

* In calculating the yields allowance has been made for accrued interest but not for redemption. † Ex dividend. ‡ The London Stock Exchange Committee have declined to quote these

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CONTENTS OF THE CURRENT NUMBER.

NOTES.

The British Association.

FROM the report which we give elsewhere it will be seen that the meeting of the British Association now being held at Dublin, which centre has not been favoured in this respect since 1878, has every appearance of being a success. Irish enthusiasm is evident in the increased number of visitors—namely 2,145, which is considerably greater than in the last two years. From the programme so far published it will be noticed that the number of Papers dealing this year with electrical engineering topics is comparatively small, and we think that perhaps experimental physics has suffered in a similar way. To make up for any deficiency in this respect an entirely new feature, in the shape of an agricultural sub-section, over which Sir HORACE PLUNKETT presides, has been introduced. It will be felt that this is a move in the right direction, and that agriculture is essentially a subject in which the British Association may do something to advance science—more particularly when it is remembered that recent developments include the application of electricity to agriculture and horticulture, a subject which is by no means well understood, but one which is full of interest.

ON Wednesday evening last the proceedings were opened by Dr. FRANCIS DARWIN, who delivered his Presidential Address. This deals essentially with subjects of a botanical character, and although the discussion of the habits of sleeping plants makes eminently interesting reading, it can scarcely find a place in the columns of *The Electrician*. We have, therefore, been compelled to make only a brief reference to this part of the programme. In the Presidential Addresses to the various Sections, three of which will be found in abstract elsewhere, the subjects dealt with are naturally of greater interest to our readers. Mr. DUGALD CLERK, in addressing Section G, dealt historically with the subject of thermodynamics, more particularly from the point of view of the heat engine. Dr. W. N. SHAW, in addressing Section A, referred to some of the difficulties experienced in running an institution which depends almost entirely upon collecting observations, and has the difficult problem before it of distinguishing between observations which may form useful material in the future and those which can only be regarded as lumber. The problem of being progressive without being wasteful under these conditions is not easy. The address of Prof. F. S. KIPPING to the Chemical Section forms interesting reading from the fact that it deals with the difficulties surrounding the chemical industry, which difficulties are, in many ways, similar to those with which the electrical industry is troubled. No consolation is drawn from the working of the new Patents Act, though it has already resulted in the establishment of branches of two of the largest German chemical works at Ellesmere Port and at Port Sunlight. Events are, of course, moving in the same direction in the electrical industry, and particulars are now being published of a large works nearing completion at Brimsdown for the manufacture of tungsten lamps. Doubtless, this is only one of many, and we shall soon have the opportunity of seeing whether works run in this country under German supervision can be as successful as they are in Germany itself. Prof. KARL DUISBERG, at the time of the Perkin jubilee, expressed the opinion that we cannot remedy the present unsatisfactory state of affairs, because German ideals and English ideals are different. The German is more of a theorist, and does not work with the immediate prospect of pecuniary

reward; the Briton is lacking in patience. Yet, if the German has learnt to be practical there should surely be a possibility of the Briton learning to be patient. Prof. KIPPING considers a number of possible causes of our failures, but in regard to these we must refer our readers to the abstract given elsewhere. The conclusion reached is that workers in pure science must recognise that it is their duty to do all they can to promote the industrial welfare of their country, and that manufacturers must concede the paramount importance of science and the impossibility of dispensing with its counsels.

Gas Engine and Motor Breakdowns.

AN annual report which we always read with interest is that issued by Mr. M. LONGRIDGE, chief engineer to the British Engine, Boiler & Electrical Insurance Company. Our attention is, of course, directed chiefly to that section of the report which deals with the breakdowns of electrical machinery; but on the present occasion, in the abstract of the report which appears elsewhere in this issue, we draw attention to the large percentage of failures of gas engines attributable to breakage of valves and valve gears, these proving faulty much more frequently than any other part—namely, as three to one. Turning to electrical plant, we find, as a natural consequence of the conditions under which they have to operate, that the percentage of failures of electric motors is much higher than that of generators. The figures for motors and gas engines—namely, 1 in 7·9 and 1 in 11·1 respectively—appear strongly in favour of the gas engine as being the more reliable machine; but it must be remembered that the electric motor is generally placed in close proximity to the machine it drives and under most adverse conditions, and, being frequently out of sight, or nearly so, receives but scant attention as compared with the gas engine.

PROBABLY on account of the necessity of easy removal of field windings, the field connections of dynamos and motors have always been of the simplest character—generally a brass coupling with two or four screws. These latter require frequent attention, as the current carried is usually small, and no indication is given of any slackness until the wires fall out of the coupling or are accidentally pulled apart. An instance of this by no means uncommon occurrence is described in Mr. LONGRIDGE'S report. As a result of the attention paid to this constructional detail by the company, an improved method may eventually be adopted. Another interesting point referred to is the accumulation of oily fluff and dust in motor cases, a spark from the commutator sufficing to ignite such inflammable material. Fortunately the danger from such fires is confined to the motor itself, as the motor casing is usually sufficient protection against external effect. Such unforeseen occurrences are, however, a sufficient indication of the necessity of expert inspection, and we are pleased to learn that this branch of the company's business is flourishing.

Mining Dangers.

THE recent colliery disaster at Wigan with all its appalling details brings to mind the extreme risks run by those engaged in the winning of coal. Such incidents as the Maypole Pit explosion serve to lift though only too slightly the curtain veiling the scenes surrounding the daily life of the miner from the public eye; all too quickly it falls again and shuts out sight and sound of an industry ever labouring under a cloud of doubt and danger. The comparative immunity of collieries from disasters so stupendous as that at Wigan is probably due to extreme official vigilance and the improved methods of working which now obtain in mining practice. Still, considering the great number of collieries in this country alone, or even in a single coal-bearing district, the wonder is that accidents are not more frequent. The mining engineer naturally reflects upon the prospect of making colliery disasters impossible by the introduction of every conceivable precaution against them.

THE electrical engineer, on his part, has already contributed much to this end by furnishing a safe and reliable method of power transmission which, in the matter of haulage, taking this as an example, would assist in clearing men rapidly out of a mine under emergency conditions. Another example is the miner's electric safety lamp, which is a commercial product and one which can be relied upon to remain alight under conditions that would extinguish the ordinary lamp. Again, in the life-saving apparatus which is now at the command of mining engineers, in various forms, electricity figures very prominently, both for lighting and communication. The latter is a very broad question, and one which might help to solve much of the mystery surrounding colliery accidents. The mining telephone is evidently not used to the extent to which it might be, and this is the more singular because the conditions of working would appear to necessitate the establishment of reliable means of communication throughout a mine. Where a fall occurs the chances of cable breakage are not very great, and with a telephone at hand imprisoned men could easily summon help and direct the course of the rescuers. No doubt a good deal of mining work is very temporary, and the telephone might, therefore, be regarded as something altogether too elaborate or even permanent to instal as a regular feature of the working equipment. Yet telephones are portable enough, and are made expressly for use in mines under every conceivable condition of working.

Electric Traction in Sweden.—The *Elektrotechnische Zeitschrift* gives some account of the developments in this direction. It appears that conversion will take place shortly on all the lines north of Stockholm, except from Laxa to Charlottenburg, Orebro to Svanta and that from Gothenburg to Stramstad. The system will be fed from five power stations, the current being stepped down at 35 sub-stations along the lines. The total length of line so supplied will be 1,310 miles, of which 1,230 miles will be single and the rest double track. The transmission voltage will be 50,000 and that at the trolley wires 15,000. The feeder system is to be equipped with the usual protective apparatus and the feeders from all except one of the stations are in duplicate and approach the line by different routes. The sub-stations are placed about 30 miles apart, and are connected to two separate feeders, and the subsidiary feeders along the track have been so designed that under the most unfavourable conditions the drop will not exceed 15 per cent.

Cable Interruptions.	Date of Interruption.
Las Palmas–Arrecife	May 18, 1908
Jedda–Suakim	July 27, 1908
Assab–Massowah	July 28, 1908
Kwandang–Menado	Aug. 5, 1908
Cadiz–Teneriffe	Aug. 17, 1908
Lagos–Kotonou	Aug. 29, 1908

The Late Mr. London.—It is now announced that the five natives who were sentenced to death for the murder of Mr. Tom London at Mombasa last year, and who unsuccessfully petitioned the Privy Council for a rehearing of the case against them, were hanged on August 28th in the presence of a large gathering of natives, the execution taking place at the spot where the crime was committed.

Telephony in the Alps.—It is announced that constructional work is being begun for a new telephone line to the Margherita Hut, near the summit of Monte Rosa, 15,217 ft. above sea level. The new observatory on the Col. d'Ollen will be first connected, and then the line will be continued to the summit of Monte Rosa. The scheme is an Italian one and is much criticised in Switzerland, where it is stated that the glaciers and masses of ice will make the erection of poles impossible.

New German Submarine Telegraph Routes.—It is announced that a new company has been formed under the title of the German South American Telegraph Co. (Ltd.), with headquarters at Cologne, the object of which is to lay and work submarine cables from Germany to Brazil, connecting with the German colonies in West and South-West Africa, via Teneriffe, Liberia, Tongotam, and the Cameroons on to Swakopmund. The German Government is said to be subsidising the new company to ensure payment of interest and sinking fund on the debentures to be issued. The capital of the company is £1,250,000 It is said to have been stipulated, as a condition of the Government subsidy, that two-thirds of the board of directors must always be of German nationality and reside in Germany. Messrs. Felten & Guilleaume-Lahmeyerwerke A.G., of Carlswerke, who originally obtained the concession and have transferred it to the new company, will, it is further announced, make and lay the new cables, and negotiations are said to be going on with the Brazilian Government with regard to the laying of the section of cable which is to land at or near Pernambuco.

Measurement of the Temperature of Electrical Machines.—A recent issue of *La Lumière Electrique* contains an article by F. Leconte on this subject. He describes a very delicate thermometer which can be introduced between the armature coils and on which 0·2 of a degree can be read with ease. The thermometer tube is filled with compressed nitrogen, which keeps the mercury continuous. Experiments show that the readings of ordinary thermometers are always below the real temperature, and that though the above thermometer has also a slight error it is more nearly correct. In discussing the various methods available for taking the temperature of machines, the author inveighs against the use of cotton pads for covering the thermometer. This arrangement often causes the thermometer to register low on account of the inadvertent contact of the hand. The thermometer should simply rest on the commutator, and should be moved about in a tangential direction until a maximum reading is obtained. Friction between the thermometer and the commutator has little effect, while rotating the machine with the thermometer pressing against it, instead of increasing the reading owing to the latter cause, lowers it owing to the air currents set up. Eddy currents cause a slight heating of the mercury, but the effect is so small that it may be neglected. To sum up, when the thermometer is simply resting on the commutator, pressure raises the temperature some 1½ deg., and the method seems accurate enough for practical purposes. It possesses the advantage that the temperature can be read off at any instant without difficulty and curves plotted.

Wireless Telegraph Notes.—A recent article in the *Dresdener Nachrichten* deals with the application of wireless telegraphy to balloon work. It says :—

The spark system of telegraphy is of exceptional value in its application to dirigible balloons. When despatched on a reconnoitring tour these balloons are compelled to return whenever they wish to communicate observations. This necessitates the employment of comparatively large numbers of balloons to ensure continuity of service. The case, however, is altered when a balloon can remain stationary in any locality and is able to report to headquarters by means of wireless telephony or telegraphy. Protracted experiments in wireless communication between balloons have lately been carried out, especially in England and the United States, the result being that, though messages could be received by those operating the balloon it was not possible to transmit them. The receiving has been found a simple matter, since the production of electrical sparks is not necessary, whereas transmission is impossible without producing sparks. Hence the employment of wireless telegraphy gave rise to serious misgivings. It was assumed, in the first place, that nothing could be done without an earth connection, till it was recognised that a balloon could be "balanced" by the aid of a large wire net. Against this was set the undue hampering of the balloon. The main objection was lest the production of sparks by the inductor and the discharge of a volume of hydrogen gas into the surrounding atmosphere should lead to an explosion. Various experiments carried out in Germany have shown, however, that an insulating appliance can be fitted by which this danger would be, if not entirely excluded, at least reduced to a minimum. The fact has been established, moreover, that messages can be transmitted from balloons even though there is no earth connection. Experiments lately made with this object in conjunction with the wireless telegraph station at Nauen proved eminently satisfactory, and are being continued by the 1st Telegraph Battalion. In expert military circles in Germany it is considered that the problem of both transmission and reception of wireless messages from one balloon to another, and with terra firma, is approaching its solution.

It is announced that arrangements have been completed for enabling passengers on the Dover-Ostend mail steamers to send wireless telegrams to the English coast at the rate of 1½d. per word for the first ten words and 1d. for each subsequent word.

It is also officially announced that the charge for private wireless telegrams exchanged with H.M. ships through coast stations belonging to the Marconi Company will in future be 6d. per word without a minimum. The additional charge for inland transmission will remain as before (½d. per word) with a minimum of 6d. per message. A message of eight words will cost 4s. 6d.

A Berlin correspondent states that a wireless telegram has been received from the steamer "Kaiserin Augusta Victoria," notifying that Dr. Polis, director of the Meteorological Observatory at Aix-la-Chapelle, is continuing his experiments in transmitting meteorological observations at sea between New York and England by means of wireless telegraphy. Dr. Polis has succeeded in receiving weather reports from America at a distance of 800 nautical miles from the U.S. coast, while reports from Europe were, it is stated, picked up 1,200 nautical miles from the English coast.

According to the *Electrical Review* (N.Y.) a wireless station will be erected by the U.S. Navy Department in Prince William Sound, Alaska, about 500 miles from the military wireless station now being installed at Fort Gibbon. The new station will form a link between Prince William Sound and the naval wireless station at North Head, Washington. The Government will thus be able to maintain wireless communication along the Pacific coast to the Alaska station.

A wireless telegraph station to operate between San José del Cabo and Mazatlan (Mexico) will shortly be working. Mazatlan is also to be connected by wireless telegraphy with Lower California by the erection of a station at the former place.

ARRANGEMENTS FOR THE WEEK.

BRITISH ASSOCIATION (SECTION G—ENGINEERING) AT DUBLIN

FRIDAY, September 4th (to-day).

Report of the Committee on Gaseous Explosions, to be read and discussed in joint meeting with Sections A and B.

MONDAY, September 7th.

"Producer Gas," by Mr. P. Emerson Dowson; "Suction Gas Producers," by Mr. P. W. Robson; and "The Utilisation of Peat for making Gas or Charcoal," by Capt. H. Riall Sankey, R.A.

TUESDAY, September 8th.

"The Laws of Flight," by Mr. F. W. Lanchester; "The Causes of Wear in Motor Vehicle Machinery," by Mr. F. H. Royce; "On a Fundamental Error in the Theory of Power Transmission by Belts," by Mr. W. Worby Beaumont.

Other Papers to be read on dates to be announced :—

"A Clock-driving Mechanism for Equatorial Telescopes," by Sir Howard Grubb, F.R.S.; "Experiments on Rotating Discs," by Messrs. J. Brown, F.R.S., and Maurice F. Fitzgerald; "Strength of Solid Round-ended Columns," by Prof. W. E. Lilly; "Rail-less Traction," by Mr. F. Douglas Fox; "On the Study of Breakages," by Mr. W. Rosenhain.

ALTERNATING CURRENT COMMUTATOR MOTORS.*

BY DR. RUDOLF GOLDSCHMIDT.

(*Continued from page 712.*)

Summary.—In this article the author discusses the theory of the single-phase commutator motor. The production of the field is first considered, and then the shunt and series methods of excitation, it being shown that the simple shunt is an impossible method. The characteristics of the ideal series motor are then given in some detail, after which the complications and difficulties encountered in the real motor are considered, including commutation and the circulating currents in the short-circuited coils. Finally, the various losses are considered.

8. The Core Loss.

It is not our intention to go into the very complex question of the calculation of core loss generally, to study the influence of eddy currents, its dependency on filling the slots of the machine and other causes, which tend to increase the core losses in any machine, alternator, induction motor or direct-current generator. We take it to be a well-known fact that we cannot obtain exact results if we are to calculate the core loss, using a hysteresis curve, determined experimentally from a sample of the iron. The actual losses come out to be double, and even three or four times, as much as found by simply multiplying the volume of the iron by the loss per unit at the working density taken from the above-mentioned curve. It is only the special behaviour of the alternating-current motor with regard to core loss we wish to point out. In the stationary part the flux changes at the well-known periodicity and the losses can be calculated just as for the stator of an induction motor. There are losses in the pole face due to the armature reaction sending the flux through it and increasing the density at certain places,

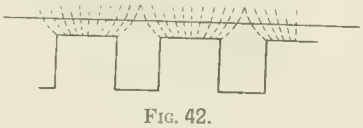


Fig. 42.

at others weakening it. If the machine is compensated, this flux from the armature will disappear, but in place of it quite an appreciable leakage flux around the slots, which carry the compensating winding, will establish itself and increase the losses. If the slots of the armature are very wide compared with the air-gap, hysteresis losses and a small amount of eddy currents will be produced in the pole face, due to the movement of the armature teeth from which the flux issues. This loss affects only a small zone where the flux is not uniform, it penetrates the pole to an extent somewhere near a quarter of the slot width (Fig. 42). The peculiar character of the hysteresis in the armature is caused by the flux having an alternating character to start with, and at the same time the iron revolving relative to it. The hysteresis loss, say in a tooth of the armature, is dependent only on the number of cycles of magnetisation it passes through and on the maximum density obtained. The difficulty lies in the fact that neither one nor the other is strictly defined. Supposing a motor runs at half its synchronous speed, and consider a certain tooth which is exactly in the neutral position between two poles at the moment when the flux is zero; whilst the flux is rising to its maximum value the tooth moves a quarter of the pole pitch. During the following quarter of the cycle the flux falls to zero whilst the tooth comes to the centre of the pole, &c., as indicated in curve I, Figs. 43 and 44A. We see that the tooth in question would be magnetised and demagnetised at double the frequency of the current. Another tooth, say one which is in the centre of the pole at the moment when the flux is zero, will be in the neutral position when the flux is zero again. Then the magnetisation changes its sign, whilst the tooth is moving into the sphere of the following pole. Through this double change the tooth receives again a magnetisation in the same direction, so that two half-loops of hysteresis are formed instead of a complete loop, as with the tooth considered first (curve II, Figs. 43 and 44B). If we were to investigate the process of magnetisation for different points of the teeth, or of the armature core proper, we should find that the character of the cycles of magnetisation which the different parts of the core have to undergo differ vastly from one another. They change with the speed, and the law which the losses follow being different for hysteresis and eddy currents is not simple to determine, as is apparent from this brief investigation. To come to a practical result we shall make use of a method largely applied to single-phase induction motors.

An alternating magnetic field is defined by its change of intensity, the locality always remaining the same. This distinguishes it from a regular revolving field which remains constant in intensity but revolves at a constant velocity. An alternating field can be replaced by two revolving fields rotating synchronously in opposite directions, both equal in

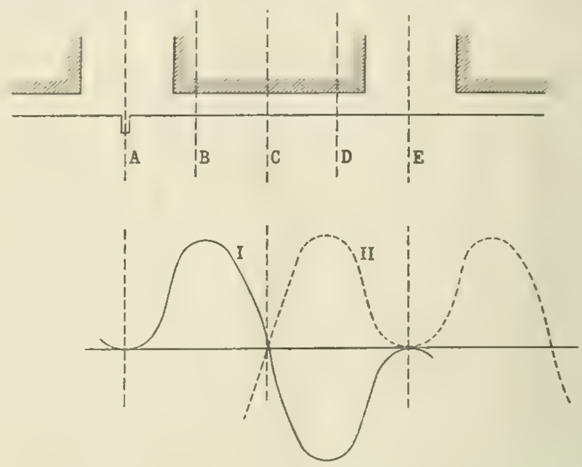


Fig. 43.

strength, the latter being half that of the original alternating field. This resolution of the alternating into two revolving fields is correct only if the flux distribution of the former is sinusoidal, and, further, it is correct only if we wish to study inductive effects. The first of these conditions is not fulfilled in our case, but by introducing a correction we may put up with this inaccuracy. The inductive effect in our case is represented by the eddy current loss which, as pointed out, is larger than the hysteresis loss in practice, and we might, therefore, consider the whole of the core loss as following the same law as that of the eddy currents. Actually the hysteresis is proportional to the frequency and to (density)$^{1.6}$, the eddy currents

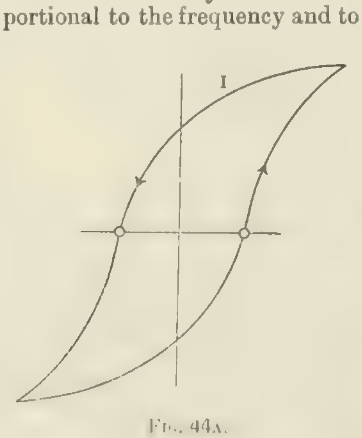


Fig. 44A.

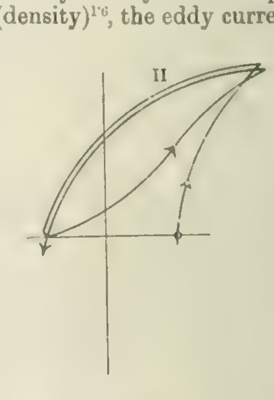


Fig. 44B.

to the (frequency)^2 and (density)^2, but as a whole the results obtained by considering the total loss as eddy-current loss only will give us an idea of what is actually happening. We will not go into the details of the mathematical proof, that resolving the alternating field into two revolving components is correct, but we can see at once that when the two revolving fluxes of half the intensity of the original flux are in the same direction they give the full value (Fig. 45A) and that half a period later, when the alternating flux is zero, the revolving ones come into opposition, cancelling one another (Fig. 45B).

When the armature is stationary (speed zero) only the teeth under the pole and the back of the armature take part in the

hysteresis loss. We will take as a basis the core losses which would be caused in the armature if magnetised under these conditions and put

$$P_{s0} = C_0 \times 0{\cdot}85 \times v^2 \times B^2.$$

B here stands for the highest density in teeth and back. The factor 0·85 comes in because only a portion of the teeth take part in the magnetisation; it is dependent on the ratio of pole width to pole-pitch. With sinusoidal flux distribution this figure would be $1/\sqrt{2} = 0{\cdot}71$. The two component revolving fluxes have equal speeds under these conditions and cause the losses

$$P'_s = P''_s = C \times v^2 \times \left(\frac{B}{2}\right)^2,$$

or $$P_{s0} = 0{\cdot}85 \times C_0 \times v^2 \times B^2 = 2 \times C \times v^2 \times \frac{B^2}{4}.$$

Therefore $C = 1{\cdot}9 C_0$, and we find for the stationary armature:

Flux 1. Flux 2.

$$P_0 = 0{\cdot}425 \times C_0 \times v^2 \times B^2 + 0{\cdot}425 \times C_0 \times v^2 \times B^2.$$

Assuming that the armature revolves in the same direction as flux 1, the relative velocity between the latter and the armature diminishes as the speed increases and becomes zero at synchronous speed, and, therefore, at this speed

$$P_{cs1} = 0{\cdot}42 \times C_0 \times (0)^2 \times B^2 = 0.$$

On the other hand, at synchronous speed the velocity relative to the armature of the flux 2, rotating backward, is double that at the beginning. Therefore

$$P_{cs2} = 0{\cdot}42 \times C_0 \times (2v)^2 \times B^2; \quad P_{cs\,\text{total}} = 1{\cdot}7 \times C_0 \times v^2 \times B^2 = 2 \times P_0.$$

It follows that at synchronous speed the core loss is double that of the stationary motor, provided the flux is the same in both cases. If the speed is a times the synchronous speed the core loss is

$$P_c = P_0 \times (a^2 + 1). \quad . \quad . \quad . \quad . \quad . \quad (17)$$

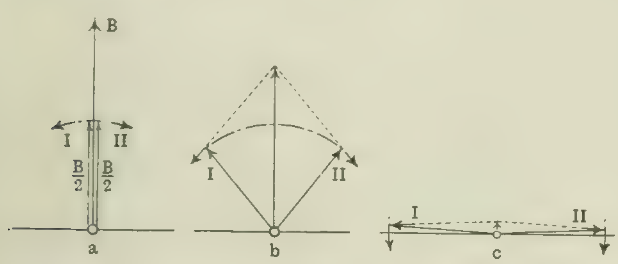


FIG. 45.

For one-half synchronous speed we find $P_{c\frac{1}{2}} = 1{\cdot}25 \times P_0$.

„ five times „ „ „ $P_{c5s} = 26$ times P_0.

With increasing speed the core loss due to the alternation of the flux is of very small influence, a^2 becoming large compared with 1 in equation (17), both fluxes revolving then in the same direction relative to the armature at speeds not so very much different from one another. If the flux were constant (direct-current excitation) we could put

$$P_{cd} = C_0 \times v^2 \times B^2 \times a^2 = 1{\cdot}18 \times P_0 \times a^2,$$

provided that the maximum density B were the same in both cases. The ratio of the losses in the same armature with direct-current and alternating excitation, with the same maximum density, is therefore $g = \frac{1{\cdot}18 \times a^2}{1 + a^2}$. Fig. 46 shows g as a function of the speed.

With a flux of sinusoidal distribution the ratio of the direct-current to the alternating-current core loss would approach the figure $\sqrt{2} = 1{\cdot}41$ instead of 1·18. We can clearly understand this relation—and this is an additional check on our two-flux method—as with very high speed the alternation of the flux proceeds comparatively very slowly, and we can consider, for short intervals, the densities in which the armature revolves to be constant, the losses being at every moment $C_0 \times (v \cdot a)^2 \times (B_{\text{momentary}})^2$, and therefore the root mean square of the losses $\frac{1}{\sqrt{2}} \times C_0 \times v^2 \times a^2 \times B^2$. Now we know that with direct current we obtain a voltage $\sqrt{2}$ times as high as with alternating current, the maximum flux being the same in both cases. If we compare the losses caused by alternating and direct-current fluxes, which are producing a given effective voltage in a certain armature, we find $g' = \left(\frac{1}{\sqrt{2}}\right)^2 \cdot g = \frac{0{\cdot}9 \cdot a^2}{1 + a^2}$, and consequently

When giving the same voltage, the core loss in an armature is smaller when excited with direct current than with alternating current.

We could split up—though not quite correctly—the losses caused by the alternating-current flux into two portions: one caused by the alternation of the flux, which is independent of the speed P_0, and the other part caused by the revolution of the armature $P_0 \times a^2$. The former is made up for electrically by the magnetisation through the field coils and causes a phase displacement between current and voltage in the latter; the part $P_0 \times a^2$ is overcome mechanically, and is felt as a reduction of the torque just as the friction in the bearings, or as the core loss in a direct-current machine, P_{cd}. We may therefore compare this loss P_{cd} with $P_0 \times a^2$, and we find that for equal effective voltages the losses are equal within 10 per cent. For the same maximum density, the core losses caused by an alternating-current flux are about 15 per cent. smaller than with direct current.

This result gives the simplest way of calculating the core loss in an alternating-current commutator motor where the maximum density has been found.

Calculate the "alternating" losses in field and armature as with a transformer (allowing for extra eddy current losses) and calculate the "revolving" core losses as with a direct-current machine, deducting 15 per cent.

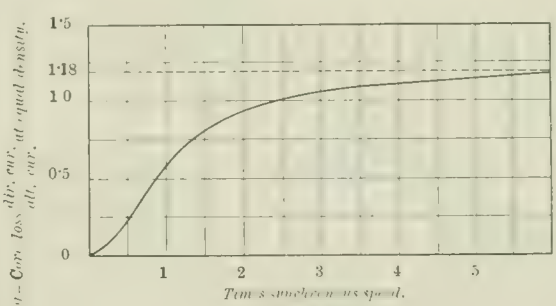


FIG. 46.

The core losses caused by the armature reaction may approximately be estimated by calculating them just as if the main flux was not there, adding about 50 per cent. for the more unfavourable distribution of lines through the influence of the main flux.

This approximate estimation is near enough, as this loss is only a fraction of the main core losses.

We have developed general formulæ for the flux dependent on the output of the machine. Utilising these formulæ in laying out a line of machines, providing sufficient section for the flux to pass, fixing approximate general dimensions in accordance with the output and estimating from these the mean length of magnetic path—this can be done very closely if one keeps in touch with fully-designed machines—the core loss can be obtained quite generally as the function of the output, periodicity and number of poles. I have carried out this investigation for machines from 3 B.H.P. to 300 B.H.P. and found that, given the number of poles and frequency, *the core loss, taken as the percentage of the output, is almost independent of the output of the machine.*

Speaking in a very broad way, the condition that, to obtain sparkless commutation, the flux must not fall below a certain figure can be expressed in the form: *the core loss of the machine must not be less than a certain percentage of the output if the machine is to run sparklessly.* Naturally by saturating teeth, poles, back of armature and yoke very little indeed—*i.e.*, by making the dimensions very much larger than necessary, or by using specially good iron and by not filing the slots—smaller figures for the percentage core loss can be obtained than those I am giving in Fig. 47.

For obtaining practical average figures, however, our data are near enough. Fig. 47 represents the "alternating" core loss only

as a percentage of the output of the machine for different numbers of poles and its dependence on the frequency. We realise at the first glance to what enormous figures the core loss rises if the frequency exceeds 25 to 30 per second. This fact is easily understood, for to obtain sparkless commutation a certain flux must be employed regardless of the frequency, and this flux fluctuating through the whole body of the machine, armature and field, must cause very high losses if the frequency of its fluctuation exceeds normal figures.

The high core loss is one of the factors—and not the most unimportant one—limiting the frequency permissible with alternating-current commutator motors. It is very interesting to see that *the limit is about the same as that imposed, for instance, by the power factor and the losses in the resistance lugs.*

To calculate the total core loss we must first divide the "alternating" core loss, as given by our curves in Fig. 47, into two portions, that in the stationary and that in the revolving part of the motor. I have found that the ratio of core loss in the rotor to the total core loss varies very little indeed with a normal design. As an average it is about 20 to 30 per cent., say, 25 per cent. As the revolving core loss at synchronous speed is equal to the alternating core loss in the rotor, the total core loss when the machine is running synchronously (750 revs. per min. at 25 cycles, 4 poles) is 25 per cent. above those figures given in Fig. 70. With a machine for 25 cycles, 4 poles, running at 750 revs. per min., the alternating core loss is 7 per cent. of the output. At synchronous speed the revolving core

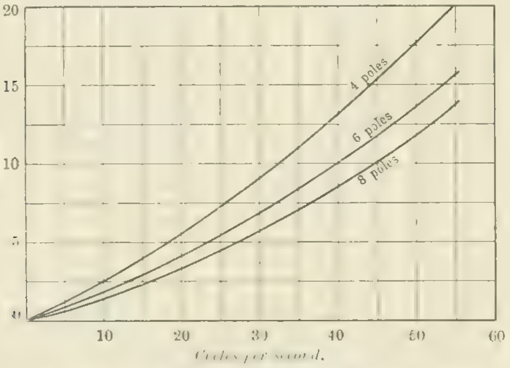


FIG. 47. CORE LOSS WITH STATIONARY ARMATURE ALTERNATING CORE LOSS AS PERCENTAGE OF OUTPUT.

loss is $0{\cdot}25 \times 7 = 1{\cdot}75$ per cent., the total $7 + 1{\cdot}75 = 8{\cdot}75$ per cent., say $\propto 9\frac{1}{2}$ per cent. of the total output, including losses through the armature reaction and eddy currents in the pole tips, &c. With 80 per cent. total efficiency the core loss would amount to $9{\cdot}5 \times 0{\cdot}80 = 7\frac{1}{2}$ per cent. of the input. With twice synchronous speed, 1,500 revs. per min., this figure would be $7 + (1{\cdot}75 \times 4) = 14$ per cent. of the output, or $16 \times 0{\cdot}8 = 12\frac{1}{2}$ per cent. of the input. The same machine, built for 750 revs. per min. 25 cycles. but having eight poles, would have an "alternating" core loss of 4·3 per cent. at 750 revs. per min.—*i.e.*, twice synchronous speed. In this case the revolving core loss, would be $4{\cdot}3 \times 0{\cdot}25 \times 2^2 = 4{\cdot}3$ per cent., the total core loss, therefore, $4{\cdot}3 + 4{\cdot}3 = 8{\cdot}6$ per cent., and inclusive reactive core loss, say $\propto 9\frac{1}{2}$ per cent. The total core loss at 750 revs. per min. is in this case the same for 4 and 8 poles. At 50 periods, 4 poles 750 revs. per min. (half synchronous) we find the "alternating" core loss 17·5 per cent., "revolving" core loss 1·1 per cent., total 16 per cent. of input. At 50 periods, 8 poles 750 revs. per min. (synchronous speed), the "alternating" core loss is 11·5 per cent., the "revolving" core loss 2·9 per cent., the total $12\frac{1}{2}$ per cent. of input.

9. The Remaining Losses.

A. *The Friction Losses.*—The friction losses of an alternating-current motor are naturally to be calculated in exactly the same way as those of any other machine. They consist of—

1. Bearing friction.
2. Windage.
3. The brush friction on the commutator.

We should go altogether beyond the scope of this treatise if we were to enter into the theory of friction generally. It is, however, essential that we should have some basis for taking account of the friction losses when making out diagrams and estimates of the efficiency. For this purpose we will use the curve Fig. 48. This curve is only correct in a very general way; it gives average figures for friction of bearing and wind-

FIG. 48.—BEARING AND WINDAGE LOSS AS PERCENTAGE OF OUTPUT.

age at different speeds. The commutator friction naturally cannot be made dependent on these two factors alone as the number of brushes and the brush pressure have the greatest influence, and this number, again, depends on the current and the current-density. The commutator diameter and the class

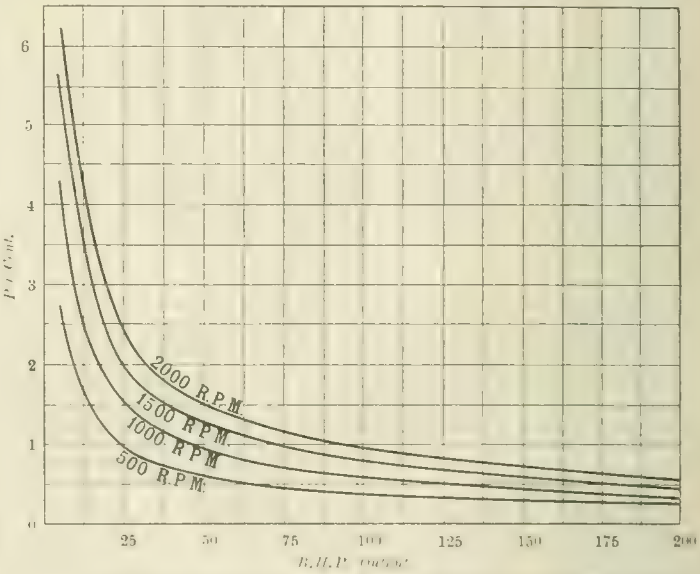


FIG. 49.—BRUSH FRICTION LOSS PER 100 AMPERES AS PERCENTAGE OF OUTPUT.

of the brush material has also considerable influence on it. Assuming a current-density of $6\frac{1}{2}$ amperes per square centimetre, a coefficient of friction of 0·30, and a pressure of 0·22 kg. per square centimetre, we obtain $\frac{1}{30}$ kg. friction per 1 ampere. With alternating-current motors, the commutator

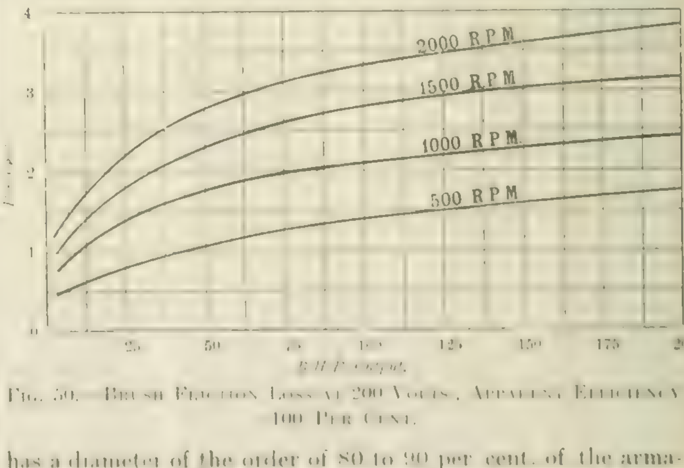


FIG. 50.—BRUSH FRICTION LOSS AT 200 VOLTS, ARMATURE EFFICIENCY 100 PER CENT.

has a diameter of the order of 80 to 90 per cent. of the armature diameter. The latter, again, is pretty closely fixed by horse power and speed, being only slightly dependent on the width of the armature if varied moderately. Resorting to practical experience on machine dimensions I have developed

a set of curves (Fig. 49), which will enable us to estimate approximately the brush friction of the motor without going into the design of the machine itself. The curves represent the brush friction loss per hundred amperes taken as a percentage of the output of the machine for different speeds and horse-power. They refer to machines for continuous rating; machines with intermittent rating have about 25 per cent. less losses than given by Fig. 49.

A general idea of the percentage brush friction loss can be gained from the curves (Fig. 50), which have been drawn up for 200 volts, the power factor and the efficiency having been assumed as 100 per cent. These figures require correction in inverse proportion to the actual voltage and actual efficiency and power factor. Thus a 250 volt motor for 200 H.P. at 750 revs. per min., with a power factor of, say, 90 per cent. and an efficiency of 85 per cent., would have a brush friction loss of about

$$2{\cdot}04 \times \frac{200}{250} \times \frac{1}{0{\cdot}9} \times \frac{1}{0{\cdot}85} = 1{\cdot}84 \times \frac{1}{0{\cdot}85} = 2{\cdot}15 \text{ per cent.}$$

of the output, or 1·84 per cent. of the input.

B. The Copper Losses.—The copper losses consist of—

1. Losses in the armature copper.
2. Losses in the compensating winding copper.
3. Losses in the field copper.

Copper losses in the armature can be obtained in a general way by a somewhat complicated process. The dimensions of the armature being approximately got by going into the design, the amount of copper to be accommodated on the surface can be found, leaving sufficient section for the teeth to carry

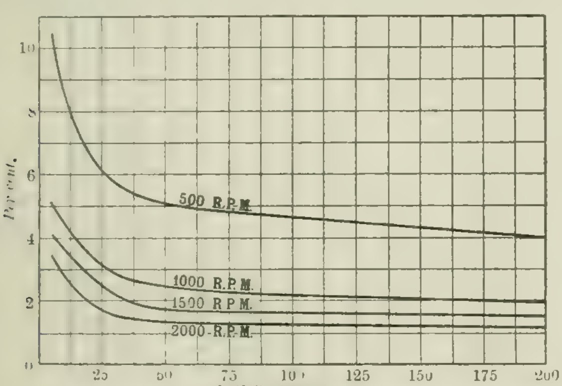


FIG. 51.—COPPER LOSS IN THE ARMATURE AS PERCENTAGE OF OUTPUT.

the necessary flux. Further, the current this copper can carry is fixed by the cooling surface. Though the method is crude it is good enough to show the law which connects the copper losses with the output, the more as I have kept sufficiently in touch with completely designed machines. The curves, Fig. 51, are the result of my investigation, giving the copper loss in the armature as a percentage of the output of the machine for different capacities and speeds, the machine having four poles. For a different number of poles we have to multiply by a constant, which is the smaller the higher the number of poles—*i.e.*, the shorter the end connections of the armature. This constant is: For six poles, 0·80; for eight poles, 0·67.

The losses in the compensating winding are closely related to those in the armature, both ampere-turns being almost equal. This winding being stationary, however, less losses are permissible. We may say, approximately, that

$$\frac{\text{Copper losses in compensating winding}}{\text{Copper losses in armature winding}} = 0{\cdot}75.$$

The losses in the main field coils depend very largely on the air-gap, but, as we saw from our former investigations on the power factor, the field ampere-turns must not be excessive compared with the armature ampere-turns, and, therefore, the loss in the field coils has some relation to the armature copper losses. With small machines the air-gap must—for mechanical considerations—be comparatively larger. We may say that with 5 H.P. to 10 H.P. machines the field loss is about 80 per cent. of the armature copper loss; with 100 H.P. to 200 H.P. machines it is only about 60 per cent.

(To be continued).

BURTON-ON-TRENT CORPORATION ELECTRICITY DEPARTMENT.

The borough electrical engineer of Burton-on-Trent is able to present a satisfactory report on the year's working to his committee. The surplus is £1,007, as against £793 in 1906-7; this amount has been partially devoted to the purchase of extra equipment, the rest being placed to the renewals fund.

Mr. Pringle, who is borough electrical engineer and tramways general manager, is placed in quite a Gilbertian situation as regards the two undertakings. In our issue of August 21st we noticed that, as tramways manager, he was deploring the increased energy consumption per car-mile, while this week, as electrical engineer, he is congratulating his committee for the same reason.

During 1907-8 there was a larger increase in units sold than in any previous year, except during the first year of the tramway load. It is satisfactory to note that the revenue from power users has increased £404, the units sold for this purpose during the year being 412,384, while the lamp connections amounted to 1,659, as against 1,341 in 1906-7.

The total units generated during the year were 1,398,014, as against 1,164,335 in 1906-7. The lighting units also increased from 310,382 to 335,550, an increase of 25,168. Last year it was hoped that the power units would exceed the traction units, but this hope has not yet been realised. The total maximum load has increased from 886 kw. to 890 kw.

We give below an analysis of the principal items of expenditure and income for the year. The total cost for the year ending March 31, 1908, are set out, together with the cost per unit for the years 1906-7 and 1907-8:—

				Cost per unit generated.	
				1907-8.	1906-7.
Works and Distribution Costs.					
Fuel	£2,363	15	8	0·472d.	0·317d.
Water, oil, &c.	347	6	1	0·070d.	0·056d.
Wages	1,229	13	6	0·246d.	0·251d.
Maintenance and repairs	897	4	7	0·180d.	0·197d.
Total Works Costs	**£4,837**	**19**	**10**	**0·968d**	**0·821d.**
Management Costs.					
Rents, rates and taxes	£738	3	10	0·140d.	0·140d.
Salaries	425	2	1	0·085d.	0·081d.
Printing and stationery	39	4	7	0·008d.	0·007d.
Loan and stock expenses	50	9	2	0·010d.	0·018d.
Fuel, light and water	—				0·005d.
Miscellaneous	126	2	8	0·025d.	0·011d.
Insurance	35	14	2	0·007d.	0·007d.
Total Management Costs	**£1,414**	**16**	**6**	**0·275d.**	**0·269d.**
TOTAL OPERATING EXPENSES (excluding Capital Charges)	**£6,252**	**16**	**4**	**1·243d.**	**1·090d.**
Capital Charges, &c.					
Bank interest	£46	16	3	0·009d.	0·009d.
Interest	2,218	7	0	0·444d.	0·361d.
Repayment	1,809	1	8	0·361d.	0·363d.
Sinking fund	926	11	7	0·185d.	0·303d.
Wetmore-road cottages	47	3	2	0·009d.	0·007d.
TOTAL CAPITAL CHARGES	**£5,047**	**19**	**8**	**1·008d.**	**1·043d.**
TOTAL EXPENDITURE (including Capital Charges)	**£11,300**	**16**	**0**	**2·251d.**	**2·133d.**
TOTAL RECEIPTS	**£12,308**	**14**	**9**	**2·461d.**	**2·293d.**
SURPLUS	**£1,007**	**18**	**9**	**0·210d.**	**0·160d.**

This surplus was carried to the renewal funds. No statement as to capital expenditure is given in the report.

WIRELESS TELEPHONY.*

BY REGINALD A. FESSENDEN.

(Continued from page 761.)

Summary.—The author first gives a brief history of the development of wireless signalling, proceeding to describe the method and apparatus used in wireless telephony. He also discusses its possibilities and how its development has been retarded.

5. *Period* 1898-1902. A. *Development and Perfecting of Sustained Oscillation-non-microphonic Receiver Method* (a). *The Current-operated Receiver.*—The first essential for the development of the system was, of course, a quantitatively responsive receiver. Several forms

* Abstract of a Paper presented at the 25th annual Convention of the American Institute of Electrical Engineers, June-July, 1908.

of this were tried, including the modification of the Boys radio-micrometer (consisting of a light thermo-couple suspended in the field of a permanent magnet and heated by radiation from a wire which in turn was heated by the current to be detected), described by the author at the Columbus meeting of the American Association in 1897.[1] This was abandoned in favour of Prof. Elihu Thomson's alternating-current galvanometer[2] suitably modified for telegraphic work.[3] Among other forms of current-operated receiver may be mentioned the following :—

The *Hot-wire-Barretter*,[4] consisting of a minute platinum wire a few hundred thousandths of an inch in diameter and approximately a hundredth of an inch in length. The term "barretter" was coined for this device for the reason that it differs essentially from the bolometer of Langley, in that it is arranged to be affected by external sources of radiant heat as little as possible, instead of as much as possible, and, to have an extremely small specific heat, an object not sought in the case of the bolometer.

The *Liquid Barretter*,[5] in which the change of resistance is effected by heating a liquid, the concentration of path being obtained by means of a fine platinum wire point. Some question has been raised as to the theory of operation of this device, but I think there is no question but that the effect is due to heat, though what percentage of the effect is due to change in ohmic conductivity by heat and what percentage is due to depolarisation by heat is still, as originally stated by the author,[6] uncertain. The facts that the device operates practically equally well irrespective of which terminal is connected to the local battery, and that the effect varies as the square of the alternating current (as a heat operated device should do) instead of directly with the alternating current as a rectifier would do, and that depolarisation is produced by the heat, have been confirmed by Dr. L. W. Austin.[7] The author has experimentally determined the fact that though the electrical impulses may have a duration of less than a millionth part of a second the change in resistance persists for approximately the tenth thousandth part of a second, which would seem to show conclusively that the action is not a *direct* effect of the waves.

(*b*) *Methods of Obtaining Sustained Oscillations. 1. Spark-gap and Local Oscillatory or "tank" Circuit.*—Prof. E. Thomson discovered that by using a transformer without an iron core (the well-known Elihu Thomson air-core transformer, later used by Tesla and others), and a spark-gap and condenser in the primary circuit, and with the secondary circuit suitably tuned, great resonant rises of potential could be obtained. In 1892 he constructed such a transformer giving discharges 64 inches long.[8] The same method was later used by Tesla[9] in his experimental researches and in his attempt to carry out Loomis's[10] method of transmitting a current through a hypothetical conducting stratum in the upper regions of the atmosphere.

The device, suitably modified for wireless telegraphic purposes, so as to give instead of a continuously cumulative rise of potential an initial rise of potential followed by a gradual feeding-in of the energy from the local circuit to supply the energy lost from radiation, was made use of in 1898 for the purpose of producing prolonged trains of sustained waves. Various types of connection between the antenna and the local oscillatory circuit were tested but it was found that the most efficient results were obtained by connecting the local circuit directly across the spark-gap.[11]

The results of some comparative tests are here given. The figures in column A are for the local circuit connected directly to the terminals of the spark-gap, those in column B are for an auto-transformer, and those in column C for a loose coupled primary and secondary.

	A	B	C
Frequency	212,000	212,000	212,000
Tank capacity	0.072 m.f.	0.072 m.f.	0.072 m.f.
Kw. output of dynamo	30	30	30
Tank current	100 amps.	370 amps.	300 amps.
Antenna current ...	18.5	16	18

The large station at Brant Rock is operated with the local circuit directly connected across the spark-gap, partly because the efficiency is somewhat greater, but also on account of the great simplification of connection and the fact that the degree of sustainment of the wave train may be adjusted very simply, if desired, by sliding the lower terminal of the antenna along a few inches of the lead of the local oscillatory circuit.

Cooper Hewitt[1] in 1902 used a modification of his mercury lamp to obtain intermittent discharges each followed by a train of high frequency oscillations.

2. *Arc Methods.*—The worker with high-frequency oscillatory currents will soon discover that we are indebted to the genius of Prof. E. Thomson for practically every device of any importance in this art. The method of producing high-frequency oscillations from an arc and continuous current was discovered by him in 1892.[2] Fig. 1, taken from his patent, shows the general form of his arrangement. If the directions given in the specification are followed, no difficulty will be met with in obtaining frequencies as high as 50,000 per second. Between 1900 and 1902 some experiments were carried out with the Elihu Thomson arc as a source of high-frequency oscillations for wireless telegraphy and telephony. Some difficulties were found, for example the arc could not be started and stopped as quickly as was necessary for telegraphic purposes and the intensity of the oscillations and their frequency varied considerably. These were overcome by making some minor improvements, for example, the difficulty in sending was overcome by permitting the arc to run continuously and using the key to change the electrical constants of the circuits.[3] The difficulty in keeping the intensity and frequency constant was overcome by substituting resistance for a portion of the inductance, and also by using the arc under pressure.[4]

Tests made by Dr. Austin[5] show that, with this method, frequencies as high as 3,000,000 per second and efficiencies as high as 60 per cent. can be obtained, together with an absolutely steady generation of the high-frequency currents and an absence of harmonic frequencies.

3. *High-Frequency Alternator.*—The first high-frequency alternator was built by Prof. E. Thomson in 1889.[6] And it was while experimenting with it in 1900 that Dr. Thomson made his very interesting discovery that high-frequency currents of large amperage could be passed through the body without injury.[7] From 1898 to 1900 numerous experiments were made on antennæ of large capacity, and it was found that instead of using sheets of solid metal or wire netting, single wires could be placed at a considerable fraction of the wave-length apart and yet give practically the same capacity effect as if the space between them were filled with solid conductors.

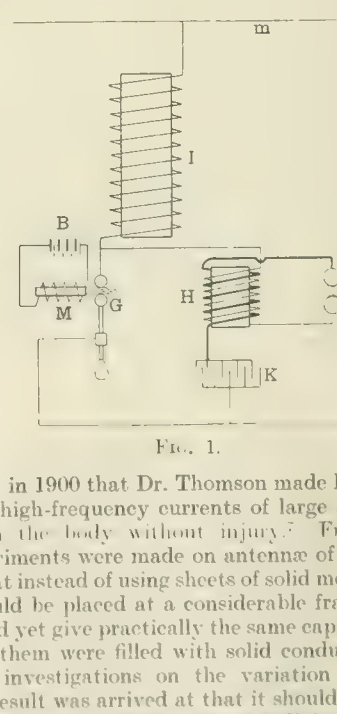


FIG. 1.

From other investigations on the variation of radiation with frequency the result was arrived at that it should be possible to construct an alternating current dynamo of sufficiently high frequency and output to give ample radiation for wireless telegraphic purposes.[8] In 1900 a leading American electrical manufacturing company consented to take up the construction of such a dynamo. As a preliminary, a dynamo of 1 kw. output and 10,000 cycles was built in 1902. By the summer of 1906 many of the difficulties had been overcome and a machine giving 50,000 cycles was installed at the Brant Rock wireless station. Various improvements were made by the author's assistants, and in the fall of 1906 the dynamo was working regularly at 75,000 cycles, with an output of half a kilowatt.

[1] *The Electrician*, June 21, 1904.
[2] Elihu Thomson, U.S. patent 363,185 (1887).
[3] U.S. patents 706,736 and 706,737 (1899).
[4] U.S. patent 706,744 (1902).
[5] U.S. patent 727,331 (1903).
[6] *The Electrician*, June 24, 1904.
[7] Austin, *Bulletin* of the Bureau of Standards, Vol. II., No. 2.
[8] *Electrical World*, February 20 and 27, 1892.
[9] U.S. patent [illegible] (189[illegible]).
[10] Loomis, U.S. patent 129,971 (1872).
[11] U.S. patents 706,735 and 706,736 (1899).

[1] Cooper Hewitt, U.S. patent 780,999 (1902).
[2] Elihu Thomson, U.S. patent 500,630 (1892).
[3] U.S. patents 706,742 (1902), 706,747 (1901), 727,330 (1903), 730,753 (1903).
[4] *Ibid.* and U.S. patent 706,741.
[5] Austin, *Bulletin* of the Bureau of Standards, Vol. III., No. 2.
[6] Thomson, *Electrical Engineer* (N.Y.), July 30, 1890, and *The Electrician*, Sept. 12, 1890.
[7] Thomson, *Electrical Engineer* (N.Y.), March 11, 1891.
[8] U.S. patent 706,737 (1901).

and was being used for telephoning to Plymouth, a distance of approximately 11 miles. In the following year machines were constructed having a frequency of 100,000 cycles per second and outputs of 1 and 2 kw. The credit for the development of this machine is due to Messrs. Steinmetz, Haskins, Alexanderson, Dempster and Geisenhoner and also to the author's assistants, Messrs. Stein and Mansbendel.

(c) *Closed Tuned Circuits.*—In 1898 the open tuned circuits originally used were discarded for closed tuned circuits[1], and it was discovered that valuable selective effects could be obtained by placing the condenser in shunt to the inductance instead of in series with it.[2]

(d) *Combination of Wave and Group Tuning.*—The fact that, if selectivity is obtained solely by tuning to wave frequencies, the number of stations is limited, was appreciated at an early date. In 1900[3] a new method was developed, the stations being tuned both to the wave frequency and to an independent or group frequency, so that stations might obtain selectivity by varying either the wave or the group frequency and thus have at their disposal a virtually unlimited number of combinations and be practically free from atmospheric disturbances.

(e) *Further Development of Damped Wave-coherer Method.*—Marconi by 1898 had carried the development of the filings coherer to its maximum point. Lodge in 1897[4] had disclosed the open secondary circuit for receiving. Marconi in 1898[5] greatly improved this by adjusting the length of the secondary so as to tune it, and by the aid of this improvement was enabled to telegraph a distance of 35 miles[6] in October, 1899. Lodge in 1902[7] invented what is perhaps the most perfect form of coherer, consisting of a thin steel disc dipping in oil covered mercury and automatically decohered by being kept in continuous rotation.

A number of self-restoring coherers, of which the Brown[8] carbon coherer may be taken as a type, including the mercury carbon coherer of Solari, came into more or less extended use, and also modifications of the imperfect contact receiver of Neugschwender.[9]

The small progress made along these lines is to be explained by the fact that the damped wave-coherer system is essentially and fundamentally incapable of development into a practical system.

Period 1902–1908. *Later Developments.*—Progress in Europe since 1902 has been marked by the gradual abandonment of the elements of the damped wave-coherer system and the substitution of elements of the sustained wave non-microphonic contact type. In 1900[10] Marconi substituted for the plain aerial an aerial with the author's tuned local circuit or tank circuit for sending, thus obtaining a considerable increase in range of transmission. In 1902, Marconi invented a very ingenious form of current-operated receiver, called the magnetic detector,[11] and with this combination achieved some very remarkable results. In 1905 Prof. J. A. Fleming[12] invented a very efficient detector based on the "Edison effect" in incandescent lamps and the observations of Elster and Geitel[13] on the rectifying effect of such an arrangement on Hertzian oscillations.

Virtually nothing was done in Europe in the way of producing sustained oscillations by the arc or high-frequency method until recently, possibly because of Duddell's erroneous statement[14] to the effect that frequencies much above 10,000 could not be obtained by the Elihu Thomson arc method, and Fleming's statement[15] that an abrupt impulse was necessary and that high-frequency currents, even if of sufficient frequency, could not produce radiation.

In 1903 Poulsen[16] invented an interesting modification of the Elihu Thomson arc, which consists in forming the arc in hydrogen instead of in air or compressed gas as previously done. This modification is not, however, so efficient as the older methods and gives oscillations varying in amplitude and intensity and accompanied by strong harmonics,[17] but I have considered it worth mentioning on account of the amount of interest it appears to have excited in Europe.

Some very important and interesting papers on electrical oscillations were published during these years by Oberbeck,[1] Wien,[2] Drude[3] and Bjerknes.[4]

[1] U.S. patents 706,735 and 706,736 (1899). [2] *Ibid.*
[3] U.S. patents 727,325 (1900) and 727,330 (1903).
[4] Lodge, Great Britain patent, 11,575 (1897).
[5] Marconi, Great Britain patent 12,326 (1898).
[6] Official report U.S. Navy of test U.S. ss. "Massachusetts," Oct., 1899.
[7] Lodge, Muirhead and Robinson, Great Britain patent 13,521 (1902).
[8] Brown and Neilson, Great Britain patent 28,955 (1896).
[9] A. Neugschwender, *Wied. Ann. der Physik*, 1899, Vol. LXVII., p. 430.
[10] Marconi, Great Britain patent 7,777 (1900).
[11] Marconi, Great Britain patent 10,245 (1902).
[12] Fleming, *Proceedings* Royal Society, London, 1905, Vol. LXXIV., Also *The Electrician*, Vol. LVI. p., 1012.
[13] Elster and Geitel, *Wied. Ann der Physik*, Vol. LII., p. 433.
[14] Duddell, *The Electrician*, 1903, Vol. LI., p. 902.
[15] Fleming, *Proceedings* of the International Congress, St Louis 1904, Vol. III., p. 603.
[16] Poulsen, U.S. patent 789,449 (1903).
[17] Austin, *Bulletin* of the Bureau of Standards, Vol. III., No. 2.

In America the development of the sustained oscillation non-microphonic system has proceeded steadily, and may now be said to have reached the stage of commercial practicability.

Following are some of the later types of detectors :—

The *frictional receiver*,[5] in which the waves produce a change of friction between two moving surfaces and so cause an indication. The *heterodyne receiver*,[6] in which a local field of force actuated by a continuous source of high-frequency oscillations interacts with a field produced by the received oscillations and creates beats of an audible frequency. The so-called *thermoelectric receivers* of Austin[7], Pickard[8] and Dunwoody[9]. The "*audion*" *of de Forest*,[10] a very interesting and sensitive device, which though superficially resembling Prof. Fleming's rectifier appears to act on an entirely different principle. The *Cooper Hewitt mercury receiver*, about which little is known but which appears to be very sensitive.

Following are some of the later methods of producing sustained oscillations :—*The substitution of a number of arcs in series having terminals of large heat capacity* in place of the single arc in the arc method.[11] The *use of regulating or "flywheel" circuits* in connection with the arc method.[12] The *method of producing oscillations* by using two arcs and throwing the discharge from one side to the other alternately at a frequency regulated by the constants of the electric circuit.[13] The *condenser dynamo*[14] which consists of two radially slotted discs separated by a mica diaphragm, charged by a continuous current source of potential, and rotating in opposite directions. The *two-phase high-frequency dynamo method.*[15] The *commutator method.*[16] In this method the high frequency is produced by means of a ball rotating at high speed on the interior surface of a commutator. The *helium arc method*,[17] in which the arc is produced in helium or argon or similar gases. The *critical pressure method*,[18] in which the electrodes extend within a certain critical distance, depending upon the pressure used, so that the discharge always passes at the same voltage irrespective of the distance between the electrodes.

Methods of Signalling.—*Continuous production of waves* but changing constants of sending circuit.[19] The *inverted method* of sending and the method of signalling by sending dots, the interpretation of which is determined by similar commutators at the sending and receiving stations.

Duplex and Multiplex Methods.—A considerable number of these have been worked out, mostly operating either by balance methods[20] or commutators.[21] It is impossible to discuss all the various improvements, such for example as the method of indicating the busy and free state of a station, the methods of sending and receiving in one direction, the various types of aerials used for receiving the other components of the electromagnetic waves besides the electrostatic component, &c.

C. Theory of Wireless Telephony.

For wireless telephony three things are necessary :

1. Means for radiating a stream of electrical waves sufficiently continuous to transmit the upper harmonics on which the quality of the talking depends.

2. Means for modulating this stream of waves in accordance with the sound waves.

3. A continuously responsive receiver giving indications proportional to the energy received and capable of responding with sufficient rapidity to the speech harmonics.

Work on the wireless telephone was commenced before a satisfactory means was discovered for producing sustained oscillations.

To ascertain the number of sparks per second which was necessary to determine articulate speech, a phonograph cylinder was taken and grooves were cut in it longitudinally. It was found in this way that practical transmission could be accomplished with 10,000 breaks per second. It is believed now that this number is unnecessarily high, possibly owing to the fact that it was impossible to cut the grooves on the cylinder without producing ridges. The lower limit may be fixed in another way.

[1] *Wied. Ann der Physik*, Vol. LV., 1895. [2] *Ibid.* Vol. VIII., 1902.
[3] *Ibid.* Vol. XIII., 1904. [4] Bjerknes, *Ibid.* Vol. XLIV., 1891, and Vol. XLVII., 1892.
[5] U.S. application 251,538 (1905). [6] U.S. application 271,539 (1905).
[7] Austin, U.S. application 319,241 (1906).
[8] Pickard, U.S. application 342,465 (1906).
[9] Dunwoody, patent 837,616 (1906).
[10] De Forest, U.S. patent 836,070 (1906).
[11] U.S. application 291,737 (1905). [12] *Ibid.* [13] *Ibid.*
[14] U.S. application 291,739 (1905). [15] U.S. patent 793,649 (1905).
[16] U.S. application 316,521 (1906). [17] U.S. application 351,560 (1907).
[18] U.S. application 355,787 (1907).
[19] U.S. patents 706,747 (1901). 706,742 (1902). 727,747 (1903).
[20] U.S. application 366,528 (1907). [21] U.S. patent 793,652 (1905).

D

Electrical circuits met with in actual working have resistance, self-inductance, capacity, and leakance. Heaviside gave the differential equations for the pressure and current over such circuits when alternating voltages were applied, but no method of solution being known the mathematical treatment of such circuits was restricted to cases where one of the constants was neglected, until Dr. A. E. Kennelly, in a masterly series of Papers, gave the complete solution.

The results were immediately found applicable to a great variety of problems, such as the transmission of signals through cables and of telephonic speech through various types of circuits.

In this way, Dr. Kennelly[1] by comparing the results obtained by Dr. H. V. Hayes[2] in practical telephonic transmission over loaded lines with the theoretical values of the current for different harmonics showed that harmonics above 2,000 per second could be neglected for telephonic transmission. The author has never succeeded in obtaining good talking with such a low frequency, but under favourable conditions fairly satisfactory speech may be obtained with 5,000 interruptions per second. For really good transmission, however, the radiation must be practically continuous, for if the spark frequency is less than 20,000 per second there is a disagreeable high pitch note in the telephone, not noticeable perhaps at first, but apt to become annoying with use. The most satisfactory way is, of course, to use a source of sustained oscillations.

It fortunately happens that for wireless telephonic purposes it is inadvisable to use a wave frequency of less than 25,000 per second, on account of the difficulty in radiating energy with low frequencies. The receiver must, of course, be continuously responsive. If, for example, it had to be tapped back in order to restore it to the responsive condition, speech could not be transmitted. It must also give indications proportional to the energy received or the character of the speech will be distorted. It must also respond with sufficient rapidity. If, for example, it takes a thousandth of a second to restore itself to its original resistance the receiver will obviously not record the higher harmonics. I have experimentally determined that a receiver which restores itself in the ten thousandth part of a second acts with sufficient rapidity.

D. History of the Development of Wireless Telephony.

The author has been asked on several occasions how the wireless telephone came to be invented. In November, 1899, shortly prior to the delivery of my previous Paper,[3] while experimenting with the receiver shown in Fig. 3 of that Paper, I made some experiments with a Wehnelt interrupter for operating the induction coil used for sending. In the receiver mentioned the ring of a short-period Elihu Thomson oscillating current galvanometer rests on three supports, *i.e.*, two pivots and a carbon block, and a telephone receiver is in circuit with the carbon block. A storage battery being used in the receiver circuit,[4] it was noticed that when the sending key was kept down at the sending station for a long dash the peculiar wailing sound of the Wehnelt interrupter was reproduced with absolute fidelity in the receiving telephone. It at once suggested itself that by using a source with a frequency above audibility wireless telephony could be accomplished. Prof. Kintner, who was at that time assisting me in these experiments and to whose aid their success is very largely due, was kind enough to make the drawings for an interrupter to give 10,000 breaks per second. Mr. Brashear, the celebrated optician, kindly consented to make up the apparatus, and it was completed in January or February, 1900.

The experimental work was, however, delayed, as the author was at that time transferring his laboratory from Allegheny, Pa., to Rock Point, Md., and it was not until six months later that the stations at that point were completed and a suitable mast was erected for trying the apparatus. The first experiments were made in the fall of 1900 with the above-mentioned apparatus, which was supposed to give 10,000 sparks per second, but which probably gave less. Transmission over a distance of one mile was attained, but the character of the speech was not good, and it was accompanied by an extremely loud and disagreeable noise, due to the irregularity of the spark.

By the end of 1903 fairly satisfactory speech had been obtained by the arc method above referred to, but it was still accompanied by a disagreeable hissing noise. In 1904 and 1905, both the arc method and another method, in which the 10,000 cycle alternator above referred to was employed, had been developed to such an extent that the apparatus could be used practically, and sets were advertised and tendered to the U.S. Government.[5] The transmission was, however, still not absolutely perfect. By the fall of 1906 the high-frequency alternator had been brought to a practical shape and was used for telephoning from Brant Rock to Plymouth, a distance of 11 miles, and to a small fishing schooner,[1] this being the first instance in which wireless telephony was put in practical use. The transmission was perfect, and was admitted by telephone experts to be more distinct than that over wire lines, the sound of breathing and the slightest inflections of the voice being reproduced with the utmost fidelity.

As it was realised that the use of the wireless telephone would be seriously curtailed unless it could be operated in conjunction with wire lines, telephone relays were invented both for the receiving and transmitting ends, and were found to operate satisfactorily, speech being transmitted over a wire line to the station at Brant Rock, retransmitted there wirelessly by a telephone relay received wirelessly at Plymouth, and there relayed out again on another wire line. On Dec. 11, 1906, invitations were issued to a number of scientific men to witness the operation of the wireless transmission in conjunction with the wire lines.[2] A report of these tests appeared in the *American Telephone Journal* of January 26 and February 2, 1907, the editor being one of the men present.

In July, 1907, the range was considerably extended, and speech was successfully transmitted between Brant Rock and Jamaica, Long Island, a distance of nearly 200 miles, in daylight and mostly over land,[3] the mast at Jamaica being approximately 180 ft. high. In 1907 several European experimenters succeeded in transmitting speech wirelessly, using some of the earlier forms of the author's arc method, and some months ago the vessels of the U.S. Pacific squadron were equipped with wireless telephones, using this arc method, by another American company.

(To be continued.)

[1] "Distribution of Pressure and Current over Alternating Current Circuits," *Harvard Engineering Journal*, 1906, p. 13.

[2] "Loaded Telephone Lines in Practice," *Trans.* Int. Elec. Congress, St. Louis, Vol. III.

[3] *Trans.* American I.E.E., Nov. 22, 1899.

[4] U.S. patent 706,736 (1899).

[5] Letter of July 8, 1905. See *The Electrician*, Feb. 22, 1907; also catalogue of 1904 and subsequent.

[1] An amusing instance may be mentioned as illustrating the incredulity with which the wireless telephone was received. The following appeared in the columns of a prominent technical journal on Nov. 10, 1906:—

"A New Fish Story.—It is stated from Massachusetts that the wireless telephone has successfully entered into the deep sea fishing industry. For the last week experiments have been conducted by the wireless telegraph station at Brant Rock, which is equipped with a wireless telephone, with a small vessel stationed in the fleet of the South Shore fishermen, 12 miles out in Massachusetts Bay. Recently, it is asserted, the fishermen wished to learn the prices ruling in the Boston market. The operator on the wireless fitted boat called up Brant Rock and telephoned the fishermen's request. The land operator asked Boston by wire, and the answer was forwarded back to the fishermen. This is a rather fishy fish story."

[2] Brant Rock, Mass., December 11, 1906.

American Telephone Journal, 100, William-street, New York City.

Dear Sirs: A limited number of invitations have been issued to witness the operation of the National Electric Signalling Co.'s wireless telephone system between Brant Rock and Plymouth, Mass., over a distance of between 10 and 12 miles. The tests will be as follows:—

1. Transmission of ordinary speech, and also transmission of phonographic talking and music by wireless telephone between Brant Rock and Plymouth. 2. Transmission of speech over ordinary wire line to wireless station at Brant Rock, relaying the speech there automatically by telephone relay and automatically transmitting the speech by wireless to Plymouth, transmitting same at Plymouth automatically directly or by telephone relay over regular wire line.

Invitations have been issued to the following gentlemen. (Here follows list of some of the guests, including Dr. A. E. Kennelly, Prof. Elihu Thomson, &c., and a request to the company to send a representative).—National Electric Signalling Co.

[3] "Long Distance Wireless Telephony," *The Electrician*, Oct. 4, 1907.

A NEW TYPE OF ELECTRIC FURNACE FOR THE SMELTING OF IRON.*

BY PROF. B. IGEWSKY.

Summary.—The author describes a rotary form of electric furnace suitable for high-pressure currents, in which a number of electrodes are used so that the current is not interrupted. In this way variations in temperature can be avoided. The rotation is provided for by means of a small motor.

It may easily be shown that a supply of electrical energy equal to 500 kw. is sufficient for the smelting of one ton of steel, and as electrical energy is now obtainable very cheaply the electric furnace should be capable of producing steel more cheaply than by the open-hearth process; the crucible steel process, which is becoming obsolete, may be excluded as a method for the production of steel on a commercial scale. Many works already employ electric furnaces such as the Stassano, Kjellin, and Heroult, and these furnaces work very successfully, but they all employ low tension electric

* Abstract of a Paper read before the Iron and Steel Institute.

current (not exceeding 100 volts), or they themselves act as transformers.

The author describes a method of working with high-pressure electric current, of which he has had seven years' experience. The furnace is one of a type employing what may be called second-class conductors, such as magnesia, lime, silicates or their colloids, such as $Al_2O_3 . 2SiO_2$, which, on being greatly heated, become conductors. It is absolutely necessary that the current should pass in the thinnest possible layer over the lower surface of the bricks as shown in Fig. 1. The resistance to the current should be very great in such a furnace. The pressure should be 1,000 volts for each metre space between the electrodes. By bringing the electrodes nearer together, or placing them further apart, or by providing the furnace with a number of electrodes, and only charging those which are immediately needed, it is possible to obtain a furnace which will work with all strengths of current in ordinary use. Such a furnace should work as steadily as an incandescent lamp, and should develop the highest temperature that the bricks can support. The problem is, however, not entirely solved. Difficulties are presented owing to a phenomenon analogous to that which the author has found to occur in the blast-furnace, and to which he gave the name of differentiation.* The electric current only flows over the surface of the brick during the earlier stages. In a very short space of time it concentrates itself along the lines of least resistance. Little by little the path selected becomes the only zone affected and the remaining surface remains quite cool. Differentiation can be obviated by dividing each electrode into a number of smaller electrodes furnished with regulators. Such a system could be employed for the firing, *e.g.*, of porcelain.

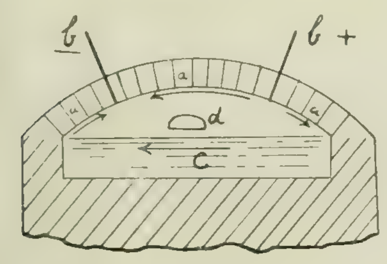


Fig. 1.

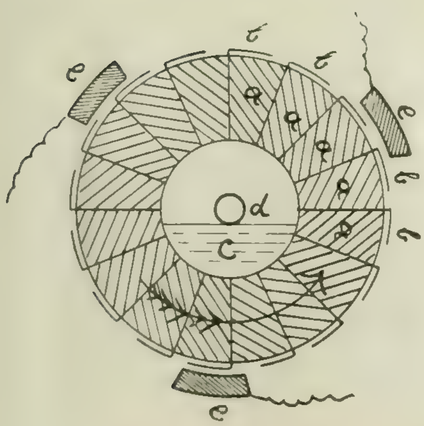


Fig. 2.

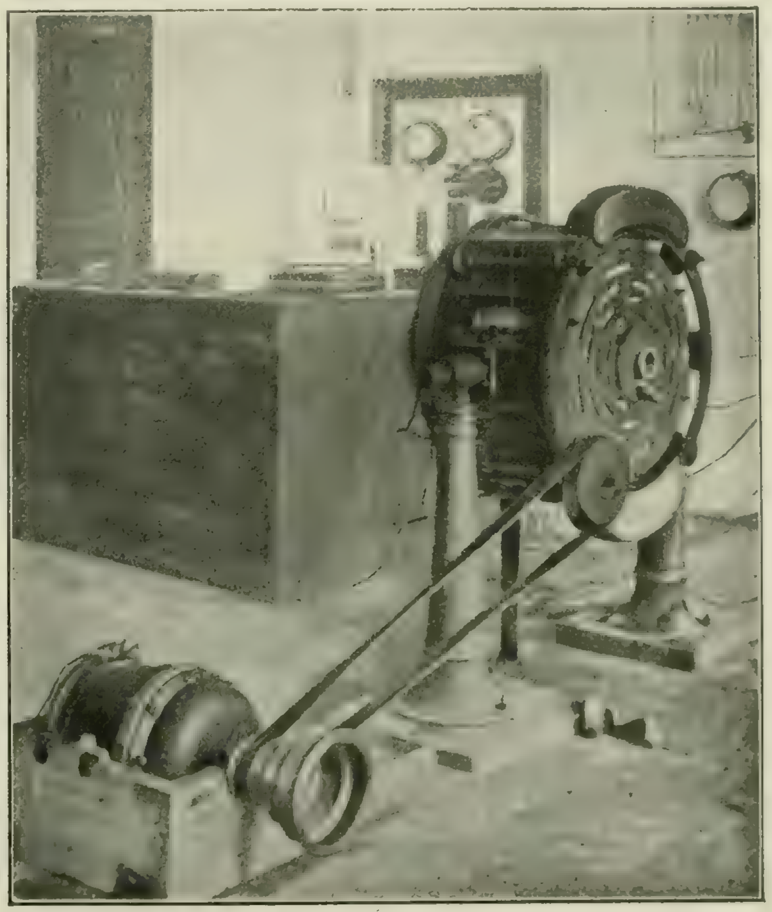


Fig. 3.—Rotary Furnace at Kieff.

The application of the principle to the manufacture of steel and to the fusion of other smelted materials is more easily solved by the furnace being made to revolve, and supplied with a sufficient number of electrodes, so that the current does not suffer interruption. In such an arrangement the bricks will at one time form the vault and at another the bottom of the furnace. By this means the variations in temperature can be avoided, and each brick passing beneath the metal will have the same conductivity over the whole of its surface as any other brick. In addition to this the bricks will be automatically moistened with slag, so that their surfaces become better conductors than their interiors. If the principle of a revolving furnace be adopted, it is necessary that it should be furnished with a commutator, otherwise the current will short circuit through the metal. Fig. 2 shows a plan for a rotating furnace using three-phase current, while Fig. 3 gives a front view of a furnace installed in the Emperor Alexander II. Polytechnic Institute at Kieff, the designer being Mr. A. E. Tzaref. A motor is employed for rotating the furnace about 20 times per minute. Fig. 4 gives the front and side elevation of the furnace, in which all the plates are of cast iron. The inside diameter of the furnace is 175 mm., and the depth 215 mm. The cubic capacity is 5·17 litres. The space that can be occupied by metal is, however, only about 2 litres, and at the commencement little more than 10 kilogrammes can be charged. In the course of time the interior bricks wear, and the capacity of the furnace becomes greater. The author prefers a three-phase electric current, but usually employs a continuous-current of 250 volts and 50–60 amperes, *i.e.*, 12–15 kw. When cold the furnace is a non-conductor.

The process of smelting is conducted in the following sequence of operations: The flame of a gas or Bunsen burner is made to impinge through the working opening, and when the furnace has been slightly warmed a little damp potassium hydrate is charged and the furnace is rotated. It will now be found that the furnace acts as a conductor, and the electric current begins to warm it. After a short time sodium hydrate is added, and when the interior of the furnace is red hot sodium carbonate is charged. The corrosive alkalies which evaporate within the furnace do not cause as much harm as might be expected. Rapid heating is, however, a danger to the bricks, which begin to crack. The best plan is to warm the furnace with gas during the night preceding the experiment. When the temperature of the furnace reaches a light red heat cast iron may be put in, and then scrap, or the order can be reversed. In the first case the author is in the habit of adding the new material gradually as the charge melts. In the latter case, when the iron becomes sufficiently hot, the smelting takes place at once on the addition of cast iron. Care is necessary, since if a quantity of cold metal be suddenly introduced at one time, it is easy to reduce the temperature to such an extent that short-circuiting occurs. The same thing occurs if the furnace becomes cool with the metal inside; small furnaces cool down in an exceedingly short time, but such an accident is hardly likely to occur in a large furnace. Indeed, in order to bring them into working condition, it would suffice to charge some hot slag from some other

* *Revue de Métallurgie*, Vol. II., p. 842.

furnace and to avoid having recourse to soda, which could not be other than injurious to the bricks. The outer bricks of the author s furnace are of fireclay, and the inner of fireclay or dinas. The fireclay bricks are fairly good conductors, but the dinas bricks are exceedingly poor conductors. The author has, however, used both for years with successful results. With fireclay bricks care should be taken that less slag should be used. With dinas bricks it is his custom purposely to add fluorspar, cryolite, magnesia, and similar substances, in order to increase conductivity. Magnesite bricks appear to be ill adapted to the purpose, because they conduct too easily. Experiments with dolomite and other bricks have not yet been carried out by the author.

The electrodes in the furnace illustrated are of iron, and melt and become slightly absorbed in the interstices of the bricks. But as the heat is developed on the surfaces of the bricks lining the inner side of the furnace, the crevices around the electrodes remain at a moderate temperature, because they retain the slag and even drops of metal which act as conductors. The author at first employed electrodes of 3 to 4 mm. in thickness, so as to drive them into the furnace from time to time by means of a hammer, but as that appears to be unnecessary he now employs thin sheet iron electrodes. There are in the furnace 24 electrodes placed at intervals of 23 mm. from each other. As in the furnace filled with liquid steel only the 14 upper bricks constitute the working surface, a difference in potential of nearly 35 volts is obtained between adjoining electrodes. As a result sparks are emitted on the collector on replacing each electrode, and frequently the spark is transformed into an arc. On the distance between these electrodes being reduced to 12 mm., the difference of potential falls to 17½ volts, and the formation of the arc becomes impossible. The author has, however, adopted an alternative. Each flat piece of the collector is divided into three parts, connected to each other with rheostat wires. By these means each electrode becomes gradually shut off whenever the difference of potential reaches the vicinity of 12 volts, and the formation of a voltaic arc is impossible. Besides that, he has fixed an additional description of brush on the electrodes, joined to the rheostats. This brush similarly serves to lessen sparking. The method employed to obviate sparking is the only complicated part of the furnace, the remaining principles being quite of an elementary nature. The manipulation of the furnace is likewise exceedingly simple, although with its present very small dimensions it requires constant attention. As a rule the author smelts a small quantity of cast iron and afterwards adds scrap. The softest steel produced possesses an ultimate strength of 56·8 kg. per sq. mm., with an elongation of 20 per cent.

On smelting iron turnings with charcoal (1 per cent.) steel was produced with an ultimate strength of 85·6 kg. per sq. mm., and an elongation of 3 per cent. Experiments for the production of steel from cast iron by the ore process were also successful, and the fireclay bricks suffered less than might have been anticipated. The advantages of a furnace of the construction indicated above are as follows :—(1) High voltage and low expenditure of current. (2) The possibility of using any form of current ordinarily employed. (3) Compactness and high efficiency. (4) Great homogeneity of the metal produced. (5) The minimum amount of surface contact with air or with the walls of the furnace. (6) Slag at a high temperature, and therefore favourable to the reactions needed for the refining of the metal. (7) A minimum superheating of the furnace. (8) The avoidance of carbon electrodes. (9) The possibility of using the furnace for the production at a high temperature of any material in a fluid state.

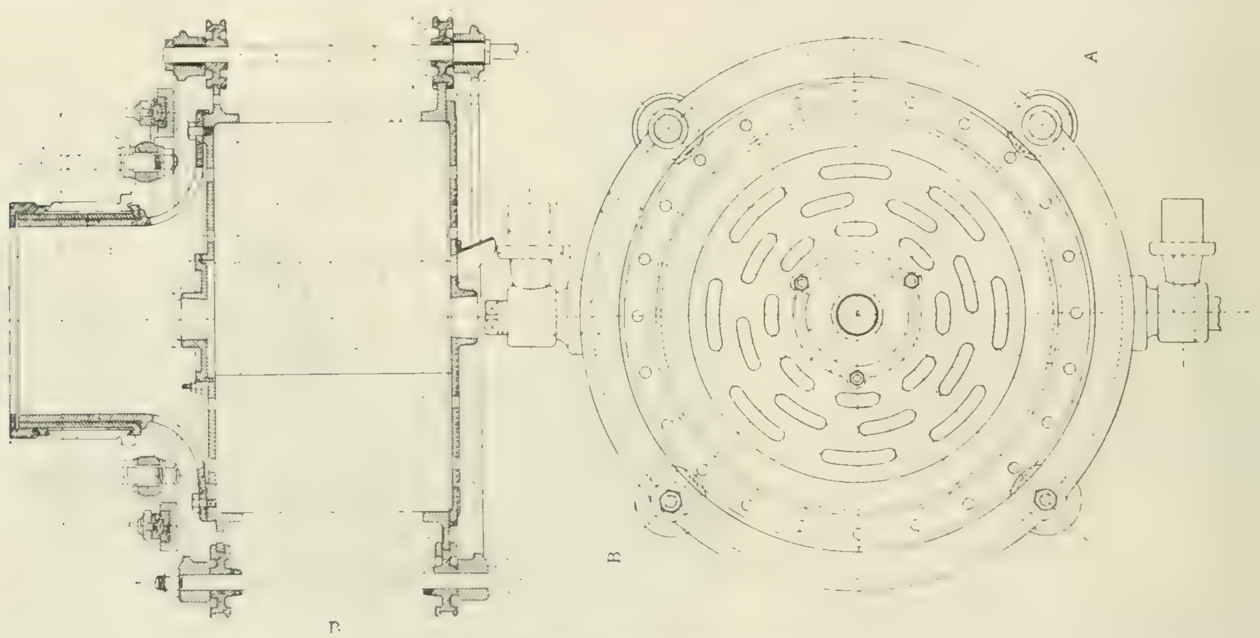


FIG. 4.—FRONT AND SIDE ELEVATION OF FURNACE.

MR. DUGALD CLERK'S ADDRESS TO SECTION G OF THE BRITISH ASSOCIATION.*

At the middle of the last century the steam engine had attained to a high degree of perfection. Its development was, it is true, incomplete, but it had been successfully applied to all the great duties of the mine, the waterworks, the factory, the railway and the steamship. The engines were mechanically excellent, the fuel economy was good, and they were built in units of thousands of horse-power. Steam power, in fact, was revolutionising the whole of the social and industrial conditions of the globe. Notwithstanding this great material and engineering success, the world was in complete darkness as to the connection between steam motive power and heat. The science of thermodynamics did not yet exist. The great change, from the errors of the old theories to the truth of the new, was due to the work of Joule, Thomson and Rankine in Great Britain, and of Carnot, Meyer, Clausius, Helmholtz and Hirn on the Continent. The story begins with the work of Carnot in 1824, who published in Paris in that year a pamphlet entitled "Reflections upon the Motive Power of Heat." He was attracted by the problem of the steam engine and the air engine. He saw that heat and motive power were connected in some manner, and he endeavoured to settle in a quantitative way the limits of that connection by the invention of an ideal series of operations by means of which the greatest conceivable amount of mechanical power may be obtained from a given quantity of heat under given circumstances. The Carnot cycle operations are applicable either to the material or to the dynamical theory of heat; but Carnot originally stated that the whole of the heat added in the first operation was to be discharged in the third. Carnot thus succeeded in proposing a standard of efficiency which was applicable to any heat engine, whatever the working fluid and whatever the operative cycle. By his method a limit could be set, fixing the maximum of mechanical energy to be obtained from a given heat quantity and a given temperature range. To reduce this to numerical values it was necessary, however, to experiment on any one working

* Abstract of the presidential address delivered by Mr. Dugald Clerk, on Thursday, September 3rd.

fluid within the desired temperature range in order to determine the work area in its relation to heat quantity and temperature fall. Carnot's writings show that he intended to make such observations; and, had he succeeded, thermodynamics would have become a science at an early date. Carnot's death, however, in 1832, at the sadly early age of 36 years, prevented this development.

His work remained practically without notice for 13 years after his death when, fortunately, it attracted the attention of William Thomson during his attendance at the laboratory of Regnault in the year 1845. He was then 21 years of age, and had already attained a considerable scientific reputation. He took up the study of Carnot's work with enthusiasm. To the acute and brilliant intellect of William Thomson it became apparent that he had in the Carnot cycle a powerful instrument capable of widely general use, apart altogether from the theory of heat engines; and he here uses it in a most skilful way to give definiteness and universal application to the idea of temperature, as Prof. Larmor states, "elevating the idea of temperature from a mere featureless record or comparison of thermometers into a general principle of physical nature." Thomson accordingly defines equal differences of temperature in terms of the reversible or Carnot engine. Equal temperature differences are to be differences between the temperatures of the source of heat and the refrigerator, when the proportion of work produced from a given quantity of heat is the same. This definition, however, gave a scale greatly differing from that of mercurial, air and other thermometers, the degrees defined by it corresponding to larger and larger intervals on the air thermometer as temperature increases. Prof. Tait pointed out also that on such a scale the temperature of a body totally deprived of heat is negative-infinite. Thomson follows up his absolute thermometric scale work with an investigation entitled "Carnot's Theory of the Motive Power of Heat," described in a Paper read in 1849 before the Royal Society of Edinburgh, in which he calculates from Regnault's experiments on steam the power developed by a Carnot reversible engine when using one Centigrade heat unit; that is, the heat necessary to heat 1 lb. of water through 1°C. for temperatures from 1°C. to 231°C., the temperature falling in the engine in each case to 0°C. The Paper is of great interest, because it shows clearly how fully the distinguished author realises the necessity for re-examining the standard ideas of the nature of heat.

At the time we are discussing—1850—the bare conception of the idea of an absolute zero of temperature is one which is startling in its boldness; and it must have been difficult indeed then to imagine any definite line of proof which could be followed to establish the real existence of such a physical limit. No such limit could be proved even by the aid of the Carnot cycle, reasoning on the material theory of heat. If we assume that heat is material, and that in some way temperature fall doing work resembles, as Carnot supposed, the fall of water doing work in passing from a higher to a lower level, then no absolute zero is possible, because the same quantity of heat is supposed to exist at the low as at the high temperature. Thomson's promises of further investigation were fulfilled in 1850, in which year he definitely accepted the dynamical theory of heat and finally abandoned the material. His conclusions are given in a memoir of the first importance which was read before the Royal Society of Edinburgh in 1851. It was entitled "On the Dynamical Theory of Heat." Before dealing with it, however, it is desirable to consider the work of Joule and others on another side of thermodynamics.

Long before 1850 the equivalence of mechanical work and heat quantity had been accepted by many scientific men, and Rumford had, indeed, made measurements of a rough kind. It remained, however, for Joule experimentally to determine the mechanical equivalent in the most accurate manner and place what is now known as the first law of thermodynamics upon the sure basis of absolute experimental determination. His first Paper was read before the Cork Meeting of the British Association in 1843, and at the Oxford Meeting in 1847 he read another—"On the Mechanical Equivalent of Heat"—describing the results of experiments with paddles rotating in liquids driven by falling weights. It was at this Meeting that he first met William Thomson, and the resulting co-operation between these two giant intellects sufficed to place the first and second laws of thermodynamics on the firm footing of accurate experiment and logical deduction. Joule had proved the generation of heat by means of mechanical work; Thomson required the proof of the converse case—the disappearance of heat when mechanical work was done by the working fluid. This proof was forthcoming in the results of experiments on the compression and expansion of air. Accordingly, we find the Carnot and Joule principles reconciled in Thomson's Paper of 1851, and the important deduction made of an absolute zero of temperature at $-273°$ on the Centigrade scale. The introduction of the idea of the mechanical equivalent of heat leads at once to an absolute zero of temperature, and allows of the determination of this physical lower limit by the use of the Carnot cycle for investigating the efficiency of a perfect engine using any working fluid. Air was the working fluid actually investigated, and the determination of its properties at ordinary temperatures was a vitally important result of the co-operation of Thomson and Joule. Their experiments lasted for many years, and their rigorous investigation disclosed the fact that internal work was done in expanding a gas; in fact, that in a gas expanding isothermally doing work, part of the heat only disappeared in external work and part was absorbed in separating the molecules.

The Joule and Carnot laws are now known as the first and second laws of thermodynamics. It appears that during Thomson's struggle to reconcile the two apparently opposing laws, Clausius, who had seen the same difficulty, arrived independently at its solution and published a Paper, "On the Motive Power of Heat and the Laws of Heat which may be deduced therefrom," at the Berlin Academy in February, 1850. In this Paper, Clausius discusses Thomson's difficulties, and also arrives at the conclusion that the Carnot cycle may be reconciled to Joule's law by the omission of the supposition that during the third process the same amount of heat is discharged from the cool body as was taken in from the hot one. Thomson gives Clausius the full credit for priority, but states that he was working on the same problem and had arrived at the same solution in the year 1850, before he had seen Clausius' work.

Rankine, as early as 1849, arrived at the general equation of thermodynamics which expresses the relation between heat and mechanical energy, and indicated the result of his investigations to the Royal Society of Edinburgh in February, 1850. Rankine thus arrived independently at the same result as Clausius about the same time. Both Rankine and Clausius, however, adopted certain theories as to the molecular structures and motions of gases, and their demonstrations to some extent depended upon their theories.

The brilliant work of Meyer, published so early as 1842, is held by some to have anticipated to a large extent both the work of Thomson and of Joule. Undoubtedly Meyer formulated true ideas and carried his generalisations through a wide range. Helmholtz also very early arrived at similar conclusions to those of Joule and Thomson; but it has been thought better to discuss the work of Thomson and Joule separately, in order to illustrate the transition period through which many distinguished minds were passing about the time. Undoubtedly great credit is due to Meyer, Helmholtz, Clausius and Hirn, and Thomson himself recognised this in the most generous way.

The ideas of Thomson and Joule now form so much of the basis of all reasoning upon motive-power engines that there is some little danger to the present generation of forgetting what they owe to these two great men. To appreciate the step made by them it is necessary to consider the position of motive power produced by heat at about the middle of the last century. At that time many attempts had been made to displace the steam engine as a heat engine by air engines in various forms—both engines heated externally and those heated internally, now known as internal-combustion engines. Papers read at the Institution of Civil Engineers in 1845 and 1853, and the discussion of those Papers by eminent men of the day, supply an accurate measure of the knowledge possessed by the engineer of the principles of action of his heat engines. The author refers at some length to these Papers and discussions to show the misunderstanding of theory at that period; even at the last meeting referred to—May 17, 1853—of all the distinguished engineers who spoke, Siemens alone had thoroughly apprehended the value of Joule's results and understood the full bearing of the mechanical equivalent of heat. He had not, however, understood Carnot's reasoning on the Carnot cycle or Thomson's deductions from Carnot. When so able a man as Siemens had at this stage only reached partial enlightenment, it was evident that much hard work and clear thinking required to be done before a well-founded theory of heat motive-power could be obtained. The data for such a theory was accumulating, and very shortly, Regnault produced his admirable investigations, and succeeded in solving many problems. The broad laws of thermodynamics have placed the theory of the heat engine in a position of certainty, which was much needed, but the Carnot cycle is an impossible one in practice. Accordingly actual engines have to operate upon imperfect cycles. The theory of these imperfect cycles has been worked out mostly during the last 25 years, although Rankine made a beginning in dealing with the theory of the Joule air engine. Subsequent work has shown that, on a simple assumption, such as constant specific heat, many engine cycles exist of a practicable nature having high theoretical efficiencies where the theoretical efficiency depends on one thing only—the ratio of compression. Some misunderstanding has arisen with regard to these imperfect cycles, and it has even been thought that such imperfect cycles would be contrary to the second law of thermodynamics. Lord Kelvin himself was of this opinion in 1881. The investigation, however, of these imperfect cycles is much more difficult than the

broad investigation of the general thermodynamic laws, because it requires accurate knowledge of the properties of the working fluid dealt with under conditions rendering observation extremely difficult. The modern internal-combustion motor is the successor to the air engine so fully discussed by eminent engineers of 55 years ago; and the forebodings of even so eminent a man as Faraday as to its ultimate success have proved unfounded. Great difficulties have been encountered and many discrepancies have had to be explained, but a minute study of the nature of the working fluid has rendered it more and more possible to calculate the efficiencies to be expected under practical conditions. At the present time we can deal with almost any cycle or any working fluid with some fair approximation to an accurate result. Much work, however, is required before all problems of the working fluid can be said to be solved with regard to any heat engine. Indeed, it may be said that under modern conditions of the use of steam, even the properties of the working fluid—steam—have not yet been satisfactorily determined. The mere question of specific heat, for example, of steam, and its variations of temperature and pressure is now under review, and important experiments are in progress in Britain and on the Continent to determine those properties. The properties of the working fluid of the internal-combustion motor are also the subject of earnest study by many Continental and British investigators. Notwithstanding all the perplexities involved in the minute study of the imperfect heat engine cycles, we are in a very different position to-day compared with the engineer of 1853. We know all the broad laws as to the conversion of heat into work or of work into heat; and, numerous as are the problems yet to be solved, we at least profit by the guiding light set out for us by Kelvin, Joule and Rankine.

INTERPOLE TRACTION MOTORS.

The requirements of modern electric tramway practice are much more exacting than those of earlier years, and to meet them necessitates special apparatus. With a view to meeting these more onerous conditions Messrs. Dick, Kerr & Co. have developed a series of "interpole motors," embodying a number of new points in design and construction, and superior in many ways to the older type. Such motors are particularly suitable for tramway systems where extensive use is made of electric braking, and in any circumstances where the duty is more than ordinarily heavy. They are said to be sparkless under practically all loads, cool in operation, and oil proof. Sparkless commutation is ensured by the addition of the "interpoles," thereby increasing the overload capacity and reducing the wear of the commutator and brushes, in some cases the motors will stand as much as 100 per cent. overload without injury. Further, the reduced wear of commutator and brushes, combined with improved methods of ventilation, results in the motor being very clean running and free from flash-overs and kindred troubles. In general it may be said that these interpole motors operate satisfactorily under conditions which would seriously embarrass motors of equal power, but unprovided with interpoles.

The motors are rated in the usual way, *i.e.*, on the output, including gear losses, for one hour with a temperature rise in any part, as measured by thermometer, not exceeding 75°C. (135°F.) above that of the surrounding atmosphere, the temperature of which does not exceed 25°C. (77°F.).

The field frame is made in the usual form (Figs. 1 and 2) of two bowl-shaped castings of soft steel of high permeability, thereby securing the smallest possible weight. The two halves are fitted together with a carefully machined joint to ensure a good magnetic circuit, and to make the frame both watertight and dust-proof. The lower half of frame is hinged to the upper half, thus permitting the lower field coils to be easily inspected and cleaned. Each armature bearing box (*see* Fig. 3) is contained in a separate solid casting, independent of the motor frame altogether, being held in position in the main motor frame by means of a tongued and grooved joint, and firmly fixed by studs. The armature can therefore be lowered with the bottom half for inspection, or can be retained in position in the top half as may be desired. It can further be removed from the main shell with its bearing boxes complete, if occasion requires it. Special attention is called to the fact that the bearing boxes for the armature are solid. This is a most valuable feature of the design, as it effectually prevents oil from the bearings creeping into the interior of the shell, thus making the motor practically oil-proof.

Fig. 3.—Armature.

Fig. 4.—Gear Case.

The main pole pieces (*see* Figs. 1 and 2) are made up of laminated steel sheet punchings riveted together, and are bolted to the inner surface of the frame. The pole pieces are interchangeable, and can readily be replaced in case of repair. Special arrangements are made for supporting the main field coils, two flat steel springs, each capable of exerting a pressure of about 400 lbs., being inserted between the field coil and the shell. The coils are held in place by the pole shoes themselves and brass washers which cover the surface of the coil. As each coil is thus forced against the brass washer by the springs with a pressure of nearly 800 lb., any shrinkage of the coil is automatically taken up, and the coils at all times are held rigidly in position. Mechanical troubles in this portion of the motor are thus entirely obviated.

The "interpoles" are of solid steel (*see* Fig. 2), situated symmetrically between the main poles and fixed in position by rivets. The "interpole" field coils are clamped in position by independent screws which are properly locked to prevent any movement. The ends of all field coils are finished off with strong bronze terminals for interconnection after they are assembled in the motor frame.

The armature core is built up in the usual way, with distance pieces to permit free circulation of air. Specially good ventilation of the armature (Fig. 3) is ensured by means of the fanning action of the connections between the armature coils and the commutator bars. These connections are made of thin flat copper strips, which, when the armature rotates, act as fan vanes, and draw a current of air right through the motor. The air enters through the opening on the top of the shell at the gear end, and is drawn towards the centre of the armature core passing through the end windings at the gear end, the armature core, the end windings at the commutator end, and finally passing out of the shell at the opposite end to which it enters. This artificially produced draught is so effective that it enables a motor to run fully 25 per cent. cooler than would be possible otherwise. The action of the fan vanes is centrifugal and therefore independent of the direction of rotation. This method of construction has the additional advantage of enabling the armature

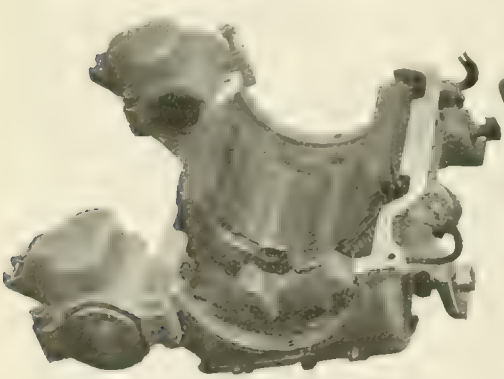


Fig. 1.—Lower Half of Field Frame.

Fig. 2.—Upper Half of Field Frame.

Fig. 5.—Dick, Kerr Interpole Traction Motor.

leads to be carried straight to the commutator risers, which greatly simplifies matters when it is required to remove the commutator, as the complete winding is left intact. All that is necessary in order to remove the commutator is to unsolder each conductor and bend it slightly upwards; the commutator can then be pulled off without any disturbance of the armature winding.

The bearings and the method of lubrication employed in the Dick, Kerr "interpole" motors are specially worthy of attention. As previously indicated, the armature bearing boxes themselves are solid castings, entirely independent of the main motor frame. They are made to guage, and interchangeable, as are also the bearing brasses themselves, which are of ample proportions for the work they have to do. A constant and efficient supply of oil to the armature bearings is secured by employing oil rings, which Messrs. Dick, Kerr & Co. have found, by actual practice, to be superior to any other method of lubrication. The oil after use in the bearings is drained back to the reservoir by specially large drain channels, which have sufficient capacity to take care of the maximum amount of oil which can possibly be supplied to the bearings. Through these channels flows a continual stream of oil which cools as well as lubricates the shaft. Special oil throwers are provided to deal with the small amount of oil which is not taken care of by the main drains, the oil from the throwers also being drained back to the oil chamber. After the bearings have been filled with oil, they will run with safety for a considerable length of time, without attention; it is said to be quite safe to allow such bearings to run for a fortnight without oiling, although it is better practice to have a regular system of oiling once

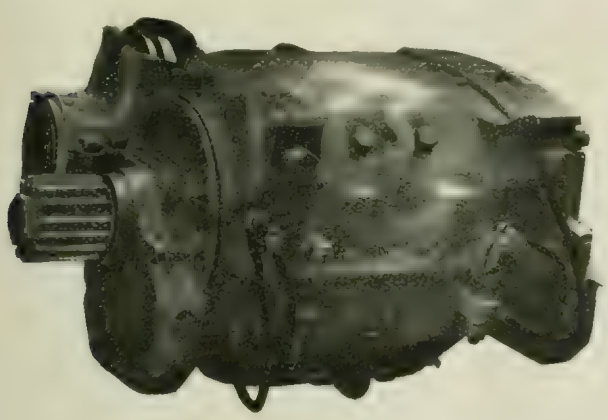


FIG. 6.—DICK, KERR INTERPOLE TRACTION MOTOR.

a week. Special chambers are provided below the oil reservoir, and into these chambers drains any oil which is not returned to the main reservoir. The bottom of each chamber can be closed by a cover, and when this opening is closed the motor can plough through almost any depth of water without getting flooded.

The axle bearings are also lubricated by means of oil, but in this case a wick arrangement is employed. These bearings, it is stated, will also run for a fortnight before requiring refilling, and arrangements are provided for allowing the wick to be quickly and easily withdrawn. Two helical springs acting on the wick holder press the wick against the axle, two springs being provided to ensure that the lubrication is not interfered with, should one spring fail from any cause. The armature bearings are made of special anti-friction bronze, the axle bearings being also of bronze or malleable iron lined with best white metal, as may be desired.

The whole of the gearing is contained in a malleable iron case (Fig. 4), in two halves, which is specially designed to withstand heavy vibration, and is supported at three points. All bolts are of the same size, and are locked from turning by special lugs cast on the frame and gear case. The nuts are locked by spring washers.

Figs. 5 and 6 show two views of these "interpole" traction motors.

"**Trackless" Trolley.**—The interest which has lately been evinced in this country has been reflected in the United States where, according to the *Engineering News*, a "trackless" trolley line has been projected from Chattanooga, Tenn., to the top of Walden's Ridge, a distance of some 15 miles. Reports state that the cars will carry 30 persons each and will receive power from a double trolley. It is also reported that the cars will be steered like an ordinary automobile.

THE CASCADE CONVERTER.*

BY AUGUST BLOCH.

Summary.—The cascade converter was patented by Prof. O. S. Bragstad and Herr J. L. la Cour in 1902, and has since been developed by them in conjunction with Prof. E. Arnold. The present Paper is intended to give a simple explanation of this converter and to show its superiority over other forms of converters.

In England the cascade converter is called a motor converter, though not quite properly. The machine comprises a polyphase continuous current converter coupled directly to a rotary-field motor. The alternating-current side of the converter is connected directly (*i e*, without the use of slip rings) to the rotor winding of the motor, and works in parallel with the same, whilst, at the same time, the rotor drives the converter mechanically. The direct-current machine, accordingly, works partly as converter, since it converts into continuous current the polyphase current taken from rotor winding, and partly as generator, since it converts the mechanical energy supplied to it into electrical energy. The cascade converter assumes a speed such that the frequency of the E.M.F. induced in the rotor is the same as that of the E.M.F. induced in the direct-current armature, this being the chief condition which makes the above-mentioned parallel operation possible.

We shall first consider the rotary-field portion by itself. This works as an induction motor whose stator and rotor are connected to networks of different frequencies. Let the stator work on a network of frequency c_1, and the rotor on a network of frequency c_2, where $c_1 > c_2$; further, for the sake of simplicity, assume both networks are three phase (*see* Fig. 1). This machine can be run up to speed by means of the starting resistance A, like an ordinary asynchronous motor, the switch S being open. When at rest, an E.M.F. of frequency c_1 is induced in the rotor. As the speed rises, the relative velocity between rotor and rotary field decreases, and with it the frequency of the rotor current.

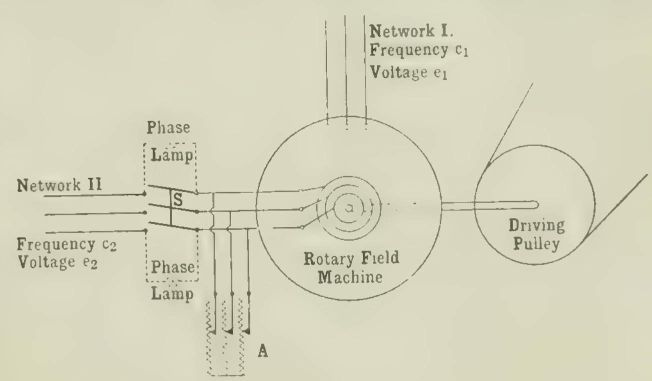


FIG. 1.

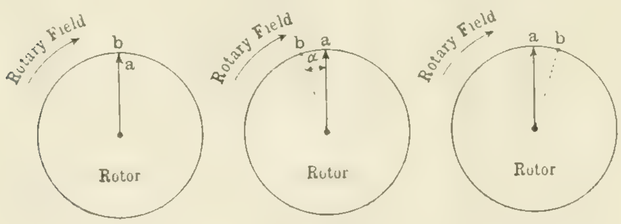
Let the number of poles in the motor be $2p_d$, then, when the relative velocity of the rotor to the rotary field is $60\, c_2/p_d$ revs. per min., a current of frequency c_2 will be induced in the rotor. Since the speed of the rotary field is $60\, c_1/p_d$, the actual speed of the rotor is $60\,(c_1 - c_2/p_d)$ revs. per min.

Let the rotor be wound so that the E.M.F. induced in it when running at this speed approximately equals the network pressure e_2. By means of the phase lamp and the switch S, the rotor can then be switched on to network II. and the starting resistance cut out. The rotary field machine will then behave as a synchronous machine—the output or input will not depend on change of speed, but solely on the respective lead or lag of the rotor in space. Thus, we have here to deal with a combination of phenomena occurring in ordinary synchronous and asynchronous machines. In a synchronous machine excited by a continuous current corresponding to every load, there is a definite position of the synchronously rotating field system which produces a corresponding lag or lead in the induced E.M.F. Corresponding to the lead, there is a watt current in phase with the E.M.F. (generator) and to the lag, a watt current displaced 180 deg. (elec.) with respect to the E.M.F. (motor).

A similar displacement of the main field, embracing stator and rotor, occurs also in an asynchronous motor, due to the influence of the rotor watt current, which is in phase with the induced E.M.F. (Note.—Watt current is used to denote the current component in phase with or directly opposed to the induced E.M.F.) In consequence of the magnetic inter linkage between stator and rotor, the stator and rotor ampere-turns almost completely neutralise one another. Let the ampere turns in the stator and in the rotor be split up into two components—the one, the watt ampere-turns, in phase with the E.M.F.'s induced by the main field, and the other, the wattless ampere turns, at right angles to the same—then the watt ampere-turns of the two parts neutralise one another. The

* Abstracted from the *Elektrotechnik und Maschinenbau.*

wattless ampere-turns combine with the magnetising ampere-turns which produce the main field. For these magnetic relations in an asynchronous machine, there is a watt current which, in the rotor, is in phase with the E.M.F, and, in the stator, is directly opposed to it. Coming back to the case represented in Fig. 1, we can suppose that one part, Φ_1, of the main field is produced by the stator winding, and one part, Φ_2, by the rotor winding. At no-load, assuming the ideal case of no losses, the rotor takes up such a position that the rotory field induces both in stator and rotor E.M.F.s displaced 180 deg. from the network pressures e_1 and e_2. Denote this position of the rotor at no-load by the vector, a, rotating uniformly and synchronously with the rotor $w\,f$, and the point b, on the rotor itself (Fig. 2A). Let now a load be applied at the pulley, then the rotor be caused to lag (Fig. 2B). This lag gives rise to the field component Φ_2 produced by the rotor winding. The E.M.F. induced in the



A — In Phase. B — Lag in stator. Lead in Rotor. C — Lead in Stator. Lag in Rotor.

Fig. 2.

stator is thus caused to lag. The result is that a watt current flows in the stator winding directly opposed to the E.M.F. (power input). Owing to the lag of the rotor with respect to the rotation of the field, the E.M.F. induced in the rotor by Φ_1 will experience a lead. Consequently in the rotor a watt current is set up in phase with the E.M.F. (power output). The first effect of the lagging of the rotor, therefore, is to set up watt currents in stator and rotor, which, with regard to the E.M.F.s induced by the main field, have the same direction as in an asynchronous motor. Thus the magnetic relations are practically the same as in the latter. The torque acts in the direction of the rotary field as in an induction motor. The watt ampere-turns in stator and rotor divided by their winding factors are equal. The wattless ampere-turns combine with the magnetising ampere-turns.

Neglecting ohmic drop, we can write: The main field combines with the stator leakage field to form the resultant stator field which maintains equilibrium with the network pressure e_1, and with the rotor

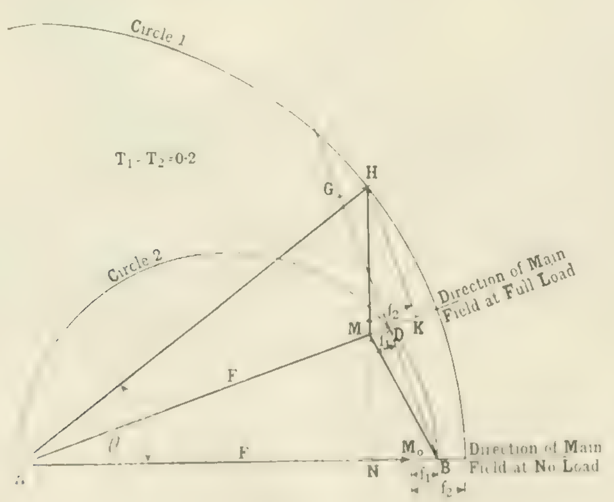


Fig. 3.

leakage field to form the resultant rotor field which maintains equilibrium with pressure e_2. The stray fields can be split up into components in phase with and at right angles to the main field. The former are produced by wattless and the latter by watt currents. From the equality of the watt ampere-turns, it follows that the stray fields perpendicular to the main field must have the same ratio to one another as the leakage coefficients T_1 and T_2 of stator and rotor. (The leakage coefficients are taken as the ratio of the reciprocals of the magnetic reluctances for the leakage and the main field.)

Let AB and the radius of circle I (Fig. 3) represent the magnitudes of the resultant stator field F_1 and rotor field F_2, respectively, which are determined by the pressures e_1 and e_2. Further denote the main field by F and the leakage fields by f_1 and f_2 respectively. At no-load (ideal) only wattless currents flow in the windings; consequently at no load the leakage fluxes are in phase with the main flux. The algebraic sum of the main field F with the leakage fields gives the resultant fields F_1 and F_2. The wattless currents leading the E.M.F. magnetise in the direction of the main field, and the leakage fields produced by them are to be taken as positive. The stray fields induced by lagging wattless currents are negative. We have the following relations

$$F_1 = F + f_1$$
$$F_2 = F + f_2$$
$$F = \frac{f_1}{T_1} + \frac{f_2}{T_2}.$$

Whence we get

$$f_1 = \{F_1[1+T_2] - F_2\}\frac{T_1}{T_1+T_2},$$
$$f_2 = \{F_2[1+T_1] - F_1\}\frac{T_2}{T_1+T_2}.$$

The currents are directly proportional to the leakage fields. If $F_2/F_1 = 1 + T_2$, then $f_1 = 0$, and the total magnetising current is yielded by the rotor.

If $\frac{F_2}{F_1} = \frac{1}{1+T_1}$, then $f_2 = 0$, and the whole magnetising current is supplied from the stator. For values of the ratio F_2/F_1 between these limits, both parts assist in the production of the main field. If $F_2/F_1 > 1 + T_2$, f_1 is negative—*i.e.*, a current lagging with respect to the E.M.F. flows in the stator. (In an asynchronous machine, the magnetising current lags behind the terminal pressure and leads the induced E.M.F.) The rotor has then not only to yield the magnetising ampere turns, but also neutralise the de-magnetising

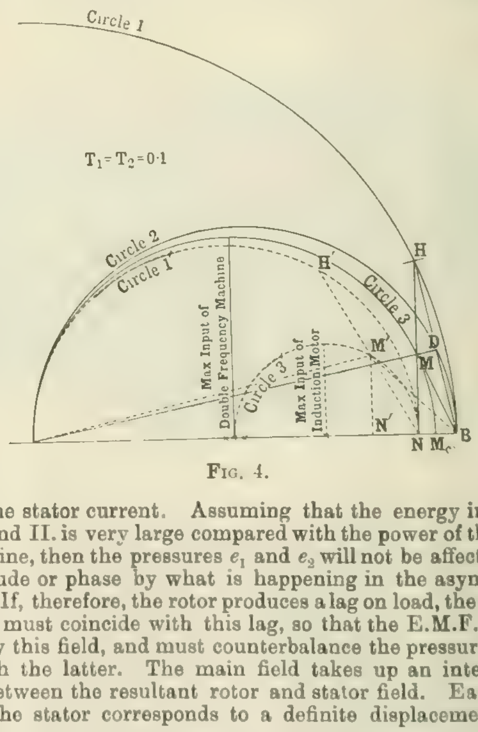


Fig. 4.

effect of the stator current. Assuming that the energy in the networks I. and II. is very large compared with the power of the rotary-field machine, then the pressures e_1 and e_2 will not be affected either in magnitude or phase by what is happening in the asynchronous machine. If, therefore, the rotor produces a lag on load, the resultant rotor field must coincide with this lag, so that the E.M.F. which is induced by this field, and must counterbalance the pressure e_2, is in phase with the latter. The main field takes up an intermediate position between the resultant rotor and stator field. Each power input at the stator corresponds to a definite displacement of the main field.

Let the vector of the stray field produced by the stator was current be BD and the direction of the main field AD. The locut of the point D is a circle with AB as diameter. Make $DG = \frac{T_2}{T_1}BD$, and through G draw a parallel to AD, then the point of intersection H with circle 1 gives the resultant rotor field AH. The angle $< HAB = \theta$ at the same time gives the displacement in space of the rotor (in electric degrees) with respect to the no-load position. The effective displacement of the rotor in space is $a = \theta / p_d$. The leakage field produced by the rotor watt current is HK. The main field must—in conjunction with the leakage fields f_1' and f_2'—yield the field components $AD = F_1'$ and $AK = F_2'$ respectively. For determining the main field AM, we have the same equations as at no-load, except that F, F_1 and F_2 must be substituted by F', F_1' and F_2'. The total stray fields are represented by the vectors HM and and BM respectively. The ratio F_2'/F_1' varies in general with the load, and depends on how the production of the main field is distributed over the stator and rotor windings. By altering the pressure at network II., this ratio can be varied, and any desired phase-displacement of the stator current produced. The displacement of the fields in space gives also the displacement of the E.M.F.s induced by them in respect to time. These E.M.F.s moreover are also proportional to the fields. Consequently the diagram in Fig. 3 can also be used as a time diagram. The resultant fields correspond to the terminal pressures, the stray fields to the reactance pressures and the main fields to the in-

duced E.M.F.s. It must be borne in mind, however, that the scales for the rotor and stator circles are different, the ratio of the same being given by the ratio of the products of the frequencies, numbers of turns and winding factors. If we then pass to the pressure diagram we can also conveniently consider the ohmic pressure drop. The leakage fields or reactance pressures are directly proportional to the currents. The area of the triangle AMB and its altitude MN gives scales for the stator input and the torque respectively.

For the case $F_1 = F_2$ and $T_1 = T_2$, the point M moves on a circle. Fig. 4 represents the diagram for this case by full lines. The dotted lines represent the Heyland diagram for the same machine as asynchronous motor with the same stator field. BM and BM′ give the respective stator currents, MH and M′H′ the rotor currents and MN and M′N′ the power inputs or torques. The maximum input of the synchronous rotary-field machine is more than twice that of the asynchronous machine. This is also to be expected when we remember that the maximum stator current for the former machine is about double that for the latter. The maximum current in an induction motor occurs at short-circuit, when the field is equal to about half the main field. The stator leakage field, at short-circuit, therefore, has only to counterbalance about half the pressure. In the case of the synchronous machine, the maximum current occurs when the rotor is displaced $180^\circ/p_d$ in respect to its position at no-load. The main field then becomes approximately zero. The stator leakage field, therefore, must counterbalance the total stator pressure, and is, therefore, about double that occurring in the induction motor.

The E.M.F.s induced per turn in stator and in rotor are related to one another as the frequencies, hence, since the watt ampere-turns are equal, it follows that the electric power in the stator and rotor windings also bear the same relation to one another. If, therefore, the watts supplied to the stator are denoted by W, the rotor will give c_2/c_1 W watts to the network II. The difference $c_1 - c_2/c_1$ W watts is given to the shaft in the form of mechanical power. The ratio of the electric power of the rotor to its mechanical power is constant, and equals $c_2/c_1 - c_2$. Whenever hunting occurs about the position of equilibrium—*i.e.*, increase or decrease of angle α (Fig. 2B)—sychronising forces are set up which tend to damp out the swinging. For example, when the swing is in the direction of lagging, the stator takes in more energy and develops a larger torque than that corresponding to the position of equilibrium. The $c_1 - c_2/c_1$th part of this increase of power is utilised for acceleration, and the c_1/c_2th part is given to the network II.

If mechanical power is supplied to the pulley (Fig. 1), the rotor will lead with respect to the no-load position (Fig. 2C) and take energy from the network II. The sum of the mechanical and electrical power supplied to the rotor will be given to network I through the stator. (In this form, the double-frequency synchronous machine was used in America some 10 years ago as a frequency converter.)

The rotary-field portion of the cascade converter represents such a synchronous rotary-field machine. The continuous-current machine coupled directly to the rotor replaces the pulley (Fig. 1) by absorbing mechanical power, and replaces the network II., since it works in parallel with the rotor winding and converts the electric energy taken from the latter into direct current. Let the number of pole-pairs in the rotary-field and direct-current machines be p_d and p_g respectively, then the equality of the frequencies in rotor and direct-current armature will be reached at a speed which corresponds to the condition

$$\left(\frac{60c_1}{p_d} - n\right)p_d = np_g,$$

whence

$$n = \frac{60c_1}{p_d + p_g},$$

i.e., the cascade converter rotates at the synchronous speed of a $2(p_d + p_g)$ pole machine with frequency c_1.

The pulsation of the rotor current is

$$c_2 = \frac{c_1 p_g}{p_d + p_g}.$$

If W denotes the total input at the stator, then

$$\frac{c_2}{c_1}\mathrm{W} = \frac{p_g}{p_d + p_g}\mathrm{W} \text{ watts}$$

will be the energy transmitted to the direct-current armature electrically and

$$\frac{c_1 - c_2}{c_1}\mathrm{W} = \frac{p_d}{p_d + p_g}\mathrm{W} \text{ watts}$$

mechanically.

At ideal no-load, the rotor will take up such a position that the rotary-field induces an E.M.F. in it which opposes the pressure on the alternating-current side of the direct current armature (Fig. 2A). When the direct-current machine is loaded, a torque is set up in the same which causes a lag as in Fig 2B. In addition to what happens in the rotary-field portion, as already discussed, there will be at the same time a lag of the pressure on the alternating-current side of the direct current armature, since the phase of the network II. is assumed to remain constant under the representation of the method of working given in Fig. 1. The pressure on the alternating-current side of the direct-current armature can—without any appreciable error—be assumed to be in phase with the E.M.F. induced in the armature winding. The angle θ in diagram in Fig. 3 no longer corresponds to the angle α of displacement of the rotor multiplied by p_d, but now

$$\theta = (p_d + p_g).$$

For every load, the direct-current pressure can be regulated by varying the excitation. At the same time the pressure on the alternating-current side of the direct-current armature will be altered, which results in a change of the wattless currents in the rotary-field machine. If, for example, the excitation is increased, the rotor will take on additional wattless current, leading in respect to its own E.M.F. and lagging with respect to the E.M.F. in the direct-current armature. This current exerts a demagnetising effect in the direct-current machine. Hence to obtain a certain pressure variation on the direct-current side, a larger alteration in the exciting current is necessary than in the case of an ordinary direct-current generator. When hunting occurs, the total stator power corresponding to the swinging is consumed in damping the same, since the electric power of the rotor will also be utilised in the direct-current armature as such.

The cascade converter is reversible. The direct-current machine then works partly as motor and partly as direct-current-polyphase-current converter. Mechanical and electrical power is supplied to the rotor, the sum of which will be transmitted to the network through the stator. The rotary-field part works in the same way as in the case discussed above, where mechanical energy was supplied to the rotor at the pulley (Fig. 1). If the stator is connected to a network where several generators are working, the reversed cascade converter will work as a synchronous machine. If, however, only current-consuming apparatus is connected to the circuit, the cascade converter loses the characteristics of a synchronous machine, just like an ordinary converter. When working on an inductive load, every change of load will cause a variation in wattless current in the direct-current armature, which will either strengthen or weaken the field in the continuous-current machine. This results in a change of speed. If the direct-current pressure is constant, there is, in addition, a relatively larger pressure drop at the terminals of the stator. As reversed converter, therefore, the cascade converter is only suitable when the stator works in parallel with other generators. The above machines may have any desired number of phases in the stator and in the rotor—the number of phases in the stator being that of the network on which it works, and is consequently three-phase as a rule. The rotor, on the contrary, is generally wound for 9 or 12 phases to obtain the best conditions for the direct-current machine.

Example.—The author then shows how the cascade converter can be started up from either the alternating or continuous-current side, and also gives illustration of such a machine of 370 kw. output, built by the E A.G. (formerly Kolben & Co.) for electrochemical work. Three-phase current is supplied to the stator at 5,000 volts and 50 cycles, whilst 3,080 amperes continuous current at 120 volts is taken off from the commutator. Both the rotary-field part and the direct-current machine have eight poles, so that the converter rotates with the velocity of a 16 pole machine at 375 revs. per min. The rotor has 12 phases and the armature on the direct-current machine is lap-wound with 12 equi-potential connectors, to which the 12 phases of the rotor are connected. There is no bearing between the two machines so that there is no necessity for a hollow shaft for these connections.

Dimensions.—As regards the dimensions of the cascade converter, it is usual for both parts to have the same number of poles. The direct-current side, therefore, works half as generator and half as 9 or 12 phase direct-current converter. As in an ordinary converter, the effective value of the current in the armature winding is smaller than in a direct-current generator of the same output. According to whether the stator is supplied with polyphase or single-phase current, the direct-current machine must have the dimensions of a generator of 65 to 70 or 80 per cent. respectively of the output of the converter. The dimensions of the rotary-field machine are determined by the angular velocity of the rotary-field, which is double that of the angular velocity of the rotor. In other words, the rotary-field machine must have the dimensions of an induction motor of the same output but double the speed. The rotor, however, may have a larger diameter than an induction rotor of the same number of poles—the dimensions of the bore being more those of a motor with twice the number of poles and half the power.

Comparison with Motor-generators and Rotary Converters.—From what has just been said re dimensions, it follows that the cascade converter is smaller than a motor-generator of like speed and output. The former machine, therefore, is cheaper and requires less space than the latter. The space consideration makes the cascade converter especially suitable for sub-stations. The losses per unit of surface can be taken the same in the cascade converter as in the motor-generator—hence, since the cascade converter is the smaller, its efficiency will be higher than that of a motor-

generator of equal output. Compared with the asynchronous motor generator, the cascade converter has the advantage of working on unity power factor, and can also be made to yield a leading wattless current to the line. This latter advantage is also possessed by the synchronous motor-generator, but on the other hand this machine cannot be easily started up from the alternating-current side. Starting difficulties are also to be numbered amongst the disadvantages of the rotary converter. The dimensions of a rotary converter depend on the number of phases. Compared with the continuous-current side of a cascade converter, a single-phase rotary converter utilises the armature 50 per cent. worse, and a three-phase converter 10 per cent. worse. Although a six-phase rotary converter utilises the armature 30 per cent. better than a cascade converter, against this are to be set the six slip-rings carrying heavying currents, and requiring a more complicated scheme of connections, which add largely to the cost of the machine. Moreover, the rotary converter is fed with the current at the full frequency, and thus needs twice as many poles for the same speed as a cascade converter. In addition to the large machine thus required, it is usually necessary to have a stationary transformer between the network and the machine. Thus the installation cost of a converter will be practically as high as that of a cascade converter. The total losses are about the same in the two cases. At a higher frequency, rotary converters have a greater tendency to hunt than cascade converters. The pressure regulation with a cascade converter can be carried over wide ranges without the use of choking coils as required by converters. The space taken up by a cascade converter is not greater than that taken up by a converter and transformer together.

SHORT SPARK PHENOMENA.*

BY W. DUDDELL, F.R.S.

Summary.—The author describes two effects which he has observed in connection with some measurements of the current in the secondary circuit of an induction coil. On introducing a small spark gap into the secondary circuit, the secondary R.M.S. current increases enormously in value, and a deflection is produced on a galvanometer in the secondary circuit.

The apparatus in use during these experiments consisted of a 12 in. Newton induction coil, which was supplied from the 200 volt direct current mains. A large resistance was placed in series with the primary of the coil to limit the current, and the current was

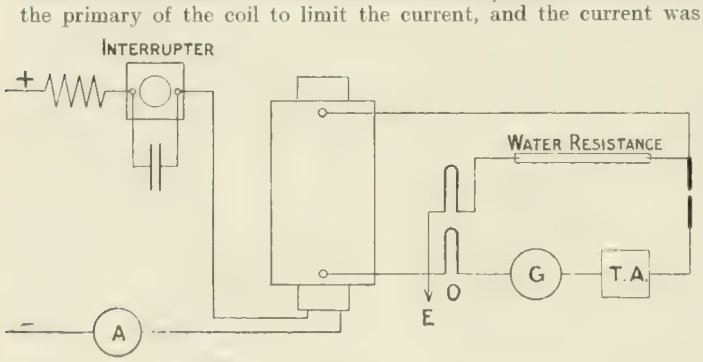


FIG. 1.

interrupted by means of a mercury jet interrupter: the connections are shown in Fig. 1. The secondary circuit contained a galvanometer, G, to measure the mean current and thermo-ammeter, T.A., to measure the root-mean-squared current. The galvanometer was specially constructed for the purpose so as to have a sufficiently low sensibility without using a shunt. It was of the moving coil type and was well insulated from earth by means of porcelain insulators. The sensibility was such that 1 milliampere gave a scale deflection of 200 divisions (1 division equals $\frac{1}{10}$ m.m.). The thermo-ammeter had a resistance of about 101·5 ohms and gave its full scale deflection for about 70 milliamperes R.M.S. value.

By breaking the current through the primary by means of a switch, the direction of the deflection of the galvanometer corresponding to breaking the primary current was determined. A deflection in this direction is called, in what follows, a positive deflection, and a deflection in the opposite direction a negative deflection.

When there was no spark gap in the secondary circuit and the coil was in action, the mean current, as read by the galvanometer, was zero, as it should be, and the root mean squared current had a value of about 3·8 milliamperes. If now a microscopic spark gap, say between two aluminium points, is introduced into the secondary circuit two curious effects take place. Firstly, the R.M.S. current enormously increases in value, and, secondly, a very large deflection is produced on the galvanometer reading the mean current, and this deflection is in the *negative* direction—that is to say in the direction corresponding to making the primary circuit. These two effects will be considered separately.

To give an idea of the magnitude of the increase in the R.M.S. current produced by introducing a very small spark-gap into the secondary circuit of the coil, in Fig. 2 the R.M.S. current corresponding to various lengths of spark between 0 and 15 mm. has been plotted, the resistance in the primary circuit of the coil and the frequency of the interrupter of the primary current being kept constant, at 137 ohms and 75 interruptions per second respectively. The current through the primary of the coil was about ½ ampere.

I have no doubt as to the cause of this effect. It is due to very high frequency oscillations being set up in the wires connected to the secondary circuit of the coil when a spark-gap is introduced. The magnitude of the oscillations will depend on the voltage between the terminals of the spark-gap just before the spark passes and on the resistance that the spark-gap offers. Now the P.D. between the terminals of the spark-gap will increase with increasing length and so will the resistance, so that on increasing the spark length we have two conflicting agencies at work, one tending to increase the magnitude of the oscillatory current, and the second tending to decrease the magnitude. It is due to this differential action that the curve is such a curious shape.

The presence of the oscillations in the secondary circuit can easily be made evident by taking a well-insulated metal plate and touching various points in the secondary circuit with it. The effect of this plate will be to largely increase or decrease, generally increase, the value of the R.M.S. current. The practical aspect of this question, from my point of view, was that, owing to the unexpectedly large value of the R.M.S. current, I burnt up several thermo-ammeters before I discovered the cause of the trouble.

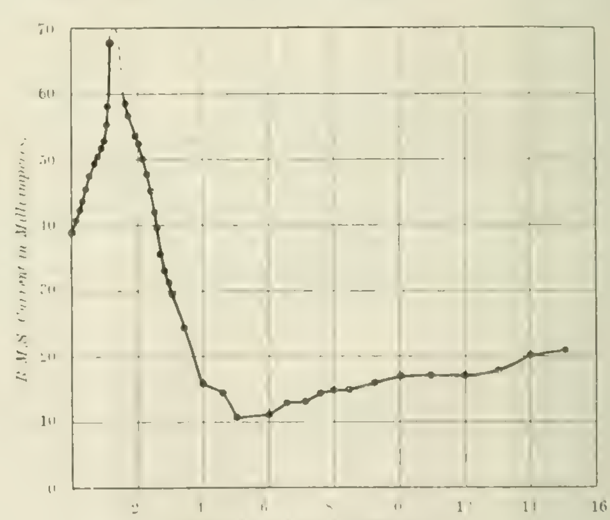


FIG. 2.

I have obtained the effect with brass, iron, zinc and aluminium electrodes, and it probably takes place with all other metals. I think that, so far, the best metal to show the effect has been aluminium.

The large deflection in the negative direction observed on the galvanometer was investigated by recording the wave forms of the P.D. and the current by means of an oscillograph. The sensibility of the oscillograph was adjusted so that 1 mm. deflection equals 1 milliampere for the current wave forms. To obtain the P.D. wave forms a water resistance of about 1 megohm was placed in series with the second moving system of the oscillograph so that 1 mm. equals about 1,000 volts. The speed of the plate on which the records were taken was 1,500 mm. per second. For this series of tests, the frequency of interruption was 75 per second, and the resistance in series with primary of the induction coil was 37 ohms.

Records were made for a series of spark lengths between aluminium point electrodes. Some typical results are shown in Figs. 3, 4, 5 and 6. Fig. 3 is the current wave form when the spark-gap is short-circuited, length 0. The straight line across the centre of the figure is the true zero line. Deflections above this zero line represent current in the positive direction and below the zero line represent current in the negative direction. It will be noticed that the maximum current in the positive direction (14·5 milliamperes) is much less than the maximum current in the negative direction (35 milliamperes), but the length of time that the negative current

* Abstract of a Paper read before the Physical Society. A short abstract of the discussion following the reading of this Paper appeared in *The Electrician*, May 8, 1908, p. 134.

lasts is much shorter than that which the positive current lasts; so that the areas of the two sides of the zero line are equal and the mean current zero.

With the smallest possible gap between the aluminium electrodes, the wave form at once changed to the type shown in Fig. 4, which is for spark length 1 mm. In this figure, the straight parts of the curve along the centre of the figure are in the position of zero current. This was carefully checked by taking records with a fixed datum-line at the zero of the curve. The line was afterwards moved to the lower part of the figure in order not to hide small details of the curve near the zero. The effect of introducing the spark-gap of 1 mm. is,

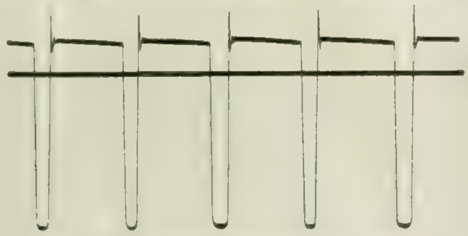


FIG. 3.—SPARK LENGTH EQUALS ZERO.

while leaving the maximum current on the two sides of the zero at practically the same value, to reduce the area of the curve on the positive side of the zero line nearly to zero, so that instead of the areas on the two sides being equal there is a large excess of area on the negative side causing a large mean current in the negative direction.

On increasing the length of the gap a small area on the opposite side of the zero line again begins to form, which increases with increasing length of gap, until the condition shown in Fig. 5 is reached. In this figure, the spark is sometimes rectifying or stopping the current flowing round the circuit in the negative direction altogether.

FIG. 4.—SPARK LENGTH, 1 MM.

We have in this figure the large triangular current wave form which corresponds to the current flowing in only one direction round the circuit, and the smaller triangular current pulses accompanied by a large current in the negative direction at make. Further lengthening the spark-gap brings it into the normal condition of long sparks. It was necessary, in order to obtain the wave form of these longer lengths, to disconnect the circuit for recording the P.D. wave form, as the leak which it formed, having a resistance of only 1 megohm, prevented the sparks passing across the gap.

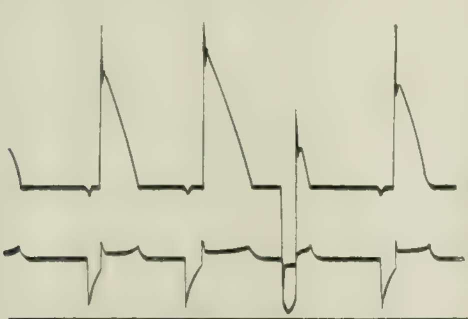


FIG. 5.—SPARK LENGTH, 15 MM.

Fig. 6 shows the P.D. wave form with so long a spark-gap that the spark could not jump across it. This is the normal wave form given on the secondary of the induction coil when supplied from a high voltage direct current circuit. It was noted that the voltage induced in the circuit at the break is about 23,000 volts and at make about 13,500, so that the make voltage exceeds one-half of the break voltage. Also, the voltage induced at the make dies away less rapidly than that induced at the break. It may be inquired how it is possible, if the make voltage is less than the break voltage, for the current to be larger at make than at break. I think that this question must be answered by noting that during the make period the primary of the induction coil is connected to the supply mains so that the energy may be directly transferred from the primary to the secondary circuit by magnetic induction—that is to say, as long as we maintain a steadily increasing flow of current into the primary, we can continue to take energy from the secondary. During the break period, however, things are very different. The whole of the energy that we can get out of the secondary is that stored up in the magnetic field which is linked with the secondary winding. The greater part of this magnetic field will pass through the core. The magnetisation of the core will depend upon the resultant magnetising ampere-turns which are equal to the primary ampere-turns less the secondary ampere-turns. At the moment of break the current in the secondary is at a value of, say, 35 milliamperes, and the current in the primary cannot have exceeded $\frac{200 \text{ volts}}{37 \text{ ohms}}$ or 5·4 amperes.

I do not know the exact ratio between the numbers of turns on the primary and on the secondary of this induction coil, but it is probably of the order of 100, so that the 35 milliamperes flowing in the negative direction in the secondary would correspond to a demagnetising current of about 3½ amperes in the primary, which would leave a comparatively small margin of resultant magnetising ampere-turns.

If this is the case, the energy that can be got out of the secondary on break is very limited, which would account for the rapid dying away of the current to zero when even a very small spark-gap is introduced in the circuit. Directly the length of the spark-gap is sufficient to prevent the current flowing in the negative direction round the secondary circuit, the whole of the demagnetising effect of the

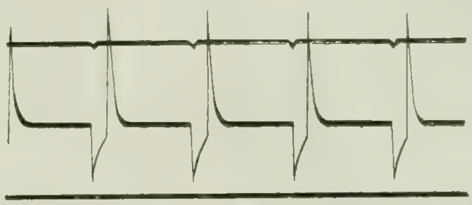


FIG. 6.—DISTANCE BETWEEN ELECTRODES TOO GREAT FOR SPARKING TO TAKE PLACE.

secondary current is done away with, and under the conditions of the experiment the magnetising current in the primary is mainly limited by the large resistance in the circuit; hence, we get a very much larger amount of energy available directly the secondary current is prevented from flowing in the negative direction. This, I think, accounts for the large difference in the size of the current waves in Fig. 5, and shows the great importance of preventing any current from flowing round the secondary circuit in the negative direction at make when using the induction coil on a high voltage supply.

I made certain that the phenomenon was not due to any want of symmetry in the points of the spark-gap by reversing the electrodes of the gap and also by interchanging the connections to it. The material of the electrodes did not seem to appreciably affect the results, but the shape of the electrodes was important in so far that the spark length at which the galvanometer deflection changed sign depended on the shape.

MANCHESTER ELECTRICAL EXHIBITION (Opening Day Oct. 3).

Supplementary List of Exhibitors.

Since the list of exhibitors at the forthcoming Electrical Exhibition which appeared in our issue of Aug. 21 was compiled, the following firms have been added :—

Abbey Electric Co.	Dowsing Rad. Heat Co.	Mawdsleys Limited
Automatic Machine Co.	Electrelle Limited	T. H. Mealy
C. D. Bate & Co.	Electric Rifle Co.	C. J. Noyes
Bateman Mach Tool Co	Elkington Limited	J. W. Phillips
Bell Rock Belting Co.	Fittings Limited	Phillipson & Co
G Birch & Co. (Ltd)	J. J. Griffin & Son	Small & Parkes
J. Birch & Son	Harper Elec. Piano Co	A. G. Thornton & Co.
Blackman Ventilating Co.	Hughes & Stirling	Triumph Stoker (Ltd)
Brayshaw Limited	Kearney High-speed Railway Co.	Vincit Limited
British Thomson-Houston Co.	H. Luke (Ltd.)	Vulcan Boiler Ins. Co.
Comb. Met. Packing Co.	McPhail & Simpson	Wellman, Seaver & Head
	Marples, Leach & Co	Wright & Co

The total number of exhibitors exceeds 230, the largest number, it is believed, ever congregated in a Trade Exhibition.

The Electrician.

The Oldest Electrical Journal (established as a weekly Journal, 1861—1878.)

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All Editorial communications to be addressed to THE EDITOR. *Letters for insertion in* "THE ELECTRICIAN," *or containing questions, to be accompanied by name and address of the writer as evidence of good faith. No notice is taken of anonymous communications.*

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TRADE ADVERTISEMENTS *intended for the current issue must reach the Office at latest by Wednesday evening's post. Renewals of expiring Advertisements and alterations to standing Advertisements by first post Wednesday. Wrapper Advertisements by first post Wednesday.*

CONTRACTS *and other* OFFICIAL ANNOUNCEMENTS, AUCTIONS, APPOINTMENTS VACANT AND WANTED, *and all kinds of* SMALL ADVERTISEMENTS *accepted up to* **3:30 P.M. Thursday.**

"THE ELECTRICIAN" INDUSTRIAL SUPPLEMENT

With "THE ELECTRICIAN" for Sept. 14, 1906, was issued the first of a series of "Industrial Supplements," to be published from time to time with "THE ELECTRICIAN." The twenty-sixth issue of the Supplement was issued (Gratis) with "THE ELECTRICIAN" for August 21.

The "INDUSTRIAL SUPPLEMENT" is a comprehensive record of developments in Electrical Plant, Machinery, Apparatus, Accessories, Sundries and Materials, and of their proved suitability for various Industrial purposes.

The "INDUSTRIAL SUPPLEMENT" is holed for filing or hanging, and filing covers can be supplied for holding 6 or 12 issues.

THE TROLLEY OMNIBUS.

There are certain innovations which require a very long time to take root in the public mind, whether it be the popular or the engineering mind is of small account, and this time is often so long that pioneers fail entirely to reap their reward—not only so, but in all probability they lose heavily in sowing the seeds from which their followers reap a rich harvest. Among such innovations must be classed the trolley omnibus, for it is by no means a new idea.

Those who visited the great Paris Exhibition in 1900 will remember the Lombard-Gerin system there shown in operation. The difficulty of want of flexibility in negotiating other traffic on the road was overcome by the ingenious device of a motor trolley head with a flexible connection. This trolley head ran along the two overhead wires, and, besides acting as a collector of current, it was equipped with a small three phase motor which was supplied with three-phase current from slip-rings on the car motor, and thus propelled the trolley head in advance of the vehicle. The omnibus was provided with a short mast on the roof, and from the top of this a flexible cable connected the car motor to the trolley head, this cable serving to transmit not only the energy from the line to the car, but to re-transmit energy for the small three-phase motor. Owing to the tendency of the trolley head to run at a higher speed than that of the omnibus, the flexible cable showed no inclination to drop, and it was easy to run a car as far away from the trolley line as was necessary to accommodate other traffic. In addition to the line to which we have referred, a second Lombard Gerin line was run in France between Fontainebleau and Samois but so far as we are aware no further progress was made with this ingenious system. Possibly the complication of a motor trolley head

and the weight of such a device, amounting to about 45 lb., thus involving a much more solid overhead construction than would be necessary otherwise, proved to be serious objections.

At the same time attempts were being made to run trolley omnibuses by means of two trolley poles per car, the poles being made very much longer than those on tramcars, so as to give the necessary freedom to the omnibus. Difficulties, however, were experienced in keeping the trolleys on the wires under all conditions, and it was on that account that the Lombard-Gerin system was brought forward. Now, however, the trolley pole system is being resuscitated. The Railless Electric Traction Co. is prepared to equip roads upon this system, and has issued a pamphlet comparing the system with other methods of dealing with urban traffic. From this pamphlet we gather that German engineers are becoming favourably impressed by the trolley omnibus, for short lines are at work at Monheim (near Cologne) and Wurzen, while the Corporation of Mülhausen have recently considered the rival systems of tramway, petrol omnibus and trolley omnibus, and, as a result, are constructing 6¾ miles of route as an extension of their tramway system.

In this country, also, the subject is at length beginning to excite some interest. Thus, the Dundee City Council have been seriously considering the merits of the trolley omnibus, and the Manchester Corporation have also sent a deputation to the Continent to consider the merits of railless traction. The low capital cost, as compared with a tramway system, is a powerful argument which will appeal to all who are not wedded to traction on rails at any cost. This phase of the question will be considered fully by Mr. F. DOUGLAS FOX in a Paper he is reading before the British Association during the present meeting in Dublin. It is well known that tramway capital expenditure is in many cases a burden too heavy to be comfortably borne. Deficits are shown by a considerable proportion of municipal tramway undertakings, notwithstanding the fact that in many cases no allowance is made for depreciation; but this must not necessarily be taken as evidence of failure, because the aim of a local authority should be to give cheap transit rather than to make profits. Nevertheless there are many cases in which the capital involved in a tramway undertaking is a burden from which the ratepayer would rather be relieved, and in such cases it might have been better if the merits of the trolley omnibus had been considered as an alternative. When once a tramway has been laid down the substitution of any other system becomes practically impossible. There are, however, cases in which it is desired to extend a tramway system to outlying districts showing but small chance of profitable working. The trolley omnibus then affords a simple solution: the overhead conductors are extended for this purpose, and tramway track can be laid down in due course when the traffic justifies such a step. There appears to be only two serious inconveniences—namely, that "through-running" from the extension to the main part of the system, and *vice versa*, is impossible; and that a car shed is also necessary on every extension of this kind. A change of car is a small matter for a passenger to endure, but it is an inconvenience, and may be sufficient to cause a council to extend a tramway on proved lines, even at the risk of a loss in working, rather than give a trial to a novel system. In the case of a circular route to connect up several radiating tramway lines this difficulty should not be so serious, because a change of cars at most junctions would be an inevitable part of the programme. We think, however, that the most promising field for the trolley omnibus will be in small towns where tramways do not exist. There are a number of such towns where increased facilities for transport would be welcomed, but where the electric tramway is a too serious financial risk to be considered, and here the trolley omnibus, if its claims can be substantiated in this country as in Germany, should meet a distinct want.

OBITUARY.

ELEUTHERE ELIE NICOLAS MASCART.

We greatly regret to record (as briefly noted in our last issue) the death of M. E. E. N. Mascart, which occurred on Tuesday, August 25, in his 72nd year.

Eleuthere Elie Nicolas Mascart was born at Quarouble, in the north of France on Feb. 20, 1837. He received his early education at Valenciennes and at the Lycée of Lille and Douai, becoming *préparateur*, or assistant professor, at the latter establishment in 1864. After holding this post for a year he was appointed Professor of Physics at the Lycée in Metz, and shortly afterwards to a similar position at Versailles. In 1868 he took the adjunct professorship of physics at the College of France, under the celebrated Regnault, and on the retirement of the latter he succeeded to the full professorship. During the Franco-Prussian war M. Mascart undertook the sub-directorship of the cartridge and chassepot factory at Bayonne, and at the end of the war was created Chevalier of the Legion of Honour. In 1878 he was appointed Director of the Central Meteorological Bureau of France, a position which he held at the time of his death, and in 1884 was elected a member of the French Academy of Sciences.

Though not known as the propounder of great discoveries, he added much to our knowledge of science, especially in the field of optics and electricity. He resembled his predecessor, Regnault, in being a reliable and careful worker, while he was the author of many excellent books. His first work was published in 1864, and was a memoir entitled "Researches on the Ultra-Violet Solar Spectrum and the Determination of the Wave Lengths of the Luminous and Ultra-Violet Rays." Since then he has given to the world a large number of memoirs, especially on light and electricity. In 1876 M. Mascart published his "Treatise on Static Electricity," and between 1882 and 1886 "Lessons in Electricity and Magnetism." This work, in which M. Joubert collaborated, has been translated into the English and German languages. M. Mascart afterwards published a "Treatise on Optics," in three volumes, which, like his preceding works, at once became a standard authority on the subject. In 1900 he published a "Traité de Magnétisme Terrestre."

M. Mascart was a past-President of the French Physical Society, of the Société Internationale des Electriciens, of the French Meteorological Society and of the French Association for the Advancement of Science; and was at the time of his death President of the Consulting Committee on Arts and Manufactures attached to the French Ministry of Commerce, and President of the Commission of Inventions for the Army and Navy. He was a member of the Institute of France, a foreign member of the Royal Society and an honorary member of the Institution of Electrical Engineers. At the Paris Electrical Exhibition and Congress of 1881, M. Mascart was general reporter of the Congress and of the Jury, for which services he was created Officer of the Legion of Honour. In connection with the Paris Exhibition of 1889 M. Mascart was President of the Technical Committee on Electricity, President of

the Jury of Class 62 (Electricity), and also President of the International Congress, and at the close of the Exhibition he was created Commander of the Legion of Honour. At the Paris Exhibition of 1900 he was appointed President of the Committees and of the Jury of Group V. (Electricity), and was subsequently made a Grand Officer of the Legion of Honour.

REVIEWS.

(Copies of the undermentioned works can be had from *The Electrician* Office, post free on receipt of published price, adding 3d. for books published under 2s. Add 10 per cent. for abroad or for foreign books.)

Modern Views of Electricity. By Sir OLIVER LODGE, F.R.S. 3rd edition. (London: Macmillan & Co.) Pp. xiv. + 502. 6s.

If we remember that the first edition of this useful work was published in 1889, before the recent revolution in electrical science, we must admire the author's courage in bringing out a third edition of a work which, in its original form, would now be considered decidedly out of date. The title, of course, might also be taken to cover something like a yearbook, or summary of the latest views put forward. But the fact that whole chapters are left practically untouched rules out this interpretation, and so we have a kind of patchwork in which long disused mental images are presented side by side with newer conceptions derived from more atomistic theories recently forced upon the electrical world. The author's famous declaration that "electricity is ether"—a bold but somewhat sterile guess made in the days of Hertz—still holds the field in many parts of the book. Thus on p. 31 we find electricity compared to "an incompressible fluid filling all space." If this is a modern view, we venture to say that it is confined to one leading physicist, viz., Sir Oliver Lodge himself. So far from the ether being identified with electricity, it is actually on trial for its very existence. Bucherer in Germany, Ritz in France, and Campbell in England have proposed systems more or less independent of the conception of the ether, and even J. J. Thomson, in his recent Adamson lecture, propounded a theory of radiation which borrows many of its most characteristic features from the old emission theory of light. It cannot, therefore, be said that the trend of modern thought is at all in the direction of those views which Sir Oliver Lodge has so ably, consistently and eloquently advocated.

It is significant that the nature of magnetism is left entirely unexplained in this work so far as magnetic *substances* are concerned, whereas the field is very fully dealt with, largely with the aid of the rack-and-pinion model. This, one might almost venture to say, is in direct opposition to the modern treatment, as exemplified in the work of Weiss and Langevin. A similar omission is noticeable in the departments of electrolytic, solid and gaseous conduction. The ether, on the other hand, is treated at considerable length, and it must be acknowledged that the treatment is lucid and extremely skilful. On p. 322 we find an interesting speculation on the origin of matter and electrons. The elasticity of the ether is "perfect," says the author, "in free space, apart from matter, until a critical shear, of unknown value, is reached. If strained beyond that, it may be supposed that a separation, or dislocation, or decomposition, of the ether into two components or constituents would occur—constituents generated, as it were, by means of the shear, and probably not existing as such in the unperturbed ether. One of these components we call positive, and the other negative electricity. Once formed, they do not disappear again; they may combine or approach each other so closely that they neutralise each other's effects at a distance; but they are still readily separable by electromotive force. . . . The negative electricity, when separated, is freely mobile and easily isolated; it is what we experience as an electron. The positive constituent does not appear thus in an isolated manner, but is only known to exist in a mass—a mass very like a hydrogen atom—possibly an inseparable aggregate of opposite charges matted together and going about as a whole. . . . These masses or aggregates may temporarily acquire, or may lose, one or more of the free electrons; and by thus becoming amenable to electrical or chemical attractions or repulsions, constitute what we call 'ions,' so long as the unbalanced or electrified conditions lasts."

The book is valuable as a species of autobiography, showing the successive phases of thought experienced by one of the foremost living physicists whose mind has been at every stage straining towards the ultimate reality of things. It also shows the electrician of the older school that there is a great deal in the conceptions prevalent in his youth which he need *not* discard. In that limited sense the book may still be described as a "modern" one.

The Mathematical Theory of Electricity and Magnetism. By J. H. JEANS, F.R.S. (Cambridge: University Press.) Pp. viii. + 536. 15s. net.

This is the work of a brilliant Cambridge man, who is now Professor of Applied Mathematics in Princeton University, U.S.A. The science of electricity and magnetism has been an exact and an advanced one for so many years, that it is almost surprising that some distinguished member of the Cambridge school has not written a similar work before. Even advanced electricians have found the reading of Clerk-Maxwell's classical work an impossible task. J. J. Thomson's comparatively elementary work entitled "Elements of the Mathematical Theory of Electricity and Magnetism" published more than a dozen years ago, is worthy of the genius of the author, and supplied a long felt want; but the Cambridge Professor of Physics has never written an advanced text-book akin to Routh's valuable work on Rigid Dynamics, or Lamb's on Hydrodynamics.

The work under review covers approximately the same range as Maxwell's. It opens with an able introduction, which summarises in a dignified and forcible style the tasks which lie before the reader. The author indulges, at the beginning of the book, in a little elementary work, in which he proves himself to be a man of humour; and then plunges into the more advanced treatment of the subject. The work is chiefly theoretical, and tedious experimental details are wisely omitted; to quote from its pages, after describing how to measure an electric charge the author says:—"This method of measuring an electric charge is, of course, not one that any rational being would apply in practice, but the object of the present explanation is to elucidate the fundamental principles, and not to give an account of practical methods."

The work does not claim to be encyclopædic, and the author himself says that "any attempt to bring a book of this kind up to the boundaries of existing knowledge would obviously be out of place"; nevertheless he does not resist the temptation (rightly, it seems to the reviewer) to give an article on the modern view of electricity; and he gives an account of what was undoubtedly the modern view two years ago; but J. J. Thomson advances so rapidly that it is almost impossible for a text-book to keep abreast of him. This is by the way.

At the end of each chapter there is given a list of references, and nearly every chapter has a collection of examples which will delight the heart of the Cambridge student, and will be of utility to serious students everywhere. A feature of the book is that a good deal of mathematics is done just before it is wanted; this lengthens the work, but it will probably be found acceptable to a big fraction of the readers. A. G.

Die Berechnung elektrischer Anlagen auf wirtschaftlichen Grundlagen. By Dr. ING. F. W. MEYER. (Berlin: Julius Springer.) Pp. xix. + 275. M. 7.

This book discusses the calculation of electrical installations according to the principles of economics and relates to the methods of choosing the most suitable system to be adopted from this point of view.

The conditions that must hold for an undertaking to become a commercial success are examined in a series of calculations applied to cases of installations working under conditions fixed by various financial and technical considerations, and the results obtained are used for the working out of numerical examples principally of extra high tension transmissions.

The formulæ obtained for the voltage of a system and the values of the losses admissible in each case, are in many instances of a cumbersome nature, and their use is facilitated

by the deduction of approximate formulæ of a simpler form. which are throughout the book marked in a manner indicating the degree of exactitude which may be expected to be obtained by their use.

Considerable space is devoted to the criticism of the writings of other contributors to this subject such as Wallace, Mershon, Swyngedauw, and Sarrat, and the author finds that the discrepancies between the results obtained by them are to a great extent due to a confusion of the conditions governing the profitable running (Rentabilität), or economical running (Wirtschaftlichkeit) of the installation.

The writer lays stress more particularly on the methods of calculation described by him than on the actual numerical results obtained, as he considers that more experience is necessary to allocate really reliable values to the constants of his formulæ.

The mathematical portions of the work form somewhat difficult reading on account of the complicated notation used, but the reader will be repaid for a careful study of the contents.

INSURANCE AND INSPECTION OF ELECTRICAL MACHINERY.

We have received a copy of the report for the year 1907 of Mr. M. Longridge, chief engineer to the British Engine, Boiler & Electrical Insurance Co. The report is divided into the usual sections: (1) Insurance and inspection of steam, gas and oil engines. (2) Insurance and inspection of electrical machinery. (3) Insurance and inspection of boilers. (4) Boiler explosions, collapses and mishaps, and abstracts of Board of Trade reports. It concludes with a short account of the trials of two steam engines using superheated steam. For the first time since the Company began to issue certificates of safety for boilers—*i.e.*, a period of 26 years—has the chief engineer to report that a life has been lost by the explosion of any certified boiler. We regret that the Company's excellent record has at last been tarnished, but from the particulars of the occurrence it is evident that it is the Company's misfortune rather than its fault that it is not able to maintain an untarnished record.

We notice from the first section of Mr. Longridge's report that the rate of breakdown was 1 in 11·7 among steam engines and 1 in 11·1 among gas and oil engines, as compared with 1 in 8·1 and 1 in 12·4, respectively, last year. It is interesting to observe that in both types of engine the valves and valve gear are believed to have failed more frequently than any other part, and that whereas the percentages of failures due to this cause in the 24 years previous to 1906 were 21 per cent. for steam engines and 32·5 per cent. for gas and oil engines, these figures stand at 28 and 43·3 per cent. respectively for the year 1907. Also in the case of gas and oil engines the next highest percentage of failures—viz., only 13·5 per cent.—was attributed to cylinders and cylinder ends, thus showing apparently that the weak point of this type of engine is its valves.

The chief engineer's remarks on this subject are as follows :—

The increase in the number of breakdowns of steam engines traceable to failures of valve gears is probably the result of increase in speeds and number of parts. The reduction in the number of breakages from spur gearing is the natural consequence of the substitution of rope and direct driving for the older system of transmission. The steady increase in the number of broken cylinders and pistons is due principally to the use of steam at temperatures and pressures higher than the parts can safely bear. The reduction in the number of main shafts broken is remarkable and inexplicable.

In gas and oil engines the increase in breakages of valves and valve gears is not satisfactory, and demands the serious attention of makers of these engines. If all side shafts were fitted with ring lubricators and levers made of wrought iron or good cast steel the percentage in the table would be reduced. The reduction in broken cylinders and pistons is encouraging, and marks the progress which is being made. Connecting rods proved less destructive than usual, probably because of improvement in design, particularly as regards strength of bolts. Breakages of crank shafts were fewer than in 1906.

An increase is again reported in the electrical branch of the business, and the number of breakdowns of dynamos and motors in 1907 exceeded the number in 1906 by 18·1 per cent., so that insurance is proving a benefit to the users of electrical machinery. The rate of breakdown was rather lower among dynamos and rather higher among motors than in 1906. The exact figures are 1 in 18·7 among dynamos and 1 in 7·9 among motors. The corresponding figures for 1906 were 1 in 16 and 1 in 8·2. Again, as in 1906, the rate among continuous current machines was much higher than among alternating, but, on the other hand, the average cost of each breakdown was much less, so that the company's practice of charging practically the same rates of premium for both types of machine is fully justified. The proportions in which the various parts of the machines are thought to have caused or initiated the breakdowns of 1907 are tabulated below:—

Part which is believed to have failed first.	Dynamos. 1906.	Dynamos. 1907.	Motors. 1906.	Motors. 1907.
Armatures and rotors ....per cent.	50	35	44	38
Magnet coils and stators	11	7	14	14
Commutators and brush gear	20	34	28	30
Miscellaneous	19	24	14	18
	100	100	100	100

Starting Switches and Controllers.	1906.	1907.
Resistance coils ... .per cent.	48	60
Contacts and switch arms	10	8
Automatic apparatus	17	13
Miscellaneous	25	19
	100	100

The causes of these breakdowns were probably as follows :—

	Dynamos. 1906.	Dynamos. 1907.	Motors. 1906.	Motors. 1907.	Starters 1906.	Starters 1907.
Accidental ....per cent.	15	8	9	4	22	9
Dirt and neglect	14	25	19	28	11	16
Age and deterioration	21	23	25	23	23	27
Bad work or design	23	21	18	18	9	8
Overloading	0	0	2	1	7	5
Unascertained	27	23	27	26	28	35
	100	100	100	100	100	100

We select from the report the following interesting and typical examples of breakdowns during the year :—

1. Protected three-phase alt. current 50 H.P. motor, one year old, taking current at 500 volts and running at 750 revs. per min. The breakdown can be well described in the Inspector's own words. "This motor," he says, "broke down and I examined it to-day. I found that six of the stator coils have been completely stripped, and about 15 of the rotor coils are badly damaged. I can only suppose that some foreign substance has got into the machine when it was running and simply demolished all the coils which were in its path, for the case was full of small bits of copper. The rotor is damaged just in one place, and from the nature of the damage great force has been expended at that point, so I can only surmise that something has caught in the rotor winding, and gone round the coils. As is frequent in such cases the driver of the machine swore that the current was switched off and the rotor at rest when the accident occurred, so he evidently knew more about it than he would tell, but I could get nothing further out of him." The motor, as stated above, was protected, but the Inspector said it was quite possible for things capable of doing the damage to get in. There is little doubt that something did get in, but what it was was not, and probably will not be, discovered. There is no question of the rotor windings having been lifted by centrifugal force, as the binders were intact.

2. Four-pole totally-enclosed series-wound 8 H.P. motor, two years old, driving a winch in a shipyard with current at 480 volts; speed, 700 revs. per min. The fuse, a No. 16 S.W.G. tin wire, having melted, one of the Company's Inspectors was sent for to examine the motor He found the solder all round the end connections of the armature conductors partly melted, and on taking out the armature four coils were seen to be completely burnt out. Wedged into the space between two of the conductors and the end of the core was a piece of cinder, which no doubt was the cause of the trouble. How it got there in an enclosed motor is a mystery. The only suggestion the writer can make is that the armature must have been set down upon it or rolled over it at some time when taken out, and that movement of the conductors while the motor was running had caused it to rub through the cotton covering and short-circuit the coils.

3. Semi-enclosed two-pole centre-hung shunt-wound $2\frac{1}{4}$ H.P. continuous current motor, taking current at 500 volts, and driving a fan in a smithy at a speed of 2,400 revs. per min According to the statement of the attendant, a belt of flame ran round the commutator when he started the motor. When he stopped it he found the remains of two rats wedged between the armature and the frame, but could discover no injury to the conductors. By testing, however, the Company's Inspector, who had been sent for, found a break in one of the end connections, close to the commutator, which had no doubt caused the spark-

[illegible]. Whether one of the rats was accountable for the breakage was uncertain.

4. Two-pole totally enclosed shunt-wound 4 H.P. Lundell motor, taking current at 230 volts, and running at 1,100 revs. per min. The Company's Inspector was sent for because smoke was issuing from the joints of the carcase. He examined it, ran it, and tested the insulation without discovering any fault. He then had it opened, and discovered that the smoke had come from the ignition of a quantity of oil, dust, and dirt which had accumulated upon the bottom of the circular magnet coil by sparks from the brushes, and that the sparking had been caused by one of the carbon blocks getting jammed in its brush holder. The insulation of the magnet coil was also slightly charred. This was patched up, the brush gear put in order, and the motor cleaned and started. Since then it has given no further trouble. This is quite a typical case. Fires inside motors started by the ignition of collections of fluff and dust are not uncommon.

5. Four-pole shunt-wound semi-enclosed motor, about two years old, giving 80 H.P. at 500 revs. per min. with continuous current at 500 volts, and protected by two No. 16 S.W.G. copper wires fusing with 332 amperes or $2\frac{1}{2}$ times the maximum current supposed to be carried by the machine. The fuse melted, and on examination two of the armature coils were found burnt. The remaining coils were saturated with oil and very dirty. The insulation of the commutator segments was also burnt close to the spokes through oil and dust settling between the spokes and short-circuiting them. This insulation, instead of being carried up a short distance, say, $\frac{1}{4}$ in. or so between the spokes, ceased at the ends of the bars, leaving very narrow wedge-shaped opening between the edges of the spokes to hold oil and dust. The machine was so damaged by dirt and neglect that the armature had to be entirely rewound, and the commutator rebuilt and re-insulated. It was only accepted for insurance about 11 months previous to the breakdown, and was then in good condition. It seems, however, that it had then just had the benefit of a thorough repair in consequence of a similar breakdown at the end of its first year's work.

6. Two-pole continuous current shunt-wound motor-transformer, working in a sub-station of a lighting supply, receiving 44 amperes at 1,080 volts and transforming to 110 volts. Normal speed, 470 revs. per min. When started from the central station on the evening of the breakdown, the armature gained sufficient speed to break one of the steel binders at the high-tension end, and spread the conductors till they jammed themselves fast between the pole pieces. On examination it was found that one end of the shunt winding had slipped out of its terminal. One of the attendants who had cleaned the machine in the morning declared that the wire was then in place, and suggested that it must have been shaken out of the terminal by vibration when the machine was started. It is far more likely that he pulled it out with the duster or waste he was using, for the wire had simply been slipped under the binding screw, and not bent round or over the terminal block. The case is mentioned because the number of shunt wires broken or pulled out of their terminals proves that such wires ought to be better protected and more efficiently secured than they generally are.

7. Four-pole compound-wound dynamo, three years old, giving 90 amperes at 250 volts when running at 550 revs. per min. The commutator contained 153 segments, insulated with one exception by mica plates. The exception had micanite. The two coils in connection with this segment were burnt out and had to be replaced. The cause was a short-circuit across the micanite insulation, produced by carbon dust and oil which had penetrated into the micanite. The other segments were quite as dirty, but the mica plates between them had kept up the insulation. The Company's experience undoubtedly is that pure mica is to be preferred to micanite or made up mica for insulating commutator bars.

8. 7 H.P. three-phase motor of foreign manufacture, driving the hoisting winch of an overhead crane with alternating current at 190 volts. The three leads to the slip rings were fused. On examining the rotor it was found that the core plates had been threaded upon the shaft and a ring shrunk on at each end to hold them. There was no key or feather to prevent them turning. The conductors were led over the ends of the core through a hole in the shaft, which was hollow, and out at the end to the slip rings. The hole had sharp edges and was not bushed with insulating material. The consequence was that the rotor got loose and rocked upon the shaft, rubbing the insulation of the leads where they entered the shaft and short-circuiting them.

9. Four-pole shunt-wound ventilated motor, 7 H.P., $14\frac{1}{2}$ amperes, 400 volts, 1,000 revs. per min., driving machine tools. Fuse when insured, [illegible] No. 16 S.W.G. tin wire, subsequently replaced by a cartridge [illegible] of [illegible] amperes. On receipt of a message by telephone that the motor had broken down an Inspector was sent to examine it. He found that the armature had been taken out, and sent to the maker's works, whither he followed it. There he found that two of the conductors were broken, one close to the commutator lug, and the other so close to the core as to necessitate lifting the coil, and as this could not be done without lifting the other coils the repair meant rewinding the armature. He also learnt that the makers had been sent for some months before on account of bad sparking and had then warned the owner that the motor was overloaded. With this information the Inspector went back to the Owner's works as soon as the armature had been repaired and replaced, and measured the current required to run all the machinery [illegible]. He found it to be 20 to 21 amperes. The owner then [illegible] that they had added some machines since the motor was [illegible] and promised to make enquiries as to the price of an [illegible].

A STUDY OF MULTI-OFFICE AUTOMATIC SWITCHBOARD TELEPHONE SYSTEMS.*

BY W. LEE CAMPBELL.

(Concluded from page 757.)

Summary.—This Paper deals with (1) The enormous economic waste which the wire, cable and conduit equipment of a telephone system involves. (2) A recapitulation and discussion of reasons which make this waste necessary or expedient in manually operated systems. (3) How this waste can and should be greatly reduced in systems employing automatic switchboards.

An investigation of the effect of plant division on service reveals what is a very serious objection to a multi-office manual system; because slower service, more mistakes by the operators, and, what is most aggravating to a telephone subscriber, more premature disconnections during conversation, are the inevitable results of having connections handled by two operators instead of by one. Increasing the number of offices in an automatic system does not appreciably affect the service. When the author states that the service of a multi-office automatic system is on a par with that of a single office automatic system, he believes that he gives it the highest endorsement possible in the present state of the telephone art. Not only has the writer not discovered any reasons which weigh materially against division of automatic systems, but he finds that the saving in the investment in cable, wire and conduit would be even greater than in a manual system. First, because division may, as clearly shown, be carried much further without seriously affecting central office expenses, and second, because the number of trunk lines required for handling traffic between automatic offices is less than between similar manual offices. In other words, an automatic trunk will carry, on the average, more busy-hour calls than a manual trunk.

The largest number of trunks per group almost universally used in automatic systems is 10. With groups of this size a minimum carrying capacity of 22·5 busy-hour calls per trunk is secured. This is a decided increase over the carrying capacity of manual trunks even where the latter are installed in groups of the greatest efficiency—that is, groups of about 73 circuits each. It would rarely, if ever, be possible to obtain such a large group if a manual plant were so divided that all offices were comparatively small, but in almost any multi-office system the majority of the trunks between offices can readily be placed in small groups of 10 trunks each. Consequently, in an automatic multi-office system maximum efficiency is secured on nearly all of the trunks. This is illustrated by curve D, Fig. 5, which gives the average minimum carrying capacity per trunk for each of the different arrangements of the hypothetical 10,000-line system. The average minimum number of busy-hour calls carried per trunk is, according to the curve, about 20·75, and the lowest figure is 19·3 for the nine-office arrangement. Supposing, for the moment, that it be practicable to use this nine-office arrangement in a 10,000-line manual system, the average number of busy-hour calls carried per trunk would be about 12. The small number of trunks that will carry the traffic between automatic offices even in a thoroughly divided system is illustrated by curve E, Fig. 5, which shows the ratio on a percentage basis between the number of trunks and the number of subscribers' lines. With the largest number of offices considered this percentage is but 9·3.

One reason for the increased efficiency of automatic trunks is found in the shorter length of time per connection. In manual practice it has been found that each trunk is occupied on the average at least two minutes per connection, whereas automatic experience proves that during the busy-hour a trunk is not occupied over 83 seconds per average connection. A subscriber to automatic service answers his telephone quicker and generally does not hold the line so long for conversation as does a manual subscriber; also, the disconnection is made much quicker in the automatic system.

A still higher trunk efficiency could often be secured in automatic systems if the trunk groups could be made larger than 10 lines each without impairing the speed at which idle trunks are selected. The manufacturers of automatic apparatus have recognised the possibilities of larger groups and are now testing equipment designed to enable them to put more lines in each. Since such equipment has not come into general use, however, it will not be considered further in this Paper.

In endeavouring to form some conception of the methods used for introducing trunking of calls on a large scale between automatic offices, it is well to understand the difference between two general types of office that are being used for this purpose. One is known as a "substation" or "district" office and the other as a "branch"

* Abstract of a Paper read before the American Institute of Electrical Engineers.

office. The difference lies in that a substation contains line switches and connector switches but no apparatus for making local connections: that is, every originating call is trunked to a distant larger office containing the selector switches, whereas a branch office contains switches of all classes and completes within itself all local connections demanded. It will readily be seen, therefore, that a substation requires more outgoing and incoming trunks than a branch office. It is best adapted to a district where there is very little telephonic intercourse, and it is also especially adapted to a small isolated district where the expense of a constant local attendant would not be warranted, and, where it is, therefore, considered advisable to instal the simplest apparatus obtainable, with arrangements for supervision from the main office to which the substation trunks are connected. When the proposed office is to be a small one, and the trunks to it are to be secured by converting the line cable at present entering the new office district into a trunk cable, there is often no immediate advantage in economising in the number of trunks. To such conditions a substation is well suited even if the trunks are long and consequently expensive. It would appear, however, that in the present state of the art such an auxiliary to a "main" office would rarely be warranted if it contained over 500 lines.

A substation may often be used to much better advantage as an auxiliary of a branch office; that is, a branch may be installed at the centre of a comparatively large district so that all trunks going out from or coming into the district will terminate at the centrally located branch office, then shorter and more numerous trunks may be run from this office to substations located about it.

As an illustration of how trunking of calls is done in a large automatic system, Fig. 9 shows a rough skeleton of a 50,000-line system.

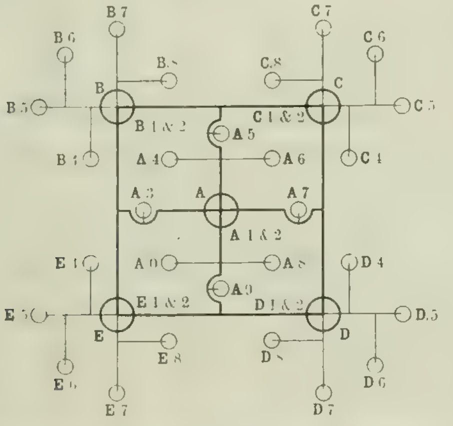

FIG. 9. SKELETON OF DIVIDED 50,000 LINE AUTOMATIC SYSTEM.

This contains five main offices, A, B, C, D and E, of which A has eight branch offices and the other main offices each have five branch offices. Since this system has an ultimate capacity of 100,000 lines, all numbers would have five figures, but, as is customary, in place of the first figure a letter is used, which not only makes the number easier for the subscriber to remember, but also designates the office to which the number belongs. It is supposed that the main office A contains equipment for 2,000 lines, the numbers of which run from 1,000 to 2,999; and that each of its branches contains equipment for 1,000 lines, the numbers in A-3 running from 3,000-3,999, in A-4 running from 4,000-4,999, &c. Each of the other main offices is also supposed to contain equipment for 2,000 lines, the numbers of which run from 1,000 to 2,999 in each. Connections in the system would be handled as follows: suppose a subscriber E-7,234 connected to branch office E-7 called A-5,124 connected to the branch office A-5. The first movement of the subscriber's calling device would operate his line switch and connect his line to an idle first selector in his own exchange, E-7; then when the calling device sent in a number of impulses corresponding to the No. A, his first selector would be operated and would pick out an idle trunk to a second selector in exchange A. The second set of impulses corresponding to the figure 5 sent in by the calling device would operate the second selector at A and extend the connection over an idle trunk to a third selector in the office A-5. The next set of impulses corresponding to the 1 of the desired number would operate a third selector at A-5, which would extend the connection to a connector switch in the proper "100 group" at A-5. This connector would be operated by the impulses corresponding to the last two digits of the desired number and would complete the connection to line and telephone A-5,124.

It may be noted that on this call the connection to A-5 passes through the main exchange A. This would be true of every call incoming into the A district—that is, all trunks incoming into the district would terminate in second selectors in the A office. These second selectors would extend each incoming connection to a third selector located at the A main office, or at the branch corresponding to the thousands digit of the particular number being called. This concentration of the incoming circuits simplifies the trunking arrangement and also reduces considerably the number of trunks entering the district, because the number of groups of incoming trunks would be nine times as great if each of the nine offices received its calls, coming from outside the district, direct instead of having them come through the main distributing office A. It should be noted on the other hand that the outgoing call from E-7 does not operate any switch at its main office E. It would probably be preferable, however, to have the trunk pass through the cross connecting frame at E. In a similar manner all outgoing trunks from each of the branch offices of E district could be terminated on the distributing frame at E, and there be cross-connected to what might be called a "through trunk cable" to each of the other main offices. If a subscriber connected to any office in the A district should call a number connected to an office in E district the incoming trunk to E district would terminate in a second selector switch at main office E, and would be passed on by it to the desired branch office or thousand group. In the skeleton diagram no trunk cables are shown interconnecting the branch offices of a district; for instance, no interconnection is shown between E-6 and E-7. If desired, such trunks could be put in, or the outgoing trunks from all the branch offices of E may, as already stated, be run to the main central office and there be cross-connected on a distributing frame. This would in many cases be the most economical arrangement, because with division carried to the extent that it is in this diagram, the number of trunks required between E-6 and E-7 would be comparatively small. A call from a subscriber at E-7 to a subscriber connected to E-6 would operate a line switch, first selector and second selector at E-7, and a third selector and connector at E-6 so that it is not necessary that the connection should pass through the main office E.

If a manual system should be divided up in the manner shown in Fig. 9, supposing for the moment that such a division would be practicable with equipment of that type, then the branch office E-7, for instance, would have 32 different groups of outgoing trunks—that is, one group for each of the other offices in the system—and would have the same number of groups of incoming trunks. With the automatic branch office arrangement, E-7 has but 10 groups of outgoing trunks—that is, one group to each of the other district main offices and one group to each other "thousand section" in use in its own E district. E-7 would have but five groups of incoming trunks—that is, one group from each of the other offices in the E district. It is seen, therefore, that by using the main offices at centres of comparatively large districts and then surrounding each main office with smaller branches, all subscribers' lines may be made very short and the use of the "through" trunks between the main offices for interconecting districts makes the trunking system comparatively simple.

One of the peculiarities of the telephone business, especially when there is competition, is that an operating company is compelled to take on the new business offered. It must keep up with its rival or drop out of the race. A one-office telephone plant sometimes must be almost entirely rebuilt within a few years of its installation in order to adapt it to a shifting of population, or to make it adequate for the customers unexpectedly demanding service. With a multi-office automatic system this need not be done. If an unexpected demand for telephones develops in a certain section of the city, it is not necessary to put in more conduits and cables or to replace present cables with larger ones to take care of the demand, but the situation is readily and practically met by putting in a substation or a branch office in the congested district. The present line cables running to the district may be used as trunk cables to the new office. Thus the traffic-carrying capacity of the cable and conduit plant reaching any district may be greatly multiplied without any additional expenditure for cable or duct. Consequently, one of the most attractive features of an automatic multi-office system is that it affords a stable value to the investment in wire, cable and conduit.

RAIL GRINDING.

[COMMUNICATED.]

The question of corrugation of tram rails has received a good deal of attention both from the theoretical and practical standpoint during recent times, and this indicates sufficiently the difficulty which, as tramway systems are extended, is met with in the proper upkeep of the permanent way. There is no doubt that if constant and steady means of coping with the unequal wear of tracks are not adopted, the smoothness of running will be seriously interfered with in a short time after starting, resulting not only in discomfort to passengers, but in an actual decrease of efficiency of work.

The means and methods of rail grinding have, therefore, been the subject of considerable research, and the chief elements by

which any grinding system stands to gain or lose are the time involved and the expense in operation and supervision. A case in point is that of the Cardiff tramways, where for some two or three years past a rotary rail grinder has been in use. As, however, owing to the exigencies of the tramway service, it was impossible to use it except between the hours of midnight and 4 a.m. it was found that the rotary grinder was utterly unable to cope with the corrugation on the system. During the hours specified it was only possible to grind efficiently a comparatively small portion of the track, and as the Cardiff tramways have 32 miles of track and the corrugation evil had permeated the whole system, the effect of this night work was of very little permanent advantage.

This brings to the front the essential evil of a system which involves the stoppage of any car route in order to reduce the irregularities on the track, such as are likely to be produced most extensively at points and crossings where there is most traffic, as by the very condition of things the parts requiring the most attention are located in such positions as to involve the greatest dislocation of traffic. Moreover, the use of a rotary grinder very frequently involves the employment of a night gang at enhanced wages and very careful supervision of their work. The operations cannot be carried out with quite the same accuracy by artificial light as in broad daylight, and the results are therefore in many cases unsatisfactory.

An alternative system is the linear grinder, consisting essentially of a block of abrasive material fixed to a portion of either an ordinary service car, or, if considered advisable, to a watering car. A useful example of this type of grinder is that invented by Messrs. Ellis & Kidd, which has been in successful operation on the tramways above indicated. This consists essentially of a carborundum block which normally is held clear of the rail by means of springs attached to the framework, which can be fixed to the car. In order to bring pressure to bear on the rail the plunger of a magnetic solenoid is fixed to the shoe carrying the block, and is so situated with regard to the magnetising coil that, on current being applied, the plunger is forced downwards, pressing the block on the surface of the rail. As the pressure is applied electrically, it is always constant, notwithstanding any jolting or oscillation of the car. If it had been applied through springs, variation would always be expected, and if applied direct, say, by means of a screw or hand lever, the pressure rapidly becomes reduced by the slightest wear of the carborundum block, and unless a man is kept constantly in attendance to tighten up the machine it becomes useless.

After experimenting for some months, Messrs. Ellis & Kidd determined the best working pressure of the carborundum block upon the rails, which is considerably below the figure that one would expect for this class of work—namely, 8 lb. per square inch. The reason that such a light pressure is found efficacious is probably owing to the fact that the normal speed of the car produces a rapid and easy cutting action.

The electrical connection consists of a series circuit from a point in the trolley circuit through a main switch under the control of the driver, and passing forward through the two solenoids of the right and left hand rail grinders to earth on the track frame.

It will be seen, therefore, that no extra hands are required to operate the new grinder, as the car driver simply lowers and raises the block by means of the switch.

It is impossible, however, to estimate actually the cost of this method of grinding as compared with the older style, inasmuch as the function of grinding is combined with the ordinary operation expenses of car running. It is obvious, however, that this apparatus, which is manufactured by Messrs. Brecknell, Munro & Rogers, of London and Bristol, constitutes a distinct advance on previous systems.

CORRESPONDENCE.

THE TANTALUM WAVE DETECTOR.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: I have read with some interest Mr. Walter's full description of the "Tantalum Detector" in your issue of August 14th, the more so as he goes into such detail over so inferior a type of detector.

I used the device over a year ago, and even prepared a U.S. patent application on the use of a tantalum electrode, but soon lost interest in it when the device proved so far inferior in sensitiveness to the electrolytic (glass point or Wollaston wire types), Dunwoodie's carborundum, Pickard's silicon detector and especially his Perikon detector. Compared with these "thermo-cell" receivers, either for radio-telegraph or telephone signals, whether in combination with mercury or hard metal electrodes, the tantalum detector has no conspicuous merit. Its superiority to the Castelli so-called (Solari) detector may go unchallenged, as also that of the primitive coherer, but the art has almost forgotten the existence of these types.

From his article I judge Mr. Walter is as unfamiliar with the Perikon or silicon detectors as his allusion to the audion indicates him to be with that; since he, even at this date, continues to confuse the latter with the "oscillation valve," taken from the early German scientists by Prof. Fleming.

I advise Mr. Walter to try a "helion" filament with mercury in place of the tantalum. I have found this much superior when used in the same way, but still hardly in the practical class.—I am, &c.,

New York, Aug. 21. LEE DE FOREST.

We have submitted Dr. de Forest's letter to Mr. L. H. Walter, and have received the following reply:—

TO THE EDITOR OF THE ELECTRICIAN.

SIR: Dr. Lee de Forest's letter is only what one would expect. In wireless telegraphy, perhaps more than in any other subject, one is quite prepared to learn that everything has been done before; the remarkable thing is that nothing is published until it has been done better by someone else. Even if Dr. de Forest did use the device over a year ago, I had arrived as far as protecting it 14 months ago.

In reply to Dr. de Forest, it is evident that his experiments with tantalum were not a success; success here depends upon attention to detail. In the present case the question of inferior sensitiveness can best be judged by the independent reader by my stating that a series of tests kindly made by the Amalgamated Radio-Telegraph Co. using De Forest apparatus, have shown that at 500 miles there is practically nothing to choose between the electrolytic and the tantalum detector.

It should be borne in mind that I did not claim the device as being exceptionally sensitive or specially desirable for radiotelegraphic work; but it is and remains one which gives far louder signals than either the electrolytic or Pickard's silicon detector, with both of which I am quite familiar.

In conclusion, I may state that my Paper was concerned with the physical interest of the matter, and not solely with the commercial prospects. That the Editor of *The Electrician* saw fit to publish it in full is a matter for which I am not responsible.—I am, &c.,

London, S.W., Sept. 2. L. H. WALTER.

WIRELESS TELEPHONY.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: In your issue of August 28th you print an abstract of a Paper which Prof. Fessenden read in July last at the Convention of the American Institute of Electrical Engineers.

The author purports to give an account of the various stages reached by Lodge, Popoff and Marconi in their experiments in wireless telegraphy. On p. 763 he gives a list of certain things which were described by Lodge in his well-known lecture before the Royal Institution on June 1, 1894. He next states the experiments made by Popoff early in 1895, which were published, in Russian, in January, 1906. He then states that Captain Jackson, R.N., and Mr. A. C. Braun had been making experiments in wireless telegraphy.

He introduces Marconi in his Paper in the following terms:—"Marconi, on June 2, 1896, filed a provisional specification," thereby implying that while Lodge in 1894, and Popoff in 1895, were actually engaged in wireless telegraphy, Marconi had done nothing on the subject until 1896. As a matter of fact, and one that is well known, Marconi had been experimenting in Italy, and had, in June, 1895, got ahead of all the other workers. It is quite certain that no inventor ever filed a provisional specification on a highly technical and novel scientific invention without having given many months hard study to the subject. Yet the different manner in which Mr. Fessenden speaks of Marconi to that in which he speaks of others seems to suggest that Mr. Marconi was behind them, in time, in the early experimental stage. There are other statements made in the same paragraph, suggesting that the provisional specification only contained that which Lodge and Popoff had already invented, which may be questioned as to

fairness. This, however, was not the opinion of the Berlin Patent Office, who, after long and exhaustive consideration of all that had been done before by others, issued Marconi's patent.

It is indisputable that on June 2, 1896, Marconi filed the first provisional specification, and that on March 2, 1897, Marconi filed the first complete specification of any patent for utilising electric waves.

In common fairness to Marconi I ask that you will insert the following rather lengthy extract from the judgment of Judge William K. Townsend, of the United States Circuit Court, delivered on May 4, 1905:—

Other inventors, venturing forth on the sea of electrical movement, met the rising tide of the Hertzian waves and allowed them to roll by without appreciating that this new current was destined to carry onward the freight and traffic of the world's commerce. They noted their manifestations, suspected their possibilities, disclosed their characteristics, and hesitated, fearing the breakers ahead, imagining barriers of impracticable channels and shifting sand bars. Marconi, daring to hoist his sail and explore the unknown current, first disclosed the new highway.

In this decision Judge Townsend carefully and thoroughly reviews the several earlier experimental researches by many of the most distinguished scientists and physicists not only in the United States but in Europe, such as the experiments of Dolbear in America, Lodge in England, Popoff in Russia, Hertz in Germany, and Branly in France, and says as follows:—

It would seem, therefore, to be a sufficient answer to the attempts to belittle Marconi's great invention that, with the whole scientific world awakened by the disclosures of Hertz in 1887 to the new and undeveloped possibilities of electric waves, nine years elapsed without a single practical or commercially successful result, and Marconi was the first to describe and the first to achieve the transmission of definite intelligible signals by means of these Hertzian waves.

—I am, &c.,

London, Sept. 1. S. FLOOD PAGE (Major).

[Prof. Fessenden's Paper is rather a chronological review of the wireless telephony position than a memoir of those who have worked to bring wireless telegraphy to the front. That being the case, Prof. Fessenden can hardly be blamed if he has not gone deeply into such matters as Major Flood Page indicates. We do not think Prof. Fessenden's comments bear the construction which Major Flood Page suggests, for the point that is raised is obvious to the average reader, and we would observe of the judgment of Judge Townsend that it does not impress us—that, in fact, it is rather in the clouds and has more picturesqueness than judicial acumen about it. We can say this without expressing any opinion on the merits of the matters in dispute between the litigants.—ED. *E.*]

THE BRITISH ASSOCIATION.

(FROM OUR OWN CORRESPONDENT.)

Wednesday, September 2nd.

This, the fourth meeting which the British Association has held in Dublin, is of considerable importance, first, because of the great educational developments which have recently taken place in Ireland, and, next, because of the very large number of members and associates who have signified their intention of being present. Since Monday morning there has been a continual stream of visitors arriving at the Irish capital, and coming immediately after the Horse Show it means that Dublin is enjoying a period of quite unusual prosperity. All the cross-Channel services have been very crowded for the past few days, and it was somewhat unfortunate that such stormy weather was experienced during the early part of the week. This undoubtedly hindered many people from crossing, and, at all events, made the beginning of the excursion exceedingly uncomfortable for many who did cross. Nevertheless, the Reception Room has been crowded all day, and very few look any the worse for the rough passage, in spite of painful personal experiences which one hears being recounted on every hand.

To-day's proceedings commenced with a Council meeting at noon, followed by a meeting of the organising sectional committees, while the Lord Mayor and Lady Mayoress were At Home at the Mansion House in the afternoon. This latter function was very well attended and constituted Dublin's official greeting to the Association.

The general arrangements which have been made are, as usual, very admirable, but there are, perhaps, rather too many social fixtures. It would be quite impossible for any person to attend all of them, even if he wished, but, as a matter of fact, Dublin itself is so full of interesting features that many people would prefer to spend their spare time in their own way; not, of course, that they are not perfectly at liberty to do this, but as a rule nearly everybody feels more or less bound to follow the programme for fear of missing something important.

At 8:30 p.m. the president, Mr. Francis Darwin, F.R.S., commenced the delivery of his presidential address to a crowded audience in the Great Hall of the Royal University. His opening words referred to the loss which the British Association had sustained in the death of Lord Kelvin, and his hearers realised the truth of the statement that "many men and women who never exchanged a word with Lord Kelvin, and are in outer darkness as to his researches, will miss his genial presence and feel themselves the poorer to-day." The remainder of the address dealt with movements of plants and is of no particular interest to readers of *The Electrician.*

A vote of thanks to Mr. Darwin was proposed by the Lord Lieutenant, seconded by Prof. Archibald Geikie, and carried by acclamation.

Thursday, September 3rd.

The proceedings of the next day opened with the Presidential Addresses to the various Sections. The report of the Electrical Standards Committee was presented, and a Paper was read on "Recent Advances in Steam Turbines," by Mr. Gerald Stoney. To these we shall refer in greater detail in our next issue.

DR. SHAW'S ADDRESS TO SECTION A OF THE BRITISH ASSOCIATION.*

In opening his address the author referred to the loss sustained by the Association through the death of Lord Kelvin whose connection with the Section was so constant and so intimate. Following closely on his death came that of Sir Richard Strachey who, as Chairman of the Meteorological Council, was in constant touch with the author, while only a few months ago Sir John Eliot died, leaving behind his Climatological Atlas of India, representing the most conspicuous achievement as a compilation of meteorological facts for a special area that has yet been seen.

Dealing with the careers of these three men, the author showed that Kelvin was permeated with the notion that Mathematics and Natural Philosophy were applicable in every branch of daily life, and made good the contention by the variety of his work. Strachey, although primarily a financier and administrator, enlisted the assistance of science in every branch of the Public Works Department of India, while Eliot, as Meteorological Reporter to the Government of India, caught the true perception of the place of science in the service of the State and made his office indispensable to the Indian Administration.

For the advancement of science men belonging to all three of the above classes are required, and in bringing to the work of the Indian Meteorological Office a mind trained in the mathematical school of which Kelvin was the most conspicuous exponent, Eliot achieved a remarkable success. A knowledge of meteorological phenomena is a necessity for Indian administrators, and the claims that science has in this respect has been amply recognised.

Turning to his own work, the author shows that the gravest danger to scientific institutions related to the necessities of life is the tendency to waste. Waste is not used here in its narrowest, but in its most liberal, sense. "It is wasteful to collect observations which will never be used; it is equally wasteful to decline to collect observations which in the future may prove to be of vital importance. It is wasteful to discuss observations that are made with inadequate appliances; it is equally wasteful to allow observations to accumulate in useless heaps because you are not sure that the instruments are good enough. It is wasteful to use antiquated methods of computation or discussion; it is equally wasteful to use all the time in making trial of new methods. It is wasteful to make use of re-

*Abstract of the Presidential Address delivered to Section A of the British Association at the Meeting at Dublin by Dr. W. N. Shaw, F.R.S.

searches if they are inaccurate: it is equally wasteful to neglect the results of researches because you have not made up your mind whether they are accurate or not. It is wasteful to work with an inadequate system in such matters as synoptic meteorology; it is equally wasteful to lose heart because you cannot get all the facilities which you feel the occasion demands."

In taking up an investigation that involves a reference to accumulated data everyone is hampered by uncertainties that might have been solved if taken up in time. It should, therefore, be a primary rule that any data collected shall forthwith be critically examined and so far dealt with as to make sure they are available for scientific purposes. Further, public evidence of the completion of this most important task should be shown in a published report or on a published map as a primary representation of the results. Such publication is not to be regarded as the ultimate application of the observation, but it is evidence that the observations are there and are ready for use. The third general rule is that the effectiveness of data of all kinds should be tested by the prosecution of some inquiry which makes use of them.

The Meteorological Office is very much in Antonio's position; their argosies are on the seas and scientific Shylocks' ruminations about ducats are not unnatural. In an office, unlike a laboratory, payment is only by results; no marks are given for "knowing how to do it." In such circumstances there might be reason for despondency if one were dependent merely upon one's own ventures and the results achieved thereby. But when one has the advantage of the gradual development of investigations of long standing, it is possible to maintain a show of cheerfulness. When Shylock demands his pound of flesh in the form of an annual report, it is not at all uncommon to find that some argosy that started on its voyage long ago "hath richly come to harbour suddenly." There have been quite a number of such happy arrivals within the last few years.

Among these are a body of statistics collected in the Weekly Weather Report since 1878, which the Board of Agriculture have made the starting point for a general investigation of the general relation between the weather and the crops. These cannot fail to have important practical bearings. Another example is the following:—For more than a full generation meteorological work has been hampered by the want of a definite understanding as to the real meaning in velocity, or force, of the various points of the scale of wind-estimates laid down in 1805 by Admiral Beaufort for use at sea, and still handed on as an oral tradition. The prolonged inquiry, which goes back really to the report upon the Berkley anemograph already referred to, issued quite unexpectedly in the simple result that the curve $p=0{\cdot}0105B^3$ (where p is the force in pounds per square foot, and B the arbitrary Beaufort number) runs practically through nine out of the eleven points on a diagram representing the empirical results of a very elaborate investigation. The empirical determinations upon which it is based are certainly not of the highest order of accuracy; they rely upon two separate investigations besides the statistical comparison, viz., the constant of an anemometer and the relation of wind-velocity to wind-pressure, but no subsequent adjustment of these determinations is at all likely to be outside the limits of an error of an estimate of wind-force. And the equation can be used, quite reasonably, as a substitute for the original specification of the Beaufort scale, a specification that has vanished with the passing of ships of the type by which it was defined. This result, combined with the equation $p=0{\cdot}003V^2$, which has been in use in the Office for many years, and has recently been confirmed as sufficiently accurate for all practical purposes by Dr. Stanton at the National Physical Laboratory and M. Eiffel at the Eiffel Tower, places us upon a new plane with regard to the whole subject of wind measurement and wind estimation. Results equally remarkable appear in other lines of investigation. Let me take the relation of observed wind velocity to barometric gradient. You may be aware that in actual experience the observed direction of the wind is more or less along the isobars, with the low pressure on the left of the moving air in the northern hemisphere, and that crowded isobars mean strong winds. Investigation upon this matter go back to the earliest days of the Office. There can be no doubt that the relation, vague as it sometimes appears to be upon a weather chart, is attributable to the effect of the earth's rotation. In order to bring the observed wind velocity into numerical relation with the pressure-gradient Guldberg and Mohn assumed a coefficient of surface "friction," interfering with the steady motion. The introduction of the new quantity, not otherwise determinable, left us in doubt as to how far the relation between wind and pressure distribution, deducible from the general principles of earth motion, could be regarded as really effective [illegible] for practical purposes. The [illegible] appeared [illegible] Paper by [illegible] communicated to the Royal Society which points out the [illegible] between the diurnal variation of pressure and

those of terrestial magnetic force, and to the work on the upper air carried on the co-operation with the University of Manchester.

Another aspect of this question of waste is the carrying on of work by a scientific office without an adequate knowledge of what is being done elsewhere in advancing science and improving methods. All new knowledge ought to be applied to the service of the State, and while original work is the main requirement, the advances must also be secured, as pointed out by Lord Rayleigh. The British Association has done much in this direction, but those most anxious for the spread of science have thought that the opportunity afforded by the meetings could not properly be utilised by crowding together all the Papers into one or two days so that they can be polished off with the rapidity of an oriental execution. In fact, the opportunity to be polished off is precisely not the opportunity that is wanted. There are some who think that a British Association week is not too long for the consideration of the subjects of which a year's abstracts occupy a volume of six hundred pages, and that, if we could extend the opportunity for the consideration of these questions from one or two days to a week, and let those members who are interested from a separate committee to develop and extend these subjects, the British Association, the country, and science would all gain thereby. I venture from this place, in the name of the advancement of science, to make an appeal for the favourable consideration of this suggestion. It is not based upon the depreciation, but upon the highest appreciation of the service which mathematics and physics have rendered, and can still render, to the observational sciences, and upon the well-tried principle that close family ties are strengthened, and not weakened, by making allowance for natural development. The plea seems to me so natural, and the alternatives so detrimental to the advancement of science in this country, that I cannot believe the Association will turn a deaf ear to it.

PROF. KIPPING'S ADDRESS TO THE CHEMICAL SECTION OF THE BRITISH ASSOCIATION.*

Although this section is chiefly occupied with matters relating to pure science, the discussion of industrial questions is also regarded as one of its important functions; it does not attempt to distinguish pure from applied chemistry, and any problem which concerns either is deemed worthy of its attention. From this point of view I propose to consider, from the standpoint of the teacher in the class room and laboratory, whether any steps can be taken to place the chemical industries of the United Kingdom of Great Britain and Ireland in a more prominent position than that which they now occupy in the world of commerce. It is not then in any grudging spirit of envy that we approach this question; recognising the splendid work of men of other countries, rejoicing in the services which they have rendered to the world at large, our only desire is not to lag behind in the general intellectual and industrial advance of nations.

It is unnecessary to trouble you with any detailed comparison of the position which we occupy to day with that which we have taken in the past. Those who doubt the seriousness of our condition may find statistical evidence more than sufficient to convince them in the technical journals and in the Board of Trade reports of recent years. The facts there disclosed show that in the manufacture of "fine chemicals," including perfumes, alkaloids and crude coal-tar products, as well as dyes, the decadence of our industry is far advanced; in the case of heavy chemicals our position, perhaps, is not quite so serious at the present moment, but the future is dark and threatening. Chemical industries are so intimately connected and dependent on one another, that the fate of one may determine the fate of all; the by-product of one process is often the raw material of another. Who, then, can deny that the patience, perseverance and high scientific skill, which have built up the colour industry abroad, if applied, as they have been and are being applied to the manufacture of heavy chemicals, will not soon defy all competition from less progressive countries?

Such a possibility is full of national danger. It has been pointed out—and the prophecy cannot be regarded as unduly pessimistic—that from present indications a time will arrive when we shall be dependent on outside sources, not only for our food supply, but also for our means of self defence. When nitrates are exhausted, when nitric acid and ammonia are prepared from the components of the atmosphere, when all chemical industries have been so highly developed abroad that they have completely vanished from these islands, and when their loss has reacted on all our other important industries, then, indeed, shall we feel the pinch of poverty; then, indeed, must we submit to national decay.

Is it possible to remedy the present unsatisfactory state of affairs and to guard against an ominous future? During the Perkin jubilee

* Abstract of the presidential address delivered by Prof. F. S. Kipping, D.Sc., Ph.D., F.R.S., at Dublin.

celebrations Prof. Carl Duisberg answered this question, in so far as it concerns the coal-tar colour industry, by an uncompromising negative. In an able and interesting speech he pointed out that, although the Briton is in general a practical man, he is lacking in patience, in the power of waiting for success; he expects to be compensated in hard cash, and at once, for his work or for his capital outlay. The German, on the other hand, is primarily a theorist possessing endless patience, and works without any immediate prospect of pecuniary reward; he has now learnt to be practical as well, but not at the expense of his ideals. It is to this happy combination of qualities that Prof. Duisberg ascribes the success of his countrymen in the coal-tar colour industry—a success which he considers we are powerless to emulate, with which it would be futile for us to try and compete.

With this view that our chemical industries must submit to gradual extinction, even when it is held by so high an authority, we cannot and must not agree; if one nation can learn to be practical, we—the four nations of these islands—one or all, can learn to be plodding and patient, and to appreciate the importance of theory.

The new Patents Act seems to many to have inaugurated a new era, and to have removed one of the principal causes of the decline of our chemical industries. The most important change, which came into operation on August 28th last, is that which requires that the article or process which is protected by the patent must be manufactured or carried on to an adequate extent in the United Kingdom after the expiration of four years from the date of the patent. If this condition is not fulfilled, any person may apply for the revocation of the patent. Some of the results of this amendment, and some indications of the great industrial changes which it will bring about, are already obvious. Foreign firms or individuals who hold British patents and who have not sufficient capital to work them in this country, or who do not think they are worth working here, are attempting to sell their British patent rights. Others are building or buying works in Great Britain, and it has been estimated that in the immediate future a sum of at least £25,000,000 of foreign capital will have been thus invested in order to comply with the new law. The prospective establishment of branches of two of the largest German chemical works at Ellesmere Port and at Port Sunlight, respectively, are already matters of common knowledge, and it may be presumed that these firms will avail themselves to a large extent of British labour.

Now, at the present time, most chemical products can be manufactured more cheaply abroad than here, otherwise we should not have any reason to consider our position. Dr. Duisberg told us that even when an important firm in England had a licence to work all the British patents of two of the largest German colour works, merely paying for the privilege a small percentage of the net profits, it failed to take any advantage of the opportunity. If, then, in this free-trade kingdom production is cheaper than abroad, the foreign firms which have branches here will be in a position superior to that which they now occupy in their own countries. If, on the other hand, owing to inefficient labour, higher wages, freights and other economic conditions, production is more costly, the superior efficiency and scientific organisation of these foreign firms will, nevertheless, enable them to command our home market with the goods made here, and to cut us out in the world market, as they do now, with those made abroad.

The conclusion which thus seems forced upon us is that, although the new Patent Act will prove to be of great value in many respects, it will do little to foster British chemical trade and the development of British chemistry; it places us on an equality with other countries as regards patent rights, and thus remedies an outstanding grievance; but, unless we have something to patent, this equality will be valueless and our chemical industries will continue to decline, possibly more rapidly than heretofore.

Let us therefore pass in review the other causes which have been suggested as contributory to our failure; after eliminating those connected with freights and tariffs, and with the alleged supineness of the Government in assisting industry, matters which may be left to the manufacturers to deal with, there still remain several which are well within the purview of this section. These are: (1) The unsatisfactory condition of secondary education; (2) the nature of the training which is given to chemists in our universities and other institutions; (3) the insufficiency of the time and money devoted to research in the manufacturing industries; (4) the lack of co-operation between manufacturers and men of science. There are some who believe that the first of these is the primary, if not the sole, cause of our weakness; that if our secondary education were placed on a sound basis all the other evils would disappear of their own accord. Whether such results would in fact follow if our system of secondary education were very much improved it is impossible to predicate; but there is no doubt that at the present time we are moving in an exactly opposite direction. The shadow of the cypress rests upon our chemical trade, and manufacturers do not see their way to employ chemists; students are not attracted to chemistry as a profession because there are so few openings; without an ample and increasing supply of such students chemical industry must continue to decline, and as a necessary consequence the development of pure chemistry is cramped and hindered to a far greater extent than is generally realised.

One cause, which I believe is by far the most effective drag on research in the vast majority of institutions not of university rank, is simply the lack of those more advanced students who, while gaining valuable experience in the methods of research, would also render useful assistance to their teacher. It might be suggested that an efficient and enthusiastic man would soon attract a number of research students. This, no doubt, is true as regards the universities, but it must be remembered that a polytechnic or other institution which does not grant degrees can hardly expect to compete with a university as a centre for research. There are not enough students to go round, to satisfy the research requirements of the teachers, and the principal reason is—the limited demand for trained chemists on the part of the manufacturers.

With whom rests the responsibility for this state of affairs? Is it with the teachers, and, if so, is it because they are incapable of training chemists or because their system is at fault? To answer this question it is necessary in the first place to arrive at some conclusion as to the kind of training which is required for the future works chemist. On consulting the opinions of the manufacturers, it would seem that they attach great importance to what is called the "practical side"; they believe that, in addition to a knowledge of theoretical chemistry, the prospective works chemist should also have some acquaintance with engineering, and should have had practical experience in working the given process. It is from this point of view that we build and equip large technological chemistry departments, such as those in the Universities of Birmingham and Leeds and in the Manchester Municipal School of Technology. The arguments in favour of this view, that it is a hybrid chemist-engineer who is required in a chemical works, seem to me to be fundamentally unsound, and the kind of training suggested by them for the works chemist can only result in the production of a sort of combined analytical machine and foreman.

Besides the great cost of the upkeep and of the working of such plant, the conditions in a chemical works cannot be successfully imitated in a university or polytechnic; attempts to do so can only lead to mistaken conclusions, and thus have the effect of rendering the works chemist quite helpless when he passes from the elegant models of his educational apparatus to the work-a-day appliances of the manufactory. Here, it seems to me, we touch the bed rock of our trouble. We have failed to realise that industrial chemistry must be based on a foundation of continuous and arduous research work. In the past we have sent out from our universities and other institutions students who no doubt were qualified to undertake routine analytical work, but the great majority of whom knew nothing of the methods of research. Such a one enters a works; the manufacturer does not realise exactly what his chemist ought to do, but he expects some immediate results, and in consequence is generally disappointed; the lack of success of the chemist is put down to his ignorance of practical matters, and there is an outcry for technical education; science is most unjustly discredited, and any suggestion of spending money on research work is scouted as a mere waste.

Now if we are to meet successfully the very formidable scientific and commercial organisation opposed to us in chemical industry, we must perforce adopt the methods of our competitors; not only must we learn patience and perseverance, but we must also call to our aid the best brain-power available. We must recognise clearly that the scientific works chemist must be thoroughly trained in the methods of research by those best qualified to do so, and we must not imagine that when he enters the works he should or could immediately become an engineer and a commercial expert; his place is in the research laboratory. The practical man—that is to say, the man who has a thorough and useful knowledge of some particular manufacturing process—must be trained under practical men in the works, and we must not imagine that a course of evening classes will convert him into an expert chemist. The ideal man who combines high scientific training and sound practical knowledge cannot be produced unless the period of his education is extended to half a lifetime, and even then only through the co-operation of the chemistry teacher and the manufacturer.

Admitting the truth of these statements—and I do not think that they can be successfully controverted—we have now to consider what steps can be taken to provide these highly-trained works chemists, and to ensure for them a cordial reception on the part of the manufacturers. In order to acquire the necessary knowledge of facts and theory, and afterwards to devote even the minimum time to gaining experience in research methods, the future works-chemist must be prepared to continue at the university or other institution during at least five years. The pass degree after three years' work should be regarded merely as an indication of a sound general education in science, and the future works-chemist should then devote at least two years more to research and to special work in chemistry, on the results of which the Honours degree might be awarded. Every encouragement in the form of low fees, free admission, research scholarships, and so on, should be offered to such students, according to their merit and circumstances, in order

that they may prolong their studies. By thus extending the period of training and making research work compulsory as far as possible, a great deal would be gained; pure science would reap an immediate benefit from the investigations of the students—as has been the case abroad—and this stimulus would necessarily react on industrial chemistry; the manufacturers could be assured that they were being supplied with men of the right type; they would soon recognise that fact, and the demand for works chemists would expand.

There is one institution, not a teaching body, which might greatly assist in this movement; I refer to the Institute of Chemistry of Great Britain and Ireland. This body examines in chemistry and grants diplomas, and claims that its examinations are a test of practical ability rather than of theoretical knowledge. I have not a word to say against the character of these examinations, but to imagine that the Institute of Chemistry qualification is the hall-mark of a chemist is ridiculous. It should be recognised that the present Institute of Chemistry qualification is only a step in the training of a chemist; the permission to present a thesis for the Associate examination should be withdrawn, and good research work should be insisted on in the case of all candidates for the Fellowship.

As a necessary corollary to making research compulsory in the training of works chemists, all our important teaching institutions must afford ample opportunities for such work, and measures must be adopted to guard against that failure of some of our universities as centres of research. Such failure, whatever may be the contributory causes, must be principally due to the absence of sufficient interest in research work on the part of the professor.

The author then discusses the many considerations to be taken into account in the appointment of a professor, and is in favour of a superannuation clause in the conditions of all appointments in teaching institutions.

The great proportion of the original work now done in this country, judging from the published records, is absolutely free from any utilitarian bias; the time, brain power and money devoted to this work are considerable, and the results from a scientific point of view eminently satisfactory. If even a fraction of the same skill and energy were brought to bear under proper conditions on problems of applied science, who can doubt but that the effect on our chemical industries would be one of vast importance? And yet it is the rarest possible occurrence to find any record of research work undertaken with a commercial object even in the natural home of such records, the *Journal* of the Society of Chemical Industry. One reason for this may be that the discoveries made in the works laboratories are not given to the world at large, but are quietly and lucratively applied in some secret manufacturing process. Another reason, unfortunately the more probable one, may be that nearly all the principal research workers are completely shut off from any industrial influences. Even if all the research capacity of the country where henceforth devoted to purely technical matters, any great improvement in our industries could hardly be anticipated without the active co-operation of the manufacturers. It should be understood, and the fact might even be advertised by the governing body, that for purposes of research work in applied chemistry—but not, of course, for analytical work—the laboratory of the university, college or polytechnic is, under certain conditions, at the service of the manufacturers. It might be thought that these conditions prevail at the present time and that any manufacturer, if he so choose, may consult the university staff on any problem in which he is interested. Possibly this is true to a limited extent, but in most institutions the members of the staff are restrained from undertaking any outside work. There are also other ways in which it might be possible to obtain the active co-operation of the manufacturers; for example, the foundation of a research scholarship by a firm for the solution of a particular problem.

I have just mentioned that practically all the published research work of this country has no direct reference to any industrial problem; nevertheless the results of this work are often of such a character that they might be of considerable technological importance. New reactions are discovered; new or improved methods of preparing known compounds; new facts as to the conditions under which important general reactions occur; and many new compounds are prepared. Now, abroad, all or nearly all such matters are protected by patents, generally taken out by some firm of manufacturers. If all those who are engaged in purely scientific research work in this country would seriously consider the desirability of obtaining provisional protection for any discovery which they may make, and would then consult some manufacturer or industrial expert, there is reason to believe that in some cases at least the patent might prove to be a commercial success.

In conclusion, the workers in pure science must recognise that it is their duty to do all they can to promote the industrial welfare of their country; the manufacturers must concede the paramount importance of science and the impossibility of dispensing with its [illegible]. Guided by these principles and by a spirit of cordial co-operation, a sustained and strenuous effort on the part of the leaders of chemical industry and of chemical science can hardly fail to accomplish the end in view.

MUNICIPAL, FOREIGN & GENERAL NOTES.

APPOINTMENTS VACANT AND FILLED.

Hammersmith (London) Council require a fourth assistant engineer to act as junior engineer-in-charge at their electricity works Commencing salary £130, rising by annual increments of £5 to £150 per annum. Applications (by 10 a.m. Sept. 11) on forms to be obtained from the borough electrical engineer (Mr. G. Gilbert Bell), Electricity Department, 88, Fulham Palace-road, W.

The directors of the East Indian Railway Co. require an assistant electrical foreman in the electrical department of the company in India. Candidates must be about 28-30 years, have had a good general education, followed by apprenticeship with an electrical or engineering firm of repute, and a thorough knowledge of high and low tension power plant (d.c. and a.c. three phase). Salary 300 rupees per calendar month. Four years' agreement, with 2nd class free passage to India and home on termination of service. Applications to the secretary (Mr. C. W. Young), 23-30, Nicholas-lane, London, E.C., by Sept. 10.

EDUCATIONAL NOTICES.

University of Manchester.—Complete theoretical and practical training is given in this university to students preparing for the higher positions in the electrical engineering profession. Electrical engineering may be taken as part of the courses preparing for the B.Sc. degree in both the honours schools of engineering and physics. A special course has also been arranged extending over three years and preparing for a certificate in electrical engineering. The John Hopkinson laboratories and dynamo house are fitted with modern machinery and excellent facilities are offered for educational and research work. The session begins on Oct. 6. Prospectuses from the Registrar.

University of Liverpool.—The session 1908-9 commences on Tuesday, Oct. 6. The courses of study in the faculty of engineering, leading to the ordinary degree of B. Eng., or the certificate in engineering, are so arranged as to confer a general scientific training for those intending to become engineers or to enter any allied profession. The honours course enables students to specialise in some branch of the profession, and opportunities are afforded for post-graduate work and research. Prospectuses from the registrar, Prof. P. Hebblethwaite, M.A.

King's College (London).—The session 1908-9 commences on Sept. 30. In addition to the ordinary day courses in the faculty of engineering and applied science, there are evening classes in mechanical and electrical engineering, architecture and building construction, drawing mathematics, physics and other science subjects. There is a large staff of lecturers and demonstrators, and prospectuses, &c., from the secretary, Mr. Walter Smith, Strand, W.C.

University College, Bristol.—In the engineering department of this college there are courses for civil, mechanical, mining and electrical engineers and surveyors. Special facilities are offered in the way of college and engineering works scholarships. A diploma is awarded to students who pass the qualifying examinations and the associateship of the college is conferred on students who obtain a first-class senior diploma. The Institution of Civil Engineers accepts the preliminary certificate of the college in lieu of its entrance examination. Prospectuses, &c., from the registrar and secretary, Mr. Jas. Rafter.

Armstrong College (Newcastle-on-Tyne).—The session 1908-9 will commence on Sept. 28. There are complete courses of instruction in mechanical, civil, electrical and marine engineering, naval architecture, mining, metallurgy, &c. Particulars from the secretary (Mr. F. H. Pruen).

Glasgow and West of Scotland Technical College.—The next session begins on Sept. 21 in the new building recently erected for the college. The diploma of the college is granted in civil, mechanical, and electrical engineering, mining, naval architecture, chemistry, metallurgy, mathematics and physics. The courses of study for the diploma usually extend over three sessions, and holders of the diploma are eligible for the degree of B.Sc. in engineering of the University of Glasgow after attendance for at least one session. New and well equipped laboratories have been provided in the departments of physics, chemistry, technical chemistry, electrical engineering, motive power engineering, mechanics and metallurgy, and facilities for research are afforded. Preliminary examination for candidates for the diploma begins on Sept. 14. Prospectus gratis from the secretary of the College.

Battersea Polytechnic (London, S.W.)—At this polytechnic there are day and evening courses of instruction. The day courses include preparation for the B.Sc. in engineering of the University of London and the polytechnic diploma in (*a*) mechanical, (*b*) electrical and (*c*) civil engineering. The entrance examination begins on Sept. 15. The evening classes include preparation for the B.Sc.

in engineering, associateship examination of the I.C.E., &c. Prospectus on application to the Secretary.

Sir John Cass Technical Institute, London.—There are evening classes in chemistry, metallurgy, physics and mathematics, designed to meet the requirements of those engaged in the chemical, metallurgical and electrical industries and in trades associated therewith. Facilities are also given for special and advanced practical work in well-equipped laboratories both in the afternoon and evening. The classes in general physics and mathematics are arranged so as to prepare for the final B.Sc. examination of London University, and there are special courses of general physics and electricity and magnetism for the Honours B.Sc. on conduction in gases and radio-activity and on the differential and integral calculus for science students. The new session begins Sept. 21. Details of classes may be obtained at the Institute, Jewry-street, Aldgate, E.C., or by letter from the Principal, Mr. C. A. Keane, B.Sc., Ph.D., F.I.C.

Hackney Technical Institute, London, N.E.—The next session commences on Sept. 21. There will be evening lecture and laboratory courses in electrical engineering subjects, including electrical measurements, dynamos and motors, alternating currents, electrical design, &c. Prospectuses from the Principal.

Northampton Polytechnic Institute (London).—The full day courses in the theory and practice of mechanical and electrical engineering will commence on Monday, Oct. 5. Entrance examination on Sept. 30 and Oct. 1. The courses include periods spent in commercial workshops and extend over four years; they also prepare for the degree of B.Sc. in Engineering at the University of London. Three entrance scholarships of the value of £52 each will be offered for competition at the entrance examinations in September. In the technical optics department there are full and part time day courses. Full particulars as to fees, &c., can be obtained at the Institute or on application to the Principal, Dr. R. Mullineux Walmsley.

Argentina.—The principle of a bill authorising the erection and equipment of new electricity works in the City of La Plata, in competition with the River Plate Electricity Co., has, it is stated, been approved by the Senate.

Australasia.—The "Australian Mining Standard" says *Footscray* (Victoria) Council are recommended by the Lighting committee to adopt electric lighting, and a poll of ratepapers is to be taken.

Coburg (Victoria) Council are in favour of accepting, and Brunswick Electric Lighting committee of rejecting, the offer which has been received for electric lighting and the provision of tramways.

Belfast.—On Tuesday the Harbour Board had before them a communication from Lord Pirrie suggesting that the Hamilton Graving Dock pumps be driven by electricity from the Commissioners power station. A joint report from the engineer and electrical engineer thereon was also read, and after discussion the further consideration of the subject was deferred.

An application of the Belfast Steamship Co. for permission to lay a cable for supplying current for lighting their manifest and other offices in the Donegall Quay shed was granted.

Birmingham District Tramways.—Efforts are being made to induce Birmingham Corporation to obtain powers to construct an electric tramway from Bordesley Green to Stechford, and at a recent meeting of the Bordesley Ward Ratepayers' Association a resolution was unanimously passed in favour of the scheme.

Blackburn.—The Council have decided to ask the Light Railway Commissioners to confer powers upon them, under the Blackburn, Whalley and Padiham Light Railways Order, 1908, to construct any light railways within the borough proposed to be authorised by the order.

Brazil.—In his report for 1907 on the trade of Brazil Mr. Consul O'Sullivan Beare deals with the district of Bahia, and regards as the chief improvement in the city the conversion of the tramways from animal to electric traction. The management of the tramways is described as in all respects excellent, Bahia having a complete network of lines served with the most modern cars, and a company which runs the service on quite up-to-date lines. The reorganisation of the tramways system had led to the paving of the streets with stone setts, improving the principal streets from their previously bad condition.

There is an upper and a lower town of Bahia, and communication is effected by lifts, which have recently been converted to electrical working. Both the tramway and the lifts are operated by a local company (the Bahia Tramway Light & Power Co.), which is incorporated under United States laws with an authorised capital of $7,500,000. There was an issue of bonds by this company in 1907, much of which was subscribed in the United Kingdom. The company not only works the tramways, but supplies energy for lighting and power, both by electricity and gas. The tramways consist of over 15 miles of track, and the company is empowered to carry freight as well as passengers. The rights possessed by the Bahia Co. were formerly owned by a company financed with German capital. The Bahia Co. have also acquired from a Belgian corporation (La Compagnie d'Eclairage de Bahia), a concession for the exclusive supply of gas and electrical energy until December, 1950. The company, whose moving spirits are two Brazilian engineers, is working to greatly extend the use of electrical energy for all purposes and has entered into a contract with Messrs. Dick, Kerr & Co. for increasing both the gas and electrical plant. For the purposes of these extensions the company has acquired water-power rights at the falls of the river Jequirice, 45 miles distant from the city. This river has a fall of 175 ft., and it is estimated that 10,000 H.P. can be successfully transmitted to the city of Bahia from this source. The falls of the river Santarem, about 60 miles distant and close to the sea, have also been acquired. The prospects of the company are regarded as very promising.

The imports of electrical machinery into Bahia during 1907 were valued at £21,661 and were equal to 253 tons in weight, compared with 91 tons in 1906.

Brighouse.—Sanction has been received by the Council to a loan of £2,353 for extensions of the electricity undertaking.

Caergwrle (Wrexham).—An electric lighting scheme for this district, prepared by Mr. A. O. Griffiths, was recently submitted to Wrexham borough electrical engineer (Mr. W. G. Pickvance), who reports that—

An electric lighting scheme, properly drawn out and carefully administrated, had the very best chances of success. The matter has been brought forward at the right time. The metallic filament lamp consumes less than half the current used by carbon filament lamps, and the capital expenditure on any new undertaking would be less in proportion. He had confidence in the possibilities of an electric lighting scheme at Caergwrle.

Electric Driving in Chemical Works.—At the meeting of Lawe's Chemical Manure Co. in London last week, the chairman stated that, in order to combat the competition from abroad, it had been necessary to effect the greatest economies. One of these had been the installation of electric motors at their works, energy being taken from Barking Council. The motors were working well, and a large saving had been effected. Mr. J. E. S. Perkin, M.Inst.C.E., a director of the company, explained to the shareholders the economy and other advantages arising from the substitution of electric motors for the numerous small steam engines which had been formerly employed for driving the company's machinery.

Electrical Process for Nut Bleaching.—The bleaching of nuts in order that they may be kept fresh and sound between seasons is a considerable industry, and sulphur has hitherto been the chief agent employed. It is now announced that a Prof. Stabler, "of America," has designed a process whereby walnuts are put into a solution of salt and water, "run through an electrical apparatus," and put on an attractive and bright appearance, while at the same time increasing their keeping qualities.

Exhibitions.—The prospectus of the Turin Exhibition of 1911 (regarding which a note appeared in our issue of March 27 last, p. 933) can be seen at 73, Basinghall-street, London, E.C. The exhibition will include sections devoted to electricity, transport (railways and tramways), public works, measuring instruments, chemicals, &c.

A prospectus is issued containing particulars of the exhibition which is to be held at Earl's Court during 1909, commencing in May. This will be entitled the "Golden West and American Industries Exhibition." An influential committee has been formed, which includes the present and prospective Lord Mayors of London, and many gentlemen of distinction in the official and commercial worlds. The directors of the exhibition point out that the trade carried on between this country and the United States comprises one-fifth of the commerce of the world, and that the exhibition for 1909 will represent the 20th annual show of the kind held by London Exhibitions (Ltd.), who hold a lease of the grounds and buildings at Earl's Court which has still 30 years to run.

Faroe Islands.—The town council of Reykjavik has granted a concession to a Danish company for supplying the town with electrical energy and gas. The concession is for 25 years, and both electrical and gas plant are to be in operation by Oct. 1, 1909.

Frankfort.—In a long and instructive report on the trade of Frankfort for 1907-8 Consul-General Sir F. Oppenheimer deals with many subjects of general and particular interest. The subject of German coal supplies is amongst those dealt with, and it would appear that German industrial undertakings have felt the increased price of this commodity as heavily as English concerns. The price of coal in Germany has steadily increased since 1886, until in 1905 it was 8 m. 40 pf. per ton at the pit's mouth, compared with 7 m. 3 pf. in 1897. Dealing with the use of steam and gas engines in Germany the report continues:—

Steam Engines.—In spite of the competition of gas, petroleum and water power, a census taken on April 1, 1907, for the whole of Prussia shows a considerable increase in the number of boilers, stationary and movable. The stationary steam engines have increase in horse-power

by 194,620 against 1906 from 4,995,797 to 5,190,417 H.P.). The number of large engines has increased and there are 661 engines of over 1,000 H.P., including 115 of 2,000 H.P. to 5,000 H.P. and 25 of over 5,200 H.P.

Top Gas Engines.—The utilisation of top gases as a motor power for gas engines in the German foundry industry is steadily progressing, chiefly in connection with the electro-technical process of producing high-class iron and steel. For a new power station constructed in Burbach two top gas engines were ordered of 2,000 H.P. and 2,300 H.P. each.

Discussing the question of "Government Monopolies," which appears to be fast becoming a question of first importance in Germany, Sir F. Oppenheimer's report proceeds:-

Syndication has gradually prepared the German mind for the idea of monopolies—Government monopolies—of an industrial kind. Industrial Government monopolies thus recommended concern, amongst others, the electrical power industries. When the electrical industry was still the spoilt child of the German investor, electrical works (compelled uninterruptedly to increase their production to cope with the increasing demand) were readily supplied with the necessary capital, but after the first seven fat years a crisis ensued because the reduced consumption revealed a critical over-production, which led to underbidding and financial collapses. The crisis was overcome chiefly with the aid of combinations. These combinations wese effected either by connecting various branches of manufacture in one concern, or by the combination of several works in the same branch of manufacture; the former effected a reduced cost of production—the latter chiefly a reduced cost of administration and general expenses. Such is the origin of the Allgemeine Electricitäts Gesellschaft with the Union; Siemens with Schuckert; Felten Guilleaume with Lahmeyer. Like the important combination in the mining and iron industries, these combinations in the electrical industry had undoubtedly a great bearing upon the combinations in the banking world, the gigantic credits often required by these industrial combinations being beyond the capacity of any of the older individual banks. It would be impossible to fix the aggregate amount invested by Germans in the various electrical enterprises. To a certain extent, no doubt, these investments have increased the tightness of the German money market, for the sums so invested, though yielding excellent revenues, are tied up for a great number of years. As far as they are sunk into German concerns the money circulates in Germany in one form or the other; but to-day it is an opinion often expressed in Germany that the electrical industry invested too considerable sums in German electrical enterprise abroad, which sums are not only permanently withdrawn from the German market, but which, though no doubt excellent investments for the future, yield a comparatively small return during the first working period. Of syndicates proper there are comparatively few in the electrical industry, on account of the great variety of manufacture, nor does it appear that the public has been sufficiently accustomed in the various branches to certain recognised standard articles. Where such standard goods have been insisted upon, syndicates have been established—*e.g.*, incandescent lamps, cables, &c. In other branches, such as electric motors and apparatus for continuous current of high pressures, there are at best loose price conventions. The nearest approach to a trust exists among the manufacturers of accumulators.

There is no doubt that the electro-technical industry, suitable to the German frame of mind, has become essentially a German industry; it is claimed that the German success is due to a very keen inter-German competition. As far as the suggestion of a State monopoly for electrical power goes, fears are raised from within the industry; such a monopoly must interfere with the freedom of motion within the industry. The great argument put forward in favour of the scheme of a Government monopoly lies in the easy decentralisation which could thus be effected in the interests of industry at large, for wherever a Government power station is established there any industry could, of course, obtain cheap power; such stations would undoubtedly become numerous in view of the extended railway system which probably would be the first to profit from such a monopoly.

Electric Power for State Railways.—The substitution of electrical power for steam power on railways with extended systems has already become the subject of official inquiry, and quite recently the Bavarian Government, which, owing to the geographical position of Bavaria, has at its disposal enormous water power, has worked out statistics showing the quantity of power needed. It was calculated that the Bavarian State railways alone would require a daily average consumption of 1,435,000 kw.-hours with at least an additional 10 per cent. as a margin for emergencies. The Prussian State Railways intend to introduce electric power in place of steam on certain lines within the railway directorate of Magdeburg. The change will not be effected for some time to come, but the decision was welcomed because it shows a departure in the right direction, and which, heretofore, the German State Railways had persistently declined to take.

The financial aspect of the scheme of Government monopoly has not yet been definitely examined, but it is believed that the various State railway systems obtaining the necessary power from the Imperial power monopoly would alone yield a sufficient basis to vouch for a satisfactory Imperial balance sheet in future. Though the immediate [illegible] benefit from the suggestion, the scheme has become the subject of frequent and sympathetic discussion, nor is the scheme itself (says Sir F. Oppenheimer) as fantastic as it might at first appear; already, central power stations supply all industries in ever increasing [illegible]. The area supplied by the municipal power stations naturally extends with the area of a town, and quite recently various towns have entered into communication to reduce the cost of the supply of electric power by jointly feeding the whole extended district. Thus the municipal power station of Mayence, together with those of Bingen and Worms, is to supply all communities in the Rhenish portion of the Grand Duchy of Hesse.

The Use of Tidal Motion for the Generating of Electricity.—Statistics have repeatedly been published to show how soon the coal supply in the various coal-producing countries will be exhausted if the demand continues to increase proportionately to the past. Such reports animate a further search for the utilisation of electrical power in preference to steam. Even the motive power of electric works is replaced by water power. Heretofore this has been chiefly effected by the natural water power of rivers. Recently new endeavours have been made similarly to utilise the motion of the tide. In Hamburg a company has been started (capital £2,000) styled the "Wasserkraft Anlage" to work a new electrical plant with the aid of the tide. The works are to supply Cuxhaven with electric light and to run an electric railway. According to present calculation, electric current ought to be supplied at a greatly reduced price. The experiment, which is protected by various patents, is followed with the keenest interest.

Guatemala.—The imports of electrical appliances and material into Guatemala in 1907 were valued at £8,110. Germany supplied £5,660, the United States £2,210 and the United Kingdom £240.

Haslingden.—The new electric tramways were officially inspected yesterday (Thursday) and subsequently opened for traffic.

Hospital Lighting.—The annual report of the East Ham medical officer of health states that during the past year electric lighting was installed in the Borough Isolation Hospital, and that it has proved of the utmost value especially in the diphtheria ward, where urgent operations have often to be performed at night.

Iceland.—In the Westmann Islands and at Seydisfjord a large number of motor boats are employed in the fishing industry. In 1907 30 of these boats were added to the existing fleet, and in the latter a number of additional boats were employed. These boats are bought in Denmark at an average price of about £300 each. An insurance society has been established on co-operative lines for insuring these boats.

Inquest.—On Friday last an inquest was held at Wattstown (Glam.) on Henry Ash, an employé of the Ferndale Collieries, who was killed on the 27th ult.

The evidence was that deceased had repaired an electric cable and had returned later to see if it was in order. He was seen going towards the cable. Later a shout was heard, and an engine driver named Worthington found that Ash was dead. The cable was carrying current at 1,300 volts.

Mr. CHARLES JONES, chief engineer and electrician of the company, stated that the cable was still in the same position as when deceased met his death. The working rule at the colliery was: "Switch off the current before examining cable." Witness was under the impression deceased must have handled the cable to examine it, and so met his death.

A verdict of accidental death was returned.

Italy.—The Bari Electrical Co. is increasing its capital from £40,000 to £160,000 with a view to establishing an electric tramway service in Bari, and extending out to Ceglie [illegible], two miles distant. The company has increased its dividend this year from 4 per cent. to 5 per cent.

The neighbouring town of Castellammare di Stabia is now supplied with electrical energy from a station just opened. Current is generated by water power, the plant installed including a 500 H.P. turbine set.

Japan.—Baron Shimpei Goto has been appointed Minister of Communications in the Japanese Ministry in succession to Viscount Masayasu Hotta retired.

Maley Tramway Brake.—On Tuesday Birmingham Corporation tramways department carried out some successful tests of the Maley brake. A full description of the brake appeared in *The Electrician* for Nov. 29, 1907.

Malvern.—The Council have unanimously confirmed the Electricity committee's recommendation to increase the salary of the assistant electrical engineer (Mr. C. E. D. Greenhalgh) by £20 per annum.

Manchester Exhibition.—It is announced that arrangements have been made between the Exhibition authorities and the National Telephone Co. to provide exhibitors with a complete telephone service at the Exhibition. The subscription for the month of October for an unlimited service will be £3. 3s. if more than 30 subscribers are obtained, or £4. 4s. if only 30 or less take up the offer.

Mexico.—The imports of electrical appliances and machinery into Mexico are not separately set out in the annual returns, but form part of an item which includes industrial, agricultural and mining machinery. The total for this group stands at £2,779,787.

At Colima there are two large ice making plants worked by electricity and five extensive cigarette factories similarly operated.

The local electric light and power company, which has been working for one year, is unable to keep pace with the demand.

Guadalajara, the capital of the State of Jalisco, has a population of about 110,000 souls, and ranks second among the cities of the Mexican Republic. The city will be connected by the end of the present month by a railway with the Pacific port of Manzanillo, and this is naturally expected to give a great impetus to trade in Guadalajara, where at present only one British trader resides.

In the State of Jalisco it is reported by Mr. Consul-General Stringer that there are many towns having considerable populations where the opportunity for introducing British electrical goods is favourable.

Mr. Stringer compares the ubiquity of the German and American commercial traveller with the general absence of the Britisher of this class. There is no tax on commercial travellers in the State of Jalisco.

In 1907 a local company (the Guadalajara Tramway, Light & Power Co., Ltd.) was formed with a capital of $11,000,000 Mexican (£1,100,000) to amalgamate two companies, one French and one Spanish, which formerly worked separately. The company is generating at present about 10,000 H.P., by water, power, and this amount can be increased to 100,000 H.P. when the demand requires it. A rival company is about to be organised which will have command of 75,000 H.P. similarly generated. The latter company will provide irrigation facilities for 200,000 acres of agricultural land, water being drawn from Lake Chapala, which covers 1,579 square kiloms., and has a depth of from 3 to 10 metres. The Guadalajara district has a very large number of factories and workshops, which are gradually being equipped for electric power.

In the State of Jalisco the federal telegraphs reach the total length of 817 miles, and telephone lines of private companies over 625 miles.

The town of Mazatlan is lighted electrically. The use of electric lighting is limited, the charge per 16 c.p. lamp per month being 4s. and £1. 16s. per month for 10 16 c.p. lights.

Naval Depot Lighting.—The work of installing the electric light in the Army and Navy sections of the Naval Ordnance Depot at Bull Point, Devonport, has now been completed. The incandescent portion of the electric lighting equipment of the Army section was taken over from the contractors on Monday. There are 15 standards with special globes each containing two 25 c.p. lamps, also single lamps outside the entrances and windows of the buildings for lighting passages, &c.

New Spanish Submarine Cable.—The Spanish Telegraph Administration has, it is announced, laid a single conductor cable between Chafarinas, in the north of Morocco, and Nemours, Algeria. The length is 53·636 km. (about 29 nautical miles).

New Zealand.—The report of the Post and Telegraph Department for the year 1907 has been issued.

The revenue was £822,639, against £488,573 in 1901, expenditure being £709,025 and £465,756 respectively. The amount expended on telegraph extension work during the year was £155,491, but there are liabilities amounting to £103,550 on account of works for which the authority of Parliament was granted too late for the necessary expenditure to be brought within the financial year. The permanent staff of the department now numbers 3,147, against 2,245 in 1901. On March 31 last there were 9,656 miles of telegraph line and 29,344 miles of wire. The length of submarine cables owned by the Dominion was 352 nauts.

The number of telephone exchange connections (it is reported) still continues to increase rapidly, and the figure has now reached 23,881 (against 17,403 in 1907), with a revenue of £116,852. 13s. 10d. 18 new telephone exchanges were opened and one closed, and the number of subscribers increased by 2,999. The total number of exchanges is 112, made up of 30 central and 82 sub exchanges.

Northfleet.—Electric current was supplied for the first time on Saturday from the Gravesend electricity works.

Obituary.—We regret to record the death of Mr. J. W. Spencer, chairman of Messrs. John Spencer & Sons, which occurred on 27th ult. at Alnmouth, Northumberland. The deceased was connected with various public companies, including the Newcastle & District Lighting Co.

We also regret to announce the death of Mr. Geo. G. Blackwell (the senior member and founder of Geo. G. Blackwell, Sons & Co., metallurgists, &c., Liverpool), which took place at Waterloo on the 26th ult.

Peru.—In his annual report of the trade and commerce of Peru Mr. L. J. Jerome regards the Peruvian market as worthy of attention in regard to the following, among other goods: Electrical appliances, telegraph and telephone wire, railway material, sugar machinery and mining tools. Telephones and telegraphs are being rapidly extended in this country, and for the first half of 1907 331 miles of telegraph lines were constructed. With regard to the use of electric power for industrial purposes, this is at present small. The cost per horse-power-hour is put at rather over 2½d. Mr. Jerome states that the terms of the concession for electricity supply operated by the Santa Rosa Electrical Co. stipulates that no consumer may use any appliance other than those which the company provide. The Santa Rosa Co. also supply electric energy to Callao.

The city of Lima is credited with 23,090 8 c.p. lamps connected at Dec. 31 last.

Refrigeration. The first International Congress of the Refrigerating Industries will be held at the Sorbonne, Paris, from Oct. 5 to Oct 12, when the subjects discussed will cover all matters relating to the freezing and cooling of produce, &c. One of the main objects of the Congress is the codification and standardisation of scientific data and the processes employed in refrigeration for all purposes. Several prominent members of the electrical profession are associated with the Congress, and the Executive committee includes the names of Mr. W. B. Esson, M.I.E.E., and Mr. Hal Williams, M.I.E.E.

Shipyard Accidents.—The Home Secretary has issued a circular drawing attention to the serious number of accidents in the shipbuilding industry, and he forwards to those concerned a copy of a report by two inspectors of factories with regard to the causation and prevention of these accidents, which will, he trusts, receive most careful consideration.

Spain.—The consular district of Barcelona is one of the most important in Spain, and a report recently presented on the trade of this district by Mr. Consul-General Roberts deals with many subjects of interest to our readers.

The city of Barcelona has perhaps one of the best and most complete electric tramway services in Europe. It consists of 156 miles of route, and is worked by a number of companies, all of German and Belgian origin. During 1907 12½ miles of new rails were laid, chiefly in connection with small extensions, completing the main system for the city and suburbs. All the routes are on the overhead system.

In connection with electro-industrial matters only 2 tons of electrical material was imported into Barcelona from the United Kingdom in 1907. The total of these imports was 1,689 tons, an increase of 1,500 tons over 1906, and compared with nil in 1905.

In the summer of 1907 the light railway connecting Burriana with Castellon was opened, and has proved a success.

Stoneham.—Some time ago the Council assented to the proposal of Southampton Corporation to extend their electric lighting mains to Bassett, subject to the approval of the Parish Councils of South and North Stoneham. South Stoneham have now passed a resolution in favour of the extension, but the North Council are opposed to it.

The New Patents Act.—As announced in our last issue, the clauses of the Patents Act, 1907, which relates to patents being worked in this country, came into force on 28th ult. This portion of the act has caused much discussion in manufacturing and political circles, and in an interview with a representative of the "Evening News" on the 28th ult., Mr. Lloyd George, the Chancellor of the Exchequer, who is credited with being the author of the measure, stated that the Act would be administered rigidly, and that any attempt to trifle with it might result in serious loss to the trifler.

"I feel certain," said Mr. Lloyd George, "that the act will do an immense amount of good and add greatly to the prosperity of the workers of this country. Already there is abundant evidence that the effects of the measure are beginning to make themselves manifest. Only last night I heard of a very large German firm which had made arrangements to erect a factory in this country for the working of their patent, which, when it is in full going order, will find employment for at least 500 people. I mention this merely as a case which has come to my notice within the last few hours. I have heard of many other similar cases, although the matter has now passed out of my immediate province. Several considerable firms in the United States are to my knowledge making arrangements to work their patents here or are prosecuting active inquiries with a view to securing sites on which to erect their factories or workshops. During my visit to Germany I also heard of firms which are coming here to establish works in order to avoid the forfeiture of their patents, which will certainly follow if the terms of the act are not complied with. Some firms may wait until the first test case is legally dealt with. In this connection I should like to make it clear that it is a great risk they are running. The position is quite plain. From the moment the act comes into operation they run the risk of losing their patent rights in this country. The act is an extremely searching one. It was framed with the full intention of making it very perilous for any holder of a patent to seek to evade its provisions. We purposely put in all sorts of clauses to add to the danger or even postponement on the part of foreign patent holders to come up to the conditions of the measure."

It is stated that an international association has been formed on the Continent to seek a means to counteract the effects of the new British Patent Act upon foreign inventors and their rights. The course recommended appears to be that of making the granting of patent rights to British inventors more onerous than at present.

Turkey.—Ali Galib Bey has been appointed Director-General of Turkish Posts and Telegraphs.

United States.—A report recently issued states that 5,874 miles of new railway track were constructed in 1907, compared with 6,067 miles in 1906. Nearly 3,500 additional miles of track were equipped with the block system of signalling. Electric railways are extending rapidly in every direction and carry freight as well as passengers. On one electric line running from St. Louis a sleeping car is attached to the night train. More than 2,000 electric cars were manufactured in St. Louis in 1907, and the total business in other electrical goods (appliances and motors, elevators, lamps, and the like) is put at £2,000,000 for St. Louis alone.

Ware.—The North Metropolitan Electrical Power Distribution Co. have applied to the Board of Trade for the revocation of the Ware electric lighting order, on the ground that an electricity undertaking cannot be carried out with profit. The order was granted to the company in 1905.

West London Tramways.—The report of Col. Yorke on his recent inspection of the tramways in Ealing on behalf of the Board of Trade has been issued. Col. Yorke states that :—

After a careful examination of the tracks from end to end, I have to report for the information of the Board that, in my opinion, the London United Tramways within the Borough of Ealing are not at the present time in such a condition "as to be a danger or annoyance to the ordinary traffic."

Wimbledon.—Tne Electric Lighting committee has approved a scheme for the improvement of street lighting.

It has been decided to instal a 220 volt 50 c p. metallic filament lamp in each of the 1,045 lamp-posts in the borough and to purchase 155 metallic filament lamps for the purpose of stock at an estimated cost of £288, while the estimated cost of altering wiring and fittings is £130. 12s. 6d.

A sub-committee has been appointed to deal with the dispute between Jas. Howden & Co., the contractors for supply of a Zoelly turbine, &c., and the borough electrical engineer respecting the amount of pipework included in the tender.

ELECTRICITY SUPPLY AND TRAMWAY ACCOUNTS.

Cleckheaton.—The electricity department accounts for the year ended March last show capital expenditure £26,260, increase £1,073.

Income was £4,023 (against £3,619 in previous year), expenditure £2,239 (£2,190), gross profit £1,784 (£1,429) and net profit £99 (against a loss of £193). 675,000 (588,640) units were generated and 347,890 (358,433) supplied for traction, 3,207 (3,291) to public lamps and 179,631 (81,383) to private consumers for power and 44,692 (39,181) for lighting. The maximum load was 475 kw. (against 460 kw.). Total working expenses were 0·924d. (against 1·095d.) per unit, interest 0·329d. (0·363d.) and sinking fund 0·373d. (0·412d.).

Malta.—In 1907-8 the revenue derived from the electricity undertaking of the Malta Government was £17,421 compared with £18,292 in 1906-7. Expenses were £11,100, a slight increase over the previous year. The capital outlay at March 31 last was £70,541, and the net profit on the year's working £6,321, compared with £7,236 in the previous year. The reduction in net profit is attributed in some measure to the large account of the military authorities being unpaid at the end of the financial year, and, owing to the improvements in glow lamps, less current was consumed for street lighting. Renewals were formerly debited to a separate fund, but are now defrayed from revenue. The total number of units generated was 1,070,720, compared with 972,657 in the previous year. Coal consumption was less, being 3,168 tons in 1907-8 and 3,279 tons in 1906-7, an economy of nearly 1 lb. per unit generated (6·6 lb. per unit against 7·5 lb.).

Newcastle-on-Tyne.—The accounts of the tramways department were adopted by the City Council on Wednesday.

The chairman of the Tramways committee (Mr. Rogers) said the extension fare stages and the unfortunate strike reduced the profit by £6,000, compared with that of the previous year, but they still had over £15,000 profit, which they proposed transferring to reserve, making it £63,000. In addition they had paid £197,000 in interest since the system was inaugurated, and £187,000 had been paid off the debt.

Norwich.—The accounts of the electricity department for the year ended March last show capital expenditure £292,036, increase £11,292.

Revenue was £35,701 (increase £5,336). Expenses were £18,907 (increase £3,529), gross profit £16,794. Interest required £8,511 and sinking fund £4,920, the net profit being £3,300. £3,300 has been placed to reserve and depreciation. 4,294,745 units were generated, [illegible] supplied to public lamps and 3,619,635 to private consumers, 1,925,432 of which were for motive power. The maximum supply demanded was 2,451 kw.

The Electricity committee's report states that the increase in units sold is 20 per cent. The expenditure includes £1,143 for new meters and an increase of £300 for coal. There are 1,255 (1,092) consumers, with the equivalent of 129,171 (120,[illegible]) 8 c.p. lamps connected and 403 [illegible] motors of an aggregate h.p. of 2,245 (2,032). Income was 2·33d. (2·[illegible]) and expenditure (apart from cost of new meters) 1·16d. (1·51d.) per unit.

Redditch.—The accounts of the past year's working of the electricity undertaking were approved by the Council on Monday.

After paying expenses there was a deficit of £510. The chairman (Mr. F. C. Dolphin) explained that in the past year there had been a great decrease in the demand for current for power due to the removal of a large industrial concern from Redditch to Birmingham and exceptionally bad trade at other works. These losses and the increased cost of coal represented a reduction in the amount of gross profit of over £600.

Stockport.—The annual accounts were submitted by the Chairman of the Finance committee (the Mayor, Ald. Bell) to the Council on Tuesday. It was reported that there was a profit of £10,369 on the tramways and £5 376 on the electricity undertaking. £22,000 has been allocated out of the year's profits of the various municipal undertakings in relief of rates.

TRADE NOTES AND NOTICES.

READY.

"THE ELECTRICIAN" ELECTRICAL TRADES' DIRECTORY AND HANDBOOK.—The 1908 Edition of the Big Blue Book, price 15s., or post free in the United Kingdom, 15s. 9d. The new and enlarged volume brings a great mass of statistical and technical data quite up to date, and the Directorial Division has been thoroughly revised and amplified.

All branches of Electrical Engineering and Industry are fully treated, and Electro-Financial matters have received every attention in the new volume, which aggregates more than 2,000 pages. The Directory Division is complete and thoroughly accurate, and has been completely revised. All mere lists of members of Societies and Institutions (so easily and cheaply available) are excluded, as quite unreliable for Manufacturers' and Dealers' purposes. The full set of valuable Statistical and Engineering Tables, &c., have been very carefully revised and extended, and remodelled into handy book form ; these are included in the 1908 Blue Book, making it the most complete book of the kind ever published.

TENDERS INVITED.

Tenders are invited for supply and erection of a power plant for the General Post Office, *Adelaide* (South Australia). Tenders, forms and specifications at the Commonwealth Office, 72, Victoria-street, London, S.W. See also an advertisement.

London County Council invite tenders for supply and delivery of about 3,600 tons steel girder tramway track rails and fastenings and about 1,550 tons of steel slot rails, and about 590 tons of conductor tee rails ; and also the road work and plate laying required for the electrification (on the conduit system) of the existing tramways in Wandsworth-road, Lavender-hill and East-hill, Wandsworth. The total length of tramway is about 6¾ miles of single line. Tenders by 11 a.m. Sept. 8.

Salford Electricity committee invite tenders for supply and delivery at the Corporation electricity department's mains depot, Frederick-road, Pendleton, of lighting and power feeder and distribution pillars. Specification, &c., from the borough electrical engineer (Mr. Victor A. H. M'Cowen, M.I.E.E.). Tenders to the chairman of the Electricity committee at the office of the Borough Electrical Engineer, Frederick-road, Pendleton, by noon Sept. 14.

Blackpool Corporation want tenders by 10 a.m. Sept. 19 for supply of 100 tons steel rails, 30 cwt. fish plates and 20 cwt. tie-bars, and for labour only in taking up and relaying about 828 yds. of double track tramway.

West Ham Guardians want tenders by 10 a.m. Sept. 17 for 12 months supply of electrical fittings, &c. Forms of tender from the Clerk, Union-road, Leytonstone, London, N.E.

Poplar (London) Guardians want tenders by 6.30 p.m., Sept. 11, for 12 months' electrical supplies. Forms of tender, &c., at 45, Upper North-street, Poplar, E.

Stoke-on-Trent Electricity committee want tenders by Sept. 8 for coal (about 500 tons of washed beans).

The *Greek* Ministry of the Interior invite tenders for supply and fixing the mechanical installations of the two graving docks now being constructed at the port of the Piraeus, comprising pumps

(with electric motors), sluice gates, cranes, winches, transformers, &c. The material will be exempt from all import duties. Tenders will be received by the Director of Public Works, Athens, up to noon Oct. 13, and must be guaranteed by a deposit equal to 5 per cent. of their amount. The contract will be adjudicated within one month from date for receipt of tenders. A copy of the official announcement of the competition (in French) and a plan of the docks may be seen by British contractors at the Board of Trade, 73, Basinghall-street, London, E.C.

Antwerp Municipal Council invite tenders for electric lighting of the municipal "Salle de Fêtes," Place de Meir. A deposit of Fr. 12,000 (about £480) will be required. Tenders to M. le Bourgmestre, Hôtel de Ville, Antwerp, by 21st inst. Specification may be seen by British contractors at the Board of Trade, 73, Basinghall-street, London, E.C.

TENDERS RECEIVED AND ACCEPTED.

Lochgelly Iron & Coal Co. have placed an order with Johnson & Phillips for supply and erection of shaft and inbye cables for the Lochgelly pits.

Manchester Electricity committee have placed an order with Veritys (Ltd.) for ½, 2, 7 and 10 H.P. motors of the "Aston" interpole type and for ½, 1, 2, 3 and 7 H.P. improved "Aston" starters for two years.

Wigan Electrical committee have accepted the tender of the Pemberton Colliery Co. for supply of 6,000 tons of Wigan 9 ft. slack at 7s. 6d. per ton.

Wimbledon Electric Lighting committee have accepted the tender of Dorman, Long & Co. for supply of steel girder work in connection with the foundations for a 1,000 kw. turbo-alternator.

Ilford Council have accepted the tender of Myall & Upon for extensions of the electricity station buildings at £2,048.

Johnson & Phillips have received an extension order from the Clyde Navigation Trust for insulators for Rothesay Dock.

Eccles Council have accepted the tender of John Spencer (Ltd.) for steel steam and cast-iron circulating water piping at £258.

Wrexham Council have accepted the tender of Meldrum Bros. for a forced draught furnace at £70.

The Postmaster-General's Department, Sydney (N.S.W.), have accepted the tender of Saunders & Stuart for 75 miles indiarubber covered copper wire at £6. 15s. per mile.

Adelaide (S. Australia) Municipal Tramways Trust have accepted Noyes Bros.' tender (on behalf of British Westinghouse Co.) for Motor equipments and car-wiring at £12,243, and that of Geo. Wills & Co. (for Australian General Electric Co.) for spares, £425.

Dockyard Electric Cranes.—Messrs. Marshall, Fleming & Co., who recently supplied a wharf crane at Devonport Dockyard, are (we are informed) just completing at Sheerness Dockyard the conversion of three overhead cranes from square shaft to electric drive. Two of the cranes are of 20 tons capacity and one of 5 tons, each being driven by three separate motors.

BUSINESS NOTICES.

The future address of the Ecco Battery & Electrical Co. will be Invicta Works, Bow Common-lane, London, E. Telegrams: "Overgaze London"; telphone 3,633 East.

Messrs. Conrad Lauer & Co. have started business as boiler and steam pipe coverers at 65, Euston-road, London, N.W. Mr. Lauer was associated with Messrs. A. Haacke & Co. for the past 25 years. Mr. Geo. Cross, who has also been with Messrs. Haacke, is now representing the new firm.

Patents Development.—The proprietors of the following patents are desirous of entering into arrangements, by way of licence or otherwise, for exploiting same and ensuring their full development and practical working in this country.

Patent No. 19979/1904 for "Improvements in Magnetic Wheels or Electromagnetic Motors." Applications to Messrs. Haseltine, Lake & Co., 7 and 8, Southampton Buildings, Chancery-lane, London, W.C.

Patents Nos. 23,501/1899, "For Improvements in Vacuum Tube Lighting," and 12,382/02 relating to "An Improved System of Electric Lighting." Applications to Messrs. Lloyd Wise & Co., 46, Lincoln's Inn-fields, London, W.C.

Patent No. 28,820/02, relating to "Improvements in Electrodes for Primary Batteries." Apply to Messrs. Lloyd Wise & Co., 46, Lincoln's Inn-fields, London, W.C.

Patents Nos. 7,585/03 and 3,913/05, "Relating to Apparatus for enabling Telephone and Telegraphic Messages to be Transmitted over the same Line"; and No. 12,691/01, "Relating to Apparatus for the Simultaneous Transmission of Telephonic and Telegraphic or other Currents over the same Line." Applications to Messrs. Lloyd Wise & Co., 46, Lincoln's Inn-fields, London, W.C.

Patent No. 556/1900, relating to apparatus for converting alternating into direct-current, or vice versa. Applications to Messrs. Cruikshank & Fairweather, 65, Chancery-lane, London, W.C.

Patent No. 13,174/1899, relating to "Annunciators used in connection with Electric Signalling Apparatus in Hotels, &c." Applications to Messrs. Lloyd Wise & Co., 46, Lincoln's Inn Fields, London, W.C.

Patent No. 11,058/1906, relating to "Improvements in Electric Circuit-breakers." Applications to Messrs. Lloyd Wise & Co., 46, Lincoln's Inn fields, London, W.C.

Patent No. 7,031/1900, relating to "Improvements in Electric Clocks." Applications to Messrs. Haseltine, Lake & Co., 7 and 8, Southampton-buildings, Chancery-lane, London, W.C.

Further particulars of the above patents are given in advertisements on another page.

Railway Signalling Apparatus.—The proprietors of British Letters Patent No. 20,132/01, "Relating to Railway Signailing Apparatus," desire to license British manufacturers to make in Great Britain railway signalling apparatus, or they would consider propositions for the sale of same. Further particulars of the patent are given in an advertisement, and applications should be made to Messrs. Boult, Wade & Tennant, 111-112, Hatton-garden, London, E.C.

Migration of the Factory.—One of the healthiest signs of the time is the migration of manufacturers from crowded industrial centres, where rates and wages are high to districts where there are good transport facilities, cheap power, &c. We have recently pointed to the case of Dundee. Firms with works situated outside the London area sometimes find that they are able to secure profitable contracts at prices which would not cover a London factory's costs. Manufacturers desirous of migrating have sometimes found difficulty in obtaining information about districts suitable for their particular industries, but an increasing number of Councils and Companies now publish useful information about their districts. It is claimed by the Kidderminster & District Electric Lighting & Traction Co., that Kidderminster offers many advantages to large manufacturing firms and to assist manufacturers to arrive at a decision the company have issued a booklet giving information concerning the district. Copies of the booklet can be obtained from the managing engineer of the company (Market-street, Kidderminster), who will also be pleased to answer inquiries. The company is already supplying energy to a large number of carpet factories, and the total motors connected to the mains at present is equivalent to over 1,000 H.P.

Electrical Signs.—Simplex Conduits (Ltd.) notify that they have opened a new department at their Birmingham factory for electrical signs. The company claim that the Simplex sign, in addition to being the cheapest sign on the market, in regard to first cost, also incurs less expense for current consumption; one 16 c.p. lamp is ample to efficiently illuminate the sign. In the event of a particularly brilliant effect being required a 25 c.p. lamp is sometimes used in the case of the largest size (24 in. diameter). Comparatively speaking, by a practical use of the reflective value of the specially prepared tin used in these signs, one lamp can be made to do the same work as eight or nine in the ordinary wood letter sign. The colouring effects obtained are also a marked advance on anything yet accomplished. The moving signs, with their wonderful kaleidoscopic effects, will be demonstrated to any member of the trade at 11, Denmark-street, Charing Cross-road, London, W.C.

CATALOGUES, &c.

An Excello Circular.—Unless a circular is both novel and attractive it is likely to fall far short of its mark. So much literature is distributed now that the happy note must be at once struck if it is to appeal. The latest "Excello" circular issued by the Union Electric Co. is worthy of all praise. The reader's eye is at once caught by a long arrow, headed by the words "alight here," and pointing to the punched space on a 'bus ticket, marked "Business Prosperity." On opening the circular an excello lamp faces the words, "Alight here for business prosperity," and so the reader is led into the very kernel of the pamphlet which tells him all about "Excello Arcs." The pamphlet will be supplied to central station

engineers with name and address printed free, and it should take well and bring business.

B. I. & H. Publications. The British Insulated & Helsby Cables have issued pamphlets L26, L28 and L29, which deal with telephone apparatus and telephone switchboards. The illustrations in the switchboard pamphlet show a number of portions of exchanges suitable for commercial, industrial and exchange services. They have been standardised for a variety of purposes, and can be made up in any size to suit customers' requirements.

"Orieco" Lamps.—The "Orieco" metallic filament lamp has been before the trade now some time, and its chief features are well known. The International Electric Co., which is supplying these lamps, have a pamphlet ready directing attention to the fact that they are now stocked for 25 to 250 volts. The energy consumption is 1¼ watts per British candle-power.

From the same source we have to acknowledge receipt of a useful booklet on Field Telephony, which should be in the hands of every "Terrier" in the new forces. It is well written by a field officer.

Intense Flame Lamps.—The Santoni Arc Lamp & Engineering Co. send us their latest list of Santoni flame lamps for 10, 20 and 40 hours' burning. Details are also supplied of the "Perl" enclosed lamp for 100 hours' burning. The lamps are all made at the company's works at Charlton.

Brockie Pell Arc Lamps.—We have received a list from the Brockie Pell Arc Lamp Co., Wimbledon, S.W., in which general particulars are given of the closed, open and flame type arcs made by the company. The flame pattern lamp is made for both single and double carbons and the burning hours range from 8 to 36 hours.

Dalite Lamp is the name given to an arc lamp which Messrs. Drake & Gorham are putting on the market for use in printing offices, particularly in connection with three-colour work. A descriptive pamphlet will be sent on application supplying all details.

Electric Power Plant.—Messrs. Mavor & Coulson have sent a copy of their latest publication, which contains a large number of illustrations of motors applied to the driving of industrial machinery Views are also shown of the firm's standard d.c. and a.c. generators for industrial and allied services. The pictures of the motor application include textile factories, engineering and steel works, shipyards, cranes, pumps, hoists, &c.

Sirius-Efesca Lamps.—Considerable ingenuity is being exercised by metal filament lamp makers in the selection of suitable names for their light and delicate proteges. The latest is the "Sirius-Efesca" lamp, which should certainly stick in the memory if only for its double-barrelled character. The lamp is distinctive in that the filament loops are passed over a central supporting stem which slightly splays them, and in this way will probably improve the light distribution. The lamp is stocked for all the voltages and c.p.'s by Falk, Stadelmann & Co., Farringdon-road, London, E.C.

Mining Drills.—The need for light electric drills for use in the workings of mines equipped with electric power plants must be constantly impressed upon mining engineers. They should be interested in the electric and air drills which Messrs. Kramos (Ltd.), Bath, are putting on the market. These are made in two sizes, air and electric, and vary in capacity from 2 H.P. to 3 H.P.

Rail Joints.—In these days of efficient rail bonds, tramway managers are not greatly concerned with rail joints. They should, however, be interested in the "Robrow" combined rail joint and anchor which is being introduced by Mr. Robert Brown, 16, Great George-street, London, S.W. The joint is formed by an extension of the rail web minus the head and foot and the anchor is made by turning back the foot into an h shape. The surfaces in each case are securely bolted and riveted respectively. The joint is said to cost no more than the ordinary rail because the ends are fashioned at the rolling mill.

"Tubolite."—The Linolite Co. have forwarded a copy of their latest price list, together with leaflets descriptive of their system of lighting.

The company state that owing to the continued increase in sales over [illegible] "Tubolite" having been sold and the simplification in manufacture, they have effected certain improvements and made reductions in prices. The company will shortly put a metal filament "Tubolite" lamp on the market of the company's standard dimensions.

Electric Heating Nets.—Herr C. Schniewindt, of Neuenrade, Westphalia, issues a leaflet (H.C. 10) containing particulars and prices of electric heating nets, which he claims are the cheapest and most reliable heating elements on the market.

BANKRUPTCIES, LIQUIDATIONS, &c.

The discharge of Thos. Clement Hodgkinson (trading as Electro Neurotone), dealer in electro-medical apparatus, 186, Goldhawk-road, London, W., has been granted, subject to debtor's consent to judgment against him for £20.

Claims against Graham & Banks (Ltd.), electrical engineers, &c., 445, Oxford-street, London, W., are to be sent by Sept. 22 to Mr. H. de V. Brougham, 33, Carey-street, London, W.C.

Claims against the Commercial Electro Chemical Analysis Co. (Ltd.) are to be sent by Sept. 30 to Mr A. C. Roberts, 9 and 10, Pancras-lane, London, E.C.

A meeting to receive an account of the French & Belgian Luxfer Prism Synd. (Ltd.) will be held on Sept. 30 at 19 and 21, Queen Victoria street, London, E.C.

A meeting to receive an account of the winding-up of the Mevagissey Electric Lighting Co. (Ltd.) will be held on Oct. 2 at the Town Hall, Mevagissey.

PATENT RECORD.

APPLICATIONS FOR PATENTS.

NOTE.—*The undermentioned Applications (except those marked †) are not open to public inspection until after acceptance of Complete Specifications. Those marked † are open for inspection 12 months after the date attached to them, if they have not been published previously in the ordinary course. Names within parentheses are those of communicators of inventions. When Complete Specification accompanies application, an asterisk is affixed.*

May 2, 1908.

9,569 JAEGER. Electric wire poles or masts. (Date applied for, 8/5/07.)*

9,571 KORDIN. Electrical locomotive signalling device.*

9,577 ALLGEMEINE ELECTRICITATS GES. Dynamo-electric machines. (Date applied for, 4/5/07.)*

May 4, 1908.

9,620 BONN & JONES. Hand-fed arc lamps.

9,636 SIEMENS-SCHUCKERTWERKE G.M.B.H. Fittings for glow lamps. (Date applied for, 25/6/07.)*†

9,637 SIEMENS-SCHUCKERTWERKE G.M.B.H. Dynamo electric machines fitted with commutation poles. (Date applied for, 16/5/07.)*†

9,638 SIEMENS-SCHUCKERTWERKE G.M.B.H. Three-phase commutator machines. (Date applied for, 13/7/07.)*†

9,639 SIEMENS BROS. DYNAMO WORKS. (Siemens Schuckertwerke G.m.b.H., Germany.) Charging and discharging switches for cables and the like.*

9,640 SIEMENS BROS. DYNAMO WORKS. (Siemens Schuckertwerke G.m.b.H., Germany.) Switching apparatus for controlling electrical machinery.*

9,654 JUSTICE. (Deutsche Gasglühlicht A. G. (Auergesellschaft), Germany.) Miners' electric lamps.

9,675 EVANS. Electricity meters.*

9,676 FROMAGET. Electromagnetic transmission. (Date applied for, 4/5/07.)*†

9,678 GILMORE. Insulating conductors.

9,697 THAMES IRON WORKS SHIPBUILDING & ENGINEERING CO., & FLOOD. Switches.*

9,698 COWPER-COLES. Apparatus for production of electrotypes.*

May 5, 1908.

9,727 SMALDON. Rail in two or more sections.

9,756 HILLIARD & PARSONS. Switches.*

9,762 & 9,763 RUZICKA. Electrical resistances.*

9,780 JONES PHOENIX DYNAMO MFG. CO., & POHL. Motors of small starting torque.

9,790 W. T. HENLEY'S TELEGRAPH WORKS CO., & PFIFFNER. Cables.

9,791 WHITE. Prepayment electrical house meters.

May 6, 1908.

9,809 DOLTON & SMITH. Arc lamps.

9,832 PETERS. Safety fuses switchboards.*

9,836 COWPER-COLES GALVANIZING SYNDICATE, & COWPER-COLES. Electro-galvanizing.

9,844 FELTEN & GUILLEAUME LAHMEYERWERKE A. G. Automatic cut-out apparatus. (Date applied for, 6/5/07.)*

9,849, 9,850 & 9,851 BOULT. (Union Switch and Signal Co., U.S.) Electric signalling systems.*

9,859 KALLMANN. Starting device for electric motors. (Date applied for, 28/10/07.)*†

9,862 DAVY. Arc lamps.

9,865 BOON. Switch plate for the aerial wires of electric tramways.*

May 7, 1908.

9,900 RICHMOND. Batteries.

9,915 POWELL. Connectors for electric conductors.

9,917 PARSONS & BALL. Timed contact devices.

9,930 DEAN. Portable interruptor for induction coils and distributors of electrical current.

IMPORTANT NOTICE.

Extra Copies of "The Electrician" Special Mining Issue (July 10th, 1908), are obtainable, price 1/- nett (post free U K., 1/4; abroad 1/6).

9,972 Sunderland & Pillinger. Increasing or decreasing the light given by arc or incandescent lamps for theatrical and analogous purposes.
9,977 Allgemeine Elektricitats-Gesellschaft. Electrical power transmission systems. (Date applied for, 8/6/07.)*†

May 8, 1908.

10,009 Cameron & Cooke. Electric ignition devices for internal combustion engines.*
10,019 Eisenstein. Apparatus for producing electrical impulse charges in wireless telegraphy.*
10,037 Boult. (Schlesische Akkumulatoren Werke A.-G., Austria.) Accumulators.*

May 9, 1908.

10,078 Somers & Crowley. Storage batteries.
10,098 Ward & Stevens. Filament for glow lamps.
10,109 Turner. Emergency brake systems for electric railways and tramways.
10,118 Von Gizinsky, McClure & Wiesner. Electrical railways, tramways and the like.*
10,121 Allgemeine Elektricitats-Ges. Dynamo-electric machines of the commutator type. (Date applied for, 30/9/07.)*
10,128 Bein. Electric portable lamps.

SPECIFICATIONS PUBLISHED.

1906 Specifications.

21,347 Felten & Guilleaume-Lahmeyerwerke Akt.-Ges. Electric signalling apparatus. (Date applied for, 4/10/05.)

1907 Specifications.

1,292 Ruhmer. Converting direct into alternating currents by means of the electric arc.
2,986 Dawson & Buckham. Electrical signalling apparatus.
5,301 Igevsky. Electric furnace.
6,092 Taylor. Systems of electrical distribution.
8,562 Paweck. Electro-deposition of zinc.
8,742 Oppermann. Electrical controllers or switches.
8,951 Davy. Distribution of electricity.
8,999 Creed & Coulson. Machines or apparatus for reproducing, in ordinary characters, telegraphic or other messages or intelligence in the form of perforations in a tape.
9,390 Simpson. Electric-vehicle or locomotive brakes.
9,434 Mainprize. Combination electric fuze and switch.
9,535 Expansion Sprinkler Syndicate (Ltd.), Fiddes & Watt. Automatic fire alarms.
9,576 Thursfield. Apparatus for starting electromotors and regulating their action.
10,119 Newbery & British Prometheus Co. Controlling electric cooking and heating apparatus and indicating when they are in use.
10,169 McNeil. Electric fire alarms and thermo-indicators.
10,171 Allgemeine Elektricitats Ges. Controlling devices for electric winding engines. (Date applied for, 2/5/06.)
10,367 Cowper-Coles. Electro deposition of iron.
10,513 Beck. Arc lamps and electrodes. (Date applied for, 5/5/06.)
10,515 Condict. Braking electrically-propelled vehicles. (Date applied for, 9/5/06.)
10,636 Black & Black. Electric traction installations using contact boxes.
10,641 Mitchell. Leakage detectors for surface contact electric traction systems.
10,650 Dawson & Buckham. Electrical apparatus for transmitting and receiving signals.
10,662 Winther-Hansen & Bouchsein. Arc lamp.
10,665 B.T.-H. Co. (A.E.G., Germany.) Switches, fuses, &c.
10,666 B.T.-H. Co. (A.E.G., Germany.) Switches.
10,687 Brown. Electrical block signalling system for railways.
10,719 Mayes & Ferranti Limited. Electric motor starters.
10,943 Brown. Connecting up cables.
10,955 Potter. Telephone switch operating mechanism (Date applied for, 28/5/06.)
10,969 Felten & Guilleaume-Lahmeyerwerke (A.G.). Repulsion electric motors. (Date applied foı, 14/5/06.)
11,066 Leitner. Dynamos for train lighting.
11,086 Sullivan. Telephone receivers.
11,165 Highfield. Electrical distribution.
11,271 Muirhead. Hertzian wave telegraphy.
11,386 Nicholls & Nicholls. Contact breakers for inductor coils.
11,476 Kay. Dynamo-electric generators and motors.
11,594a Allgemeine Elektricitats Ges. Electric motors for rolling mills. (Date applied for, 21/5/06, originally in No. 11,594/07.)
11,979 Deutsche Beck Bogenlampen Ges. Electrode for arc lamps. (Date applied for, 29/1/07.)
12,139 Planchon. Filaments for electric lamps.
12,253 Beck, & Deutsche Beck-Bogenlampen Ges. Alternating-current electromagnet.
12,462 Lawley-Pinching & Walton. Sockets for electrical purposes.
12,563 Jullien & Dessolle. Rendering electrolytic copper homogeneous. (Date applied for, 31/5/06.)
12,585 Haag. Telegraphing type printed messages.
12,712 Miller. Obtaining unidirectional electric current from spark coils.
13,279 Simpson. Brakes for tramway vehicles and the like.
13,543 Highfield. Control of the supply of electrical energy.
14,162 Plumstead, & Newton & Lawrence Ltd. Igniting [illegible] electrically.
14,368 Lake (Charles M. Thompson Co.). Automatic telephone switches.
14,638 Taylor. Medical batteries.
15,171 B.T.-H. Co. (G.E. Co., U.S.). Insulating sheet metal and other electric conductors.
15,451 B.T.-H. Co. (G.E. Co., U.S.) Manufacture of refractory electrical conductors for electric lamps, furnaces, &c.
16,051 Siemens Bros. Dynamo Works & Parker. Dynamo-electric machines.
16,166 Highfield. Supplying current to electric motors in series systems.
16,500 Lake (Sanford). Electric self-winding clocks.
16,531 B.T.-H. Co. (G.E. Co., U.S.). Supports for the filaments of electric incandescent lamps.
16,778 Wright. Printing telegraph receivers.
17,046 Newman & Lodge. Application of electricity for stimulating vegetable growth.
17,254 Le Fevre. Portable electric massaging and like apparatus.
18,101 Wunner'sche Bitumen-Werke Ges. Manufacture of electric insulating materials. (Date applied for, 29/4/07.)
18,259 B.T.-H. Co. (G.E. Co., U.S.) Electric heating devices.
18,261 B.T.-H. Co. (G.E. Co., U.S.) Laminated core structures for dynamo-electric machines.
18,329 Warwick Machinery Co. (G.E. Co., U.S.) Fluid admission nozzles for turbines.
18,670 Meyer. Transmitting signals to a distance by alternating-currents. (Date applied for, 25/10/06.)
18,742 Heys. (Scott Electrical Co.) Arc lamps.
19,546 Codd. Magneto-ignition apparatus for internal-combustion engines.
19,697 Von Kando. Suspension of electric motors for electric vehicles.
19,855 Boyden. Electrical switches.
20,202 Siemens Bros. Dynamo Works. (Siemens Schuckertwerke Ges.) Rotary converters.
20,814 British Insulated & Helsby Cables. & Allen. Cable connecting devices.
21,077 Allison (Behan). Electromotors.
21,167 Pirdschun. Switches for electric circuits.
21,299 Bellini & Tosi. Directed wireless telegraphy.
21,827 Latour. Single-phase series alternating current commutator motors. (Date applied for, 3/10/06.)
22,085 Schwarzwalder. Electric batteries.
22,224 Zander (Held). Case for electric indicators.
22,605 Siemens Bros. Dynamo Works. (Siemens-Schuckertwerke Ges.) Systems of electric power-transmission for driving ships' propellers and other apparatus.
22,808 Poppe. Electrical contact breakers for internal-combustion engines.
23,199 Timar & Von Dreger. Arc lamps. (Date applied for, 4/9/07.)
23,239 Bergmann. Switches.
23,586 Weman. Galvanic element and manufacturing same. (Date applied for, 27/10/06.)
24,023 Clymer & Woodhouse. Electro-medical apparatus. (Date applied for, 7/11/06.)
24,671 Siemens-Schuckertwerke Ges. Arrangements on electricity meters for determining maximum consumption. (Date applied for, 8/11/06.)
24,871 Vialard-Goudou. Vapour lamps or burners.
25,313 Allgemeine Elektricitats-Ges. Alternating-current commutating machines. (Date applied for, 15/11/06.)
25,792 Stratton, Beaver & Claremont. Joint boxes for cables.
25,961 Hosken. Automatic sand-valve opener for tramcars and other electrically-driven vehicles.
26,920 Siemens Bros. & Co. (Siemens & Halske Akt.-Ges.). Electrical locking apparatus for railway signals.
26,937 Evans. Coin-operated apparatus for controlling the supply of electricity.
27,177 Barclay. Insulators. (Date applied for, 22/7/07.)
27,385 Cowper-Coles. Electro-deposition of metals.
27,739 Jantcek. Arc lamps and electrodes. (Date applied for, 20/12/06.)
28,451 Herrmann. Lengthening the burning life of electric lamps.
28,634 Lamme & Storer. Electric locomotives or motor vehicles. (Date applied for, 5/1/07.)

1908 Specifications.

35 Weissenborn. Electrical pattern for the manufactuıe of jacquard cards.
889 Amalgamated Radio-Telegraph Co. Radio-telegraphy. (Date applied for, 14/1/07.)
898 Bosch. Bearings for electromagnetic sparking machines. (Date applied for, 23/9/07.)
1,427 De Forest. Space telegraphy. (Date applied for, 29/1/07.)

COMPANIES' MEETINGS AND REPORTS.

BROWN, BOVERI & CIE. A.G. (MANNHEIM).—The report for the year ended March states that the works were again well employed, though many orders were booked at greatly reduced rates. The manufacture of steam turbine generating sets formed the chief feature of the year, and a number of repeat orders were received, including a steam turbine of 3,000 kw. for Cologne electricity works. The electrical department was also busily engaged, especially on polyphase motors for steel works, mines, &c. The profit was M. 2,570,980 (£128,549), against M. 2,163,188 (£108,159) in 1906-7. A dividend of 6 per cent. (the same as last year) has been declared.

DUMBARTON BURGH & COUNTY TRAMWAYS CO.—The directors' report states that the profit for the year is £3,870. 16s. 8d., which the directors recommend should be applied in payment of the preference dividend, and to carry forward £1,730. 1s. 10d. The Dumbarton Burgh tramways were taken over on Jan. 1, 1908, and have since been operated by the company. The county tramways have been constructed, and the first section, from Dumbarton to Alexandria, was opened for traffic on May 7. The through route from Dalmuir to Balloch was opened on June 25. The branch line (1 mile long) from Alexandria to Jamestown is practically complete. The traffic receipts from the tramways have been satisfactory.

LISBON ELECTRIC TRAMWAYS CO. (LTD.)—At a meeting of the debenture holders on Wednesday a resolution was adopted to modify the rights of the debenture holders and to authorise the trustees to concur with the company in executing a proper and sufficient supplemental trust deed.

LONDON GENERAL OMNIBUS CO. (LTD.)—The receipts for the year ended June were £1,116,184, or £43,253 less than in 1906-7, while the expenditure was £1,245,346, an increase of £41,107. The falling off in receipts is attributed to bad weather and increased competition with the L.C.C. tramways, and the increase in expenses to the high price of corn and the greater number of motor 'buses worked by the company.

MERSEY RAILWAY CO.—The chairman (Mr. Jas. Falconer) stated at the meeting on Wednesday that during the past six months there had been a further increase in the number of passengers and in the receipts. For the 12 months ended June 30 last the total receipts exceeded £100,000, compared with £61,250 in the last year of working by steam power. In the last half-year of working by steam power (ended Dec. 31, 1902) the receipts amounted to £29,470, compared with £51,784 in the past six months, an increase of 76 per cent.. In the same period the number of passengers had risen from 3,357,000 to 6,867,000, while the season tickets had increased from 1,595 (yielding £2,646) to 5,882 (yielding £6,849). The increased revenue had been obtained notwithstanding a substantial reduction in the average fare per passenger. The figures proved that, as the outcome of the excellent train service provided, there was a steady development going on of the district served by the line. The result of the past half-year's working was all the more satisfactory in view of the fact that it was achieved in circumstances not entirely favourable to a railway running through a tunnel. Apart from the bad trade which had prevailed in the district, and which naturally affected travelling on a line like theirs, the weather was bright and calculated to tempt people to take advantage of other travelling facilities. The only item of importance in the expenses was the heavier coal bill. The hopeful future of the railway was that with electric traction the working expenses did not increase in anything like the same proportion as the receipts did. They were practically stationary, and, therefore, as the receipts improved the net profit was bound to increase to a much larger extent than would have been the case with steam working.

NEW COMPANIES, STATUTORY RETURNS, RECEIVERS AND MANAGERS, &c.

NEW COMPANIES.

BAT METER CO. (LTD.) (99,327.)—Reg. Aug. 27, capital £20,000 in £1 shares (2,000 preference), to carry on the business of manufacturers of and dealers in electric, gas and water meters, &c. Private company. First directors, G. Heeley, F. A. Brocq and P. Bertin. Reg. office, 3, Eden-street, Hampstead-road, London, N.W.

DYNAMO ELECTRIC CAR TRANSMISSION SYND. (LTD.) (99,331.)—Reg. Aug. 27, capital £2,000 in £1 shares, to adopt an agreement for the purchase of certain patents and applications, and to carry on the business indicated by the title. Private company. First directors, A. F. Wright and A. L. H. Hotopt.

MACDONALD, SYER & CO. (LTD.) (99,300.)—Reg. Aug. 24, capital £1,000 in £1 shares, to carry on the business of consulting civil and electrical and general engineers, &c. Private company. First directors, C. S. Syer (manager) and J. W. Fletcher. Reg. office, 41, Snow hill, London, E.C.

STATUTORY RETURNS.

CARBONE ARC LAMP SYND. (LTD.)—Return to Dec. 3, 1907, gives capital as [illegible] in shares of £1 each, of which 7,607 ordinary, 100 A deferred and 100 B deferred have been taken up. £1 per share has been called up on 107 ordinary, £7,500 is considered as paid on 7,500 ordinary, 100 A deferred and 100 B deferred. Mortgages and charges, nil.

CHISWICK ELECTRICITY SUPPLY CORPN. (LTD.)—Return to June 3 gives capital as £100,000 in 99,900 ordinary and 100 founders' shares of £1 each, of which 62,700 ordinary and 100 founders' have been taken up. £62,800 has been paid. Mortgages and charges, £50,000.

COUNTY OF NORTHAMPTON ELEC. POWER & TRACTION CO. (LTD.)—In return to June 25 capital is £25,000 in £10 shares, all of which have been taken up and paid for in full. Mortgage and charges, nil.

CITY OF BIRMINGHAM TRAMWAYS CO. (LTD.)—The capital in return to May 17 is £1,000,000 in 120,000 ordinary and 80,000 preference shares of £5 each, of which 60,000 ordinary and 40,000 preference have been taken up. £5 per share has been called up on 6,047 ordinary and £1 per share on 53,953 ordinary and £5 per share on 40,000 preference, and £284,191 has been received, including £3 paid on three shares forfeited. Mortgages and charges, £300,000.

LLANGOLLEN & DISTRICT ELECTRIC LIGHT & POWER CO. (LTD.)—In return to June 15 capital is £6,000 in 3,500 preference and 2,500 ordinary shares of £1 each, of which 2,114 have been taken up. £1 per share has been called up on 2,114 and £2,110. 15s. has been received, leaving £3. 5s. in arrears. Mortgages and charges, £2,000.

PETERBOROUGH ELECTRIC TRACTION CO. (LTD.)—Return to May 12 gives capital as £60,000 in 6,000 ordinary and 6,000 preference shares of £5 each, of which 4,000 ordinary and 4,400 preference have been taken up. £5 per share has been called up and paid. Mortgages and charges, £21,000.

MORTGAGES AND CHARGES.

CALMONT, KING & CO. (LTD.)—Particulars of £2,000 debentures, created by resolution of Aug. 7, 1908, have been filed pursuant to sec. 10 (3) of the Companies Act, 1907, the amount of present issue being £500. Property charged, company's undertaking and property, present and future, including uncalled capital. No trustees.

RECEIVERS AND MANAGERS.

ECCO BATTERY & ELECTRICAL CO. (LTD.)—Notice of appointment of C. L. Davies, C.A., 1, Lombard-court, London, E.C., as receiver and manager on May 18, 1908, under powers contained in debenture dated Jan. 11, 1907, has been filed pursuant to sec. 11 (2) of Companies' Act, 1907.

CITY NOTES.

MEMORANDA (Sept. 3).—Bank rate 2½ per cent. (since May 28, 1908). Price of silver, 23$\frac{5}{16}$—23$\frac{11}{16}$d. per oz. Consols 85¼—85⅜ for money and 85⅜—85⅞ for account. Consols Pay Day, Oct. 1; Stock and Shares Continuation Days, Sept. 9 and 28; Ticket Days, Sept. 10 and 29; Pay Days, Sept. 11 and 30.

PRICES OF METALS (London).—*Copper*, cash, 60½—60¾; three months, 61⅛—61⅜. *Lead*, English, 13⅜—13½; foreign, 13¼—13⅜. *Spelter*, foreign cash, 19⅜—19½. *Tin*, English, 131—132; foreign, cash, 132¼—132¾, three months, 133¼—133⅜. *Iron*, Cleveland, cash, 52/8—52/9, three months, 52/2—52/4.

BANK FUR ELEKTRISCHE UNTERNEHMUNGEN, ZURICH.—For the year ended June a dividend of 10 per cent. has been declared, against 9½ per cent. for the previous year.

BRITISH INSULATED & HELSBY CABLES (LTD.)—An interim dividend at the rate of 8 per cent. has been declared for the half-year ended June 30, payable Sept. 16.

CROSSLEY BROS. (LTD.)—Owing to depression in trade and the unsettled outlook, the directors regret that it seems to them undesirable to pay a higher dividend than at the rate of 5 per cent. on the ordinary shares for the half-year ended June 30.

GENERAL ELECTRIC CO. (RUSSIA).—The net profit for the past year was 511,470 roubles, against 439,050 roubles in 1906-7. A dividend of 4 per cent. (against 3 per cent.) has been declared.

GLOBE TELEGRAPH & TRUST CO. (LTD.)—Interim quarterly dividends of 3s. per share on the preferred shares and 2s. per share on the ordinary shares have been declared.

MACKAY COMPANIES.—Regular quarterly dividends of 1 per cent. on the preferred shares and of 1 per cent. on the common shares in the Mackay companies will be paid on Oct. 1. The transfer books will not be closed.

MONTE VIDEO ELECTRIC LIGHT CO.—The profits for the year ended June last were $116,737 gold, an increase of over $21,000 compared with the preceding year. The lamps connected for private lighting have increased by 12,431 incandescents and 51 arcs.

PUEBLA TRAMWAY, LIGHT & POWER CO. (LTD.)—The accounts for the half year ended Dec. 31 last showed a net profit after providing for bond interest, &c., of £7,463, from which has been deducted certain preliminary expenses, leaving £6,755 to be carried forward.

STOCK EXCHANGE NOTICES.—The Stock Exchange committee have ordered [illegible] additional first mortgage 5 per cent. gold bonds of the *Rio de Janeiro Tramway, Light & Power Co. (Ltd.)* to be quoted. The committee have been asked to appoint a special settling day in provisional certificates, fully and partly paid, for £57,503 4½ per cent. debenture stock of the [illegible], and to grant a quotation to a further issue of 2,077 £10 fully paid shares of the [illegible].

ELECTRIC TRAMWAY AND RAILWAY TRAFFIC RECEIPTS.

Line	Week ended.	Amount.	Inc. or Dec. (a)	Aggregate: No. of weeks.	Aggregate: Amount.	Aggregate: Inc. or Dec. (a)
		£	£		£	£
Aberdeen Corporation	Aug. 26	1,720	+ 65	13	20,311	+ 80
Airdrie	,, 2[illegible]	224	− [illegible]	33	7,382	+ 68
Anglo-Argentine	,, 25	22,500	+ 6,395	34	667,872	+ 108,364
Ayr Corporation	,, 29	1[illegible]	+ 35	15	6,139	+ 14
Baker St. & Waterloo Ry.	,, 29	2,665	+ 610	9	25,325	+ 4,710
Barnsley	,, 21	230	+ 12	33	5,877	+ 307
Barrow	,, 21	297	− 12	33	8,281	− 280
Bath Electric Trams, Ltd.	,, 26	750	− 168	34	25,173	− 1,592
Birkenhead Corporation	...	...	...	...	...	...
Birmingham Corporation	,, 29	6,0[illegible]2	− 29	22	137,[illegible]	+ 5,271
Birmingham & Mid.	,, 14	763	− 38	32	26,831	+ 833
Blackburn Corporation	,, 26	1,060	− 108	22	27,981	+ 1,108
Blackpool Corporation	,, 27	2,051	− 125	21	31,541	+ 132
Blackpool and Fleetwood	,, 29	1,193	+ 114	...	...	...
Bolton Corporation	,, 30	2,240	− 89	22	52,560	+ 1,167
Bombay	,, 6	R33,341	+ R3,475	31	R1,100,352	+ R212,649
Bournemouth Corporation	,, 26	2,282	− 282	21	38,131	− 2,180
Bradford Corporation	,, 29	4,586	− 147	21	105,768	+ 937
Brighton Corporation	,, 30	1,161	− 102	22	22,267	+ 662
Bristol Trams & Carriage	,, 28	4,916	− 460	40	173,739	+ 416
Burnley Corporation	,, 29	1,157	− 94	22	27,338	+ 1,057
Burton Corporation	,, 30	283	− 17	22	6,125	− 516
Bury Corporation	,, 30	1,133	− 10	‡23	26,677	− 1,882
Calcutta Tramways Co.	,, 29	R15,900	+ R378	9	R418,052	− R6,168
Cardiff Corporation	,, 29	2,223	− 16	22	49,099	− 466
Cavehill	,, 21	130	+ 34	33	3,117	+ 250
Central London Railway	,, 29	6,580	+ 2,340	9	62,597	+ 18,901
Charing C., Euston & H'stead	,, 29	2,860	+ 515	9	28,750	+ 6,040
Chatham & Dist. Lt. Rys.	,, 27	874	− 69	34	26,162	+ 1,001
City & South London Rly.	,, 30	2,843	...	9	26,141	− 1,373
City of Birmingham	,, 21	2,613	− 127	33	92,257	− 235
Colchester Corporation	,, 25	218	− 30	8	1,929	− 123
Cork Electric Trams Co.	,, 27	480	− 34	34	15,764	− 487
Croydon Corporation	,, 28	1,227	− 337	22	32,135	− 128
Devonport & Dist. Trams	,, 21	499	− 23	33	15,305	+ 93
Dover Corporation	,, 29	277	− 45	22	5,371	− 162
Dublin & Lucan Railway	,, 28	147	+ 16	8	1,355	− 52
Dublin United	,, 28	6,436	− 2,437	8	50,318	− 14,234
Dudley-Stourbridge	,, 21	941	− 45	33	27,939	− 1,042
Dundee Corporation	,, 26	1,236	+ 73	‡15	18,249	+ 1,288
East Ham Council	,, 29	805	− 157	22	19,213	− 1,086
Exeter Corporation	,, 28	371	− 6	22	7,261	− 147
Falkirk and District	...	...	...	...	...	...
Gateshead & Dist. Trams	,, 21	996	− 36	33	33,467	+ 154
Glasgow Corporation	,, 29	16,969	− 520	13	221,000	+ 405
Glossop	,, 28	122	− 9	35	5,362	− 272
Gravesend—Northfleet	,, 21	243	− 62	33	7,094	− 1,026
Great Northern & City Rly.	,, 29	1,174	− 313	9	11,501	− 2,702
Gt. Northern, Piccadilly, &c.	,, 29	4,370	+ 870	9	43,400	+ 8,425
Greenock & Port Glasgow	,, 21	641	− 58	33	17,796	− 4,274
Hartlepool Tramways	,, 21	298	− 61	33	8,035	− 1,568
Hastings Elec. Trams Co.	,, 27	1,512	− 289	9	12,827	− 975
Hong Kong	,, 29	$7,[illegible]	− $212	35	$275,763	− $14,519
Huddersfield Corpn.	,, 29	1,527	− 95	22	36,107	+ 221
Hull Corporation	,, 29	2,357	− 7	22	52,949	+ 42
Ilford District Council	,, 29	418	− 83	22	10,174	− 562
Ilkeston District Council	,, 26	144	− 3	2[illegible]	3,105	+ 41
Ipswich Corporation	,, 29	455	− 72	22	9,274	− 225
Isle of Thanet Co.	,, 29	1,548	− 240	48	26,665	− 389
Jarrow	,, 21	116	− 11	33	3,589	− 460
Keighley Corporation	,, 27	166	− 18	8	1,446	− 7
Kidderminster & District	,, 21	135	− 12	33	3,869	− 165
Lanarkshire Trams Co.	,, 27	1,321	+ 27	34	44,229	+ 3,814
Lancashire United	,, 26	1,583	+ 105	34	45,960	+ 2,470
Leamington	,, 21	212	+ 20	33	5,635	+ 379
Leeds Corporation	,, 29	6,462	+ 9	22	148,571	+ 4,687
Leicester Corporation	,, 29	2,034	− 99	9	20,852	+ 128
Leith Corporation	,, 29	517	+ 18	15	8,699	+ 48
Lincoln Corporation	,, 29	131	− 7	22	2,657	− 77
Liverpool Corporation	,, 22	10,828	− 199	34	362,213	− 6,858
Liverpool Overhead Rly.	,, 30	1,398	− 135	9	13,364	− 2,002
*London County Council	,, 22	35,359	+ 4,641	†21	725,944	+ 80,785
London United	,, 29	6,595	− 1,591	34	231,871	+ 2,988
Lowestoft	,, 29	451	− 8	48	9,695	+ 161
Maidstone Corporation	,, 29	190	...	22	4,112	...
Manchester Corporation	...	...	...	...	...	...
Mersey Railway	,, 29	1,800	+ 61	9	16,539	+ 203
Merthyr	,, 21	207	− 18	33	7,009	+ 64
Metropolitan Dist. Railway	,, 29	8,273	+ 1,553	9	78,215	+ 11,970
Metropolitan Elec. Trams	,, 21	6,456	+ 1,304	33	188,993	+ 37,459
Middleton	,, 21	485	+ 35	33	12,279	+ 495
Nelson Corporation	,, 29	136	− 13	§21	3,168	− 180
Newcastle-on-Tyne Corp.	,, 29	3,712	− 87	22	85,627	− 5,568
Newport (Mon.)	,, 29	658	− 28	22	15,090	− 937
Northampton Corporation	,, 28	473	− 5	§21	10,541	+ 656
Oldham, Ashton & Hyde	,, 21	721	+ 6	33	19,911	− 170
Oldham Corporation	,, 30	2,164	− 2	‡23	45,251	+ 731
Perth (N.B.) Corporation	,, 29	173	− 3	15	2,490	− 107
Perth (W.A.) Elec. Trams	,, 28	1,207	− 129	35	48,170	− 995
Peterborough	,, 21	139	− 4	33	4,256	+ 49
Portsmouth Corporation	,, 29	2,420	− 297	22	48,023	+ 452
Potteries	,, 21	1,609	− 142	33	60,228	− 886
Preston Corporation	,, 26	741	− 32	8	6,233	− 327
Rotherham Corporation	,, 27	630	− 8	[illegible]1	13,275	+ 125
Rothesay	,, 21	636	+ 110	33	7,753	− 48
Salford Corporation	,, 31	4,420	− 311	22	105,374	+ 631
Sheerness	,, 19	79	− 1	33	1,916	− 23
Sheffield Corporation	,, 30	5,128	− 127	†23	127,578	− 571
Singapore Trams	,, 29	$8,810	+ $244	...	...	...
South Metropolitan	,, 21	958	+ 38	33	27,935	+ 686
South Staffs	,, 21	861	− 40	33	29,234	− 430
Southend Corporation	,, 26	744	+ 40	22	10,799	+ 785
Southport Tramways	,, 21	426	− 165	33	9,615	− 538
Stalybridge, Hyde &c., Jt Bd.	,, 29	720	− 70	†22	17,771	− 347
Sunderland Corporation	,, 30	1,216	− 268	22	23,917	− 5,494
Sunderland District	,, 26	512	+ 82	43	20,[illegible]	+ 1,571
Swansea Trams	,, 2[illegible]	1,034	− 691	33	31,155	+ 1,417
Swindon Corporation	,, 26	141	− 11	...	...	...
Taunton	,, 21	46	− 8	33	1,377	− 77
Tynemouth and District	,, 21	391	+ 11	33	7,850	− 478
Tyneside Trams Co.	,, 26	426	− 41	8	3,615	− 321
Wallasey District Council	,, 29	984	− 42	§21	20,555	+ 965
Walsall Corpn.	,, 29	519	− 24	35	15,615	+ 1,241
Warrington Corpn.	,, 27	361	− 5	21	8,142	− 117
West Ham Corporation	...	...	...	...	...	...
Weston-super-Mare	,, 19	187	+ 51	33	4,902	+ 123
Wolverhampton Co.	,, 21	450	− 42	33	15,2[illegible]	− 532
Wolverhampton Corpn.	,, 29	793	− 53	12	10,848	+ 268
*Worcester	,, 21	331	− 19	33	9,572	20
Wrexham	,, 21	115	− 1	33	3,391	+ 6
Yorkshire W.R. Trams	,, 30	1,212	− 57	35	42,833	...
Yorkshire Woollen District	,, 21	371	+ 8	33	30,542	− 1,242

(a) These comparisons are with the corresponding period last year. § Plus 3 days. † Plus 2 days. * Partly electric. ‡ Minus 3 days. ¦ Minus 2 days.

ELECTRICAL COMPANIES' SHARE LIST.

Share	Last Dividend	Name.	Price Wed., Sept. 2.	Rate % Yielded. £ s. d.	Dividend Due.	Business Week to Sept. Highest.	Lowest.
		ELECTRICITY SUPPLY.					
10	5 0	Bournemouth & Poole Elec. Sup. Ord.	10 −10½	6 13 6	Mar, Sept	10	..
10	4 6	Do. 4½ per Cent. Cum. Pref	9½ −10	4 10 0	Feb, Aug	..	..
10	6 0	Do. 6 per Cent. Cum. Second Pref	10½ −1[illegible]	5 6 [illegible]	Feb, Aug	..	..
St.	4½	Do. 4½ per Cent. Deb. Stock (red.)	10[illegible] −103	4 7 6	Jan, July	..	..
5	3 6	Bromley (Kent) El. Lt. & Power Shares	4[illegible] −5	5 10 0	April, Oct	..	..
St	4½	Do. Do. 1st Debs.	94 −97	4 12 9	May, Nov	..	..
5	4 6	Brompton & Kensington Elec. Sup. Ord.	[illegible] −7½	6 0 0	March	..	..
5	3 6	Do. 7 per Cent. Pref.	[illegible] −7½	4 13 6	Mar, Sept	..	..
St.	4%	Central Elec. Sup. Co. 4% Guar. Db. Stock	99 −102	3 18 [illegible]	June, Dec	..	..
5	2 6	Charing Cross (W. End & City) El. Sup. Co.	3½ −4	6 [illegible] 0	Feb, Aug	3½	..
5	2 3	Do. 4½ per Cent. Pref.	4 −4½	5 0 0	Feb, Aug	..	..
St.	4%	Do. 4 per Cent. Deb. Stock (red.)	93 −99	4 1 [illegible]	Jan, July	..	..
5	2 3	Do. City Undertaking 4½% Cm. Pref.	3½ −4	5 12 0	Jan, July	..	..
5	2/6	Chelsea Electric Supply Ord.	3 −3½	6 8 9	March ..	—	..
St.	4½%	*Do. 4½ per Cent. Deb. Stock (red.)	100 −103	4 7 6	June, Dec	..	..
10	5 0	City of London Electric Lighting Ord.	9½ −10½	5 17 0	Feb, Aug	[illegible]	..
10	6/0	Do. 6 per Cent. Cum. Pref.	11¾ −12¼	4 14 0	Jan, July	..	..
St.	5%	Do. 5 per Cent. Deb. Stock (red.)	122 −125	4 0 0	June, Dec	..	..
St.	4½%	Do. 4½ per Cent. 2nd Deb. Stock (red.)	101 −104	4 6 6	Jan, July	..	..
5	2%	County of Durham Elec. P.D. Ord.	2¾ −3	3 9 7	April, Oct	..	..
5	5%	Do. 5 per Cent. non Cum. Pref.	3¾ −4½	6 5 0	April, Oct	..	..
10	4 0	County of London Elec. Supply Ord.	7½ −8½	5 17 6	Feb, Aug	8[illegible]	..
10	6 0	Do. 6 per Cent. Cum. Pref.	10¾ −11[illegible]	5 9 6	Mar, Sept	1[illegible]	..
St.	4½	Do. 4½% Deb. Stock (red.)	107 −110	4 2 0	Jan, July	..	..
St.	4½	Do. Second Deb. Stock	99 −102	4 8 0	May, Nov	..	..
5	3 6	Folkestone Electricity Supply Co. Ord.	4¾ −5½	5 7 0	April, Oct	..	..
5	2 6	Do. 5 per Cent. Cum. Pref.	5 −5½	4 11 0	Mar, Sept	..	..
St.	4½%	Do. 4½ 1st Deb. Stock (red)	97 −100	4 10 0	Feb, Aug	..	..
5	4 6	Hove Electric Lighting Ord.	6 −6½	6 11 0	April, Oct	..	..
5	4 0	Kensington & Knightsbridge Ord.	7¾ −8¼	5 14 0	Feb, Aug	..	..
5	6%	Do. 6 per Cent. 1st Pref.	6 −6½	4 12 0	Jan, July	..	—
St.	4%	Do. 4 per Cent. Deb. Stock (red.)	94 −97	4 2 6	..	..	..
St.	4%	Kensingtn. & Kngtbg. Co. & Notting Hill Co. (Joint Station) 4% Deb. Stock (red.)	97 −101	3 19 0	April, Oct	—	..
St.	4½%	Kent Elec. Power Co.	86 −90	5 0 0	Jan, July	..	..
3	1 6	London Electric Supply Ord.	[illegible] −1¼	5 8 0	Mar, Sept	..	..
5	3 0	† Do. 6 per Cent. Pref.	4½ −4¾	6 3 0	Mar, Sept	4⅝	..
St.	4%	Do. 4 per Cent. 1st Mort. Deb.	89 −92	4 7 0	Jan, July	..	..
5	2 6	Metropolitan Electric Sup. Ord.	4½ −5	6 10 0	April, Oct	..	..
5	2 3	Do. 4½ per Cent. Cum. Pref.	4½ −5	4 10 0	Jan, July	..	..
St.	4½%	Do. 4½ per Cent. Deb. Stock 1st Mort.	105 −109	4 1 6	June, Dec	..	..
St.	3½	Do. 3½ per Cent. Mrt. Deb. Stock (red.)	84 −89	3 19 0	Jan, July	..	..
100	4½	Midland Elec. Corp. for P.D. 1st Mort. Db.	94 −97	4 12 6	June, Dec	..	..
10	4	Newcastle & Dist. Elec. Ltg. Ord.	7½ −8	5 3 2	Feb, Aug	—	—
100	4½	Do. 4½ per Cent. Deb.	94 −96	4 14 9	Jan, July	..	..
5	8%	Newcastle Elec. Supply Ord.	5½ −5¾	7 12 4	Feb, Aug	..	..
5	5%	Do. 5 per Cent. non Cum. Pref.	5¼ −5¾	4 15 8	Feb, Aug	..	..
100	4%	Do. 4 per Cent. Mort. Deb. red. 1907.	95 −97	4 3 4	Jan, July	..	..
1	3%	Northern Counties Elec. Sup.	—	..	Mar, Aug	—	..
100	4½%	Do. 4½ per Cent. Deb.	93 −95	4 15 9	Jan, July	..	..
10	6 0	Notting Hill Electric Ord.	11¾ −1[illegible]	5 10 6	March ..	..	..
5	2 6	Oxford Electric Ord.	5⅝ −6⅛	5 14 0	March ..	..	..
St.	4%	Do. 4 per Cent. Deb. Stock	95 −98	4 2 0	Jan, July	..	..
5	5 0	St. James' & Pall Mall Elec. Ord.	7 −8	6 1 6	Feb, Aug	..	..
5	3/6	Do. 7 per Cent. Pref.	6½ −7¼	4 16 0	Feb, Aug	..	..
St.	3½	Do. 3½ per Cent. Deb. Stock (red.)	88 −90	3 18 0	Jan, July	..	..
5	..	Smithfield Markets Electric Sup. Ord.	¼ −¾	..	Feb	..	..
St.	4%	Do. 4 per Cent. Deb. Stock	68 −72	5 11 0	Feb, Aug	..	..
5	4 0	South London Electric Supply Ord.	2½ −2[illegible]	5 19 0	April ...	..	..
1	0/6	South Metrop'n Elec. Lt. & Power Ord.	[illegible] −[illegible]	4 0 0	..	..	..
1	0 8¾	† Do. 7 per Cent. Cum. Pref.	[illegible] −1	5 18 0	Feb, Aug	..	..
St.	4½	Do. 4½ 1st Db. Stk. Red.	100 −103	4 7 6	April, Oct	..	..
5	2/6	Urban Electric Supply Ord.	½ −1	..	April, Oct	—	..
5	2 6	Do. 5 per Cent. Cum. Pref.	1½ −2½	10 12 0	April, Oct	..	..
St.	4½%	Do. 4½ per Cent. 1st Mort. Deb.	82 −85	5 6 0	April, Oct	..	..
5	5 0	Westminster Elec. Sup. Ord.	7½ −8½	5 17 6	Mar, Sept	8	7[illegible]
5	2 3	Do. 4½ per Cent. Cum. Pref.	5½ −5⅝	4 0 0	Jan, July	5[illegible]	5[illegible]
		ELECTRIC RAILWAYS, TRAMWAYS, &c.					
St.	4%	Baker St. & Waterloo 4% Perp. Db. St	92 −94	4 5 0	Jan, July	93½	93
1	..	Bath Elec. Trams Pref. Ord.	½ −[illegible]	10 13 0	April	..	—
1	0/6	Do. 5 per Cent. Cum. Pref.	⅝ −⅞	5 14 0	Jan, July	..	..
St.	4½%	Do. 4½ 1st Mort. Deb. Stock (red.)	86 −92	4 19 0	April, Oct	..	..
St.	4½	B'ham & Midland Trams 4½ 1st Db. Stk.	91 −94	4 17 0	Jan, July	..	..
10	9%	Bristol Tramways & Carriage Ord.	10¾ −11¼	8 0 0	Feb, Aug	..	..
10	4%	Do. Cum. Pref. (fully paid)	8¾ −9¼	4 6 6	..	..	..
St.	4%	Do. 4 per Cent. Debs.	95 −98	4 2 0	Feb, Aug	..	..
10	..	British Electric Traction Ord.	1¼ −1½	..	June, Dec	1[illegible]	1[illegible]
10	3/0	Do. 6 per Cent. Cum. Pref.	3⅞ −4⅜	..	Feb, Aug	4½	4[illegible]
St.	5%	Do. 5 per Cent. Perpetual Debs.	96 −99	..	April, Oct	97½	—
St.	4½%	Do. 4½ per Cent. 2nd Deb. Stock	76 −78	5 15 0	May, Nov	7[illegible]	76
St.	3%	Central London Ordinary Stock	68 −70	4 5 8	Feb, Aug	69½	68¾
St.	4%	Do. 4 per Cent. Pref. Stock	85 −87	4 12 0	Feb, Aug	..	..
St.	2%	Do. Deferred Stock	50 −53	3 15 0	Feb	51	..
100	4%	Do. 4 per Cent. Debs.	101 −101	3 17 0	Jan, July	..	..
St.	4%	Charing X, Euston & Hmpstd Per. Db. Stk.	82 −84	4 15 0	Jan, July	8[illegible]	83
5	2/6	City of Birmingham Trams. 5% Cm. Pref.	4¼ −4¾	5 5 0	April, Oct	..	..
100	4%	Do. 4 per Cent. 1st Mort. Debs.	97 −100	4 0 0	April, Oct	..	..
St.	1½%	City & South London Rly. Con. Ord.	32 −33	4 19 0	Feb, Aug	3[illegible]	32
St.	5%	Do. 5 per Cent. Perp. Pref. (1891)	111 −114	4 7 6	Feb, Aug	..	..
St.	5%	Do. (1896)	109 −112	4 9 3	Feb, Aug	..	..
St.	5%	Do. (1901)	107 −110	4 11 0	Feb, Aug	..	..
St.	5	Do. (1903)	102 −105	4 15 3	Feb, Aug	..	..
St.	4%	Do. 4 per Cent. Perpetual Debs.	100 −103	3 17 6	May, Nov	103½	..
10	6/0	Dublin United Trams. Ord	11½ −12½	5 4 0	Feb, Aug	..	..
10	6/0	Do. 6 per Cent. Pref.	12¼ −13¼	4 10 6	Feb, Aug	..	—
10	..	Gt. Northern & City Rly. Pref. Ord. (4%)	½ −1	..	Feb, Aug		
10	0/9	G. Northern, Piccadilly & Brompton Ord.	7 −7½	5 6 9	Feb, Aug		
St.	4%	Do. 4 per Cent. Deb. Stock	91 −93	4 6 0	Jan, July	92½	92
5	4/0	Hastings & Dist. Elec. Trams. 6% Cm. Pf.	3 −4	..	Mar, Sept	3¼	..
St.	4½%	Do. 4½ Db. St.	92 −96	4 13 9	April, Oct	..	..
10	9%	‡ Imperial Tramways Ord.	10 −11	7 7 5	Mar, Sept	..	..
10	6%	‡ Do. 6 per Cent. Pref.	9½ −10½	5 11 0	Mar, Sept	..	..
St.	4½%	‡ Do. 4½ per Cent. Debs.	90 −92	4 18 0	Jan, July	..	..
5	..	I. of Thanet E. T. & Lt. 5 per Cent. Pref.	⅞ −1⅜	..	Mar, Sept	..	—
St.	4%	Do. 4 per Cent. Deb. Stock	59 −61	6 11 0	Jan, July	..	—
10	6/0	† Lanarkshire Tramways	9[illegible] −[illegible]	6 3 0	Feb, Aug	..	..
St.	5%	Lancs. Utd. Trams 5% Prior Lien Db. St.	92 −94	5 6 6	Jan, July		..
10	..	Liverpool Overhead Railway Ord.	1¼ −1¾	..	Feb, Aug	..	—
10	5%	Do. 5 per Cent. Pref.	5¾ −6¼	8 0 0	Feb, Aug	..	..
St.	4%	Do. 4 per Cent. Deb.	81 −83	4 13 0	Jan, July	..	..
10	5/0	London United Trams. 5% Cum. Pref.	5½ −6½	7 14 0	Jan, July	6[illegible]	6
St.	4%	Do. 4 per Cent. 1st Mort. Deb. Stock	76 −81	4 15 9	Jan, July	7[illegible]	76
St.	..	Mersey Con. Ord. Stock	1 −3	—	Feb, Aug.	..	..
St.	..	Do. 3 per Cent. Perp. Pref.	8 −6	—	..	..	..
1	..	Metropolitan Elec. Tramways Ord	[illegible] −¼	—		..	..
1	..	Do. Def.	[illegible] −[illegible]	..	April..	..	..
1	0/6	Do. 6 per Cent. Cum. Pref.	[illegible] −[illegible]	6 3 6	Feb, Aug	..	..
St.	4½%	Do. 4½ per Cent. Deb. Stock	92 −95	4 14 9	Jan, July	91	93
St.	1%	Metropolitan Railway Consolidated	3[illegible] −36½	1 7 0	Feb, Aug	38	35
St.	2¾%	Do. Surplus Lands Stocks	65 −67	4 2 0	Feb, Aug	67	65
St.	3½	Do. 3½ per Cent. Preference	84 −87	4 0 6	Feb, Aug	85	84½
St.	3½	Do. 3½ per Cent. "A" Preference	73 −76	4 12 0	Feb, Aug	..	..
St.	3½%	Do. 3½ per Cent. Convertible Pref.	71 −73	4 10 0	Feb, Aug	72	..
St.	3½	Do. 3½ per Cent. Debenture Stock	90 −93	3 15 3	Jan, July	91½	91
St.	3½	Do. 3½ per Cent. "A" Ditto	88 −90	3 17 0	Jan, July	89½	..

* In calculating the yield allowance has been made for accrued interest but *not* for redemption

† Ex Dividend

ELECTRICAL COMPANIES' SHARE LIST.—*Continued.*

ELECTRIC RAILWAYS & TRAMWAYS—*Continued.*

Share	Last Dividend	Name	Price Wed., Sept. 2.	Rate % Yielded £ s. d.	Dividend Due	Business Week to Sept. 2. Highest	Lowest
St.	..	Metropolitan District Railway Ord.	11 —12	—	Feb, Aug	12⅛	11¼
St.	..	Do. Extension Pref. (5 per Cent.)	19 —23	..	Feb, Aug	..	..
St.	3½	Do. Assented Ext. Pref. (Int. Guar. by Und. Elec. Rlys. Co. of London, Ltd.)	48 —52	6 14 6	Feb, Aug	..	..
	[illegible]	Do. 3 per Cent. Consoltd. Rent-charge	73 —76	3 19 0	Jan, July	..	..
St	4%	Do. 4 per Cent. Midland Rent-charge	98 —102	3 18 0	Jan, July	..	—
St.	1½	Do. Guar. Stock 4 per Cent.	47 —52	3 17 0	Mar, Sept	..	..
St	6	Do. 6 per Cent. Perp. Deb. Stock	113 —118	5 2 0	Jan, July	117¼	116¾
St.	4%	Do. 4 per Cent. Ditto	71 —76	5 5 0	Jan, July	70⅛	..
St.	..	New Gen. Tract. 6 per Cent. Cum. Pref.	¼—¾	..	May	..	—
5	1/9	Potteries Electric Traction Ord.	¼—½	8 0 0	April, Oct	..	..
1	0/6	Do. 6 per Cent. Cum. Pref.	⅝—¾	6 13 0	Feb, Aug	..	..
1	4½%	Do. 4½ per Cent. Deb. Stock	93 —96	4 14 6	May, Nov	..	..
St.	0/7½	S. Met. Elec. Trams. & Ltg. 6% Cm. Pref.	¾—1	6 0 0	Feb, Aug	..	..
1	4%	Do. 4 per Cent. Deb. Stock	76 —80	5 0 0	Jan, July	..	..
St.	5%	Sunderland Dist. Elec. Trms. 5% 1st Mt. Db.	78 —82	6 2 0	Jan, July	..	..
100	£1/0	†Underground Elec. Rys. Co. of London	38 —42	..	June, Dec	..	..
	..	Yorkshire (W.R.) Elec. Trams. Ord.	⅞—1⅛	—	March ..	..	..
5	..	Do. 6 per Cent. Cum. Pref.	3⅛—3⅝	—	..	..	..
5	4½	Do. 4½ per Cent. 1st Debs.	83 —86	5 5 0	Jan, July	..	..

ELECTRIC MANUFACTURING, &c.

Share	Last Dividend	Name	Price Wed., Sept. 2.	Rate % Yielded £ s. d.	Dividend Due	Highest	Lowest
St.	..	Aron Electricity Meter Ord.	⅝—11/16	..	..	..	..
1	1/4½	Do. 6% Cum. Pf. (ex cu a/c arrears)	1[illegible]—1[illegible]	7 12 0	April, Oct	..	..
1	2/4½	Babcock & Wilcox Ord	3 15/16—4 1/16	4 18 3	April, Oct	4	3⅞
1	0/7½	Do. Pref.	1½—1⅝	3 13 9	..	..	..
1	6/0	†British Insulated & Helsby Cables Ord.	6½—7	7 4 0	July, Feb	..	..
5	3/0	Do. 6 per Cent. Pref.	6 —6½	4 12 0	Jan, July	..	..
5	4½%	Do. 4½ per Cent. 1st Mort. Deb. (red.)	103 —106	4 5 0	Jan, July	..	..
St.	4½%	†British Thoms'n-Houst'n 4½% 1st Mt. Db.	91 —96	4 14 0	Mar, Sept	..	..
St.	..	British Westinghouse 6 per Cent. Pref.	1/16—3/16	..	Feb, Aug	7/16	⅜
5	4%	Do. 4 per Cent. Mort. Deb. Stock	43 —48	8 8 0	Jan, July	..	..
St.	..	Brush Electrical Engineering	½	—	March ..	..	..
2	..	Do. 6 per Cent. Pref. non-Cum.	⅛—⅜	..	Mar, Sept	..	..
2	4½%	† Do. 4½ per Cent. Perp. 1st Deb. Stock	68 —73	6 3 0	Mar, Sept	..	—
St.	4½%	Do. Perpetual 2nd Deb. Stock	50 —54	8 6 6	Jan, July	..	..
St.	10/0	Callender's Cable Con. Ord.	9¾—10¾	6 17 6	Jan, July	..	..
5	2/6	Do. 5 per Cent. Cum. Pref.	5¼—5¾	4 7 0	Jan, July	..	..
5	4½%	Do. 4½ per Cent. 1st Mort. Debs. (red.)	107 —109	4 2 6	Nov, May	..	..
St.	1/0	Castner-Kellner Alkali Co.	1 5/16—1 11/16	8 0 0	May, Nov	1[illegible]	1 9/16
1	4½%	Do. 4½ per Cent. 1st Mort. Deb. (red.)	103 —107	4 4 0	Feb. Aug	104	..
St.	0/9⅜	Chadburn's (Ship) Telegraph Ord.	1 1/16—1 3/16	7 11 6	March ..	..	..
1	0/7½	Do. 6 per Cent. Cum. Pref.	1 1/16—1 3/16	5 13 0	April, Oct	..	..
1	[illegible]	Consolidated Electrical Co.	⅝—⅞	7 0 0	August ...	..	..
1	1/0	Consolidated Signal Co.	1 5/16—1½	10 0 0	April, Oct	1 7/16	..
1	0/7½	Do. 6 per Cent. Cum. Pref.	⅝—⅞	6 4 0	April, Oct	—	..
1	3/0	Crompton & Co. (Nos. 1 to 85,000)	1 1/16—1 3/16	9 5 0	Jan, July	..	..
3	5%	Do. 5 per Cent. 1st Mort. Debs. (red.)	90 —93	5 7 0	Jan, July	..	..
100	0/7½	Davis & Timmins	⅞—1⅛	..	Mar, Sept	..	..
1	2/0	Dick, Kerr & Co. Ord.	1[illegible]—1[illegible]	7 11 0	Sept	..	..
5	0/7½	Do. 6 per Cent. Cum. Pref.	1 —1¼	4 16 0	Sept	1[illegible]	1⅛
5	4½%	Do. 4½ per Cent. Deb. Stock	99 —102	4 8 6	Jan, July	..	—
St.	2/6	Edison & Swan United ("A" Sh.) (£3 pd.)	½—¾	..	Feb, Aug	9/16	..
5	4/2	Do. (£5 paid)	1½—2½	5 0 0	Feb, Aug	..	—
5	4%	Do. 4 per Cent. Mort. Deb. Stock (rd.)	76 —79	5 1 6	June, Dec	..	..
St.	5%	Do. 5 per Cent. 2nd Deb. Stock	85 —87	5 15 0	Mar, Sept	—	..
St.	..	Edmundson's Elec. Corp. Ord.	⅛—⅜	..	Jan, July	..	..
5	..	Do. 6 per Cent. Cum. Pref.	½—1	..	May, Nov	..	..
5	4½%	Do. 4½ per cent. 1st Mort. Deb. (red.)	59 —66	6 16 0	Jan, July	..	..
St	..	Electric Construction Co.	⅜—⅝	..	Jan, July	½	..
2	[illegible]	Do. 7 per Cent. Cum. Pref.	1⅛—1⅜	..	July	—	..
2	[illegible]	Do. 4 per Cent. Perp. 1st Mort. Debs.	66 —71	5 13 0	Jan, July	..	..
St.	[illegible]	General Electric (1900) 5% Cum. Pref.	7½—8	6 5 0	June, Dec	..	..
10	4%	Do. 4 per Cent. 1st Mort. Debs.	86 —90	4 9 0	Mar, Sept	..	—
St.	1/0	†Henley's Telegraph Works Ord.	10¼—11¼	6 10 0	Feb, Aug	..	..
5	2/3	† Do. 4½ per Cent. Pref.	5 —5½	4 2 0	Feb, Aug	..	..
5	4½%	Do. 4½ per Cent. 1st Mort. Deb. Stock	107 —109	4 2 6	Mar, Sept	107½	..
St	5/0	India Rubber, Gutta Percha, &c., Wrks.	16½—16½	6 2 0	Feb, Aug	16	..
10	4%	Do. 4 per Cent. Debs. (red.)	99 —101	3 19 0	April, Oct	..	—
100	..	National Elec. Construction Co.	⅛—⅜	..	April	..	..
1	0/9½	Richardsons, Westgarth & Co., Ltd. Ord.	7/16—9/16	7 2 0	Nov	[illegible]	..
1	0/7½	Do. 6 per Cent. Cum. Pref.	¾—⅞	6 17 0	May, Nov	[illegible]	[illegible]
1	4½%	Do. 4½ per Cent. Perp. Deb. Stock	87 —90	5 0 0	Jan, July	..	..
St.	..	Simplex Conduits Ord.	1½	..	..	—	—
1	..	Do. 6 per Cent. Cum. Pref.	5½	—	..	..	—
	12/0	Telegraph Construction & Maintenance	32 —34	6 4 0	Mar, July	33	..
12	4%	Do. 4 per Cent. Deb. Bonds (1909)	100¼—102½	3 17 6	Jan, July	..	..
100	1/0	Vickers, Sons & Maxim, Ltd. Ord.	1 11/16—1 13/16	5 11 0	..	1[illegible]	1[illegible]
1	1/6	Do. 5 per Cent. non-Cum. Preference	1 —1⅛	4 9 0	..	1 1/16	..
1	5%	Do. 5 per Cent. non-Cum. Preferred	101 —105	4 15 0	..	..	..
St.	4%	Do. 4 per Cent. 1st Mort. Db. Sk. red.	104 —106	3 15 0	June, Dec	..	..
St.	4½%	Do. 4½ per Cent. [illegible] Mort. Deb. red.	104 —106	4 5 0	June, Dec	..	..
100	15/6	Do. [illegible] Debs. [illegible]	102½—104½	..	..	104	103¾
100	[illegible]	[illegible]	8½—9½	8 17 9	.	..	..
1	1/9	W[illegible] Ord.	[illegible]—1¼	4 0 0	Apr, Oct	..	..
5	[illegible]	Do. 6 per Cent. Cum. Pref.	2½—3	8 11 6	Apr, Oct	2[illegible]	..
5	4%	Do. 4 per Cent. 1st Mort. Debs.	72 —76	5 5 6	May, Nov	..	..

TELEGRAPHS.

Share	Last Dividend	Name	Price Wed., Sept. 2.	Rate % Yielded £ s. d.	Dividend Due	Highest	Lowest
10		Amazon Telegraph	2 —3	—	June, Dec	..	—
100	5%	Do. 5 per Cent. Debs. (red.)	90 —93	5 7 6	June, Dec	92⅛	..
St.	15/0	Anglo American	58 —61	6 16 0	F,My,Ag,N	60	.
St.	[illegible]	Do. Preferred	104 —105	3 15 6	F,My,Ag,N	104⅝	104¼
St.	1%	Do. Deferred	16½—17½	5 18 0	F,My,Ag,N	17⅛	16⅞
St	4%	Commercial Cable 4 per Cent. Deb. Stk	86 —91	4 8 0	Jn,Ap,Jy,O	87½	86½
10	6/0	Cuba [illegible] Ord.	7½—8½	7 0 0	Feb, Aug	7½	..
10	10/0	Do. Preference 10 per Cent.	15½—16½	6 1 6	Feb, Aug	.	..
5	[illegible]	Direct Spanish Ord.	3 —3½	6 4 0	April, Oct	..	..
5	5/0	Do. 10 per Cent. Cum. Pref.	8 —9	5 11 0	April, Oct	..	..
100	4½%	Do. 4½ per Cent. Deb.	100 —103	4 7 6	Jan, July	..	.
	5/0	Direct United States Cable	13⅛—13⅞	6 7 6	Ja,Ap,Jy,O	13½	13[illegible]
100	4½%	Direct West India Cable 4½% Rg. Db. (rd.)	100 —102	4 8 0	June, Dec	.	..
St.	[illegible]	Eastern Ordinary	136½—138½	5 0 6	Ja,Ap,Jy,O	137⅛	136⅝
St.	17/6	Do. 3½ per Cent. Pref. Stock	84½—86½	4 1 0	Ja,Ap,Jy,O	86⅛	85
St.	4	Do. 4 per Cent. Mort. Deb. Stk. (red.)	103 —106	3 16 0	May, Nov	104½	102¾
10	2/6	Eastern Extension	12¾—13¼	5 5 6	Ja,Ap,Jy,O	13⅛	12⅞
St	4%	Do. 4 per Cent. Deb. Stock	101½—102½	3 17 6	Feb, Aug	101⅝	100⅞
100	4%	Eastern & S. African 4% Mort. Deb. 1900	99½—101½	3 18 6	Feb, Aug	..	..
	4%	Do. 4% Mauritius Sub. Debs. red.	101 —103	3 17 0	May, Nov	102⅜	..
10	[illegible]	G. N. Copenhagen [illegible] Coupon 71	27½—29½	6 15 0	Jan, July	..	—
100	4½	Halifax & Bermuda 4½% 1st Mt. Db. (red.)	100 —102	4 8 0	June, Dec	..	..
	[illegible]	Do. [illegible]	66 —70	5 12 0	May, Nov	..	..
	$1	[illegible] Companies Common	69 —73	5 10 0	Ja,Ap,Jy,O	..	..
	$1	Do. Preference	69 —73	5 10 0	Ja,Ap,Jy,O	..	..
		Marconi's Wireless Telegraph Co.	[illegible]	..	April		..
	4	Pacific & Europe'n Tel. 4% Guar. Dbs. (red.)	99 —102	3 18 0	June, Dec	.	—
		[illegible] American	1[illegible]—1	4 5 0	May	.	..
	4	Do. 4 per Cent. Debs.	99 —102	3 18 0	Jan, July	.	..
1		West India & Panama	[illegible]	..	May, Nov		
10		Do. 6 per Cent. 1st Pref.	8 —8½	7 1 0	May, Nov		..
10		Do. 6 per Cent. 2nd Pref.	[illegible]	..	May, Nov	[illegible]	[illegible]
100		Do. [illegible] Debs.	101 —103	4 17 0	Jan, July	..	.
10	8/0	[illegible]	14 —14¼	4 18 0	Mr,Jn,O,D	14 1/16	13¾
St	4%	Do. 4 per Cent. Deb. Stock (red.)	[illegible]	3 16 0	June, Dec	..	.
	4%	[illegible]	[illegible] —88	4 11 0	..	[illegible]	..

TELEPHONES.

Share	Last Dividend	Name	Price Wed., Sept. 2.	Rate % Yielded £ s. d.	Dividend Due	Business Week to Sept. Highest	Lowest
100	$2	Amer. Telephn. & Telegh. Cap. St.	130 —134	5 19 3	..	..	—
..	4%	Do. Coll. Trust $1,000 4 per Cent. Bds	91 —93	4 6 6	Jan, July	91¼	90⅝
St.	5%	Anglo-Portug'se Tel. 5% 1st Mt. Db. Stk.	101 —104	4 16 0	Mar, Sept	..	—
5	5/0	Chili Telephone	8 —8½	4 14 0	August ..	8½	8 1/16
1	0/7½	Monte Video Telephone Ord.	1 —1⅛	6 4 0	Nov	..	..
1	0/6	Do. 5 per Cent. Pref.	¾—[illegible]	5 3 0	May, Nov	..	..
St.	6%	National Co. Pref. Stock	108½—110½	5 8 6	Feb, Aug	109⅝	10[illegible]
St.	6%	Do. Def. Stock	118 —120	5 0 0	Feb, Aug	121	118½
10	6/0	Do. 6 per Cent. Cum. 1st Pref.	10½—11½	5 4 6	Feb, Aug	..	..
10	6/0	Do. 6 per Cent. Cum. 2nd Pref.	10½—11½	5 4 6	Feb, Aug	.	..
5	2/6	Do. 5 per Cent. non-Cum. 3rd Pref.	5⅝—5¾	4 7 0	Feb, Aug	5⅝	..
St.	3½%	* Do. Deb. Stock 3½ per Cent. (red.)	98½—100½	3 9 6	June, Dec	99¾	9[illegible]
St.	4%	Do. 4 per Cent. Deb. Stock (red.)	103 —105	3 16 0	Jan, July	103½	..
1	1/0	Oriental	1[illegible]—1[illegible]	6 1 0	April, Oct	..	..
1	0/7½	Do. 6 per Cent. Cum. Pref.	1[illegible]—1[illegible]	4 11 6	April, Oct	1[illegible]	..
St.	4%	Do. 4 per Cent. Red. Deb. Stock	89 —92	4 7 0	Jan, July	—	..
St.	4½%	Telephone Co. of Egypt 4½% Db. Stk. (red.)	99 —102	4 12 0	Jan, July	..	—
5	5/0	United River Plate	6[illegible]—7⅛	5 12 0	July	..	..
5	2/6	Do. 5 per Cent. Cum. Pref.	5 —5½	4 11 0	June, Dec	..	..
St.	4½%	Do. 4½ Deb. St. Red.	102 —104	4 6 6	Jan, July	..	..

FINANCIAL, INVESTMENT, &c.

Share	Last Dividend	Name	Price Wed., Sept. 2.	Rate % Yielded £ s. d.	Dividend Due	Highest	Lowest
5	8/0	Elec. & Gen. Investment 6% Cum. Pref.	3½—4	7 10 0	Jan, July	3⅝	..
10	5/9	Globe Telegraph & Trust	10½—11	5 7 0	Sp De Mr Ju	10⅛	10⅝
10	3/0	Do. 6 per Cent. Pref.	13½—14	4 5 9	Sp De Mr Ju	13⅞	13 9/16
10	6%	Submarine Cables Trust (Cert.)	128 —131	4 11 6	April, Oct	..	..

COLONIAL AND FOREIGN ELECTRIC RAILWAYS, TRAMWAYS, &c.

Share	Last Dividend	Name	Price Wed., Sept. 2.	Rate % Yielded £ s. d.	Dividend Due	Highest	Lowest
5	3/0	Anglo-Argentine 6% Cum. 1st Pref.	6[illegible]—6[illegible]	4 12 0	April, Oct	6⅝	6[illegible]
5	5/0	Do. 10% Non-cum. 2nd Pref.	8[illegible]—8[illegible]	5 14 3	Jan, July	8[illegible]	8[illegible]
St.	6%	Do. Permanent 6% Deb. Stock	141 —146	4 2 0	June, Dec	..	—
St.	5%	Auckland Elec. Trams. 5% Deb. (red.)	103 —106	4 14 3	Jan, July	..	..
5	4/0	Brisbane Electric Trams. Invest. Ord.	4 9/16—4 13/16	4 3 0	May	4¾	..
5	2/6	Do. 5 per Cent. Cum. Pref.	4⅞—5⅜	4 17 6	May, Nov	..	..
St.	4½%	Do. 4½ per Cent. Db. Prov. Certs.	99 —103	4 7 6	Jan, July	..	..
St.	8%	British Columbia El. Ry. Df. Ord.	129 —133	6 0 0	Mar, Sept	..	..
St.	30/0	Do. Pref. Ord. Stock	109 —113	5 6 0	May, Nov	111½	..
St.	5%	Do. 5% Cum. Perp. Pref. Stock	104 —108	4 12 6	Jan, July	104½	..
40	4½%	Do. 4½ per Cent. 1st Mort. Debs.	101 —104	4 6 6	April, Oct	103	..
100	4½%	Do. Vancouver Power Debs.	100½—103½	4 7 0	Jan, July	..	—
St.	4½%	Do. 4½% Perp. Con. Deb. St.	101 —104	4 1 6	—	..	..
St.	5%	Buenos Ayres Elec. Trams (1901) Ltd. Deb. St.	93 —97	5 2 6	Ja, Jul ..	..	..
5	..	Buenos Ayres Grand National Ord.	2 —2½	..	..	2½	2[illegible]
5	2/6	Do. 5 per Cent. Cum. Pref.	3¾—4¼	..	Feb, Aug	4[illegible]	..
100	5½%	Do. 5½ per Cent. Pref. Debs.	99 —103	5 7 6	Jan, July	..	..
100	6%	Do. 6 per Cent. 1st Deb. Bonds.	100 —104	5 14 6	April, Oct	..	..
St.	5%	Buenos Ayres Lacroze Trams 1st Mt. Db.	94½—96½	5 3 6	Mar, Sept	..	..
St.	6%	Buenos Ayres Port & City Tram. 1st Mt. Deb. Stock £75 Paid	61 —65	6 12 0	Feb. Aug	..	..
5	2/6	Calcutta Tramways (1 to 137,610)	5½—6	5 0 0	Mar, Sept	..	..
100	2/6	Do. 6 per Cent. Cum. Pref.	4⅞—5½	4 13 0	Jan, July	—	..
1	4½%	Do. 4½% 1st Deb. Stock (red.)	101 —104	4 6 6	Jan, July	..	..
St.	..	Cape Electric Tram Shares	⅛—⅜	..	..	..	—
5	1/3	City of Buenos Ayres Trams Co. (1904) Sh.	5⅝ —5⅞	4 5 3	F,My,A,N	5[illegible]	5[illegible]
St.	4%	Do. 4 per Cent. Deb. Stock	99 —103	3 17 [illegible]	June, Dec	..	..
.	5%	Colombo Tr. & Ltg. 5% 1st Mt. Db.	90 —93	5 6 6	May, Nov	..	—
100	5%	Electric Traction Co. of Hong Kong 5 per Cent. 1st Mort. Debs.	85 —90	5 10 0	June, Dec	..	..
1	5%	Havana Elec. Ry. Con. Mt. 5% $1,000 50 year Coup. Bds.	85 —90	5 11 0	Feb, Aug	..	..
1	..	Kalgoorlie Elec. Trams Sh.	[illegible]	..	..	..	..
100	5%	Do. 5 per Cent. "A" Deb. Stock	85 —89	5 12 0	Jan, July	..	—
5	6%	Do. 6 per Cent. "B" Ditto	65 —70	8 11 6	Jan, July	..	..
5	1/0	Lisbon Elec. Trams. Ord.	1 —1¼	4 0 0	July	..	..
100	0/7½	Do. 6 per Cent. Cum. Pref.	1 —1½	4 16 0	Jan, July	..	..
St.	5%	Do. 5 per Cent. Reg. Mort. Debs	92 —97	5 3 0	Jan, July	94½	93[illegible]
St.	5%	Madras Elec. Trams. 5% Deb. Stk.	93 —96	5 4 0	Jan, July	..	..
.	5%	Manila Elec. Ry. $1,000 Gold Bonds	84 —88	5 14 0	Feb, Aug	..	..
100	4/½	Mexico Trams Co. Com. St.	126 —128	3 16 0	..	129½	127¼
500	5%	†Do. Gen. Con. 1st Mort. 5% Gold Bds.	92½—93½	5 7 6	..	91[illegible]	92½
St.	4½%	Montreal St. Ry. Sterling 4½ per Cent. Debs. (1922) (Nos. 601 to 2,000)	100 —102	4 8 0	Feb, Aug		
1	1/0	Perth Elec. Trams Ord	[illegible]	7 3 6	May	[illegible]	..
St.	5%	Do. 1st Mt. Db. Stock	101 —104	4 16 0	Jan, July	..	—
5	3/0	Rangoon Elec. Trams & Supply Co. 6 Cum. Pf.	5⅛—5⅝	5 6 6	..	..	—
St.	4½	Do. 4½% 1st Mort. Deb. Stk.	95 —100	4 10 0	..	99½	—
..	$2½	Sao Paulo Tramway, Light & Power Co. $100 Stock	156 —160	5 12 6	..	165	156
	5%	Do. 5 per Cent. 1st Mt. $500 Db.	99 —100	5 0 0	June, Dec	99½	99
100	4½%	‡Toronto Ry. Co. 1st Mt. 4½% Ster. Bonds	97 —99	5 1 0	Feb, Aug	99¾	..

COLONIAL AND FOREIGN ELECTRICITY SUPPLY &c.

Share	Last Dividend	Name	Price Wed., Sept. 2.	Rate % Yielded £ s. d.	Dividend Due	Highest	Lowest
5	8/0	†Adelaide Elec. S'ply Co. 6% Cu. Pr.	4¾—5¼	5 14 0	Mar, Sept	..	..
10	6/0	Bombay E. S. & T. 6% Cm. Pf.	9½—10⅛	5 16 3	..	..	.
St.	4½	Do. 4½ per Cent. Deb. Stk. (red.)	94 —96	4 13 9	Jan, July	95	94½
5	4/9	Calcutta Elec. Supply Ord.	5¾—6¼	5 17 0	April, Oct	6[illegible]	
100	7/2	Canadian Gen. Elec. Co. Com. St.	104 —105	6 10 6	..	105½	104¼
100	5%	Castner Electrolytic Alkali Co. (of U.S.A.) 1st Mort. Stl. Debs.	92 —97	5 2 6	Jan, July		
500	5%	Elect. Development Co. of Ontario	84 —87½	5 15 0	..	89	88
5	..	Elec. Ltg. & Trac. Co. of Aust. 6 per Cent. Cum. Pref.	2 —2½	..	Feb, Aug	..	..
St.	5%	Do. 5 per Cent. Deb. Stock	84 —89	5 12 0	Jan, July	..	
St.	5%	Elec. Supply Co. of Victoria 5 per Cent. 1st Mort. Deb. St.	90 —93	5 7 6	Jan, July		
St.	6%	Indian Elec. Sup. & Trac. Co. Constn Deb. St. Rd.	30 —40	15 0 0	Jan, July	..	..
100	0/3	Kalgoorlie Elec. Power & Ltg. Ord.	[illegible]	..	..	.	
1	0/7½	Do. 6 per Cent. Cum. Pref.	⅜—⅝	8 0 0	April, Oct	[illegible]	..
St.	5%	Madras E. S. Corp. 5 per Cent. Constn Deb. St.	85 —90	5 11 0	April, Oct	..	..
500	5%	Mexican Elec. Light Co. 5% 1st Mort. Gold Bonds	86½—87½	5 11 9	..	87	[illegible]
St	$1	Mexican Lt. & Power Co. Com. St.	[illegible]	..	..	83¾	[illegible]
500	5%	Do. 5% 1st Mort. Gold Bnds.	90½—91½	5 [illegible] 6	..	91⅛	[illegible]
100	[illegible]	Montreal Lt. Ht. & Power Co. Cap. St.	102 —105	[illegible] 15 6	F,My,A,N	103¼	1[illegible]
1	[illegible]	River Plate Electricity Co. Ord.	[illegible]	5 16 0	April ..	[illegible]	
1	[illegible]	Do. 6 per Cent. non-Cum. Pref.	[illegible]—1	6 0 0	May ..		
St.	6%	Do. 6 per Cent. Deb. Stock	97½—99½	6 0 6	Jan, July		
5	[illegible]/0	Rosario Elec. Co. 6% Pref. (1–20,000)	4[illegible]—5¼	5 14 0	April, Oct	5[illegible]	.
100	$1	Shawinigan Water & Power Co. Cap. St.	81 —85	4 16 0	..	[illegible]	81
..	5%	Do. 5 per Cent. Bds.	103 —105½	4 15 6	Jan, July	103⅝	..
..	6d.	Victoria Falls Power Co. Pref.	⅛—¼	—	Jan, July		..

* In calculating the yield, allowance has been made for accrued interest but *not* for redemption. † Ex dividend. ‡ The London Stock Exchange Committee have declined to quote these.

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CONTENTS OF THE CURRENT NUMBER.

NOTES.

Omnibus Losses.

THE report of the directors for the year ended June 30th last, presented on Tuesday at the annual meeting of the London General Omnibus Co., provided rather unpleasant reading for the shareholders, although the disastrous results of the year's working had been foreshadowed at the annual meeting last year, besides being apparent from figures and statements which have appeared from time to time during the last few months. The actual loss on the past year's working is £129,162, to which has to be added debenture interest and other charges, making the total deficit £194,933. This stupendous deficit is attributed by the directors to inclement weather, competition of the London County Council tramways, development of the "tube" railways and the increased number of motor vehicles which the company has been running. Of these contributory causes, all except the last are, of course, outside the company's control, so that it is largely in the effects of the recent amalgamation that improved results must be sought, and by this step the directors hope to effect considerable economies.

THE main cause of all the trouble is undoubtedly the cost of maintaining the motor omnibuses. Although the total number of vehicles in service has been reduced during the year from 1,336 to 1,258, the working expenses have increased by over £41,000. Several systems of petrol electric drive are on the market, but so far they have not come greatly into favour, and the heavy outlay for repairs continues. As will be seen from the Paper read by Mr. F. DOUGLAS FOX before the British Association this week, the first instalment of which appears on another page, the author, like most other engineers, does not believe that petrol motor omnibuses can, at present, compete with tramways, but he seems to be more confident of the success of the electrobus. Although, for the sake of the electrical industry, to say nothing of the increased comfort for all who are obliged to use the City streets, we shall be only too pleased to record the assured success of this vehicle, we must at present remain dubious on this point until the Electrobus Company publish complete particulars of the actual cost of operation, which should not be very difficult now that a considerably increased number of vehicles are in operation.

Underground Mains.

THE calculation of underground mains offers unusual opportunities to the mathematician, and probably for this very reason the methods in general use are rough and ready. The practical engineer rather shrinks from abstruse calculations in laying out his network, partly, no doubt, because he is generally uncertain how the demand will develop, and he is inclined to provide for the future by a liberal allowance of copper. As a natural result, there is a good deal of haziness on the subject, and much less has been written on this than on other branches of electrical engineering. We think, therefore, that our readers will welcome the series of articles, which begins in the present issue of *The Electrician*, on the "Design of Underground Mains and Networks," by Mr. J. R. DICK, and which will be followed by articles on the same subject by Mr. F. FERNIE. It will be noted that these articles form the basis of a forthcoming book by these authors.

The Telephone and Crime.

WHILE the telephone may be responsible for many crimes and by some people be regarded as a mild form of criminal against a decorous civilisation, there is not the least reason why it should not be employed more than it now is, in both the prevention and detection of crime. It appears to be more than ever essential that "suburban-

country" districts should be interlinked, as to their police stations and detective agencies, by telephone. So many people now live, or rather sleep, in the country, while they work in the town, that the opportunities for "daylight" crimes are more frequent and call for more stringent action on the part of police authorities to ensure against their perpetration. Of the utility of such a course as coupling up these stations by telephone there can be little doubt. Like many other modern inventions, the telephone needs to be learned, if we may use such an expression, to be fully appreciated. In police matters it should be an integral part of the system and it should come naturally to the mind of officials that the telephone will probably supply the first need in cases of crime. We feel that our Criminal Investigation authorities have not taken the trouble to investigate the possibilities of the telephone in the pursuit of their labours. Certainly no excuse can be offered of any lack of telephone apparatus or means of intercommunication. The ramifications of the telephone system are now wide enough to admit of the interlinking of all towns and most villages in which police stations are placed. A correspondent in *The Times* calls attention to the lack of telephones in country police stations and the reliance which is placed on cycles for bringing assistance in case of need. Considerations of cost may compel the authorities to delay this important work in country districts, but we feel there should be no barrier in the way of placing a telephone in every police station in suburban districts where the homes of thousands who travel to and from a city every day are located.

Electric Lighting at Medina.—In connection with the opening of the Hedjaz railway last week, it is reported that the mosque at Medina containing the tomb of Mohammed has been lighted by electricity, the inaugural ceremony being attended by the Sultan's representatives.

Electric Traction on Railways.—Referring to Mr. Philip Dawson's article in our issue of August 28th, we learn that the pressed steel bogie truck illustrated in Fig. 5 on p. 749 is manufactured by the Metropolitan Amalgamated Railway Carriage & Wagon Co., and not by the Brush Electrical Co., as stated in the article.

Submarine Signalling.—According to *The Times* the Submarine Signal Co. have in hand the equipment for an electrical submarine bell to be installed at Tarifa. This is said to be the first electric bell to be fitted on this side of the Atlantic. It will be worked by a dynamo in the lighthouse at Tarifa, with a cable extending ¼ mile off the shore into 20 fathoms of water, the action of the hammer being controlled by electromagnets inside the bell casing. The code of signals is awaiting the approval of the Spanish Minister of Marine.

Venner Time Switch.—The *London Gazette* contains a notice that the Board of Trade announced on September 5th their approval of the Venner time switch, type B, deposited at the Board of Trade on November 11, 1906, on behalf of Venner & Co., provided that the apparatus be tested, fixed and used as described in the specification and instruction deposited at the Board of Trade and dated and numbered July 14, 1908, and H.9,014. The Board have further approved the means provided for fixing apparatus of this description and for connecting with service lines, as described in the same specification and instruction.

Cable Interruptions and Repairs.

	Date of Interruption.	Date of Repair.
Las Palmas—Arrecife	May 18, 1908 ...	—
Jeddah—Suakim	July 27, 1908 ...	—
Assab—Massowah ...	July 28, 1908 ...	—
Kwandong—Manado	Aug. 5, 1908 ...	Sept. 8, 1908
Cadiz—Teneriffe	Aug. 17, 1908 ...	—
Lagos—Kotonou	Aug. 29, 1908	—
Pernambuco—Cayenne	Sept. 3, 1908 ...	—

Electricity for Fuji Yama.—According to the *Electrical World* the beautiful mountain peak of Japan, Fuji Yama, which is so frequently seen pictured on Japanese screens and fans, is to be modernised by electricity, preparations having been made to instal an electric power plant to illuminate the peak at night, and numerous telephone and telegraph stations are to be erected along the route to the summit.

"The Electron."—The third monthly issue of the staff publication of Siemens Bros. Dynamo Works is before us. It contains a number of interesting articles both of a technical and general character, and well maintains the standard set by the previous issues. Judging by the reports of the various assistants, the bond of union amongst the members of the Siemens Stafford Institute must be a very close one.

Personal.—At a special meeting of the Senate of Dublin University held last week the honorary degree of Doctor of Science was conferred upon the following members of the British Association: Mr. Francis Darwin, F.R.S.; Sir David Gill, K.C.B.; Dr. W. N. Shaw, F.R.S.; Capt. H. G. Lyons, F.R.S.; Dr. H. Lamb, F.R.S.; Dr. C. S. Sherrington, F.R.S.; Dr. E. Rutherford, F.R.S.; Dr. A. B. Macallum; Dr. A. Kossel; and Dr. A. A. W. Hubrecht.

Wireless Telephone Notes.—"Wireless" opera is the latest development, and Dr. Lee de Forest is reported to have promised that "Any person residing within 10 miles of Covent Garden (London) will be able to hear the opera by wireless telephony. The apparatus will be so cheap that it will be within the reach of everyone. I have already succeeded in transmitting a solo over 30 miles without wires, and the practicability of transmitting every note of the orchestra and chorus in any theatre in London is not a matter of question, but of certainty." Dr. Lee de Forest has recently repeated the statement that the battleships of the United States now on a voyage around the world are fitted with the De Forest system of wireless telephone apparatus enabling oral communication to be maintained for a distance of 40 miles. The inventor is about to visit this country to submit to the Admiralty apparatus with a range of 75 miles.

Electricity Supply in Paris.—We have from time to time in the columns of *The Electrician* summarised the various projects which have been brought forward for co-ordinating the electricity supply of Paris. It is now announced by the *Electrical World* that the French Government has appointed a commission to report on the feasibility of transmitting electrical energy to Paris from water-powers of the Rhone, a distance of about 275 miles. The project under study was originally proposed in 1903 by MM. Blondel, Harlé and Mahl, and contemplated a hydro-electric plant with a capacity of 115,000 kw., the total cost of which was estimated at £2,400,000 (see *The Electrician*, Vol. LVII., p. 612). The following is an estimate of the amount of electrical energy that will be required by Paris annually in the near future :—

Electric traction, subways	100	million kw.-hours.
Electric light and power........................	300	,, ,,
Electric traction, street railways, &c.	100	,, ,,
Electric traction at railway termini.........	125	,, ,,
Total..	625	,, ,,

To furnish this quantity of energy, it is estimated, will require a plant capacity corresponding to 170,000 kw. at the end of the transmission lines.

Post Graduate Lectures on Radio-telegraphy.—A course of nine post-graduate lectures on "The Scientific Principles of Radio-telegraphy and Radio-telephony," are to be given at the University of London, University College, by Prof. J. A. Fleming, M.A., D.Sc., F.R.S., Pender Professor of Electrical Engineering. Major W. A. J. O'Meara, R.E., C.M.G., chief engineer to the Post Office, will preside at the introductory lecture of the course, which will be addressed to a general audience on Wednesday, October 14th, at 5 p.m., and will be open free to the public. (Cards of admission must be obtained beforehand). Succeeding lectures, being an advanced exposition of the subject, will be given on Wednesdays at 5 p.m., and will be free to graduates of the University and to undergraduates in their third year who may be qualified to take advantage of them. The fee for the course to all others will

be £2. 2s. Those desirous of attending the course should apply to Mr. Walter W. Seton, M.A., Secretary, University College, Gower-street, London, W.C.

Municipal Tramways Association.—At the seventh annual conference, which is to be held in the Exchange Hall, Nottingham, on September 23rd, 24th and 25th, in addition to the presidential address to be delivered by Mr. J. Aldworth (general manager of the Nottingham Corporation tramways), the following Papers will be read and discussed: "Some Through-running Problems and their Solutions," by Mr. H. E. Blain; "Treatment of Corporation Employés Incapable of Performing Ordinary Duty," by Ald. H. Linsley; "The Application of Technical Science to the Construction, Maintenance and Operation of Tramways," by Messrs. R. G. and J. G. Cunliffe; and "The Ticket Check," by Mr. L. Mackinnon. Visits will be paid to the Trent Bridge Car Repairing Works and the St. Ann's Well-road generating station, whilst Friday afternoon, September 25th, will be devoted to an excursion to Belvoir Castle. The annual dinner of the Association will be held at the Victoria Station Hotel on Thursday evening, September 24th, at 7 p.m.

Electric Traction in the Pyrenees.—It is announced from Paris that concessions will shortly be granted to the Midi Railway Co. for the working of the following lines, which are about to be constructed: (1) A standard-gauge railway from Auch to Lannemezan; (2) a narrow-gauge railway from Castelnau-Magnoac to Tarbes; (3) a standard-gauge railway from Arreau to Saint-Lary. These lines will be worked electrically, and the energy will be derived from a hydro-electric generating station in the valley of the Oule. In addition to these, the following railways, now worked by steam, will be electrified—viz., the lines from Montréjeau to Luchon, from Lannemezan to Arreau, from Tarbes to Bagnères de Bigorre, and the section between Montréjeau and Tarbes, on the railway from Toulouse to Bayonne. Moreover, the agreement signed between the Government and the Midi Railway Co. provides for the subsequent electrification of a certain number of lines situated to the west of those already named. These are the railways from Lourdes to Pierrefitte, from Pau to Bédous, from Buzy to Laruns, and the section between Tarbes and Pau, on the line from Toulouse to Bayonne.

Electric Tramways in Germany in 1907.—The *Zeitschrift für Kleinbahnen* gives the following statistics relating to this subject. It appears that 8,378 two-axle cars, 1,164 four-axle cars and 63 locomotives are in use. The following table gives details for some of the principal cities in Germany:—

Place.	Inhabitants.	No. of passengers. Millions.	Length of track. Miles.	Income per passenger. Pence.
Berlin and suburbs ...	3,013,000	481·1	222	1·22
Hamburg-Altona	971,000	157·2	103	1·30
Munich	539,000	65·3	35	1·25
Dresden	517,000	87·5	83	1·31
Leipzig	503,000	86·4	67	1·15
Breslau	471,000	55·3	33	1·00
Cologne...............	429,000	76·7	44	1·09
Frankfort	395,000	68·6	36	1·19
Nuremburg-Furth ...	355,000	29·6	21	1·15
Elberfeld-Barmen	319,000	27·4	27	1·21
Hanover Linden	308,000	39·5	97	1·30
Düsseldorf	253,000	34·6	32	1·14

National Physical Laboratory.—We have received Vols. III. and IV. of the collected researches carried out at the National Physical Laboratory, and forming a valuable contribution to the series initiated by the two volumes already published.

Vol. III. consists of the following Papers: (1) "An Alternating Stress Testing Machine for Experiments on Reversals of Stress," by Dr. T. E. Stanton, reprinted from *Engineering*. (2) "On the Resistance of Iron and Steel to Reversals of Direct Stress," by Dr. T. E. Stanton and Leonard Bairstow; this Paper was communicated to the Institution of Civil Engineers. (3) "Investigations on Light Standards and the Present Condition of the High-voltage Glow Lamp," by C. C. Paterson (*The Electrician*, Vol. LVIII., pp. 560, 611, 639). Our readers will remember that this Paper was read before the Institution of Electrical Engineers and gave rise to an interesting discussion. (4) "On the Properties of the Alloys of Aluminium and Copper, being the Eighth Report to the Alloys Research Committee of the Institution of Mechanical Engineers," by Dr. H. C. H. Carpenter and C. A. Edwards, with an appendix by W. Rosenhain. (5) "Tempering and Cutting Tests of High-speed Steels," by Dr. H. C. H. Carpenter; this Paper is reprinted from the *Journal* of the Iron and Steel Institute. (6) "On the Structural Changes in Nickel Wire at High Temperatures," by Dr. H. C. H. Carpenter; being a reprint of an article which appeared in *Engineering*. (7) "Experiments on the Effects of Change of Barometric Pressure on the Rates of Watches," by Dr. C. Chree; this is a reprint from the *British Horological Journal*. The following Papers appear as reprints in Vol. IV.: (1) "A New Current Weigher and a Determination of the E.M.F. of the Normal Weston Cadmium Cell," by W. E. Ayrton, T. Mather and F. E. Smith, reprinted from the *Philosophical Transactions* of the Royal Society. (*The Electrician*, Vol. LX., p. 751). (2) "The Normal Weston Cadmium Cell," by F. E. Smith, from the *Philosophical Transactions* of the Royal Society (*The Electrician*, Vol. LX., 403). (3) "The Silver Voltameter," by F. E. Smith, T. Mather and T. M. Lowry, from the *Philosophical Transactions* of the Royal Society (*The Electrician*, Vol. LX., p. 403). (4) "On Methods of High Precision for the Comparison of Resistances," by F. E. Smith, from the *Report* of the British Association, 1906 (*The Electrician*, Vol. LVII., pp. 976, 1,009). (5) "On the Measurement of Mutual Inductance by the Aid of a Vibration Galvanometer," by A. Campbell, from the *Proceedings* of the Physical Society of London (*The Electrician*, Vol. LX., p. 60). (6) "On a Standard of Mutual Inductance," by A. Campbell, from the *Proceedings* of the Royal Society (*The Electrician*, Vol. LX., p. 209). (7) "On the Use of Variable Mutual Inductances," by A. Campbell, reprinted from the *Proceedings* of the Physical Society of London (*The Electrician*, Vol. LX., pp. 641, 685). (8) "Inductance Measurements," by A. Campbell, reprinted from *The Electrician*, Vol. LX., p. 627. (9) "On Resonance Points in Microphone Transmitters," by A. Campbell.

Wireless Telegraph Notes.—We have not, so far, heard a great deal from the Antipodes as to claims for prior rights in regard to electrical inventions—and this is scarcely to be wondered at. But it is to be altered. A Melbourne correspondent of the "Financier" (London) writes:—

After the Commonwealth Government had invited tenders for the installation of wireless telegraphy "an important and most promising invention—far superior, it is believed, to any process that can be offered by Marconi, Poulsen, De Forest or others"—was perfected by an Australian expert. The director of our naval forces and the Minister of Defence have had their attention directed for some time to experiments by this local inventor, whose name has till now been kept secret. He ranks as one of the earliest experimenters. He is a friend of Tesla's and was favoured with wireless expositions and demonstrations from that distinguished scientist long before the name of Marconi was associated with the matter. The same talented Australian is said to be the original discoverer of telegraphic photography, and it was while engaged in developing telegraphic photography that "the new wireless marvel burst upon his gaze." He discovered a new form of wave, totally different from the Hertzian and the Poulsen, with which he was able to transmit messages with accuracy. His system is worked with a low power—only one-sixth of the electrical power needed to produce vibrations in the Marconi system. There is "a vast pole" at the inventor's residence in the suburbs of Melbourne, like a ship's mast, carrying the antennæ of his wireless equipment. All the messages now interchanged between vessels of the Royal Navy in Sydney, Melbourne and Adelaide are intercepted by this suburban installation. The inventor is not poor and seeks no reward. Electrical research is his favourite pursuit, and he has brought his system unpatented to the Commonwealth and presented it to Australia.

This reads like a fairy tale, and did it emanate from "stale old Europe" we should so regard it. But hailing from the brand new Commonwealth of Australia it merits perforce our respectful desire for more particulars. We await especially a description of that wave which differs from those of Hertz and Poulsen.

The *New York Herald* has received information that the long-mooted scheme for a comprehensive system of wireless telegraphy in the Southern Pacific is certain to be realised.

We recently referred to the installation of a system of wireless telegraphy on the roof of the new Admiralty buildings, Spring Gardens, London, and we have since given an interesting photograph of the masts and wires. The *Daily Telegraph* states that these are being replaced in a permanent form on the three great towers overlooking the Horse Guards' Parade, in St. James' Park.

In this connection (says the *Telegraph*) it is interesting to recall the fact that during the great Napoleonic war there was fixed on the top of the old Admiralty buildings in Whitehall a semaphore or telegraph, by means of which on a fine day messages could be sent in an hour to Portsmouth and one or two other stations. The semaphore was first adopted by the British Government in 1795 and remained in use until the late forties. Some of the older generation of Londoners will remember the lofty building known as "Watson's telegraph to the Downs," which was established in 1842 in the neighbourhood of Tooley-street, for the purpose of connecting London and Deal with the semaphore telegraph. This station was entirely destroyed by a disastrous fire in 1843.

THE DESIGN OF UNDERGROUND MAINS AND NETWORKS.*

BY J. R. DICK, B.Sc.

Summary.- The author considers the general design of a low-tension network. Having determined the probable positions and amounts of the loads, the sections of conductors are selected in accordance with temperature and pressure drop limits. Stepping of distributor cables is not necessarily advantageous. Elasticity of networks: In designing the feeder system certain methods, here given, for the composition and resolution of currents taken from distributors are useful. Graphical methods are considered, and a law for determining the best feeder areas.

The design of a low tension distribution system to supply a large area is, in this country at least, usually considered to be a problem best solved by methods based on experience. The preference for empirical rules is, no doubt, due in great measure to the feeling that the uncertain data at the disposal of the engineer hardly justify an attempt at an exact mathematical solution.

For example, it is possible to calculate the sizes of the mains when the undertaking is first established or at any given stage in its history, but in the course of a year or two the character and amount of the loads in different districts may vary to such an extent as to practically nullify the value of the results. This inherent uncertainty is probably responsible for the safe but unenterprising rule, frequently quoted in the early days, to put down "plenty of copper" to allow for unforeseen developments. It is somewhat of a reproach to distributing engineers that the parts of a network are not considered as carefully as the members of a steel bridge truss, although some of the data for calculating the latter suffer from a corresponding lack of definiteness. More progress might, however, be made towards remedying this state of things.

Some writers on the subject have not hesitated to say that the most that can be done is to choose the dimensions of the distributing mains with a margin liberal enough for any future loads, and to make provision for increasing the sections of the feeders or adding to their number as the necessity arises.

Even within these limitations there are some cardinal principles which must be more or less consciously applied by the practical designer. Furthermore, it is frequently most important in the routine of the station management to know what is happening at different points of the network, and to ascertain this the application of these principles is essential.

To determine the numerical values of the current and voltage at any point of each individual cable is a tedious but not really a difficult matter. Several practical methods are available, all of which finally result in obtaining n simultaneous equations if there are n meshes in the network under investigation. The solution of these gives the voltages at every point, from which the currents can be calculated or vice versâ. Before entering into details of the analyses usually adopted, it is advisable to review briefly the scope of the procedure in general.

The outlines of the network in the case of underground distribution (but not necessarily with overhead mains) are fixed initially by the plan of the principal streets. The unknown quantities to be determined are the sizes of the distributor cables and the number size and position of the feeders, in order to ensure that the pressure at any consumer's terminals may not vary beyond certain limits. Where incandescent lamps preponderate this condition is a *sine quâ non*, but where the current is used chiefly for motive power the same importance is not attached to pressure variations and the calculation of the cable sizes may rest on a different basis. There is one criterion affecting the reliability of the supply to which reference has constantly to be made—that is, to keep the maximum current densities low enough to prevent undue heating of the cable. Another principle not to be overlooked is that of efficiency. This implies the determination of the size of the conductors to satisfy the technical requirements just given while keeping the capital cost and annual charges against the system at a minimum. Bearing in mind these three essentials of (1) pressure regulation, (2) temperature rise, (3) efficiency, the development of the design would be somewhat as follows.

The consumers' loads must in the first instance be estimated. They vary in amount with the industrial character of the town, but from the experience now available in all kinds of towns the number of consumers and their demands can be assumed with considerable accuracy in any street.

Having considered the class of house and the probable number of lamps to be connected ultimately, the best plan is to express this as a uniformly distributed load in amperes per yard of main. In reckoning the load in amperes for a lighting system the 8 c.p. 28 watt lamp has hitherto been taken as the unit.

This allows an enormous margin for improvements in efficiency due to the extended use of metallic filament lamps, and for a network being laid down to-day due consideration should be given to them. It is interesting to note that in recent years the changes in methods of distribution, such as the introduction of the three-wire system, doubling the pressure, and the use of high efficiency lamps, have virtually increased the capacity of the mains many times, thus concealing errors due to want of foresight in the original design and postponing the period when the addition of copper becomes imperative.

Besides the uniformly distributed load thus assumed, allowance will have to be made at the proper points for specially heavy loads, such as hotels, factories, office blocks, &c. The figures so obtained are, moreover, liable to be vitiated at a later date by the erection of a business block or hotel displacing old property, but the cross-sections will not have been calculated to such a nicety as to be incapable of dealing with extra demands of this kind.

When the positions and probable values of the loads are indicated on the map of the district the next logical step is to choose a site for the central station, which should be as nearly as possible in the centre of mean position of all the loads considered as masses. Unfortunately this desirable site (near the centre of the town) is usually more profitably occupied. The engineer has, besides, other considerations to weigh, which do not concern us here, and for our purpose we may assume that its position is fixed as favourably as possible for the load centres.

The outlines of the network and the position of the central station being given, the important question arises of how many feeders to employ, and where to connect them, so that the pressure may be maintained within the prescribed limits. To satisfy this requirement alone an endless number of arrangements could be made, but there is one which is theoretically the best, *i.e.*, when the total cost of the network and feeders together is a minimum. Obviously such a minimum is possible, for one broad alternative is to have numerous feeders with the network cables comparatively small, while the other is to have fewer feeders and the distributors much heavier. The fact that distributors and feeders are run at different current densities has also to be borne in mind.

It must be pointed out that minimum cost is not necessarily the same thing as minimum weight of copper, for to the latter has to be added the cost of its manufacture into cable and that of erection or laying. The mathematical determination of the number and position of feeders to give the most economical result (not merely the minimum weight of copper) is possible in certain simple cases, of which illustrations will be given later, but there is no general solution that would be applicable to ordinary working conditions. For the preliminary project all that can be premised is that the feeders should be run by the shortest routes to the natural load centres of the areas they are intended to supply. Owing to the lack of precise rules the initial positions may have to be considerably modified by the information obtained from a further study of the network.

The question of regulating the pressure at the feeding points simply and effectively has also an important influence on the selection of their positions. If it is impossible to have all the feeders of approximately the same length it is advisable to arrange that they fall into groups according to length so that

each group may be connected to a separate 'bus bar run at a voltage giving the proper value at the feeding point. In effect the procedure has to be one of trial and error, with the ultimate object of reducing the capital expenditure to the lowest possible point. The same principles are applicable to both the primary and secondary networks of high-tension systems with substations.

The next step in the design is to ascertain the total load and the drop in each branch cable, with the feeders in their assumed positions. A distributor fed from one end only presents no difficulty as its total load is at once given by adding all the consumers' loads. For distributors connecting two feeders it may be taken as a first approximation that each of the latter will supply current to a point midway to the next. This is called the "cutting point," as it is there that the current in the distributor changes its direction. It is there also that the drop in voltage is greatest. By adding all the loads in the cables between the cutting points and the feeding point the total current in each feeder is determined at once and from Kelvin's law of the most economical current density their sizes can be calculated. In dealing with the distributors the one governing condition is to make the maximum drop at full load between the feeder and the cutting point less than the amount permitted by the Board of Trade. The cable section employed is not that calculated, but preferably the standard size next larger.

After having determined the sizes of all the distributors and feeders to satisfy the technical and economic conditions it is necessary to compare the working current densities with the maximum values which are permissible without causing too great a rise in temperature. Although these vary somewhat according to the nature of the dielectric, mode of laying, &c., the figures given by the Institution of Electrical Engineers should not be exceeded. When all the cross-sections have been checked and altered where necessary, the result is a complete network of distributors and feeders each of which is approximately dimensioned. The next series of operations, a refinement which many engineers dispense with, is to regard the network with its loads as given, and to ascertain the actual voltage at every important point and the full-load current in every cable. This may lead to results diverging considerably from the assumptions on which the cross-sections were tentatively based, and alterations in the latter may have to be made. Theoretically any change of this kind will influence the whole system, but as the effect is negligible at points remote from the feeders immediately concerned it is unnecessary to go through the tedious process of re-determining the complete current and voltage distribution. (Teichmüller, *E.T.Z.*, 1901, No. 11.)

The basis of all the calculations has hitherto been taken to be the maximum possible load as far as it can be foretold. It is well known, however, that the actual maximum demand may only be 30 to 70 per cent. of this, especially if the diversity factor also be taken into account. Thus the loads originally calculated for the cables and consequently their cross-sections can be diminished by a ratio depending on the class of consumer and the character of the town. This ratio will obviously be different in the business and residential districts.

Although the supply to the whole of an authorised area may be provided for in the manner just described the complete network need not be laid down at once for in very few cases can the capital expenditure be afforded. It is more usual to let it gradually be evolved in accordance with the demands for current that arise in different districts, or a sufficient number of spare ducts or cable ways may be laid into which additional copper can be drawn at a later date. It is advisable, however, to work to a scheme for the entire network, so that as it develops naturally each part may be correctly proportioned for its ultimate duty. Otherwise the total cost is likely to be excessive or the voltage regulation unsatisfactory. It will be apparent from the general review of the methods adopted even before going into details that they are not susceptible of mathematical treatment to give a single best solution. When such exists it has to be found by a process of trial and error. In other words any network can be completely analysed by the application of Ohm's and Kirchoff's laws but there are no simple rules for constructing a network synthetically. Thus the designing is possibly as much of an art as a science, and experience may be able to decide upon an arrangement as good as that obtained from a laborious series of arithmetical operations, but a verification by the methods indicated is always most desirable.

In discussing the general problem of interconnected conductors supplying consuming devices the latter may be considered as resistances with or without back E.M.F., and can be completely dealt with by Kirchoff's laws. It is simpler, however, to take the current passing through a lamp or motor instead of its resistance, and to use other methods. The principles discussed here apply only to continuous currents or to non-inductive alternating circuits. The modifying effects of induction and capacity will be dealt with subsequently. Fortunately the voltage across the mains and the current through standard lamps can be assumed to be constant at any point of the longest distributor. This is due to the very condition intended to be safeguarded by the calculations, viz., the restriction of the pressure variation within the limits of $2\frac{1}{2}$ to 3 per cent Thus the actual voltage at the furthest point cannot differ more than 3 per cent. from the normal, and this applies also to the current. Consequently the drop obtained by assuming the same voltage along the whole length of the distributor cannot be subject to a greater error than 3 per cent.

The simple case of a distributor fed at one end only is frequently met with in the outlying parts of a network, and the voltage drop at the farthest point is determined as follows :—

c_n = current taken by any consumer, and

r_n = the resistance between any two consumers (Fig. 1).

The total drop

$$v = c_1 r_1 + c_2(r_1 + r_2) + c_3(r_1 + r_2 + r_3) \dots + c_n(r_1 \dots r_n),$$

which is simply the sum of the drops due to each load reckoned from the point of supply F or what may be called the moments

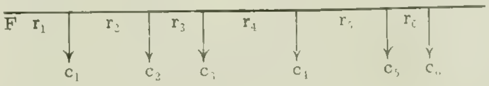


FIG. 1.

of the currents about that point. If the loads are all equal and equidistant $v = cr + c\,.\,2r + c\,.\,3r + \dots c\,.\,nr$, and the total drop is the sum of this arithmetical progression,

$$v = cr\frac{n}{2}(1+n),$$

or when n is large

$$= cr\frac{n^2}{2}.$$

If the current is taken off the mains regularly at short distances we can treat the load as equivalent to an uniform one of C_0 amperes per unit length, therefore any $c = C_0\frac{L}{n}$. Further, if the main be of uniform cross-section and total resistance R, for any of the n elements,

$$r = \frac{R}{n},$$

$$v = \frac{C_0 L}{n}\,.\,\frac{R}{n}\,.\,\frac{n^2}{2} = \tfrac{1}{2}C_0\,.\,L.R.$$

Since C_0L is the total current the drop at the far end is that due to the whole load acting at half the distance from F. If the distributor is considered as a cantilever and the currents replaced by weights the analogy between the drop and the bending moment will be at once apparent. The similarity of the two problems is useful in some cases which have to be dealt with graphically, but in practice graphic methods have little advantage over the arithmetical, except where the object aimed at is to find a minimum value so that a certain best result is achieved.

If the cross-section of the main is S the resistance R = L/SK where K is a constant depending on the specific conductivity. With L in yards and S in square inches, which are the most convenient British units, K = 40,000 approximately for copper.

The expression for the drop in an uniformly loaded distributor $v = \frac{1}{2} . C . LR$ becomes by this substitution

$$v = \frac{1}{2} \cdot \frac{C_0L^2}{S . K}$$

or

$$S = \frac{1}{2}\frac{C_0L^2}{v . K},$$

which enables the cross-section to be calculated when the value of v is given, as is usually the case. If, in addition to the uniform load C_0 in amperes per yard run, there are some exceptionally large consumers, whose loads are C_1, C_2, C_3, &c., at distances l_1, l_2, l_3, the total drop is then

$$v = \frac{1}{2} \cdot \frac{C_0L^2}{S . K} + \frac{C_1l_1 + C_2l_2 + C_3l_3 \dots C_nl_n}{S . K}$$

$$= \frac{1}{2}\frac{C_0L^2}{SK} + \frac{\Sigma_n C_nl_n}{S . K}$$

and

$$S = \frac{1}{v . K} \cdot (\tfrac{1}{2}C_0L^2 + \Sigma_n C_nl_n).$$

These formulæ refer only to one conductor of a two-wire main, and if the drop is v for the positive and negative together

$$v = \frac{C_0L^2}{SK} \quad \text{and} \quad S = \frac{C_0L^2}{v . K}.$$

When the distributor joins two feeding points or forms an inter-connector of the network so that it is fed from both ends (Fig. 2) it is obvious at once that

F_1 P F_2

Fig. 2.

with the assumed simplification of uniform loading; P is the cutting point between F_1 and F_2, if the pressures are the same at each. Then F_1P and F_2P can be considered as conductors fed from one end only. If L is the distance F_1F_2 then

$$F_1P \text{ is } \tfrac{1}{2}L \text{ and } v = \frac{1}{2}\frac{C_0FP^2}{SK} = \frac{1}{8}\frac{C_0L^2}{S . K} \text{ and } S = \frac{1}{8}\frac{C_0L^2}{vK}.$$

Thus the maximum drop with the same cross-section and length of main fed from its two ends is only one quarter of that of a main fed at one end, or it could carry four times the load with the same drop. It does not follow, however, that these improvements could be realised, as the cross-section might fail to conform to the criterion of safe current density. The value of this near to the single feeding point would be

$$C_0L \div \frac{1}{2}\frac{C_0L^2}{vK} = \frac{2v . K}{L} \text{ amperes per square inch.}$$

With two feeders the value near the feeding point would be

$$\tfrac{1}{2}C_0L \div \frac{1}{8}\frac{C_0L^2}{v . K} = 4\frac{vK}{L}.$$

Thus the current density would be doubled, and if already at the maximum it would not be possible to have the area of the main one quarter of its former value when fed at each end if the current density were kept within its maximum limit. But if the drop v_1 were diminished to one half — *i.e.*, $v_1 = \frac{1}{2}v$,

$$S = \frac{1}{8}\frac{C_0L^2}{v_1 . K} = \frac{1}{4}\frac{C_0L^2}{vK},$$

and current density

$$= \tfrac{1}{2}C_0L \div \frac{1}{4}\frac{C_0L^2}{vK} = 2\frac{Kv}{L},$$

which is the same value as for the main fed at one end, and assumed to be running at its maximum current density before the second feeder was added. The same formula indicates that for short lengths of main the temperature rise and not the voltage drop may be the dominating factor in imposing a limit to the current density. Thus, if $v = 5$ volts (or $2\frac{1}{2}$ per cent. of 200 volts) and L = 100 yds. (or 200 forward and return),

$$\text{Current density} = \frac{2Kv}{L} = \frac{2 \times 40{,}000 \times 5}{200}$$

$$= 2{,}000 \text{ amperes per square inch.}$$

This being inadmissible the voltage drop would have to be reduced to about $1\frac{1}{4}$ per cent. instead of $2\frac{1}{2}$ per cent. in that length of main, which would bring the value to approximately 1,000 amperes per square inch, a safe figure for the usual size of distributor. The principle of securing an economy in copper is exemplified in the comparison just given of the cross-section of distributors fed at one or both ends respectively. A little consideration will show that, under the conditions of a limiting drop with an uniform load, the area of the conductor should, theoretically, not be the same throughout, but that it should be stepped in accordance with the load at each point.

The law on which the stepping is based is derived as follows:—

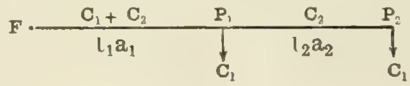


Fig. 3.

FP_2 (Fig. 3) is a main fed from F supplying currents C_1 and C_2 at P_1 and P_2 so that the total drop to P_2 is V. The problem is to ascertain how this total drop is to be divided between the two lengths so that the volume of copper employed is a minimum.

The cross-section in $FP_1 = a_1 = \frac{(C_1 + C_2)l_1}{KV_1}$,

and in $P_1P_2 = a_2 = \frac{C_2l_2}{K(V - V_1)}$.

The volume of copper is $= M = l_1a_1 + l_2a_2$,

$$M = \frac{(C_1 + C_2)l_1^2}{KV_1} + \frac{C_2l_2^2}{K(V - V_1)}$$

Differentiating with respect to the variable V_1, and equating to 0 to obtain the minimum value,

$$-\frac{(C_1 + C_2)l_1}{KV_1^2} + \frac{C_2l_2^2}{K(V - V_1)^2} = 0,$$

$$\frac{V_1^2}{(V - V_1)^2} = \frac{l_1^2(C_1 + C_2)}{l_2^2 . C_2}.$$

$$\frac{V_1}{V - V_1} = \frac{l_1\sqrt{C_1 + C_2}}{l_2\sqrt{C_2}}.$$

and as $V_1 = \frac{(C_1 + C_2)l_1}{a_1K}$ and $V - V_1 = \frac{C_2l_2}{a_2K}$,

by substitution we obtain

$$\frac{a_1}{a_2} = \frac{\sqrt{C_1 + C_2}}{\sqrt{C_2}}.$$

From this formula it is apparent that the main should be stepped so that the cross-section of each part is proportional to the square root of the current it carries. One case of some interest is that in which the current supplied by the distributor is tapped off at a uniform rate per yard run.

If FP (Fig. 4) is fed from F as before and is of length L the section a carrying current C,

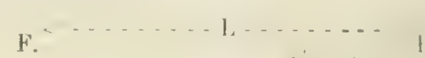


Fig. 4.

at any point X at distance l from P is given by $a/a_1 = \sqrt{C}/\sqrt{C_1}$ where a_1 and C_1 are the cross-section and current at F. But $C = cl$ and $C_1 = cL$, where c is the load in amperes per yard run and $C = \frac{C_1}{L} . l$, and $a = a_1\frac{\sqrt{l}}{\sqrt{L}}$. The drop at any point X at a distance l from P is

$$dv = C . \frac{dl}{Ka} = \frac{C_1}{LKa} . l . dl.$$

Substituting $a = a_1\frac{\sqrt{l}}{\sqrt{L}}$, $\int dv = \int \frac{C_1}{L^{\frac{1}{2}}Ka_1} . l^{\frac{1}{2}}dl$,

and integrating $v = \frac{2}{3} . \frac{C_1}{L^{\frac{1}{2}}Ka_1} . l^{\frac{3}{2}} + B$.

when $l = L$, $v = 0$ ∴ $B = -\frac{2}{3}\frac{C_1L}{Ka_1}$

and v at any point $= \frac{2}{3}\frac{C_1}{Ka_1}\left(L - \frac{l^{\frac{3}{2}}}{L^{\frac{1}{2}}}\right)$,

when $l=0$, $$v_0 = \frac{2}{3}\frac{C_1L}{Ka_1},$$
which is the total drop from F to P, and
$$a_1 = \frac{2}{3}\frac{C_1L}{Kv_0}$$
is the cross-section at F.

When v_0 is stated, as is usual, the volume of copper is found thus,
$$\text{Volume M} = \int_0^L a \,.\, dl$$
$$= \int_0^L \tfrac{2}{3} \cdot \frac{C_1L^{\frac{1}{2}}}{Kv_0} \,.\, l^{\frac{1}{2}} \,.\, dl$$
$$= \tfrac{4}{9} \cdot \frac{C_1L^2}{Kv_0},$$
or, as $C = cL$ $$= \tfrac{4}{9} \cdot \frac{cL^3}{Kv_0}.$$
From the former investigation of a conduc or of uniform section supplying a uniformly distributed load it was found that
$$a = \tfrac{1}{2}\frac{cL^2}{Kv_0},$$
and volume of copper is therefore
$$= \tfrac{1}{2}\frac{cL^3}{Kv_0}.$$

Thus the saving in copper is only $\frac{1}{2}-\frac{4}{9}$, or about 11 per cent. If the load were distributed unequally and mostly at the far end the saving would be less, but if its "centre of gravity" lay nearer the feeding point than half way the saving would be proportionately more. If the length is so short that current density must be considered in selecting the size of conductor, some advantage lies with the stepped design just obtained.

Thus the current density at F is
$$cL \div \tfrac{2}{3} \cdot \frac{cL^2}{Kv_0} = \tfrac{3}{2} \cdot \frac{Kv_0}{L},$$
whereas in the uniform conductor we have already found it to be $2Kv_0/L$. Obviously this is due to the greater volume of metal being placed near the feeding point, and graphically the relations of the two conductors are represented in Fig. 5.

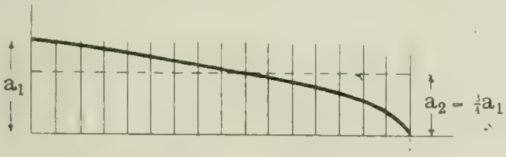


Fig 5.

Equation of the parabola is,
$$a = a_1\frac{\sqrt{l}}{\sqrt{L}} \text{ (Fig. 5).}$$

It may be observed that there is no saving in copper by tapering the conductor uniformly from F to P. At any point of such a conducto:
$$C = C_1\frac{l}{L}, \quad \text{and} \quad a = a_1\frac{l}{L},$$
$$dv = -\frac{C}{Ka} \,.\, dl,$$
$$dv = -\frac{C_1}{Ka_1} \,.\, dl,$$
from which
$$v = \frac{C_1L}{Ka_1} - \frac{C_1l}{Ka_1}.$$
Cross-section at feeding point $= a_1 = \dfrac{C_1L}{Kv_0}$, varying down to 0, giving an average of $\frac{1}{2}\frac{C_1L}{Kv_0}$. With an uniform conductor the section was $\frac{1}{2}\frac{C_1L}{Kv_0}$, therefore the volume of copper is the same. Thus there is no advantage with the conical conductor, except an equalising of the current density.

It is unnecessary to consider efficiency of running or minimising the C^2R losses in this investigation as the one controlling condition is that v_0 shall not exceed a certain maximum.

(*To be continued.*)

RECENT ADVANCES IN STEAM TURBINES.*

BY GERALD STONEY, B.E.

Summary. The author first describes the development of continuous current turbo-generators, with special reference to commutating poles and compensating winding, passing on to consider turbo-alternators. He then refers to recent developments in exhaust steam turbines and finally describes the progress made in the use of steam turbines for marine work.

Two years ago I had the privilege of reading a Paper on "Steam Turbines" before this section at the York meeting, but in view of the very rapid development of the steam turbine, both on land and for marine propulsion, it may possibly be excused if the same subject is once more brought before you. On land the progress of the steam turbine is to be seen in all directions, and one thing which is especially remarkable is the rapid increase in size. Eight years ago the largest one made, which was considered an immense machine at the time, was for only 1,000 kw., and now there are large numbers ranging from 5,000 kw. to 8,000 kw. running and under construction.

Steam turbines of large size may be roughly divided into two classes, as the Laval turbine with a single reaction wheel requires gearing and is impracticable for large sizes. These two classes comprise, firstly, the Parsons turbine, in which there is both action and reaction, and the expansion takes place equally in the moving and fixed blades, and secondly, those in which the whole of the expansion takes place in the fixed blades, the velocity of the steam being taken up without expansion by the moving blades. This latter class can then be sub-divided into those in which at each stage there is only a single row of moving blades as in the Rateau and Zoelly turbines, or one in which there are several rows of moving and fixed blades in each stage, which take up the velocity without any additional expansion, as in the Curtis. There are again various combinations, consisting of mixtures of one or more classes, but none of these have as yet been manufactured to any large extent. The oldest type, and one which is more in use than any other, is the Parsons, but in America the Curtis has been manufactured in large numbers, and on the Continent the Zoelly, Rateau and A. E. G., although both in America and on the Continent the Parsons has taken a leading position.

Hand in hand with the development of the steam turbine has gone the development of the various machinery to be driven by it, and in this direction electrical machinery has been prominent. For many years continuous current turbo-dynamos were looked at askance by engineers on account of commutation troubles, for it is easy to see that the ordinary constants applicable to slow speed dynamos to secure sparkless commutation are far exceeded when the speed is raised to that of turbine-driven dynamos. On this account it was early seen that some sort of compensating winding to improve the commutation and compensate for the reaction of the armature was necessary. Commutating poles alone have not proved satisfactory in practice, there being nearly always considerable difficulty in securing good commutation with them, and as a consequence commutating poles combined with compensating windings—the commutating poles giving the reactance voltage necessary for commutation and the compensating winding compensating for armature reaction—have been adopted by many firms. But even better commutation can be secured by a compensating winding alone, in which the ampere-turns of the compensating winding exceed the ampere-turns of the armature to such an extent as to give a commutating field in the gap between the pole-pieces.

Such compensating winding is generally chiefly concentrated on the pole-pieces, and is made with from 2 to 2½ times the number of ampere-turns of the armature, in order both to compensate for leakage and to give a good commutating field; and since this method of compensating has no iron commutating pole, it has the advantage that there is no self-induction to cause time lag at sudden changes of load, and, as the field of the gap between the poles is entirely in air, it instantly responds to changes of current in the compensating winding, and thus the sparking found when there is a sudden change of load with commutating poles is avoided, and the risk of a flash-over largely reduced. Also since there is no iron to become saturated, the commutating field is always strictly proportional to the load, and thus the trouble due to saturation causing sparking at some loads and not at others is avoided. This advantage is specially prominent where the dynamo is required to give varying voltages and to commutate at any of them without outside adjutsment of the compensating windings by diverters or otherwise. The adoption of these devices has made it possible to make turbo-dynamos of large size, and now as much as 1,500 kw. can be obtained from a single armature, whereas before such compensating devices were adopted 500 kw. was the maximum, and even then the commutation was anything but satisfactory.

* Paper read before Section G, British Association. Slightly abbreviated.

In turbo-alternators there is practically now—except for small sizes and low voltages—one standard pattern—that is, a revolving field rotating inside a stator. In the stator there is little variation in design, except in regard to the ventilating arrangements, which have to be very ample on account of the comparatively large quantity of heat to be removed from a small volume. One point which has received great attention in recent years is the staying of the end windings of such alternators, it having been found that, owing to their great length, when a "short" took place the stresses on the winding were such as to break the insulation and cause disaster. The amount of these forces has been vastly more than was ever anticipated, and if the windings are not thoroughly stayed, such movements may be set up as to cause disaster. In the rotors there are two prominent types, the barrel and the salient pole, and much discussion has ensued as to the advantages of the one or the other. After considerable experience of both, on the whole I may say that at present I prefer the salient pole type. Ample ventilation is much easier to provide for, and improvements made in protecting and supporting the field coils of this type of rotor have resulted in a design giving great reliability with the maximum use of the space available. One improvement has been enclosing every coil in a tight sheath of sheet steel, so that any movement which may take place due to centrifugal force is between the steel sheath and the body of the rotor, and thus the insulation is protected from any rubbing which might cause it to be cut through and consequently break down.

Voltage regulation of alternators is also of considerable importance, as owing to the inductive load required by induction motors there is a heavy demagnetising effect on the rotor, and consequent drop of voltage when the load rises. Several methods have been proposed for compounding alternators, most of them requiring a separate commutator or moving contacts altering the resistance of the exciter or main windings, but a method of compounding alternators has recently been brought out, which is being largely used with good results. In this apparatus the current supplied by the machine is made to act on the exciter field system in such a way as to reduce the leakage, artificially increased in the first instance, and so raise the voltage of the exciter, and increase the excitation of the alternator, so that any desired amount of compounding required can be obtained. This arrangement has been recently described in a Paper read before the Institution of Electrical Engineers.*

The other applications of the steam turbine, such as driving air compressors and pumping water, have also been largely extended during the last few years, and especially prominent in this direction has been the application of turbo blowers to blast furnace work, some having been recently installed for as much as 50,000 cubic ft. of air per minute at 10 to 15 lb. pressure. In this connection it may be mentioned that a very usual size, which is for about 20,000 cubic ft., weighs about 25 tons, and that an ordinary reciprocating blower of equal capacity weighs about 450 tons, or about 18 times as much as the turbo blower.

In many parts of the country reciprocating engines are running non-condensing, and it has now been found that the exhaust steam from them is of great value. Such exhaust steam cannot be practically utilised by reciprocating engines on account of the huge size and volume of the cylinders required, but it is quite otherwise with the steam turbine, where the large volumes of the low pressure steam are exactly what are required for the highest economy. This has led to the introduction of exhaust steam turbines, taking steam at atmospheric pressure and exhausting into a condenser. Considering that there is as much power in expanding steam from atmospheric pressure down to 27½ in. vacuum as there is from 150 lb. down to atmospheric pressure, it is easily seen that the power of a non-condensing plant can be doubled by the addition of an exhaust steam turbine and condenser, and in cases where there is not a supply of cooling water, improvements in cooling towers have enabled them to be put up both cheaply and well. In this connection the use of intermittent supplies of exhaust steam, such as that obtained from engines running intermittently, as in rolling mills or winding engines at collieries, has received a great impetus by the utilisation of thermal accumulators, in which the intermittent supply of steam is alternately condensed and re-evaporated, so that a constant flow is obtained for use in the exhaust steam turbine. And yet another refinement has been introduced by the use of mixed pressure turbines, in which there is a low pressure part sufficiently large to give full power when working with exhaust steam, and if the supply of this fails, a high pressure part is brought automatically into action using steam direct from the boilers, and thus there is economical running, whether the reciprocating engines supplying the exhaust steam are working or not.

In all turbines the question of vacuum is a very important one, and various improvements have been made in condensers to enable higher vacua to be obtained. The importance of this will be seen when it is remembered that in the average steam turbine 1 in. of vacuum is equivalent to from 4 per cent. to 5 per cent. of steam consumption, or in other words, it may be taken that for every 3°F. by which the temperature due to the vacuum is reduced, a gain in steam consumption of 1 per cent. is made. Increase of circulating water is very important. A very usual amount is about 30 times the weight of steam, but if this is increased to 45, the gain in consumption is 4 per cent., and if increased to 65 times a further gain of 2 per cent. is made. As a rule, extra circulating water can be pumped without much difficulty, the extra power required for this being very small, but generally the temperature of the inlet to the condenser is fixed by the supply of water available.

The great desirability, then, in a condenser is to obtain the temperature due to the vacuum as close as possible to that of the water leaving the condenser, as, of course, the maximum vacuum possible is that due to the temperature of this water. In ordinary condensers it is generally found that this difference amounts to 20°F—25°F., and among the various arrangements to reduce this may be mentioned dry air pumps, and also the arrangement of baffles and pumps in the "contraflo" condenser. But a method which has been very satisfactory in practice is what is called a "vacuum augmentor," which is simply a small jet of steam drawing the air and vapour from the condenser, and delivering it through a small auxiliary condenser to an ordinary air-pump, so that while there may be, say, a vacuum of only 27½ in. at the air pump, 28½ in. or 29 in. may be attained in the main condenser. Such an appliance is especially valuable when, as is often the case on board ships at sea, the system has considerable air leaks. With this arrangement the difference between the temperature of the water leaving the condenser and that due to the vacuum can be reduced to about 5°F. or 6°F., and this when condensing up to 12 lb. of steam per hour per square foot of condenser. As will be seen, this shows an economy in the turbine of some 6 per cent. in steam consumption above an ordinary condenser, and when it is remembered that the steam jet of the augmentor uses only about 0·6 of 1 per cent., or only one-tenth of the steam consumption gained, it is easy to see that a great benefit is derived from the use of such an arrangement.

In marine work, the development of the steam turbine also is very rapid. Two years ago the great express Cunarders "Lusitania" and "Mauretania" were only in process of construction, now they have proved themselves to be the fastest liners afloat, and it is pleasing to note that the turbines of these great ships have proved most satisfactory in service. It was a great step from the 8,000 H.P. of a cross-channel steamer, which was the largest that had been made at the time these boats were designed, to the 65,000 H.P. of these express Cunarders. It is interesting to note that the turbines proved themselves to be very economical, a consumption of 12·77 lb. per shaft horse-power having been attained as an average of the whole voyage across the Atlantic with about 150 lb. pressure at the entrance of the turbine, and a vacuum of 28·3 in. barometer 30 in. At present all cross-channel steamers in hand are being fitted with steam turbines; the whole of the ships in the Admiralty programme have also turbine engines.

Hitherto, the link supplied between the steam consumption in a marine engine, and the horse-power developed, which is represented by the indicated horse-power, has been missing in a turbine, but the introduction of the torsion meter, which measures the horse-power passing through a shaft by the amount of torsion caused, has supplied this missing link most satisfactorily.

It may be generally said that about 15 knots is the lowest speed of vessel at which the turbine can satisfactorily compete with the reciprocating engine as regards economy. The difficulty of the problem lies in the fact that at low speeds the screws have to be made to revolve slowly, and at the same time the horse-power required is moderate, and thus the turbines have to be very large and heavy, and besides this the blades are so short that the loss by leakage is excessive. These considerations have led to the combination of a reciprocating engine for the high-pressure part of the range, and a turbine for the low pressure part of the range, and it is anticipated that an extra economy of about 15 per cent. can be attained in this way. The advantages of such an arrangement were first pointed out by Mr. Parsons in 1894, but it has only recently been put into practice. It may be mentioned that eight years ago there were only 25,000 H.P. of marine turbines afloat; two years ago there were 800,000 H.P., and now there are over 1¾ millions completed and under construction.

In this short Paper I have endeavoured to give an idea of the exceedingly rapid progress of the steam turbine, and its applications. Whether in future the progress will be equally as rapid is difficult to say, but so far as can be seen at present there is no sign of saturation in the curve of progress.

* *The Electrician*, April 3, 1908, p. 944.

7,500 KW. TURBO-ALTERNATORS FOR BUENOS AYRES.

We are pleased to be able to give the following description of the generators, probably the largest so far built, which have recently been completed for the extensive new power station which the Compagnie Transatlantique Allemande d'Electricité are erecting in Buenos Ayres.

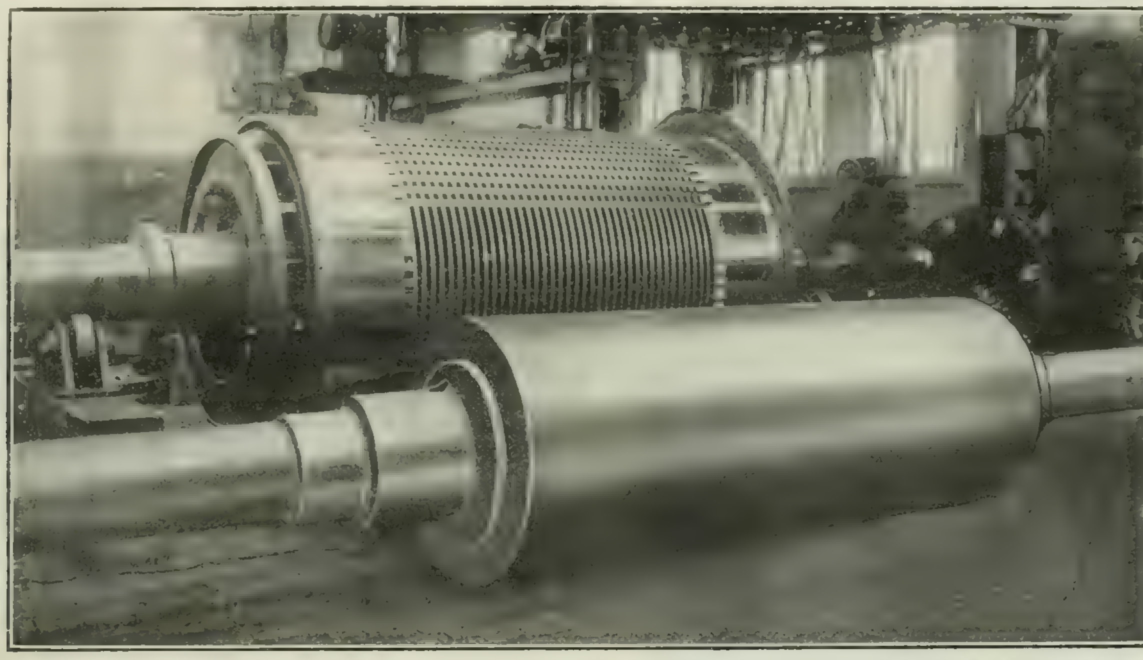


Fig. 1.—Rotor Construction of one of the Brown-Boveri Alternators for Buenos Ayres.

Five turbo-alternator sets of 7,500 kw. capacity each and two turbo-dynamo sets, each of 1,000 kw. capacity, have been ordered in Europe, the order for certain of the turbines and for the whole of the generators being placed with Messrs. Brown, Boveri & Co., of Baden. This order includes the supply of two 11,000 H.P. steam turbines, together with six 7,500 kw. alternators (two 50 cycle machines and four 25 cycle machines) and four 500 kw. dynamos. One of the turbo-alternator sets consists of a turbine driving both a 25 cycle and a 50 cycle alternator, each of 7,500 kw., which accounts for the extra machine, while a tandem arrangement for the continuous current sets was adopted on account of the direct current supply pressure, which is 230 volts. The speed of all the turbo-alternators is 750 revs. per min., and the pressure at the terminals of the alternators 12,500 volts.

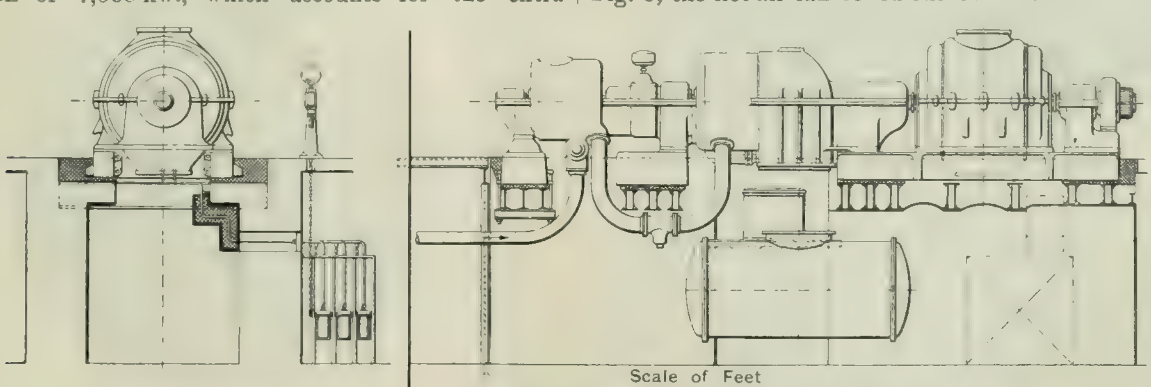


Fig. 2.—General Arrangement of 7,500 kw. Three-phase Turbo-Alternator for Buenos Ayres.

Scale 1 : 200.

The 7,500 kw. alternators follow very closely the general design of standard Brown-Boveri machines of this type, a detailed description of which appeared in the issues of *The Electrician* for September 20 and 27, 1907. The field magnets are constructed on Mr. C. E. L. Brown's "cylindrical" system, with regard to the advantages of which it will suffice to say here that it allows of an exceedingly solid and mechanical construction of the rotor and one which permits of thorough ventilation and perfect and permanent balancing being obtained. In this construction the rotor is built up of steel plates carried upon a centre hub of forged steel, and in slots provided in the outer periphery of these steel plates the field coils are placed and held therein by means of metal wedges. An air space is provided between each core plate, and the whole structure is thoroughly and uniformly ventilated by means of cool air drawn in from the outside by fans placed at each end of the rotor body. These fans and the general character of the rotor construction can be plainly seen from Fig. 1 herewith.

The armature for these large machines is built in two parts, as shown in Fig. 3, and perhaps the most striking feature in the design is the great care which has been taken to secure the coils in the slots and at their ends against possible movement due to heavy short circuits. As may be noticed from Fig. 3, the hot air can be led out from the machine either from the top or bottom, as may best suit the local conditions, having regard to the very considerable amount of energy that is necessarily dissipated in heat when a number of such large machines are working together in the same engine room.

The whole design is totally enclosed, with the exception of one of the chimney-shaped openings in the stator and the air inlet at each end. This total enclosure, taken in conjunction with the perfect and permanent balance readily attainable with the Brown-Boveri cylindrical construction of the field system, enables the machines to work with a quite negligible

amount of noise, as the hot air can get away without any throttling through the large opening provided for the purpose, while the course of the air currents in the machine itself is so arranged that while they produce a maximum of cooling effect, the resistance in the air passages is reduced to a minimum.

The weight of a complete alternator as above described, with shaft, but exclusive of bearings and bedplate, is 73·4 tons, the weight of the stator being about 48·1 tons and the weight of the rotor 25·3 tons.

Of the 11,000 H.P. turbines to which these alternators are coupled, as already stated, two are being made in Baden, while the remaining three have been, or are being, made by Messrs. Franco Tosi, of Legnano, on the Brown-Boveri-Parsons system, and we give a diagram showing the general arrangement of one of the complete turbo-alternators in Fig. 2. The actual rating of the turbines is 11,000 B.H.P., but they are capable of developing 14,200 H.P. for at least two hours under normal steam conditions, which are a steam pressure of 180 lb. per square inch and a steam temperature of 572°F. The large size of the turbine made it necessary to adopt a two-cylinder design

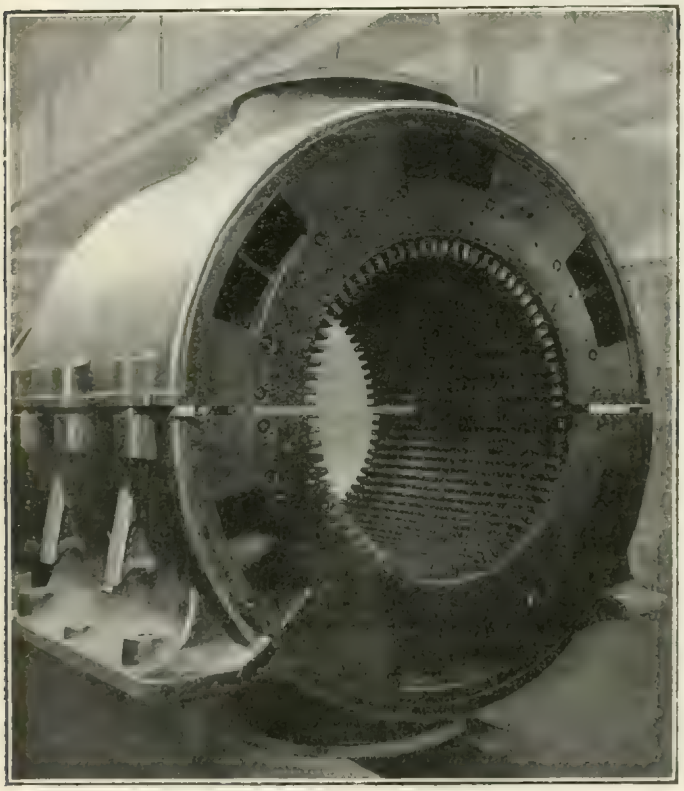


FIG. 3.—ARMATURE OF 7,500 KW. THREE-PHASE TURBO-ALTERNATOR.

with a bearing between the cylinders, and this construction offers important advantages in other ways when—as in this case—superheated steam is used. In the high-pressure cylinder of the turbine the steel drum is forged in one piece and shrunk directly on to the shaft, while at the low pressure side a cast steel ring is inserted between drum body and shaft.

The weight of each 7,500 kw. turbo-alternator, complete with surface condenser, is 375 tons, and the steam consumption at full load amounts to 13·86 lb. per kilowatt-hour.

In accordance with Messrs. Brown, Boveri & Co.'s latest practice, oil relays, instead of steam relays, are used for the operation of the admission valves of these turbines, the great advantage of these being that not only is more sensitive governing readily obtainable, but the action of the relay is independent of variations of the steam pressure, while, as the oil for the relay is supplied by the small oil pump, which also supplies the oil for the bearings at starting up and at low speeds, the turbine cannot be started at all unless the oil for lubrication is already circulating through the bearings.

We are indebted to Messrs. Brown, Boveri & Co. for the above particulars of these machines.

WIRELESS TELEPHONY.*

BY REGINALD A. FESSENDEN.

(*Continued from page 788.*)

Summary.—The author first gives a brief history of the development of wireless signalling, proceeding to describe the method and apparatus used in wireless telephony. He also discusses its possibilities and how its development has been retarded.

E. METHODS AND APPARATUS.

1. *Methods and Apparatus for Producing the Electromagnetic Waves.*—These have been already referred to. A rotating spark-gap, giving approximately 20,000 discharges per second, was connected to a 5,000 volt source of direct current. The terminals were of 40 per cent. platinum iridium. In operation the apparatus is arranged to charge a condenser to a definite potential and discharge it.

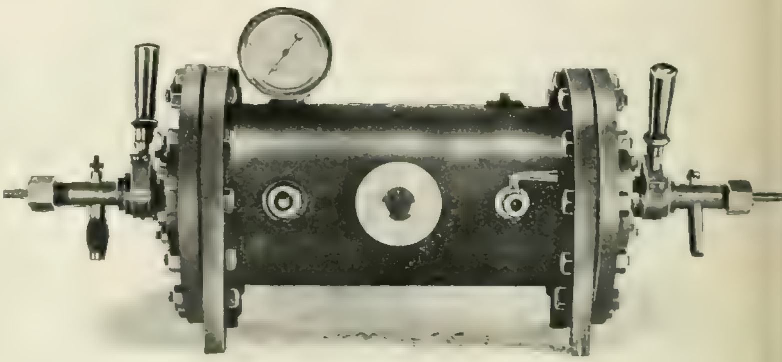


FIG. 2.—NATIONAL ELECTRIC SIGNALLING CO.'S ARC APPARATUS.

Fig. 2 shows a form of apparatus for operating the arc in a gas under pressure. The apparatus is also used for the arc in vacuum and the critical distance arc. Fig. 3 shows a field disc, 12 in. in diameter and with 300 slots on it. There are 600 armature slots, each containing two turns of 13 mil wire. The field current is 5 amperes. The resistance of the armature is 6 ohms; it gives 160 volts and about 7 or 8 amperes. Other armatures have been constructed having a resistance of 4 ohms. For some work double armatures are used giving about 270 volts. The output of the single armature machines at 81,700 cycles is approximately 1 kw. The output of the double armature machine is approximately 2 kw.

Other types of high-frequency alternators are under construction. One type, shown in Fig. 4, is designed for use on shipboard. The

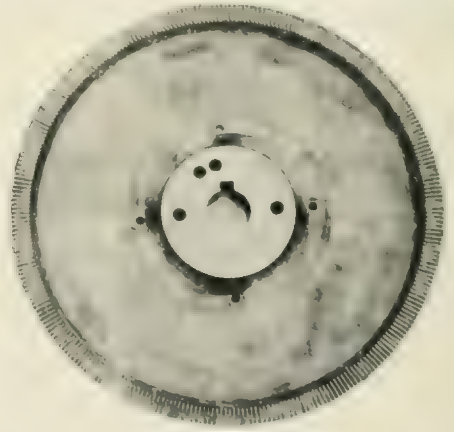


FIG. 3. FIELD DISC.

armature disc is 6 in. in diameter and two armatures are used. It is arranged to be mounted on gimbals and to be driven by a steam turbine connected to the steam pipe by flexible armoured steam hose. The frequency is about 100,000 and the output about 3 kw. Another type, now being constructed by Mr. Alexanderson, to whose efforts the success of this type of generator is largely due, is designed to have an output of 10 kw. Designs have been made for a generator of still larger size with a calculated output of 50 kw. and a frequency of 50,000. This machine is intended for trans-Atlantic work. For some of these machines, instead of driving by gear or

* Abstract of a Paper presented at the 25th annual Convention of the American Institute of Electrical Engineers, June-July, 1908.

steam turbine, a special two-cycle motor has been devised, to operate at a frequency of 500 cycles per second.

The high-frequency alternator method is believed to possess a number of advantages over other methods, inasmuch as it is set in operation by merely opening a steam valve and has no complicated electrical apparatus or circuits of any kind. The speed is regulated by the steam pressure, this being accomplished by an electrically operated reducing valve. For measuring the frequency various speed indicators have been tried, but it has been found that the best way is to use a resonant circuit with an ammeter, this being an extremely sensitive means of indicating the frequency and in addition affording a means of automatically keeping the speed constant to a small fraction. The reducing valve is adjusted so that if left to itself the machine will run slightly above normal speed. As soon as it reaches one-tenth of 1 per cent. higher than its designed speed the resonance begins to fall and a contact is opened which slightly throttles the steam. In this way the frequency is kept varying between the limits of one-tenth of 1 per cent. above speed, and one-tenth of 1 per

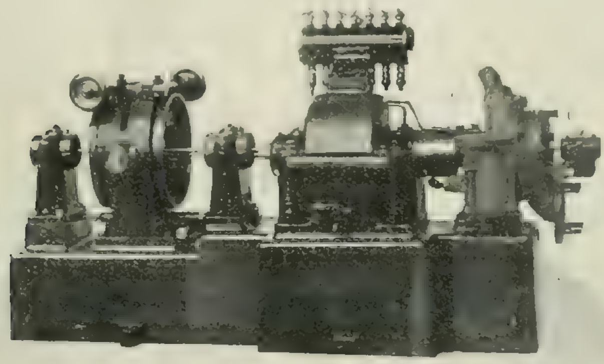


Fig. 4.—High Frequency Alternator.

cent. below speed. Where the drive is electric instead of by turbine, a storage battery is used to drive the two-phase generator and even better results may be obtained as regards regulation than with steam.

2. *Transmitters.*—The types of transmitters most commonly used are the carbon transmitter and static transmitter, and the

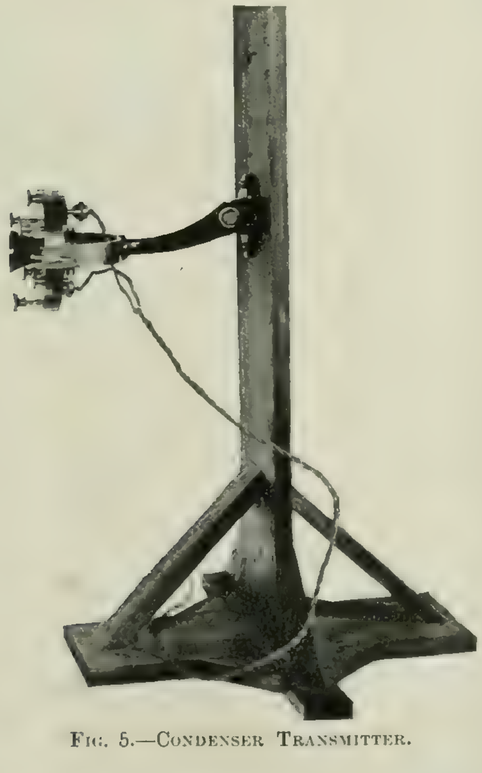


Fig. 5.—Condenser Transmitter.

carbon transmitter relay. It was found that the ordinary carbon transmitter was unsuited for wireless telephone work on account of its inability to handle large amounts of power. A new type of transmitter was therefore designed which the writer has called the "trough" transmitter. It consists of a soapstone annulus to which are clamped two plates with platinum iridium electrodes. Through a hole in the centre of one plate passes a rod, attached at one end to a

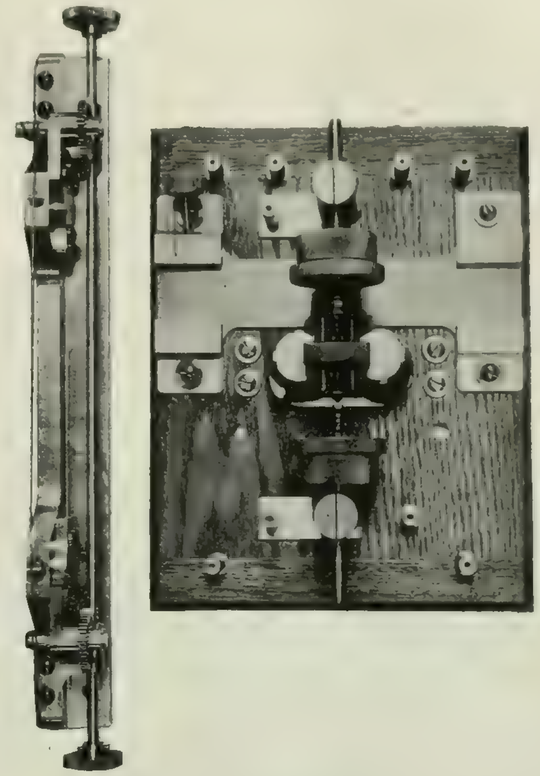


Fig. 6.—Transmitting Relay.

diaphragm and at the other to a platinum iridium spade. The two outside electrodes are water-jacketed. This transmitter requires no adjusting. All that is necessary is to place a teaspoonful of carbon granules in the central space. It is able to carry as much as 15 amperes continuously without the articulation falling off appreciably. It has the advantage that it never packs. The reason for this appears to

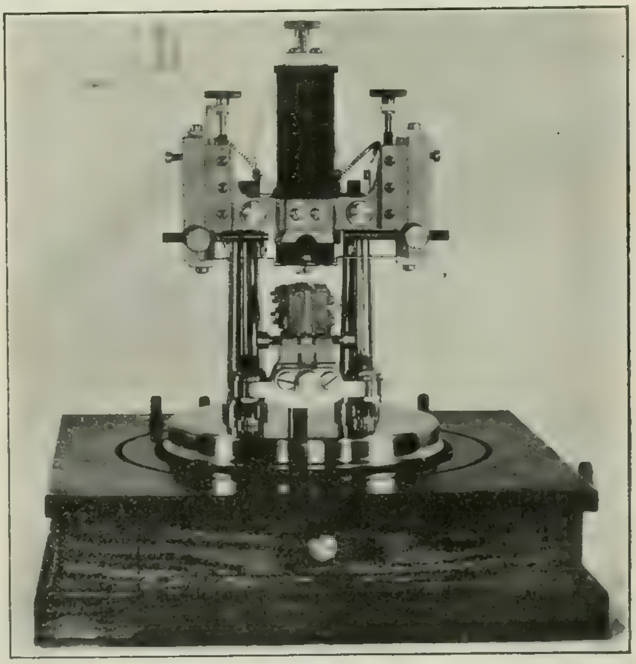


Fig. 7.—"Trough" Relay.

be that when the carbon on one side heats and expands the electrode is pushed over against the carbon on the other side. These transmitters have handled amounts of energy up to one-half horse power, and under these circumstances give remarkably clear and perfect articula-

tion and may be left in circuit for hours at a time. Fig. 5 shows a type of condenser transmitter in which the vibration of the diaphragm alters the electrical capacity of the transmitter, thus throwing the circuit in and out of tune or spilling more or less energy through a leakage circuit. Fig. 6 shows a transmitting relay for strong currents. The only thing noticeable about this is that the telephone magnet is a differential one. Fig. 7 shows a "trough" relay.

Other types of transmitting relays are employed for amplifying very feeble currents. It will readily be understood that where

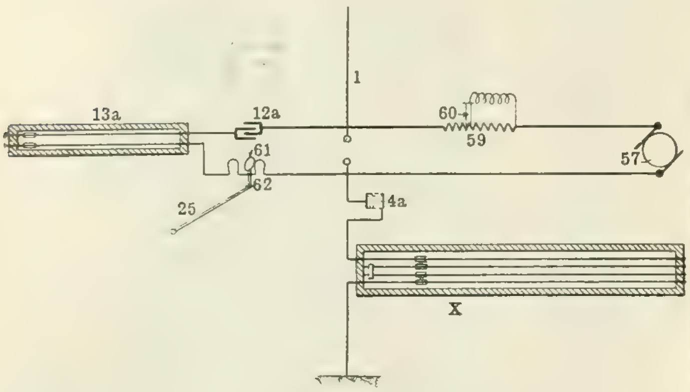


Fig. 8.

a person in Albany, for example, wishes to talk to another person on board a ship off New York, the wireless station being located near New York, the volume of the transmission received at New York will not be very strong, and while it may be possible to transmit it without amplification, amplification is advisable. The receiver of one of these amplifiers is a combination of the differential magnetic relay and the trough transmitter. An amplification of 15 times can be obtained without loss of distinctness. The side electrodes of the trough are water-jacketed. Successful amplification depends upon the use of strong forces and upon keeping the moment of inertia of the moving parts as small as possible. Amplification may also be obtained by mechanical means but as a rule this method introduces scratching noises which are very objectionable even though comparatively faint.

Other types of transmitters have also been used, such as liquid jet transmitters, operating by closing the air-gap in a magnetic circuit, and so changing the inductance of the oscillating circuit, &c.

Fig. 9.

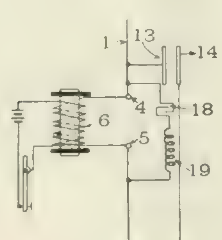


Fig. 10.

In a louder speaking telephone recorder employed, a small iron disc is placed opposite a nozzle through which air at high pressure is blown. As is well known, this causes the disc to be held close to the nozzle. The telephone magnets alter the position of the disc and thus produce very loud talking. The transmitting relays are connected in the wire line circuit in the same way as the regular telephone relay, except that in place of being inserted in the middle of the line they are placed in the wireless station and an artificial line is used for balancing. There is no difficulty met with on the wireless side of the apparatus, but on the wire line side there are the well known difficulties due to unbalancing which have not yet been entirely overcome. For the correction of these difficulties, therefore, we must look to the engineers of the wire telephone companies. At present the difficulties are, if anything, less than those met with in relaying on wire lines alone.

3. *Transmitting Circuits.*—Fig. 8[1] shows a type of arc circuit. Fig. 9[1] shows a suitable type of connection for use with a high frequency alternator. Fig. 10[2] shows a type of circuit for use with the condenser transmitter. Fig. 11[2] shows a type of circuit in which the modulation is accomplished by changing the inductance of one of the oscillating circuits. As a matter of fact the transmitter may be placed almost anywhere in the circuit between the arc or dynamo and the antenna, or between the arc or dynamo and earth, or in the transformer circuit, or in shunt to an inductance or capacity, the results obtained in all cases being indistinguishable. The sole criterion of success seems to be that the transmitter should be capable of handling the energy and the circuit should be properly adjusted. Some success has also been attained by placing the transmitter in the field of the dynamo[3] but this method requires very careful designing of the field circuit.

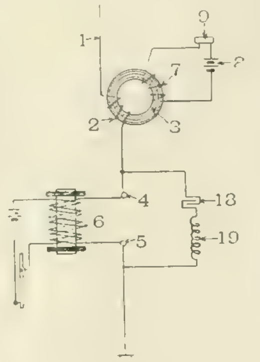


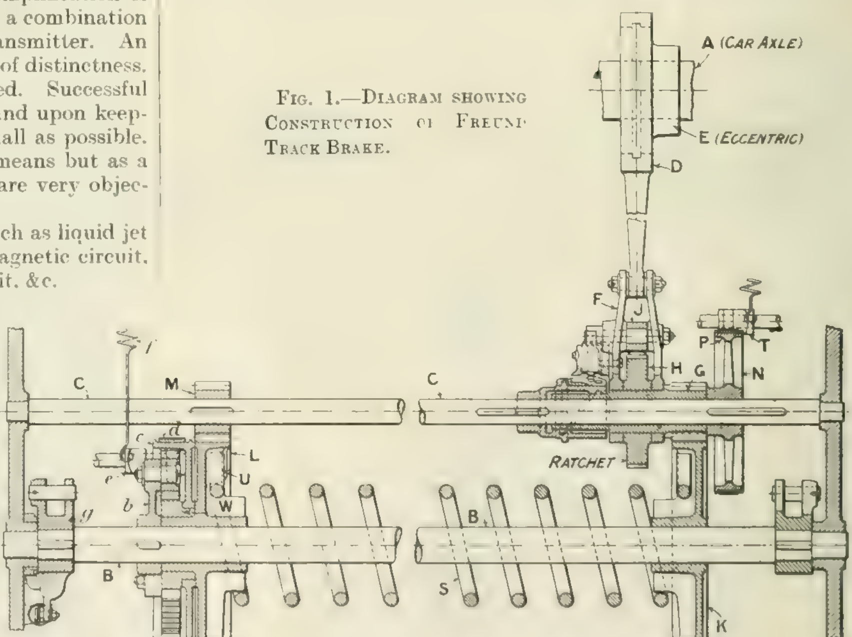
Fig. 11.

(*To be continued*).

THE FREUND AXLE-WOUND TRACK BRAKE.

The action of this brake, which has been designed and patented by Mr. E. Freund, depends on the energy stored in a coiled spring which is automatically kept at a given compression by an eccentric on the car axle. It will thus be seen that the force of application of the brake will at all times be identical and independent of the driver, who has merely to move a horizontal lever, fitted on a vertical

Fig. 1.—Diagram showing Construction of Freund Track Brake.



spindle on the car platform, to bring the car under control. It is suggested by the inventor that this movement of the lever should be performed by the driver with his body, thus leaving his hands free for the operation of the wheel brake and controller.

The following claims are made for the Freund axle-wound track brake:—(1) Simplicity and reliability. (2) Errors in handling impossible, as there is only one controlling lever, which has always to be handled in the same way. (3) Complete stops are as easily obtainable as speed regulation for coasting. (4) Highest braking effect combined with a minimum of work and responsibility for the motorman. (5) Track and wheel brakes are independent of each other, and neither hand nor foot of the motorman being engaged with the track brake, the wheel brake can be put on simultaneously with it. If one fails the other is already on and prevents serious consequences. (6) The brakes can be applied from any part of the car, and simultaneously from several points without causing any trouble. (7) The brake can

[1] U.S. patents Nos. 706,742 (1902) and 730,753 (1903).

[1] U.S. patents Nos. 706,742 (1902) and 730,753 (1903).

[2] U.S. patent No. 706,747 (1901). [3] U.S. patent No. 793,649 (1905).

be applied before a car enters a dangerous "down" grade. (8) The brakes are as suitable for service as for emergency purposes. (The driver gets, therefore, perfectly accustomed to the handling of the brake in service, and he has, in case of emergency, only to carry out an accustomed movement. This is an important point with regard to reliability.) (9) The most rapid stops can be effected without the least discomfort to passengers and without objectionable strains to the rolling stock. (10) The brakes come off as easily and as rapidly as they go on (a very great advantage when passing through dense traffic, and one that is absent with all "emergency" brakes). (11) The brakes are equally effective on ordinary rails, on special work (manganese steel specials), on "up" or "down" gradients and with derailed cars. (12) Skidding of the wheels is overcome. (13) Low first cost. (14) Maintainable by cheap labour, because, being composed of plain mechanical parts only, it does not require any service adjustments either on account of 2½ in. wear of brake blocks nor on account of 2 in. radial wear of tyres. (15) Easily inspected, and worn out parts rapidly replaceable. (16) All parts are under reduced strains while the brakes are in operation. Failure of parts would occur during rewinding, *i.e.*, when there is no danger. (17) Failure of any essential part would give unmistakeable and ample warning. (18) Motors are allowed to cool down while the cars are descending gradients, enabling smaller motors to be used with the Freund brake than with magnetic or electric brakes.

As mentioned above, the braking power is obtained from two or more helical springs which surround a rocking shaft carried across the truck, and which, turning one way, presses the brake blocks on to the rails, and turning the other, lifts them off the rails. The ends of the springs are housed in two gear wheels concentric with the rocking shaft, one of which is connected to it by a planet gear controlled by two band brakes on drums. When the springs are wound up they tend to turn the rocking shaft through the gears, in the direction to apply the brakes. Releasing one of the band brakes permits such application. The release of the other band brake allows a pull-off spring to rotate the shaft in the opposite direction, raising the blocks from the rails. In both operations the manual effort is confined to releasing the band brakes by a light pull on one or the other pull rod or cord. The springs are wound up by a connecting rod driven by an eccentric on one of the car axles, by means of a pawl and ratchet wheel geared into one of the wheels carrying the ends of the springs. The amount of the winding is limited by a threaded sleeve sliding on the ratchet wheel spindle, which lifts the pawl out of gear when the sleeve reaches a predetermined point. The movement of the sleeve is proportional to that of the springs, and it is moved to or from the disengaging point proportionately to the winding or unwinding of the springs. The movement is not unlike that of some steam steering gears, as applied to the shifting of the valve gear.

The spring is usually fully wound up while the car is travelling a distance of about 90 yds., and would be fully unwound after about four brake applications if it were not automatically rewound during such series of applications. The effective pressure on the brake blocks is stated to be about 4 tons.

From the accompanying diagram, Fig. 1, it will be seen that the whole apparatus is housed in the space enclosed on the right and left by the side frames of the truck and by the motors in front and the rear, and it occupies about 18 in of the truck length. The bearings of the cross brake shaft B and of the counter-shaft G are shown as parts of the side frames. This would, as a rule, not be the case. They would be housed in two shields bolted to the side frames, and this has the advantage of allowing the whole apparatus to be fitted up at the fitting shop and of fixing it very rapidly on the car. A is one of the axles of the car, E is an eccentric revolving with it, and D an eccentric strap and rod linked to the ratchet lever F, which is pivoted on the sleeve of pinion G. The latter is keyed to the ratchet wheel H and both are turned on shaft G when the axle A revolves, the pawl J being allowed to engage with H; G is, under these circumstances, turned anti-clockwise. The wheel K with which G meshes turns, therefore, clockwise. The wheel L is, as a rule, prevented from turning on shaft B by pinion M, and the brake pulley N, both of which are keyed on C. The brake strap P is tightened by a spring, and prevents N from turning. The spring S, whose ends are firmly bedded between flanges on L and K is thus held fast on the left-hand side while it is being turned round with K on the right; thus a torsional strain is imparted to it. Provision is made for keeping the pawl J out of mesh with the ratchet wheel H when the torsional strain imparted to S has reached a certain amount. The energy stored in the spring S is made use of for braking purposes by releasing the brake pulley N. This may be done from either platform or any other part of the car by pulling the lever T. The spring S then turns the wheel U, and wheel W which is keyed to it, clockwise, and the star *b* on which the planet wheels are pivoted turns in the same direction; while wheel *c*, with which the three planet wheels also mesh, is held fast by the brake band *d*, controlled by lever *e* and spring *f*. As the star *b* is keyed upon the cross brake shaft B, the depression levers *g* are turned clockwise and the track blocks (not shown) are depressed. If the lever *e* is from any part of the car pulled to the left, the strap *d* is lifted and the wheel *c* following the strain exerted by the release springs turns clockwise, and the track blocks are lifted. This movement can be regulated by a special brake gap regulator which is fitted.

Tests, spread over four years, have shown that the springs are as little liable to fail as the springs which support locomotive boilers, &c. Moreover, failures would not take place when the brakes are put on, because the springs are released for this purpose, but when the latter are rewound, *i.e.*, at a moment when their failure would not matter.

A good idea of the mechanism and operation of the brake can be obtained from the view of the apparatus in Fig. 2.

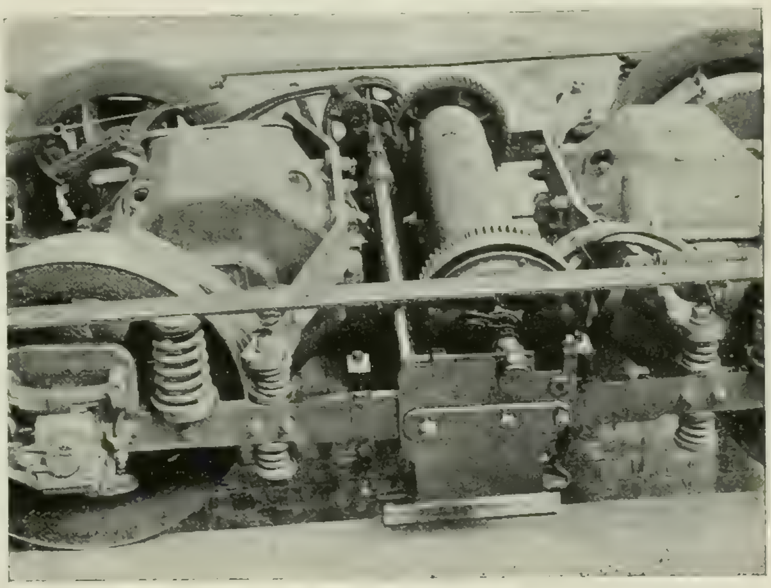


FIG. 2.—VIEW OF FREUND TRACK BRAKE.

A number of tests have been carried out on the Yorkshire Woollen District Tramways, and particulars of some recent ones are as follows:

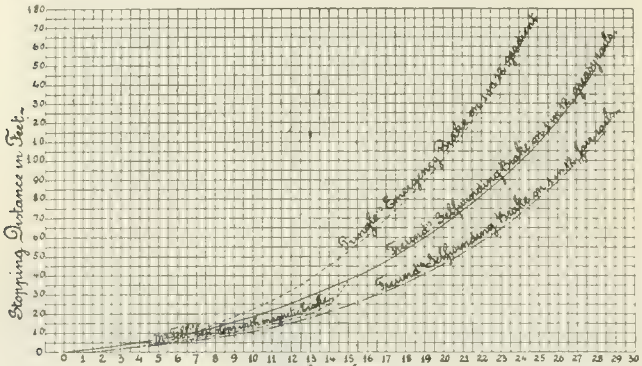
No.	Rail.	Blocks.	Speed. M.P.H.	Dist. to stop. Yds.	Gradient.	Brakes used.*
1	Dry	Wood	18	29	1 in 12	Track brake
2	,,	,,	22	36	to	,,
3	,,	,,	20	25	1 in 17	Track and
4	,,	,,	24	33	,,	hand brake
5	,,	,,	20	22	,,	together
6	Greasy,	,,	9½	4	Varied from	,,
7	rain fall-	,,	13	10	1 in 12 for	,,
8	ing at com-	,,	16	14½	most of dis-	,,
9	mencement	,,	20½	28	tance to 1 in	,,
10	,,	,,	22	30	17 at the end	,,
11	,,	,,	8	4	,,	Track only
12	,,	,,	12	14	,,	,,
13	,,	,,	19½	45	,,	,,
14	,,	,,	22	54	,,	,,

Mr. H. M. Sayers has made a number of tests of the brake upon a gradient varying from 1 in 12 to 1 in 25, at speeds varying from 8 to 22 miles per hour, and upon rails both dry and greasy, and in a report on the brakes says that the results of his tests show that the mechansim makes prompt and effective use of the available pressure and frictional coefficient of the blocks. In order to test the value of the winding of the springs during braking, he had some special tests made with repeated applications during the stopping intervals,

* Sand was used in tests 2 and 5 only.

which gave excellent results, showing a power, which is not possessed by any other brake within his knowledge, of reducing the stopping time and space in extreme cases. He also made some tests of the brake as a "coasting" brake, allowing the car to descend a steep gradient at a steady regulated speed. The result was again excellent, although the driver had no training in this particular use, and it showed that the car was kept under effective control without acceleration on long descents, the safety condition for working heavy hill routes.

He also states that the Freund brake answers excellently the purposes of a service brake, an emergency brake, and a hill or coasting brake; and as it does not interfere with the auxiliary use of the wheel brakes, and is not affected by the abuse of those brakes even to the



Comparison of stops effected with the latest type of magnetic brake (best stops on level road) with (average stops on 1 in 12 falling gradient) with The Pringle Emergency and The Freund Service and Emergency Brake.

FIG. 3.

skidding point, and as there is not any mutual interference between it and the electrical equipment, it is, in his opinion, a long step towards the ideal brake for tramway purposes.

In Fig. 3 are plotted the results of the tests made with the Freund track brake; and, for the sake of comparison, curves are also given for a magnetic track brake and Pringle's emergency skid brake obtained from published tests.

GENERAL URBAN AND INTERURBAN TRANSPORTATION AND RAILLESS ELECTRIC TRACTION.*

BY F. DOUGLAS FOX, M.A.

Summary.—The author first discusses the question whether rails should be adopted for urban transportation, and gives some interesting particulars concerning the cost of running petrol 'buses and electric 'buses with accumulators. He then describes the trackless trolley system as installed at Mulhausen, and passes on to consider existing British municipal tramways, showing how they are handicapped by heavy capital expenditure. A table of statistics regarding 71 tramways is given, and the author considers in detail the figures for income, capital expenditure per mile, route length factor, density of traffic, income per car-mile, working expenses, average fares, &c. In conclusion he hopes that transportation engineering will become more and more an exact science.

Present Conditions.—Except abroad it is rarely that the engineer has an opportunity of designing an original and complete transportation scheme for a town of large size. From the horse 'bus up to the tube railway there is almost always something already provided in the way of travelling facilities. Any new scheme of transport is usually designed either to extend some existing system or else to supersede it. The City horse 'bus first took over the urban duties of the old stage coach. Then the railway, after displacing the stage coach on the turnpike, entered also upon the city street in the form of the horse tram. Shortly afterwards the enclosed locomotive or "steam dummy" was put on the tramway in place of the horse. Then the underground railway circled and crossed the city in tunnel and tube. Electricity was then introduced, first to supply the motive power for the tramway and then for the underground railway. Then came the internal combustion and steam engine to propel the omnibus and relieve the horse of its duties. Finally electricity, by means of secondary batteries and the trackless trolley system, has also put in its claim for the last-named duty.

It is a curious fact, whether it be a sign of our conservatism or of the rapidity of the development of street traction, that almost every phase of the above evolution, from the stage coach upwards, can still be seen on some city streets to-day. The respective functions and the vehicles themselves are modified, but they are almost all in more or less evidence together. The scope of the following notes is limited to the discussion of transportation systems for the streets of towns of moderate size and by surface lines alone. The aim will be to show in detail the comparative economics of the tramway and the mechanical omnibus.

Rails or no Rails.—The question as to whether urban transportation on the surface is best accomplished with or without rails has yet to be solved by actual experience. The solution may demonstrate the superiority of one or the other, both from a technical and commercial standpoint, or it may prove the usefulness of each system in its own place.

The principal technical points to be considered are simplicity of mechanism, ample capacity, speed, power of rapid acceleration, comfort and convenience.

The commercial features are moderate capital expenditure and cost of operation, including ample depreciation.

On the one hand the cost of construction of electric tramways has been steadily mounting up. Even in its most economical form the cost of the permanent way exceeds that of some railways. In addition, the authorities in many cases demand an underground current supply, either in conduit or by the surface contact system. As will be shown later on, the analysis of the commercial results of corporation-owned tramways of the United Kingdom on the overhead trolley system, shows, as a whole, an unprofitable business.

The mechanical omnibus can be installed for less than half the cost of a tramway, but its working expenses are somewhat higher. When interest on capital is combined with working expenses and both together are reduced to cost per car-mile, it will be shown that there is not much margin of profit between the tramway and the petrol 'bus. If, however, the mechanical omnibus were no more than on a commercial parity with the tramway, it would, if there were still a clear field and no favour, be preferable on account of the lower capital expenditure.

This country has, however, committed itself heavily to the tramway system, having embarked capital in it to the extent of about 35 millions of municipal indebtedness, 10 millions of companies' obligations and 20 millions of preference and ordinary stock. In other words, the cream of urban traffic has already gone to the tramway. The motor omnibus cannot now displace its rival, but must look for its field with some exceptions either to the smaller towns or to suburban extensions of city tramways, or to foreign countries. Since the denser and more remunerative traffic is already dealt with, the motor omnibus should, in order to succeed in Great Britain, be able to pay with a lower revenue than the average of the tramways.

As to the technical features, on the one hand, a railway is an unnatural adjunct to a city street. On its own right of way it is unexceptionable, but in the midst of a public thoroughfare, it interferes with a dense, heterogeneous traffic, both during construction, operation and repair. On the other hand, the tramcar as at present designed is superior to the motor omnibus in comfort and capacity. The latter can handle an enormous traffic, it can travel quite as fast as is consistent with safety and in point of comfort has been lately greatly improved. It is, however, limited, as to its capacity, from respect for the road surface, to ⅓ the weight permissible and allowed on the tramway.

The mechanical omnibus will be considered in three forms, that operated by (1) the internal combustion engine; (2) by the electric secondary battery, and (3) by the trackless trolley system. The tramway will be considered from the analysis of the statistics of 71 corporation-owned undertakings in Great Britain; serving populations varying from 13,000 at Maidstone to over a million at Glasgow. There are actually 75 municipal tramways, but as to four of them the data are not complete.

Capital has up to the present time only been embarked in the mechanical omnibus to any large extent in that form where the petrol or steam motor is used. In London alone, some 3½ millions of capital have been invested, which, at the market quotations, would appear to have a present value of about one million. There can be little doubt that the motor omnibus was bound to come, but it seems to have come too quickly. There is no restriction to public carriers on highways such as there is to railway companies and mutually destructive and competitive undertakings in the form of omnibus lines can be carried on to any extent. When capital poured into motor omnibus companies, the existing horse omnibus companies were driven into adopting them also, to the prejudice of their commercial standing. The 3½ millions of capital above mentioned do not include that of many companies which have disappeared.

The statistics of working costs of the mechanical omnibus are as yet little more than estimates. Although based upon a considerable

* Paper read before Section G of the British Association at Dublin.

quantity of data derived from actual working, they must be stated with the reserve due to a comparatively new industry.

In the 71 cases of corporation-owned tramways considered later on, the working expenses vary from about 4½d. to 8½d. per car-mile. The capital charges of interest, sinking fund and depreciation, similarly reduced vary from 2d. to 5½d. The averages of these data are 6·34d. and 3·62d. respectively. These two figures added represent an average minimum remunerative revenue of 9·96d. The actual average revenue obtained is 10·52d. per car-mile. Thus the average net profit barely exceeds ½d. per mile.

In the petrol omnibus, as will be shown later, the working expenses and depreciation together are estimated at 10·86d. per car-mile. Adding to this for interest and sinking fund at 6 per cent. and reducing similarly; the minimum remunerative revenue is estimated at 11·7d. per car-mile, and this is based on a somewhat sanguine view of the costs of maintenance. The variation is great, and under certain conditions the figure might be well over 1s. per car-mile. In the tramway list considered, there are only 10 out of the 71 cases in which the traffic receipts reach 11·7d. per car-mile.

On the other hand, directly an omnibus line is able to earn a profit at all, each ½d. per car-mile, when reduced to percentage on its much smaller capital, means three times as much profit as it does on the tramway.

The electric omnibus with accumulators (popularly known in London as the "Electrobus"), as will be seen later, is estimated as capable of meeting its expenses and depreciation at 9·5d. per car-mile and adding to this a 6 per cent. allowance for interest and sinking fund, the minimum remunerative revenue becomes 10·25d. per car-mile. In the tramway list there are 35 of the 71 in which the traffic receipts reach this figure.

The electric omnibus with overhead wires, the trackless trolley system, is estimated as a possible paying concern with a revenue of from 7d. to 9d. according to class of construction. In the tramway list there are 65 which have a revenue of over 7d. and 50 of over 9d. per car-mile.

As compared with the tramway, the mechanical omnibus is still in its infancy, and is continually being improved. There is, moreover, a great stimulus to invention in order to save the outlay on permanent way, and to occupy the immense field of public highways which await occupation by improved methods of mechanical transportation. In India alone, there are said to be 150,000 miles of good roads, upon which both passenger and goods traffic could be handled upon a prodigious scale. The Renard "India" Train Transport Company are already making a bid for this traffic.

Estimates of Motor Omnibus Expenses.—In order to estimate more particularly the working expenses and fixed charges of motor omnibus lines, we will first take those of petrol omnibuses and use the estimates given in a Paper read by Mr. W. G. Hardy, A.M.I.E.E., before the Society of Road Traction Engineers in December of last year, and published in the January number of the *Tramway World*.

Mr. Hardy, at the outset of his Paper, admits that "his experience was limited to a comparatively small number of mechanically propelled vehicles, he having been more directly concerned with those that are driven by electric power." He could not, of course, when dealing with a subject as to which statistics are but recent, and very conflicting, have given anything more than an extremely approximate estimate. The general conclusion of the estimate is that a fleet of 20 petrol omnibuses *can* be made to pay when the receipts amount to 1s. per car-mile. An examination of the details leads one to the opinion that this *possibility* exists, but the dubious feature in the estimate is that of repairs and depreciation. It only needs a ride from end to end of London on the top of a motor omnibus to notice the many disabled motor omnibuses, and to see how unreliable as yet the vehicle is. It is as difficult to estimate the cost of all these breakdowns in actual repairs, as in loss of revenue. If therefore one takes, for purposes of comparison with the tramway, the working expenses and fixed charges of the petrol omnibus at Mr. Hardy's figure one does so with this reservation as to repairs. We mean the best class of this vehicle now running, but in all probability one which will be yet much improved upon.

The details of Mr. Hardy's estimate are as follows:—

Motor-Omnibus Estimate.

Number of cars in stock		20
„ „ „ in service		13
Total Capital Expenditure		£25,000
Car mileage per annum		425,880
Receipts per car-mile		12 pence
Total Receipts		£21,294
Working expenses per car-mile	9·449d.	10·856 pence
Depreciation „ „ „	1·407	
Total operating expenses		£16,772. 3s. 4d.
Depreciation, 15 per cent.		2,497. 10s. 4d.

The details of the operating expenses reduced to car mileage are as follows:

Petrol, carbide, grease and oil	1·600 pence
Rubber tyres	2·000 „
Drivers and conductors	1·801 „
Ticket checks	0·163 „
Attendance on buses	0·528 „
„ at garage	0·132 „
Repairs to chassis (including engines)	0·602 „
„ „ „ Materials	1·000 „
„ „ „ Bodies	0·113 „
„ „ „ Buildings and tools	0·088 „
Lighting and Power	0·059 „
Sundries	0·161 „
Rents, Rates, Taxes and Insurance	0·564 „
Salaries and Management	0·638 „
Total	9·449 pence.
The depreciation taken at 15 per cent. per annum works out at per car mile	1·407 pence.

The minimum cost of working of a fleet of this size is therefore, according to Mr. Hardy, 10·856d. per car-mile, leaving, out of a revenue of 1s. per car-mile, 1·144d., or on 425,880 car-miles a profit of about £2,000 per annum, or 8 per cent. on the capital.

In order to compare the above estimate with a tramway of equal capacity, a length of track must be assumed together with a frequency of service and average speed which correspond fairly with a traffic density such as would yield receipts as high as 1s. per car-mile. Mr. Hardy assumes a speed limit of 7½ miles per hour. This, as will be referred to later on, is too high for such conditions of general traffic where a revenue of 1s. per car-mile could be earned. A time interval of five minutes has been taken, and an average speed as near to 7 miles per hour as will correspond with 13 cars and a length of route of 3·75 miles, double track. The capital expenditure per mile and the working expenses per car-mile have been taken at the average of the 71 corporation-owned tramways the statistics of which are analysed later. The depreciation has been taken at £400 per annum per mile of single track.

Comparative Tramway Estimate.

Number of cars in stock	20
„ „ „ „ service	13
Length of track (double line)	3·75 miles
Capital expenditure	£88,000
Time interval between cars	5 min.
Average speed	6·93 m.p.h.
Receipts per car-mile	12d.
Working expenses „	6·34
Depreciation	1·69
Total receipts	£21,294
Working expenses plus depreciation	£14,250
Gross profit	£7,044
= 8 per cent. on the capital.	

Thus the commercial results of the motor omnibus line and the tramway work out at an equal rate of profit on the investment, the amount of capital in the case of the motor omnibus line being less than one-third of that of the tramway.

As regards the estimated receipts taken in both cases at 1s. per car-mile, this is quite a possible revenue in London streets, but by no means an ordinary one in comparison with general tramway statistics. Out of the 71 cases considered, there are only 6 in which the receipts reach this figure. It has been assumed, moreover, in the comparison that the business done by the motor omnibus is equal to that done by the tramcar, although the latter is of much greater capacity. This is an anomaly which is supported by fact in London but cannot be regarded as of universal application. Although comparative estimates of such diverse systems of transportation are difficult to make, the preceding comparison at least shows that the petrol omnibus has not as yet proved itself a more economical method of transportation than the tramway.

The Electric Omnibus with Accumulators.—The Electrobus, which has now been running for the best part of a year in London, is probably a more formidable rival than the petrol 'bus, not only to the horse omnibus but also to the tramway. The results of six months' running were examined by the writer's firm, Sir Douglas Fox & Partners, in conjunction with Mr. T. Graham Gribble. Certain points of importance which have all previously been the subject of much controversy were in this examination fully established:—

1. That the vehicle, which, when fully loaded, with its complement of passengers, weighs 7½ tons, can do 40 miles without any distress of the batteries.

2. That the current consumption upon London streets, after allowing for all losses, does not exceed that of the average tramcar.

3. That the wear and tear of the chassis, including motor, is moderate as compared with that of the petrol 'bus.

4. That steep gradients, such as that of Ludgate-hill, are easily overcome with a full load on, and with no apparent distress of the battery.

The batteries were the property of, and maintained by, two well-known accumulator companies on a mileage contract of 2d., and the representatives of these companies stated that they were very satisfied with their contracts. One of these gentlemen also stated that at this figure a life of six months was sufficient to pay for the batteries, some of which had already run that time and were still in good condition. The operation of the line, up to the time when the tests were made, had been more or less experimental, but sufficient data were available for making an estimate of the cost of operating a service of 100 buses under similar conditions of duty. A business of considerable magnitude is obviously necessary in order to cover the cost of superintendence and skilled labour at the charging station, but, assuming a garage of 100 'buses, with a total performance of 2,400,000 car-miles per annum, there appears from the probable net cost of the batteries, and their apparent life, good grounds for regard ing the mileage contract of 2d. as well within the powers of the battery company to continue indefinitely.

The general conclusion of the studies and tests made was that such a fleet of 100 electric omnibuses could be operated at an expenditure of 9½d. per car-mile, including maintenance and depreciation. The capital expenditure may be assumed at £125,000, upon which 6 per cent. for interest and sinking fund would come to 0·75d. per car-mile, thus making the minimum remunerative revenue for such an installation 10·25d. per car-mile.

With regard to current consumption, as against the loss in charging and discharging batteries should be set the favourable feature of the possibility of charging at night time when the demand on the central station is at its lightest, and consequently current has been offered to the Electrobus Company by a municipal central station at a very low figure. The many attractive features of the electric omnibus as compared with the petrol omnibus must dispose everyone interested in urban transportation to wish for it all the support, moral and financial, necessary for its development and perfection.

The principal improvement still to be looked for is the extension of the capacity of the battery without additional weight, and to the performance of a full day's work with one charge. It can now do 40 miles regularly with one charge. The Electrobus has performed the journey from London to Brighton of 50 miles, without any distress.

However much the electric omnibus, driven from accumulators, may yet be improved, the cost of the batteries added to that of the rubber tyres, will in all probability limit its use to those circumstances where a fairly good revenue is to be obtained. The possibility is still a remote one of battery power being reduced in cost, and of some cheap substitute for rubber being found as together to reduce these items of working expense to a level with the cost of operating cars upon rails.

Electricity has, however, in the method known as the "Trackless Trolley System," of operating road vehicles by overhead wires, entered the field of highway transportation with much more likelihood of favourable competition with both the tramway and with the light railway. The peculiar facility with which, by this system, both passenger and goods traffic can be handled over the same line, the latter not requiring the expense of rubber tyres, renders this method probably the most economical system of highway transportation which has yet been devised.

Electric Road Cars with Overhead Wires (Railless Electric Traction).—On the Continent of Europe, numerous installations of electric road traction are in operation for the transportation of both goods and passengers, in which the driving current is obtained from aerial conductors, and taken by a swivelling contact boom, having sufficient lateral freedom to enable the car to deviate in either direction sufficiently to pass other vehicles.

These installations date from the year 1901, and each year sees not only fresh lines opened, but also installations of greater importance are being undertaken. Seven of these lines are in operation in Germany, one in France, and three in Italy. The Italian Government is said to have in contemplation the utilisation of the public highways for this mode of transportation upon an extended scale.

Mulhausen Installation.—One of the latest of the projects, now well on the way to completion, is that of Mulhausen in Alsace. The city, of 100,000 inhabitants, is already supplied with a tramway system, but it was found necessary to further connect the suburbs with these tramways and also with one another. It was also desired to obtain better access to the Public Gardens during the summer months. The traffic was, however, estimated to be too light to render a tramway profitable. The Corporation appointed a commission to report first as to whether any means of communication could be made remunerative, and secondly, as to what means to adopt.

The complete scheme was to be for 6¾ miles of route, on which 550,000 car-miles were to be made per annum. The commission reported on three alternative proposals:—

1. For a very cheaply constructed tramway for which plans and specifications were prepared by their own engineer.

2. For a service of motor omnibuses operated by benzine engines, for which several tenders were made by manufacturers of these vehicles.

3. For a "railless traction" line of electric omnibuses with aerial conductors.

The Trackless Trolley System.—The line to the Public Gardens has gradients as steep as 1 in 12; the zone line is comparatively flat. The estimates were to include a fixed charge of 4 per cent. interest upon capital. The conclusions of the committee were, that the electric omnibus (trackless trolley system) was the only method having prospects of commercial success, and the installation was therefore contracted for, and is now under partial operation.

The digest of the estimates is as follows:—

——	Tramway.	Benzine Omnibuses.	Electric Omnibuses with aerial conductors (trackless trolley system).
Total cost	£62,530	£23,581	£25,050
Do. per mile of route	£9,260	£3,500	£3,700
Expenses per car-mile including repairs, renewals, dep., and 4 per cent. int..	7·30d.	9·45d.	5·13d.

The Benzine omnibuses and the electric vehicles were of about the same capacity; the tramcars would have given considerably more accommodation.

The prices of labour for both construction and operation are lower in Germany than in England. The tariff is correspondingly low.

The Mülhausen line is interesting, not only from being the longest yet undertaken upon this system, but also from the severity of the gradients. The corporation decided that the Public Garden line should precede the zone route, and that the brake tests should be such that the brakeing of either axle independently should be sufficient to hold the car on the steepest gradient, and also to bring it to a standstill in the shortest possible time. Also, that these tests should be carried out in winter. The road is of macadam saturated with tar by a new German process, which attains a smoothness almost equal to that of asphalte, and much resembles "tarmac."

The car is steered and driven on the front axle, the wheels of which are rubber tyred, the rear axle having steel tyres; both axles are supplied with mechanical brakes, and the front axle with an electric brake. The car accelerates and maintains speed on the gradient of 1 in 12 without any trouble; the single forward brake gear is sufficient for holding the car, but the braking of the tyred wheels on the rear axle has required modification. During a recent visit paid to this installation by Mr. Bertram Douglas Fox, chief electrical assistant to the writer's firm, the car was put through all the tests required by the authorities, and the performances were satisfactory. This section of the line is now opened for traffic. On some of the lines in Germany, goods transportation is being carried on upon the same lines as a passenger business without any inconvenience, the former being handled by trains of cars hauled by a double-ender electric locomotive, the cars being provided with a coupling and steering device which compels them to follow the exact course taken by the locomotive.

Making all due allowance for cheaper labour in Germany, there appears good ground for the view that this method brings electric transportation upon highways into a possible competition with any other method of handling traffic. At the figures of working expense estimated by the Mülhausen committee, such a system could pay its way in this country with the smallest revenue earned by any tramway in England, even allowing for the higher rate of wages here than in Germany.

As to the respective fields for the electric omnibus with accumulators or with overhead wires, these may be defined by the question as to whether overhead wires are permissible, and also whether, in the former case, the traffic is sufficiently heavy to cover the extra cost of the batteries. The two systems may be viewed as complementary, because in many problems of urban transportation, it may be found expedient to operate different sections of the same city on one or the other method. Taken together, recent advances point to the probability that in this way electricity has entered upon the field of transport upon public highways, to do as much for it as it has done for transport upon railways.

(To be continued.)

ELECTRIC STREET LIGHTING.*

BY W. F. LONG.

The author first makes a few general remarks about street lighting, and describes the Glasgow arc lamp starter for controlling street arc lamps from the power station. There is not a great deal of street arc lighting in Cape Town, but, with the exception of Darling-street, it is controlled either from the central power station or the accumulator station. A series of flame arc lamps, the first in Cape Town, has recently been installed in the Dock-road. The lamps used are the now well-known "Oriflamme" type, the normal current being 9 amperes, but we find that these lamps give much better results with 10 amperes. The power absorbed on the circuit of 11 across 440 volts, including line resistance, is 4,400 watts, giving a total candle-power of 14,300 and costing at the current price for street lighting in Cape Town 0·0016d. per candle-power per hour, including all labour and materials for trimming and general maintenance, together with interest charges on the capital expenditure in providing and installing the lamps.

The lamps are placed in Hyde Park carriers on tapered steel poles placed in the centre of the roadway, the whole of the wiring being carried out by means of No. 4 S.W.G. bare wire carried on insulators attached to the poles. Owing to the exceptionally long spans, 210 ft., and to the fact that at the time heavier poles could not be obtained for the ends of the line, it was not possible to run two wires of the above section on the lamp poles themselves; the return wire is therefore attached to the poles at the side of the road carrying the ordinary three-wire distribution system.

In addition to the flame lamps, each pole also carries a double bracket fixed about 12 ft. 7 in. from the surface of the road, each bracket containing two 110 volt 25 c.p. tantalum lamps in series, which are, of course, wired on a separate circuit. The overhead wires in this case being No. 12 S.W.G. are attached by means of insulators to the sides of the Hyde Park carriers, so that the only wire causing a shadow with the arcs is the one No. 4, and this, I may say, is hardly noticeable. Both the arc and tantalum circuits are controlled direct from the generating station.

As regards side-street lighting, some 12 months ago a trial was made with 25 c.p. 110 volt tantalum lamps on an extension to our street-lighting system, and as the illumination required per pole was not to exceed 25 c.p., these lamps were installed by running series overhead wires between poles. The lamps proving very satisfactory and being seldom reported as not lighted, steps were taken to change the majority of the carbon filament street lamps for tantalums, so that now quite 80 per cent. of the street lighting is carried out in this manner. A No. 14 S.W.G. bronze wire has ample carrying capacity as the series wire, even if, as in some cases, the lamps are a considerable distance apart.

As an instance of the saving that can be effected by this lamp, I should state that the cost of street lighting in Cape Town has been reduced this year by 33⅓ per cent., although some 300 additional side-street lamps and about 20 arc lamps have been erected, whereas the charge per unit for energy consumed for street-lighting purposes has only been reduced by 12 per cent.

The Cape Town City Council has been successful in obtaining the street lighting of Woodstock in competition with the local gas company. The work in connection with this scheme is now in course of construction. The distributing system will be entirely overhead and carried out on a three-wire system similar to Cape Town, with 440 volts across the outers. The lamps to be erected comprise 300 in number, and will consist of two 110 volt 32 c.p. (hefner) osram lamps, in series in one fitting. The energy required will be transmitted from the power station in Cape Town to the boundary of Woodstock and Cape Town by extending an existing 0·4 sq. in. concentric feeder; the feeder being also used for the supply of energy to private consumers until such time as the loads warrant the use of a sub-station. The overhead distributing system entails the use of some 300 poles and 35 miles of bare overhead wires, the whole was to be completed by January 1, 1908, when the five years' street-lighting contract commenced.

The following particulars are useful as a guide to the possibilities of street lighting locally by means of metallic filament lamps as against incandescent gas. One suburban municipality is paying to-day £7 per 60 c.p. incandescent gas lamp per annum for 2,000 hours burning. A recent quotation to another suburban municipality was £6. 10s. per 55 c.p. incandescent gas lamp per annum for 2,000 hours burning.

The average of various tests of gas mantles made in recent years proves that these take 0·1 cubic ft. of gas per candle-power per hour, which information, together with the above, gives the following comparative table for gas and metallic filament lamps :—

System of Lighting.	District.	Candle Power.	Charge per Lamp per An.	Hours Burning.	Cost per C.P. per Hour.	En'rgy Consumed.*	Cost of Energy.†
			£ s. d.		d.		s. d.
Inc'ndes'nt	Sea Point	60	7 0 0	2,000	0·0140	12,000	11 8
Incandescent ...	Woodstock	55	6 10 0	2,000	0·0141	11,000	11 9
Tantalum Electric	Cape Town	25	2 18 2	3,000	0·0093	127	5½
Osram Electric	Woodstock	50	5 10 0	2,000	0·0132	125	10½

The column "Cost of energy" includes both interest charges and maintenance. The Woodstock figure of 10½d. per unit is high, owing to the fact that the whole of the capital expenditure entailed has to be repaid in five years.

ON THE MEASUREMENT OF LARGE INDUCTANCES CONTAINING IRON.‡

BY SIR OLIVER LODGE, D.SC., F.R.S., AND B. DAVIES.

Summary.—The authors describe some interesting methods of measuring large inductances, and also experiments on the behaviour of iron inductances under low magnetic forces and with varying air-gaps.

The advantage of inserting self-inductance in telegraphic lines, especially in lines rendered inefficient by electrostatic capacity like submarine cables—an advantage first discovered and advocated on theoretical grounds by Mr. Oliver Heaviside, F.R.S.—is so marked

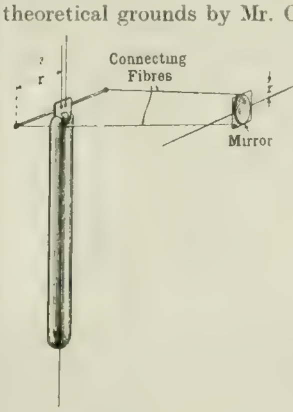


FIG. 1.

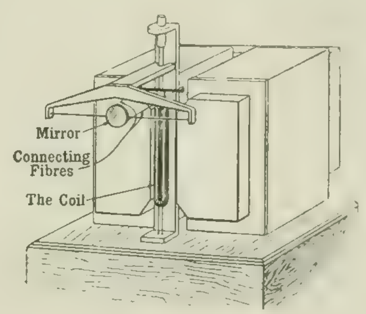


FIG. 2.

that a number of investigations have been conducted by the electricians of the Eastern Telegraph Co. in the research laboratory in Electra House, and by Mr. B. Davies.

Some of the self-induction coils used are of considerable magnitude, approaching 100 henrys; and for compactness, as well as to avoid mutual inductive interference, it is customary to make them with iron cores forming a nearly closed magnetic circuit. An air-gap is, however, introduced into this circuit and is made variable at will. The inductance of such a coil depends, of course, greatly on the width of the gap, and it is also a function of the strength of current circulating round the iron; accordingly the measurement of its self-induction, though an important measurement, is not an easy one, when the alternating current involved in the measurement is reduced to 10^{-4} or 10^{-5} amperes, and special means have had to be devised.

The usual methods of measurement were tried, but were found to give inconsistent results, and were at best laborious, involving much time. The difficulties arose partly from the presence of harmonics, introduced by hysteresis when the magnetising forces were great, partly also from magnetic creeping, which was very troublesome in closed or nearly closed iron magnetic circuits even when the current was small. Further difficulties arose from the fact that the inductance varied with the frequency of the current alternations, and they were emphasised by the enormous time constants which some of the coils possessed, the time required to rise within $1/e$th of the ultimate value being in some cases as much as 4 seconds.

The currents supplied to a cable can be represented as being due to sudden rises and falls of E.M.F., but by the time they reach the distant end they have become approximately sinusoidal; in fact, the

* Abstract, from the *Journal* (August, 1908) of the Institution of Electrical Engineers, of a Paper read before the Cape Town Local Section.

* Gas—cubic ft.; electricity—units.

† Gas per 1,000 cubic ft.; electricity per unit.

‡ Abstract of an original communication to the *Journal* of the Institution of Electrical Engineers

currents representing the signals at the end of a cable of moderate length may always be regarded as composed of sinuosities with three frequencies, n_1, n_2, n_3. Of these n_1 and n_2 are always in the ratio 1 : 2 ; while the third n_3 is a low irregular frequency superimposed on n_1 and n_2. The first frequency (n_1) corresponds to regular reversals at the sending end—that is, to dots and dashes, or right and left deflection, alternately. The second frequency (n_2) corresponds to the case of a succession of impulses all of the same sign, a series of dots or a series of dashes. It is this unidirectional sending which tends to charge the cable and so cause a slow fluctuation of zero which represents the third frequency n_3. About this there is nothing regular, but it is always much slower than the others, and ought to be eliminated and carried off to earth, along with earth disturbances, by a coil of low resistance but high self-induction which is arranged to shunt the receiving instrument, this elimination being assisted by the obstruction offered by the receiving series condenser. The second frequency —the sinuosity representing a succession of dots—is not needed in practical telegraphy. The three waves are $y_1=a_1 \sin pt$; $y_2=a_2 \sin 2pt+C$; and approximately $y_3=a_4 \sin \frac{1}{20}pt$. The attenuation of signals is such that a_2 is practically obliterated at the distant end, and matters are so arranged mechanically and electrically in the recorder circuit that this frequency is never useful ; it is generally killed by a few hundred miles of cable, at moderately high speeds of signalling. We are therefore left with the frequencies n_1 and n_3. These together govern the design of most of the inductances used for submarine telegraphic purposes.

Description of the Galvanometer.—The method of measurement described below depends on the use of a galvanometer for observing the maximum amplitude of the alternating current. The instrument consists of a moderately strong electromagnet of adjustable strength, the field of which can be raised to about 8,000 C.G.S. The magnetic circuit is all iron except the narrow gap in which the coil is placed. The coil has about 500 turns wound on a light aluminium frame 4 cm. long and ½ cm. wide. The oscillation of the coil is measured by means of a mirror and a spot of light ; but the mirror is mounted, not on the coil in the usual manner, but on a saddle suspended independently

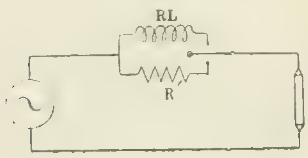


Fig. 3.

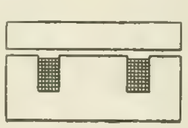


Fig. 4.

and connected to the coil by a couple of silk fibres, after the same fashion as the siphon of the siphon recorder is connected. The object of this method is the magnification of the motion of the coil mechanically.

The arrangement of coil and mirror is shown in Fig. 1. It is the usual arrangement of the coil and siphon of the siphon recorder.* The mechanical magnification of motion has an important effect on the quickness of the coil, and can easily be overdone. In one of the instruments already used, the dimensions of the various parts of the moving system were as follows: Moment of inertia of coil 0·16 grm. cm.^{2} ; moment of inertia of mirror and saddle 0·013 grm.-cm.^{2} ; magnification ratio$=r_1/r_2=4·0$. The total effective moment of inertia of the system around the axes of the coil is therefore 0·16 + 0·208.

The damping of the coil is mainly brought about by the currents generated in the aluminium "former" on which the coil is wound, as it moves in the strong field of the magnet. The coil is also damped by the currents induced in it when the circuit is closed, but it is desirable to keep this part of the damping small. The magnet strength is adjusted until the main damping makes the coil just dead beat, the correct magnitude being obtained by observing the disappearance of oscillation when the instrument is joined to a cell in a non-inductive circuit. Fig. 2 shows the instrument complete.

Method of Measurement.—The inductance to be measured is connected up in series with the galvanometer and a specially designed sine alternator of small power and known frequency, and the amplitude of the oscillation is observed. The inductance is then removed and a non-inductive resistance placed in its stead, being adjusted so as to produce the same amplitude of oscillation. If RL (Fig. 3) is the impedance to be measured, and R′ is the non-inductive impedance substituted to produce the same oscillation, we have the simple relation $R'=\sqrt{(R^2+p^2L^2)}$; and since R is usually small compared with pL this gives $L=R'/p$. The strength of the current involved in the measurement is known from the amplitude of the oscillation, the deflection being easily reproducible with a known steady current ; so that the two measurements, the one for L and the other for the corresponding current, are made simultaneously. In order to render the oscillation galvanometer available for a wide range of current values, it can be shunted by a non-inductive resistance. The speed of the alternator must be accurately known, and is obtained by means of a Judd and Fraser speed indicator.

As an example of the sensibility of the instrument, and the time of swing of the coil, the following figures serve for an unshunted galvanometer intended for moderately weak currents :—

Time of swing of the moving system (without the magnetic field)	$\frac{1}{25}$ second.
Current strength giving 1 mm. oscillation at 1 metre scale distance	$4 \cdot 10^{-6}$ amp.
Strength of magnetic field (approximately)	3,000 C.G.S.
Magnification ratio....................................	4·0
Resistance of moving coil.........................	770 ohms.

The above sensitiveness is useful for the measurement of alternating currents of the order of 10^{-4} to 10^{-3} amps. For the weaker currents the control had to be reduced. With a coil swinging 5 per second and a field of about 3,000 C.G.S., the sensitiveness runs up to a value such that 10^{-8} amps. gives 1 mm. swing at 1 metre scale distance.

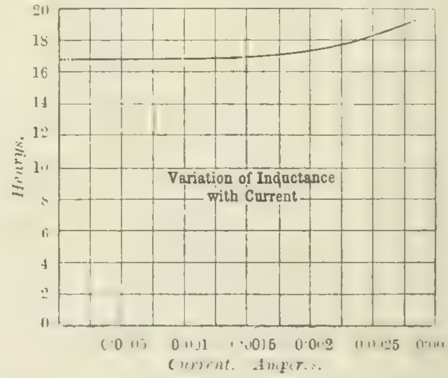


Fig. 5.

(To convert the abscissæ into magnetising force in C.G.S., multiply the current in amperes by 22.)

The Behaviour of Iron Inductance under the Action of very Low Magnetic Forces.—When the magnetising forces are weak, the behaviour of iron inductance approaches that of an air-cored inductance, as is shown by readings obtained by means of the oscillation galvanometer. These are plotted in Fig. 5. The curve shows that the inductance is practically independent of the current strength for all magnetising forces below 0·04 C.G.S. The range of currents received at the distant end of a submarine cable is such as to give a value $4\pi nC$ (commonly called magnetising force) varying from about 0·001 to 0·02 C.G.S., a range that is more than covered by the curve shown. The curve shows also that the hysteresis is almost nil, since only by a change in the value of L can the hysteresis loop be formed. From this it follows that a sinuously impressed E.M.F. gives also a sinuous current in such an inductance under the conditions named. Hence the iron inductance behaves almost like an air-core inductance, for feeble magnetising forces. This has been found a valuable property of iron inductance coils placed at the end of a submarine cable.

An extremely convenient method of arranging a continuous variation, so as to obtain all possible values of inductance between two given limits, is to arrange the air-gap of the iron circuit so as to be varied by means of a hand screw. Assuming the iron-cored inductance coil to be of the form given in Fig. 4, and made of thoroughly laminated high-quality iron, we devised the following empirical equation to express the self-induction for weak currents under different circumstances : L = kn (G + g) [illegible]. Where n is the number of turns, G the width of the air-gap in mm., g a constant depending chiefly on the reluctance of the iron determined experimentally, and a, b and k other constants depending mainly on the design of the instrument. For the form shown in Fig. 4 the values of the constants were as follows : a = 1·90, b = 0·47, g = 0·1, k = 18·0. Note that G is to be expressed in mm. not cm.

Fig. 6 shows how the inductance varies with the thickness of the air-gap, both by calculation from this formula and by direct observation.

* An amplitude galvanometer has also been arranged by Mr. A. Campbell at the National Physical Laboratory. The difference in this is that in Campbell's galvanometer the coil has the least possible damping, [illegible] instrument, whereas in the galvanometer here [illegible] to be aperiodic. The one is used for null [illegible] frequency, but it cannot be depended on [illegible] current strength except at constant frequency, whereas the [illegible] current accurately, and frequency [illegible] all.

Distribution of Magnetism in the Cross-section of the Iron Core. In an iron magnetic circuit whose cross section was about 220 sq. cm., a small air-gap was arranged—the gap being at right angles to the length of the circuit and to the lines of induction. The relative intensity at various points in the plane of the gap was measured by means of an exploring coil connected to the oscillation galvanometer, while the alternating current producing the induction flowed through the main coils of the inductance. The amplitude of the galvanometer oscillation was thus a measure of the intensity of induction.

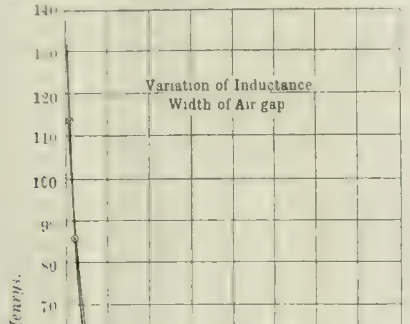


FIG. 6.—SHOWING HOW THE INDUCTANCE DEPENDS UPON WIDTH OF AIR-GAP AND HOW NEARLY THE ABOVE EMPIRICAL EXPRESSION FOR L AGREES WITH OBSERVATION.

With a steady magnetising force the distribution of induction is uniform except at the edges where the fringe effect is observed. But with a varying magnetising force, such as that given by a sinusoidal current, there is apparently a screening effect, or something analogous to screening, which prevents the interior portion attaining the full value of magnetisation appropriate to the impressed magnetising force. Fig. 7 gives two curves showing the magnetic induction for a frequency of 100 per second, and for a frequency of 14·6 per second, in the interior of the air-gap at different distances from the centre. By extrapolation it is seen that the drop in

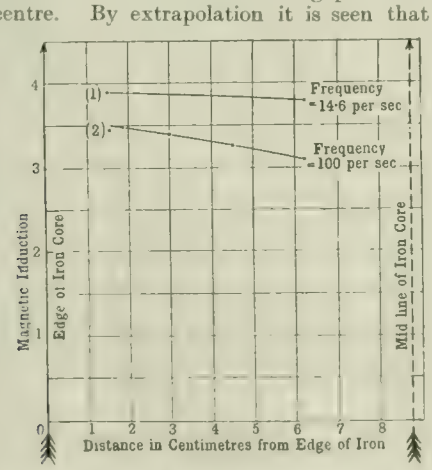


FIG. 7.—DISTRIBUTION OF MAGNETIC INDUCTION IN CROSS-SECTION OF IRON CORE.

the value of the magnetic induction between the edge of the iron core and its centre is about 3 per cent. for the lower frequency and about 22 per cent. for the higher frequency. This explains in part the decreasing value of L of such an instrument as the frequency is raised.

The mean value of the permeability may be roughly estimated from the inductance and the geometrical dimensions of the instrument. For a magnetic circuit as Fig. 4, this gives the value as 228. The magnetic circuit is made of Stalloy iron plates 0·014 in. thick and closely packed. The magnetising force being 0·0003 C.G.S. per cm., and the alternating current strength 8×10^{-6} C.G.S.

Calculating the inductance L′ of a coil alone, and measuring the total inductance L of the coil with iron, the instrument just under consideration gives the value of the inductance of the iron-cored coil as 44 times that of the ironless one.

Conclusions. (1) That measurements based on a determination of square root of mean square would serve fairly well for low magnetising forces. (2) That the inductance of an iron-cored coil is nearly independent of frequency for all frequencies up to about 20 per second, when the magnetising force does not exceed 0·04 C.G.S. (3) That the inductance of a nearly closed magnetic circuit is a definite and dependable function of the width of the air gap for moderate currents and frequencies.

THE ELECTRICAL CONDUCTIVITY OF CERTAIN LIGHT ALUMINIUM ALLOYS AS AFFECTED BY EXPOSURE TO LONDON ATMOSPHERE.*

BY ERNEST WILSON.

The physical properties of certain light aluminium alloys have formed the subject of communications,† and, as stated therein, a specimen of each alloy was placed on the roof of King's College, London, in order to investigate the effects of exposure to London atmosphere. The specimens are in the form of wire 0·126 in. (3·2 mm.) diameter, and were placed on the roof on June 11, 1901. They have been again taken down in June, 1908, and their electrical resistance has been measured. The results are set forth in the following table:—

No. of specimen.	Analysis. Si.	Fe.	Cu.	Ni	Mn.	Zn.	Specific resistance in 10^{-6} ohm at 15°C before exposure in 1901.	Percentage variation of electrical resistance at 15°C. During 1901-2, taken on value in 1901.	During 1901-4, taken on value in 1901	During 1901-8, taken on value in 1901.	Breaking load in lbs. per sq. in. of cross section before exposure in 1901.
16	0·31	0·37	0·11	...	...	..	2·92	1·04	1·50	5·65	26,600
4	0·38	0·25	0·16	...	...	...	2·88	1·86	4 83	6·05	25,700
13	0·38	0 25	1·58	...	...	...	3·34	3 49	6·25	11·3	39,000
14	0·40	0·31	1·86	...	...		3·25	5·24	7·91	15·4	40,600
15	0·40	0·40	2·61	...	...	...	3·34	7·20	11·51	24·3	43,500
1	0·38	0·22	0·17	...	...	0 62	2 86	3·54	7·07	16 6	28,100
2	0·43	0·28	0·30	...	...	1·20	2·94	2·67	5·81	19·0	30,500
5	0·43	0·39	0·09	..	...	2·04	3·07	2·33	4·21	18 4	26,000
7	0·37	0·25	0·05	0·75	...	.	3.05	1·22	3·66	9·84	29,700
8	0·35	0·29	0·09	1·19	...	.	3·24	2·10	4·28	11·4	33,700
20	0·37	1·10	0.06	2·25	...	...	3·18	1·55	2·05	8 33	38.600
24	0·35	1·16	0·09	...	...	...	2·97	0·765	1·68	5·34	31,300
3	0·37	0·28	0·59	...	...	0·59	3·06	2 52	4·67	16 6	30,500
6	0·39	0·31	0·63	...	...	1·20	3·12	2·02	3·58	10 2	30,900
17	0·35	0·53	0·10	0 83	...	0 90	3·03	0·63	1·89	6·51	31,700
12	0·31	0·59	0·19	1·09	...	0 73	3·33	1·26	2·24	6 73	31,700
18	0·43	0·40	0·21	1·13	...	1 94	3·24	2·29	4·14	23·6	34,500
19	0·35	0·29	0·11	2·01	...	1·77	3·26	2·60	5·31	33·5	36,200
11	0·39	0 56	0·24	2·31	..	0·38	3·48	1·95	4·31	9·40	34,500
22	0·37	0·43	1 08	1·29	...	...	3·41	−1·42	6·90	19 4	45,900
21	0·39	2·57	0·10	1·39	...	...	3·24	−0·97	9·50	7·35	42,200
10	0·32	0·54	0·02	...	0 05	...	3 09	0·783	2·12	5·41	29,000
9	0·31	0·35	0·03	...	0·35	..	3·30	1·94	2·31	5·20	30,500
23	0·44	0 56	0·09	...	1·78	...	3·49	2·34	2·71	5·30	35,300
Al.‡	0·14	0·31	...	...	...		2·76	not exposed.	3·58§	8 65§	28,200

It will be noticed that the deterioration of the copper alloys increases with the percentage of copper. Those alloys containing zinc as well as copper have very much deteriorated, and the breaking load was not higher than that of commercially pure aluminium. The copper-nickel alloy (No. 22) has the highest tensile strength, but has considerably deteriorated. Those alloys containing a comparatively high percentage of iron (Nos. 20, 21, 24) show little deterioration, and their tensile strength is high. Manganese in fairly large proportions increases tensile strength, and has little effect upon durability. An examination shows that the specimens are not badly pitted, but a test for tensile strength would render them unavailable for further exposure tests.

* Paper read before Section G of the British Association.
† See *Journal* Institution of Electrical Engineers, 1902, Part 154, Vol. XXXI.; British Association Reports, 1901, 1902, 1903, 1904; *The Electrician*, Vol. XLVIII., pp. 387, 389, Vol. XLIX., p. 868, Vol. LI., p. 898, Vol. LIII., p. 752; *Journal* of the Royal Society of Arts, December 13, 1901.
‡ Commercial aluminium. § Taken on value in 1902.

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THE BRITISH ASSOCIATION.

Presidential addresses have been delivered, papers have been read, conversazioni, garden parties and other social functions of a more or less tedious nature have been held and well attended, and the great gathering of professional and amateur scientists has gone on its way rejoicing. For another twelve months "the daily round, the common task" must engage the serious attention of the two and a quarter thousand, and then some of them will meet again at Winnipeg, under the presidency of Prof. J. J. THOMSON. Dublin has opened its arms and accorded a right royal welcome to the visitors; presidents of Sections and other eminent persons have had photographs and biographical notices in the newspapers, while the hotel keepers and boarding house proprietors have reaped a rich harvest. On the whole, however, we are inclined to think that the average member or associate gets good value for the money which he spends during the week, in spite of the inconveniences which he has to endure. Many of these might be obviated if only the management gave more attention to detail, instead of trusting quite so much to luck, and relying on members' good feeling, or lack of spirit, whichever it may be. Certain it is that there has been a great deal of grumbling at what is described as the muddling methods of the persons responsible. As an instance, let us call attention to the fact that the room placed at the disposal of Press representatives was in the School of Pathology, a building more distant from the Reception Room than any in the group. In the official programme it was stated that letters would be delivered to callers on Sunday between 9 and 10:30 a.m. Unfortunately, however, the Post Office officials held a different view, and retired at

10 a.m. The result was that some 200 peaceable citizens, having made a hasty Sunday morning breakfast, hurried off to the Reception Room, where they immediately adopted almost a pugilistic attitude towards the official in charge, who happened to be a Trinity College porter. The letters were there—on the other side of the counter—and there they remained till Monday morning. This may seem a trivial incident, but unfortunately it was not the only one of the kind, and in any case it is not of such a nature as to foster admiration for the executive methods of the great British Association.

With regard to the actual work of the Sections, it was just about up to the usual level, with the exception of Section G. Last year the Papers and discussions of this Section were not of a high order of excellence, but this year the work of the Section has been of even less value. To whatever cause this may be due, we cannot help thinking that it is to be regretted. Whether it is due to depression in the industry or whether it is due to lack of interest in the British Association we do not know, but it is quite certain that there is some disturbing influence at work. During the entire meeting only two or three Papers dealing with electrical matters were read before the Section, Mr. DOUGLAS FOX's Paper on "Urban Transportation" being a notable example. It may be that engineers, and particularly electrical engineers, being eminently practical men, do not see the force of discussing highly technical matters before an uninitiated audience, whose applause is largely regulated by the frequency with which the speaker's name appears in the newspapers. They may prefer to discuss technical matters before technical societies, and there is much to be said for this point of view. Nevertheless, it must not be forgotten that the British Association is one of the few channels through which reliable information concerning engineering or scientific progress can be put before the public; and the Association has now become a recognised national institution for this purpose.

With regard to Section A, which deals with pure physics, the case is entirely different. Almost without exception, the most eminent British physicists foregather to discuss matters of absorbing interest to themselves and to receive the adulation of their listeners, who never fail to drink in the words of wisdom which fall from the mouths of the great ones. How much the said listeners understand is a matter for conjecture, but they always manage to appreciate a difference of opinion between two *savants* and evince the liveliest interest therein. In fact, if it were not for these occasional differences of opinion the proceedings might sometimes become rather tedious.

Perhaps the most serious work in Section G was that on Monday morning, when the great question of the utilisation of peat as a fuel was discussed. We need scarcely remind our readers that this is a topic which recurs at more or less regular intervals, but in any case it always recurs. There seems to be some fatal fascination about the utility of peat, which affects engineers and the public alike. Over and over again, schemes have been put forward, engineers have made favourable reports, subscriptions have been invited, and then a painful silence has ensued. This has been the rule for so long that it has now become monotonous, and the mere mention of the word "peat" brings a cynical smile to the lips of the hearer. Capt. SANKEY's scheme, however, does at least bear the stamp of novelty. The suggestion is briefly that ammonium sulphate should be the main product and electricity a mere bye-product. For this purpose it is proposed to build large works at Robertstown, on the Grand Canal, so that not only will the peat be obtained on the site, but there will be excellent facilities for the removal of the products. Moreover, it is hoped that manufacturers will be induced to erect works in the near neighbourhood on account of the cheap electric power supply. Mr. CROSSLEY's estimates were charming, and ensured a cheap power supply simply because the fuel costs would be reduced to zero. While we do not suggest that the estimates have not been worked out with the greatest care, we cannot help thinking that some mistake has been made—it is too good to be true. Perhaps too much stress has been laid on the cost of fuel. Moreover, the scheme necessitates the employment of gas engines for driving electric generators, and, while it would be rash to prophesy anything as to what the future has in store, experience with these engines has not been altogether happy. For the present, therefore, the scheme, which appears admirable on paper, must be accepted with reserve, and judgment must be withheld until more detailed accounts are forthcoming.

REVIEWS.

(Copies of the undermentioned works can be had from *The Electrician* Office, post free on receipt of published price, adding 3d. for books published under 2s. Add 10 per cent for abroad or for foreign books.)

Modern Electrical Theory. By NORMAN R. CAMPBELL, M.A. Cambridge Physical Series. (Cambridge University Press, 1907.) Pp. xii + 332.

To those who wish to see the electron theory treated mathematically to the same extent as was usual in dealing with the older theories in University text-books, this work will be welcome for many reasons. Its freshness and originality of treatment contrast favourably with some of the old-style volumes associated with the Cambridge school, and the author's evident familiarity with the most modern experimental methods and results exorcise the "stuffy" feeling one often brings back from perusing the products of the more "cloistered" seats of learning. As in duty bound, the author begins with the "field" and the electromagnetic theory of light. He then puts the modern development in a particularly luminous manner as follows: "Like all the truly useful theories of science, the Maxwellian theory of light introduced more problems than it removed. It answered the question as to the physical nature of the vibrations in a light wave, but it raised the vast question of the relation of electricity to matter. Instead of being content with representing the properties of the extremely complex systems which we call material bodies by the introduction into our equations of three constants, we ask ourselves what are the processes which give rise to the necessity of those constants. . . . Logically and historically the development of the 'electron theory' is based on the discrepancy between the values of K and n^2." The electron theory is treated first deductively in its applications to dielectric constants, magnetism, magneto-optics, and conduction, and then inductively in dealing with the phenomena of ionisation, the new radiations and photoelectricity. The chapters on magneto-optics, conduction in solids, and the Hall effect are remarkably suggestive. At the end of them, the author gives a definition of an electron which should go far to obviate any future disagreements as to the exact meaning of the term.

It is limited to those bodies of charge e which are common constituents of all matter. In the last Part the author deals with the relations between electricity and matter suggested by electrical, chemical, and spectroscopic phenomena. The author is almost ultra-modern in his sparing use of that hitherto much-abused word "ether," but his dictum that "a page of symbols covers a multitude of assumptions" is much to be commended, especially as he himself never loses sight of the hypothetical character of many of his own assumptions.

E. E. F.

Cours d'Electricité. Tome III: Electrolyse, Electrocapillarité, Ions et Electrons. By H. Pellat, Professor at the University of Paris. (Paris: Gauthiers-Villars, 1908.) Pp. vi + 290. 77 figs. Fr.10.

When a man writes a text-book of electricity in three parts, and the issue of those parts stretches over 10 such eventful years as 1898-1908, he runs the danger of either seeing his last volume out of touch with modern progress, or out of touch with his first volume. Prof. Pellat made some sensation with h's first volume by eliminating Coulomb's laws from his treatment of electrostatics, and dealing entirely in surface densities of electrification. That was at a time when electrostatics was in a very unsatisfactory state, and electrical theory in the modern sense in its infancy. Perhaps the author would gladly rewrite his first volume now. The present volume, taken by itself, is a strong work. We are glad to see the author's interesting determinations of atomic diameters from electrolysis given in detail. Of electrocapillarity the book offers an exceptionally full treatment. The sketch of modern electric theory is a little too brief in proportion, and does not deal sufficiently with its more difficult aspects.

Electricity: What is It? By W. Denham Verschoyle. (London: Swan, Sonnenschein & Co.) Pp. xiv. + 260. 2s. 6d. net.

It is difficult to assign any useful purpose which this book may fulfil in an electrical library, except as a warning against rash theorising. The subjects of electricity and magnetism are disposed of in a single chapter of 44 pages, the main conclusions of which appear to be those stated on p. 132, viz., "There is no positive electricity; there is no negative electricity; there is no such thing as electricity." Even after the "mental effort" involved in accepting this declaration of faith, the author admits (p. 164) that "the problem of the Universe is still almost as far from solution as before." The remainder of the book is taken up with elaborate disquisitions on atoms and molecules, alpha and beta "forces," dissociation, devolution, and "life." All manner of things are reduced to the properties of an entity called a "gyron," a "primitive ether motion of a vortexial nature," apparently a gyrostat capable of rapidly turning its own axis of rotation with all degrees of freedom. Its properties are not, as one would have a right to expect, deduced from well-known hydrostatic principles, but worked out by vague popular arguments which might be made to prove anything or nothing. By similar arguments, it is shown that "current electricity is produced by motion in a more or less straight path, whilst static electricity is the result of accelerated motion towards some central point." The electron is tentatively defined as "the unit charge of electricity" (p. 19), but eventually (p. 164) it finds "no place in the gyron theory." The effects known as "electrical are directly caused by explicit motion of the smallest single bodies of which we have any direct or inferential knowledge." To be more "explicit," the author adds that "static effects are due to motion temporarily restricted by or within any molecular or atomic system; dynamic effects are due to purely translative motion between any two points." The remainder of the chapter and the book is a laboured attempt to press known facts into the new mould. The fit cannot be described as a good one, and since no new facts are either discovered or predicted, the busy electrical world is not likely to go to the trouble of discovering any remote claim to utility which the book may possess, more especially as it is somewhat carelessly brought out, and disfigured by a large number of spelling mistakes such as [illegible] "latteral," "helliconal," "brillance," and even [illegible]

THE BRITISH ASSOCIATION AT DUBLIN.

(FROM OUR OWN CORRESPONDENT.)

Thursday, September 3rd.

(Continued from page 805.)

As was to be expected, Dr. W. N. Shaw's presidential address to Section A (Mathematical and Physical Science) dealt almost exclusively with meteorolgy, and contained little of interest to readers of *The Electrician.* The same remark applies to the remainder of the Section's proceedings, with the exception of the presentation of the report of the Electrical Standards Committee, which we reprint on another page. This report was presented by Dr. R. T. Glazebrook, who called special attention to the variation of resistance as evidenced by the various coils under observation. In reply to the discussion, which was very desultory, he expressed the opinion that the changes were due to the soldered connections and not to the coils themselves. It is the intention of the committee to have one of the coils opened up to see if anything can be ascertained regarding the change in value of its resistance. Dr. Glazebrook asserted that ultimately standard coils would be abandoned, and that fundamental means, or mercury, would have to be employed. He maintained that mercury was superior to platinum, in that it could be maintained at a fixed temperature by immersion in ice.

This has been a very slack day so far as Section G (Engineering) is concerned. Mr. Dugald Clerk's presidential address dealt generally with the application of the laws of thermodynamics to engines of various kinds, and was largely of an historical nature. A vote of thanks was proposed by Sir William White, and carried with acclamation. Mr. Gerald Stoney then read his Paper on "Recent Advances in Steam Turbines," an abstract of which will be found in another column. He called attention to the great progress which has been made in the construction of turbines for use on land during the past few years. In 1900 the largest steam turbine made, and that was considered an immense machine, had a rated output of 1,000 kw.; at the present day a large number ranging from 5,000 kw. to 8,000 kw. are running and under construction.

In the discussion on Mr. Stoney's Paper, Sir Wm. White said he was firmly of the opinion that the reciprocating engine must give way before the turbine, but much would have to be done before the latter gave way to the internal-combustion engine, although this was quite within the bounds of possibility. It was a great feat to reduce the speed of turbines to less than 200 revs. per min., as was required for marine work; in fact, it was a step the equivalent of which had required 50 years' work with reciprocating engines. He was convinced that the combination of high-pressure reciprocating engines and exhaust steam-driven turbines was the thing of the future and was bound to come. While much credit was due to workers in the turbine field, he felt that nothing but admiration could be experienced for the Hon. C. A. Parsons, who had displayed so much courage and determination in attacking a difficult problem. Mr. Parsons was, after all, the pioneer of turbine construction. Mr. Worby Beaumont and other speakers expressed favourable opinions regarding the combination of turbines and reciprocating engines. Mr. Stoney, in reply to an inquiry, said that when only the low-pressure blades of a turbine were being utilised in the consumption of exhaust steam from other engines, the high-pressure blades simply churned up the steam, and neither compressed nor exhausted it. Hence, there was practically no diminution of efficiency.

This concluded the business of the Section for the day.

Friday, September 4th.

At 10 a.m. the general physics part of Section A held a joint meeting with Sections B and G for the purpose of discussing the first report of the committee appointed to deliberate on "Gaseous Explosions." This report is extremely interesting from a physical point of view, but there is little of direct interest in it to electrical engineers. In the discussion, Dr Harker called attention to the suitability of platinum thermometers for the measurement of high temperatures and men-

tioned that this method had recently been adopted in Germany. Principal Griffiths remarked that in the seventies a committee of Section A had actually reported that the platinum scale was impossible, but that this view was now shown to be totally erroneous. The President (Mr. Dugald Clerk) described some interesting experiments which he had conducted with a view to ascertaining how completely combustion was effected when a gaseous mixture was exploded. He arranged a piston in a cylinder in such a manner that when the former was driven forward by the explosion it travelled beyond the exhaust point which was covered with wire gauze. He was thus able to collect the products of combustion and analyse them for unconsumed gases. With a mixture of 1 part of gas to 7 of air he found that $2\frac{1}{2}$ per cent. of the gas had not undergone combustion, and that the same figure applied to a 1 in 10 mixture. He was of opinion, however, that if the experiment had been performed more rapidly a considerably higher degree of accuracy could have been obtained, which would have shown the percentage of unconsumed gas to be five or six.

On the resumption of Section A, Sir Wm. Ramsay read a Paper entitled "Do the Radio-active Gases (Emanations) belong to the Argon Series?" The author stated that the residues of the fractionation of 120 tons of liquid air were examined in the chemical laboratory of University College, London, by Prof. Moore. After removal of oxygen and nitrogen, argon, kryphon and xenon remained, and were separated by methodical fractionation. The xenon amounted to about 300 cm.^{3}; it was methodically fractionated at -130 deg., and a final residue of 0·3 cm.^{3} was obtained. The spectrum of this portion was photographed, and differed in no respect from that of xenon. It is practically certain that if this residue had contained 1 per cent. of a denser gas that gas would have been detected. It follows, therefore, that if there is a heavier constituent in air than xenon, its amount does not exceed 1-25 billionth of the whole. Now, it is certain that if such an element existed it would be gaseous, and would be found in air. Its non-existence implies either the absence of such elements from the periodic table or their instability. As possible atomic weights for missing elements are 178, 216 and 260, it is rendered probable that they are respectively unstable emanations—those of thorium, of radium and of actinium.

In the discussion, Prof. Rutherford asserted his opinion that the emanations of thorium and radium belonged to the group of inert gases, while Sir Oliver Lodge pointed out that it appeared as if all substances of high atomic weight were very unstable. Sir Wm. Ramsay, in reply, stated that a difficulty arose in the fact that neon was a product of the emanation, but Prof. Rutherford expressed disagreement with this view, and said there was no evidence that neon was a product of the emanation.

The next Paper on the list was by Mr. W. Makower "On the Number and Absorption of the β Particles emitted by Radium." This was a description of experiments which the author had performed for the purpose of verifying or disproving previous work. The apparatus employed consisted of a small glass tube about 1 mm. in diameter, whose walls were 0·1 mm. thick. This was filled with radium emanation and suspended inside a copper cylinder, the whole being contained in a glass vessel exhausted of air and the copper connected to an electroscope. From data obtained the author showed that by using varying thicknesses of glass sleeves, which could be fitted over the emanation tube, the β rays which got through were inversely proportional to the thickness of glass employed, and hence it appeared probable that the particles were actually stopped and not merely scattered. His results regarding the number of β particles emitted agreed with those obtained by the ionisation process. Prof. Rutherford, who opened the discussion, agreed that it looked as if the particles were stopped, but Prof. J. J. Thomson did not agree with this view, and held that Mr. Makower's experiments had not disproved that they were only scattered. He asked the audience to consider a parallel beam of β particles passing through a metal plate. If there were no scattering then the ionisation produced on the other side of the plate would be exactly the same over the area covered by a mere prolongation of the beam as it would over a very much larger area. As a matter of fact, the ionisation produced in the area covered by a prolongation of the beam was less than $\frac{1}{10}$th of the whole, proving that the particles were scattered. Sir Oliver Lodge pointed out that Mr. Makower had used glass, whereas Prof. Thomson had dealt with a metal plate, and he doubted whether the results would be the same for conductors and non-conductors. In replying to the discussion, Mr. Makower said he did not consider his experiments were conclusive on the stopping or scattering of the particles.

Sir J. Dewar then read his Paper on "The Rate of Production of Helium from Radium." As a result of long and interesting experiments, he found that helium was given off at the rate of 0·37 cubic mm. per gram of radium per day, and this agreed very closely with the amount obtained theoretically by Prof. Rutherford. He asked Mr. Strutt, in view of this result, how he proposed to account for the production of 30 litres of helium per day, which was the amount turned out by a spring in the South of France. This would require no less than 100 tons of radium, and unless this quantity of radium was admitted to exist beneath the spring, perhaps Mr. Strutt would suggest the existence of large pockets of helium in the earth.

The Hon. R. J. Strutt said he could not account for the production of 30 litres of helium per day, as this would necessitate the spring draining some hundred million million tons of rock. He supposed there must be pockets of helium stored up, as Sir J. Dewar had suggested. Sir Oliver Lodge pointed out that if the rock were 25 miles thick the area drained would only be about 20 km. square, or about as large as the Isle of Wight!

Monday, September 7th.

Work was resumed in Section A this morning by a discussion on the "Theory of Wave Motion," opened by Prof. Horace Lamb, F.R.S. The section then divided into three departments, the only Paper of electrical interest being by Sir Oliver Lodge and Mr. Benjamin Davies "On the Measurement of Large Inductances Containing Iron." This Paper was based on an original communication to the Institution of Electrical Engineers, and provoked no discussion. It dealt with the measurement of self-induction of coils inserted in submarine telegraph cables. These coils have an inductance of the order of 100 henrys, and for compactness their cores form a nearly closed magnetic circuit. The inductance depends upon the width of the air-gap and upon the strength of current; hence, the measurement of the self-induction, although very important, is not easy, when the alternating current involved in the measurement is reduced to 10^{-4} or 10^{-5} ampere, and special means have had to be devised. The method employed depends upon the use of a galvanometer for observing the maximum amplitude of the alternating current involved in the operation. Having designed the instrument, the rest of the work was comparatively easy. This galvanometer consists of a moderately strong electromagnet of adjustable strength, the field of which can be pushed up to about 8,000 C.G.S. units. The magnetic circuit is all iron, except the narrow gap in which the coil is placed. The coil has about 500 turns wound on a light aluminium frame 4 cm. long and $\frac{1}{2}$ cm. wide. Its oscillations are measured by means of a mirror and a spot of light; but the mirror is mounted, not on the coil in the usual manner, but on a saddle suspended independently and connected to the coil by a couple of silk fibres, after the same fashion as the siphon of the siphon recorder. The object of this method is the magnification of the motion of the coil mechanically. In order to measure the inductance, it is connected in series with the galvanometer and a specially designed sine alternator of small power and known frequency, and the amplitude of the oscillation is observed. The inductance is then removed and a non-inductive resistance placed in its stead, being adjusted so as to produce the same amplitude of oscillation. Then, if R = the resistance of the induction coil, L = its self-inductance, R′ = the resistance of the non-inductive resistance and p has its usual meaning, we have

$$R' = \sqrt{(R^2 + p^2L^2)};$$

and since, in practice R is usually small compared with pL, this gives $L = R'/p$.

In Section G the greater part of the morning was devoted to the reading of three Papers involving the consideration of gas-producing plant. The first was entitled "The Utilisation of Peat for making Gas or Charcoal, with Recovery of Bye-Products," by Capt. H. Riall Sankey, R.E. We shall give an abstract of this Paper later, and there is, therefore, no need to deal fully with it here. Suffice it to say that Capt. Sankey made out a very good case, but, nevertheless, he scarcely succeeded in convincing his audience. The second Paper was entitled "Producer Gas," by Mr. J. Emerson Dowson. The author commenced by giving a few historical details relating to producer plant, and gave a good deal of credit to the brothers Siemens. For purposes of regulation he advised the employment of a gas-holder as being superior to any other device; it also possessed the additional advantage of enabling the attendant to ascertain whether sufficient gas was being made, while its rise and fall could be used to regulate automatically the production of gas to suit a varying rate of consumption. The third Paper was by Mr. P. W. Robson, on "Suction Gas Producers," which we shall give in a future issue.

The discussion was opened by Mr. Crossley, of the well known firm of gas engine makers, who remarked on the large sums of money which had been wasted on Irish peat enterprises. He thought, however, that at last there was a prospect of some success being achieved. He supported Capt. Sankey's statement that peat was economical even if it contained as much as 60 per cent. of moisture; his own company had proved this by experiment. With regard to the application of peat fuel to the production of electrical energy, he maintained that, owing to the value of bye-products, the fuel costs would be reduced to zero. He gave figures relating to a plant for the carbonisation of 10 tons of dry peat per hour; the capital cost was put at £50,000, and it was estimated that each ton of peat would produce 140 tons, or even 170 tons, of ammonium sulphate. Putting the amount of nitrogen in dry peat as 2·2 per cent., and allowing a suitable amount for depreciation of plant, &c., the profit worked out at £24,000 per annum. On this basis the cost of production per ton of sulphate was about £5. 10s., while the selling price was £11. 10s. These figures make no allowance for the sale of gas. Referring then more particularly to producer plant, Mr. Crossley said that its introduction had saved the situation for the makers of gas engines. Previously, it seemed that suppliers of cheap electricity and others had combined to effect the destruction of gas engine makers, and an enormous amount of difficulty was experienced with gas companies. Some of these latter even threatened to boycott the engine manufacturers if they encouraged the use of producer plant in any way.

Mr. Alexander Siemens also spoke in the discussion, as did Mr. Rigby, who questioned Capt. Sankey's suggestion that a depth of 4 in. would suffice for drying the peat. If the layer of peat were of no greater thickness than this, an area of some 200 acres would be required to effect the drying of a sufficient quantity to keep a 5,000 kw. plant going. He considered, however, that other bye-products, such as acetic acid, methyl alcohol, &c., could be recovered, and their sale would, of course, improve the financial efficiency of the plant. A point that people did not appreciate fully was the extremely high heat efficiency of a producer plant; this he stated was no less than 60 per cent. Working under the best conditions, it might be assumed that about 0·9 lb. of steam was required for every pound of anthracite. He had recently designed a new producer, in which the coal undergoes a preliminary combustion in the hopper of the producer. The gaseous products of combustion are then carried into the base of the producer, together with the necessary steam, and there allowed to act upon the coke.

A Paper by Mr. Rosenhain on "The Study of Breakages" concluded the business of the section, Prof. E. Wilson's Paper on "The Electrical Conductivity of Certain Light Aluminium Alloys as affected by Exposure to London Atmosphere" being taken as read.

A good deal of amusement has been caused by an incident which occurred last week. On Friday the Irish newspapers contained letters from indignant correspondents protesting against the large sign-board placed over the principal entrance to Trinity College. This board bore the words "The British Association" in capital letters of bright yellow on a blue ground. Apparently the authorities did not act with sufficient rapidity for the taste of some of the students who are remaining up for the long vacation. At all events, some of the more enterprising of these gentlemen took it upon themselves to remove the last eight letters on the signboard during the night, with the result that the citizens of Dublin, as well as members and associates, had the time-worn joke thrust upon them in a most forcible manner the next day.

Tuesday, September 8th.

Section A has again been divided into three departments, of which the first (*a*) was devoted to mathematics, the Papers dealing with such subjects as the distribution of electricity on a moving sphere, the fourth dimension and other matters of equal interest.

In department (*b*) (general physics) Prof. E. Rutherford, F.R.S., read a short but exceedingly interesting Paper on "The Scintillations of Zinc Sulphide." In commencing, he recapitulated his hypothesis that each scintillation which occurs when radium emanation is in proximity to a zinc sulphide screen is due to the impact of a helium atom. This effect is not merely mechanical, but, the author maintained, is due to chemical dissociation, the actual flash being caused either by the dissociation itself, or more probably by the recombination which takes place almost immediately. Hence it is possible to observe the action of individual atoms. Prof. Rutherford's experiments were conducted with a view to ascertaining the efficiency of the transformation of the energy of the atoms into light energy. He enclosed some 200 milligrams of radium bromide in a glass tube, which also contained a zinc sulphide screen, and then compared the luminosity of the latter with that of a standard source of light by means of direct photometry. As a result he found that the illuminating power of the aggregate scintillations was of the order of 1/50 to 1/200 of a candle-power, and this showed the efficiency of the transformation of energy of the α particles to be approximately 80 per cent. This figure was enormously in excess of what he had anticipated. In reply to questions, Prof. Rutherford stated that his figures were only approximate as the ordinary errors which occurred in photometric determinations had to be taken into account, and of course impaired the accuracy of his results. The light itself, when examined with a spectroscope gave a continuous blue spectrum, and did not exhibit the characteristic spectrum of zinc.

Mr. Horace H. Poole then read a Paper on "A Determination of the Rate of Evolution of Heat by Pitchblende." A spherical vacuum jacketed vessel with a narrow neck was filled with powdered and carefully dried pitchblende. The neck was filled with cotton-wool and rendered water-tight with sheet rubber, and the whole buried in ice. The difference of temperature between the layer of pitchblende in contact with the bottom of the vessel and the ice was measured by a sensitive thermo-couple. After about a fortnight this temperature became steady, when the heat leakage across the walls of the vessel was equal to the heat generated by the pitchblende. This leakage depended solely on the vessel and on the difference of temperature between the inner and outer walls, which was measured by the thermo-couple. The thermal conductance of the vessel was found by substituting water for the pitchblende and determining its rate of cooling. Hence the heat leakage was known, and, knowing the amount of pitchblende present, the heat evolution per gramme was found. The thermo couple was calibrated by placing one junction in finely broken ice and the other in a mixture of broken ice and water, which could be subjected to a known pressure. The deflection caused by the resulting small change of temperature was noted, and hence the sensitiveness of the couple was found. Using 560·7 gms. of pitchblende in an atmosphere of nitrogen, the temperature finally steadied at 0·0092°C. As the thermal conductance of the vessel was 5·8 calories per hour per degree difference of temperature between inside and outside, this corresponded to a heat leakage of 0·053 calorie per hour. Hence the heat evolution per gramme of pitchblende was 0·000094 calorie per

hour. This was about twice the quantity estimated from the known amount of radium present.

Section G opened with a Paper on "The Laws of Flight," by Mr. F. W. Lanchester, and was followed by Mr. F. H. Royce's Paper on "The Causes of Wear in Motor Vehicle Machinery." Neither Paper possessed any features of electrical interest, but the latter showed that many of the failures of motor vehicles were due simply to lack of engineering knowledge on the part of the builders.

Wednesday, September 9th.

There has been a great exodus of members and associates during the past two days, and as a consequence to-day's meetings were very sparsely attended—indeed, some of the Sections did not meet at all. Section A was concerned entirely with meteorological matters, while only three Papers were down for reading in Section G. The first was by Messrs. J. Brown, F.R.S., and Maurice F. Fitzgerald, entitled "Experiments on Rotating Discs." The authors began by referring to the difficulty of the mathematical analysis of the elastic deformation, under centrifugal stress, of rapidly revolving discs, particularly when formed with a central hole, surrounded by a thick boss, gradually reduced outwards to a thin edge by an arbitrary curve, and mentioned the investigations of Dr. Chree and Mr. F. Purser of the cases of cylinders and ellipsoids. The authors' experiments, made for the purpose of finding out whether approximate formulæ, such as have been given for cases in practice in such works as that of Stodola on "Steam Turbines," are sufficiently correct for practical purposes. Two discs, made of red rubber weighing 72 lb. per cubic foot, were tested. The discs were both 12 in. external diameter. One was solid, $\frac{1}{2}$ in. thick at edge, 2 in. at the centre, its surfaces being two flat cones. The other was $\frac{5}{8}$ in. thick at edge, in its centre was a hole $1\frac{1}{2}$ in. diameter, surrounded by a boss, with flat ends $2\frac{1}{2}$ in. diameter and 3 in. thick, the surfaces between the edges of the boss and disc being shaped to hollow hyperbolic curves. The discs were suspended from the end of the shaft of a small motor, placed with its axis vertical, and circles drawn on the faces, previously painted white, while spinning. Photographs being taken of the discs while spinning and when at rest, the strains at different radii were found by comparison of the photographs, and plotted as curves, shown by lantern slides. The results were compared with those of approximate formulæ. In the case of the solid disc the difference between the speeds causing a given strain as calculated and as observed amounts to about 20 per cent. and may, considering the imperfect elasticity of indiarubber, be considered a fair enough approximation; but in the case of the other disc, though the formula gives a tolerably fair idea of the shape of the curve of strains, its error as to the actual magnitude of the speed causing a given strain is so great, being nearly 400 per cent., as to lead to the conclusion that the formula could not be trusted for practical purposes.

Mr. F. Douglas Fox then read his Paper on "Urban and Suburban Transit and Methods of Railless Traction." This Paper was decidedly the best that was presented in Section G, and it is to be regretted that it was discussed so briefly. The author had evidently expended an enormous amount of time and trouble in its compilation, and there is no doubt that it will prove an extremely valuable work of reference for years to come. Elsewhere we print this Paper in full.

Mr. Sheardown, in opening the discussion, said the outlook for petrol-driven omnibuses was a very poor one, and Mr. Fox's low figure of 1s. per car-mile for these vehicles was very difficult to attain. The difficulty in municipal tramway systems was that they were not carried on for the purpose of making money but for catching votes. A non-paying route was a very difficult matter; it was generally of no use to reduce the service in the hope of raising the receipts per car-mile, as this usually had the effect of reducing the number of passengers, who often preferred walking to waiting for a car. In fact, it was often found that a more frequent service on a non-paying route would cause an increase in the receipts per car-mile, and so convert the route into a paying one. Reducing the length of the stage was quite hopeless, as passengers preferred walking the extra distance to paying another fare. He thought it was too soon to gauge the possibilities of the electrobuses now running on the streets of London, for, although people now preferred them to petrol 'buses, and thus enabled them to secure more passengers, yet if they displaced the petrol vehicles entirely this preference would not apply. With regard to road surfaces, he was of the opinion that the paving of the London streets made comparison with working expenses on country roads impossible. Railless traction had a great future in country districts, provided there were good facilities for a supply of cheap power, the great advantage consisting in low capital expenditure. Moreover, it would be possible to work with much less substantial overhead construction than was necessary in towns.

Another speaker, referring to the table which compares the working expenses of tramways, petrol omnibuses and the trackless trolley system, inquired whether the figure of 5·13d. per car-mile, for the last-named system, included cost of road maintenance, which would be considerable. To this Mr. Fox replied in the affirmative, stating that the figure allowed was £100 per mile per annum.

Mr. Ryan considered that the railless system would be very suitable for many districts in Ireland, but he did not agree with Mr. Sheardown regarding the possibility of tyre expenses being lower in London than in the country. This, he explained, was due to the fact that the starting and stopping, which had a very serious effect on tyres, was much more frequent in the Metropolis.

Other speakers referred to the effect which the vehicles would have upon road surfaces.

In the course of his reply, Mr. Fox mentioned that the weight per axle in the vehicles of the proposed system was much less than that in either petrol or accumulator 'buses, being only about $1\frac{1}{4}$ tons.

In the afternoon a garden party was given to members of the Association by the Lord-Lieutenant at the Viceregal Lodge, but inclement weather detracted greatly from the enjoyment of the function. This concluded the 1908 meeting.

CORRESPONDENCE.

OSCILLATION VALVE OR AUDION.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: My attention has been drawn to the letter of Dr. de Forest in your issue of September 4th, in which, in characteristic fashion, he endeavours to depreciate Mr. Walter's tantalum wave detector. As far as concerns himself, Mr. Walter has made a sufficient reply, but I note that Dr. de Forest also seizes the opportunity for insisting on a difference between his "audion" and my glow lamp detector, a distinction which I think exists chiefly in his own imagination, and couples it with the entirely unwarrantable assertion that my invention was "taken from early German scientists."

In a letter to *The Electrician* of January 4, 1907 (Vol. LVIII., p. 464), I met a similar allegation by proving that no German investigator had anticipated me in showing that a glow lamp, having an insulated plate or plates sealed into the bulb, could be used as a sensitive radio-telegraphic receiver, and I need not repeat my proofs. The first mention of such an appliance for the above purpose occurs in my British patent No. 24,850 of 1904, and the first published account in the *Proc.* Roy. Soc. for March, 1905. After that date Dr. de Forest apparently woke up to the fact that a new class of radio-telegraphic detector had been invented in England. My equivalent U.S.A. patent was applied for April 19, 1905, and granted November 7, 1905. On December 9, 1905, Dr. de Forest applied for a U.S.A. patent, No. 823,402, in which, on p. 3, he makes full reference to this glow lamp detector, and refers to it properly as due to me.

Nine months later, however, he read a Paper to the American Institute of Electrical Engineers on an identical appliance, then re-christened an audion, and, for obvious reasons, took considerable pains to refer the origin of this glow lamp detector to Elster and Geitel.

It has since been extolled by him as an invention of his own, and in half-a-dozen or more U.S.A. patents its use and construction in various ways has been described by him with copious elaboration and a multiplicity of claims as "an oscillation responsive device," but which in every form consists of a glow lamp having one or more metal plates or wires sealed into the bulb. Now the last claim in my U.S.A. patent of April 19, 1905, runs as follows; "At a receiving station in a system of wireless telegraphy employing electric oscillations of high frequency a detector comprising a vacuous vessel, two conductors adjacent but not touching each other in the vessel, means for heating one of the conductors, a circuit outside of the vessel connecting the two conductors, means for detecting a continuous current in the circuit, and means for impressing on the circuit the received oscillations."

I think Dr. de Forest will have some difficulty in showing that his so-called audion, no matter how used, is not comprised within the above claim, and it may become necessary before long to obtain a more unbiassed opinion than his own or mine on this matter. Meanwhile, however, there is not the slightest justification for reckless or untruthful statements that my invention was taken from early German scientists. The German Patent Office is not in the habit of granting to foreigners patents for inventions which consist merely in appropriating the work of German scientists, whether early or late, yet the German Patent Office granted to me, after the usual lengthy examination and oppositions, and issued on May 6, 1907, a patent for this glow lamp detector as a radio-telegraphic receiver, and this patent, in virtue of the rules of the Convention, dates back to November 16, 1904, the date of application of the British patent.

Your impartial readers, at any rate, will see that when the United States and German Patent Offices have granted me patents for the invention of this glow lamp receiver, which has been successfully used across the Atlantic, there is absolutely no excuse for a subsequent patentee of similar devices making use of misleading insinuations with the object of disparaging the work which preceded his own.—I am, &c,

Hampstead, Sept. 8. J. A. FLEMING.

REPORT OF THE BRITISH ASSOCIATION COMMITTEE ON PRACTICAL STANDARDS FOR ELECTRICAL MEASUREMENTS.*

The Committee desire in the first place to record their deep sense of the loss they have sustained by the death of Lord Kelvin. He was an original member of the Committee appointed at Cambridge, October 3, 1862, and he continued his active interest in their work up to the end. His name will always be associated with the establishment of the absolute system of electrical measurement and with the determination of the absolute units. The Reports of the Committee from 1862 onwards contain a large amount of valuable information in a form which is not generally very accessible—the reprint of the earlier reports, issued under the editorship of Fleeming Jenkin, in 1873, is out of print—and the Committee suggest that their reports from 1862 up to the present time might be reprinted as a memorial to Lord Kelvin. The present time is in other respects specially suitable for such a reissue, for it is hoped that the proposed International Congress, to be held in London in October, will settle in a definite manner the few matters relating to the fundamental units which are still outstanding, and will organise a method whereby a close agreement may be maintained among the electrical standards in use throughout the world.

The electrical measurements of certain of the fundamental units, which have been in progress for some time at the National Physical Laboratory, have been brought to a conclusion, and the results published in three Papers in the *Philosophical Transactions* of the Royal Society.

(1) "A New Current Weigher and a Determination of the Electromotive Force of the Normal Weston Cadmium Cell." By Prof. W. E. Ayrton, F.R.S., T. Mather, F.R.S., and F. E. Smith, A.R.C.Sc., *Phil. Trans.*, A, Vol. CCVII., pp. 463-549.

(2) "On the Normal Weston Cadmium Cell." By F. E. Smith, *Phil. Trans.*, A, Vol. CCVII., pp. 393-420.

(3) "On a Comparison of many forms of Silver Voltameters." By F. E. Smith. And "A Determination of the Electrochemical Equivalent of Silver." By F. E. Smith and T. Mather, F.R.S., *Phil. Trans.*, A. Vol. CCVII., pp. 545-581.

"The Chemistry of the Silver Voltameter." By F. E. Smith and T. M. Lowry, D.Sc., *Phil. Trans.*, A, Vol. CCVII., pp. 581-599.

From the first of these it appears that to a very high degree of accuracy the E.M.F. of the Weston cadmium cell, as set up at the National Physical Laboratory, when expressed in terms of the ampere (10^{-1} C.G.S. units of current) and the international ohm is 1·0183$_3$ at a temperature of 17°C.

The second Paper deals with the preparation of the Weston cadmium cell, and contains a comparison between cells set up at the Laboratory and others constructed elsewhere, the general conclusion being that cells can be prepared by different persons in different countries which will agree in E.M.F. to 1 or 2 parts in 100,000.

In the third Paper there is given an account of a comparison of some six forms of silver voltameters, and it is shown that the silver deposited by a current of 1 ampere in all these various forms is the same if proper precautions are taken, and amounts to 1·11827 mg. per second.

After this work was completed a comparison was made by Messrs. T. Mather and F. E. Smith, by the kindness of Mr. Trotter, between the ampere standard of the Board of Trade and the ampere as realised by the new Ayrton-Jones balance at the National Physical Laboratory. The comparison, an account of which appears in the *Proceedings* of the Royal Society, A, Vol. LXXX., 1908, was very satisfactory. It was found that the Board of Trade ampere will deposit silver at the rate of 1·1179$_1$ mg. per second, a value which is nearly identical with the number 1·1179$_4$ given by Lord Rayleigh and Mrs. Sidgwick in 1884. Indirectly the E.M.F. of the normal Weston cadmium cell was found to be 1·0187$_9$ Board of Trade volt at 17°C., the Board of Trade volt being defined as the P.D. between the terminals of a resistance of 1 Board of Trade ohm when 1 Board of Trade ampere is passing through it.

During the year the 10 mercury standards at the National Physical Laboratory have again been set up and intercompared. An account of this work appears in an appendix by Mr. F. E. Smith, the value of the international ohm, as realised by the mean of the 10 tubes, being taken as unit. The following table gives the values of the individual tubes as found in 1903 and 1907:—

Table I.

Mercury standard.	Value in mean international ohms. 1903.	1907.	Difference value 1907–1903.
M	0·97170$_5$	0·97169$_1$	0·[illegible]
P	1·00038$_7$	1·00042$_1$	+3$_4$
T	1·00019$_1$	1·00020$_2$	+1$_1$
U	0·97349$_7$	0·97348$_8$	−0·[illegible]
V	1·00137$_8$	1·00137$_1$	−0·[illegible]
X	1·00106$_0$	1·00106$_2$	0·[illegible]
Y	1·00026	1·00026$_2$	0$_2$
Z	1·00130$_1$	1·00129	−0·[illegible]
G	1·00105$_2$	1·00104$_1$	[illegible]
S	1·00097$_4$	1·00097$_2$	−0·[illegible]

Except in the case of tube P, where there is an apparent change of 3 to 4 parts in 100,000, the differences are negligible.

Mr. Smith has also compared with the mercury tubes a large series of wire standard resistances, including those made by Matthiessen and Hockin for the B.A. Committee in 1865-67, and various other old standards kindly lent to the Committee by their owners for the purpose. The general conclusion is that all the original coils except D and E, which are made of platinum, have changed appreciably since

Table II. —*Resistance at 16° in Terms of the Original B.A. Unit* (1867).

Coil.	Material.	1867.	1876.	1879-81	1888.	1908.	Max. change
A	Pt. Ir.	1·00000	1·00077	1·00056	1·00147	1·00122	0·00147
B	Pt. Ir.	1·00029	1·00121	1·00080	1·00104	1·00098	0·00092
C	Au. Ag.	1·00050	1·00141	1·00101	1·00146	1·00173	0·00123
D	Pt.	1·00092	1·00092	1·00092	1·00092	1·00092	0·00000
E	Pt.	1·00152	1·00152	1·00152	1·00152	1·00152	0·00000
F	Pt. Ag.	.		1·00016	1·00072	1·00160	0·00144
G	Pt. Ag.	1·00022	1·00030	0·99982	1·00025	1·00175	0·00193
H	Pt. Ag.	1·00020	.		1·00042	1·00044	0·00024
Flat	Pt. Ag.	.	.	1·00079	1·00120	1·00125	0·00046

* Slightly abbreviated. The report was issued during the meeting at Dublin. The Committee consists of Lord Rayleigh (chairman), Dr. R. T. Glazebrook (secretary), Prof. W. E. Ayrton, J. Perry, W. G. Adams and G. Carey Foster, Sir Oliver J. Lodge, Dr. A. Muirhead, Sir W. H. Preece, Prof. A. Schuster, J. A. Fleming and J. J. Thomson, Dr. W. N. Shaw, Dr. J. T. Bottomley, Rev. T. C. Fitzpatrick, Dr. G. Johnstone Stoney, Prof. S. P. Thompson, Mr. J. Rennie, Principal E. H. Griffiths, Sir A. W. Rücker, Prof. H. L. Callendar, and Messrs. G. Matthey, A. P. Trotter, T. Mather and F. E. Smith.

they were constructed, though since 1888, during a period of 20 years, for which the coils have been very carefully watched, the changes also in A, B, C, H and Flat have been small. F and G have, however, in the same period changed considerably.

The mean resistance of six other platinum-silver coils, first measured in 1888, appears to have increased since that time by 14 parts in 100,000; and five more platinum-silver coils, first measured in 1894-7, have now a greater mean value by 8 parts in 100,000. It would appear also that in many of the variable coils the changes have occurred mainly, if not entirely, at the soft-soldered joints, and with a view of testing this the Committee have authorised the secretary to open and examine one of the coils.

A comparison, given in the Appendix, has also been made of all the magnanin resistances in the possession of the Standards Department of the Laboratory. The behaviour of the various coils is somewhat different; while some have been very constant, others appear to have changed considerably.

At the Conference on Electrical Units, held at the Reichsanstalt in 1905, it was suggested that the Jena glass 59''' was, from its good elastic properties, the best glass to employ for mercury resistances, and accordingly efforts have been made to get some suitable tubes. Five tubes have recently been secured, after great difficulty, which will probably do for standards, but the difficulty of drawing them is a serious obstacle to their use. A number of tubes of French glass, "verre dur," are also on order.

Progress has also been made during the year in the design of the Lorenz apparatus, to be given by the Drapers' Company, and the manufacture of the bed and the heavy-metal work has been entrusted to Messrs. Armstrong, Whitworth & Co., who have kindly undertaken it. The marble cylinders required have been delivered at the National Physical Laboratory.

Preparations for the holding of an International Congress on Electrical Units in London in October next are well advanced. Specifications dealing with the international ohm, the international ampere, and the Weston cadmium cell, which have been prepared at the National Physical Laboratory after consultation with other workers to serve as a basis of discussion at the Congress, are given in the Appendix with a view of making them known.

Appendix I.

On the Secular Changes of the Standards of Resistance at the National Physical Laboratory. By F. E. Smith, A.R.C.Sc.

(From the National Physical Laboratory.)

It has long been known that many resistance coils of platinum-silver, of maganin, and of other resistance alloys do not keep constant in resistance. The causes of the changes may lie in some alteration in structure of the alloy, of some change in strain, of surface action, of faulty joints, or, as suggested by Dr. Rosa, they may lie in the insulating medium. The question of the permanence of manganin standards has been discussed recently by Messrs. Rosa and Babcock* and by Drs. Jaeger and Lindeck,† and it seemed desirable to bring together all the information available regarding the changes which have taken place in the coils of the Association, and of others which have from time to time been compared with them.

At the National Physical Laboratory the primary standards of resistance are of mercury, and the secondary standards are of platinum, platinum-iridium, gold-silver, platinum-silver, and of manganin. It will be shown that the mercury standards have kept constant, that the platinum coils have probably kept constant, that the platinum-iridium, gold-silver, and a few of the platinum-silver coils have changed considerably, while other platinum-silver coils have kept very nearly constant. Of the manganin coils a few have kept very nearly constant, but most of them have increased in resistance.

The platinum, platinum-iridium, and some of the gold-silver and platinum-silver coils are the property of the Association, and many of them were first compared by Matthiessen and Hockin in 1865-7. Most of the manganin standards were constructed by O. Wolff, Berlin, but four were built by Mr. Melsom at the National Physical Laboratory. These standards vary in nominal value from one-thousandth of an ohm to 10,000 ohms.

The method of comparing resistances has been dealt with in a previous Report,‡ and for the purposes of this communication it will be sufficient to state that, on all occasions when mercury standards were erected, the resistance coils were measured in terms of the mean unit represented by the mercury columns, with a probable error of about 5 parts in 1,000,000. In the intervals between the comparisons with mercury standards the values of the coils in international ohms were at times uncertain within 1 to 2 parts in 100,000, but the relative values of the unit coils of manganin with potential leads could at all times be determined with an error not greater than about 2 parts in 10,000,000, and the one-thousandth ohm and 10,000 ohms manganin standards could in general be measured in terms of the unit coils within about 5 parts in 1,000,000. In the intervals between the erections of the mercury tubes a very careful survey of the history of the coils was often necessary to determine the most probable changes in the coils, and a slight readjustment of the values allotted to the coils was sometimes made when the mercury standards were next employed. The probable error of the resistance values assigned to the manganin standards on any date is almost certainly less than 1 part in 100,000.

* *The Electrician*, June 14, 1907, and November 15, 1907.

† *Ibid.*, August 2, 1907.

‡ B.A. *Report*, Section A, 1906.

Mercury Standards of Resistance.

The mercury standards of resistance are 10 in number, and were constructed in 1902-3. The mean international ohm as realised by the ten standards is taken as the unit, and each tube is measured in terms of it. In practice two manganin coils act as intermediaries. The measured values in 1903 and 1907 are given in Table I. in the report above. With the exception of P the relative values of the standards have kept remarkably constant, and in the case of P the increase in resistance may be apparent only, for only in 1907 has an increase been noted. It is thought that a very thin film of grease may be coating a portion of the inner wall of the tube. As the tubes M, G, and S are of French *verre dur*, and the remainder of Jena 16''' glass, there is justification for assuming the constancy of the standards. It is of interest to state that the relative values of the French mercury standards in 1885 and 1905 and of the mercury standards of the Reichsanstalt in 1893 and 1904, are also in very good agreement.

Wire Standards of Platinum, Platinum-Iridium, Gold-Silver, and Platinum-Silver.

The original coils of the Association are six in number; two are of platinum, two of platinum-iridium, one of gold-silver, and one of platinum-silver. They were compared together by Messrs. Matthiessen and Hockin in 1865-67, by Messrs. Chrystal and Saunder in 1876, by Dr. Fleming in 1879-81, by Dr. Glazebrook and Mr. Fitzpatrick in 1887-88, and by the author in 1908. In addition to these six coils, Messrs. Chrystal and Saunder examined a platinum-silver coil marked No. 29 F, and also a coil known as Flat, while measurements of another platinum-silver coil H are given in the Report for 1888. These coils —in all, 9—have remained in charge of the secretary.

In a report to the Association in 1888 Dr. Glazebrook discussed the probable changes which had taken place in the coils since 1867, and changes in the platinum-silver coils only are discussed in the Reports for 1892 and 1903. In 1865-67 the probable error of the comparisons appears to have been of that order which would be introduced by an error in the temperature of the coils of about 0·1°C. In 1888 and 1903 the error of the comparisons corresponds with an error in the temperature of the coils of a little less than 0·1°C., and in 1908 the error has been reduced so as to correspond with about 0·02°C. All of the coils are surrounded by paraffin wax, and it is only by maintaining a constant temperature for many hours that very accurate observations can be made. The scale of temperature employed for the 1908 measurements is the hydrogen scale; that used for previous observations is almost certainly the Kew glass scale. Dr. J. A. Harker has recently shown* that the difference between these two scales is negligibly small; hence we may assume that the same scale of temperature has been used throughout.

The present method of comparing the coils is by substitution in one arm of a Wheatstone shunt bridge, of which the other three arms consist of manganin resistances. The high tempertaure coefficient coils are kept in a room remaining constant in temperature to 0·01°C. over several days, and the temperature does not differ from 16·0°C. by more than 0·5°C. About 16 measurements, spread over several days, are made of each coil, and the value at 16·0°C. is deduced from these measurements. During 1908 approximate values for the temperature coefficients of resistance of the coils have been obtained by varying the temperature from 14° to 17°C. These values are given in Tables IV. and VII.

In 1867 the temperatures are given at which the coils were 1 B.A. unit, and this procedure was in part followed in 1876, 1879, and 1888. The unit of 1867 was, however, probably different to those of 1876, 1879, and 1888. Messrs. Chrystal and Saunder (1876) assumed one of the coils (B) to have remained constant between 1867 and 1876, and expressed the values of the other coils in terms of it. The unit, in terms of which the measurements of 1879-81 were made, is the mean B.A. unit as indicated by Fleming on his chart; it is supposed to represent the mean of the resistances of the six coils A, B, C, D, E, G at the temperatures at which they were originally correct.

* *Proc.* Roy. Soc., A, Vol. LXXVIII.

It is this unit which was used by Lord Rayleigh in his work on the ohm, and by Dr. Glazebrook since about 1880, and it has been closely adhered to in all measurements made by the Committee since that date.

A close examination of the chart at the present day shows that the mean of the values of the six coils is really about 0·99985 unit; hence if this interpretation be accepted, the mean B.A. unit is really 15 parts in 100,000 less than the unit which has been taken since 1880; but it has not been thought wise to attempt any correction on this score, except in the compilation of Table IV. At times a sudden change in a coil has been recorded, as in 1888, when Dr. Glazebrook reported that F had suddenly risen in value by 0·00048 B.A. unit,‡ and that Flat had fallen by 1 part in 10,000.§ Similar changes may have been observed when the coils were comparatively new, and it is possible that a slightly variable coil was disregarded, or a correction applied because of it, when the chart summarising the observations for 1879-81 was constructed. The chart gives the values of the coils from 0°C. to 25°C., and the graphs are such that the value of a coil can be read with an error not greater than 3 parts in 100,000, which is equivalent to a change in temperature of 0·1°C. of a platinum-silver coil. The resistances of the coils at various temperatures as given by the chart are given in Table I.

Table III.—*Giving the Values of the Coils in 1879-81, from Fleming's Chart.*

Coil.	Temp. at which coil was stated to be correct in 1867.	Value of coil, from Fleming's chart, at temp. given in 1867.	Value of coil, from Fleming's chart, at 16·0°C.
A	16·0°C.	1·00011	1·00011
B	15·8	1·00006	1·00035
C	15·3	1·00007	1·00056
D	15·7	0·99960	1·00052
E	15·7	1·00010	1·00102
F	...	...	0·99971
G	15·2	0·99916	0·99937
Flat	...	...	1·00034

If we tentatively adopt as the B.A. unit at any date the exact mean of the resistances of the coils A, B, C, D, E, G at the temperatures at which they were originally said to be equal, the values of the coils at 16·0°C. in 1867, 1876, 1879-81, 1888, and 1908 are as given in Table IV. This table has been very easy to compile, because only the differences between the resistances of the coils at the various dates, and their temperature coefficients, were required.

In all the tables of this Appendix the values of high-temperature coefficient coils are given within 1 part in 100,000; but as the errors of observation must often have exceeded the change in resistance corresponding with a change in temperature of a coil of 0·5° to 0·1°C., too much significance must not be attached to an apparent change in resistance, corresponding with a difference in temperature of a coil of a tenth of a degree.

Table IV.—*Values at 16°C.*

Coil.	Material	Approx. temp.co-effi. 1908	1867.	1876.	1879-81	1888.	1892.	1903.	1908.
A	Pt. Ir.	0·00148	1·00000	1·00021	1·00026	1·00083	...	...	1·00034
B	Pt. Ir.	0·00148	1·00029	1·00065	1·00050	1·00040	...	...	1·00010
C	Au. Ag	0·00070	1·00050	1·00085	1·00071	1·00082	...	...	1·00085
D	Pt.	0·00312	1·00092	1·00036	1·00067	1·00028	...	...	1·00004
E	Pt.	0·00314	1·00091	1·00099	1·00117	1·00088	...	...	1·00064
F	Pt. Ag.	0·00027	...	...	0·99986	1·00008	1·00051	1·00083	1·00072
G	Pt. Ag.	0·00028	1·00022	0·99974	0·99952	0·99961	0·99925	0·99975	1·00087
H	Pt. Ag.	0·00028	1·00020	...	...	0·99978	0·99943	0·99976	0·99956
Flat	Pt. Ag.	0·00027	...	...	1·00049	1·00056	1·00033	1·00050	1·00037
Mean of A,B,C,D,E,G =			1·00047	1·00047	1·00047	1·00047	...	...	1·00047

It is clear that changes of very considerable magnitude have taken place, and the task before us is to select the most constant and the most variable coils. In all such cases a table of difference values is most helpful. Table V. gives such values for the six coils A, B, C, D, E, G in 1×10^{-5} B.A. units at 16°C. We conclude from the differences given in column 7 and the temperatures given in the last column of Table V. that B and E have possibly remained constant during the period 1867-1908 and that C and D are next in order of constancy. The coils D and E have remained relatively constant since 1876.

Dr. Glazebrook in 1888 measured the B.A. unit in terms of the specific resistance of mercury, and found that the value of the resistance of a column of mercury, 1 metre long, 1 sq. mm. in section, at 0°C. was 0·95352 B.A. unit. For the purposes of the comparison,

‡ B.A. *Report* 1888. § *Phil. Trans.*, A, 1888, p. 364.

Table V.—*Difference between Values in 1×10^{-5} B.A. Units.*

Coils.	1867.	1876	1879-81	1888	1908	Max. diff. between diff. values	Diff. in col. 7 equiv. to an uncertainty of temp. of coil with largest temp. co-effi. of
A–B	−29	−44	−24	43	24	87	0·6°C.
A–C	−50	−64	−45	1	−51	65	0·4
A–D	−92	−15	−41	55	30	147	0·5
A–E	−91	−78	−91	−5	−30	86	0·3
A–G	−22	47	74	122	−53	175	1·2
B–C	21	−20	−21	−42	−75	55	0·4
B–D	−63	29	−17	12	6	92	0·3
B–E	−62	−34	−67	−48	−54	33	0·1
B–G	7	91	98	79	−77	175	1·2
C–D	−42	49	4	4	81	123	0·4
C–E	−41	−14	−46	6	21	67	0·2
C–G	28	111	119	121	−2	123	1·8
D–E	1*	−63	−50	−60	−60	64	0·2
D–G	70	62	115	67	−83	198	0·6
E–G	69	125	165	127	−23	188	0·6

* Hockin (1867 Report) gives the temperatures at which D and E were correct in 1865, 1866 and 1867. From the values given by him it appears that the difference D–E was -59×10^{-5} B.A.U. at 16°C. in 1865, -59×10^{-5} in 1866, and 1 in 1867. These differences, taken in conjunction with those given in the above table, make it practically certain that the difference given for 1867 is incorrect, and should be replaced by a difference of the order −60.

Dr. Glazebrook used the two coils F and G, and their values are given by him as F=0·99807 B.A.U. at 10°C., G=0·99778 B.A.U. at 10°C. These values were taken from Fleming's chart, and when corrected to 16°C. they are practically identical with those recorded in Table III., as they should be. Flat was also used (0·99857 B.A.U. at 10°C.) but observations during the two years preceding 1888 showed that it was relatively lower than when examined by Dr. Fleming, and its value was not, therefore, taken from the chart.

In 1908 the individual coils were compared with the new mercury standards set up at the N.P.L. and their values found in terms of mercury. If we assume that the mean value of the coils A, B, C, D, E, G, is the same as when Fleming's chart was constructed, we obtain as the resistance of 1 metre of mercury, 1 sq. mm. in section, at 0°C., the value 0·95333 B.A.U., an alteration of 20 parts in 100,000 since 1888. If, on the other hand, we suppose that the mercury units set up in 1908 agree exactly with those constructed in 1888, then the mean value of the six coils in question has altered by 0·00020 B.A.U. At the present date, assuming as found in 1888 the resistance of 1 metre of mercury, 1 sq. mm. in section at 0°C. to be 0·95352 B.A.U., the individual coils have the values given in Table VI., column 3.

The apparent changes in resistance of the coils, together with the alterations in temperature of the coils necessary to produce equal changes in the resistance, are given in Table VII.

From Tables VI. and VII. it appears to be practically certain that the coils B, D, E and H have the same resistance in 1908 as they had in 1888. The agreement of the values for D and E is very remarkable for the temperatures at which these coils were believed to be correct in 1888 are stated to the nearest tenth of a degree only; an apparent change in resistance of 15 parts in 100,000 would, therefore, have been negligible. With respect to G, it has risen by over 1 part in 1,000 during the past five years and Flat changed by 17 parts in 100,000 in 1902.* The fluctuations in the value of H are believed to have amounted to about 1 part in 10,000 during the period 1888-1908.†

Of the four coils B, D, E, H, apparently constant for the period 1888-1908, we have already concluded from the differences given in Table V. that B, D and E have remained approximately constant since 1867. One of the coils, D-E appears, from Table V., to have changed in the interval 1867-1876, and the apparent change corresponds with the change resulting when one of the coils is lowered 0·2°C. in temperature. It is, however, practically certain that the change is only apparent. The temperatures at which the platinum coils were stated to be correct in 1865, 1866, and 1867 are given by Mr. Hockin in the Report for 1867. They are as follows:—

Coil No. 35 (D)	B.A.U. at 15·7°C.	January	7, 1865
	.. .. 15·7°C.	August	18, 1866
	.. .. 15·7°C.	February	10, 1867
Coil No. 36 (E).	.. .. 15·5°C.	January	7, 1865
	.. .. 15·5°C.	August	18, 1866
	.. .. 15·7°C.	February	10, 1867

* Brit. Assoc. *Rep.*, 1903. † *Ibid.*

Table VI. *Values of Coils at* 16° C. *in* 1888 *and* 1908 *obtained from comparison with Mercury Tubes, assuming the Resistance of* 1 *metre of Mercury to be* 0·95352 *B.A. Unit.*

Coil.	Value in 1888 at time of determination of spec. res. of mercury.*	Value in 1908.
A	1·00068	1·00042
B	1·00025	1·00018
C	1·00067	1·00093
D	1·00013	1·00012
E	1·00073	1·00072
F	0·99970	1·00080
G	0·99936	1·00095
H	0·99963	0·99964
Flat	1·00023	1·00045

* In Dr. Glazebrook's experiments the terminals of the mercury standards were not exactly at 0°C., and an error of about 4 parts in 100,000 was probably introduced because of this. No correction on this score has, however, been applied, as the magnitude of the error is only of the same order as the probable error of the observations.

Table VII.

Coil.	Resistance of coil in 1908 minus Resistance of coil in 1888.	Change equiv. to diff. of temp. of
A	26 $\times 10^{-5}$ B.A.U.	0·18 C.
B	−7	0·05
C	+26	0·37
D	−1	0·00
E	1	0·00
F	+110	4·0
G	+159	5·7
H	+1	0·03
Flat	+22	0·81

In the Report for 1888 the temperature coefficient of D is given as 0·00308 B.A.U., and of E as 0·00302 B.A.U. These values agree closely with those given in Table IV., and they have been used in the compilation of the following complete list of the difference values (D-E) which now deserves attention :—

D-E	59	10^{-5} B.A.U. at 16·0°C.	Year 1865
,,	= −59	,, ,, ,,	,, 1866
,,	1	,, ,, ,,	,, 1867
,,	63	,, ,, ,,	,, 1876
,,	50	,, ,, ,,	,, 1879-81
,,	−60	,, ,, ,,	,, 1888
,,	60	,, ,, ,,	,, 1908

The conclusion is obvious. The original difference between the coils was approximately 60×10^{-5} B.A. unit and has remained constant ever since. There is little doubt that the difference recorded for 1867 is incorrect ; it may easily happen that there is a difference of 0·2°C. between the apparent and true temperatures of a coil embedded in paraffin wax, and such a difference would completely explain the 1867 result.

This conclusion necessitates a revision of the difference values in Table V. The corrections are easily made, for the differences A-E, B-E, C-E and E-G should be respectively equal to the differences A-D, B-D, &c.

We believe that the two platinum coils have remained constant in resistance since 1867, and that the values in 1867, 1879-81, 1888, and 1908 of these and other coils in terms of the original B.A. unit (1867) are as given in Table II. of the report above.

From Tables II. and V. (above) it is clear that the maximum number of coils which can have kept constant is two, and if the platinum coils have not remained constant then one only of the other coils can have done so. Since D and E are of pure platinum, and not of an alloy, it is probable that these would change least. If our conclusions are correct, the results are not only of some value as showing the changes which may take place in the resistance of certain alloys when embedded in paraffin wax, but they are also of value because the coils link together so many determinations of the ohm in absolute measure and of the specific resistance of mercury. It is not convenient to collect the various determinations here, but as an instance of the uses to which the data given in this Appendix might be put we take Lord Rayleigh's and Mrs. Sidgwick's determination in 1881† of the specific resistance of mercury. It was found that 0·95412 B.A. unit was equal in resistance to a column of mercury 100 cm. long, 1 sq. mm. in section, at 0°C. Now in Lord Rayleigh's experiments the terminals of the mercury standards were not at 0°C., but at 5° or 6°C., and it was shown by Dr. Glazebrook‡ in 1888 that an error of about 0·00024 was almost certainly introduced because of this. If we apply a correction of this amount, Lord Rayleigh's value becomes 0·95388 B.A. unit as the resistance of 100 cm. of mercury at 0°C. The coils F and Flat were used in the 1881 determination, and the values of these coils were taken from Fleming's chart. They were therefore :—

F = 0·99971 B.A. unit at 16·0°C. (From Table III.)
Flat = 1·00034 B.A. unit at 16·0°C. (From Table III.)

From Lord Rayleigh's observations, therefore,

F at 16·0°C. = 0·99971/0·95388 = 104·805 cm. mercury ; and
Flat at 16·0°C. = 1·0034 /0·95388 = 104·871 cm. mercury.

At the present time (1908)

F at 16·0°C. = 104·959 cm. mercury ; and
Flat at 16·0°C. = 104·922 cm. mercury.

Using the 1908 values and the changes in F and Flat, recorded in Table II. (of Report), we conclude that in 1881

F at 16·0°C. was equivalent to 104·808 cm. mercury ; and
Flat at 16·0°C. was equivalent to 104·874 cm. mercury.

The difference from the values given by Lord Rayleigh is 3 parts in 100,000, which is less than the probable error of the observations. We conclude, therefore, that the determination of Lord Rayleigh and Mrs. Sidgwick in 1881 is in excellent agreement with that made at the National Physical Laboratory in 1908, and this latter has already been shown to agree with that made by Dr. Glazebrook in 1888.

The following is now a very useful summary. The values of the coils in centimetres of mercury in 1881, 1888, and 1908 are given in Table VIII. :—

Table VIII. —*Giving the Values at* 16·0°C. *of certain Coils in cm. of Mercury in* 1881, 1888 *and* 1908, *obtained from comparisons with Mercury Standards.*

Coil.	1881*	1888†	1908‡	Max. Diff.
	cm.	cm.	cm.	cm.
A	104·847	104·946	104·918	0·071
B	104·872	104·901	104·893	0·029
C	104·894	104·945	104·972	0·078
D	104·885	104·888	104·887	0·003
E	104·948	104·951	104·950	0·003
F	104·805	104·843	104·959	0·154
G	104·769	104·807	104·974	0·205
H	—	104·836	104·837	0·001
Flat	104·871	104·898	104·922	0·051

* Values deduced from Lord Rayleigh's determination of the specific Resistance of Mercury. F and Flat were used ; for Relative Values of Coils (*see* Table II. of report).

† Values at time of Dr. Glazebrook's Determination. F, G, and Flat were used ; for Relative Values of Coils (*see* Table VI).

‡ Values directly Determined through N.P.L. Mercury Standards of Resistance.

The preceding comparison strengthens the conclusions already arrived at respecting the most constant coils. From Table VIII., D and E have apparently kept constant in resistance since 1881, while H appears to have remained constant since 1888. It is of some importance to note that in 1892 the ratio of the B.A. unit to the ohm was accepted as being 1 ohm = 1·01358 B.A. unit, this being based on the values 100 cm. mercury = 0·9535 B.A. unit. 106·3 cm. mercury = 1 ohm.

(To be Continued.)

† *Phil. Trans.*, Vol. CLXXIV., p. 173.
‡ *Ibid.*, A, 1888, pp. 375-6.

BOOKS RECEIVED.

(Copies of the undermentioned works can be had from *The Electrician* office, post free, on receipt of published price, adding 3d. for books published under 2s. Add 10 per cent. for abroad or for foreign books.)

"Proceedings of the Royal Society." Vol. LXXX. No. B. 541. Series B, Biological Sciences. (London : Harrison & Sons.) 3s. 6d.

"Proceedings of the Royal Society." Vol. LXXXI. No. A546. Series A. Mathematical and Physical Sciences. (London : Harrison & Sons). 3s.

"The Principles of Alternating Currents." By Edgar T. Larner. (London : Crosby Lockwood & Son). 3s. 6d. net.

"Science Abstracts." August, 1908. Vol. XI., part 8. Section A, Physics ; section B, Electrical Engineering. (London : E. & F. N. Spon.) 1s. 6d. each.

"Cranes." By Anton Böttcher. Translated and supplemented by A. Tolhausen. (London : A. Constable & Co.) 42s. net.

AN IMPROVED DRY DANIELL PILE.*

BY J. BROWN, F.R.S.

Summary. This Paper describes a few improvements in details of the dry Daniell pile, and an experiment indicating its capability in maintaining its potential for considerable periods.

The method of construction of the pile was shown at the meeting in South Africa in 1905, its characteristics described and a few elements exhibited.† In December of that year a working example of it was made, having plates 4·6 in. square, the zincs bright as they came from the manufacturer, the coppers cleaned by dilute sulphuric acid. For the electrolytes blotting paper sheets were wet with dilute solutions of copper sulphate and zinc sulphate, quickly dried by hanging up in a warm room. If the solutions be too strong, coarse crystals form in the paper preventing a smooth surface. The papers were cut by adjustable shears to the same size as the plates. The plates and the papers, as described, were built into a pile of 124 cells (no plain paper now used), its ends insulated with sheets of rubber and paraffined paper, and strongly clamped between wooden cheeks by means of ⅝ in. iron bolts. When used to electrify the needle of a quadrant electrometer, the pile, as first set up in 1905, gave a deflection for one Daniell cell of 77 to 80 divisions on the scale. It has not been altered since, and is now giving about 82.

The pile was exhibited to the section.

MUNICIPAL, FOREIGN & GENERAL NOTES.

APPOINTMENT VACANT.

Belfast Library and Technical Instruction committee invite applcations for the position of assistant lecturer and demonstrator in the mechanical engineering department at the Municipal Technical Institute, Belfast. Salary £180 per annum. Particulars of duties and conditions of appointment from the principal (Mr. Fras. C. Forth), to whom applications by noon Sept. 23. See an advertisement.

EDUCATIONAL NOTICES.

Armstrong College (Newcastle-on-Tyne).—The session 1908-9 will commence on Sept. 28. There are complete courses of instruction in mechanical, civil, electrical and marine engineering, naval architecture, mining, metallurgy, &c. Particulars from the secretary (Mr. F. H. Pruen).

Battersea Polytechnic (London, S.W.)—At this polytechnic there are day and evening courses of instruction. The day courses include preparation for the B.Sc. in engineering of the University of London and the polytechnic diploma in (*a*) mechanical, (*b*) electrical and (*c*) civil engineering. The entrance examination begins on Sept. 15. The evening classes include preparation for the B.Sc. in engineering, associateship examination of the I.C.E., &c. Prospectus on application to the Secretary.

Sir John Cass Technical Institute, London.—There are evening classes in chemistry, metallurgy, physics and mathematics, designed to meet the requirements of those engaged in the chemical, metallurgical and electrical industries and in trades associated therewith. Facilities are also given for special and advanced practical work in well-equipped laboratories both in the afternoon and evening. The classes in general physics and mathematics are arranged so as to prepare for the final B.Sc. examination of London University, and there are special courses of general physics and electricity and magnetism for the Honours B.Sc. on conduction in gases and radio-activity and on the differential and integral calculus for science students. The new session begins Sept. 21. Details of classes may be obtained at the Institute, Jewry-street, Aldgate, E.C., or by letter from the Principal, Mr. C. A. Keane, B.Sc., Ph.D., F.I.C.

Hackney Technical Institute, London, N.E.—The next session commences on Sept. 21. There will be evening lecture and laboratory courses in electrical engineering subjects, including electrical measurements, dynamos and motors, alternating currents, electrical design, &c. Prospectuses from the Principal.

Northampton Polytechnic Institute (London).—The full day courses in the theory and practice of mechanical and electrical engineering will commence on Monday, Oct. 5. Entrance examination on Sept. 30 and Oct. 1. The courses include periods spent in commercial workshops and extend over four years; they also prepare for the degree of B.Sc. in Engineering at the University of London. Three entrance scholarships of the value of £52 each will be offered for competition at the entrance examinations in September. In the technical optics department there are full and part time day courses. Full particulars as to fees, &c., can be obtained at the Institute or on application to the Principal, Dr. R. Mullineux Walmsley.

We have to acknowledge receipt of a copy of the "announcements" (Educational and Social) of this Institute for the Session, 1908-9. There are day and evening courses in electrical and mechanical engineering, technical optics and artistic crafts, and in horology. In addition, there are evening courses in technical chemistry and domestic economy. The classes of the day courses commence on Oct. 5, and those of the evening courses on Sept. 28. Enrolments for the latter commence on 14th inst.

The recent provision of increased accommodation obtained by the occupation of the British Horological Institute not having been found sufficient for the growing requirements of the "Northampton," an additional building is now being erected, and it is hoped that the greater part of it will be available immediately after Christmas. The new building will contain a lecture room larger than any of the existing lecture rooms, and increased class room accommodation. It also provides for the enlargement of the mechanical engineering workshops and the mechanical laboratory, and includes new power laboratories. With this increased accommodation the work in the mechanical engineering department will be materially assisted. In the new session the work of the day courses in engineering, technical optics and artistic crafts will be continued with minor developments on the lines which are now so well known. In the evening classes the electrical engineering department announces a full sessional course in wireless telegraphy and telephony, the pioneer course held last May in this subject having proved very successful. In the technical optics department, besides minor developments, there will be classes for kinematograph operators in continuation of the pioneer classes last session.

University of London (University College).—The courses of instruction in mechanical, civil, municipal and electrical engineering begin on Monday, Oct. 5. The fee for the full three-year diploma course in engineering, including the course for graduation (B.Sc. in the faculty of engineering, is 120 guineas. The college contains spacious mechanical and electrical engineering laboratories, workshops, drawing office, &c., and the extension to the engineering school will be ready for students entering in October.

Heriot-Watt College, Edinburgh.—The opening of the new engineering laboratories will take place on 16th inst., when the Right Hon. the Earl of Rosebery will perform the inaugural ceremony. The laboratories contain complete equipment for steam, oil, suction gas, coal gas and petrol prime movers. The college offers courses of training for mechanical and electrical engineers, and special instruction is provided in prime movers for advanced students. Further information may be obtained from the principal, Mr. A. P. Laurie, M.A., D.Sc.

South-Western Polytechnic (Chelsea, London, S.W.)—A complete three years' course in electrical engineering is held during the day and a four years' course in the evening. There are courses of lectures and practical work in elementary, intermediate and advanced electrical engineering, electrical design, instruments and lamps, alternating and polyphase currents, electric wiring and fitting, calculus for engineers, &c.

Glasgow and West of Scotland Technical College.—We have received a copy of the guide to the evening classes in science and technology for the session, 1908-9, at this college. The guide gives in a handy and accessible form useful information to students as to the lines of systematic study in electrical and mechanical engineering, &c., and also a concise statement of the facilities for technical studies in continuation classes leading up to the higher work of the technical college. The continuation classes begin on Sept. 14, and the technical classes on Sept. 21.

Northern Polytechnic Institute.—We have received a copy of the prospectus for the session 1908-9. There are day and evening classes in electrical and mechanical engineering, physics, chemistry, &c. The courses of instruction prepare for the B.Sc. (in engineering) of the University of London.

Accrington.—Sanction has been received to a further loan of £7,500 for extensions of the electricity undertaking.

Admiralty Wireless Telegraph Operators.—In order to provide an adequate staff of wireless operators on board H.M. ships, the training of signalmen is to be so regulated that these ratings shall be capable of rendering assistance in the wireless room without detriment to their duties as visual signalmen.

In this direction, my lords state that recent experience has proved that for the efficient conduct of wireless telegraphy work in ships at sea operators should be in four watches; further, that there should be two men in each watch, the second of whom should be competent to assist generally, and to take his turn in the silent cabinet, as a continuous period of two hours is considered to be as long as a man can remain without loss of efficiency. Four telegraphist ratings are, therefore, to be provided for,

* Paper read before Section A of the British Association.

† *Vide The Electrician*, September 15, 1905, p. 858.

each ship. The four men required to assist these ratings will be drawn from the signalmen, and ordinary signalmen allowed in the complement, and are to work in the wireless room when watch is being kept. The instruction of signal boys in the training establishment and in the signal school will be carried out as at present. Subject to Admiralty approval, a limited number of signal ratings, who show special aptitude for wireless telegraph work, will be allowed to transfer to the wireless telegraph branch in existing vacancies, provided they pass the necessary examinations. In future leading signalmen and higher signal ratings are not to be employed in the wireless room unless absolutely necessary. Men of these ratings, however, who are now borne in lieu of wireless telegraphy ratings, may continue to be so employed for the present. The course for boy telegraphists in the training ship will remain as at present. The courses and examinations for telegraphists and higher ratings will also remain, but all telegraphist ratings are to receive instruction in signalling to enable them to acquire a knowledge of signal books.

Africa.—The "British and South African Export Gazette" states that a telephone exchange is to be equipped at Beira, and a telephone line (210 miles in length) erected between Pietermaritzburg and Pretoria and Johannesburg.

The Victoria Falls Power Co. have completed the equipment of their Brakpan (Transvaal) power station. To the original plant of four 750 kw. three-phase generators with four engines and 10 boilers there have been added two 3,000 kw. A.E.G. generators, two Curtis turbines and eight 1,500 H.P. Babcock boilers, besides coal transporter, new switchboards, &c. It is stated that the company's Germiston station, which is expected to be completed early next year, will contain plant of double the capacity of that in the Brakpan works.

Belfast.—At last week's meeting of the Corporation the chairman of the Electricity committee presented a report on the question of interruption to the Queen's-road tramway service by firms bringing heavy articles across the line. It was resolved that

As a temporary expedient it be an instruction to the general manager and the electrical engineer, on receipt of notice that the tramway service required to be interrupted by shipyard operations, to arrange for the removal and replacing of the overhead wires where necessary.

In connection with the arbitration between Messrs. J. G. White & Co., and the Corporation in regard to the engines at the generating station, it was decided to engage Mr. A. E. Porte, M.I.E.E., to give evidence for the Corporation.

Berlin Underground Electric Railway.—The Municipal Council of Schöneberg, a suburb of Berlin, have approved plans for the construction of an underground electric railway, estimated to cost 10,200,000 marks (£510,000). It is stated that the contract has been obtained by the Siemens-Schückert Company.

Bradford.—Recently the City Council directed an experiment to be made in street lighting in order to compare the efficiency and cost of electricity and gas.

The work of erecting the lamps, &c., has been completed, and swan-neck attachments for lamps have been inserted in 18 tramway posts in Manningham-lane. Flame arc lamps, similar to the lamps which have been adopted for lighting Oxford-street (London), are to be used. The lamps are of 2,500 c.p. The Gas committee have not decided upon the steps which they propose to take in the competition.

Brighton.—The tramway service is to be revised for the winter months in the hope that expenses may be reduced.

Burnley.—A recommendation of the Tramways Committee to fix wattmeters on the tramcars to register the quantity of electrical energy consumed, has been referred back.

The height of the new chimney at the electricity works is to be increased to 210 ft. so as to obviate the need for forced draught and to effect a saving in regard to mechanical stokers.

Burslem.—The L. G. Board are asked to grant sanction to the borrowing of £12,000 for extensions of the electricity undertaking.

Ceylon.—The "Indian and Eastern Engineer" states that the Ceylon Government have provisionally approved the details of the scheme submitted by Messrs. Ryland & Cooper for the electric lighting of Nuwara Eliya, pending the receipt of advice from the consulting engineers.

Mr. N. Naylor has gone out from England to take charge of Stone's electric lighting on the trains of the Ceylon Government Railway.

Cheltenham.—On Monday the Council authorised an expenditure of £700 (out of renewals fund) on new plant at the electricity works, including £312 for a condenser and £350 for a new motor generator.

Colchester.—The borough electrical engineer (Mr. A. R. Sillar) has recently received several important applications for the supply of electrical energy for power, including one from Messrs. Spottiswoode & Co.) who propose to adopt electric driving at their works at Hythe Quay.

Dover.—Application has been made for sanction to a loan of £3,000 for extending the electric light mains to St. Margaret's-at-Cliffe.

Eastbourne.—The watch committee recommend the Council not to licence the proposed service of electric omnibuses as they consider the needs of the borough are sufficiently met by the existing municipal service.

Edinburgh.—The Electric Light committee recommend the Council to reduce the minimum charge for power from £2 to £1. 10s. per annum.

Electric Headlights on Locomotives.—The Georgia (U.S.A.) Legislature has passed a law requiring railways to use electric headlights on the locomotives of all through trains. It is reported that the law is to be resisted as unconstitutional.

Electric Traction for Colliery Purposes.—The Consett Iron Co. have constructed a narrow gauge railway (2 ft. 2 in.) on the overhead system for the haulage of coal from the Whittonstall drift to the Chopwell colliery, co. Durham, a distance of about 2 miles. At present there is only one locomotive, which can draw 25 tons. The contract for the equipment of the line was carried out by Siemens Bros. Dynamo Works.

Electrical Power Distribution in Canada.—It is reported that legal proceedings are being taken to restrain the Ontario Government from proceeding with the construction of the electric transmission line from Niagara. The grounds of the action are that as $10,000,000 (£2,000,000) is invested in the Canadian Electrical Development Co. and $7,000,000 (£1,400,000) in the Toronto Electric Light Co., neither Toronto nor the Provincial Government can enter with fairness into competition with these private concerns.

Electricity in Dockyards.—"Engineering" states that Messrs. Swan, Hunter & Wigham Richardson have just launched two steel floating docks, to the order of the Para Construction Co., for the Port of Para, Brazil.

The new port works now under construction will provide extensive new quays, with a depth of water alongside at low water of 30 ft., commodious warehouses, and up-to-date electrical equipment to meet all modern requirements. Each dock is capable of lifting vessels up to 1,700 tons displacement, and has a length of 230 ft., an extreme width of 64 ft., a docking width of about 45 ft., and a draught over the keel blocks of 12 ft. The docks have been constructed to the designs of Messrs. Clark & Standfield, of Westminster, and are of the box type. The pumping machinery is electrically driven, current being supplied from a generating station situated on shore. An air-compressing plant is also installed on the docks, which will likewise be electrically driven.

Electrobuses for Bath.—A special committee recommend the Council to license motor taxicabs to ply for hire in the city. The committee have also granted the request of the London Electrobus Co. to receive a deputation and to allow them to send down an omnibus for inspection. It is the intention of the company to apply for licences for six electric omnibuses.

Fareham.—An unopposed inquiry was held here last week into the application of the Council to borrow £10,000 for new electricity works.

The consulting engineers are Messrs. May & Hawes. Diesel oil engines are to be used for driving the alternators, which will have a capacity of 200 kw. There will be 27 flame arc lamps for street lighting.

The inspector (Mr. H. Ross Hooper) thought that instead of a £10,000 loan for a period of 22 years, there should only be a loan of £8,300 repayable in 15 years, leaving the outstanding balance on the old works to be provided out of the rates.

Felixstowe.—At the meeting of the Council last week the Lighting committee reported that as the outcome of their negotiations with the Suffolk Electric Supply Co., the latter offered to accept £8,000 for all their rights under the agreement of the 18th May, 1903, including the overhead mains, provided such offer was accepted before the end of September.

Further complaints as to the nuisance caused by the existing works had been received, and the Council were threatened with legal proceedings. They had been advised by their consulting engineer that the only course open to the Council was to buy out the company on or before June 30, 1909, and in the meantime to erect steam generating plant near the sewage outfall works or other approved site; the company to remove their four-cylinder gas engine and the producer set used in connection therewith, which had been the chief cause of the trouble. The present works to be used as a distributing station, the small gas engines being retained for charging the battery and in case of temporary breakdowns, but their general use to be discontinued.

The committee therefore recommended that the company's offer of £8,000 be accepted, subject to the following conditions: (1) that the purchase include all the company's interest in the Felixstowe electricity undertaking, including mains and connections, and all plant works and materials, except the 4-cylinder gas engine and the producer plant in connection therewith; (2) that the completion take place on June 30, 1909, or such other date as may be fixed by the Council on giving one month's notice to the company; (3) that all extensions in the meantime be made by, and at the option of the Council, and that until such completion is effected, the company con-

time to work the undertaking; (4) that application be forthwith made to the L. G. Board and the Board of Trade (if necessary) for their sanction to the proposed purchase.

The chairman of the committee (Mr. Cowles) moved the adoption of the report, and urged the Council to accept the company's offer.

A discussion ensued, but the matter was adjourned until Wednesday next.

German Electricity Suppliers and Wiring Work.—The Saxon Branch of the Union of Electrical Installation Firms in Germany has asked the Minister of the Interior to prevent the monopoly of house installation work by electricity supply undertakings and their nominees.

It is complained that the action of the electricity works has made free competition impossible, and is not in the interests of consumers as it not only prevents the latter from getting installation work done at the lowest price but retards reduction in the price of current because the number of installations carried out is restricted by the absence of free competition.

The Ministry has asked the Chambers of Commerce in Saxony to express their opinion on the subject, and the Leipzig Chamber (in whose district the Saxony branch of the Union is most largely represented) has replied that firms which erect and equip electricity works for the electricity supply departments of municipalities or private companies often impose a condition that they shall also have the privilege of carrying out the wiring works and supply of motors or be entitled, in a greater or less degree, to influence the placing of orders for such work with other firms. This, it is represented, tends to keep up prices. The Chamber thinks that experience has proved that a check upon the growing monopoly of installation work is desirable in the interests of the smaller and medium-sized firms of contractors.

The Union of Bavarian Industries has also energetically protested against the monopoly.

Gillingham.—At the meeting of the Council last week various extensions of the electric light mains were authorised.

G.N.R. Royal Saloon.—A Royal "saloon" which the G.N.R. Co. has had fitted up for the use of their Majesties contains a day compartment, smoking compartment, a convertible compartment, which serves as a dining room in the day and a sleeping room by night, a dressing room en suite, in addition to the balcony and attendants' compartments. The electric fittings throughout have been specially designed to produce a rich effect combined with simplicity, and to take up as little room as possible. The whole of the decoration and furnishing have been carried out by Waring & Gillow.

Haslingden.—As announced in our last issue, the official inspection of the first portion of the Haslingden tramways (from Accrington to the Commercial Hotel, Haslingden) took place on Friday last, and the line was opened for traffic on Saturday. The overhead work, to Messrs. Handcock & Dykes' specification, is on the Pringle system, the contract having been carried out by Messrs. Dick, Kerr & Co. Pending the completion of the undertaking, arrangements have been made for Accrington Corporation to supply and run their cars on this section at an agreed price per car-mile.

Herne Bay.—The Council will apply for a provisional electric lighting order.

Hythe.—A poll of the ratepayers on the tramway question has resulted in a majority in favour of the principle of tramways, but against the use of the overhead in lieu of the conduit system originally proposed.

India.—Mr. J. W. Meares, electrical adviser to the Government of India, has estimated the capital cost of establishing electricity works for Ootacamund Municipality at 1,00,000 rupees, which it is suggested should be borrowed from the Government at 4 per cent. and be repayable in 15 years.

"Indian Engineering" states that the overhead system has succeeded beyond expectation in connection with the Calcutta tramways and mishaps have been reduced to a point sufficiently low to allay all public misgiving.

Inquests.—On Monday the adjourned inquiry was held into the death of the three persons who were killed by the explosion of Capt. Lovelace's airship at the Franco-British Exhibition, London, on Aug. 14.

Capt. T. T. Lovelace, recalled, said his airship was kept in a tent 120 ft. by 45 ft. by 37 ft. The tent was supported by poles and was lighted by electricity from wires running over poles. Every precaution was taken to prevent a short circuit. On the morning of the disaster there was a rip on the port side. A piece of cloth had become torn, and he instructed Miss Hill to repair it. In view of the highly inflammable nature of the gas (hydrogen) he had given strict injunctions against the use of lights or smoking. Electric fans were employed in the air dome for ventilation and for discovering any defects there might be in the balloon. On the morning of the accident a quantity of gas had been lost, and it was necessary to inflate the bag with air. After this was done the net was tied up. He was then starting to go into the balloon tent to ask Miss Hill (deceased) to do something to the airship rudder, which was outside, when the explosion occurred. The balloon would hold 10,000 c.f. of gas. That morning there were about 9,000 to 9,500 c.f. of gas in it, and he blew in about 500 ft. of air. That quantity did not make an explosive mixture. He meant that seriously. The airship had been constructed in the United States and was brought over to the Exhibition in June. He held qualifications as aeronaut, as engineer, and as master mariner. He had a diploma from the Panama Government, and he was recognised as an aeronaut.

John Henry Leonard, assistant balloonist, said that on the morning of the disaster the bag was filled about two-thirds with hydrogen when, under orders, the air was ordered to be blown in. The electric fan was placed near the neck. The witness said he noticed the gas bag was getting very tight. He went outside to Capt. Lovelace, and asked him to go in and look at the balloon, as it was, he thought, full enough. He came in, and witness went round to the other side of the balloon to examine a repair in the fabric that Miss Hill had made. Having examined it he was preparing to put on the patch—a solution—as was always done, when the accident occurred. He did not hear any explosion then or after. He looked at his hands and found all the skin hanging as if blown off. Witness here described what he saw of the movements of those in the tent at the time and gave particulars of their injuries. Witness and Waites (one of the deceased) were taken to the infirmary and while there he asked Waites "Had you stopped the fan and tied up the net?" Waites said he had not. Of this he was quite sure. Witness said he heard the fan working up to within two minutes of the explosion.

Wilfred H. Bedwell, an electrician employed at the Exhibition, deposed that just before the accident he had occasion to visit the tent for a pair of steps. When in the tent, about four to five minutes before the disaster, he saw a man sitting near the neck of the balloon with his feet towards the airship. The fan was then working.

Henry W. Grand, aeronaut, said that he saw Waites filling the balloon. He thought the balloon was filled enough, and said so. He then stooped down and shut the fan off.

The Coroner: How long was it from the moment that you stopped the fan that the accident occurred?—About eight or ten minutes.

So if anyone says the fan was running continuously up to within two minutes of the explosion that would not be correct?—No, I stopped it myself. No one was smoking and he had never noticed the fan spark. In reply to the Coroner, the witness said he really feared that Waites must have started the fan afterwards.

Sidney Oliver, labourer, who was engaged in repairing the network said that a minute or so before the explosion he saw the fan working. He had to pass the fan, and saw Waites there and the fan working.

Mr. Eustace Ridley, electrical and mechanical engineer, of the Fire Brigade Department, London County Council, said that on Aug. 10 one of his assistants inspected the electric light arrangements at the tent. The plugs were so arranged that they could be automatically cut off if the tent collapsed, and that, in fact, actually happened. He examined the tent after the explosion, and found no trace of any short-circuit in the electrical arrangements. The fans used were ordinary standard fans of a type which frequently sparked. They were Brush fans. He was of opinion that there was a circumscribed explosion followed by a fire. If the balloon had been filled with 10,000 ft. of explosive mixture the explosion would have been terrible. His suggestion was that a celluloid comb, which Miss Hill might have been wearing, could have become ignited by the sun. If it was known that the fans were being used for such a purpose whilst the public were there it would have been objected to.

The jury returned a verdict of accidental death in each case. They found that the explosion was caused by using an electric fan to force air into the airship, this use the jury considered to be dangerous.

An inquest was held at Preston last week into the death of J. E. Johnson, who was killed at Messrs. Dick Kerr & Co.'s works on 2nd inst.

Evidence was given that deceased, who was 45 years of age, had been employed by Messrs. Dick, Kerr & Co. for the past seven years.

Lewis Dallas said Johnson was near witness assisting at the switchboard, when he muttered "Oh," and said he had had a shock. He took three steps away, collapsed and became unconscious. Death ensued in about 20 minutes. The voltage of the current could not have been more than 300 on that particular switch, and he could not account for deceased getting a fatal shock. Shortly before the accident happened deceased complained of feeling tired, but he believed he was in good health.

Leonard Lucas, tester's assistant, thought Johnson must have got his boots wet. He could not account in any other way for his receiving the shock, for the ground in the vicinity was dry. He had had many shocks during the two or three years he had been engaged on that work, and of more than 300 volts. About 10 seconds before the accident deceased asked witness to switch off and he did so slowly. Just as witness broke the circuit deceased shouted.

Mr. H. Ainsley Cox, chief of the testing department, said the insulation of the switch was all right, as he tested it immediately after the accident. Deceased had been engaged on that work for nearly 12 months, and had been in the service of the firm for some years in Calcutta and Tokio, and only a few weeks ago they had put him forward for a station superintendent's position at Calcutta. The voltage of the switch was between 250 and 300, and the maximum voltage was 500. He could not, personally, consider he had had a dangerous shock at 300 volts, and he could not understand how such a voltage could prove fatal, especially to a healthy man.

The Inspector of Factories (Mr. Seymour): You work up to very high voltages sometimes. Have you any particular precautions?—We use rubber mats and gloves occasionally, but I don't think anyone cares to

use gloves. There are too many pin holes in them as a rule. But they are there if the men choose to use them.

Witness further said that since the accident he had made experiments to try to discover the exact voltage. Under the most unfavourable circumstances, with the floor wet with brine and boots soaked in brine, they did not get more than 650 volts, and that was not necessarily fatal.

Dr. PILKINGTON said there were no bruises, burns, or marks of injury, but there was one very remarkable appearance. In all cases of death, especially sudden death, where the body was filled with blood, the blood gravitated to the lowest parts of the body, which became purple and livid, with the exception of those places in which the body had rested, such as the shoulders and buttocks. In the case of deceased, however, the back was very livid, and there was an unusual whiteness on the buttocks and shoulders, where the weight of the body had rested, but those patches were outlined by a band of red. This band looked much as if it had been made by a hot iron, but the skin was not burnt. Having regard to the healthy conditions of the organs, the absence of any actual disease, the congested condition of all the organs, the appearances he had described and the evidence he had heard, he concluded that death was due to electric shock. The extreme amount of fat in the body, and round the organs would make deceased less able to withstand any sudden shock. None of the organs were in such a condition as would account for death.

The jury found that death was due to electric shock, accidentally received.

Llandudno.—Owing to the increasing demands of the Llandudno & Colwyn Bay Light Railway Co. for electric current, the Electric Light committee have been compelled to consider the question of making additions to the generating plant.

L.C.C. Tramways.—A committee of Battersea Borough Council recommend that consent be given to the doubling and reconstruction of the tramlines from Lavender-hill to Chelsea Bridge. Consent is also to be given to the reconstruction of the Lavender-hill and St. John's-hill lines, and work on the Chelsea Bridge line has been begun.

London Underground Railways.—A circular has been issued by the Underground Electric Railways Co. of London, announcing that on and after Oct. 1 no season tickets will be issued on the Baker Street & Waterloo, Great Northern, Piccadilly & Brompton, and the Charing Cross & Hampstead Railways, but travellers will be able to purchase tickets in strips of six at a lower rate than ordinary present fares. These strips can be purchased in any quantity. The season-ticket system on the District Railway remains unchanged.

Maidstone.—An unopposed inquiry was held last week into the application of the Council to borrow £18,440 to cover excess expenditure to March 31 and also for extensions of the electricity undertaking.

The borough electrical engineer (Mr. E. E. Hoadley) pointed out that the excess expenditure up to March 31 (£5,559) was in connection with main laying. All the loans had been pooled and it was impossible to tell when the loan granted for one purpose was exhausted. It was practically impossible to make up a list, and he thought the best way would be for the Board to grant a short period loan so as to clear it off. In some towns it had been granted for 12 years.

The Inspector (Mr. H. R. Hooper) said he thought it was reasonable to ask for 12 years. The average was from five to 12 years.

Melbourne Suburban Railways.—The report of Mr. C. H Merz on the proposal to convert the suburban railways of Melbourne to electric traction was sent in some weeks ago, and it is now reported that he proposes a general scheme, involving an expenditure of £2,000,000, and a smaller scheme for converting four lines only, at a cost of £800,000. The report has already been discussed by the railway authorities, and there seems a likelihood that the Government will favour and carry out the smaller scheme. Tenders are expected to be invited shortly.

Municipal Authorities and Annual Conferences.—From time to time local authorities receive reminders (in the shape of notices of surcharge by Local Government Board auditors of expenses incurred by municipal officials in attending technical conferences, &c.), that the authority for incurring expenditure of this character is very limited. Kensington Council considers it highly desirable that Metropolitan Borough Councils should have power to incur reasonable expenditure in respect of the attendance of members and officials at conferences having a bearing upon their duties, and London County Council has been asked to insert in their next general powers Bill a clause to this effect.

Neath.—At the meeting of the Rural Council on Wednesday the chairman of the Electric committee (Mr. W. Howell), said they had applied for sanction to borrow £18,000 for electricity supply. They had already secured customers for over 100,000 units annually. £7,000 was included for the purchase of the power station of the South Wales Electrical Power Distribution Co., and they hoped to get power to effect a transfer within the next month. It was intended to connect the districts of Briton Ferry and Llansamlet, where they had a number of prospective customers.

New South Wales Tramways.—The report of the chief commissioner of railways (Mr. T. R. Johnson), on the working of the Government railways and tramways for the year ended June 30, states that the number of miles of tramway open was 132¾. The total capital expenditure on lines open for traffic was £3,732,991. The total earnings amounted to £1,011,994, compared with £908,701 last year, an increase of 11·37 per cent. After making provision for upkeep and providing £25,000 to clear off the capital cost of old cable plant, conduits, &c., of certain lines, £32,000 on account of old steam motors, and £25,000 towards depreciation of the Ultimo Power House machinery, the total expenditure amounted to £809,065 compared with £727,947. The percentage of expenditure to receipts was 79·95 per cent. compared with 80·11 per cent. The net result, after providing for all working expenses and £134,504 interest on capital, was a surplus of £68,425 compared with £48,961. During the year 172,020,932 passengers were carried.

Obituary.—The death occurred on Sept. 1, in his 65th year, of Mr. Richard Jones, late works manager of the Electric Construction Co., Wolverhampton.

Oldbury.—The transfer of the Oldbury electric lighting order (1900) to the Birmingham & Midland Tramways (Ltd.), has been settled. The company agrees to pay the costs incurred by the Council in obtaining the order, together with interest, amounting altogether to £535. 18s. 7d.

Oldham.—The Council have applied for sanction to a loan of £10,250 for extensions of the electric lighting mains, &c.

Pacific Cable.—The annual report to March 31, 1908, of the Pacific Cable Board, dated July 22, is just issued. After deploring the loss of Sir Spencer Walpole, the late Chairman of the Board, and of Mr. C. H. Reynolds, the late manager, the reports set out the financial results of the preceding year's operations.

The traffic receipts amounted to £113,548. 18s. 1d., less £3,911. 13s. paid to the Atlantic companies for handling the Board's messages. Interest on deposits realised £522. 17s. 3d., leaving the deficiency (£62,362. 10s.) recoverable in the following proportions:—U.K. £17,322. 18s. 4d., Canada £17,322. 18s. 4d., Australia £20,787. 10s., New Zealand £6,929. 3s. 4d. Total receipts £172,522 12s. 4d. Expenditure included head office (salaries and expenses) £4,345. 9s. 1d., ditto (advertising, canvassing, engineers' fees, royalties, and cost of remitting money home) £1,596. 12s. 7d., stations (salaries and expenses) £38,764. 16s. 1d., ship (salaries and expenses) £16,759. 12s. 11d., provident fund £1,511. 3s. 8d., renewal account £32,000.

Compared with 1906-7, there was a falling off of £2,852. 15s. 2d. in gross traffic receipts; but of this the greater part (£1,800 to £2,000) is only apparent, the accounts for 1906-7 having included the receipts at Southport for 13 months, while those for 1907-8 include only 12 months' takings. On the expenditure side there has been an increase of £4,082. 13s., £2,027. 16s. due to the insurance on the Board's cable ship; but nearly one-half of the premium will probably be eventually recovered. The remainder of the increase is attributable to various causes. Expenditure on the maintenance and working of the cable during the year, including £32,000 carried to renewal account and £1,511. 3s. 8d. contributed to the provident fund, amounted to £94,977. 14s. 4d., or £15,182. 8s. less than the net revenue earned. The annuity to the National Debt Commissioners absorbs this surplus, and £62,362. 10s. in addition, which has to be made good by the several Governments associated in the enterprise. The total contributions to the renewal fund, including interest, amounted on the 31st March last to £198,836. 12s. 11d., £12,500 of this sum being held in spare cable.

The Board's forecast of its probable revenue and expenditure during the year 1908-9 is as follows:—

Traffic revenue ...	£108,000	Sixth annuity	£77,545
Estimated deficit......	69,566	Renewal fund	31,000
		Working expenses ...	69,021
	£177,566		£177,566

The land line services in Australia and New Zealand have been generally well maintained by the Governments concerned. The Atlantic companies have afforded uninterrupted cable communication throughout the year, and a rapid and efficient service. In Canada the lines of the Canadian Pacific Railway, both in Vancouver Island and elsewhere, suffered considerable interruption, first from bush fires and unusual electrical disturbances in July, August and September, and later from severe storms in November and December. In the latter month, a gale occurred in Vancouver Island which is said to have been the worst on record in that region, and caused an interruption of over 70 hours, all the wires having been thrown down. In August, moreover, the traffic, more especially that to the States, was considerably disorganised by reason of the strike of telegraph operators in Chicago, and the sympathy it excited amongst those employed by the Canadian Pacific Railway.

The health of the staff has been satisfactory throughout the year, and the service rendered by them has continued to be maintained on the high level of efficiency and zeal which has characterised it in previous years. Throughout the year the cable has worked without interruption, and no repairs have been called for. The buildings, electrical apparatus, and plant, at all stations, have been maintained in good order. No damage has occurred to the repairing vessel "Iris," and the discipline and effi-

ciency of the ship's company have continued to be thoroughly satisfactory. The wharf and shed, which the New Zealand Government undertook to provide for her use at Auckland, were completed by January of this year, and permanent moorings for the vessel are now in course of being supplied.

Paraguay.—In Mr. Consul C. Gosling's report for 1907 it is stated that during the year a telegraph line was constructed between Asuncion and Villa Encarnación (1,208 miles) at a cost of £6,469. A cable between the same town and Posadas is shortly to be laid, and will connect Paraguay and Argentina. Telegraphic communication between Villa Encarnación and Bella Vista on the Brazilian frontier is also in course of construction, and will when completed unite these two countries. A wire from the village of Yhú to the River Paraná, opposite the Yguazú Falls, is also contemplated.

Paris Electricians' Strike.—On Wednesday M. Pataud (Secretary of the Electricians' Union) was sued in one of the Paris courts for damages by three music-hall artistes, as being responsible for the strike from which they alleged they suffered damage. He was ordered to pay each plaintiff 8 francs damages.

Personal.—On the 8th inst., the marriage of Mr. C. Turnbull, M.I.E.E., Borough Electrical Engineer, of Tynemouth, to Miss Lily Grey Turner took place at St. James' Congregational Church, Newcastle-upon-Tyne.

Portsmouth.—On Tuesday the Corporation decided to extend the tramways system to Milton.

Sheffield.—On Wednesday the City Council voted £10,000 out of the tramway funds towards starting relief works for the unemployed during the coming winter.

Sunderland.—On Wednesday the Council directed that two motor generators, now at Messrs. Laing's sub-station, be removed to Dunning-street works, at a cost of £1,011, to be borne out of current revenue, and that a new 600 kw. rotary converter be installed at the latter works, at a cost of £2,506, to be borne out of capital account.

Ald. TURNBULL moved, "That it be an instruction to the Electricity and Lighting committee to (1) obtain a complete independent valuation of the whole of the present plant of the electricity undertaking; (2) prepare a detailed statement of the cost of power supply to each private customer, the cost to include all capital expenditure and the amount of profit or loss on each account for the preceding 12 months to be shown, the return to be presented within three months." He said he had no feeling against the chairman of the Electricity committee or the Electrical Engineer. It was right that they should know whether the engines and boilers at Dunning-street were all right. One of the reasons which had induced him to bring the matter forward was the extravagant charge made to the Tramways committee. There was a strong feeling in the town, rightly or wrongly, that they were charging the shipyards and engineering shops too little for power. How was it they could supply to the yards and engineering shops current from $\frac{3}{8}$d. or $\frac{5}{8}$d. per unit which cost the committee 2d? He was asking the Council to do, what all private firms did, take stock.

Ald. BRUCE pointed out that last month he compared their balance-sheet with that of the Newcastle-upon-Tyne Electric Supply Co. and showed that they had done better than the company. The extension at Doxford and Laing's involved an annual charge of £5,000, and they had not recouped any of that because of the standstill in trade. No wonder there was an adverse balance of £1,600 when they failed to get £4,000 in consequence of Laing's failure. Their prices were among the lowest in the United Kingdom, and they were competing against a gas company whose charges were also amongst the lowest in the country. They had had to expend money in opposing power companies trying to get in. The machinery had been passed by the insurance company's inspector as in excellent condition, and the superintendent engineer reported that, if kept in as good condition, it would run for many years to come.

The motion was lost by 24 votes to 7.

Theft of Telephone Wire.—At the Old Bailey on Tuesday James Harrigan was sentenced to three years' penal servitude, and his brother (Thomas Harrigan) to six months' hard labour for stealing copper wire, the property of the Postmaster General. On July 31 telephonic communication between London, Manchester, Liverpool and Leeds was interrupted, and investigation showed that the line had been cut near Kensal Green, the stolen wire being found at prisoners' home.

Thrybergh (Rotherham).—The Dalton Main Colliery Co. have submitted to the Council a scheme for the supply of electricity in this district.

"Trackless" Trolley Tramways.—It is announced that the deputation recently appointed by Manchester Corporation to visit the Continent for the purpose of collecting information as to the "trackless" trolley system of traction, recommend the Corporation to make an experiment on certain routes in the suburbs. The official report has not yet been published, but the following figures have appeared as to the total expenses per car mile of a "trackless" tramline in Germany:—

Management, legal and clerical expenses, 0·561d.; salaries, wages and uniforms, 2·303d.; power, 0·948d.; renewal of rubber tyres (one pair of wheels), 0·658d.; other maintenance and repairs, 0·252d.; material, oil, light, tools, &c., 0·271d.; fire insurance, employers' liability assurance, contribution to road maintenance, sick and benefit funds, &c., 0·387d.; total cost, 5·38d. The working expenses per car-mile in Manchester last year was 7·07d. and the cost of power per car-mile was 2·02d.

It is reported that the Hastings & District Electric Traction Co. are also considering the question of adopting the system for certain of the narrow streets of Hastings.

Trade Union Congress.—At the annual Trade Union Congress opened at Nottingham on Monday, there were 518 accredited delegates, representing 213 societies, and a membership of 1,776,000.

In his address the president (Mr. D. J. Shackleton, M.P.), referred to the strength of trade unions as represented at the Congress and to the secession of the Amalgamated Society of Engineers. On the subject of old-age pensions he said 70 years was an outside age in these days of pressure of work and speeding of machinery, and they could not rest satisfied with a scheme which, in too many cases, would compel old people to become paupers for a number of years before they could become pensioners. If 65 was a reasonable age for the Civil service, surely 60 was adequate for those who had so many risks attending occupations in factories and workshops, mines, buildings, ships, and the various agricultural occupations of the country. As to unemployment he felt that the first step to real and effective alteration must be in the direction of reducing the hours of labour of those who were in employment. A sincere effort should be made to stop systematic overtime. A few hours overtime per week in a great industry meant thousands going without work entirely.

Whitworth.—Rochdale Tramways committee have made arrangements with Whitworth Council for the construction of about three miles of tramway in this district. Whitworth Council will obtain a provisional order and the Corporation will construct and work the lines.

Yarmouth.—The Borough Surveyor has been instructed to report as to lighting Cobholm with electricity instead of gas.

ELECIRICITY SUPPLY AND TRAMWAY ACCOUNTS.

Aberdeen.—The reports of the city electrical engineer (Mr. J. Alex. Bell) for the year ended July, states that the extension of the Ferryhill works to the full size allowed by the site will shortly be commenced.

264 new consumers were added during the year, including 163 in the area of supply taken over from the Deeside & District Co. The Admiralty have practically decided to take current for wireless telegraphy at Stoneywood and the County Council District committee have decided to take supply for the public lighting of Culter. Owing to the fall in the price of copper the conversion of the copper strip culverts in various streets to cables laid on the solid system has cost only £5,761, instead of £7,917 estimated. A 750 kw. set and a reversible booster were installed last autumn and two 100 kw. and two 50 kw. motor generators have been ordered for supply to the Cults district. Mr. Bell calls the attention of a sub-committee who are considering the question of alterations in charges for current to the fact that consumers can now, by the use of metallic filament lamps, reduce their accounts by one-half, and that a further call will be made upon the reserve fund for the considerable length of culvert still remaining to be reconstructed. 6,106,941 units were generated (compared with 5,540,120 in previous year), 1,671,375 (1,601,980) sold to private consumers for lighting, 1,033,238 (851,886) for power, 287,394 (269,191) for public lighting, 1,964,862 (1,922,388) to Corporation tramways, and 147,167 (149,062) to the Suburban Co.'s tramways. The maximum load (including tramways) was 3,147 kw. (2,912 kw.) and the load-factor 18·46 (18·79). The total connections (not including tramways) are equivalent to 256,199 (235,209) 33-watt lamps and there are 2,006 (1,742) private consumers. Total horse-power of motors connected is 3,605 (3,289). Total revenue was 2·04d. (2·02d.); total works and general costs were 0·99d. (0·84d.) Sinking fund and interest required 0·65d. (0·68d.), and the net profit (placed to depreciation and reserve funds) was 0·40d. (0·50d.).

The accounts were approved by the Council on Monday.

Halifax.—The report of the general manager of the Corporation tramways (Mr. W. M. Rogerson) for the year ended March 31, states that the capital expended was £394,615, an increase of £1,335 during the year.

After paying all expenses and providing for interest, sinking fund, &c., there was a deficit of £9,606, equal to 1·291. per car mile. This sum included £7,334. 17s. 8d. for compensation paid in the North Bridge, New Bank and Pye Nest accidents (less £1,000 received from the insurance company in the Pye Nest case) and £4,695 spent in relaying track. 20,378,672 passengers were carried and 1,786,890 car miles run. 3,487,643 units of electrical energy were consumed. The parcels receipts were £1,313, an increase of £310 over 1906-7.

King's Lynn.—The accounts of the electricity department for the year ended March last show capital expenditure £50,111 (increase £346).

Revenue was £7,490, expenditure £3,709 and gross profit £3,791 (against £3,742 in previous year). Net profit was £564 (£593) of which

£457 has been applied to reduction of capital. £102 to relief of rates; 605,982 (against 564,072) units were generated. 190,844 (167,563) supplied to private consumers for lighting by meter and 4,212 (5,220) by contract, 166,281 (143,480) for motors and heating and 192,587 (197,766) for public lighting. There are 31,438 (29,685) equivalent 8 c.p. lamps connected. The maximum supply demanded was 377 kw. (335 kw.) and the load factor was 16·79 (17·52). Working and general costs were 1·25d. (1·20d.) and total costs (including capital charges) 2·78d. (2·81d.).

Lowestoft. The Tramways committee report that the Borough Accountant has included £900 in the estimate for the borough fund for the tramways deficiency for the half-year ending March 31, 1909.

The chairman of the committee (Mr. C. Y. Fry) said the passengers for August, compared with last year, showed a decrease of 4,000, and the receipts £16. The total increase to date was £138. The chief point in the report was the £450 needed for the repair of the track. He did not think it right that that amount should be put into the district fund. The item was a permanent one, and instead of a deficiency this year of £1,700, as last year, the deficiency would be £2,500. They could look upon an extra £800 as a minimum every year for the upkeep of the track unless they took some drastic steps to cut down expenses or to raise the fares. He reckoned that they should put by another £1,000 a year to meet the situation. The public should know that.

Shoreditch (London). There was a gross profit of £19,548 on the past year's working of the electricity supply and refuse destructor undertakings. After paying interest, sinking fund, &c., there was a deficit of £236.

The Electric Lighting committee point out that the electricity accounts are prepared on a slightly different basis to previous years. The accrued proportions of interest and sinking fund, wages, &c., had been taken into account at the suggestion of the district auditor. The additional amount cast on the accounts for 1907-8 is £3,025. 8s. 5d. for loan charges alone; but for this there would have been a surplus of £2,789. 6s. 3d. Notwithstanding that the price of coal has been 21 per cent. above that of the previous year, the total expenses (including loan charges) show an increase of only 3·37 per cent., while on the other hand, the income has increased 8·52 per cent.

TRADE NOTES AND NOTICES.

TENDERS INVITED.

The Directors of *Mersey Railway Co.* invite tenders for the supply of asbestos packings, india rubber and gutta percha, boiler suits, bolts, nuts, screws, &c., brake gear, car fittings, collector shoes and brackets and brake blocks, &c., electrical sundries, fog signals, incandescent lamps, tools, metals, oils, &c., signal gear, signal wire, &c. Intending tenderers should apply to the Secretary, Mr. Geo. H. Langham, Worcester House, Walbrook, London, E.C. Patterns and samples will be on view on 14th and 15th inst. Tenders (on official forms) to the Secretary by noon, 18th inst. See also an advertisement.

Tenders will be received at the office of the *Commonwealth of Australia* representative, 72, Victoria-street, Westminster, London, S.W., until noon, Oct. 19, for supply and delivery at that office of four complete sets of instruments (signalling and protecting), necessary for direct duplex cable working, for the Postmaster-General, Melbourne. Forms of tender, &c., can be obtained at the General Post Offices, Sydney, Melbourne, Adelaide, Perth, and Hobart, and at the Commonwealth office as above. Tenders (on forms supplied) to Capt. Collins, Commonwealth representative, 72, Victoria-street, Westminster, S.W. Further particulars are set out in an advertisement.

Melbourne City Council invite tenders for supply of 12,696 ft. insulated copper cable. Copies of specification, conditions of contract and forms of tender from the agents for the Council (Messrs. McIlwraith, McEacharn & Co. Proprietary, Ltd.), Billiter-square-buildings, London, E.C., to whom tenders by noon Sept. 23. See also an advertisement.

Tenders are invited for supply and erection of a power plant for the General Post Office, *Adelaide* (South Australia). Tenders, forms and specifications at the Commonwealth Office, 72, Victoria-street, London, S.W. See also an advertisement.

Salford Electricity committee invite tenders for supply and delivery at the Corporation electricity department's mains depot, Frederick-road, Pendleton, of lighting and power feeder and distribution pillars. Tenders to the chairman of the Electricity committee at the office of the Borough Electrical Engineer, Frederick-road, Pendleton, by noon Sept. 14.

Blackpool Corporation want tenders by 10 a.m. Sept. 19 for supply of 100 tons steel rails, 30 cwt. fish plates and 20 cwt. tie-bars, and for labour only in taking up and relaying about 823 yds. of double track tramway.

Hull Corporation invite tenders for one year's supply of ironwork and of insulator bolts and cups for the telephone department. Tenders to the Town Clerk by 10 a.m. of Sept. 23.

Hull Corporation require tenders by noon Sept. 18 for supply of surface condensing plant, with motor-driven pumps, for Osborne-street power station. Forms of tender, &c., from City Engineer.

Mile End (London) Guardians require tenders for 6 or 12 months' supply of electrical fittings, ironmongery, engineer's materials, &c. Forms of tender from the Clerk.

Ilford Council want tenders by noon Sept. 22 for supply of an overhead travelling crane for the electricity works. Forms of tender, &c., from the Clerk.

Pontypridd Council want tenders by Sept. 21 for supply of small paper-insulated and small vulcanised rubber-insulated cables. Forms of tender, &c., from the Electricity Department.

Ashton Manor Council want tenders by first post, Sept. 12 for supply of coal to the electricity department.

The British Consul-General (Sir C. Hertslet) at Antwerp states that a deposit of about £480 will be required from tenderers for the electric lighting of the Salle de Fêtes, Place de Meir, *Antwerp*, for which tenders have to be sent to the Bourgmestre by Sept. 21. Copy of specification may be seen at 73, Basinghall-street, London, E.C., and can be obtained from the Hotel de Ville, Antwerp, for Fr. 0·50.

The Spanish Postal Department, *Madrid*, require tenders by 1 p.m. Sept. 18 for supply of 55 tons of 3 mm. bronze wire for State telegraph lines. Deposit equal to 5 per cent. (10 per cent. from the accepted tenderer) of the upset price (about £5,200) will be required. The "Madrid Gazette" for Aug. 30, containing further particulars, may be seen at 73, Basinghall-street, London, E.C.

The Direccion General de Obras Publicas, Madrid, will receive (until Sept. 26) offers for a concession for the construction of an electric tramway from the Plaza de Mosen Verdagner (Vallvidrera) to Torrente de Raventerola, *Barcelona*, to compete with an offer already made by Don Salvador Andreu, of Barcelona.

Offers are invited by Sept. 26 by the Direccion General de Obras Publicas to compete with an application by the Sociedad de Tranvias de *Barcelona* for a concession for an extension of their line.

The State Railway Administration, *St. Johann, Saarbrücken* (Germany) want tenders by 11:30 a.m. Sept. 28 for supply and erection of an electric turntable. Forms of tender, &c., from the State Railway Administration (Room 218), St. Johann, Saarbrücken, on payment of 5s. (not stamps).

The Finanzdeputation, *Hamburg*, want tenders by noon Sept. 25 for supply of 11 electric travelling cranes. Conditions of tender (price 15s.) from Secretariat II., Finanzdeputation, Hamburg.

The Norwegian State Railways Department, *Christiania*, want tenders by 3 p.m. Sept. 19 for an electric light installation for Moss Station. Specifications, &c., may be seen at 73, Basinghall-street, London, E.C.

The Egyptian Ministry of the Interior, *Cairo*, require tenders by noon Oct. 29 for erection and equipment of electricity supply works at Zagazig. Specifications, &c., may be seen at the Ministry of the Interior, Cairo.

TENDERS RECEIVED AND ACCEPTED.

Bristol Electricity committee has placed an order with Bruce Peebles & Co., of London and Edinburgh, for an additional 500 kw. motor converter set for Temple Back electricity works. This is the second repeat order for machines of this capacity and the company has already supplied to the Bristol authorities five 500 kw., and three 300 kw. motor converters.

Bristol Electrical committee have accepted the following tenders: T. Lovell & Sons, for superstructure of Shirehampton sub-station, £419; British Thomson-Houston Co., direct current switchgear for Avonmouth Dock, £177. 5s.; and Siemens Bros. Dynamo Works, two power distribution boards at Avonbank, £365. 14s.

Burnley Council have accepted the tender of Hurst, Nelson & Co. for five tramcar bodies at £339 each, and that of the British Thomson-

Houston Co., for the electrical equipment at £262. 10s. per car. The trucks are to be made in the shops of the Corporation tramway department at £110 per car, and the accessories at £82. 1s. 10d. per car.

Stockport Council have placed an order with W. A. Shaw & Co. for putting the assembly hall and fire station into telephonic communication.

Bradford Corporation have accepted the tender of Hadfield's Steel Foundry Co., for steel points, crossings, &c., at £455, and that of Collinson Bros. for wiring the tramway offices at Hall Ings at £146.

Reigate Council have accepted the tender of Isaac Storey & Sons for condensing plant and cooling tower at £935. There were seven tenders, ranging from £2,465 to £1,314.

Malvern Council have placed an order with the British Insulated & Helsby Cables for cable for the Malvern Wells extension.

The Lancashire Dynamo & Motor Co. have received an order for a three wire hand reversible booster for Manchester Corporation.

Torquay Council have accepted the tender of Belliss & Morcom for a steam engine at £1,365.

Canterbury Council have placed an order with G. E. Dashwood for wiring the Corn Exchange, &c.

The Austral Otis Engineering Co. (South Melbourne) are making for the Electrolytic Refining & Smelting Co., Port Kembla (N.S.W.), five motor-driven copper converters, each 10 ft. 6 in. in length and 7 ft. 6 in. in diameter, which will, it is said, be the largest plant of the kind in Australia.

An additional Aldrich electric pump has been ordered from the American makers (through W. & J. Lempriere, Melbourne) for the North Broken Hill (N.S.W.) mine.

The A.E.G. Electrical Co. of South Africa and Hubert Davies & Co. have orders for motors, of 100 H.P. and 50 H.P. respectively, for the Geldenhuis Deep, Ltd. (Transvaal), mines.

Dewsbury Council have accepted the following tenders:—

Lancashire Dynamo Co., reversible booster and switchgear; Tudor Accumulator Co., storage battery; Callender's Co., traction cable and pilot wire.

Dublin Corporation have accepted the tender of the Greenmount Oil Co. for supply of machinery oil, &c.

Surface Condensers.—The surface condenser department of Messrs. Willans & Robinson, Rugby, has received during the past two months several important orders for surface condensing plants, notably five sets for the Westminster Electric Supply Corpn. (per Messrs. Kennedy & Jenkin), three sets for Japan, one set for Edmundson's Electricity Corpn., one set for the British Mannesmann Tube Co., one set for Dewsbury Coporation, one set for Western Australia, &c.

Foreign Contracts.—At the meeting of Manchester Corporation last week it was resolved, on the motion of Mr. Howell, that

"In all cases where it is proposed by a committee to give a contract to any foreign firm, or to purchase goods of foreign manufacture, the chairman of such committee should draw the Council's attention to it and explain the reasons for sending a contract abroad.

BUSINESS NOTICES.

The Gilbert Arc Lamp Co. have appointed Messrs. Parmiter, Hope & Sugden, 50, Ellesmere-street, Hulme, Manchester, their agents for Lancashire and Yorkshire. A large stock of Gilbert standard apparatus will be kept.

John P. Beckett and John H. Trolley (trading as J. P. Beckett & Co.), electrical engineers and contractors, Victoria-street, Gt. Grimsby, have dissolved partnership. Debts by Mr. Beckett.

The partnership between John Reginald Wiley Middleton, Alfd. Daniels and Fras. Wm. Balch, electrical engineers, 11A, King-street, Dover, has been dissolved so far as concerns Mr. Balch, who retires. Debts by Messrs. Middleton & Daniels, who continue as Middleton & Co.

Messrs. W. H. Lockett & Co., printers' engineers and electricians' have removed to Dean-street, Fetter-lane, E.C. Telegrams: Sedately, London; Telephone, 1285 Holborn.

Sale by Auction.—Messrs. Horne & Co., 8, Delahay-street, Storey's Gate, Westminster, S.W., will sell by auction at the Royal Arsenal, Woolwich, on Thursday, Sept. 24, at 11 a.m. unserviceable and absolete stores, including quantities of iron, steel, brass, copper, gunmetal, lead, zinc, phosphorobronze, &c., hand cranes, lathes, machines, electric cable, telegraphic instruments, electric lamps, porcelain insulator cups, cut-outs, &c. Lots may be viewed at the Royal Arsenal Woolwich, on Monday, Tuesday, and Wednesday, previous to and on morning of sale. Catalogues at the War Office, Whitehall; the Ordnance Office, Tower; and the Ordnance Office, Royal Arsenal, Woolwich. See also an advertisement.

Plant for Sale.—The L. & N.W. Railway Co. have displaced electric lighting plant (Westinghouse engine and Byng-Hawkins dynamo) for sale. Can be seen on application to Electrical Department, L. & N.W. Railway, Carlisle. Offers to the secretary (Mr. J. Bishop), Euston Station, London, N.W. See also an advertisement.

Offers are invited for a 25 H.P. nom. improved compound Robey engine and a 25 H.P. nom. loco. boiler. The plant is in good condition, suitable for electric generating plant, and can be seen by appointment. Communications to Mr. A. H. Millar, chief librarian, Albert Institute-buildings, Dundee. See also an advertisement.

Mr. Hy. Quartermaine, Woking, advertises for sale some electric lighting plant, including two Alley & Maclellan steam engines coupled direct to two Mavor & Coulson dynamos, switchboard, Pritchett & Gold battery, two electric motors, two Davey Paxman boilers, two Worthington pumps, &c.

Patents Development.—The proprietors of the following patents are desirous of entering into arrangements, by way of licence or otherwise, for exploiting same and ensuring their full development and practical working in this country.

Patent No. 19,979/1904 for "Improvements in Magnetic Wheels or Electromagnetic Motors." Applications to Messrs. Haseltine, Lake & Co., 7 and 8, Southampton-buildings, Chancery-lane, London, W.C.

Patent No. 5,551/1900, relating to apparatus for converting alternating into direct-current, or vice versa. Applications to Messrs. Cruikshank & Fairweather, 65, Chancery lane, London, W.C.

Patent No. 13,174/1899, relating to "Annunciators used in connection with Electric Signalling Apparatus in Hotels, &c." Applications to Messrs. Lloyd Wise & Co., 46, Lincoln's Inn Fields, London, W.C.

Patent No. 11,058/1906, relating to "Improvements in Electric Circuit-breakers." Applications to Messrs. Lloyd Wise & Co., 45, Lincoln's Inn-fields, London, W.C.

Further particulars of the above patents are given in advertisements on another page.

CATALOGUES, &c.

Jandus Lamps.—Messrs. Drake & Gorham have ready two booklets giving details of Jandus and Regenerative arc lamps and the Jandus enclosed arc lamp. The latter have been before the trade for many years and do not require any description. The former was first commercially launched about the middle of the lighting season last year, and some particulars will be found in *The Electrician*, Vol. LX, p. 760. The cost of carbons is $\frac{1}{8}$d. per hour, and the energy consumption 0·22 watts per candle-power.

Photographic Arc Lamps.—The Electrical Company send us a further list (No. 288) which contains some useful information on the subject of arc lamps for studio work, engraving, photography, &c. The lamps are supplied on suitable stands with reflected arrangements for adjusting the angle at which the light is delivered. Interested customers will find a number of types from which to make a selection.

Miniature Lamps.—Messrs. Neville, Williams & Co., Southwark-street, London, S.E., issue a neat pocket catalogue of Howard miniature lamps made in a variety of styles and sizes, for candle fittings, pocket lamps, miners' lamps, telephone switchboards, cycle and automobile lamps, &c. The lamps are supplied for high voltage, both for series and parallel working, and also for use with batteries.

Seamless Tubing.—The catalogue of Benedict nickel seamless tubing is being published by Messrs. W. Geipel & Co., St. Thomas-street, S.E. This describes how the tubing is manufactured and the various uses to which it can be put. It is strongly recommended for condenser tubes and all classes of piping work in which it is necessary to avoid internal corrosion.

BANKRUPTCIES, LIQUIDATIONS, &c.

Geo. H. Smith, electrical engineer, 15, Ashley-road, Altrincham, has been adjudicated bankrupt. The first meeting of creditors will take place on Sept. 16 at the O.R.'s, Byrom-street, Manchester.

A first dividend of 15s. will be payable on Sept. 14, at 5, Lime-street, London, E.C., in the liquidation of the Empire Electric Light & Power Co. (Ltd.)

The Gratze Patents & Engineering Synd., Ltd., is being wound up voluntarily and Mr. S. Cole, 9 and 10, Pancras-lane, London, E.C., has been appointed liquidator. A meeting of creditors will be held on Sept. 14 at Cannon-street Hotel, London, E.C.

PATENT RECORD.

APPLICATIONS FOR PATENTS.

NOTE.—*The undermentioned Applications (except those marked †) are no open to public inspection until after acceptance of Complete Specifications Those marked † are open for inspection 12 months after the date attached to them, if they have not been published previously in the ordinary course. Names within parentheses are those of communicators of inventions. When Complete Specification accompanies application, an asterisk is affixed.*

May 11, 1908.

10,156 ERDMANN. Preventing collision between ships by means of electric waves.*

10,157 TURNER & DIXON. Electrical controlling devices.

10,168 SIMPSON. (Simpson & Adamson, India.) Trolley heads for electric vehicles.

10,171 SIEMENS BROS. & CO. Reducing reflex action at points of connection of conductors differing in values of electrical properties. (Application for Addition to 9273/06.)*

10,172 SIEMENS BROS. & CO. (Siemens & Halske A.-G., Germany.) Telephone jacks.*

10,211 POLLOCK & WERD. Insulators. (Date applied for, 9/5/07.)*†

10,238 COWPER-COLES. Generation of power.

May 12, 1908.

10,241 GAYDON & PARK. Non-conducting accumulator bag.

10,244 THOMS & MOSSOP. Electro-deposition of metallic alloys.

10,269 RUZICKA. Arc lamp.*

10,273 SNYDER. Sanding apparatus.*

10,317 MERSHON. Insulating supports for high-tension conductors. (Date applied for, 21/5/07.)*†

10,339 LEWIS. Electrode for arc lamps.

10,341 B.T.-H. Co. (A.E.G., Germany.). Incandescent lamps.

May 13, 1908.

10,343 KITSEE. Systems of electrical wave transmissions.*

10,344 LYNDE. Incandescent vapour burners.

10,358 BOOTH. Electrical controller for "dimming" electric lights.

10,378 CORNELIUS. Electric furnaces.

10,394 SIEMENS BROS. & CO., & FERREIRA. Electrically operating railway and like signals.*

10,406 GARRARD & FERRANTI, Ltd. Control of electric circuits.

10,431 HATFIELD. Voltameters.

May 14, 1908.

10,433 LULOFS. Frequency meter.

10,478 COATES & PATRICK. Electric ignition on gas engines.

10,489 DIGBY. Electric lampholder.*

10,507 PETERSON & CALLENDER'S CABLE AND CONSTRUCTION CO. Flexible conductors exposed to mechanical tension.

10,520 NEW IGNITION SYNDICATE & SANDY. Electrolyte.

10,521 BOULT. (O. A. Miller Treeing Machine Co., U.S.) Electrically-heated tools.

10,535 COHEN, CRAMER & GEIPEL. Manufacture of cables and of material for use therein.

10,536 CLOTHIER & REYROLLE & CO. Switch gear.

May 15, 1908.

10,539 BERRY. Electric hammer worked by electrical current.

10,552 HENSHAW & SWINDELLS. Controlling trolley poles of electric cars (Application for Addition to 25,415/05.)

10,577 DONATI. Alternating current regulators. (Date applied for, 15/5/07.)*†

10,590 B.T.-H. Co. (G.E. Co., U.S.) Incandescent lamp filaments.

10,591 LEENDERS. Electric fire, and burglary alarm.

10,611 FYNN. Alternate current motors.

10,614 HOOKHAM & HOLDEN Electrolytic meters. (Application for Addition to 3,327/05.)

10,626 & 10,627 ANDERS. Electrical driving devices particularly for clocks. (Date applied for, 11/9/07.)*†

10,631 PINCHIN. Disinfector for telephone receiver and transmitter.

10,632 PATERSON & DARK. Clamping device for brushes of switches.*

May 16, 1908.

10,680 BRITISH PROMETHEUS CO., COOPER & SHARP. Safety devices for electric heating apparatus for liquids.

10,687 THAYER. Electric vehicles.*

10,690 GIMINGHAM. Incandescent lamps.

10,696 BURNS & SYLVERLYTE ELECTRIC LAMP CO. Electric lamp.

10,697 ROOS. Armatures for dynamo electric machines.*

10,699 MAXSE. (J. T. Piat, Reunion.) Telegraphic relays.

10,712 COLLIS, EXLEY & LEITNER. Electric light fittings for railway and like carriages.

May 18, 1908.

10,719 VAN RADEN. Magneto-electric ignition apparatus.

10,723 FILLIS. Surface contact for electrical traction.

10,729 MARR & CHALMERS. Telephone receivers, which may be used as transmitters.

10,739 SUMMERS & HILL. Operating lock bolts by electricity.

10,759 BEVES & BRITISH PROMETHEUS CO. Regulating current in electric heating appliances.

10,760 BRITISH PROMETHEUS CO., COOPER & SHARP. Luminous electric radiators.

10,764, 10,767 & 10,768 TATE. Storage battery plates. (Date applied for, 20/12/07. Comprised in 28,132 20/12/07.)*

10,769 TATE. Storage battery plates. (Date applied for, 20/12/07. Comprised in 28,106 20/12/07.)*

10,773 ROCK. Holders for electric lamps.

10,784 JOHNSON-LUNDELL ELECTRIC TRACTION CO. & PRICE. Controlling electric motors for tramcars, lifts and the like.

10,792 NETTLEY. Electric radiators or heaters.

May 19, 1908.

10,808 DORMAN. Producing pure metallic filaments.

10,820 WOOD & WOOD. Anti-vibrating lead terminal for electrical ignition motors.

10,829 KITSEE. Electrical conductors.*

10,838 BEST. Electrically igniting miners' safety lamps in mines.

10,845 CROMPTON & CO., MACFARLANE & BURGE. Dynamo-electric machines.*

10,848 BERRYMAN. Electric terminals or clamps.

10,856 COTTON. Electric ignition devices for inverted incandescent gas burners.*

10,860 JONES & JONES, jun. Electrical time switches.

10,878 PASCHEN. Regulating the degree of hardness of Röntgen tubes.*

10,885 WOLFRAM-LAMPEN A.-G. Manufacture of filaments for incandescent lamps. (Date applied for, 29/11/07.)*†

10,889 CHAUDET, *née* WARNENT. Carbon holders for arc lamps. (Date applied for, 29/11/07.)*†

10,891 WOLFRAM-LAMPEN A.-G. Manufacture of filaments for incandescent lamps. (Date applied for, 7/10/07.)*†

10,893 CHAMBERLAIN & HOOKHAM & HOLDEN. Electricity meters.

SPECIFICATIONS PUBLISHED.

1907 SPECIFICATIONS.

4,713 FESSENDEN. Transmission of energy by electromagnetic waves.

8,842 SCHATTNER. Electric motor controllers.

9,397 DE PONT. Compositions suitable for insulation.

10,072 B.T.-H. Co. (G.E. Co., U.S.). Electric motor control systems.

10,293 COLLINS, HAYES, & WATSON. Trolley heads.

11,288 FYNN. Alternate current motors.

11,352 BRUCE. Electric whistles or sound signalling apparatus.

11,459 & 11,520 TUCKER. Switches.

11,471 COWPER-COLES. Electro-deposition of metals.

11,695 AMALGAMATED RADIO-TELEGRAPH CO. (Seibt). Radio-telephony.

11,794 LANG. Control of electric motors.

11,874 SIEMENS BROS. DYNAMO WORKS & POYNDER. Combined electrical and mechanical systems for the storage of power.

12,238 B.T.-H. Co. (A.E.G.). Systems for electrically operating railway signals, points and the like.

12,353 AUSTIN. Receivers for wireless telegraphy. (Date applied for, 29/5/06.)

12,368 LEHMANN. Electric amperemeters, voltmeters, &c.

12,369 BRZESKI & STRAUSS-COLLIN. Arc lamps.

12,406 SEDGWICK. Electric apparatus for communicating between one part of a vessel and another, and for analogous purposes.

12,436 SCIPLE. Cross arms for telegraph, telephone, or other wires.

12,578 HEYLAND. Self-regulating electrical machines for alternating or direct current. (Date applied for, 30/5/06.)

12,633 GALLETTI. Producing electric oscillations. (Date applied for, 29/1/07.)

12,634 GALLETTI. Producing electric oscillations. (Date applied for, 9/3/07.)

12,635 GALLETTI. Wireless telegraphy. (Date applied for, 29/12/06.)

12,636 GALLETTI. Wireless telegraphy. (Date applied for, 24/1/07.)

12,857 TONRY. Ball and socket joints for electric light, and like fittings.

12,902 QUINT. Enclosed arc lamps.

12,969 HELLMANN. Devices for effecting electric synchronous working of two apparatus.

13,032 EASTWOOD. Systems for electric railways.

13,285 ELLISON. Circuit breakers for the protection of alternating current induction motors.

13,596 JAHR. Wireless telegraphy.

14,572 HAYWOOD, & MCKENZIE & HOLLAND. Electrically detecting the position of switch tongues and locking bolts of railway points.

15,012 ROSS. Magnet or solenoid coils for electrical apparatus.

15,050 YATES. Electric fire and burglar alarm.

15,412 WALTER. Receivers for wireless telegraphy.

15,878 SIEMENS BROS. & CO. & GRIMSTON. Electrically-controlled selective switch and a transmitter of current impulses for use therewith.

COMPANIES' MEETINGS AND REPORTS.

CITY OF YORK TRAMWAYS CO.—At the meeting on Wednesday Mr. W. H. Thackwray said the light railway order of the Corporation had been settled and only awaited the completion of certain formalities before receiving confirmation. He hoped the Corporation would, in course of time, take over the system and relieve the company.

DIRECT WEST INDIA CABLE CO. (LTD.)—The accounts for the year ended June 30 show an available sum, after providing for debenture interest, and including £30,047 brought forward, of £36,196. The directors recommend a further dividend of 3 per cent., making the usual distribution of 6 per cent. for the year, leaving £33,496 to be carried forward. During the year debentures have been paid off to the amount of £6,100, leaving £50,900 outstanding.

DUMBARTON BURGH & COUNTY TRAMWAYS CO.—At the meeting on Friday Major C. Heaton-Ellis congratulated the shareholders on having the whole of the tramway line from Dalmuir to Balloch, and from Alexandria to Jamestown (with the exception of a few yards) completed and in full working order. Traffic receipts were very satisfactory, and they might rest assured that they had a valuable property capable of showing considerable increase on present satisfactory results.

HALIFAX & BERMUDAS CABLE CO. (LTD.)—The accounts for the year ended June 30 show an available sum, after providing for debenture interest and including £17,848 brought forward, of £20,943. The directors recommend a further dividend of 2½ per cent., making the usual distribution of 5 per cent. for the year, leaving £17,193 to be carried forward. During the year debentures have been paid off to the amount of £9,300, leaving £19,600 outstanding.

MANSFIELD & DISTRICT TRAMWAYS CO.—The directors' report for the year ended Dec. 31 states that receipts show a substantial increase, but expenses were somewhat heavier than anticipated. After payment of debenture interest and preference dividend the balanc (£888) has been carried forward.

UNITED ELECTRIC CAR CO. (LTD.)—The report for the year ended June 30 states that after paying debenture interest (£2,500) and charging £5,677. 6s. 5d. for depreciation, the profit is £7,091. 11s. 5d., added to £5,095. 10s. 3d. from last year, making £12,187. 1s. 8d. Deducting preference dividend to Dec. 31 (£3.000), the available balance is £9,187. 1s. 8d. The directors recommend payment of the balance preference dividend (£3,000) carrying forward £6,187. 1s. 8d.

YORKSHIRE ELECTRIC POWER CO.—During the half-year ended June 30 the receipts from the sale of energy and for work done for consumers, &c., amounted to £8,698. 9s., against £7,293. 13s. 5d. for the preceding half-year. Profit amounted to £1,249. 16s., against £836. 10s. 5d. After payment of mortgage interest the profit was £363. 6s. 10d., against a loss of £139. 2s. 11. The directors consider this increase satisfactory in view of the general slackness of trade and the still prevailing high price of coal. At June 30 agreements had been entered into with consumers for a total of 6,578 kw., an increase of 1,030 kw. during the six months. Most of these agreements were made during the latter part of the half-year, and the consumers are not yet connected. Mr. A. H. Meysey-Thompson has been elected a director in place of Sir Richard Mottram retired.

NEW COMPANIES, STATUTORY RETURNS, RECEIVERS AND MANAGERS, &c.

NEW COMPANIES.

ELECTRICAL & ENGINEERING SUPPLIES CO. (LTD.) (99,423).—Reg. Sept. 5, capital £1,000 in 950 preferred ordinary shares of £1 each and 1,000 founders' shares of 1s. each, to carry on the business of manufacturers of and dealers in electric light apparatus, conduits, dynamos, lamps, fittings and accessories, electric accumulators, motors, batteries, &c. Private company. First directors, J. A. Nones and W. H. Taylor.

H. HOOPER & CO. (LTD.) (99,384.)—Reg. Sep. 2, capital £5 000 in £1 shares (3 000 6 per cent. cumulative preference), to acquire business of electrical engineer and contractor carried on as H. Hooper & Co. Private company. First directors, J. H. Bulkley and H. Hooper (permanent managing directors). Reg. office, 181, High street, Lewisham, London, S.E.

VICTORIA GARAGE & ELECTRICAL CO. (LTD.) (99,389.)—Reg. Sept. 2, capital £1,500 in £1 shares, to acquire the businesses carried on as the Victoria Garage & Electrical Co. and the Stoan Cycle & Motor Depot. Private company. First directors, E. J. Swift (managing), D. Thompson and A. Turner. Reg. office, 68, John street, Coventry.

STATUTORY RETURNS.

BERRY CONSTRUCTION CO. (LTD.)—Return to July 3 gives capital is £10,000 in £1 shares, all of which have been taken up. £1 per share has been called up on 4,000 and £3,21[illegible]. 5s. has been received, leaving £[illegible] 15s. in arrears. 6,000 shares are considered as fully paid. Mortgages and charges nil. (Nominal capital since increased to £15,000 in £1 shares.)

CALLENDER'S CABLE & CONSTRUCTION CO. (LTD.)—Return to June 4 gives capital £500,000 in 60,000 ordinary and 40,000 preference shares of £5 each, of which 35,000 ordinary and 40,000 preference have been taken up. £5 per share has been called up on 15,000 ordinary and [illegible] preference and £27[illegible] has been received. £100,000 is considered as paid on [illegible] ordinary. Mortgages and charges, £3[illegible]0,000.

CHADBURN'S (SHIP) TELEGRAPH CO. (LTD.)—According to return to July 14, capital is £120,000 in 60,000 ordinary and 60,000 preference shares of £1 each, all of which have been taken up. £1 per share has been called up on 50,000 preference and 50,000 ordinary and £100,000 has been received. £20,000 is considered as paid on 10,000 preference and 10,000 ordinary. Mortgages and charges, nil.

ELECTRIC & GENERAL INVESTMENT CO. (LTD.)—The capital in return to Aug. 11 is £200,000 in 20,000 ordinary, 100 founders' and 19,900 preference shares of £5 each, all of which have been taken up. £1 per share has been called up on the ordinary, and £5 per share on the founders' and preference shares and £120,000 has been received. Mortgages and charges, £10,000.

INDIAN ELEC. SUPPLY & TRACTION CO. (LTD.)—The capital in return to July 13 is £600,000 in £5 shares, of which 1,007 have been taken up. £4. 10s. per share has been called up and paid. Mortgages and charges, £125,000.

SLOAN ELECTRICAL CO. (LTD.)—In return to July 22 capital is £15,000 in 5,000 A, 5,000 B preference and 5,000 ordinary shares of £1 each, of which 5,000 A, 4 B preference and 2,750 ordinary have been taken up. £1,254 has been paid on 4 B preference and 1,250 ordinary, and £6,500 is considered as paid on 5,000 A preference and 1,500 ordinary. Mortgages and charges, nil.

J. G. WHITE & CO. (LTD.)—According to return to July 13 the capital is £200,000 in 15,000 preference shares of £10 each and 50,000 ordinary shares of £1 each, all of which have been taken up. £150,000 has been paid on the preference and £50,000 is considered as paid on the ordinary. Mortgages and charges, nil.

RECEIVERS AND MANAGERS.

LONDON ELECTRIC LAMP CO. (LTD.)—Notice of the appointment of F. Geoghegan, C.A., 8, Old Jewry, E.C. as receiver, on Aug. 21, 1908, under powers contained in 1st mortgage debenture dated Dec. 18, 1907, has been filed pursuant to sec. 11 (2) of Companies Act, 1907.

FOREIGN COMPANY.

COMPAGNIE GENERALE D'ELECTRICITE DE LOURENCO-MARQUES.—Particulars filed Aug. 18. Capital Fr. 1,250,000. in shares of Fr. 100 each. Reg. in France. Directors, H. E. M. Bourke, A. M. Billington and A. Davidson (London), M. L'Epine (Paris) and H. Saner, M.D. (London and Bulawayo). British address, 488-22, Salisbury House, E.C., where Mr. J. W. Clark is authorised to accept service.

CITY NOTES.

MEMORANDA (Sept. 3).—Bank rate 2½ per cent. (since May 28, 1908). Price of silver, $23\frac{5}{8}$—$23\frac{13}{16}$d. per oz. Consols $86\frac{1}{16}$—$86\frac{3}{16}$ for money and $86\frac{1}{16}$—$86\frac{3}{16}$ for account. Consols Pay Day, Oct. 1; Stock and Shares Continuation Day, Sept. 28; Ticket Day, Sept. 29; Pay Day, Sept. 30.

PRICES OF METALS (London).—*Copper*, cash, $61\frac{1}{16}$—$61\frac{3}{8}$; three months, $61\frac{13}{16}$—$61\frac{7}{8}$. *Lead*, English, $13\frac{1}{2}$—$13\frac{3}{4}$; foreign, $13\frac{1}{8}$—$13\frac{3}{8}$ *Spelter*, foreign cash, $19\frac{1}{4}$—$19\frac{3}{8}$. *Tin*, Fine Foreign, $130\frac{1}{4}$—$130\frac{3}{8}$, three months, $131\frac{3}{8}$—$131\frac{1}{2}$. *Iron*, Cleveland, cash, 52/4, two and three months, 52/2—52/4.

BRITISH ELECTROMOBILE CO. (LTD.)—The first annual report states that trading during the period ended March 31 resulted in a loss of £2,411. A rearrangement of the finances of the company is outlined.

BROMLEY (KENT) ELECTRIC LIGHT & POWER CO. (LTD.)—The directors have declared a dividend at the rate of 4 per cent. per annum on the ordinary shares.

CANADIAN GENERAL ELECTRIC CO. (LTD.)—The directors announce a dividend of 1¾ per cent. on the common stock for the quarter ended 30th inst.

COMPAGNIE INTERNATIONALE D'ELECTRICITE GAZ ET EAU (SOC. ANON.)—This company has been formed in Brussels, with a capital of Fr. 12,000,000, to construct and work electricity, gas and water works in various parts of the world. The Anglo-French Industrial Synd. of London is interested in the new venture.

DAVIS & TIMMINS (LTD.)—The directors recommend payment of 6 per cent. preference dividend for the six months to June 30.

DEUTSCH-SUDAMERIKANISCHE TELEGRAPHEN GESELLSCHAFT.—We may add to the information given in our last issue (p. 781) regarding this new German submarine telegraph company the following particulars: The first members of the board are Regierungsrat S. Samuel (president), Geh. Oberregierungsrat Josef Hoeter (vice-president), Dr. Ing. Emil von Guilleaume and Herren Max von Guilleaume, Louis Hagen, Karl von der Herberg, W. Muller and R. Witting. The following will join the board after the first general meeting of the company: Baron Emil von Oppenheim, Dr. Springer, Prof. Bernhard Salomon, Herren Franz Clouth, T. von Guilleaume, H. Marks and G. Michels.

DUNDEE, BROUGHTY FERRY & DISTRICT TRAMWAYS CO. (LTD.)—The directors' report for the year ended July 31 states that profit stands at £3,324. The earnings of the tramways have risen to £12,60[illegible].

FELTEN & GUILLEAUME LAHMEYERWERKE A. G.—The directors of this company have decided to increase the share capital from 20,000,000 marks (£1,000,000) to 25,000,000 (£1,250,000) by offering new shares to existing shareholders. It is proposed also to issue 5,000,000 marks (£250,000) of 4½ per cent. bonds.

ROSARIO ELECTRIC CO. (LTD.)—The directors have declared a dividend of 5s. per share on the first and second preference shares and 1s. 3d. per share on the ordinary shares, payable Oct. 1.

SAO PAULO TRAMWAY, LIGHT & POWER CO. (LTD.)—A quarterly dividend of 2½ per cent. has been declared.

ELECTRIC TRAMWAY AND RAILWAY TRAFFIC RECEIPTS.

Line	Week ended.	Amount.	Inc. or Dec. (a)	Aggregate: No. of weeks.	Aggregate: Amount.	Aggregate: Inc. or Dec. (a)
		£	£		£	£
Aberdeen Corporation	Sept. 2	1,555	− 19	14	21,899	+ 61
Airdrie	Aug. 28	234	+ 9	34	7,6.6	+ 77
Anglo-Argentine	Sept. 2	23,505	+ 7,881	35	691,377	+ 116,248
Ayr Corporation	,, 5	196	− 16	16	6,736	− 1
Baker St. & Waterloo Ry.	,, 5	2,9.0	+ 830	10	28,315	+ 5,510
Barnsley	Aug. 28	230	+ 64	34	6,108	+ 371
Barrow	,, 28	283	− 25	31	8,504	− 304
Bath Electric Trams, Ltd.	Sept. 2	826	− 168	35	25,999	− 1,760
Birkenhead Corporation	,, 6	1,077	− 45	...	...	..
Birmingham Corporation	,, 5	6,355	+ 116	23	144,322	+ 5,287
Birmingham & Mid.	Aug. 21	844	− 17	33	27,676	+ 814
Blackburn Corporation	Sept. 2	1,117	− 100	23	27,098	+ 996
Blackpool Corporation	,, 3	1,930	− 3.9	22	33,471	− 58
Blackpool and Fleetwood	...	...	...	..	...	...
Bolton Corporation	,, 6	2,243	− 145	23	54,803	+ 1,022
Bombay	Aug. 13	R35,918	+ R8,964	32	R1,136,300	+ R121,615
Bournemouth Corporation	Sept. 2	2,065	− 322	22	40,166	− 2,502
Bradford Corporation	,, 5	4,735	− 101	22	110,103	+ 836
Brighton Corporation	,, 6	1,036	− 66	23	23,303	+ 596
Bristol Trams & Carriage	,, 1	5,011	− 311	41	178,810	+ 102
Burnley Corporation	,, 5	1,226	− 131	23	28,564	+ 926
Burton Corporation	,, 6	287	− 14	23	6,412	− 530
Bury Corporation	...	...	...	...	...	...
Calcutta Tramways Co.	,, 5	R47,826	− R628	10	R465,878	− R6,796
Camborne-Redruth	,, 5	132	− 16	36	4,548	+ 176
Cardiff Corporation	,, 5	2,161	+ 25	23	51,260	− 442
Cavehill	Aug. 28	92	− 11	34	3,209	+ 239
Central London Railway	Sept. 5	7,150	+ 2,569	10	69,747	+ 21,470
Charing C., Euston & H'stead	,, 5	3,205	+ 850	10	31,955	+ 6,890
Chatham & Dist. Lt. Rys.	,, 3	848	+ 50	35	27,010	+ 1,051
City & South London Rly.	,, 6	3,101	+ 183	10	29,242	− 1,190
City of Birmingham	Aug. 28	2,656	− 152	34	94,913	− 387
Colchester Corporation	Sept. 2	233	− 14	9	2,162	− 137
Cork Electric Trams Co.	,, 3	485	− 13	35	16,249	− 500
Croydon Corporation	,, 4	1,281	− 199	23	33,416	− 327
Devonport & Dist. Trams	Aug. 28	492	− 36	34	15,797	+ 58
Dover Corporation	Sept. 5	255	− 18	23	5,627	− 179
Dublin & Lucan Railway	,, 4	151	− 17	9	1,506	− 69
Dublin United	,, 4	5,835	− 1,739	9	56,184	− 16,542
Dudley-Stourbridge	Aug. 28	868	− 106	34	28,807	− 1,148
Dundee Corporation	Sept. 2	1,224	− 83	†16	19,473	+ 1,214
East Ham Council	,, 5	861	− 77	23	20,074	− 1,160
Exeter Corporation	,, 4	340	− 22	23	7,602	− 168
Falkirk and District	...	...	...	...	...	...
Gateshead & Dist. Trams	Aug. 28	1,923	+ 11	34	34,490	+ 165
Glasgow Corporation	Sept. 5	16,809	− 1,506	14	237,809	− 1,133
Glossop	,, 5	125	− 11	26	5,487	− 253
Gravesend—Northfleet	Aug. 28	223	− 70	34	7,317	− 1,095
Great Northern & City Rly.	Sept. 5	1,319	− 282	10	12,820	− 2,984
Gt. Northern, Piccadilly, &c	,, 5	4,835	+ 1,160	10	48,235	+ 9,585
Greenock & Port Glasgow	Aug. 28	581	− 135	34	18,377	− 4,409
Hartlepool Tramways	,, 28	291	− 73	34	8,326	− 1,641
Hastings Elec. Trams Co.	Sept. 3	1,356	− 247	10	14 183	− 1,222
Hong Kong	,, 5	$7,934	− $123	36	$283,697	− $14,648
Huddersfield Corpn.	,, 5	1,562	− 66	23	37,669	+ 168
Hull Corporation	,, 5	2,429	− 26	23	55,379	+ 16
Ilkeston District Council	,, 2	156	...	22	3,262	+ 45
Isle of Thanet Co.	,, 5	1,358	− 147	49	28,023	− 536
Jarrow	Aug. 28	120	− 7	34	3,709	− 467
Keighley Corporation	Sept. 3	155	− 8	9	1,601	− 16
Kidderminster & District	Aug. 28	128	− 39	34	3,997	− 204
Kilmarnock Corporation	,, 29	116	− 2	15	2,421	− 165
Lanarkshire Trams Co.	Sept. 3	1 266	− 148	35	45,496	+ 3,667
Lancashire United	,, 2	1,350	+ 2	35	47,331	+ 2,389
Leamington	Aug. 28	197	− 2	34	5,832	+ 377
Leeds Corporation	Sept. 5	6,453	− 270	23	165,025	+ 4,510
Leicester Corporation	,, 5	2,212	+ 2	10	23,064	+ 130
Leith Corporation	,, 5	512	− 32	16	9,211	+ 16
Lincoln Corporation	,, 5	121	− 1	23	2,778	− 78
Liverpool Corporation	Aug. 29	16,611	− 337	35	372,854	− 7,195
Liverpool Overhead Rly.	Sept. 6	1,333	− 203	10	14,697	− 2,205
*London County Council	Aug. 29	33,166	+ 1,249	†22	759,110	+ 82,035
London United	Sept. 5	6,911	− 445	35	238,782	+ 2,643
Lowestoft	,, 5	354	− 20	49	10,049	+ 140
Maidstone Corporation	,, 5	196	...	23	4,639	...
Manchester Corporation	,, 5	14,951	− 1,020	23	349,781	+ 11,026
Mersey Railway	,, 5	1,875	+ 121	10	18,414	+ 327
Merthyr	Aug. 28	218	+ 1	34	7 227	+ 65
Metropolitan Dist. Railway	Sept. 5	8,961	+ 1,837	10	87,176	+ 13,807
Metropolitan Elec. Trams	Aug. 28	5 501	− 83	24	194,810	+ 37,376
Middleton	,, 28	394	− 28	34	12,673	+ 466
Nelson Corporation	Sept. 5	130	− 35	§22	3,298	− 215
Newcastle-on-Tyne Corp.	,, 5	3,723	− 231	23	89,351	− 5,797
Newport (Mon.)	,, 5	647	− 35	23	15,738	− 972
Northampton Corporation	,, 3	468	+ 8	§22	11,009	+ 664
Oldham, Ashton & Hyde	Aug. 25	572	− 32	31	20,484	− 202
Oldham Corporation	Sept. 6	1,863	− 42	‡24	47,814	+ 689
Perth (N.B.) Corporation	,, 2	154	− 11	16	2,645	− 119
Perth (W.A.) Elec. Trams	,, 4	1,218	− 97	36	49,388	− 1,103
Peterborough	Aug. 28	141	− 14	34	4,397	+ 35
Portsmouth Corporation	Sept. 5	2,208	− 168	23	50,232	+ 286
Potteries	Aug. 28	1,661	− 165	34	61,892	− 1,051
Preston Corporation	Sept. 2	782	− 30	9	7,015	− 357
Rotherham Corporation	,, 3	602	− 22	12	13,677	+ 102
Rothesay	Aug. 28	451	+ 28	34	8,203	− 20
Salford Corporation	Sept. 7	4,187	− 284	23	109,861	+ 253
Sheerness	Aug. 26	69	− 23	34	1,985	− 46
Sheffield Corporation	Sept. 6	5,417	− 222	†24	132,995	− 793
Singapore Trams	,, 5	$8,874	− $622	...	...	...
South Metropolitan	Aug. 28	783	− 237	34	27,818	+ 149
South Staffs	,, 28	899	− 169	34	30,134	− 599
Southend Corporation	Sept. 2	678	+ 35	23	11,478	+ 820
Southport Tramways	Aug. 28	309	− 48	34	9,952	− 586
Stalybridge, Hyde &c., Jt. Bd	Sept. 5	752	− 99	†23	18,484	− 446
Sunderland Corporation	,, 6	1,171	− 337	23	28,089	− 5,741
Sunderland District	,, 2	524	+ 2	44	21,194	+ 1,572
Swansea Trams	Aug. 28	959	− 184	34	32,444	+ 1,232
Swindon Corporation	...	...	...	...	...	...
Taunton	,, 28	47	− 2	34	1,424	− 80
Tynemouth and District	,, 28	365	− 35	34	8,215	− 513
Tyneside Trams Co.	Sept. 2	430	− 51	9	4,045	− 372
Wallasey District Council	,, 5	910	+ 18	§22	21,494	+ 983
Walsall Corpn.	,, 5	517	− 38	36	19,132	+ 1,203
Warrington Corpn.	...	...	...	...	...	...
West Ham Corporation	Aug. 27	2,036	− 286	22	49,585	− 2,843
Weston-super-Mare	,, 26	364	− 54	34	5,266	+ 69
Wolverhampton Co.	,, 28	449	− 93	34	15,673	− 626
Wolverhampton Corpn.	Sept. 2	825	− 43	13	11,628	+ 225
*Worcester	Aug. 28	311	− 18	34	9,683	− 38
Wrexham	,, 28	116	...	34	3,507	+ 6
Yorkshire W.R. Trams	...	...	...	...	...	...
Yorkshire Woollen District	,, 28	911	+ 30	31	31,483	− 1,211

(a) These comparisons are with the corresponding period last year. § Plus 3 days. Plus 2 days. * Partly electrical. † Minus 3 days ‡ Minus 2 days.

ELECTRICAL COMPANIES' SHARE LIST.

Share	Last Dividend	Name.	Price Wed., Sept. 9.	Rate % Yielded. £ s. d.	Dividend Due.	Business Week to Sept. 9: Highest.	Lowest.
		ELECTRICITY SUPPLY.					
10	5 0	Bournemouth & Poole Elec. Sup. Ord.	10 —10½	6 13 6	Mar, Sept,	10,	10⅛
10	4 6	Do. 4½ per Cent. Cum. Pref.	9½—10	4 10 0	Feb, Aug	..	..
10	6 0	Do. 6 per Cent. Cum. Second Pref.	10½—10⅞	5 6 6	Feb, Aug	..	..
St.	4½%	Do. 4½ per Cent. Deb. Stock (red.)	100 —103	4 7 6	Jan, July	..	..
5	3 6	Bromley (Kent) El. Lt. & Power Shares	4½—5	5 10 0	April, Oct	..	..
St.	4½%	Do. Do. 1st Debs.	94 —97	4 12 9	May, Nov	.	..
5	4 6	Brompton & Kensington Elec. Sup. Ord.	7¼—7¾	6 3 0	March....	..	..
5	3 6	Do. 7 per Cent. Pref.	7½—7½	4 13 6	Mar, Sept	.	..
St.	4%	Central Elec. Sup. Co. 4% Guar. Db. Stock	99 —102	3 18 0	June, Dec	.	..
5	2 6	Charing Cross (W. End & City) El. Sup. Co.	3½—4	6 5 0	Feb, Aug	3¾	..
5	2 3	Do. 4½ per Cent. Pref.	4 —4½	5 0 0	Feb, Aug	4¼	..
St.	4%	Do. 4 per Cent. Deb. Stock (red.)	93 —99	4 1 0	Jan, July		..
5	2 3	Do. City Undertaking 4½% Cm. Pref.	3½—4	5 12 0	Jan, July	3¾	..
5	2/6	Chelsea Electric Supply Ord.	8 —8½	6 8 9	March ..	—	..
St.	4½%	* Do. 4½ per Cent. Deb. Stock (red.)	100 —103	4 7 6	June, Dec	..	..
10	5 0	City of London Electric Lighting Ord.	9½ 10½	5 17 0	Feb, Aug	.	..
10	6/0	Do. 6 per Cent. Cum. Pref.	11¾—12¾	4 14 0	Jan, July	..	..
St.	5%	Do. 5 per Cent. Deb. Stock (red.)	122 —125	4 0 0	June, Dec	..	..
St.	4½%	Do. 4½ per Cent. 2nd Deb. Stock (red.)	101 —104	4 6 6	Jan, July	..	..
5	2%	County of Durham Elec. P.D. Ord.	2¾—3	8 9 7	April, Oct	..	..
5	5%	Do. 5 per Cent. non Cum. Pref.	3⅞—4½	6 5 0	April, Oct	..	..
10	4/0	County of London Elec. Supply Ord.	7½—8½	5 17 6	Feb, Aug	..	..
10	6 0	Do. 6 per Cent. Cum. Pref.	10⅞—11⅜	5 9 6	Mar, Sept	10¾	.
St.	4½%	Do. 4½% Deb. Stock (red.)	107 —110	4 2 0	Jan, July	..	..
St.	4½%	Do. Second Deb. Stock	99 —102	4 8 0	May, Nov	..	..
5	3 6	Folkestone Electricity Supply Co. Ord.	4¾—5¼	6 7 0	April, Oct	.	.
5	2 6	Do. 5 per Cent. Cum. Pref.	5 —5½	4 11 0	Mar, Sept	..	..
St.	4½%	Do. 4½ 1st Deb. Stock (red)	97 —100	4 10 0	Feb, Aug	..	..
5	4/6	Hove Electric Lighting Ord.	6 —6½	6 11 0	April, Oct	..	..
5	4/0	Kensington & Knightsbridge Ord.	7¾—8¼	5 14 0	Feb, Aug	..	..
5	6%	Do. 6 per Cent. 1st Pref.	6 —6½	4 12 0	Jan, July	..	—
St.	4%	Do. 4 per Cent. Deb. Stock (red.)	94 —97	4 2 6	..	..	..
St.	4%	Kensingtn. & Kngtbg. Co. & Notting Hill Co. (Joint Station) 4% Deb. Stock (red.)	98 —102	3 18 0	April, Oct	—	..
St.	4½%	Kent Elec. Power Co.	86 —90	5 0 0	Jan, July	..	..
3	1/6	London Electric Supply Ord.	⅞—1⅛	5 8 0	Mar, Sept	..	..
5	3/0	† Do. 6 per Cent. Pref.	4⅝—4⅞	6 3 0	Mar, Sept	..	..
St.	4%	Do. 4 per Cent. 1st Mort. Deb.	89 —92	4 7 0	Jan, July	..	..
5	2/6	Metropolitan Electric Sup. Ord.	4¼—4¾	6 16 6	April, Oct	4½	4⅜
5	2/3	Do. 4½ per Cent. Cum. Pref.	4½—5	4 10 0	Jan, July	..	..
St.	4½%	Do. 4½ per Cent. Deb. Stock 1st Mort.	105 —109	4 1 6	June, Dec		..
St.	3½%	Do. 3½ per Cent. Mrt. Deb. Stock (red.)	84 —89	3 19 0	Jan, July	..	..
100	4½%	Midland Elec. Corp. for P.D. 1st Mort. Db.	94 —97	4 12 6	June, Dec	..	..
10	4%	Newcastle & Dist. Elec. Ltg. Ord.	7½—8	5 3 2	Feb, Aug	—	—
100	4½%	Do. 4½ per Cent. Deb.	94 —96	4 14 9	Jan, July	..	..
5	8%	Newcastle Elec. Supply Ord.	5⅛—5⅝	7 12 4	Feb, Aug	..	..
5	5%	Do. 5 per Cent. non Cum. Pref.	5¼—5⅜	4 15 8	Feb, Aug	..	..
100	4%	Do. 4 per Cent. Mort. Deb. red. 1907.	95 —97	4 3 4	Jan, July	..	..
1	3%	Northern Counties Elec. Sup.	—	..	Mar, Aug	—	..
100	4½%	Do. 4½ per Cent. Deb.	93 —95	4 15 9	Jan, July	..	..
10	6/0	Notting Hill Electric Ord.	11¾—12¾	5 10 6	March ..	..	..
5	2 6	Oxford Electric Ord.	5⅝—6⅛	5 14 0	March ..	..	..
St.	4%	Do. 4 per Cent. Deb. Stock	95 —98	4 2 0	Jan, July	..	..
5	5 0	St. James' & Pall Mall Elec. Ord.	7—8	6 1 6	Feb, Aug	..	..
5	3 6	Do. 7 per Cent. Pref.	6½—7½	4 16 6	Feb, Aug	..	—
St.	3½%	Do. 3½ per Cent. Deb. Stock (red.)	88 —90	3 18 0	Jan, July	..	..
5	.	Smithfield Markets Electric Sup. Ord.	¼—¾	..	Feb	..	..
St.	4%	Do. 4 per Cent. Deb. Stock	68 —72	5 11 0	Feb, Aug	..	..
5	4/0	South London Electric Supply Ord.	2⅝—2⅞	5 19 0	April....	..	..
1	0/6	South Metrop'n Elec. Lt. & Power Ord.	⅝—⅞	4 0 0	..	..	..
1	0 8⅖	† Do. 7 per Cent. Cum. Pref.	1—1⅟₁₆	5 18 0	Feb, Aug	..	..
St.	4½%	Do. 4½ 1st Db. Stk. Red.	100—103	4 7 6	April, Oct	102	—
5	2/6	Urban Electric Supply Ord.	½—1	..	April, Oct	—	..
5	2/6	Do. 5 per Cent. Cum. Pref.	1⅛—2⅜	10 12 0	April, Oct	..	..
St.	4½%	Do. 4½ per Cent. 1st Mort. Deb.	82 —85	5 6 0	April, Oct	..	..
5	5/0	Westminster Elec. Sup. Ord.	7½—8½	5 17 6	Mar, Sept	..	..
5	2/3	Do. 4½ per Cent. Cum. Pref.	5⅝—5⅞	4 0 0	Jan, July	5¾	..
		ELECTRIC RAILWAYS, TRAMWAYS, &c.					
St.	4%	Baker St. & Waterloo 4% Perp. Db. St	93 —94	4 5 0	Jan, July	93½	93⅛
1	..	Bath Elec. Trams Pref. Ord.	¼—¾	10 13 0	April....	—	—
1	0/6	Do. 5 per Cent. Cum. Pref.	½—¾	6 13 4	Jan, July	..	—
St.	4½%	Do. 4½ 1st Mort. Deb. Stock (red.)	85 —90	5 0 0	April, Oct	87½	..
St.	4½%	B'ham & Midland Trams 4½ 1st Db. Stk.	92 —95	4 14 9	Jan, July	..	..
10	9%	Bristol Tramways & Carriage Ord.	10½ —11	8 3 6	Feb, Aug	..	..
10	4%	Do. Cum. Pref. (fully paid)	8¾—9¼	4 6 6	..	..	..
St.	4%	Do. 4 per Cent. Debs.	93 —98	4 2 0	Feb, Aug	..	..
10	..	British Electric Traction Ord.	1⅛—1⅜	..	June, Dec	1⅛	—
10	3/0	Do. 6 per Cent. Cum. Pref.	3⅝—4⅜	..	Feb, Aug	3½	..
St.	5%	Do. 5 per Cent. Perpetual Debs.	95 —99	..	April, Oct	98½	93¾
St.	4½%	Do. 4½ per Cent. 2nd Deb. Stock	76 —78	5 15 0	May, Nov	..	..
St.	3%	Central London Ordinary Stock	68 —70	4 5 8	Feb, Aug	.	..
St.	4%	Do. 4 per Cent. Pref. Stock	84 —86	4 13 0	Feb, Aug	86½	84
St.	2%	Do. Deferred Stock	49 —52	3 17 0	Feb	51	..
100	4%	Do. 4 per Cent. Debs.	101 —104	3 17 0	Jan, July	102¾	..
St.	4%	Charing X, Euston & Hmpstd Per. Db. Stk.	82 —84	4 15 0	Jan, July	83½	—
5	2/6	City of Birmingham Trams. 5% Cm. Pref.	4¼—4¾	5 5 0	April, Oct	..	..
100	4%	Do. 4 per Cent. 1st Mort. Debs.	97 —100	4 0 0	April, Oct	..	..
St.	1½%	City & South London Rly. Con. Ord.	32 —33	4 19 0	Feb, Aug	33	32¾
St.	5%	Do. 5 per Cent. Perp. Pref. (1891)	111 —114	4 7 6	Feb, Aug	..	..
St.	5%	Do. (1896)	109 —112	4 9 3	Feb, Aug	—	..
St.	5%	Do. (1901)	107 —110	4 11 0	Feb, Aug	..	..
St.	5%	Do. (1903)	102 —105	4 15 3	Feb, Aug	..	..
St.	4%	Do. 4 per Cent. Perpetual Debs.	100 —103	3 17 6	May, Nov	..	..
10	6/0	Dublin United Trams. Ord	11½—12½	5 4 0	Feb, Aug	..	..
10	6/0	Do. 6 per Cent. Pref.	12½—13½	4 10 6	Feb, Aug		¾
10	..	Gt. Northern & City Rly. Pref. Ord. (4%)	½—1	..	Feb, Aug		
10	0/9	G. Northern, Piccadilly & Brompton Ord.	7 —7½	5 6 9	Feb, Aug		..
St.	4%	Do. 4 per Cent. Deb. Stock	91 —93	4 6 0	Jan, July	92½	91⅛
5	4/0	Hastings & Dist. Elec. Trams 6% Cm. Pf.	3 —4	..	Mar, Sept	..	..
St.	4½%	Do. 4½ Db. St.	92 —96	4 13 9	April, Oct	..	..
10	9%	‡Imperial Tramways Ord.	10 —11	7 7 3	Mar, Sept	..	..
10	6%	‡Do. 6 per Cent. Pref.	9½—10½	5 11 0	Mar, Sept	..	..
St.	4½%	‡Do. 4½ per Cent. Debs.	90 —92	4 18 0	Jan, July	..	..
5	..	I. of Thanet E. T. & Lt. 5 per Cent. Pref.	⅞—1⅛	..	Mar, Sept	..	..
St.	4%	Do. 4 per Cent. Deb. Stock	55 —61	6 11 0	Jan, July	..	—
10	6/0	†Lanarkshire Tramways	9⅝—9⅞	6 3 0	Feb, Aug	..	..
St.	5%	Lancs. Utd. Trams 5% Prior Lien Db. St.	92 —94	5 6 6	Jan, July	..	..
10	..	Liverpool Overhead Railway Ord.	1¼—1⅝	..	Feb, Aug	..	—
10	5%	Do. 5 per Cent. Pref.	5¾—6¼	8 0 0	Feb, Aug	..	..
St.	4%	Do. 4 per Cent. Deb.	84 —86	4 13 0	Jan, July	..	..
10	5/0	London United Trams. 5% Cum. Pref.	5½—6½	7 14 0	Jan, July	..	—
St.	4%	Do. 4 per Cent. 1st Mort. Deb. Stock	75 —80	5 0 0	Jan, July	75	..
St.	—	Mersey Con. Ord. Stock	1 —3	—	Feb, Aug.	..	—
St.	..	Do. 3 per Cent. Perp. Pref.	8 —6	—	..	..	..
1	..	Metropolitan Elec. Tramways Ord.	⅝—⅞	—	.	..	..
1	..	Do. Def.	¼—⅜	..	April.. .	..	..
1	0/6	Do. 5 per Cent. Cum. Pref.	1⅟₁₆—1⅟₁₆	6 3 6	Feb, Aug	.	..
St.	4½%	Do. 4½ per Cent. Deb. Stock	92 —95	4 14 9	Jan, July	91	..
St.	½%	Metropolitan Railway Consolidated	35 —36	1 7 6	Feb, Aug	36½	35
St.	2¾%	Do. Surplus Lands Stocks	65 —67	4 2 0	Feb, Aug	67	65
St.	3½%	Do. 3½ per Cent. Preference	84 —87	4 0 6	Feb, Aug	85½	84⅛
St.	3½%	Do. 3½ per Cent. "A" Preference	73 —76	4 12 0	Feb, Aug	—	..
St	3½%	Do. 3½ per Cent. Convertible Pref.	70 —73	4 16 0	Feb, Aug	72	70⅛
St	3½%	Do. 3½ per Cent. Debenture Stock	90 —93	3 15 3	Jan, July	92	90½
St.	3½%	Do. 3½ per Cent. "A" Ditto	88 —91	3 17 9	Jan, July	..	..

* In calculating the yield allowance has been made for accrued interest but *not* for redemption
† Ex Dividend

ELECTRICAL COMPANIES' SHARE LIST.—*Continued.*

ELECTRIC RAILWAYS & TRAMWAYS—*Continued.*

Share	Last Dividend	Name	Price Wed., Sept. 9	Rate % Yielded £ s. d.	Dividend Due	Business Week to Sept. 9 Highest	Lowest
St.	..	Metropolitan District Railway Ord.	11 —12	—	Feb, Aug	11⅞	11½
St.	..	Do. Extension Pref. (5 per Cent.)	18 —22	..	Feb, Aug	..	..
St.	3½	Do. Asserted Ext. Pref. (Int. Guar. by Und. Elec. Rlys. Co. of London, Ltd.)	48 —52	6 14 6	Feb, Aug	..	..
St.	3%	Do. 3 per Cent. Consoltd. Rent-charge	73 —76	3 19 0	Jan, July	75	..
St.	4%	Do. 4 per Cent. Midland Rent-charge	98 —102	3 18 0	Jan, July	..	—
St.	1¾	Do. Guar. Stock 4 per Cent.	47 —52	3 17 0	Mar, Sept	..	..
St.	6	Do. 6 per Cent Perp. Deb. Stock	116 —119	5 1 0	Jan, July	117¼	117⅛
St.	4%	Do. 4 per Cent. Ditto	71 —76	5 5 0	Jan, July	74½	73½
5	..	New Gen. Tract. 6 per Cent. Cum. Pref.	¼—¾	..	May	..	—
1	0/9⅜	Potteries Electric Traction Ord.	¼—½	8 0 0	April, Oct	..	..
1	0.6	Do. 5 per Cent. Cum. Pref.	19/32—23/32	6 19 0	Feb, Aug	..	..
St.	4½%	Do. 4½ per Cent. Deb. Stock	93 —96	4 14 6	May, Nov	..	..
1	0 7½	S. Met. Elec. Trams. & Ltg. 6% Cm. Pref.	¾—1	6 0 0	Feb, Aug	..	..
St.	4%	Do. 4 per Cent. Deb. Stock	76 —80	5 0 0	Jan, July	..	..
100	5%	Sunderland Dist. Elec. Trms. 5% 1st Mt. Db.	78 —82	6 2 0	Jan, July	..	..
..	£1/0	†Underground Elec. Rys. Co. of London	38 —42	..	June, Dec	40½	..
5	..	Yorkshire (W.R.) Elec. Trams. Ord.	⅞—1⅛	—	March ..	..	..
5	..	Do. 6 per Cent. Cum. Pref.	8⅛—3⅝	—	..	..	..
St.	4½	Do. 4½ per Cent. 1st Debs.	83 —86	5 5 0	Jan, July	..	..

ELECTRIC MANUFACTURING, &c.

Share	Last Dividend	Name	Price Wed., Sept. 9	Rate % Yielded £ s. d.	Dividend Due	Highest	Lowest
1	..	Aron Electricity Meter Ord.	7/32—11/32	..	..	..	..
1	1/4⅘	Do. 6% Cum. Pf. ex cn a/c arrears)	11/16—13/16	7 12 0	April, Oct	[illegible]	..
1	2/4⅘	Babcock & Wilcox Ord.	3¾—4	5 0 0	April, Oct	3 [illegible]	3⅞
1	0/7⅛	Do. Pref.	1½—1⅝	3 13 9	..	..	..
5	6/0	British Insulated & Helsby Cables Ord.	6½—7	7 4 0	July, Feb	6 11/16	..
5	3/0	Do. 6 per Cent. Pref.	6 —6½	4 12 0	Jan, July	..	..
St.	4½%	Do. 4½ per Cent. 1st Mort. Deb. (red.)	103 —106	4 5 0	Jan, July	..	..
St.	4½%	†British Thoms'n-Houst'n 4½% 1st Mt. Db.	91 —96	4 14 0	Mar, Sept	..	..
5	..	British Westinghouse 6 per Cent. Pref.	7/16—9/16	..	Feb, Aug	..	..
St.	4%	Do. 4 per Cent. Mort. Deb. Stock	43 —48	8 8 0	Jan, July	..	..
2	..	Brush Electrical Engineering	½	—	March ..	..	..
2	..	Do. 6 per Cent. Pref. non-Cum.	⅛—⅜	..	Mar, Sept	..	..
St.	4½%	† Do. 4½ per Cent. Perp. 1st Deb. Stock	68 —73	6 3 0	Mar, Sept	..	—
St.	4½%	Do. Perpetual 2nd Deb. Stock	50 —54	8 6 6	Jan, July	..	..
5	10/0	Callender's Cable Con. Ord.	9¾—10¾	6 17 6	Jan, July	..	..
5	2/6	Do. 5 per Cent. Cum. Pref.	5½—5¾	4 7 0	Jan, July	..	..
St.	4½%	Do. 4½ per Cent. 1st Mort Debs. (red.)	107½—109½	4 2 0	Nov, May	..	..
1	1/0	Castner-Kellner Alkali Co.	1 [illegible]—1 11/16	8 0 0	May, Nov	1⅝	1 [illegible]
St.	4½%	Do. 4½ per Cent. 1st Mort. Deb. (red.)	103 —107	4 4 0	Feb, Aug	..	..
1	0 9⅜	Chadburn's (Ship) Telegraph Ord.	[illegible]—1 1/16	7 11 6	March ..	..	..
1	0/7½	Do. 6 per Cent. Cum. Pref.	15/16—1 1/16	5 13 0	April, Oct	..	..
1	0/8⅖	Consolidated Electrical Co.	⅜—½	7 0 0	August ...	..	..
1	1/0	Consolidated Signal Co.	1⅛—1 [illegible]	9 12 0	April, Oct	1 11/32	1⅛
1	0/7½	Do. 6 per Cent. Cum. Pref.	[illegible]—31/32	6 4 0	April, Oct	—	..
3	3/0	*Crompton & Co. (Nos. 1 to 86,000)	1 1/16—1 3/16	9 5 0	Jan, July	..	..
100	5%	Do. 5 per Cent. 1st Mort. Debs. (red.)	91 —94	5 5 6	Jan, July	92	90½
1	0/7½	Davis & Timmins	⅞—1⅛	..	Mar, Sept	..	..
5	2/0	Dick, Kerr & Co. Ord.	1¼—1½	6 13 4	Sept	1⅜	1 5/16
5	0/7½	Do. 6 per Cent. Cum. Pref.	1 1/16—1 [illegible]	4 11 0	Sept ..	..	..
St.	4½%	Do. 4½ per Cent. Deb. Stock	100 —103	4 7 6	Jan, July	..	—
5	2/6	Edison & Swan United ("A" Sh.) (£3 pd.)	½—¾	..	Feb, Aug	..	..
5	4/2	Do. (£5 paid)	1½—2½	5 0 0	Feb, Aug	..	—
St.	4%	Do. 4 per Cent. Mort. Deb. Stock (rd.)	76 —79	5 [illegible] 6	June, Dec	..	..
St.	5%	Do. 5 per Cent. 2nd Deb. Stock	85 —87	5 15 0	Mar, Sept	—	..
5	..	Edmundson's Elec. Corp. Ord.	⅛—⅜	..	Jan, July	..	..
5	..	Do. 6 per Cent. Cum. Pref.	½—1	..	May, Nov	..	..
St.	4½%	Do. 4½ per cent. 1st Mort. Deb. (red.)	59 —66	6 16 0	Jan, July	..	..
2	..	Electric Construction Co.	⅝—⅞	..	Jan, July	1 [illegible]	11/16
2	2/9	Do. 7 per Cent. Cum. Pref.	1⅛—1⅞	..	July	—	..
St.	4%	Do. 4 per Cent. Perp. 1st Mort. Debs.	66 —71	5 13 0	Jan, July	..	..
10	5/0	General Electric (1900) 5% Cum. Pref.	7½—8	6 5 0	June, Dec	..	..
St.	4%	Do. 4 per Cent. 1st Mort. Debs.	85 —90	4 9 0	Mar, Sept	..	—
5	[illegible]/0	†Henley's Telegraph Works Ord.	10¾—11¼	6 10 0	Feb, Aug	11	..
5	2/3	† Do. 4½ per Cent. Pref.	5 —5½	4 2 0	Feb, Aug	..	..
St.	4½%	Do. 4½ per Cent. 1st Mort. Deb. Stock	107 —109	4 2 6	Mar, Sept	..	..
10	5/6	India Rubber, Gutta Percha, &c., Wrks.	16½—16½	6 2 0	Feb, Aug	16½	..
100	4%	Do. 4 per Cent. Debs. (red.)	99 —101	3 19 0	April, Oct	..	—
1	..	National Elec. Construction Co.	⅛—⅜	..	April	..	..
1	0/9⅜	Richardsons, Westgarth & Co., Ltd. Ord.	7/16—9/16	7 2 0	Nov	[illegible]	..
1	0/7½	Do. 6 per Cent. Cum. Pref.	¾—⅞	6 17 0	May, Nov	..	..
St.	4½%	Do. 4½ per Cent. Perp. Deb. Stock	85 —88	5 2 0	Jan, July	..	..
1	..	Simplex Conduits Ord.	1½	..	..	—	—
5	..	Do. 6 per Cent. Cum. Pref.	5¼	..	..	..	—
12	12/0	Telegraph Construction & Maintenance	32½—34½	6 2 6	Mar, July	32½	..
100	4%	Do. 4 per Cent Deb. Bonds (1909)	101 —103	3 17 0	Jan, July	100½	..
1	1 0	Vickers, Sons & Maxim, Ltd., Ord.	1¼—1⅞	8 17 0	..	1 [illegible]	1 [illegible]
1	0/6	Do. 5 per Cent. non-Cum. Preference	1 —1⅛	4 9 0	..	1 [illegible]	1 [illegible]
St.	5%	Do. 5 per Cent. non-Cum. Preferred	100 —103	4 17 6	..	..	..
St.	4%	Do. 4 per Cent. 1st Mort. Db. Sk. (red)	104 —106	3 15 0	June, Dec	..	..
100	4½%	Do. 4½ per Cent. 2nd Mort. Deb. (red.)	104 —106	4 5 0	June, Dec	..	..
100	16/6	Do. 5 per Cent. 3rd Mort. Debs. Scrip.	103 —105	4 15 0	..	104⅛	103½
10	10/0	J. G. White & Co. 6% Cm. Pref.	8½—9½	8 17 9	..	..	..
5	1/0	Willans & Robinson Ord.	¾—1¼	4 0 0	Apr, Oct	¾	..
5	3/0	Do. 6 per Cent. Cum. Pref.	2½—3	8 11 6	Apr, Oct	..	..
100	4%	Do. 4 per Cent. 1st Mort. Debs.	72 —76	5 5 6	May, Nov	75	..

TELEGRAPHS.

Share	Last Dividend	Name	Price Wed., Sept. 9	Rate % Yielded £ s. d.	Dividend Due	Highest	Lowest
10	..	Amazon Telegraph	2 —3	—	June, Dec	..	—
100	5%	Do. 5 per Cent. Debs. (red.)	90 —98	5 7 6	June, Dec	..	..
St.	15/0	Anglo American	58 —61	5 16 0	F,My,Ag,N	60	59
St.	30/0	Do. Preferred	104 —105	3 15 6	F,My,Ag,N	104⅞	104⅛
St.	1%	Do. Deferred	17 —17½	5 17 6	F,My,Ag,N	17⅜	1[illegible]
St.	4%	Commercial Cable 4 per Cent. Deb. Stk.	86 —91	4 8 0	Jn,Ap,Jy,O	90½	89
10	6/0	Cuba Submarine Ord.	7½—8½	7 0 0	Feb, Aug	..	..
10	10/0	Do. Preference 10 per Cent.	15½—16½	6 1 6	Feb, Aug	..	..
5	2/0	Direct Spanish Ord.	3 —3½	6 4 0	April, Oct	..	..
5	[illegible]/0	Do. 10 per Cent. Cum. Pref.	8 —9	5 11 0	April, Oct	..	..
100	4½%	Do. 4½ per Cent. Deb.	.00% 103%	4 7 6	Jan, July	..	..
[illegible]	[illegible]/0	Direct United States Cable	13⅛—13⅝	6 7 6	Ja,Ap,Jy,O	13½	13¼
100	4½%	Direct West India Cable 4½% Rg. Db. (rd.)	100 —102	4 8 0	June, Dec	..	..
St.	[illegible]/0	Eastern Ordinary	135½—138½	6 0 6	Ja,Ap,Jy,O	137½	135½
St.	17/6	Do. 3½ per Cent. Pref. Stock	84½—86½	4 [illegible] 0	Ja,Ap,Jy,O	86	85
St.	4%	Do. 4 per Cent. Mort. Deb. Stk. (red.)	103 —106	3 16 0	May, Nov	104½	103½
10	2/6	Eastern Extension	12⅜—12⅞	5 5 6	Ja,Ap,Jy,O	12 [illegible]	12⅜
St.	4%	Do. 4 per Cent. Deb. Stock	100½—102½	3 17 6	Feb, Aug	101½	100
100	4%	Eastern & S. African 4% Mort. Deb 1900	99½—101½	3 18 6	Feb, Aug	..	..
[illegible]	4%	Do. 4% Mauritius Sub. Debs. (red.)	101½—103½	3 16 6	May, Nov	..	..
10	[illegible]	G. N. of Copenhagen, with Coupon 74	27½—29½	6 15 0	Jan, July	29	—
100	4½%	Halifax & Bermuda 4½% 1st Mt. Db. (red.)	100 —102	4 8 0	June, Dec	..	..
	52/6	Indo European	66 —69	6 12 0	May, Nov	68	..
100	$1	Mackay Companies Common	69 —73	5 10 0	Ja,Ap,Jy,O	..	..
100	$1	Do. Preference	69 —78	5 10 0	Ja,Ap,Jy,O	..	..
1		Marconi's Wireless Teleg. Co.	⅜—⅝	..	April	..	..
100	4	Pacific & Europe'n Tel. 4% Guar. Dbs. (red.)	99 —102	3 18 0	June, Dec	..	—
1	[illegible]	West Coast of America	1 [illegible]—1 [illegible]	4 6 0	May	..	—
100	4	Do. 4 per Cent. Debs.	99 —102	3 18 0	Jan, July	..	..
10		West India & Panama	[illegible]	..	May, Nov	..	..
10	[illegible]	Do. 6 per Cent. 1st Pref.	8 —8½	7 1 0	May, Nov	8½	..
10		Do. 6 per Cent. 2nd Pref.	8¼—9¼	..	May, Nov	..	..
100	[illegible]	Do. 5 per Cent. Debs.	101 —103	4 17 0	Jan, July	..	..
10	[illegible]	Western Telegraph	13⅝—13⅞	6 1 0	Mr,Jn,O,D	13⅞	13[illegible]
St.	4	Do. 4 per Cent. Deb. Stock (red.)	101½—103½	3 16 6	June, Dec	..	..
..	4	Western [illegible] Teleg. $1,000 4% Bonds	85 —88	4 11 0	..	..	..

TELEPHONES.

Share	Last Dividend	Name	Price Wed., Sept. 9	Rate % Yielded £ s. d.	Dividend Due	Highest	Lowest
100	2⅜	Amer. Telephn. & Telegh. Cap. St.	133 —137	5 17 0	..	135½	133
..	4%	Do. Coll. Trust $1,000 4 per Cent. Bds	92 —94	4 6 6	Jan, July	93	92½
St.	5%	Anglo-Portug'se Tel. 5% 1st Mt. Db. Stk.	101 —104	4 16 0	Mar, Sept	..	—
5	5/0	Chili Telephone	8 —8½	4 14 0	August ..	..	..
1	0/7½	Monte Video Telephone Ord.	1 —1⅛	6 4 0	Nov	..	..
1	0/6	Do. 5 per Cent. Pref.	27/32—31/32	5 3 0	May, Nov	..	..
St.	6%	National Co. Pref. Stock	108½—110½	5 8 6	Feb, Aug	109¾	10[illegible]
St.	6%	Do. Def. Stock	118 —120	5 0 0	Feb, Aug	118⅞	118
10	6/0	Do. 6 per Cent. Cum. 1st Pref.	10½—11½	5 4 6	Feb, Aug	..	..
10	6/0	Do. 6 per Cent. Cum. 2nd Pref.	10½—11½	5 4 6	Feb, Aug	1[illegible]	..
5	2/6	Do. 5 per Cent. non-Cum. 3rd Pref.	5⅝ —5⅞	4 7 0	Feb, Aug	5 [illegible]	[illegible]
St.	3½%	* Do. Deb. Stock 3½ per Cent. (red.)	98½ —100½	3 9 6	June, Dec	99	9[illegible]
St	4%	Do 4 per Cent. Deb. Stock (red.)	103 —105	3 16 0	Jan, July	—	..
1	1/0	Oriental	1¼—1⅜	5 16 3	April, Oct	—	..
1	0/7½	Do. 6 per Cent. Cum. Pref.	1 [illegible]—1 [illegible]	4 11 6	April, Oct	..	..
St.	4%	Do. 4 per Cent. Red. Deb. Stock	89 —92	4 7 0	Jan, July	—	..
St.	4½%	Telephone Co. of Egypt 4½% Db. Stk. (red.)	99 —102	4 12 0	Jan, July	..	—
5	5/0	United River Plate	6⅞—7⅛	5 12 0	July	..	..
5	2/6	Do. 5 per Cent. Cum. Pref.	5 —5½	4 11 0	June, Dec	..	..
St.	4½%	Do. 4½ Deb. St. Red.	102 —104	4 6 6	Jan, July	103	..

FINANCIAL, INVESTMENT, &c.

Share	Last Dividend	Name	Price Wed., Sept. 9	Rate % Yielded £ s. d.	Dividend Due	Highest	Lowest
5	8/0	Elec. & Gen. Investment 6% Cum. Pref.	3½—4	7 10 0	Jan, July	..	..
10	5/9	Globe Telegraph & Trust	10½—11	5 7 0	Sp De Mr Ju	10⅞	10⅞
10	3/0	Do. 6 per Cent. Pref.	13½—14	4 5 9	Sp De Mr Ju	13⅞	13⅞
10	6%	Submarine Cables Trust (Cert.)	129 —132	4 11 0	April, Oct	..	..

COLONIAL AND FOREIGN ELECTRIC RAILWAYS, TRAMWAYS, &c.

Share	Last Dividend	Name	Price Wed., Sept. 9	Rate % Yielded £ s. d.	Dividend Due	Highest	Lowest
5	3/0	Anglo-Argentine 6% Cum. 1st Pref.	6 3/16—6 7/16	4 12 0	April, Oct	6⅜	6[illegible]
5	5/0	Do. 10% Non-cum. 2nd Pref.	8 11/16—8 13/16	5 14 3	Jan, July	8[illegible]	...
St.	6%	Do. Permanent 6% Deb. Stock	142 —147	4 1 6	June, Dec	..	—
St.	5%	Auckland Elec. Trams. 5% Deb. (red.)	103 —106	4 14 3	Jan, July	..	.
5	4/0	Brisbane Electric Trams. Invest. Ord.	4⅝—4⅞	4 2 6	May	4[illegible]	..
5	2/6	Do. 5 per Cent. Cum. Pref.	4⅞—5⅛	4 17 6	May, Nov	4[illegible]	..
St.	4½%	Do. 4½ per Cent. Db. Prov. Certs.	99 —103	4 7 6	Jan, July	102	101½
St.	8%	British Columbia El. Ry. Df. Ord.	134 —138	5 16 0	Mar, Sept	136	135
St.	30/0	Do. Pref. Ord. Stock	114 —118	5 2 0	May, Nov	..	..
St.	5%	Do. 5% Cum. Perp. Pref. Stock	104 —108	4 12 6	Jan, July	..	..
40	4½%	Do. 4½ per Cent. 1st Mort. Debs.	101 —104	4 6 6	April, Oct	103⅛	..
100	4½%	Do. Vancouver Power Debs.	100½—103½	4 7 0	Jan, July	101⅞	—
St.	4½%	Do. 4½% Perp Con. Deb. St.	101 - 104	4 1 6	—	..	..
St.	5%	Buenos Ayres Elec. Trams (1901) Ltd. Deb. St.	95 —99	5 1 0	Ja, Jul ..	..	..
5	..	Buenos Ayres Grand National Ord.	2½—3	..	..	2 [illegible]	2½
5	2/6	Do. 5 per Cent. Cum. Pref.	4 —4½	..	Feb, Aug	4½	4
100	5½%	Do. 5½ per Cent. Pref. Debs.	100 —105	5 4 6	Jan, July	..	..
100	6%	Do. 6 per Cent. 1st Deb. Bonds.	101 —106	5 13 0	April, Oct	..	..
St.	5%	Buenos Ayres Lacroze Trams 1st Mt. Db	95 —97	5 3 0	Mar, Sept	95½	95½
St.	6%	Buenos Ayres Port & City Tram. 1st Mt. Deb. Stock £75 Paid	61 —65	6 12 0	Feb, Aug	..	..
5	2/6	Calcutta Tramways (1 to 137,610)	5½—6	5 0 0	Mar, Sept	..	..
100	2/6	Do. 5 per Cent. Cum. Pref.	4⅞—5½	4 13 0	Jan, July	—	..
1	4½%	Do. 4½% 1st Deb. Stock (red.)	101 —104	4 6 6	Jan, July	..	..
St.	..	Cape Electric Tram Shares	⅛-⅜	..	..	..	—
5	1/3	City of Buenos Ayres Trams Co. (1904, Sh.	5⅝ —5⅞	4 5 3	F,My,A,N	5¾	[illegible]
St.	4%	Do 4 per Cent. Deb. Stock	99 —103	3 17 [illegible]	June, Dec	100⅛	..
..	5%	Colombo Tr. & Ltg. 5% 1st Mt. Db.	90 —93	5 6 6	May, Nov	..	—
100	5%	Electric Traction Co. of Hong Kong 5 per Cent. 1st Mort. Debs.	85 —90	5 10 0	June, Dec	..	..
1	5%	Havana Elec. Ry. Con. Mt. 5% $1,000 50 year Coup. Bds.	85 —90	5 11 0	Feb, Aug	..	..
1	..	Kalgoorlie Elec. Trams Sh.	½—⅝	..	..	..	..
100	5%	Do. 5 per Cent. "A" Deb. Stock	85 —87	5 12 0	Jan, July	..	—
5	6%	Do. 6 per Cent. "B" Ditto	65 —70	8 11 6	Jan, July	..	..
5	1/0	Lisbon Elec. Trams. Ord.	1 —1¼	4 0 0	July	..	..
100	0/7½	Do. 6 per Cent. Cum. Pref.	1 —1½	4 16 0	Jan, July	..	.
St.	5%	Do. 5 per Cent. Reg. Mort. Debs	92 —97	5 3 0	Jan, July	..	..
St.	5%	Madras Elec. Trams. 5% Deb. Stk.	93 —96	5 4 0	Jan, July	..	
.	5%	Manila Elec. Ry. $1,000 Gold Bonds	84 —88	5 14 0	Feb, Aug	..	
100	4/[illegible]½	Mexico Trams Co. Com. St.	124 —126	3 17 0	..	127	125½
500	5%	†Do. Gen. Con. 1st Mort. 5% Gold Bds.	92½—93½%	5 7 0	..	93	92½
St.	4½%	Montreal St. Ry. Sterling 4½ per Cent. Debs. (1922) (Nos. 601 to 2,000)	100 —102	4 8 0	Feb, Aug		
1	1/0	Perth Elec. Trams Ord	[illegible]	7 3 6	May	..	..
St.	5%	Do. 1st Mt. Db. Stock	101 —104	4 16 0	Jan, July	..	—
5	3/0	Rangoon Elec. Trams & Supply Co. 6 Cum. Pf.	5¼—5⅝	5 6 6	..	..	—
St.	4½	Do. 4½% 1st Mort. Deb. Stk.	95 —100	4 10 0	..	..	—
..	$2½	Sao Paulo Tramway, Light & Power Co. $100 Stock	156 —160	5 12 6	..	155	
..	5%	Do. 5 per Cent. 1st Mt. $500 Db.	99 —100	5 0 0	June, Dec	.	
100	4½%	†Toronto Ry Co. 1st Mt. 4½% Ster. Bonds	97 —99	5 1 0	Feb, Aug	9[illegible]	9[illegible]

COLONIAL AND FOREIGN ELECTRICITY SUPPLY &c.

Share	Last Dividend	Name	Price Wed., Sept. 9	Rate % Yielded £ s. d.	Dividend Due	Highest	Lowest
5	8/0	†Adelaide Elec. S'ply Co. 6% Cu. Pr.	4¾—5¼	5 14 0	Mar, Sept	..	..
10	6/0	Bombay E. S. & T. 6% Cm. Pf.	9¾—10¼	5 16 3	..	..	
St.	4½	Do. 4½ per Cent. Deb. Stk. (red.)	93 —95	4 13 9	Jan, July	94½	..
5	4/9	Calcutta Elec. Supply Ord.	5¾—6¼	5 17 0	April, Oct	6[illegible]	
100	7/2	Canadian Gen. Elec. Co. Com. St.	105 —109	6 9 6	..	105	[illegible]
100	5%	Castner Electrolytic Alkali Co. (of U.S.A.) 1st Mort. Stl. Debs.	92 - 97	5 2 6	Jan, July		
500	5%	Elect. Development Co. of Ontario	84 - 87%	5 15 0	..	..	
5	..	Elec. Ltg. & Trac. Co. of Aust. 6 per Cent. Cum. Pref.	2 —2¼	..	Feb, Aug	..	..
St.	5%	Do. 5 per Cent. Deb Stock	83 —88	5 13 9	Jan, July	..	
St.	5%	Elec. Supply Co. of Victoria 5 per Cent. 1st Mort. Deb. St.	90 —93	5 7 6	Jan, July		
St.	6%	Indian Elec. Sup. & Trac. Co. Constn Deb. St. Rd.	30 —40	15 0 0	Jan, July	..	..
10s	0/3	Kalgoorlie Elec. Power & Ltg. Ord.	[illegible]	..	..	..	
1	0/7½	Do. 6 per Cent. Cum. Pref.	⅜—½	8 0 0	April, Oct		..
St.	6%	Madras E. S. Corp. 6 per Cent. Constn Deb. St.	85 —90	6 11 0	April, Oct	..	..
500	5%	Mexican Elec. Light Co. 5% 1st Mort. Gold Bonds	87 —88%	5 18 9	..	87½	8[illegible]
St.	$1	Mexican Lt. & Power Co. Com. St.	79 —80	..	..	81½	78½
500	5%	Do. 5% 1st Mort. Gold Bnds.	93½—94½	5 6 0	..	94	[illegible]
100	6/2	Montreal Lt. Ht. & Power Co. Cap. St.	106 —109	5 10 0	F,My,A,N	1[illegible]	10[illegible]
1	1/7½	River Plate Electricity Co. Ord.	1 —1⅛	5 6 6	April	1	1
1	1 2⅜	Do. 6 per Cent. non-Cum. Pref.	[illegible]	5 13 0	May ..	1	.
St.	5%	Do. 5 per Cent. Deb. Stock	98 —101	4 19 0	Jan, July		
5	3/0	Rosario Elec. Co. 6% Pref. (1-20,000)	4⅞—5⅛	5 14 0	April, Oct	[illegible]	
100	$1	Shawinigan Water & Power Co. Cap. St.	82 —84	4 15 3	..	[illegible]	[illegible]
..	5%	Do. 5 per Cent. Bds.	103 —105%	4 15 6	Jan, July	104½	[illegible]
..	6%	Victoria Falls Power Co. Pref.	[illegible]	—	Jan, July		..

* In calculating the yield allowance has been made for accrued interest but not for redemption. † Ex dividend. ‡ The London Stock Exchange Committee have declined to quote these.

THE ELECTRICIAN:

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CONTENTS OF THE CURRENT NUMBER.

NOTES.

Railway Electrification.

In our last issue we referred to the report recently drawn up by Mr. C. H. Merz on the proposed electrification of the Melbourne suburban railways. This report has just been submitted to the Victorian Railways Commissioners, and an official abstract of its contents has now been made public, and will be found elsewhere in this issue. In the event of the Commissioners carrying out the full scheme outlined in the report, which is undoubtedly one of the most important so far prepared on the subject of railway electrification, the scheme will certainly have considerable influence on future progress, since it covers a route length of no less than 124 miles. In the case of the English railway companies, however, the present policy appears to be that of waiting for further developments at home and abroad, and for absolutely reliable information concerning the running costs under electrical conditions of working. In this connection a most important question is the system to be adopted. It will be noticed that Mr. C. H. Merz advocates a third rail with continuous current at a pressure of 800 volts. This will most probably lead to further discussion among the experts, who, at the present time, to judge from recent correspondence in the Press, are as far as ever from unanimity on this question. The disputants might do well to remember the old controversy of continuous current *v.* alternating current for lighting networks in the days when engineers thought it necessary to adhere to one system or the other for all cases. We now know that both systems can live side by side with advantage, and in due time it may be realised that the continuous current and the single-phase systems of traction both have their spheres of utility.

The Rubber Exhibition.

We hope that those electrical engineers who can pay a visit to the Rubber Exhibition, which remains open at Olympia until the 26th inst., will not fail to do so. The principal centre of interest in the Exhibition lies in the specimens of the various kinds of rubber material which to-day form the basis of the rubber industry and also the methods adopted for extracting this useful natural product from its source. The Exhibition appears to have been organised principally by those countries interested in the production of rubber and its development into useful articles of commerce. For this reason the bulk of the exhibits will be found to furnish geographical details of the great rubber-bearing centres, together with specimens of the rubber exported from those areas. The official catalogue is an excellent guide to the Exhibition, and those who are not acquainted with the various kinds of present-day rubber will find it an advantage to glance through one or two of the articles in this publication.

It will, perhaps, be felt that the interest of electrical men in rubber is hardly as great as it used to be, say, 10 years ago. For the insulation of cables, impregnated paper has assumed such an important position that a rubber-covered cable is now seldom used, on the score of its greater cost if for no other reason. Still, there is no questioning the fact that indiarubber plays a most important part in electrical industry, and it will be to the general benefit if steps can be taken to encourage the cultivation of this commodity on thoroughly scientific lines. Almost two-thirds of the world's supply of rubber, which in 1907 reached 69,000 tons, comes from the wild trees of tropical America. Tropical Africa contributes about one-third, and the whole of Asia, including both wild and plantation rubber, furnishes only about 3 per cent. It will be seen from these figures that there still remains an immense field open for the cultivation of rubber in plantations. Another striking fact, which

will doubtless give the electrical engineer considerable food for reflection, is that practically the whole of this American raw rubber is collected by hand labour and treated by hand in small quantities. The rubber milk is collected by the gatherer and is coagulated at the end of the day by smoking it over a fire. This smoking process is continued until a piece of rubber weighing from 3 lb. to 30 lb. is collected at the end of the stick used to turn the material over the fire. Attempts have been made to treat the rubber milk, or latex, in bulk, but, we understand, so far without success. One firm exhibiting in the commercial section, Messrs. David Bridge & Co., announces that possibly a complete plant working on the lines of Mr. DA COSTA's experiments will be tested in the yard of the Exhibition. The process is carried out by the infusion of steam and the smoke from palm nuts, native twigs, leaves, &c., into the latex. We also understand that this very important development will be thoroughly discussed by experts at the conferences to be held during the course of the Exhibition.

Tramway Capital Expenditure.

WHATEVER opinion may be held as to extravagant expenditure, there is no doubt that English engineering compares most favourably, at any rate from a mechanical point of view, with that carried out in other countries. The objection is frequently raised that so much attention is paid to obtaining sound construction as to result in the cost of the work being excessive. In the case of municipal electric supply stations and tramways, this large capital expenditure imposes a heavy burden on the undertakings, in the way of interest and sinking fund. For example, although the working costs amounted to only 60 per cent. of the receipts in the case of the 71 municipal tramway undertakings considered by Mr. F. DOUGLAS FOX in his Paper read last week before the British Association, the resulting profit of £2,528,160 was largely absorbed by the capital charges, so that after setting aside £528,733 for depreciation the net surplus only amounted to about 1¼ per cent. on the total expenditure, and if adequate depreciation had been allowed in all cases even this small return would have been materially lessened. The author draws attention to the fact that the average cost per mile of an American or Continental tramway is only one-third that of the average figure for English tramways and little more than half the lowest figure in this country. Also, notwithstanding the fact that the first cost of such undertakings is much less in America, higher fares are there in vogue.

IN this connection, however, it is worth while to remember that the conditions are very different from those which hold good in this country. For example, on the Continent it is quite usual for a portion of the roadway to be restricted to the tramway service alone. This means, of course, that the track can be laid in accordance with railway methods instead of tramway methods, and paving, which is a costly matter, is unnecessary, as well as the usual concrete foundation. Even where a tramline is run on a road used also for other traffic, the construction is very often not solid and Vignoles rails are used with a total disregard to the well-being of the other vehicles. Of course, where the traffic is heavy such methods are inadmissible, but the important point is that in this country these methods are practically never permitted whatever the conditions. Where light cars can be run on a lightly constructed track, outlying districts can be served in a way that is impossible if the authorities insist upon our usual solid construction. Under present conditions it is only natural that many tramway undertakings in this country should find it almost impossible to show a satisfactory financial result. Tramway companies suffer under the further disadvantage that they are generally unduly penalised by the local authorities through whose streets the cars are run, whereas municipal undertakings are frequently not charged with the full capital expenditure occasioned by street widenings and other accessory work.

The British Association.—The following return has been made of the number of tickets issued for the recent meeting at Dublin: Old life members 288, new life members 24, old annual members 459, new annual members 111, associates 1,152, ladies 222, foreign members 14, total 2,270.

Electrification of a Swiss Mountain Railway.—The Interlaken-Lauterbrunnen-Wengern Alp-Grindelwald rack and pinion railway, which is at present worked by steam, is in process of conversion to electric traction, and it is stated that the system to be adopted is the overhead trolley with continuous current. The line is about 15 miles long and rises to a height of 6,700 ft. above sea level. The conversion to electrical working is being made largely with a view to fuel economy, since ample water power is available for the generation of electrical power.

Electrification of Baden Railways.—The *Vossische Zeitung* announces that the Baden Government has decided to introduce electric traction on the sections of the State Railway line between Basel and Zell, and between Schopfheim and Säckingen. The Siemens Schuckert system is to be adopted, and the electric power will be supplied from special stations to be erected near the Rhine. The contract for the conversion of the line has been obtained by the Siemens-Schuckert Werke and the Allgemeine Elektrizitäts Gesellschaft. Ten 1,000 H.P. electric locomotives have been ordered in the first instance.

Wireless Telegraph Notes.—The U.S. Consul at Tahiti (Society Islands), Mr. J. D. Dreher, describes in a recent report the network of wireless telegraph stations which it is proposed shall be established amongst the scattered islands of the Pacific.

Mr. Dreher states that it is proposed to include in this system Australia, New Zealand, the Fiji, New Hebrides, Solomon, Samoan, Cook, Society and Marquesas Islands, and the phosphate islands of Ocean, Pleasant and Makatea, and that it is expected that the various Governments having possessions in the South Pacific will aid in the establishment of the proposed system. Negotiations are said to have already proceeded so far that success seems to be almost assured. Of the proposed capital of £70,000, the owners of the phosphate deposits on Ocean and Pleasant Islands have subscribed £10,000. It has not yet been decided where the main office of this proposed company (which is to be called the Pacific Islands Radio-Telegraph Co.) is to be located.

From a report recently received from Mr. Consul General H. L. Churchill we learn that the Artom experimental wireless telegraph station established at Dieppe has continued its experiments with Havre and Barfleur, but with disappointing results. A new station, working a system by Messrs. Bellini and Tosi, has recently been established, and it is said the results of the experiments have been encouraging.

Cable Interruptions and Repairs.

	Date of Interruption.	Date of Repair.
Las Palmas—Arrecife	May 18, 1908	—
Jedda—Suakim	July 27, 1908	—
Assab—Massowah..............	July 28, 1908	Sep. 15, 1908
Cadiz—Teneriffe	Aug. 17, 1908	Sep. 10, 1908
Lagos—Kotonou	Aug. 29, 1908	Sep. 15, 1908
Paramaribo—Cayenne	Sep. 3, 1908	—
Pontianak—Saigon	Sep. 16, 1908	—
St. Vincent—Barbados	Sep. 16, 1908	—

Elastic Suspension for Metallic Filaments.—In a U.S.A. patent, recently granted to Paul Druseidt and described in the *Electrical World*, a glass carrier for the filament spiders is supported at each end by spiral springs, and the leading-in wires are connected to the filament by a spring or similar flexible arrangement. Side supporting springs may also be used. The springs are said to greatly lengthen the life of the filament.

Electrochemical Cleaning Baths.—A Paper read by Mr. C. H. Procter before the American Brass Founders' Association contains a description of electrochemical methods of cleaning articles previous to electro-deposition of metals. The cleaning bath should be of wrought iron and heated by iron steam coils, and the author recommends for an electro-cleaning solution for ordinary purposes 3 oz. to 4 oz. of caustic potash to each gallon of water, and to every 100 gallons of solution 8 oz. of cyanide of potassium. When the articles contain much oil or grease on the surface, the density of the solution can be increased.

An Electric Railway for Colliery Purposes.—*The Times* Engineering Supplement states that the Consett Iron Co. have lately inaugurated an electrically worked surface railway about 2 miles long, for the purpose of hauling coal from the Whittonstall drift to the Chopwell colliery. The gradients are somewhat severe in places, reaching even 5 per cent. The gauge is 2 ft. 2 in., and at present the equipment comprises one locomotive, capable of drawing a load of 25 tons. The railway and locomotive equipment was supplied by Messrs. Siemens Bros. Dynamo Works, and an order for a duplicate locomotive has lately been placed by the Consett Iron Co. with the same firm.

Single-Phase Induction Motor for Two Voltages.—The *Electrical World* mentions that a patent has recently been taken out by Mr. F. R. Kunkel for an arrangement whereby a single-phase induction motor may be used for two voltages, one equal to twice the other. The main winding of the motor is divided into two sections that are arranged in series for the higher voltage and in parallel for the lower voltage. The novelty of the scheme consists in connecting the auxiliary (split-phase) winding in parallel with only one of the sections when the two are joined in series, so that substantially the same voltage is applied to the starting circuit regardless of whether the motor is connected to a high-voltage or a low-voltage circuit, providing, of course, that the high-voltage is double the low voltage.

Direct Extraction of Copper from its Ores by Electrical Methods.—In a letter on this subject to the *Mining Journal*, Mr. E. Spargo describes a method, due to T. S. Anderson, whereby the above end is obtained. This process has been in operation for some two years, during which time nearly every grade of ore has been treated from 1·74 per cent. to 50 per cent. It consists essentially of four operations—namely, crushing, roasting, lixiviation and deposition, no smelting being necessary. After crushing, and being mixed with a given quantity of iron, the ore is roasted in an electric or other type of furnace. The gases are taken to a condensing chamber and are there transformed to sulphuric acid; the roasted ore is then automatically conveyed to the lixiviating tanks, which are so arranged as to facilitate the removal of the residues. The "coppery" solution then passes direct to the depositing room, where pure electrolytic copper is produced in tubes, sheets, &c., the latter being about 40 in. square and 100 lb. in weight. The copper is ready for the market without any subsequent working and readily obtains the highest price. 600 H.P. is the total power required for all processes for the production of 10 tons of copper per 24 hours. A quantity of the Annandale Co.'s ore has recently been treated, and pure electrolytic copper produced therefrom at a total cost of £12. 10s. per ton.

New Central Stations in the U.S.A. in 1908.—The *Electrical World* gives statistics showing the progress made in electricity supply in the U.S.A. during the first seven months of this year. The total number of central station companies noted as incorporated from January 1st to August 1st is 228. This does not include municipal plants authorised, of which 81 were in course of construction during the period considered. As to capitalisation, that of 21 of the 228 plants was not reported, the total for 207 being about £13,000,000. This great total is principally due to large capitalisations in 7 of the 39 States represented. The total for Pennsylvania, for example, is about £68,000 for 18 plants, while for 22 California plants it is about £3,400,000. In the latter case, as well as in several others, large water-power developments account for the swollen figures, and some of the plants are for the wholesale supply of electrical energy. During the period considered, 167 plants were in course of construction in 42 States, 81 being municipal and 86 private plants. The expenditure for 60 of the 81 municipal plants was reported at about £1,400,000, or an average of £23,000 per plant, while for 35 of the 86 private plants the expenditure was about £1,120,000, or an average of £32,000 per plant. In almost all cases the municipal plants are in small towns, and our contemporary says it can be safely assumed that many owe their existence to the failure of private capital to undertake the building of plants in small communities, owing to the small demand for electrical service, which is often limited practically to street lighting.

German Electric Power Rates.—A recent United States consular report gives some details of several hydro-electric enterprises under Government ownership, from which the following figures are extracted: The city of Aix la Chapelle, the county of the same name and two neighbouring counties have equipped a water-power plant on the river Ruhr. The several owners of the plant purchase electrical energy wholesale from the operating company, paying from 0·488d. to 0·44d. per kilowatt-hour, and selling at retail rates from 2·97d. to 4·76d. per kilowatt-hour for low-tension lighting service; 2·95d. to 4·16d. per kilowatt-hour for low-tension power service, and 0·5d. to 2·9d. per kilowatt-hour for high-tension (5,000 volt) power service. The city of Solingen, which owns and operates a hydro-electric plant, charges 5·3d. per kilowatt-hour for lighting when the consumption is less than 350 hours of maximum demand per year, and 2·9d. per kilowatt-hour for all additional units. For power the rates are 2·14d. per kilowatt-hour up to 750 hours of maximum demand per year, and 0·95d. for units after that point. Another plant referred to merely as "Ennepethalsperre" charges 4·16d. per kilowatt-hour for light and 2·38d. for power. In addition there is a yearly charge of £1·42 per horse-power of each motor, and a further charge, according to the size of the motors, as follows: Up to 5 H.P. £1·42, from 5 to 10 H.P. £1·90, from 10 to 15 H.P. £2·38, from 15 to 20 H.P. £2·85, from 20 to 30 H.P. £3·8, from 30 to 50 H.P. £4·76, above 50 £5·7. It is stated that the additional motor charges are arranged to distribute general expenses among motor users.

ARRANGEMENTS FOR THE WEEK.

MUNICIPAL TRAMWAYS ASSOCIATION.

WEDNESDAY, September 23rd.

10:15 a.m. Reception by the Mayor, Sheriff and Chairman and Members of the Nottingham Tramways Committee at the Exchange Hall, Nottingham.

10:30 a.m. Conference in the Council Chamber at the Exchange Hall. Presidential Address by Mr. J. Aldworth, and Paper on "Some Through-running Problems and their Solutions," by Mr. H. E. Blain.

1 p.m. Luncheon at the Victoria Station Hotel at the invitation of the Nottingham Corporation Tramways Committee.

3 p.m. Inspection of the Trent Bridge Car Repairing Works and the St. Ann's Well-road Generating Station.

7:30 p.m. Reception at the Art Museum, Nottingham Castle, by the Mayor and the Chairman and Vice-Chairman of the Nottingham Tramways Committee.

THURSDAY, September 24th.

10 a.m. Conference in the Council Chamber at the Exchange Hall. Papers on "Treatment of Corporation Employes Incapable of Performing Ordinary Duty," by Ald. H. Linsley on "The Application of Technical Science to the Construction, Maintenance and Operation of Tramways," by Messrs. R. G. Cunliffe and J. G. Cunliffe; and on "The Ticket Check," by Mr. L. Mackinnon.

7 p.m. Association dinner at Victoria Station Hotel.

FRIDAY, September 25th.

10 a.m. Meeting of Managers' Section.

10:30 a.m. Business Meeting of Association in the Council Chamber at the Exchange Hall.

1:30 p.m. Excursion to Belvoir Castle.

ALTERNATING CURRENT COMMUTATOR MOTORS.*

BY DR. RUDOLF GOLDSCHMIDT.

(*Continued from page 785.*)

Summary.—In this article the author discusses the theory of the single-phase commutator motor. The production of the field is first considered, and then the shunt and series methods of excitation, it being shown that the simple shunt is an impossible method. The characteristics of the ideal series motor are then given in some detail, after which the complications and difficulties encountered in the real motor are considered, including commutation and the circulating currents in the short-circuited coils. Finally, the various losses are considered.

10. The Diagram of the Real Motor.

The diagram of the real motor distinguishes itself from that of the ideal machine by taking account of the losses, but it has one weakness in common with the latter—the saturation of the magnetic path is supposed to be so low that the flux can be put practically proportional to the current. We must divide the losses into two classes:—

1. Losses which are proportional to the square of the current.
2. Losses which cannot be expressed as a simple function of the current.

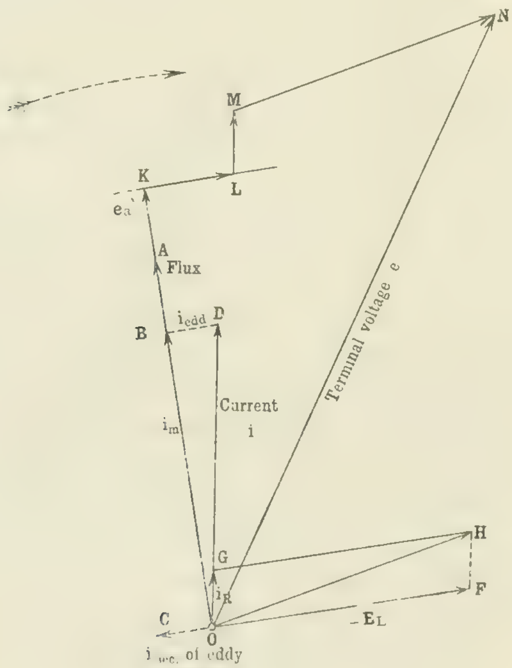

Fig. 52.

The first class comprises all the copper losses in field, armature and compensating winding. We may also include the loss caused by the main current in the commutator connections and under the brushes, though the latter is not exactly proportional to the square of the current. One might feel inclined to let also the alternating core loss pass as belonging to the first class. This would, however, mean misunderstanding the character of the hysteresis and the eddy-current loss. They cannot be represented by substituting an equivalent resistance in the circuit of the main current; on the contrary, they apparently diminish the resistance of the main circuit of the machine, acting just as the secondary circuit of the transformer reacts on the primary. Therefore, the case is represented by an equivalent connection diagram (Fig. 51) with an ohmic resistance in parallel to the field. These losses turn part of the magnetising current into watt current; the resistance in the main circuit would produce a watt component in the voltage. Both make the angle between volts and amperes smaller, but the resistance of armature, field coils, &c., may seriously affect the overload capacity of the machine, reducing the voltage left for the armature. The alternating core loss has not this effect. Just like that of the eddy currents caused by the alternations of the flux is the effect of the circulating current in the coil under commutation, in fact it can be treated as part of, and together with, the core loss. The revolving core loss and the friction loss tend to prevent the armature from revolving; they diminish the useful torque. These losses are, therefore, covered mechanically and do not affect the phase of the current in any other way than the useful load on the pulley or pinion of the motor. As a fundamental rule for the design of the diagram, we will establish the following as the simplest way for practical purposes.

We will construct the diagram neglecting all losses of the second class, taking account of them afterwards by means of a correction. Then we can put in these losses more exactly than it would be possible if we should attempt to find an approximate law for the relation of loss and current so as to embody them in the diagram. In the linear diagram which we may draw up for a certain working condition the effect of hysteresis, eddy and circulating current losses may easily be taken into account. We start with the assumption of a certain flux, OA (Fig. 52), requiring a magnetising current, OB, for driving it through the air-gap and other parts of the magnetic path in phase with the flux itself. The flux produces eddy currents, OC, and circulating currents lagging behind the flux by about 90 deg., which will be represented in the main circuit, together with the hysteresis losses, by the component BD vertical to OB (parallel to OC). OB and BD together give the main current OD, which flows through field and armature in series. The flux produces in the field coils an E.M.F. vertical to it, which is compensated by the E.M.F. $(-E_L)=OF$ vertical to the current and leading the latter by 90 deg. In phase with the current an E.M.F., OG, is required equal to current × resistance of field coils, so that the total voltage of the terminals of the latter is the vector sum of OG and OF—*i.e.*, OH.

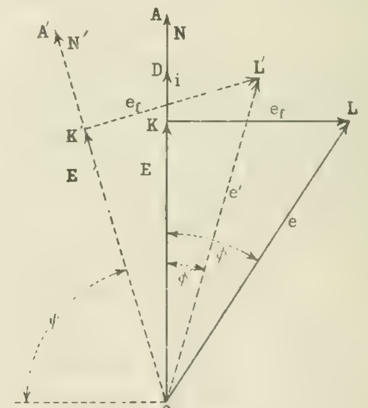

Fig. 52A.

The armature revolving in the flux OA generates an E.M.F., OK, in phase with OA. We add to this KL = E.M.F. of self-induction in armature and compensating winding plus watt component to cover the core losses caused by the armature and compensating cross-flux. KL is, due to this watt component, less than 90 deg. in advance of the current.

Adding further LM = current × resistance of armature, brush contact, resistance leads and compensating winding, we find OM, the voltage across armature and compensating winding. OM and OH together give the terminal voltage e = ON.

One of the interesting effects of the core, eddy and circulating currents loss is the shifting of the phase of E.M.F. E in the armature backward, together with the flux. E and the total current come out of phase, and the torque is slightly reduced, but there is also a beneficial effect, for through the shifting of phases the power factor is improved more than it would be in the ordinary way by the addition of the watt current due to hyteresis. An interesting method to improve the power factor is based on this principle.

Special attention must be drawn to the fact that the harmful circulating currents reacting on the phase of the flux are quite useful, and for this reason they have sometimes been suppressed to a smaller degree than one might expect. Tests have been carried out by the Siemens-Schuckert Co. (Richter)

to show that the power factor can be made equal to unity through allowing circulating currents to flow more or less unchecked. Naturally the heating of the brushes and the commutator prevent the actual practical application of this expedient.

The power-factor improving qualities of the losses caused by the alternations of the main flux and the shifting of E will be clearly seen from the simplified diagram Fig. 52A. OKDAL is the diagram for the ideal motor. If now the flux N is made to lag behind the current i, by an angle, ψ (the hysteretic and eddy current lag), it will obtain the position OA′. The E.M.F. E will follow it to OK′ and, apart from details, the new triangle OK′L′ will be identical with the original one, OKL, the new phase displacement being $\phi' = \phi - (90 - \psi)$. *The complement of the hysteretic and eddy-current lag subtracts directly from the original angle between current and terminal voltage.* Assuming, for instance, $\cos\phi = 0{\cdot}80$—*i.e.*, $\phi = 37$ deg. and $\sin\psi = 0{\cdot}10$, 90deg. $- \psi$ being 6deg.—we find $\phi' = 37 - 6 = 31$deg., and the new power factor $\cos\phi' = 0{\cdot}86$. Supposing we had a $\cos\phi = 0{\cdot}705$ only, ϕ being 45deg. and $\sin\psi = 0{\cdot}10$, corresponding to a loss of 10 per cent., $90 - \psi$ is 6 deg. and $\cos\phi' = 0{\cdot}78$. This is only the improvement due to the shifting of the phase of the flux, a further increase of the power factor being effected by the watt-component of the current for covering the loss.

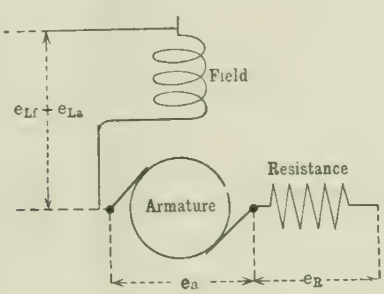

Fig. 53.

This diagram will be still clearer if we add together all components of voltages for overcoming the ohmic drop in field armature and brushes into one, in a way eliminating all resistance from the armature and field and adding it separately, as diagrammatically shown in Fig. 53. At the same time we combine e_{Lf} and e_{La}. Diagram Fig. 54 is the same as Fig. 52, except for the order in which the components of the voltage are combined. We find, again, the current-triangle $i_{magn} - i_{core\ loss} - i$. In phase with $i_{magn.}$ we draw the flux and the voltage induced in the armature by rotation e_a. Vertical to it we draw $e_{Lf} + e_{La}$, and in phase with the total current i the ohmic drop $i \times r$. All three voltages together, e_a, $(e_{Lf} + e_{La})$ and $i \times r$, give the terminal voltage e.

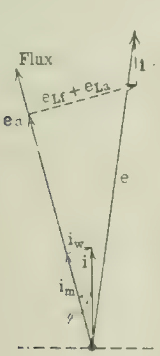

Fig. 54.

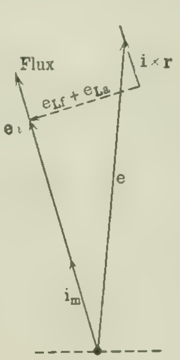

Fig. 55.

If we do not take account of i_w in our diagram the effect in the combination of E.M.F.s is felt in $i \times r$ only, this factor being slightly reduced and shifted backward in its phase (Fig. 55). Except for this small defect we are able to construct a diagram completely neglecting i_w and to add this current component afterwards in a convenient way. The advantage of neglecting i_w at first lies in the fact that the E.M.F.s of self-induction of field, compensating winding and armature are 90 deg. displaced against i_m, not against the total current, and that E is in phase with i_m only.

Except for the component $i \times r$ we could use our ideal diagram exactly, and it is clear that the presence of the resistance can involve only a minor modification.

Drawing again the circle and the triangle of voltages OAB (Fig. 56), AB now represents the E.M.F. of self-induction in field a and armature $e_{Lf} + e_{La}$, OB is no longer $e_a = E$ alone, but e_a plus $i \times r$. The phase of the current remains exactly the same—*i.e.*, that of e_a and $i \times r$, and, as before; its intensity can be represented by AB. Erecting again AC vertical to OB, BC is the torque and AC the watt component of the current, but no longer the useful energy as it includes a component for the ohmic loss. When the motor is stationary e_a becomes zero and the point A obtains a position A′ on the circle as close to O as possible, OA′ being the drop in the ohmic resistance which cannot be eliminated. BA′ is the maximum current obtainable, the "short-circuit current," fixed by the self-induction of field and armature and now, also, by the ohmic resistance. The short-circuit triangle OA′B, drawn for full voltage on the stationary motor, is a fixed quantity for a certain machine. Draw A′C′ vertical to OB; BC′ is the torque at starting and A′C′ the watt component of the current A′B, due to the ohmic losses in the motor. If the current is only AB this watt component goes down to HC, as it can easily be proved that the amount HC, cut off from the vertical AC by the short-circuit line A′B, is proportional to the current AB.

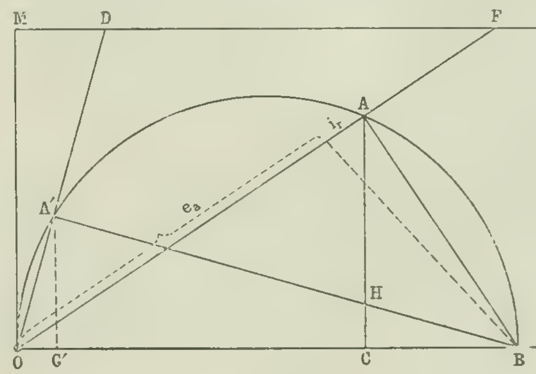

Fig. 56.

Therefore the part *AH between A′B and the circle represents the useful energy** *except for the losses of friction and revolving hysteresis.*

Drawing DF in Fig. 56 parallel to OB, similar to the diagram for the ideal motor, the amount cut off on this line by the lengthened OA—*i.e.*, DF—represents the speed. It is smaller than before by the amount DM in consequence of the voltage drop in the ohmic resistance.

It remains to bring in the core loss component so as to fix the phase and amount of the total current. This can be done for every point of the diagram in the way shown in Fig. 54, i_w being determined as exactly as possible. Considering that the majority of the losses which i_w represents are eddy currents (including the circulating currents in this class) the component for these losses i_w can be put very nearly proportional to e_L,—*i.e.*, proportionate to i_m itself—the angle of hysteretic phase displacement ψ between i_m and i being assumed to be constant. Then i is equal to constant $\times$ i_m, so that it is only a question of "scale" for the current in our diagram to give the value of i direct. Also the influence the component i_w exercises on the power factor can be easily shown. AB being i_m (Fig. 56), we add i_w=AG at right angles (OA lengthened); BG is then the total current i in proper phase, and OH is the power factor if OB=1. The geometrical locus for G is a circle which passes through O and B and the centre P of which is vertically above the centre of the main circle, the angle PBO$=\psi$.

(To be continued.)

* Compare *Elektrotechnische Zeitschrift*, 1900, the author's simplified form of the Heyland diagram for induction motors.

PROF. L. C. MIALL'S ADDRESS TO THE EDUCATIONAL SCIENCE SECTION OF THE BRITISH ASSOCIATION.*

Book Learning.—The knowledge of books may be an excellent form of useful knowledge; it may also, when it strives merely to record and remember, be unproductive and stupefying. In the ages of learning, the schoolmaster too became a pedant. His chief duty he supposed to consist in furnishing his boys with knowledge which they might some day want. If it were not that Nature has endowed schoolboys with a healthy power of resistance, their memories might have come to resemble the houses of those who believe that whenever they throw a thing away they are sure to want it again—houses in which room after room is so packed with antiquated lumber as to be uninhabitable. Happily for us, a great deal that we once knew and might foolishly wish to keep quickly fades from the memory. Only a small fraction of the knowledge which enters the mind of an inquisitive person is kept for so long as a month. What we remember so greatly exceeds what we can use that we need not deeply regret the loss that is always going on. No doubt we often find it necessary to recall a multitude of small facts, in order, it may be, to elicit a general conclusion or to produce a telling argument. But is it wise to prepare years in advance by storing all the facts in the memory? I cannot think so. Exercise of the memory involves nervous strain, and after an early age a considerable nervous strain. It is more economical and more business like to employ mechanical contrivances rather than brain tissue for such purposes, to leave the vast mass of useful facts in grammars, dictionaries, and text books, and to collect those for which we have a present use in the note-book or the card index. The history of learning warns us that it is not good to lay up in our memories a great store of knowledge whose use lies far in the future. Apply to knowledge what moralists tell us about money. It is only the money that you may expect to put to use within a reasonable time that does you any good, and the same holds true of knowledge. Unused knowledge, like unused money, becomes corrupt.

Science.—It is the function of science to produce verifiable knowledge. Science achieved her earliest successes by investigating the simplest properties of tangible things—number, form, uniform motion. Here she learned how to combine the knowledge of many concrete facts into general statements, which (to the confusion of thought) we call scientific *laws*. Science applies her general statements to new cases, using facts to make general statements, and general statements to discover or verify facts, so that a considerable part of scientific knowledge is in perpetual use. Science is no longer content with the study of simple properties and tangible things. She will consider facts of every kind as soon as she can find the time. There is no hope of withdrawing from scientific treatment any kind of experience which the human senses or the operations of the human mind furnish; to be safe from the inroads of science you must betake yourself to some study which does not meddle with facts.

Generalisation involves incessant reference of effects to their causes. Facts can only be ill-classified and superficially generalised so long as the causes of the facts remain uninvestigated. Science of any good kind sets up, therefore, the habit of methodical inquiry and the habit of reasoning—productive reasoning, we might call it, to distinguish it from the reasoning of the schools. The best examples of productive reasoning are to be found in the investigations of science, and especially of those experimental sciences which deal with simple tangible objects, whose properties can be studied one at a time. The virtues of science are exactness, impartiality, candour. Scientific impartiality means the determination to accept no authority as binding except the assent of all competent persons. Scientific candour means perpetual readiness to revise opinions which are held in respect. Loyalty, except of one kind, loyalty to herself, science has no use for and does not cultivate. I think it is true, but you can judge as well as I, that during the last four centuries there has been no generator of useful knowledge at all comparable with science.

Herbert Spencer has raised the question: What knowledge is of most worth? He considers knowledge in its bearing on life and health, on the gaining of a livelihood, on citizenship, on artistic production and enjoyment; lastly, as a means of discipline. The answer which he gives under each head is "Science"; that is his verdict on all the counts. Spencer seems to contend that for everybody and under all possible circumstances science is that knowledge which is most valuable, but this is a conclusion hard to receive. There are persons who are intellectually unfit to acquire the scientific habit of mind, or who follow an occupation incompatible with any but a light and recreative study of science. Suppose that a youth is wholly uninterested in science; or that after fair trial he shows no capacity for it; or that he is eager to become a poet; or that he will inherit a lucrative business in which science plays no part; would not these propensities and circumstances modify our choice? I cannot believe that Spencer was so unpractical as to deny them any weight at all. Is it possible that he was thinking of mankind, of the British nation, or of some other large collection of men; that it is to the nation or the race that science will prove itself of most worth? If this is the right interpretation, we have some ground for blaming Spencer's neglect to mention so important a qualification. Those who admit that the nation requires scientific knowledge beyond knowledge of any other kind are not compelled to maintain that the individual man must give his chief attention to science. A minute division of labour, intellectual as well as manual, is necessary in modern life, and we become every day more dependent upon other people's knowledge. An elementary knowledge of many sciences, such as Spencer valued and himself possessed, steadily becomes less attainable, and less applicable to real business; less attainable, because the standard is always rising; what was a respectable acquaintance with science in the days when Spencer was educating himself would now be thought no better than a smattering; less applicable, because business now requires and commands the science of experts. Business demands the very best science that the age can supply, and it can afford to pay high enough to get it. Obviously the best knowledge of any kind can only be possessed by a few.

Those who agree with me that the science which is applicable to industry or to public health is steadily growing harder of attainment, will not, I hope, turn this into an argument for restricting the study of science to a few. The elementary science of the school, if good of its kind, is valuable for its effect upon the character and the intelligence; it is necessary for the timely discovery of young people who can be trained to carry on scientific discovery; and it engenders a sympathy with science which is of high importance to the State. If the science of the school does no more than make the phenomena of everyday life a little more comprehensible and a little more interesting, it will fully justify itself.

There is not, and cannot be, a scale of usefulness by which everybody's choice can be at once determined. Before deciding what the schoolboy is to study we must inquire what are his aptitudes, inclinations and opportunities. And the importance of science, which I do not think Spencer has exaggerated, will be fully recognised when every nation and city, every profession and trade, every person and interest, can be guided as often as need arises, not by their own scientific judgment but by the judgment of scientific experts.

Technical Education.—Technical education may be pursued in at least three ways: (1) We may seek to qualify the pupil for his calling by a thorough training in some science or art, and then, by the application, under the guidance of an expert, of that science or art to a particular industry. The experience of at least two generations seems to show that this method is really effective; it does what it professes to do. (2) The second method aims at no more than supplying information directly applicable to the industry in question. Surely this is the least profitable of the three. The information is not accurately lodged, either in the memory or in the note-books of the students; it soon becomes obsolete in consequence of the advance of knowledge; and it does little to cultivate intelligence or the power of doing. Where intelligence and the power of doing already exist, mere information may be valuable, but the best storehouse of information is the printed book. (3) Lastly, we may aim at nothing more than facility by repetition. Such practical arts as reading, writing, drawing, needlework, and cookery are largely acquired by imitation and constant practice. Skill in these arts is a tool, whose profitable application depends much upon the intelligence and enterprise of the possessor. Independent attempts to meet difficulties, friendly criticism of these attempts, questioning about the causes of failure, are the expedients which a wise and experienced teacher, ever at hand, would employ. Such a teacher is of course rarely to be had, but is now and then found in a sensible mother. Perhaps the best substitute for the sensible mother would be plain, practical lessons on elementary science, such as Edgeworths, Dawes, and Henslow used to give.

Literature.—Literature differs from most kinds of useful knowledge in having an immediate value. The benefits which we receive from literature are comparable with those which we receive from good society. We are expected to enjoy and appreciate; we are not to be for ever asking: "What have I got that I can carry away?" Literature may be more good than society; it may compare with the intimate talk on grave subjects of a wise and high-minded friend. Unfortunately those whose office it is to introduce us to literature often treat it as if it were only a particular sort of useful knowledge. They occupy our attention so completely with

* Abstract from the presidential address delivered by Prof. L. C. Miall, D.Sc., F.R.S., at Dublin.

grammar, metre, etymology, and historical allusions that we have no leisure to enjoy and appreciate.

I have little fear that the scientific age which is now upon us will be permanently hurtful to literature. The higher criticism, which is the study of life as well as of letters, will survive too. One literary art, the art of rhetoric, may be weakened and lost when the scientific spirit becomes predominant—that sort of rhetoric, I mean, which may be fitly described as insincere eloquence. Rhetoric seeks above all to persuade, and in a completely scientific age men will only allow themselves to be persuaded by force of reason. Even in our imperfectly scientific age those men gain most by speech who have something important to say, who say no more than they know, and who use all possible plainness. It will be enough for my present purpose if we can agree that literature has an aim and purpose of its own, and must not be treated simply as a branch of useful knowledge. Literature and science, for instance, are incommensurable.

The Necessity of Choosing.—Every headmaster and headmistress is occupied with the eternal question how to make room for all the things that are demanded of the school. Theorisers, who have no responsibility for the time-table, insist from time to time upon new additions, and are happy if they can only express their own opinions with an emphasis which satisfies their sense of justice. It is my opinion that far too much has already been conceded to demands which, reasonable when taken separately, are unreasonable when taken together. Thus, by ancient usage, Latin is made a necessary subject in certain schools. Then a claim is put in for Greek as more interesting and equally important. French and German demand admission, and put forward claims which can hardly be overstated. The result is that some boys in secondary schools attempt four languages, and many attempt three. Then we usually find that no foreign language, ancient or modern, is mastered to the point at which it can be used in reading, writing, or conversation. Our wish to be fair and consistent has landed us in an absurdity. The root of the whole difficulty lies in the fact that while there are perhaps 15 or 20 branches of knowledge eminently fit to be taught in school, no pupil can profitably undertake more than five or six at a time. The sciences taught in school may spoil one another's chances in the same way. Not a few schools are convinced that they must have chemistry and physics because of their industrial importance, hygiene because of its relation to the health of the community, physiology to make the hygiene intelligible. The schoolboy is made to buy more sciences than he can pay for, and his time is gone before he reaps any of the advantages which are so much desired.

One inevitable result is that the school hours, including the preparation of lessons, are nearly always too long. Another result is that the schoolboy who is willing, but not very clever, is often overworked. I have known many such cases myself, and have also known cases in which excellent results have been attained in a good deal less than the customary time. If we could consent that our pupils should remain ignorant of many useful things, if we could materially shorten the lessons of very young pupils, and if we could bring the home-lessons into much smaller compass, I believe that the education which we offer would really be more valuable.

Mastery of Something.—The accumulation of miscellaneous knowledge of useful things, copious, inexact, inapplicable, may, like rag-picking, leave us ignorant of the world in which we live. Let us try to reach the inner life of something, great or small. The truly useful knowledge is mastery. Mastery does not come by listening while somebody explains; it is the reward of effort. Effort, again, is inspired by interest and sense of duty. Interest alone may tire too quickly; sense of duty alone may grow formal and unintelligent. Mastery comes by attending long to a particular thing—by inquiring, by looking hard at things, by handling and doing, by contriving and trying, by forming good habits of work, and especially the habit of distinguishing between the things that signify and those that do not. It is too much to expect that mastery will often be attained in school. School is but a preparation, not I think for promiscuous learning, but for the business of life. The school will have done its part if in favourable cases it has set a pattern which will afterwards develop itself naturally and harmoniously.

Electrification of Pacific Railroads.—According to the *Electrical World*, Mr. E. H. Harriman has recently stated that as soon as the money market conditions improve, three sections of lines of the Harriman system will be electrified. It is his purpose to electrify the mountain division of the Union Pacific road, which runs over the Rockies; the mountain division of the Southern Pacific, which runs over the Sierras, and the new mountain division of the Shasta route, which will run, like the present route, over the Siskiyou Mountains. The estimated cost is said to be about £8,000,000.

THE ELECTRIC LIGHTING OF DRURY LANE THEATRE ROYAL.

On March 25, 1908, the stage of the historic theatre of Drury Lane was completely destroyed by fire, and the daily Press promptly attributed the disaster to some electrical cause. As to how far this was the case may be gathered from the fact that on the previous day the current was switched off at 6 p.m. and the fire alarm sounded at 3:20 a.m. next morning. Whatever the cause, a great deal of damage was done, and needless to say most of the electrical equipment was more or less useless. Consequently, after the inevitable delays caused by the assessment for the insurance companies involved, the work of reconstruction was begun, and has been carried through in an extremely short time. The electrical part of the work has been practically completed in six weeks from the start. To some people this may not seem to be so very short a time after all, but it is difficult to realise without actual inspection the great quantity of work involved; thus it is no exaggeration to say that many miles of cable have been used in connection with the new installation, the whole of the wiring being carried out in screwed tubing, whilst a new design of batten has also been evolved, so that great credit is due to the contractors, Messrs. Pinching & Walton, for the rapid way in which the work has been carried through. This will be better understood when it is stated that owing to the size of the installation, ordinary accessories and fittings could not be used.

In our issue of February 12, 1904, we gave a full account of the electrical equipment of the theatre at that time. A great deal of the present equipment is practically the same as there described. For example, the hoisting gear of the bridges is the same as it was at that time, although it has been necessary to rewind the motors after their experience of being several feet under water. There were also certain parts of the installation which were not affected, as for example, the main services from the supply company. These are in duplicate in order to comply with the regulations of the London County Council, but they are both taken from the mains of the Charing Cross, West End & City Electricity Supply Co. One service is from the regular theatre system of the company, and the other from the lighting system, so that they really form two distinct sources of supply.

A recently introduced feature is the system of ventilation of the stage. It was found that a great deal of discomfort was experienced by that part of the audience sitting in the stalls anywhere near the stage, by what may be described as a waterfall of cold air from the stage into the stalls. In order to check this, warm air is now forced by a fan on to the stage at any point where cold air would come in if this system of ventilation were not adopted, that is at doors, &c. In this way a stream of warm air finds its way on to the stage and rises straight up without passing into the auditorium. Matters can be so adjusted that there is either no passage of air from one to the other, or that the air actually tends to pass from the auditorium on to the stage. The warm air so supplied is forced in by a 3 ft. fans of the well-known "Sirocco" type, the air being drawn through sheets of moistened canvas; the latter is fixed on a large horizontal drum, kept rotating so that it is continually moistened with water, the air being then forced through a grid of pipes which are steam heated, somewhat similar to an air cooled condenser, and finally supplied to the required points by ducts in the usual way. In all probability the air so forced in will rise to the top of the building, and will pass through the ventilators, there provided, without further assistance, thus giving a very efficient ventilation. If this does not prove entirely satisfactory, there is provision for fixing a fan for the purpose of extracting the air, similar to one which is already in use above the auditorium.

Beneath the stage is fixed the electric and hydraulic plant for operating the bridges. There is also the dimmer room, the latter being unaltered though rewired. The lights used for illumination-effects consist of white, red and blue, the white lights being naturally more numerous. The dimmer room

contains three rows of dimmers corresponding with these three colours. Each large dimmer at present controls 125 35-watt lamps, and each of the smaller dimmers controls 62 35-watt coloured lamps; but each is capable of controlling the 64-watt lamps which were used before the change to metallic filament lamps was made. Recently "Z" metallic filament lamps have been substituted for the carbon lamps, notwithstanding the fact that most makers of such lamps held the view that they were unsuitable for theatre work, on account of the difficulties occasioned by "dimming." Experience has shown that such lamps are eminently satisfactory, and apparently this erroneous view was only due to the fact that the lamps were tried without modifying the conditions. Naturally the resistances to be inserted in order to dim metallic filament lamps have not the same value as for carbon lamps, and, equally, both kinds of lamps cannot be expected to run in parallel off the same dimmer. Fig. 1 is an illustration of the dimmer board, which is placed on the stage immediately above the dimmer room. Each

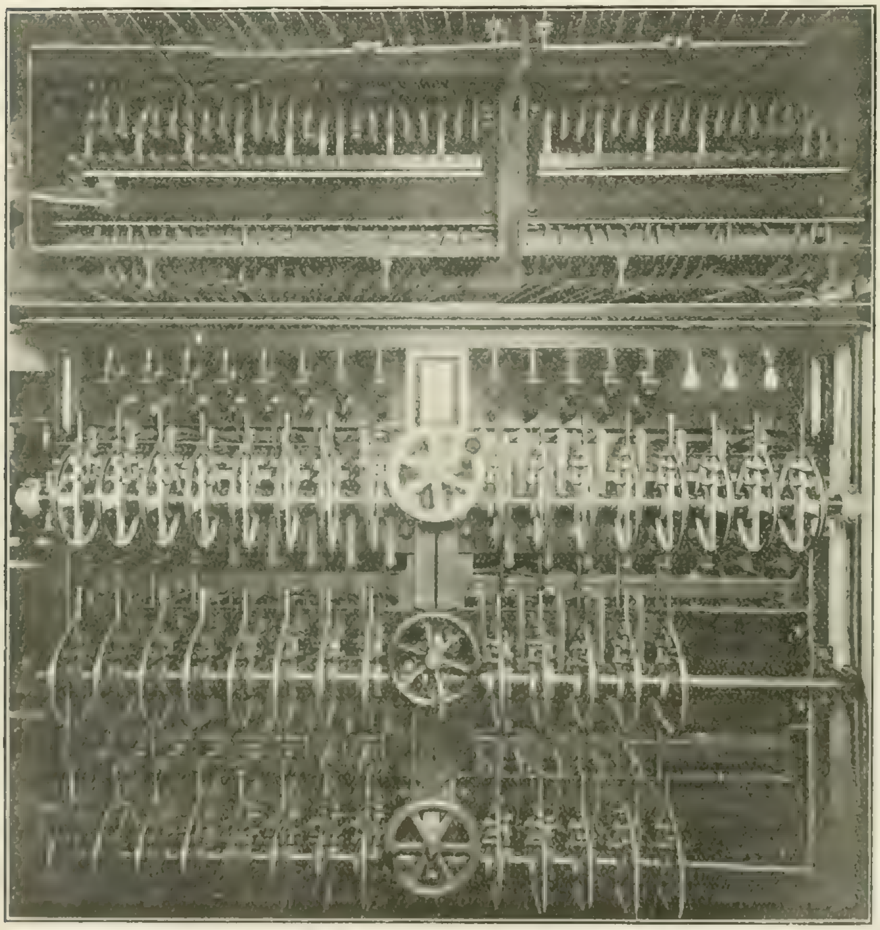

Fig. 1.—Dimmer Board.

wheel controls a dimmer, and they can be worked separately or altogether as desired, the three rows corresponding, of course, to the white, red and blue lamps.

It might be thought that arc projectors would be used largely in a theatre of this kind for varying the illumination as desired, at any particular point. This, however, is not the case, partly because the light so obtained is apt to be coloured, and partly because the stage is very large, and such lamps, as a large number of them would be required, would be prohibitive. In the flies on either side are about 20 oxy-hydrogen projectors. In order to supply these there is an oxygen main and a hydrogen main along each of the galleries, and as these mains are quite small it will be realised that a very simple arrangement is adopted, the necessary supply being taken from india rubber tubing as required. Signals are given to the operator by means of red and blue lamps. The supply of oxygen and hydrogen is [illegible] large drums, about 10 ft. high at a pressure of 3 lb. per sq. in. Water is automatically run into these drums to keep up the pressure and they are recharged from the familiar gas cylinders as required.

The new battens, of which there are 12, for lighting the stage are of some interest, as they are of new design. Each is 42 ft. long, only $10\frac{1}{2}$ in. wide, weighs 7 cwt., and contains 250 lamps, so that altogether 3,000 metallic filament lamps are fixed in these battens. Originally such battens were not earthed; in fact earthing was not permitted, but the result of this was that it was impossible to know, generally speaking, if there was any defect in the insulation. Under certain circumstances this may be dangerous. For example, in one case a wire, which had doubtless been used for the flight of a stage fairy, was being drawn up with a weight attached when it came against the metal work of a defective batten. The wire made a good earth, with the result that the weight dropped on to the stage. All the battens are now earthed by earthing the runners, which form the guides for the counterweights on either side of the stage. Fig. 2 shows the arrangement of the wiring for the battens, and it will be seen that it does not cause any obstruction on the stage. When it is remembered that each batten contains 250 lamps and is only $10\frac{1}{2}$ in. wide, the difficulty involved in the design will be apparent. It may be mentioned that the width is a matter of some importance where a great deal of scenery and many other battens have to be handled. Another point of interest is that no tilting of these battens is required, as is often the case with other designs, the distribution of light being varied by merely altering their height.

For connecting up each batten a fuse board is provided, having 11 circuits and lined with uralite. This board is fed by two pairs of 19/16 cables and one pair of 19/14 cables, so as to give the three sections desired, and from each box 22 7/18 cables are taken to feed the batten. The circuits are divided up so that 5 supply white lights, 3 red and 3 blue. The 22 outgoing cables are covered by a canvas hose and pass over a counter-weighted bridle. (See Fig 2.) The latter rises and falls with the batten, and thus unnecessary slack is avoided. In addition to the battens there are 52 hanging lengths for use in various positions as found necessary.

Over the main switchboard is fixed a junction box, 8 ft. 6 in. long by 3 ft. wide, into which pass all the cables. From this box they pass through screwed tubing to two other junction boxes a short distance above the one just mentioned. These two boxes are 5 ft. by 4 ft. and 4 ft. by 3 ft. respectively. The cables are then taken to twelve iron cased fuse boards, fixed on the fly rail, for the battens referred to above. These boards have cast-iron bases, 18 in. by 18 in., and each is fitted with three $1\frac{1}{2}$ in. tubes screwed in to the box so as to make a solid connection. A special nozzle is fixed at the back of each box, on to which the hose pipe leading to the battens is fixed by means of a special clip.

On the lighting gallery are twelve 25 ampere plugs, these being controlled from a "special effect" board on the stage, which also controls twenty-four 25 ampere plugs on the stage floor. This "special effect" board is fed by a pair of 37/12 cables which are run from an independent "intake" room on the other side of the building and fed by a separate service from the mains. The plugs just referred to are of a special cast iron cased, type with two pins, and in each instance the tubing is screwed into the plug so that the installation may be considered watertight throughout. There are also twenty-four

25 amp. plugs which are controlled from the main switchboard, and which can be used in connection with the dimmers.

One of the smaller details consists of an electrically operated centrifugal pump, which can be coupled up to a fountain on any part of the stage, the water flowing back to the tank from which it is taken, thus avoiding objectionable damp from water used without any particular means of escape, as is often the case.

The lighting in the auditorium remains as it was, except that metallic filament lamps are being used to a large extent. Adequate control of the lighting is essential in a theatre, so as to avoid danger of panic, but on the other hand, it is necessary that the lighting of the auditorium, as distinct from that of the corridors, should be controlled from the stage. In order to enable the attendants in the auditorium to switch

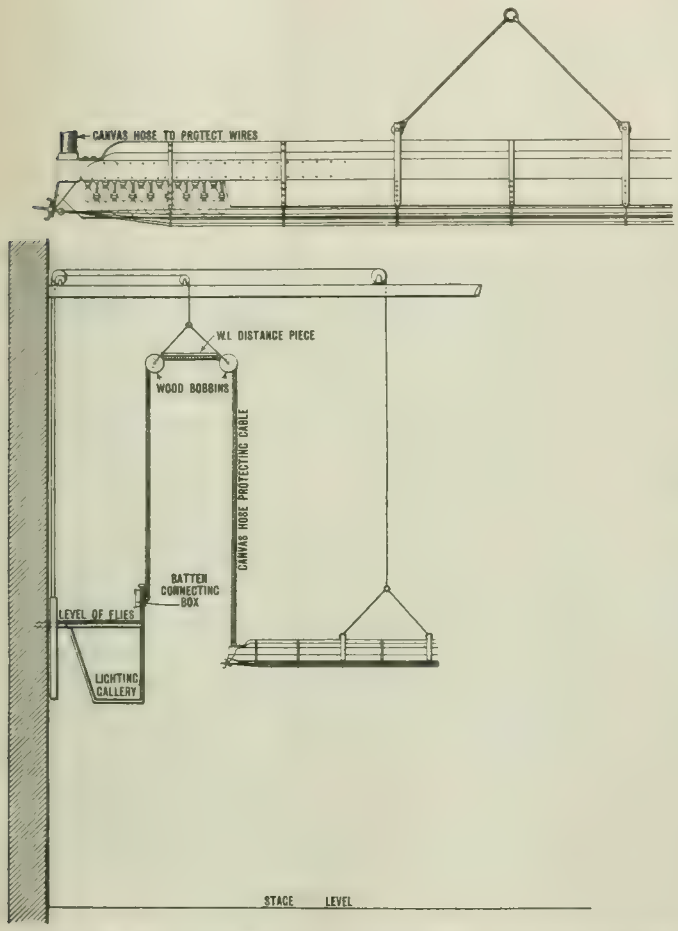

FIG. 2.—ELEVATION OF PART OF A LIGHTING BATTEN (ABOVE); ALSO METHOD OF SUSPENDING SAME AND THE CABLE TO BOX IN THE FLIES.

on the lights if necessary, although turned off at the stage, a set of double pole switches has been provided coupled together and worked by a single handle. This handle is generally tied down, but on an emergency the whole of the lights can be thrown over to the other circuit by forcing the handle over.

We are indebted to Mr. Adrian Collins, A.M.Inst.C.E., consulting electrical engineer to the Drury Lane Theatre, for his courtesy in showing us the details of the installation, and to Messrs. Pinching & Walton, the contractors, for supplying us with information in regard to some of the details.

INFLUENCE OF TEMPERATURE ON THE E.M.F. OF CADMIUM CELLS.*

BY R. JOUAST.

In 1901 Jager and Lindeck showed that the E.M.F. of standard cadmium cells with saturated electrolytes could be represented as a function of the temperature by the equation

$$E_t = E_{20} - 0{\cdot}000038(t-20) - 0{\cdot}00000065(t-20)^2,$$

the formula being applicable down to 0°C. for cells whose negative electrode was an amalgam containing 12 or 13 per cent. of cadmium. Certain cells, containing a 14 per cent. amalgam, showed irregularities in the neighbourhood of zero—*i.e.*, their E.M.F. exceeded by some ten-thousandths of a volt the value given by the above formula.

As a result of experiments made recently in the Laboratorie Central d'Electricité, we have determined that for all cells containing a 12·5 per cent. amalgam, the way in which they are made not effecting the result, the formula stated above represents very accurately their E.M.F. at zero as a function of that at 20 deg., the increase observed being on an average about $\frac{1}{10000}$ less than that given by the formula.

The same does not apply to cells containing a 10 per cent. amalgam. In the neighbourhood of zero the E.M.F. of these cells, which agree fairly well at 10 deg., differ between themselves by several ten-thousandths of a volt. They are all higher than the values given by the formula by amounts which may reach $\frac{1}{1000}$ of a volt. Further, when the cells are quickly cooled, their E.M.F. increases suddenly by about $\frac{2}{1000}$, then sinks slowly, and does not attain a constant value for several days. In cells containing a 12·5 per cent. amalgam, on the contrary, the E.M.F. increases slowly and reaches a constant value in a few hours.

These anomalies are not explained by the hypothesis put forward to account for irregularities in the 14 per cent. cells. It has been admitted that cadmium amalgam is made up of two parts, the one solid and the other liquid, which cease to co-exist at zero, in a 14 per cent. amalgam, but do so in a 12·5 per cent. and *a fortiori* in a 10 per cent. amalgam. New researches are necessary to clear up this point, but at least it seems prudent in accurate measurements to avoid the use of cells with 10 per cent. amalgams, or at least to prevent their temperature from falling below 10°C.

* Translated from the *Comptes Rendus*.

WIRELESS TELEPHONY.*

BY REGINALD A. FESSENDEN.

(*Continued from page 830.*)

Summary.—The author first gives a brief history of the development of wireless signalling, proceeding to describe the method and apparatus used in wireless telephony. He also discusses its possibilities and how its development has been retarded.

4. *Receivers.*—The receiver which the author has found most satisfactory for general purpose is the liquid barretter. Fig. 12 shows this receiver. It consists of a fine platinum wire, about a ten-thousandth of an inch in diameter immersed in nitric acid. Tests

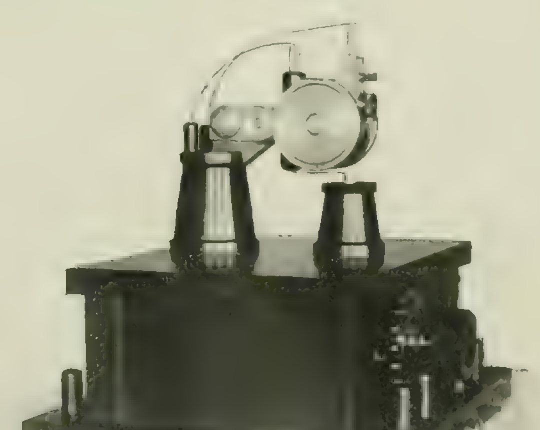

FIG. 12.—LIQUID BARRETTER.

made with this receiver show that it responds without apparent loss of efficiency to notes as high as 5,000 per second. Some very careful measurements recently made by my assistants, Messrs. Glaubitz and Stein, give the following results :—

Voltage of high-frequency circuit necessary to produce readable signals	15×10^{-5} volts.
Ohmic resistance of receiver	2,500 ohms.
Value of high-frequency current necessary to produce readable signals	6×10^{-8} amperes.
Electromagnetic wave energy required to produce audible note for period of one second	1×10^{-4} ergs.

The telephone used for detecting the signals had a resistance of approximately 1,000 ohms. Some measurements were made to determine the change of current in the telephone circuit by using a sensitive galvanometer in series with the telephone, but the results

* Abstract of a Paper presented at the 25th annual Convention of the American Institute of Electrical Engineers, June-July, 1908.

obtained were obviously too low, possibly on account of the electrostatic capacity of the turns of the galvanometer with respect to each other. It will be noted that the amount of electromagnetic wave energy necessary to produce a signal is considerably less than that given in a previous note.[1] The difference is possibly to be attributed to improvements in adjustment and operation.

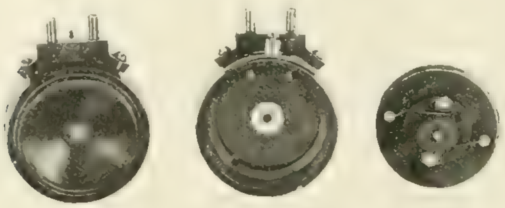

Fig. 13.—"Heterodyne" Receiver.

The above measurements were taken by shunting the barretter across a piece of straight resistance wire in series with a hot-wire ammeter, to determine the voltage necessary, and by introducing resistance in series with the barretter to determine the resistance of the barretter. The figures were also checked in a number of other ways and very concordant results were obtained, so that it is believed they may be relied upon.

Fig. 14.—"Heterodyne" Head Telephone.

The previously mentioned thermoelectric receivers or rectifiers of Dr. Austin and Mr. Pickard and the vacuum tube receivers of Fleming, de Forest, and Cooper Hewitt also act very satisfactorily. The fact that the author has not been able to get as good results from them may be due to greater familiarity with the liquid barretter and heterodyne receiver.

Fig. 16.—Apparatus for Tuning.

Figs. 13 and 14 show a form of heterodyne receiver adapted for use for telephone work.

Receiving Connections.—Where the wireless telephone is operated by first talking into the transmitter and then throwing a switch and listening, the usual wireless telegraphic connections are used. This has been found in practice to be very inconvenient, however, and several methods have therefore been devised for talking and listening simultaneously, which methods can, of course, also be applied to duplex wireless telegraphy. Among these methods may be mentioned the commutator method[1] and the balance method.[2] The former method is fairly well known, and consists in rapidly connecting alternately the transmitter and receiver. The balance method consists in using a phantom aerial as shown in Fig. 15, where P is a phantom aerial, the circuit having such capacity inductance and resistance as to balance the radiating antenna. In order entirely to cut out disturbances in the receiver while sending, an interference preventer, IP., the elements of which are shown in Fig. 16, is used in the receiving circuit.

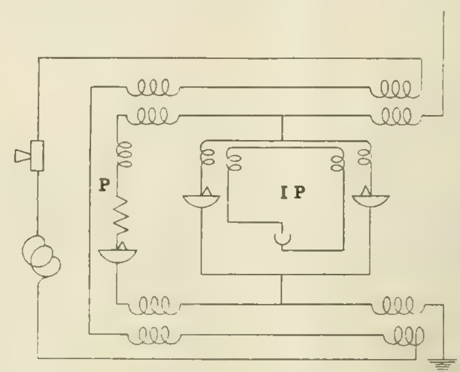

Fig. 15.

It may be here mentioned that balance methods work much better with wireless telephony and telegraphy than with line telephony and telegraphy, for the reason that the radiation resistance of an antenna is absolutely definite and is not affected by the weather, as are line circuits. Consequently, the balance can be made very sharp and once made does not need to be altered.[3] Of course, half if capacity alone be considered a single station on each side of the Atlantic can handle more traffic than all the present cables. It should be pointed out, however, that the mere ability to handle the messages is not sufficient, and that unless the wireless telegraph companies obtain land facilities equal to those at present enjoyed by the cable companies they cannot handle the traffic as efficiently, *i.e.*, cannot deliver a message from New York to an individual in London and receive a reply in the same time.

[1] *Electrical World and Engineer*, October 31, 1905.

[1] U.S. application 350,199 (1906). [2] U.S. application 366,528 (1907).

[3] This method, may, of course, be used for duplex working in wireless telegraphy. As some question has been raised in regard to the capacity of wireless telegraph lines, the author would say that he has received messages at the rate of 250 words per minute by wireless and is now experimenting with apparatus designed to give 500 words per minute. With duplexing this gives 1,000 words per minute or 60,000 words per hour. The manager of one of the largest cable companies has stated (London *Daily Mail*, September 24, 1907) that all the trans-Atlantic cables together send 24,000 words per hour. It would appear, therefore, that

the energy is lost, but that is a matter of practically no importance, as the cutting down of the strength of a telephonic conversation to one-half is as a rule hardly noticeable, especially where there are no line noises or distortion of the speech through capacity effects.

6. *Receiving Station Relay.*—The receiving station relay is similar to the transmitting relay previously described. The same remarks apply to its use in connection with wire lines as to the transmitting relay.

F. OPERATION.

As will be realised from the above, the operation of a wireless telephone system is very simple. The operator merely throws his switch to the position for telephoning and talks into an ordinary transmitter and listens in an ordinary telephone receiver. When the duplex method is used, as is always advisable, the conversation proceeds exactly as over an ordinary telephone line. Fig. 17 shows talking by relays from a local circuit. I believe I am correct in saying that the transmission by wireless telephone is considerably more distinct than by wire line and that the fine inflections of the voice are brought out much better. This, I presume, is due to the fact that there is no electrostatic capacity to distort the speech, as in the case of wire lines, though I think the effect is also partly due to the absence of telephone induction coils with iron cores. Possibly some of the

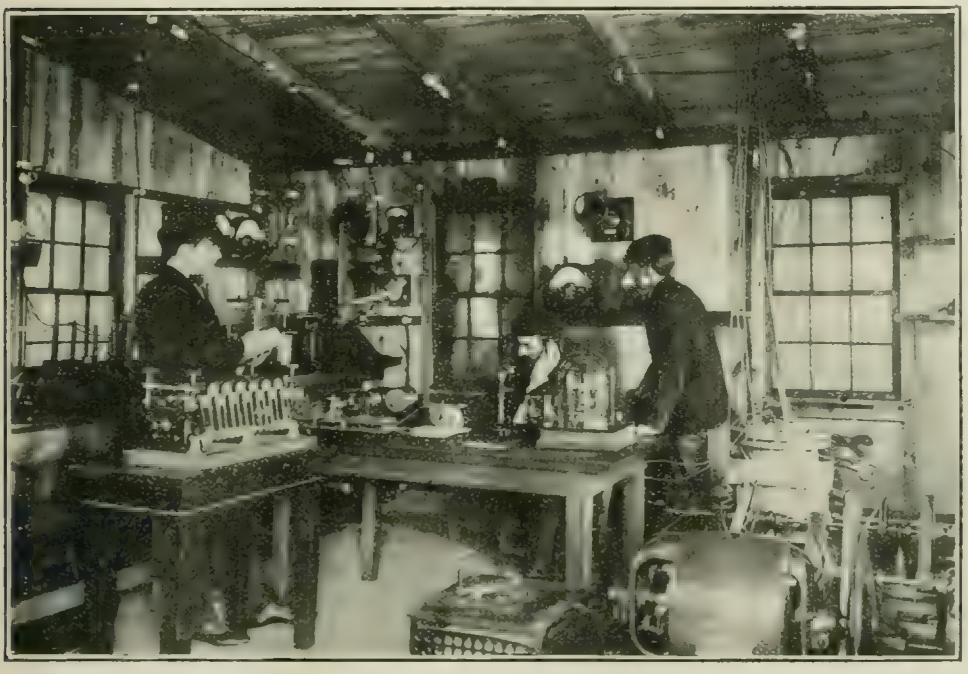

FIG. 17.—VIEW OF PLANT IN OPERATION.

gentlemen present have witnessed the operation of the wireless telephone transmission between Brant Rock and Plymouth and between Brant Rock and Brooklyn. If so, I think they will bear me out in saying that the transmission was clearer than over wire lines. As a rule, there is absolute silence in the wireless telephone receiver except when talking is going on, though of course the usual noises may be heard if persons are walking across the room, &c. This makes listening in less of a strain than when talking over wire line. Even during severe atmospheric disturbances the talking is not interfered with to any noticeable extent, provided, of course, that an interference preventer is used.

A comparative test was made with talking between Brant Rock and Brooklyn by wireless and by wire telephony. The talking over the wire line was done from a long distance station in Brooklyn. The wireless transmission was considerably the better. The fact that the wire line included in its circuits a cable from New York to Brooklyn was of course a disadvantage, but even allowing for this, practice and theory appear to be in agreement to the effect that transmission by wireless telephony over long distances is better than by wire line. This method should be of especial value to independent telephone companies, which have their local exchanges, but no long distance lines, especially since no franchises or rights of way are necessary.

(*To be concluded*).

GENERAL URBAN AND INTERURBAN TRANSPORTATION AND RAILLESS ELECTRIC TRACTION.*

BY F. DOUGLAS FOX, M.A.

(*Concluded from page 834*).

Summary.—The author first discusses the question whether rails should be adopted for urban transportation, and gives some interesting particulars concerning the cost of running petrol 'buses and electric 'buses with accumulators. He then describes the trackless trolley system as installed at Mulhausen, and passes on to consider existing British municipal tramways, showing how they are handicapped by heavy capital expenditure. A table of statistics regarding 71 tramways is given, and the author considers in detail the figures for income, capital expenditure per mile, route length factor, density of traffic, income per car-mile, working expenses, average fares, &c. In conclusion he hopes that transportation engineering will become more and more an exact science.

The Tramway System.—The extent to which the capital of the country has been committed to the tramway system has already been briefly referred to. An attempt will now be made, by an analysis of the statistics of the municipal tramways to show the degree to which this great system of urban transportation has overstepped the limits of commercial soundness, and by the selection of typical cases to show the principles which should govern the design of a transportation system from a commercial point of view. There will always be some element of conjecture in a project of this character, but the startling cases of commercial failure occurring in quite modern tramways are not to be accounted for merely by the inevitable variations in the travelling habit of the public, or other differences. They are mainly due to defective analysis of the situation.

The statistics are in two divisions. First, installations which have combined generating stations for lighting and tramwy purposes, and second, those which have separate generating stations for tramway purposes.

The statistics of municipal tramways are in two divisions.

The towns compared in the first division are 55 in number, as under :—

Aberdeen, Ayr, Blackburn, Blackpool, Bolton, Bradford, Brighton, Burnley, Burton-on-Trent, Bury, Chester, Chesterfield, Colchester, Croydon, Darlington, Darwen, Derby, Doncaster, Dundee, East Ham, Gloucester, Halifax, Ilford, Ipswich, Keighley, Kilmarnock, Kirkcaldy, Lancaster, Leith, Lincoln, Liverpool, Lowestoft, Maidstone, Manchester, Nelson, Newport (Mon.), Nottingham, Oldham, Perth, Plymouth, Rochdale, Rotherham, cSalford, Southampton, Southport, South Shields, Stalybridge, Sunderland, Wallasey, Walsall, Warrington, West Ham, Wigan, Wolverhampton and Great Yarmouth.

The towns in the second division are 16 in number, as under :—

Belfast, Bexley, Birkenhead, Bournemouth, Cardiff, Glasgow, Huddersfield, Hull, Leeds, Leicester, Newcastle, Northampton, Portsmouth, Preston, Reading and Sheffield.

The analysis of the statistics of the above 71 installations will naturally take as its first consideration the general commercial results of the entire tramway system as far as owned by corporations, or to borrow the useful Continental expression :—

1. *The Rentability of the Tramway System.*

The capital expenditure on the 71 installations has been		£27.213.674
The gross income in 1907 was		6.361.860
The operating expenses		3.833.370
Leaving net income		2.528.160
The deductions made were :—		
Interest	801.906	
Sinking fund	641.074	
Income tax	39.012	
Depreciation	528.733	
Sundries	176.753	
		2.187.478
Net surplus		+ 340,682

* Paper read before Section G of the British Association, at Dublin.

The gross surplus was contributed by 36 towns, which was disposed of as follows :—

Carried forward	56,854
Reserve	52,932
Reduction of rates	335,194
	£444,980

Deficits were shown by 20 towns, the remainder coming out even.

In the following table the deductions from income, &c., are redecud to percentages of income and of capital expenditure :—

—	Percentage of Net Income.	Percentage of Capital Expenditure.
Interest	31·90	2·945
Sinking Fund	25·55	2·355
Income tax	1·55	0·143
Depreciation	20·60	1·945
Sundries	7·00	0·650
Total	86·60	8·038

The surplus from the 36 towns was disposed of as follows :—

Carried forward	2·25	0·209
Reserve	2·10	0·195
Reduction of rates	13·27	1·230

The entire surplus available from the aggregate of the undertakings is thus seen to be about 1½ per cent. on the cost of construction. On 30 of the tramways, representing over 500 miles of single track, no allowance for depreciation is made. If this is reckoned at £400 per mile, or £200,000 per annum, the surplus would be reduced to about 0·75 per cent. on the capital expenditure. The total amount set aside for depreciation by those towns which make any appropriation under this heading averages £336 per mile of single track. If the whole of the 2,071 miles included in the list were provided for at £400 per mile, there would be a deficit in place of a surplus.

Amongst the advantages of municipal ownership of tramways are :—

1. That the capital can be obtained at a lower rate of interest.
2. That the whole of the street is under the control of the local authority.
3. That the construction is usually first class.

Amongst the disadvantages are :—

1. That the entire undertaking is built up on borrowed money, uncovered by share capital.
2. That the ratepayers cannot have the sense of the responsibilities of ownership which shareholders have.
3. That it does not, as a whole, pay, and, to a large extent, the ordinary passenger travels at the expense of the ratepayer.

A surplus of a bare 1½ per cent. on such a system of tramways as that of Great Britain cannot be claimed as a lucrative result. It may be contended that the system as a whole would have been equally unremunerative if it had been built up and run by private companies. Without discussing so wide a question, it is plain that this form of municipal exploitation is greatly on the increase and enters into the programme of politicians of socialistic tendency. More than 20 years ago the suggestion of free urban transportation was put forward in the Colonies. The London County Council is engaged in a collossal municipalisation scheme in which the experiment of a maximum capital expenditure is combined with a minimum passenger fare and at the present rate of progress, it cannot be many years before the general public will be compelled to take something more than an academic interest in it.

Occasionally some journalist raises a warning note, but the whole subject arouses as little concern in the persons most concerned as does the National Debt. Whether municipal indebtedness is to be reduced or not does not trouble the average ratepayer. The working classes need cheap travel. Whether the means adopted will relieve or increase the rates affects them far less than the question of the facilities themselves, and the working classes elect the town council. It is only when the increase of rates reaches the point of driving the manufacturer, possibly their own employer, to a cheaper district, that it begins to touch their personal interests. If corporations want to borrow and the working classes support them, the Board of Trade will sanction the loan, even when the rates are already [illegible] can be tolerated.

At a certain council meeting a short while since, when the tramway project was under discussion, the chairman said, with a fine satire, that the financial prospects were a "Limerick," to which the ratepayers must apply the last line. The authorisation was, however, [illegible] and duly granted.

Analysis of 55 Tramway Installations having Combined Generating Stations for Traction and Lighting Purposes.

—	Total of 55 Towns.	Manchester. Greatest population served. Greatest length of track.	Darwen. Greatest traffic receipts and greatest expenses per car-mile.	Wigan. Greatest route mileage in proportion to population. Greatest number of rides per head per annum. Greatest deficit.	West Ham. Greatest capital expenditure per mile.	Maidstone. Least population served. Least track mileage.	Lincoln. Least route mileage and least in proportion to population.	Doncaster. Least traffic receipts per car-mile.	Kilmarnock. Least operating expenses per car-mile.	Halifax. Least capital expenditure per mile.
Population served	7,045,285	800,000	41,864	61,000	308,284	13,000	52,500	41,500	36,000	178,000
Length of route ... miles	756·88	90·5	4·36	25·0	14·7	2·0	1·75	9·9	4·25	37
Length of single track ,,	1332·25	111·8	7·16	25·0	26·43	2·3	2·96	10·5	5·5	52·32
Route length factor: miles route per 1,000 population	0·1074	0·113	0·104	0·41	0·048	0·154	0·033	0·238	0·118	0·207
Capital Expenditure £	15,052,619	1,725,845	85,436	515,212	547,989	26,255	39,231	84,735	54,078	393,280
Do. per mile of route ..	19,900	19,100	19,075	20,712	37,210	13,127	22,400	8,560	12,730	10,630
,, per mile of single track ..	11,300	15,538	11,928	20,712	20,728	11,477	13,243	8,050	9,788	7,516
Income ..	3,681,866	719,673	14,008	62,469	119,775	5,891	5,845	12,367	8,603	77,327
Do. per mile of route ..	4,865	7,940	3,217	2,500	8,130	2,945	3,340	1,248	2,023	2,089
Do. per mile of single track ..	2,762	6,470	1,957	2,500	4,535	2,560	1,975	1,178	1,565	1,478
Operating expenses ..	2,360,774	454,693	8,619	48,821	72,419	4,031	3,829	9,734	6,300	57,882
Interest, sinking fund, and depreciation ..	1,199,095	211,891	5,505	30,040	33,528	1,608	2,518	3,995	2,708	22,302
Net surplus or deficit ..	151,831	55,000	— 116	16,392	13,990	374	— 502	1,362	405	— 1,677
Appropriation to relief of rates ..	169,191	55,000	Nil.	Nil.	9,668	Nil.	Nil.	Nil.	Nil.	Nil.
Passengers carried per annum	791,015,891	143,264,501	2,562,234	11,269,947	35,502,836	1,186,566	1,437,946	2,753,506	2,331,277	18,899,242
Riding factor: average journeys per head per annum	112	179	61	185	115	91·27	27·39	66·35	64·76	106
Average fare charged per mile d.	..	0·56	0·81	1·00	0·56	1·00	0·428	0·80	0·97	0·77
Car miles made per annum	82,168,927	15,523,459	240,893	1,452,458	2,556,854	157,050	137,186	495,404	328,829	1,624,275
Receipts per car mile d.	10·76	11·02	13·956	10·09	10·963	8·633	10·044	5·83	6·02	11·29
Expenses	6·90	7·03	8·587	8·07	6·798	6·16	6·699	4·72	4·60	8·55
Interest, sinking fund, and depreciation per do. ..	3·50	3·27	5·5	4·97	3·15	2·46	4·41	1·93	1·98	3·29
No. of cars in daily use	2803·37	425	6	48	80	5	4	13	9·11	57
,, ,, in stock	3508	566	17	67	100	7	8	25	14	96
,, ,, in use per mile of route	3·7	4·7	1·375	1·92	5·44	2·5	2·28	1·31	2·14	1·54
,, ,, in stock	4·64	6·26	3·90	2·68	6·80	3·5	4·57	2·54	3·3	2·59

Analysis of 16 Tramway Installations having Separate Generating Stations for Tramways and Lighting.

	Total of 16 Towns.	Glasgow. Greatest population served and carried. Greatest car-mileage. Greatest number of passengers per car-mile.	Newcastle. Greatest Income per car-mile.	Bexley. Greatest route mileage in proportion to population served. Least population served. Least mileage. Highest expenses per car mile.	Portsmouth. Greatest cost per mile.	Hull. Least route mileage in proportion to population. Lowest average fare charged per mile.	Belfast. Least income per car-mile. Lowest operating expenses per car-mile.	Preston. Least capital expenditure per mile. Highest average fare charged per mile.	Northampton. Least average journeys per head of population.
Population served	4,119,132	1,050,000	300,000	16,300	202,000	266,762	349,180	120,000	90,000
Length of route ... miles	403·35	80·23	27·87	5·25	14·50	13	46·5	10·54	5·5
„ „ single track ... „	739	165·59	53·0	6·91	28·50	27·29	73·22	17·20	9·07
Route length factor	0·098	0·076	0·093	0·328	0·072	0·049	0·133	0·088	0·061
Capital Expenditure ... £	12,161,055	3,104,061	1,103,972	94,858	670,157	436,543	1,072,445	187,269	127,374
„ „ per mile of route ... „	30,400	38,750	41,500	18,050	46,300	33,500	23,000	17,750	23,200
„ „ per mile single track ... „	16,450	18,750	21,773	13,723	23,514	16,057	14,646	10,888	14,036
Income ... „	2,679,994	895,842	208,654	12,988	102,014	121,186	181,139	37,946	22,942
Do. per mile of route ... „	6,650	11,160	7,480	2,475	7,040	9,320	3,900	3,600	4,170
„ „ „ of single track ... „	3,630	5,420	3,930	1,880	3,580	4,440	2,480	2,205	2,530
Operating Expenses ... „	1,472,926	485,256	107,326	8,846	45,755	70,178	103,258	20,783	12,531
Interest, sinking fund, depreciation, &c. ... „	988,383	343,817	75,959	4,942	47,587	34,298	68,514	17,163	9,908
Net surplus or deficit ... „	235,468	+ 70,279	+ 28,440	— 673	+ 9,025	+ 17,528	+ 9,478	..	+ 1,000
Application to relief of rates ... „	166,003	45,000	13,584	..	5,000	2,528	8,962	..	1,000
Passengers carried per annum	625,413,614	224,063,098	45,506,468	1,737,204	20,668,825	29,151,543	42,945,849	8,459,742	5,400,955
Riding habit	152	213	152	106·58	102·32	109	123	70·5	60
Average fare charged per mile	..	0·45	0·65	0·80	0·85	0·36	0·40	0·95	0·68
Car miles made per annum	62,832,281	20,350,367	4,263,174	268,619	2,199,823	2,956,406	5,296,895	904,582	573,579
Receipts per car-mile	10·25	10·565	11·75	11·604	11·129	9·84	8·21	10·068	9·78
Expenses per „	5·63	5·721	6·04	7·904	4·991	5·69	4·68	5·514	5·00
Interest, sinking fund, &c., per car-mile	3·78	4·05	4·28	4.42	5·20	2·78	3·11	4·55	4·15
No. of cars in use daily	1671·76	544	111	..	73	71·25	123	20	16·5
„ „ in stock	2520	780	187	16	100	116	220	30	22
„ „ in use per mile of route	4·15	6·79	3·99	..	5·04	5·48	2·65	2	3
„ „ in stock „ „	6·25	9·73	6·72	3·05	6·90	8·92	4·73	3	4

As to the present outlook, it may be asked whether there is any probability of the tramway system clearing off its debt. If we take the system in its entirety we can see no possible chance. From the Board of Trade returns lately issued we see that the loan capital has risen in the last 30 years from 4 to 64 millions. Amortisation has, of course, gone on, but the borrowers keep on borrowing more than they pay off. If, on the other hand, we take the seven largest and best paying tramways, in which it would appear as if construction had approached its limit, we find that at the present rate of amortisation the debt would be cleared in about 26 years and these tramways would then have about a million pounds of surplus at their disposal. They could either apply it to reduce the average passenger fare of a 1d. to ⅞d., or they could reduce rates by an amount equal to about 5s. per head of population served. Probably, however, long before then, they will have decided to replace the overhead system by an electrical conduit or in some other way to have enlarged instead of reduced their loan capital.

More will be said upon this subject of the apparently socialistic tendency of municipalisation under the heading of tariff as fixed by the deficit-producing undertakings.

2. *Rentability as Compared with Size.*—Although as a rule big tramways pay and small ones do not, there are remarkable exceptions of both kinds. Fourteen cities of populations varying from 100,000 to 232,000 either show a deficit or no surplus. The aggregate amount of deficit being £7,225.

On the other hand, the smallest town boasting an electric tramway—Maidstone, with 13,000 inhabitants—shows a surplus. Ayr, a town of 33,000, pays fixed charges, puts aside a depreciation fund and carries over a surplus of £1,000.

The following table illustrates this point:—

Population.	Number of tramways.	Number providing depreciation fund.	Number showing surplus.	Number showing deficit.	Number with even balance.
up to 20,000	2	0	1	1	0
20 to 40,000	7	4	4	3	0
40 to 60,000	9	3	0	8	1
60 to 80,000	6	3	2	1	3
80 to 100,000	4	2	2	0	2
100 to 150,000	12	3	3	2	7
150 to 200,000	8	5	3	1	4
200 to 300,000	6	5	6	0	0
300 to 500,000	5	5	5	0	0
500 to 1,000,000	3	2	3	0	0

It will be noticed that prosperity is at its lowest ebb in the case of tramways serving from 40 to 60,000 and only becomes invariable in the case of those serving over 200,000. Comparing route mileage with single track mileage it will be seen that in tramways serving 40 to 60,000 there is a sudden increase of proportion of double track mileage. It would seem, therefore, that at this point of population tramway construction has been too heavily saddled with the cost of double track. It is not to be inferred that all the tramways which show no depreciation fund or even which show a deficit, are permanent failures from a commercial standpoint. Some of them are of recent date, and may have a good future before them. On the other hand, it would appear from the foregoing table that about half the tramways provide no depreciation fund, and about one-quarter come out with a deficit.

3. *Capital Expenditure per Mile.*—The total capital expenditure, in the 55 tramways having combined generating stations, ranges from £10,630 to £37,210 per mile of route, and from £7,516 to £20,728 per mile of single track, the two extreme cases being Halifax and West Ham respectively.

In the 16 towns having separate generating stations for lighting and tramway purposes, the cost ranges from £17,750 to £46,300 per mile of route and from £10,888 to £23,514 per mile of single track, the two extreme cases being Preston and Portsmouth respectively.

The cause of this great variation is mainly in the cost of permanent way and widenings, and expenses incidental to obtaining authorisation. The rolling stock, overhead equipment and generating stations are fairly uniform in cost. With regard to permanent way, however, in the first place there is generally a horse car track to be bought up, and a new track laid down, which involves numerous and often heavy incidental expenses. Some towns are overburdened with length of permanent way needed to reach the population, others with peculiarly heavy cost of the permanent way itself. At Halifax, for instance, 37 miles of route were needed to serve 178,000 population, or about twice the average proportion. The cost per mile of track is comparatively low, the average number of rides quite normal, and the

receipts per car-mile exceptionally high, but the undertaking appears to be handicapped by its length. At Wigan, the ratio of length to population is four times the average, and the cost of track per mile nearly twice the average, under such circumstances the immense deficit of over £16,600 is not to be wondered at.

Comparing the capital expenditure of British with that of American and Continental tramways we find that the British undertakings are as much burdened by excessive first cost as is the railway system. An estimate is given in Mr. Ashe's book which he regards as a fair average of the cost of an American tramway and which works out at about £6,300 per mile of route, or about one-third that of the average and not much more than one-half the lowest figure in British tramways. The estimate made by the town council of Mülhausen, Germany, previously referred to, for a tramway was also between one-half and one-third of the average of British tramways. In America, a lower first cost is combined with a higher tariff. The question of first cost should obviously be studied in connection with the possible tariff as to which more is said under Clauses 6 and 9.

4. *Route Length Factor.*—This factor is the length in miles of route per 1,000 of population. Its normal length depends upon the extent to which the population is scattered or condensed, and whether the routes are parallel or radial. The factors given in the table are only approximate averages for British tramways in an element of design, which is necessarily extremely variable. They apply only to the more usual form of towns and their suburbs, but not to inter-urban lines or towns with detached suburbs. In these cases the factor is higher. As a general rule, the factor is in inverse proportion to the size of the town, because, as the population increases, it becomes denser, principally on account of the increased value of land.

In the tramways considered, this factor ranges from 0·033 to 0·4. Only one case having over 0·2 mile per 1,000 is remunerative. On the other hand, the low ratios are not either as a rule remunerative. Lincoln, for instance, with 52,500 people and a factor of 0·033, comes out with a deficit. The riding habit factor is only 27, thus the tramway can only by a flower of speech be said to "serve" its population.

The average of the 55 towns in the first list is 0·107, and in the second list 0·098 mile of route for 1,000 population.

Approximate Route-Length Factors for Urban Tramways in England.

Population.	Route Factor.	Population.	Route Factor.
20,000	0·180 to 0·220	120,000	0·113 to 0·139
40,000	0·162 to 0·198	140,000	0·105 to 0·129
60,000	0·147 to 0·179	160,000	0·099 to 0·121
80,000	0·134 to 0·170	180,000	0·094 to 0·115
100,000	0·123 to 0·150	200,000	0·090 to 0·110

As a mere memoriser, and subject to amendment according to circumstances, the factor may be taken as ranging from 0·2 in the smallest to 0·1 in the largest town.

In America, the riding habit being much greater, the towns are also better served.

5. *Density of Traffic or Riding Habit.*—Very approximately, the density of the traffic, expressed in average journeys per head of population per annum, varies with the size of the city. When the route mileage is proportioned to the population, the variation of riding habit becomes still more closely proportional to the size of the city than in the statistics. In the 71 cases cited, the riding habit varies from 27 at Lincoln, a town of 55,000, to 213 at Glasgow with 1,000,000. Lincoln, however, has only 0·033 per mile per 1,000 people and as they do not live in sky-scraper buildings they cannot be said to be served.

Maidstone again, already referred to, with a population of only 13,000 people carries it 91 times per annum, forming a very favourable exception in high density of travel with small population. Kirkcaldy, Southport and Wigan are also remarkable cases of the same kind.

It may be thought a hazardous thing to give any rule for estimating the density of travel in a city where results vary as greatly as they do. It is, however, less hazardous to form some kind of rule based upon study of statistics, than to make a mere guess, as is too often done. The following table is only intended as a rough approximation, subject to more accurate estimation from the study of the particular case, *and provided the system is of dimensions, and so laid out as to be fairly described as "serving" the population.*

Population.	Riding Habit.	Population.	Riding Habit.
20,000	50	120,000	89
40,000	[illegible]	140,000	93
60,000	74	160,000	95
80,000	81	180,000	97½
100,000	86	200,000	100

[illegible] 100,000 more, add 12½ rides per head per annum.

The curve corresponding with the above figures will, *in the main*, agree with the statistics of British corporation-owned tramways, and will generally be found rather under than over the actual riding habit.

6. *Income per Car-Mile.*—In the cases analysed, the income per car mile ranges from 5·8d. to 13·9d. The average of all is about 10½d. per car mile. Low receipts may be caused by a too frequent time interval between cars, by too low a tariff, by too low a speed, or other ground of unpopularity in the cars themselves.

In America, the income per car-mile of 18 electric railways given in a table by Mr. Ashe ranges from 4·61d. to 14·25d. per car-mile, the lowest income where no deficit is made being 4·65d.

7. *Working Expenses per Car-Mile.*—In the British tramways analysed, the variation is from 4·6d. to 8·59d., the average being 6·25d. High costs are generally found with a high route length factor. Probably the upkeep of track is chiefly responsible, but administration expenses borne by a light business in proportion to size are also contributory. The lowest working expenses are those of Kilmarnock, which is, however, not thereby saved from a deficit. The riding habit factor is here fairly high as compared with the route-length factor, and the tariff is normal. With this size of town, something abnormal is required, either in the riding habit or the tariff to make the undertaking pay.

8. *Interest and Sinking Fund per Car-Mile.*—In the British tramways these figures range from 1·93d. to 5·30d. very approximately in direct proportion to the capital expenditure per mile. The average of the whole is about 3·6d. Probably about half this burden is due to permanent way.

9. *Average Fare Charged per Mile.*—This ranges in the British tramways from 0·36d. to 1·0d., and the great variation does not appear to correspond with variation in cost of construction and operation. In the case of electric lighting companies, the cost to the consumer is always made to vary with the cost of production, but in traction companies there are many curious anomalies. The Parliamentary fare on railways is 1d. per mile, and there is no reason why a tramway should be victimised by a tariff of about one-third of that amount. In some cases it is possible to operate a tramway on a much lower tariff than 1d. per mile, which is of course then recommendable, as, for instance, at Hull, where with a tariff of 0·36d. per mile, the Corporation is able to put aside a fairly good depreciation fund, and to carry over a surplus amounting to 4 per cent. of the capital expenditure. Maidstone, on the other hand, the smallest remunerative tramway of the United Kingdom, levies the standard tariff of 1d. per mile, and could not have earned a profit at a lower tariff. It has, however, more than double the normal riding habit factor.

When one comes to the long list of tramways which declare a deficit and compares it with the fares charged per mile, the results are startling. Probably London, with its deficit of over £25,000 per annum would be the most surprising of any. Unfortunately, in the statistics, London does not give its average passenger fare. There can be no doubt, however, that it is extremely low. Taking the other 19 tramways, which together have a deficit of £48,000 per annum, we find that with three exceptions these tramways levy a fare under 1d. per mile, carrying passengers at rates varying from 57 per cent. under normal fare and upwards. The financial result, supposing these tramways all levied a fare of 1d. per mile instead of their present fare, would represent a surplus of about £70,000 in place of a deficit. It will at once be replied that the travelling public would not submit to a fare of 1d. per mile in these cases. Naturally they would not. When once the passenger has been allowed to travel partly at the expense of the ratepayer, he will not surrender his privilege. It is practically impossible to raise fares when once they have been established at an unremunerative figure. This does not, however, contradict the fact that, combining actual deficit with possible surplus, a sum of over £100,000 per annum is given away to the general travelling public in place of finding its way to the coffers of the undertakings.

If municipalisation of tramways is subject to ordinary business principles, the practice of letting the public travel partly at the expense of the ratepayer is to be condemned as vicious. If, on the other hand, commercial principles are not to be held to govern this form of exploitation, consistency should demand that the full programme of the Socialistic propaganda should fix the goal of municipalisation as that of free urban transportation. There is at present a lack of programme.

10. *Power Consumption, Cost per Car-Mile, and Cost per Unit of Power.*—The variations in the statistics are very much greater than would appear natural to the diversity of local conditions. As to power consumption per car mile, this varies from 0·88 unit in the case

of Keighley to 2·08 units at Burnley. This variation is more normal than that of the cost, and depends upon the weight of cars, density of traffic, and gradients to be overcome. The maximum gradients in the two above mentioned towns are 1 in 25 and 1 in 9·8 respectively.

The cost per B.O.T. unit varies from 0·32d. at Leeds to 2·14d. at Lowestoft. The variation depends on the kind of engines used, the cost of fuel, and the output of the plant. The output in the two cases cited above are 13 million and 350,000 units respectively. It should not, however, be taken as a necessary drawback of a small installation that the power cost should be anything like as high as it often is. Even with steam plants, there are cases of comparatively small installations where the cost per unit is under 1d. At Cork, it is supplied at something over ½d.

The internal combustion engine has been proved to be capable, when judiciously installed, and efficiently managed, of placing the small power station almost on a level as to fuel cost with the large station. Gas engines with suction or producer gas as fuel have under certain conditions been proved extremely economical. Unfortunately, however, there are many cases of very unfavourable results which are all easily to be accounted for either from bad design or management, but which have much interfered with the progress of this form of generator.

There certainly ought, however, to be no tramway needing to pay 2d. per unit for power.

With regard to the total cost per car-mile for power, this varies from 0·37d. at Glasgow to 3·13d. at Douglas (I.O.M.). This latter case is somewhat different from ordinary tramways, but Burnley comes close to it with 3·032d. per car mile. From various causes therefore, many of them quite avoidable, it costs eight times as much to drive a car in one place in England than in another. Certainly a surprising fact, even when all allowances are made.

11. *Average Speed per Hour.*—The gain in speed through the introduction of mechanical traction in great thoroughfares is not as much as the passenger imagines.

During the tests made with the London Electrobus, speed curves were obtained of several omnibuses plying on the same route, between Liverpool Street and Victoria. The variations were considerable with the same class of vehicle, but the average of a number of tests was as follows :—

— —	Average speed between termini. Miles per hour.	Highest average speed between any two cross streets. Miles per hour.
Horse Omnibus	5·30	8·75
Electric Omnibus	6·25	10·00
Petrol Omnibus	6·50	11·00

The police regulations limit the maximum speed to 12 miles per hour. Taking the above averages, a passenger travelling half a mile, would save about a minute as between the horse 'bus and the electric or about a quarter of a minute as between the electric and the petrol 'bus, but the latter saving is mostly a matter of chance.

The statistics of average speed per hour of tramways are misleading. They sometimes mean schedule speed and sometimes the actual average, that is to say the total car miles per annum divided by the total car hours per annum. Thus the minimum is Northampton, 5·6 miles per hour, which is the true average, while the maximum is 10 miles per hour at Hull. This latter, however, is only the schedule speed, the true average being 7·1 miles per hour. Northampton might, as far as speed is concerned, continue to operate by horse traction.

The London County Council also under "Average speed" appears to give the schedule speed of 8½ miles per hour, whereas it works out at 7 miles per hour.

Conclusion.—In the developments of methods of urban transportation which have been the result of private enterprise, there has been until lately, no attempt at comprehensive treatment, and much disastrous competition. Of late years, in London, a broader policy has been followed, of endeavouring to make the various methods as far as possible mutually helpful, but even in that city a Central Board of Traffic is still required.

The railways, the tubes, the tramways, the motor and horse omnibuses, each and all have their proper sphere, and it is to be hoped that in the future transportation engineering will become more and more an exact science, in the application of the various available methods to the spheres of usefulness for which they are best suited, and the avoidance of that great barrier to progress, the waste of capital.

THE ELECTRIC ARC BETWEEN A SOLID AND A LIQUID ELECTRODE.*

BY G. ATHANASIADIS.

It is impossible to maintain an arc between a cooled kathode and an anode which can become heated, but one may be obtained between a cold anode and a kathode heated to bright red heat.

Numerous experiments have been undertaken in order to determine the conditions under which an arc may be struck and maintained between an electrolyte and a solid electrode of carbon or metal. Further, the influence of a condenser and choking coil, placed in parallel with the arc as in the Duddell arrangement, has been studied. Among the electrolytes employed were solutions of phosphorus salts and acidulated water containing from 15 to 20 per cent. of sulphuric acid. One of the electrodes consisted of a carbon plate placed under the liquid and the other of a metal or carbon rod of different diameters and whose depth of immersion varied.

Influence of Diameter and Depth of Immersion.—When a small diameter (1—1·5 mm.) copper wire is immersed 4 to 5 cm. in the electrolyte it is noticed that the current reaches 6 amps. owing to a decrease in the resistance of the circuit. The current then falls rapidly to 0·5 amp. as the electrode polarises. The end of the wire becomes phosphorescent and at the same time it emits a piercing sound, the current remaining constant as the voltage increases up to 220 volts. Polarisation is more rapid the shorter the length of wire immersed, while white fumes arise at the same time from the anode owing to the decomposition of the sulphuric acid.

By reversing the current the wire becomes incandescent and melts rapidly. The same phenomena are obtained by using wires of iron, tin, aluminium, &c., as well as carbon rods. If larger (3—4 mm.) copper wires are employed polarisation begins when the anode touches the liquid and increases progressively as the wire is immersed up to 2 or 3 cm. It then becomes constant, as does the phosphorescence at the end of the wire. By again reversing the current an arc is obtained round the part of the wire immersed, which becomes incandescent and eventually melts. A very loud sound accompanies the formation of the arc, whilst the liquid round the electrode is brought to a state of ebullition and drops are projecting violently away. By increasing the potential difference to 220 volts the phenomenon becomes more pronounced, while the current strength, which depends on the depth of immersion, varies between 1 and 8 amps., and is always intermittent.

It should be noted that if the duration of the arc is prolonged and the incandescence thus increased, the current gradually drops while it increases as does the sound emitted as the anode is lowered into the liquid. In order to strike an arc in 5 or 6 cm. of liquid it must first be obtained by bringing the wire and liquid into contact and then gradually lowering the wire until the kathode becomes incandescent. But the voltage must be raised in order that the arc may be maintained at a greater depth. If the direction of the current is rapidly reversed, thus making the incandescent electrode the anode, polarisation takes place immediately even when the wire is immersed 5 or 6 cm., and the current drops to 0·5 amp. The necessary condition for maintaining polarisation is, therefore, sufficient heating of the anode.

Influence of Capacity.—If a large capacity condenser (10—20 mfd.) is connected in parallel with the arc, the latter becomes more brilliant and its sound more piercing. This becomes very loud and the liquid is projected violently in all directions. The alternate current in the condenser circuit is between 0·2—0·35 amp. By increasing the capacity of the condenser, the above phenomenon becomes more pronounced. But this capacity has no effect on the polarisation when the wire is the anode. The sound is great when the vessel containing the liquid is open, but when it is closed, *e.g.*, a Woollff's bottle, it is influenced by the sound capacity.

Influence of Self-induction.—If a choking coil, S, is connected in series with the arc, and another, S_2, in the condenser circuit, it is observed that the influence of the condenser on the arc decreases as the self-induction of S_1 and S_2 is raised. It is greatest when the self-induction is zero. But if the primary of a Ruhmkorff coil is connected in series with the arc sparks 8 or 9 cm. long can be obtained, the arc acting as a Wehnelt interrupter. The frequency of these interruptions varies between 50 and 180 per second.

In conclusion, Duddell's experiment is successful even when a liquid anode and solid kathode are used. The arc formed between an electrolyte and a solid kathode may be produced, even when the latter is immersed some 7 cm. or more, by bringing the voltage up to 220 volts. This arc may in certain cases act as a Wehnelt interrupter, but with less vigour. It is impossible to strike an arc between a solid anode and an electrolyte kathode, even at 220 volts; but polarisation of the solid electrode may always occur, however far it is immersed in the liquid.

* Translated from the *Comptes Rendus*.

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USEFUL KNOWLEDGE.

From the Presidential Address of Prof. L. C. MIALL to the Educational Science Section of the British Association the man of ordinary memory will derive no little comfort Many of us deplore the shortness of our memories, and envy those of our friends who seem to be able to remember all they desire. Indeed, there is no doubt that a good memory is an enormous advantage, for the simple reason that it lightens work, if this runs from the beaten track, and enables the possessor to follow a very broad path with comparative ease. Nevertheless, a man of short memory may do excellent work. Fortunately, as Prof. MIALL mentions, there is a great deal that is not worth remembering, and what we remember so greatly exceeds what we can use that we need not deeply regret the loss that is always going on. Just as most of us consume two or three times as much food as is necessary, so many of us attempt to remember very much more than is essential. It is not nearly so necessary to know more things as to know them better, and to know what to do with them.

Further, as Prof. MIALL reminds us, the exercise of memory involves nervous strain, and thus the undue exercise of this faculty requires an expenditure of energy which might very possibly be put to better purpose. It is more economical and more businesslike, as he points out, to employ mechanical contrivances rather than brain power for such a purpose—to leave the vast amount of useful facts in text books, and to collect those for which we have a present use in the note book or the card index—in fact, the printed book, rather than the memory, should be looked upon as the storehouse of information. Many of us will also sympathise with Prof. MIALL's partiality for the wastepaper basket as an accessory appliance to the notebook.

A consideration of the retention of knowledge naturally leads to the question of its acquisition—that is, to the problem of teaching. In the past there has been an inclination to spend time upon an elementary knowledge of many different sciences. With our continued progress this is more and more difficult, and such knowledge becomes more and more useless. It is, therefore, necessary to make a choice at an earlier age than formerly. At the same time the number of subjects increases rather than diminishes, with the result that the time-tables of our schools are apt to be very much overcrowded. Prof. MIALL mentions a case in which chemistry and English literature were given one hour a week between them. The inevitable result is that the school hours, including the preparation of work, are nearly always too long. This, no doubt, is an argument in favour of considering the natural aptitude of each pupil as far as possible, though where general education is concerned this may be difficult. Certain it is, however, that no pupil can benefit to the full unless he studies particularly that subject for which he has a natural taste. By so doing the co-operation of the pupil is secured and a system of "natural education" is obtained. In this connection we are glad to see that Prof. MIALL lays stress on the importance of leisure; as he puts it, "Natural education demands leisure for the pupil." Important though this may be in primary education, it is still more so in the final stages. Knowledge derived from books is not of the highest importance, and, if the pupil has any aptitude at all, it is much more necessary that he should have sufficient leisure in which to think things over. Only by so doing can he obtain a thorough grasp of his subject, and proceed from mere book knowledge to methods of research.

THE MEASUREMENT OF POWER FACTOR.

BY CHARLES V. DRYSDALE, D.SC.

Anyone who has had much experience of accurate alternate current testing must have frequently encountered difficulties in measuring power-factors or phase displacements in certain cases. The recent article by Dr. Lulofs in these columns, explains some interesting and useful methods of surmounting these difficulties, and a few notes on these methods from the practical point of view may be of interest.

Dealing first with three-phase balanced circuits, Dr. Lulofs mentions a simple method in which the main coil of a wattmeter is connected in one main, while the shunt coil is connected in turn between this main and each of the others, as in Fig. 1. In this case, if w_1 is one of the readings so obtained, and w_2 the other, we have $\tan\varphi = \sqrt{3}\frac{w_1 - w_2}{w_1 + w_2}$ as stated. When two wattmeters are employed in the ordinary manner for unbalanced three-phase circuits, their readings are obviously w_1 and w_2, when the load is balanced, and no changing over is required.

This method, though very accurate for low power-factors, is unsatisfactory for circuits of high power-factor, as then w_1 and w_2 are large and nearly equal, so that $w_1 - w_2$ is a small difference between two large quantities. But if, in the case of the single wattmeter, a third reading be taken with the wattmeter shunt connected between the other pair of mains, we have a reading $w_3 = w_1 - w_2$, and the small numerator is directly measured.

By far the most convenient method, however, is to employ a double wattmeter, as in Fig. 2. In this case the true watts $w = w_1 + w_2$ are directly given by the instrument reading, while if either the shunt or series coil of one wattmeter is reversed by a simple commutator a reading $w' = w_1 - w_2$ is obtained, so that $\tan\varphi = \sqrt{3}\frac{w'}{w}$. This method is particularly convenient and accurate, when testing induction motors and three-phase transformers. With low voltages the whole of the shunt circuit may be reversed, but with high voltages, the moving coil only or the main coil must be reversed to avoid a high P.D. between the fixed and moving coils.

Turning to single-phase measurement, Dr. Lulofs indicates three methods (1) by shunting the pressure coil by a self-induction (2) by shunting the series resistance of the pressure circuit by a capacity (3) by connecting a capacity in series with the pressure circuit. He does not, however, give us a clear idea as to the relative advantages of these different methods. A moment's reflection will show that the ideal method of employing a wattmeter for the purpose would be one in which the current in the pressure circuit was simply displaced by

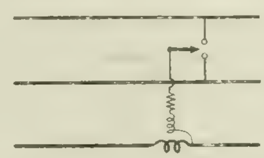


FIG. 1.—SINGLE WATTMETER METHOD OF THREE-PHASE POWER FACTOR MEASUREMENT.

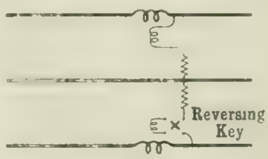


FIG. 2.—DOUBLE WATTMETER METHOD OF THREE-PHASE POWER FACTOR MEASUREMENT.

90 deg. without altering its value. In this case the ordinary wattmeter reading would be $w = W\cos\phi$ (Fig. 3), while the reading with shifted phase would be $w' = W\sin\phi$ from which $\tan\phi = w'/w$. Unfortunately, this condition cannot be realised without complicated connections, but the nearest approach to it is obtained by substituting a condenser for the series resistance of the pressure circuit, instead of shunting it or joining it in series. This is the device which I have consistently used for phase displacement tests of all kinds,* and have found to give uniformly good results. The theory, is, of course, the same as that of Dr. Lulofs' third method, though as the resistance is now very small it can be very much simplified for practical purposes. The simplest way of dealing with it is shown in Fig. 4.

The substitution of the condenser for the series resistance has two effects (a) an alteration of the current in the shunt coil

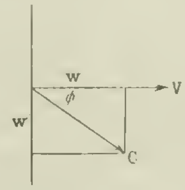


FIG. 3.

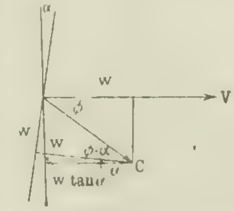


FIG. 4.

(b) a shift of its phase by something less than 90 deg. If α is the angle of departure from perfect quadrature, which depends on the resistance of the shunt coil (and also the dielectric losses in the condenser) it is obvious that the first reading of the wattmeter would be $w = W\cos\phi$ and the second $w'' = W\sin(\phi - \alpha)$, supposing for the moment that the shunt current is the same in both cases. By expansion or from the diagram it is readily seen that $w'' = w' - w\tan\alpha$ approximately, hence $\tan\varphi = \frac{w'}{w} = \frac{w''}{w} + \tan\alpha$. The current in the wattmeter shunt with the condenser exceeds the normal current, however, in the ratio of R the total shunt resistance to $\frac{1}{Kp}$ the capacity reactance,

* "The Measurement of Phase Differences," *The Electrician*, August 24 and 31, 1906. "Some Measurements on Phase Displacements in Resistances and Transformers," *Ibid.*, November 16 and 23, 1906. "The Use of Shunts and Transformers with A.C. Measuring Instruments," *Phil. Mag.*, July, 1908.

and $\tan \alpha = Krp$, where r is the resistance of the moving coil (neglecting inductance and dielectric loss). Hence our formula becomes $\tan \phi = \frac{1}{KRp} \cdot \frac{w''}{w} - Krp$, which is equivalent to Dr. Lulofs' formula when r is small.

It is inconvenient, however, to have to measure the quantities K, R, r and p, which are needed in either this formula or in others, and this may be readily got over by a simple arrangement of the testing connections, as in Fig. 5. As is there shown the circuit contains an ammeter, voltmeter and wattmeter, the latter being provided with a condenser and key by which it may be substituted for the series resistance in the pressure circuit. In addition to the load to be tested, a non-inductive resistance is provided, and a highly inductive coil, the power-factor of which is known to be less than 0·1 (almost any solenoid with a good laminated divided iron circuit will do). A three-way switch allows either the load, resistance or inductance to be thrown into circuit at will. Three simple preliminary measurements will then serve for all purposes, as follows :—

1. Switches on a and c. The wattmeter, if direct reading, should then agree with the product of the amperes and volts, if not we have the wattmeter constant $k = VC/w$.

2. Switches on b and d. The wattmeter shunt and main currents may then be considered sufficiently nearly in phase for us to take the new wattmeter constant for lagging currents as $k' = VC/w$.* Then the ratio of the constants will be $f = k'/k$.

3. Switches on b and c. The main current is in phase with the voltage, and the shunt current nearly in quadrature with it. A small wattmeter reading w will be obtained, whereas with a similar current in phase, it would have been VC/k'.

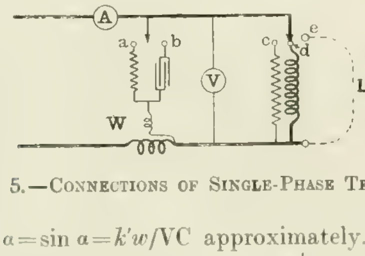


Fig. 5.—Connections of Single-Phase Test-Table.

Hence $\tan \alpha = \sin \alpha = k'w/VC$ approximately. We then have for readings with any load $\tan \phi = f \frac{w'}{w} + \tan \alpha$, where f and $\tan \alpha$ are given as above. This formula should be used for small angles of lag or lead, and the ordinary formula $\cos \phi = kw/VC$ for large angles.

The above method and expression seem complex when described, but are extremely convenient and simple in practice. The ammeter, voltmeter and wattmeter are connected just as in ordinary practical tests, and the only additions are the condenser, with its substitution switch, and the auxiliary non-inductive and inductive coils. The readings given above need only be taken occasionally as checks, and they have the advantage of enabling the wattmeter to be checked against the ammeter and voltmeter at any time. Neither the capacity, inductance, resistance nor frequency need be known, provided that the check readings are taken with the same frequency as the test; and dielectric losses in the condenser are eliminated, as $\tan \alpha$ is determined by experiment instead of by calculation.†

In the writer's opinion the diagram Fig. 5 is the correct arrangement of a single phase alternate current testing table for nearly all purposes, and it is astonishing to realise the number of tests which may be made with it. These include measurements of input and power-factor on all machines and loads, the phase displacements in liquid and wire rheostats, measurement of high and low inductances, magnetising and core losses in iron and transformers, and dielectric losses, accurate regulation tests, &c. By using a highly inductive coil instead of a condenser in the shunt, capacity measurements can be made independently of wave form as in Dr. Sumpner's new method, and condensers or cables may be introduced in series with the pressure circuit for dielectric or capacity tests.

This explanation has not been loaded with questions of corrections for errors in or power absorbed by the instruments, but these will readily be realised by those interested in the subject. Of course, the measurements should all be made with approximately sine wave form if phase measurements are to have any meaning.

* If higher accuracy is required the angle of phase difference is readily found by taking a reading with switches on a and d and combining it with the angle α found from the next test, and $k' = \frac{VC}{w} \cos \theta$, where θ is the phase angle between the main and shunt currents.

† Although almost any condenser may be employed, it is generally convenient to select one of which the capacity reactance $\frac{1}{Kp}$ is approximately equal to the resistance R of the shunt circuit. The two constants are then nearly equal and f nearly unity.

REPORT OF THE BRITISH ASSOCIATION COMMITTEE ON PRACTICAL STANDARDS FOR ELECTRICAL MEASUREMENTS.†

(*Concluded from page 847.*)

Other Platinum-silver and Gold-silver Coils.

In addition to the platinum-silver coils F, G, H and Flat, originally constructed to represent the B.A. unit at a particular temperature, there are three other platinum-silver coils, numbered 3,715 (Nalder Bros.) and 269 and 270 (Elliott Bros.), made to represent the ohm = 1·01358 B.A. unit. There are also two 10 ohm platinum-silver coils, numbered 288 and 289 (Elliott Bros.). All these coils are the property of the Association, and they were extensively used from 1888 to 1903 for the standardising of other coils. From the results of observations recorded in the Report for 1903 it appears that from 1894 to 1903 Nos. 3,715 and 270 remained constant in resistance, and that from 1897 to 1903, 288 and 289 remained constant. In 1903 the N.P.L. mercury standards of resistance were constructed, and since then the mercury standards have been taken as constant and the resistances of all coils expressed by means of them. The B.A. unit (as obtained from all the platinum-silver coils, taking the values given in 1888 as correct, and applying corrections for estimated changes in the coils) was in 1903 found to be equal to 1/1·01367 international ohm. Accepting this ratio for the time being, the resistances at 16°C. of certain coils, compared in 1888, 1894, 1897, 1903 and 1908, are given in the following table :—

Table IX.

Coil.	Material of construct'n	Approx. temp.coefficient.	Resistance. 1888.	1894.	1897.	1903.	1908.	Max. diff. (parts in 100,000).
*3,715	Pt. Ag.	0·00030	...	1·00050	...	1·00050	1·00057	7
*269	,,	0·00029	...	1·00070	...	1·00089	1·00089	19
*270	,,	0·00032	...	1·00006	...	1·00006	1·00003	3
*288	,,	0·0030	.	. .	10·0060	10·0060	10·0056	4
*289	,,	0·0026	. .	...	10·0026	10·0026	10·0031	5
64	,,	0·00033	0·99976		...	...	0·99987	11
19	Au. Ag	0·00071	0·99923		...	...	0·99937	14
68(H)	Pt. Ag.	0·00029	0·99909	...		...	0·99932	23
1 C.F.T.	,,	0·00028	0·99927		...		0·99941	14
34	Au. Ag	0·00071	0·99980	. .	...	.	1·00006	26
3	Pt. Ag.	0·0031	9·9956	...	...	...	9·9963	7
4	,,	0·0033	9·9941	...		...	9·9964	23
10 C.F.T.	,,	0·0030	9·9934			...	9·9940	6

* The resistances of these coils are given in ohms. 1 ohm = 1·01358 B.A.U.'s. The remaining coils have their resistances given in B.A. units.

For the loan of coil No. 64 we are indebted to Prof. Trouton, of University College; originally this coil was in the possession of Prof. Carey Foster. For the loan of the coils numbered 19, 68 (H), 1 C.F.T., 34, 3, 4, and 10 C.F.T. we are indebted to Mr. H. A. Taylor.

† Slightly abbreviated. This report was issued during the meeting at Dublin. The Committee consists of Lord Rayleigh (chairman), Dr. R. T. Glazebrook (secretary), Profs. W. E. Ayrton, J. Perry, W. G. Adams and G. Carey Foster, Sir Oliver J. Lodge, Dr. A. Muirhead, Sir W. H. Preece, Profs. A. Schuster, J. A. Fleming and J. J. Thomson, Dr. W. N. Shaw, Dr. J. T. Bottomley, Rev. T. C. Fitzpatrick, Dr. G. Johnstone Stoney, Prof. S. P. Thompson, Mr. J. Rennie, Principal E. H. Griffiths, Sir A. W. Rucker, Prof. H. L. Callendar, and Messrs. G. Matthey, A. P. Trotter, T. Mather and F. E. Smith.

of Victoria-street, London. We tender our hearty thanks to Prof. Trouton and Mr. Taylor. All the coils, excepting 19 and 34, are of platinum-silver; 19 and 34 are of gold-silver.

In Table IX. maximum differences of the order 1 to 5 parts in 100 000 may probably be neglected if this maximum difference does not occur in the period 1903-1908. In 1903 and 1908 the errors of observation were very small, and a recorded difference of 1 or 2 parts in 100,000 must be taken as indicating a true change in the resistance of a coil. The method of measuring a very small change in resistance will be made clear in the next section on manganin coils. The most constant coils appear to be 270, 288, 289, 10 C.F.T., 3 and 3,715. Of these six resistances two only are unit coils; the remainder are coils of 10 ohms each. In Table IX. the values of eight unit coils and of five 10 ohm coils are tabulated, and of the latter four have kept nearly constant. This fact is important, as it points to the changes of resistance being largely due to actions at the soft-soldered joints, and not entirely, if at all, to the action of paraffin wax (possibly acid) on platinum-silver. In addition, part of the changes may be due to change in structure of the alloy.

The values at 16 C. of the coils A, B, C, D, E, F, G, H and Flat, in terms of the unit of resistance employed for the purposes of Table IX., are approximately

A	1·00050	D	1·00020	G	1·00103
B	1·00026	E	1·00080	H	0·99972
C	1·00101	F	1·00088	Flat	1·00053

Manganin Standards of Resistance.

The manganin standards of the National Physical Laboratory are in constant use and have proved of very great value. They not only facilitate electrical measurements, but they bring them to a far higher degree of accuracy than was formerly attainable. Nevertheless, the variations in these resistances have in many cases been a source of trouble, and attempts have been made, and are being continued, to construct standard coils of manganin which shall remain practically constant in resistance. Since 1903 the manganin standards have been intercompared at least four times every year, and the probable changes have been deduced from occasional comparisons with mercury standards and from tables of difference values, due regard being also paid to the past history of the coils. As an example of the comparisons we take the case of seven 1 ohm coils which were intercompared in January, April, July and October, 1906. The observed differences are given in Table X.

Table X.

Coils.	Differences in 1×10^{-5} ohm at 17 C.				
	Jan., 1906.	April, 1906.	July, 1906.	Oct., 1906.	Max. diff.
1,690 – 780	6·82	6·87	7·05	5·93	1·12
1,690 – 2,351	2·17	2·35	2·04	1·47	0·88
1,690 – 2,483	0·26	0·48	0·26	–0·30	0·78
1,690 – 381	–5·80	6·05	–5·97	–6·27	0·47
1,690 – L·17	15·63	13·41	12·69	11·80	3·83
1,690 – L·18	16·69	16·05	15·54	14·92	1·67

Any one of these differences was not obtained from a single observation, but is the mean of six differences. All possible combinations of the seven coils were taken—21 in all—and the differences observed. From these 21 observations six values resulted for the difference between any two of the coils; it is the mean of these six values which is recorded. The temperature during the observations was very nearly 17°C., and the differences were corrected to 17°C. before taking the mean.

An analysis of the figures given in Table X. indicates that the coils L·17 and L·18 probably changed most during 1906, and that the other five coils changed by amounts less than 3 parts in 1,000,000 from January to July, 1906. From July to October the difference 1,690—780 changed by an appreciable amount and the differences in the values for July and October, viz :—

1,690 – 780	....	Change	$1{\cdot}12 \times 10^{-5}$ ohm.
1,690 – 2,351	....	„	0·57 „
1,690 – 2,483	....	„	0·56 „
1,690 – 381	....	„	= –0·30 „

indicate that 1,690 probably fell in resistance in this period by about 6 parts in 1,000,000, and 780 rose by about 5 parts in 1,000,000. The other small changes are difficult to assign and are possibly due to variable humidity. The errors in the differences recorded are certainly less than 1×10^{-6} ohm. The above is only part of the analysis of the differences which is in general made. Comparisons with coils other than units are also often desirable, but need not be dealt with here.

A Table* gives the resistance of a number of manganin coils in the October of each year from 1903 to 1907, and charts Nos. 1 and 2 show the complete changes in most of the coils from March, 1903, to June, 1908. In the table the resistances are given in the same month of each year in order to eliminate as much as possible the effects of humidity on the resistances of the coils. Resistances L·19, 2,448 and 2,449 were placed in atmospheres of varying humidities in the interval, October, 1907—April, 1908, and hence the curves for these coils are not continued on the charts after January, 1908.

At first, limiting our attention to the unit coils, we see from the charts that these have varied during the past five years by the following amounts:—

Table XI.

Coil.	Maximum change in resistance in five years.	Difference value. Resistance in 1908 minus resistance in 1903.
1,690	$3{\cdot}7 \times 10^{-5}$ ohm	$3{\cdot}7 \times 10^{-5}$ ohm
780	4·6 „	4·6 „
2,351	7·8 „	–0·2 „
2,483	4·4 „	3·2 „
381	2·6 „	–0·2 „
L·17	10·2 „	9·6 „
L·18	8·8 „	8·8 „
	Mean = 6·0 „	Mean = +4·2 „

If we neglect L·17 and L·18 the mean value of the other five coils is $2{\cdot}2 \times 10^{-5}$ ohms greater in 1908 than in 1903. Apart from the cause of these changes, it is interesting to form some idea of what interpretation of the differences might reasonably have been applied if mercury standards had not been the master standards. If the mean value of the seven coils had been taken as remaining constant, the error in five years would have amounted to 4·2 parts in 100,000. A comparison of coils of nominal values differing from unity might, however, be made, and such might largely influence the result.

The maximum changes which have taken place in the other resistance standards and the difference values (1908-1903 values) are given in Table XII.

Table XII.

Resis. standard.	Nominal value. Ohms.	Max. change since 1903. Parts in 100,000	1908 value minus 1903 value. Parts in 100,000	Mean difference. Parts in 100,000
O.W. 2,196	0·001	22·4	22·4	+12·1
O.W. 2,493	0·001	2·0	1·8	
O.W. 2,200	0·01	33·0	33·0	+16·6
O.W. 2,492	0·01	1·9	0·2	
O.W. 2,352	0·1	2·0	1·4	+ 4·7
O.W. 2,484	0·1	8·0	8·0	
O.W. 738	10	2·2	1·7	+ 6·5
O.W. 1,693	10	8·0	7·2	
L·19	10	11·0	9·6*	
L·20	10	8·3	7·6*	
O.W. 739	100	1·2	–1·0	+ 8·5
O.W. 2,450	100	18·0	18·0	
O.W. 740	1,000	11·8	11·1	+50·4
O.W. 2,449	1,000	89·4	89·4	
O.W. 2,448	10,000	40·0	36·8	+36·8

Mean difference value (1908 – 1903 values) = +16·5 parts in 100,000.
Mean difference value (1908 – 1903 values) including the unit coils = +12·6 parts in 100,000.

The mean difference in the values of all the manganin coils for 1908 and 1903 is 12·6 parts in 100,000. The oldest coils are 381 (17 years old), 780, 738, 739, and 740 (13 years old), and 1693 and 1690 (eight years old), the ages being approximately only. The remainder of the coils are from five to six years old.

The most constant coils belonging to various groups are :—

381	— most constant	of the	unit coils.	
738	„	„	10 ohms coils.	
739	„	„	100	„
740	„	„	1,000	„

In general, therefore, the older the coil the more constant does it appear to be.

With reference to the sudden changes in resistance, as shown by the curve for 2,351 in 1903, of 381 in 1904-5, and of L·20 in 1906, we can offer no complete explanation; but it is possible that variable humidity of the surrounding medium, such as might arise from the presence of a small quantity of moisture in the insulating oil, was responsible for part of these changes. The breaks in the curves for 2,483, 2,351, L·17, L·18, 1,693, and 2,484 are due to these coils being away from the National Physical Laboratory; they were being compared with the wire standards of the Reichsanstalt.

The increase in resistance of No. 2,449 is phenomenal. The *daily* rate of change for 1906 is over four parts in 10,000,000; that is, in

* We have omitted this Table.—Ed. *E.*

* These are the difference values (1908 – 1904 values).

about 22 days the coil changed in resistance by about one part in 100,000. In April, 1907, we attempted to measure the change from day to day, and for this purpose we compared 2,449 and 740 every working day for four weeks. The results obtained are as follows:—

Day of Observation......	1	3	5	8	10	12	15
Difference (2,449—740) Parts in 100,000	52·05	52·15	52·30	52·35	52·35	52·30	52·55
Day of Observation......	17	19	22	24	26	29	
Difference (2,449—740) Parts in 100,000	52·65	52·75	52·95	53·00	53·00	53·15	

The change was, therefore, a very gradual one, and easily detected. It is of interest to note that the rate of change for the last six months of 1907 is less than that for 1903-6.

The possible causes of the changes in the manganin resistances may be classified under the following heads:—(1) change in structure of the alloy; (2) surface action; (3) humidity effect; (4) change in the soldered joints connecting the wires of high-resistance coils to the current leads; (5) change at the junctions of the potential leads with the resistance standard. Only the first of these appears to fully explain the gradual rise in resistance. Causes (2) and (4) would have an inappreciable effect on very low resistances; yet some of these—*e.g.*, 2,196—have changed by considerable amounts. Cause

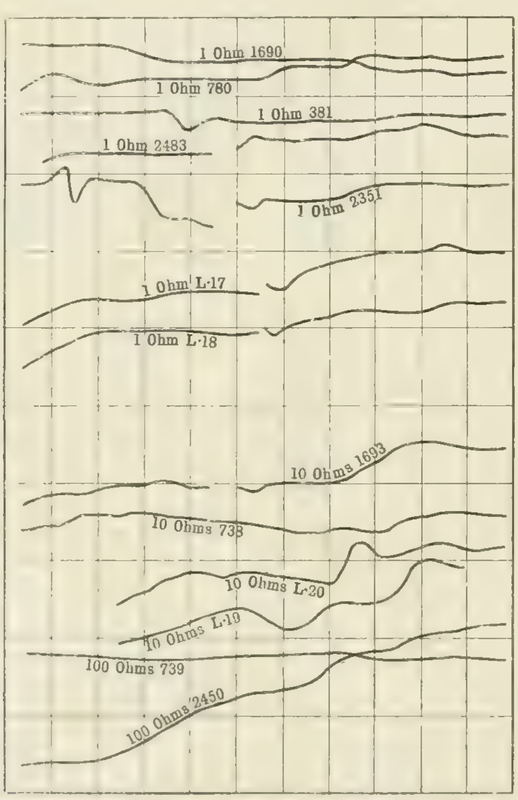


CHART I.—SHOWING THE VARIATIONS IN RESISTANCE OF MANGANIN.
Standard coils of nominal values: 1 ohm, 10 and 100 ohms.

(5) would have no effect on high-resistance coils, since these are not provided with potential leads; but Table XII. shows that all of the high-resistance coils have changed. Cause (2) produces in general a cyclic change, and, while being without doubt a cause of variation, it cannot be modified to explain all the gradual increases in resistance owing to the negligible effect of humidity on very low resistance standards. Cause (1) appears, therefore, to have been the chief one in the cases we have considered.

It is necessary, however, that we should say something about other manganin coils. In 1903 the resistances were measured of some manganin coils (1 to 5,000 ohms) in a box by R. W. Paul, London. The coils could not readily be immersed in oil, and the measurements were therfore uncertain to about 1 part in 100,000. The resistances were again measured in 1904, 1906, and December, 1907. The maximum change in the resistance of any coil is 5 parts in 100,000, while the mean increase in resistance during 1903-7 is four parts in 100,000. In 1902, and again in 1907, the resistances were measured of some manganin coils (1 to 10,000 ohms) in box No. 1,723 by O. Wolff, Berlin. The maximum change in resistance during the period 1902-7 is about 6 parts in 100,000, and a few of the coils have kept practically constant. Many manganin coils in other boxes are known, however, to have changed very considerably.

It will be seen that of the manganin standards we have examined some have kept remarkably constant, while others are practically useless as standards. It must not be concluded, however, that all manganin resistances are subject to such changes. Drs. Jaeger and Lindeck have shown that the manganin standards of the Reichsanstalt keep very constant, and the manganin coils at the Bureau of Standards also appear to be of a fairly constant type, though subject to considerable cyclic changes owing to variable atmospheric humidity. The manganin standards reported on in this Appendix comprise *every standard resistance of manganin* in use in the Standards Department of the National Physical Laboratory.

APPENDIX II.

Specifications for the Practical Realisation of the Definitions of the International Ohm and International Ampere, and Instructions for the Preparation of the Weston Cadmium Cell.

(From the National Physical Laboratory.)

The following specifications have been prepared after consultation with various authorities, and will form a basis for discussion at the forthcoming Congress on Electric units in London. They have not been authoritatively adopted, and are subject to amendment.

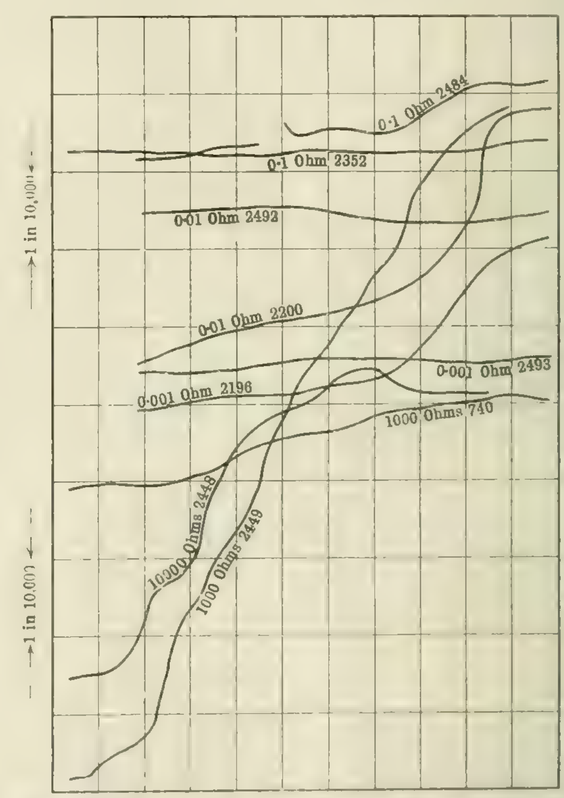


CHART II.—SHOWING THE VARIATIONS IN RESISTANCE OF MANGANIN.
Standard coils of nominal values 0·001, 0·01, 0·1 ohm, 1,000 and 10,000 ohms.

In the last Report specifications for the realisation of the international ampere and for the construction of the cadmium cell were given, the processes of preparation, &c., being described with considerable detail. These specifications appeal to a much wider circle than the present ones, for the latter are intended mainly to serve as a guide to the standardising institutions of the various countries in order to obtain, as far as possible, complete agreement in the units of electric measurements. Certain instructions, such as the purification of mercury, have therefore been omitted, but all which is thought to be essential for an exact reproduction of conditions is still included. Instructions for the erection of mercury standards have not previously been issued.

The International Ohm.

The international ohm shall be equal to the resistance offered to an unvarying electric current by a column of mercury at the temperature of melting ice, 14·4521 grammes in mass, of a constant cross sectional area, and of 106·300 cm. in length, arranged in accordance with the following specification:—

The column of mercury shall be of circular section, or nearly so, and shall be contained in a tube of suitable glass which has been carefully annealed. The tube shall be straight to the eye, and the maximum variation in its area of cross-section shall not exceed 2

parts in 100. The tube is to be carefully calibrated, and the correction for its conicality determined. In determining the weight of mercury contained by the tube when filled at the temperature of melting ice, the column of mercury is to be bounded by planes at the terminal cross-sections of the tube. The tube should not be unduly heated, and it should be filled with mercury by exhaustion of air. The axial length of the tube should be measured at 0°C. if possible, otherwise the coefficient of expansion of the glass should be determined and the axial length of the tube at 0°C. calculated from axial measurements made very near to that temperature. To facilitate measurements of the axial length, the ends of the tube should be ground very slightly convex.

For the electrical measurements the ends of the tube are to be connected to spherical bulbs of glass, the slightly convex ends of the tube forming, very nearly, portions of the internal spherical surfaces of the bulbs. Each bulb is to be provided with a current and a potential lead, the point of entry of the former, and an end of the tube being at opposite ends of a diameter of the bulb. The potential lead shall be situated in a plane midway between the point of entry of the current lead and the end of the tube, and at right angles to the line connecting them. Contact with the mercury shall be made by means of platinum wires. The diameter of a bulb is to be from 30 to 33 times the diameter of the terminating section of that end of the tube to which it is connected.

If L is the axial length in centimetres of the mercury column contained by the tube at 0°C., W the weight of the column in grammes, and μ the correction for the conicality of the tube, the resistance of the column at 0°C. is

$$\mu \frac{L^2}{(106{\cdot}300)^2} \cdot \frac{14{\cdot}4521}{W} = 0{\cdot}001278982\,\mu \frac{L^2}{W} \text{ international ohms.}$$

When the spherical bulbs are fitted to the ends of the tube and the whole filled with mercury, if r is the mean radius of the tube and r_1, r_2, the mean radii in centimetres of the terminal sections, the resistance at 0°C. between the potential leads is

$$0{\cdot}001278982\ L^2/W \left\{ \mu + \frac{0{\cdot}80 r^2 (r_1 + r_2/r_1 r_2)}{L} \right\}^* \text{ international ohms,}$$

correct to 1 per cent. of the added resistance

$$0{\cdot}001278982\ L/W \{0{\cdot}80 r^2 (r_1 + r_2/r_1 r_2)\}.^*$$

The electrical measurements are to be carried out at 0°C., the tube and spherical vessels being surrounded by melting ice and about 15 centimetres below the upper surface of the ice. The connecting wires employed for the current and potential leads must be thin, the flow of heat through them to the mercury being insufficient to warm the mercury as to produce appreciable error. The insulation resistance between the mercury column and the ice surrounding the tube must not be less than 10,000,000 ohms. The current employed in comparing the mercury resistance with other resistances shall be limited by the condition that the mercury shall not be warmed sufficiently to produce appreciable error. The mean of at least five tubes must be taken to determine the value of the mercury unit. The mean of at least three fillings shall be taken as the value of the resistance of a tube.

Specification for the Practical Application of the Definition of the International Ampere.

Conditions under which silver is to be deposited to measure currents from 0·5 to 8 amperes :—

The solution shall consist of from 15 to 25 parts by weight of pure crystallised silver nitrate in 100 parts of distilled water free from chlorine. It shall be used for one determination of current only. In cases in which it is desired to measure a current of about 1 ampere the anode shall consist of a disc or plate of pure silver about 60 sq. cm. in area and three or four mm. in thickness. It is supported by a silver rod riveted through its centre. The anode shall be inserted into a cup of filter paper separately supported.

The cathode shall consist of a platinum bowl about 10 cm. in diameter and 7 cm. in depth. About 300 cub. cm. of the silver-nitrate solution are to be placed in the cathode bowl, and the anode is to be supported near the top of the solution and is to be just covered by it. Not more than from 7 to 10 grammes of silver should be deposited. (For the measurement of smaller currents, say, from ¼ to ½ ampere, a bowl holding about 60 cub. cm. of solution may be used, the anode being proportionately reduced in size and from 2 to 3 grammes of silver being deposited.) The deposit should be rinsed with distilled water free from chlorine until the addition of a drop of neutral solution of sodium chloride in water, to the wash water, produces no milkiness. The cathode bowl is then nearly filled with distilled water and left for at least three hours ; it should be rinsed three times, the last of these wash waters remaining in the bowl for 10 minutes. This last wash water should give no milkiness when added to a neutral solution of sodium chloride in water. The deposit is to be dried in an electric oven at a temperature of about 160°C. ; it is placed in a desiccator to cool, and is afterwards weighed. The mass of the deposit, expressed in grammes, divided by the number of seconds during which the current has been passed and by 0·001118, gives the mean current in amperes.

Preparation of the Weston Cadmium Standard Cell.

The cell has mercury for its positive electrode, and an amalgam consisting of from 12 to 12·5 parts by weight of cadmium in 100 parts of the amalgam for its negative electrode. The electrolyte consists of a saturated solution of cadmium sulphate, and solid cadmium sulphate is contained within the cell. A paste, consisting of solid mercurous sulphate, mercury, and solid cadmium sulphate, rests on the positive electrode. For the positive electrode, pure distilled mercury should be used.

The amalgam may be made either by electrodeposition or by mechanical mixing. It should be fused and freed from oxide by washing with dilute sulphuric acid. For the preparation of the cadmium sulphate crystals and solution, commercially pure recrystallised cadmium sulphate should be dissolved in pure distilled water so as to form a clear saturated solution. Evaporation at about 35°C. is then allowed to proceed, when crystals separate from the solution. The crystals are washed with successive small quantities of distilled water to form a saturated solution. The solution should be neutral to congo red.

The mercurous sulphate should be quite pure, and its crystals should not be so small as to have an abnormal solubility or so large as to be inefficient as a depolariser. The following is an example of a method for preparing the salt satisfactorily :—Add 15 cubic cm. of pure strong nitric acid to 100 grammes of pure mercury, and place on one side until the action is over or nearly over. Transfer the mercurous nitrate thus formed, together with the excess of mercury, to a beaker containing about 200 cubic cm. of dilute nitric acid (1 volume of acid to about 40 volumes of water) ; a clear solution should result. Prepare about 1 litre of dilute sulphuric acid (1 volume of acid to 3 of water), and while the mixture is hot add the acid mercurous nitrate solution to it. The solution should be added as a very fine stream from the narrow orifice of a pipette, and the mixture violently agitated during the mixing. Mercurous sulphate is precipitated. Decant the hot clear liquid and wash the precipitate twice by decantation with dilute sulphuric acid (1 volume of acid to 6 of water). The precipitate should then be filtered and washed three times with dilute sulphuric acid (1 to 6), and afterwards 6 or 7 times with saturated cadmium sulphate solution to remove the acid. The mercurous sulphate should then be flooded with saturated cadmium sulphate solution and left for one hour, after which the solution is tested with congo red paper. In general no acid will be detected, and if so the mercurous sulphate is ready for use.

To set up the cell the **H** form of vessel is the most convenient. The platinum wires inside the vessel should be amalgamated by passing an electric current to each in turn through an acid solution of mercurous nitrate. The vessel must afterwards be washed out twice with dilute nitric acid and several times with distilled water ; it must be free from stains and scrupulously clean ; it is dried by the application of heat. The amalgam is fused and its surface flooded with very dilute sulphuric acid ; sufficient of it to cover the amalgamated platinum wire completely should then be introduced into one of the limbs of the **H** vessel. To free from acid, the amalgam may be remelted and washed with distilled water. Into the other limb of the vessel sufficient mercury is introduced to cover the amalgamated platinum wire completely. Then the paste, finely powdered crystals of cadmium sulphate, and saturated cadmium sulphate solution are added in the order named and the cell sealed.

Its E.M.F. at 20°C. is $1{\cdot}018_5$ volt.

The E.M.F. at any other temperature (t) may be obtained from the equation :—

$$E = 1{\cdot}018_5 - 0{\cdot}000038(t-20) - 0{\cdot}00000065(t-20)^2,$$

the limits of temperature being—(these have not yet been fixed).

BOOKS RECEIVED.

(Copies of the undermentioned works can be had from *The Electrician* office, post free, on receipt of published price, adding 3d. for books published under 2s. Add 10 per cent. for abroad or for foreign books.)

"Electrical Engineer's Pocket Book. By H. A. Foster. 5th edition. (London : A. Constable & Co) 21s. net.

"Mineral Waxes." By Rudolf Gregorious. Translated from the German by Chas. Salter. (London : Scott, Greenwood & Son.) 6s. net.

"Glaser de-Cew die Dynamoelektrischen Maschinen." By Kurt Riemenschneider. Vol I. of "Elektrotechnische Bibliothek." (Leipzig : A. Hartleben.) M.3.

* The end correction factor is given in these formulæ as 0·80 ; this value is, however, subject to amendment.

CORRESPONDENCE.

MODERN VIEWS OF ELECTRICITY.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: In your issue of September 4th I find a review illustrating precisely the kind of notion which the republication of my book was intended to guard against—namely, a supposition that recent advances have overthrown the work of Clerk Maxwell and Faraday: whereas in truth any apparent conflict between the old and the new is largely a matter of emphasis, and of one-sided though legitimate attention.

One sentence, moreover, in that review is so misleading to present-day students that it is necessary to quote and rebut it. The reviewer says: "The author's famous declaration that 'electricity is ether'—a bold but somewhat sterile guess made in the days of Hertz—still holds the field in many parts of the book."

I am not aware that anyone has made such a "declaration." The statement represents nothing that I have ever held or taught, and to put it in quotation marks is surely a piece of carelessness.

Referring to the index of my first (1889) edition I find that the relations between ether and electricity are mentioned on pages 17, 338 and 349.

On p. 17 occurs the sentence: "We have nowhere asserted that electricity and the ether are identical."

On p. 338 (from a lecture given in 1882 before the "days of Hertz"): "Light consists of undulation or waves in the medium; while electricity is turning out quite possibly to be an aspect of a part of the very medium itself."

And on p. 349 (from the same lecture): "Is the ether electricity then? I do not say so, neither do I think that in that coarse statement lies the truth; but that they are connected there can be no doubt."

Finally, I wish to say that in the recent edition of this book nothing is intentionally retained that will not stand scrutiny in the light of recent researches.—I am, &c.,

Birmingham, Sept. 14. OLIVER LODGE.

[The "declaration" referred to occurs on p. ix. of the Preface to the first edition of the "Modern Views." Its exact wording is: "What has so long been called electricity is a form, or rather a mode of manifestation, of the ether. . . . . A rough and crude statement adapted for popular use is that electricity and ether are identical." It is only fair to add that the book itself contained many speculations quite independent of this view, which foreshadowed the atomistic theory of electricity, notably in the departments of solid and electrolytic conduction. My review nowhere asserted or suggested that the work of Clerk Maxwell or Faraday had been overthrown by recent advances. But it would be strange, indeed, if some of their speculations had not been found untenable.—THE REVIEWER.]

THE PROPOSED ELECTRIFICATION OF THE MELBOURNE SUBURBAN RAILWAYS.

In connection with the brief note which appeared in our last issue referring to the report of Mr. C. H. Merz on the proposal to convert the suburban railways of Melbourne to electric traction, we are now able to give the following official abstract of the report referred to, which has just been issued to the Press:

The report presented by Mr. Charles H. Merz, of London, the consulting engineer appointed by the Victorian Railways Commissioners, deals with two main questions: Firstly, is the substitution of electric traction for steam traction on the Melbourne suburban system financially profitable? Secondly, if so, what is the best way to apply the electric working?

After referring to the exceptional importance of the suburban business in the case of Melbourne as compared with other great cities, the principal features of electric working generally, and the advantages which it offers both to the travelling public and to the management are dealt with at length. It is shown that electrification allows for a more frequent service throughout the day, and the running of trains at regular intervals, as well as greater punctuality and safety in working. Fires from locomotives' sparks and smoke steam and dust would be practically abolished, while the lighting and heating of the carriages would be much improved. In addition to this, journeys would be shortened by 15 to 30 per cent. Following upon this are elaborate technical investigations and calculations both as to the first cost and the working cost with electric traction, as compared with steam, and a list is then given of the improvements in the time table which can be brought about.

As showing the improved services which electric traction offers the journey from Flinders-street to Sandringham takes 38½ minutes with steam and would take 31 with electric traction; to Williamstown 37 minutes with steam, 31 with electric; to Camberwell 21 minutes with steam, 17 with electric, and other journeys in proportion. Instead of 70 trains a day to Essendon there would be 88 with electric; instead of 40 to Williamstown there would be 75 with electric; instead of 28 to Sandringham there would be 73 with electric, and other routes with corresponding improvements.

The main conclusion is that on account of the great advantages to the public and the improvement in financial results to be expected from electrification, the installation of electric traction on the suburban railways is desirable on grounds of finance and of public convenience, and it should be carried out in the following stages: (1) The Port Melbourne, St. Kilda, Sandringham and Broad Meadows branches. Route length, 29 miles. (2) Stage (1), and, in addition, the Camberwell and Williamstown branches. Route length, 65 miles. (3) The complete scheme, including in addition to stage (2), the Sunshine, Coburg, Preston, Heidelberg, Dandenong, and Mordialloc branches. Route length, 124 miles. Mr. Merz considers it would not be convenient to try and convert more than the lines in stage (1) at first, nor financially advisable to convert less than the lines in stage (2).

The following is the summary of conclusions appended to the report:

Capital Outlay.—(1) The total capital outlay for the conversion of the whole suburban system will be £2,227,050. It is recommended that a portion only of the system be converted at present (*see* No. 19).

(2) In considering these figures the expenditure necessary if steam traction be retained must also be taken into account. This expenditure, on rolling stock only, amounts to £408,358.

Cost of Electric Working.—(3) The expenses per train-mile with electric traction would be 11d. as against 18·9d. with steam. With the former, however, there would be a greater train mileage.

(4) The total operating expenses with electric traction for the whole suburban service would be £27,267 per annum less than with steam (*see* No. 9).

Financial Result.—(5) The total annual expenditure for the whole service, including 4 per cent. on the new capital outlay, would be £44,791 more than with steam; against this must be put the additional revenue due to the improved service.

(6) The surplus, after paying interest on new capital for the complete scheme, would, with electric traction, be £40,251 greater than was obtained in 1906 with steam.

Improved Service.—(7) If electric traction be adopted an improved schedule speed and frequency of service becomes possible, with the existing tracks and termini.

(8) An increase of 20 per cent. over the present schedule speed and an increase of 71 per cent. in the train-mileage are financially justifiable, and are covered by the expenses referred to above.

Rolling Stock.—(9) The adoption instead of locomotives of the "multiple-unit" system of train operation is recommended, giving the increase of 71 per cent. in the train-mileage with an increase of only 23 per cent. in the ton mileage.

(10) Cross-compartment coaches should be adopted, and the existing bogie stock be altered and used for the electric service.

(11) The total stock required would be 496 coaches with electric working, as compared with 546 coaches and 110 locomotives with steam, the reduction in the number of coaches being due to the higher schedule speed.

Electrical System.—(12) A direct current 800 volt system would be the cheapest and best system for this particular case.

(13) The direct current should be distributed to the trains from sub-stations, by means of a protected conductor rail.

(14) The sub-stations should be supplied with three-phase high tension current from the power station by means of underground cables in the central areas, and by overhead lines in the less populous districts.

Power Station.—(15) The energy required should be generated in a central power station situated at Yarraville designed to handle the load of 35,000 E.H.P.

(16) This power station should be designed to burn either black or brown coal, and the power plant consist of water tube boilers and steam turbines.

(17) The Spencer-street and Elsternwick stations should be shut down, and the St. Kilda Tramway and the existing lighting system be supplied in bulk from Yarraville.

(18) The Yarraville power station should be also used for the lighting of the railway stations, and the driving of the Newport and North Melbourne workshops.

Initial Scheme.—(19) If electric traction be decided on, the scheme proceeded with in the first instance should consist of the Port Melbourne and St. Kilda, and the Brighton and Essendon branches, involving, with power plant, an initial expenditure of £801,880.

(20) After paying interest on this sum the surplus from these lines would, with electric traction, be £21,358 greater than was obtained in 1906 with steam traction.

(21) If steam be retained upon these lines £141,019 will have to be spent on rolling stock for them alone.

(22) The conversion of these lines should be so arranged that the electric zone might be extended to the other suburban lines at a future date with a minimum of alteration and expense.

Other Operating Changes.—(23) Such questions as systems of train despatching, automatic signalling, new block sections, special provisions for race traffic, &c., would be best deferred until part, at least, of the system is being worked electrically.

THE MECHANICAL ATTACHMENT TO THE WESTINGHOUSE MAGNETIC BRAKE.

The problematic side of tramcar braking is peculiar to the tramcar owing to the peculiar conditions which have to be met, and which do not arise in the braking of railway trains. The locomotive driver must, it is true, be equally keen, and wideawake to the road ahead, but he is not continually called upon to meet the unforeseen "emergency" with anything like the frequency or liability to disaster which confronts the tramcar driver. As Colonel Yorke said after the Highgate accident: "I am disposed to think that it is a mistake in tramway practice to regard any brake as an emergency brake and as one which is only to be used on rare occasions. In tramcar driving, the emergency is ever present." The same authority, in the same report, comments on the fact that while the engine driver has served through the various stages of shunter, fireman and goods driver, before he is allowed to drive a passenger train, the driver of the tramcar has frequently very little valuable experience behind him; and this represents a large part of the problem, the "human element" to be accounted for. Perfect as a brake may be, it serves little purpose if, when an emergency arises, the driver loses control through lack of familiarity with his brake.

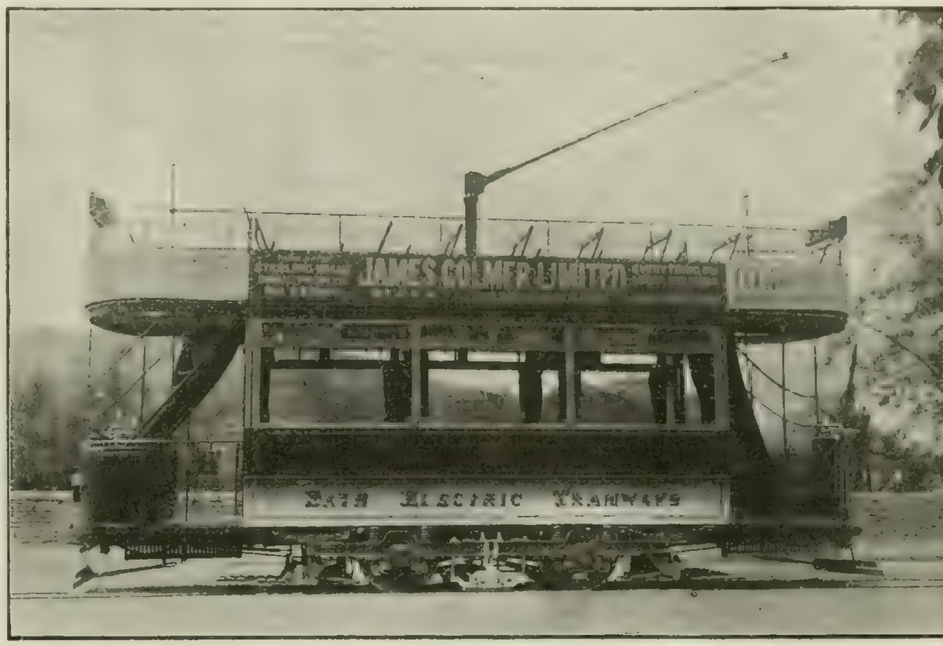


Fig. 2.—Tramcar fitted with "Mechanical Attachment."

Many efforts have to be made to increase the confidence of the tramcar driver in his brake: to get him to realise exactly what his brake can do, and to feel so sure of its action that nothing unexpected can make him flurried. The "mechanical attachment" fitted to the Westinghouse magnetic brake is a distinct advance towards the solution of this problem. This device is not an emergency brake, but is supplementary to the magnetic brake. Used in conjunction with the magnetic brake, it is of great value for coasting down hills, for, should the magnetic brake unexpectedly fail, the driver is given confidence by knowing that the mechanical attachment will keep his car well within safe limits of speed, or will enable him to stop it promptly and hold it stationary on the steepest gradient.

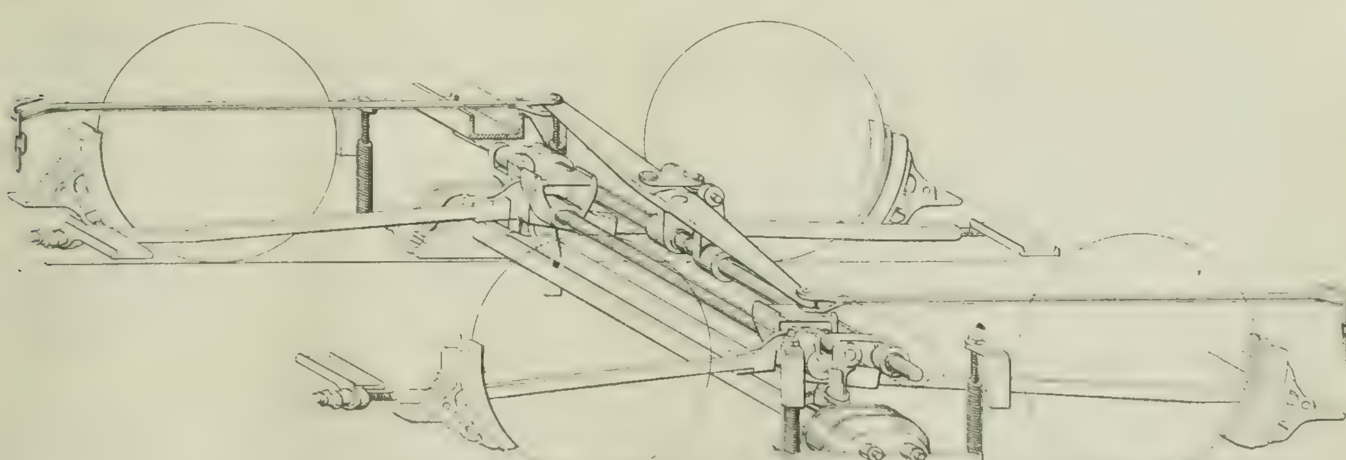


Fig. 1.—The Mechanical Attachment to the Westinghouse Magnetic Brake.

The device is of simple construction, and is easy of inspection, as the accompanying illustrations will show. On each platform of the car a handwheel is mounted on a standard, and, if necessary, the brake can be applied by means of the mechanical attachment by the driver and conductor simultaneously. The action is simple, the track magnets being depressed on to the rails, by means of pull rods and levers, and producing by means of the resultant drag on the rails, a pressure between the brake blocks and the wheels which is pro-

portional to the force applied at the rim of the handwheel. The mechanical attachment does not necessitate any additional gear on the platform, for the handwheel is attached to a hollow spindle working on the existing hand-brake spindle, similar to that employed for operating the ordinary slipper brake. The correct vertical pressure upon each track magnet is obtained by means of a divided crank shaft attached to the floating lever, and provided with suitable equalising means.

It will thus be seen that the mechanical attachment operates the brake not only as a track brake but as a combined track and wheel brake, and does not in any way interfere with the magnetic brake operating as a combined track and wheel brake in the usual way. When used for coasting on long gradients it has the advantage of relieving the motors from generating current for energising the track magnets.

Before submitting the device to the Board of Trade, the tramways department of the British Westinghouse Co. thoroughly tested the effectiveness of the attachment, and experiments showed that a 10-ton double-deck, single-truck car, running free at 20 miles per hour, down a gradient of 1 in 16, could be promptly brought to rest by means of the mechanical attachment alone. Thus, since it appeared to be a valuable supplement to the magnetic brake, the device was submitted to the Board of Trade. The Bath Electric Tramways Co. kindly allowed experiments to be conducted on their cars, and so satisfactory have these trials been that the Board of Trade have approved the "mechanical attachment" with favourable comment and authorised its use in regular service.

Fig. 1 shows the arrangement of the "mechanical attachment," whilst Fig. 2 illustrates it as fitted to a car on the Bath tramways.

THE RUBBER EXHIBITION.

The first European exhibition devoted solely to the production and use of rubber was opened on Monday last by Sir Henry A. Blake, G.C.M.G., president of the International and Allied Trades Exhibition. Sir Henry, we may remark, was the president of the first rubber exhibition held in the world—at Ceylon, 1906. In his opening address he drew attention to the important position assumed by rubber as the basis of many of the world's industries also to its beneficial influences in many branches of civilisation. As an insulator for ocean cables it played its most important part in making for peace among nations by instituting a rapid intercommunication service.

The exhibition is mainly centred around the growth and production of rubber, and those countries in which this valuable material is found are the chief participants in the exhibition. The sections of the exhibits given in the official catalogue include Ceylon, Netherlands, Brazil, Mexico, West Indies and British West Indies. There are also loan and commercial sections. The raw rubber sections are the largest in the show, particularly the spaces devoted to the products of several Brazilian States and the Netherlands. Electrical men should find an opportunity for making the acquaintance of the specimens of rubber on view. The photographs alone are an education in themselves and vividly portray the conditions under which rubber is wrested almost from the grasp of Nature.

The casual visitor cannot fail to be struck with the impure appearance of the specimens of rubber shown on the various stands. Many of these are in the form of huge balls and some of them have been cut open. The appearance of the interior is, if anything, less encouraging, from a commercial point of view, than the exterior. An interesting section of the exhibition is one in which native houses are shown and also the form of buildings which must be adopted by Europeans in the swampy and marshy districts in which rubber is found.

Probably the largest commercial exhibit is that of the India Rubber, Gutta Percha & Telegraph Works Co. From an electrical point of view interest is centred in a varied collection of specimens of ebonite and ebonised articles. These range from telephone mouth-pieces to heavy insulated bolts for switchboard and other electrical work. Spanners, flyers and other tools are also shown with ebonite covered handles, and there is a goodly collection of ebonite boxes for batteries, instruments, &c. A good example of rather complicated ebonite is a large hand pump for blowing the dust from instruments and apparatus charged at a high potential. There is a case of sections of indiarubber and gutta-percha insulated cables, which will doubtless be inspected with interest. The floor of the stand is covered with a specially treated indiarubber matting, which has been designed to resemble mosaic tiles. The appearance of this floor covering is undoubtedly good and an excellent imitation of actual tiles. The soft resilient tread, of course, immediately undeceives the visitor who steps within the enclosure of the stand. We understand that the material is quite durable and can be arranged to suit any scheme of decoration. The long association of this company with the rubber industry and the fact that it pioneered the introduction of indiarubber-covered cables in this country will doubtless increase the interest of electrical engineers in the exhibit.

The machinery section of the exhibition contains examples of the latest forms of rubber-working machinery. Messrs. Francis Shaw & Co., of Manchester, exhibit washing and crêpeing machines, a Scot vacuum drying stove, and various types of hydraulic processes for blocking and sheeting work. There is also a waste rubber grinding machine driven by an electric motor through double helical machine-cut wheels. An emergency switch is fitted above the rollers, so that in case of accident the machine can be stopped by the pressure of a push button. Messrs. David Bridge & Co., of Castleton, Manchester, show an electrically-driven washing and sheeting machine with grooved rollers, which can be disconnected from the motor by one of Heywood & Bridge's friction switches. The details of this last-mentioned device are also shown on the stand. This firm make a speciality of rubber-working machinery, and, we understand, are in a position to equip complete works throughout for the treatment of this material. Messrs. Tangyes have a number of their well-known suction gas and oil engines running on a stand driving various machines by "Teon" belting supplied by Messrs. Fleming, Birkby & Goodall, who have also an exhibit on the same stand. Messrs. Bergtheil & Young have two of their well-known "Bandy" electric punkaps in operation at the end of this stand, and they appear to be attracting considerable attention. Seeing that they are intended principally for extremely hot climates, and that the bulk of the world's product of rubber is drawn from tropical zones, a fan of this kind should be in great demand.

THE FIRE ON THE CITY & SOUTH LONDON RAILWAY.

The report of Lieut.-Col. H. A. Yorke and Mr. A. P. Trotter to the Board of Trade on the fire that occurred, on July 16th, on the City & South London Railway about 40 yds. south of Moorgate-street Station, was issued yesterday.

The inspectors are unable to say with certainty what was the actual origin of the fire, but it would appear that leakage of electric current has been known to occur between the power rail and the running rails, due to an accumulation of iron and carbon dust on the sleepers and insulators, the leakage being sufficient to set this dust and the upper surface of the sleepers on fire. Although this is a possible cause of the fire, another theory is that sparks from the shoes of a locomotive caused the ignition of the dust.

Having regard to the considerable time which elapsed between the discovery of the fire and any signs of electric arc on the spot, or opening of circuit-breakers at the works, it seems probable that the fire did not originate from any defect in the insulation or in the continuity of the electric cables, but began with a smouldering which may have developed into flames by the draught of passing trains.

Although permanent way men walk through the tunnels every night clearing away rubbish, the tunnels are extremely dirty, and some of the dirt is of a dangerous character—namely, that which consists of iron dust and carbon dust, the former from the brake shoes, wheels and rails, the latter from the carbon brushes of the motors. In addition to this there is in some places a good deal of oil drippings. The insulators are said to be cleaned once in three or four months. This dust is inflammable. The coating of dust on a wire will burn with a smouldering glow, if ignited, and will, if fanned, say by the draught of a passing train, burst into flames. The sides of the tunnels and the wires carried along them are covered with it. When dust accumulates on an insulator it sometimes forms a path for an electric leak, which ignites it, and this may set fire to a sleeper. Such small fires have been experienced. When a driver sees one, he informs the station-master of the next station, who telephones back, and the driver of another train being warned, stops and extinguishes it with a brush. Pieces of waste have also been found on fire. Each locomotive carries a bucket of sand and a 10 gallon tank of water which is connected with the compressed air tank, enabling a jet to be thrown.

Had the space in the invert below the cross-over, 20 ft. by 64 ft. long, and 8 ft. deep at the middle, been filled in and made flush with the sleepers, it seems likely that the fire, confined to the surface, could have been extinguished by sand.

The original accounts of the event were much exaggerated. It is satisfactory to be able to report that at no time were any passengers in danger. All the witnesses, including the lift attendants and the platform ticket collector, state that the passengers left the platform quietly. Four lift journeys were made, one of the three lifts making two journeys; some passengers left by the stairs.

With a view of reducing the risk of fire, and also smoke, the following seven recommendations are made:

(1) Considerably greater attention should be given to cleanliness; dust should be more carefully removed. (2) A liberal use of white-wash would enable any accumulation of dust to be detected. (3) The filling up of the inverts, particularly of the large tunnels, should be carried out. (4) No electric wires or cables should be carried below or between the sleepers, but should be neatly arranged along the sides of the tunnels, and all crossing of cables should be overhead. (5) The

use of wood should be eliminated as far as possible, and the planking and the wooden platforms should be replaced by slate or granolithic slabs. (6) On discovery of a fire all traffic should be stopped in that section until the fire is completely extinguished. (7) Prompt notice should be given to the Fire Brigade.

The requirements of the Board of Trade in regard to stations, permanent way and equipment of underground electric railways accompany the Report.

MANCHESTER EXHIBITION.

On Tuesday we visited Manchester, and found that great progress had been made, and everything points to a degree of readiness at the opening on the 3rd prox. not usual with industrial shows of this character. The main structure is complete, and a large number of the stands are already finished. The distributing station of Manchester Corporation, which will be an attractive feature of the Exhibition, is approaching completion, and there is every evidence that the building and its adjuncts will be ready for the opening ceremony. There is always an element of delay in undertakings of this kind, due usually to the dilatoriness of exhibitors in sending their exhibits. The management ask for the co-operation of the trade in a supreme endeavour to obviate any trouble of this kind.

LEGAL INTELLIGENCE.

Electrical Instrument Manufacturers (Ltd.).—Winding-up Petition.—On the petition of W. J. and A. E. Berrill, advertising agents, an order was made on Monday by the County Court Judge at Edmonton for the compulsory winding up of this company, which was incorporated in October, 1905, with a nominal capital of £5,000, the amount credited as paid up being £2,007. The office of the company was at Freezywater, Waltham Cross, and it was stated that the company accepted a two months' bill (drawn by petitioners) for £42. 2s. 9d., but the bill was dishonoured, and judgment had been entered for £42. 11s. 4d. and £7. 10s. costs. Execution was issued but was not satisfied.

His Honour: There seem no assets to distribute.

Counsel said it was not the practice to go into the question of assets on a petition. There was, however, a substantial amount of machinery. While these proceedings were pending one of the directors bought up the debentures, and had since applied for a receiver and manager to be appointed. The machinery cost £2,000 and the debentures were only for £250.

MUNICIPAL, FOREIGN & GENERAL NOTES.

APPOINTMENTS VACANT AND FILLED.

Liverpool Education committee require a head master for the Preparatory Trades Day School, to act also as superintendent of Evening Technical Classes. Salary £250 to £300 per annum. Applications, with references, &c., to the Director of Technical Education, Central Technical School, Byrom-street, Liverpool, by noon Oct. 2. See also an advertisement.

A senior science master, to teach applied mathematics, physics, and chemistry, is required by Sheffield Education committee. Salary £140 or £150, rising to £200. Applications by Sept. 21.

EDUCATIONAL NOTICES.

Armstrong College (Newcastle-on-Tyne).—The session 1908-9 will commence on Sept. 28. There are complete courses of instruction in mechanical, civil, electrical and marine engineering, naval architecture, mining, metallurgy, &c. Particulars from the secretary (Mr. F. H. Pruen).

Battersea Polytechnic (London), S.W.—At this polytechnic there are day and evening courses of instruction. The day courses include preparation for the B.Sc. in engineering of the University of London and the polytechnic diploma in (*a*) mechanical, (*b*) electrical and (*c*) civil engineering. The evening classes include preparation for the B.Sc. in engineering, associateship examination of the I.C.E., &c. Prospectus on application to the Secretary.

Sir John Cass Technical Institute, London.—There are evening classes in chemistry, metallurgy, physics and mathematics, designed to meet the requirements of those engaged in the chemical, metallurgical and electrical industries and in trades associated therewith. Facilities are also given for special and advanced practical work in well-equipped laboratories both in the afternoon and evening. The classes in general physics and mathematics are arranged so as to prepare for the final B.Sc. examination of London University, and there are special courses of general physics and electricity and magnetism for the Honours B.Sc. on conduction in gases and radio-activity and on the differential and integral calculus for science students. The new session begins Sept. 21. Details of classes may be obtained at the Institute, Jewry-street, Aldgate, E.C., or by letter from the Principal, Mr. C. A. Keane, B.Sc., Ph.D., F.I.C.

Hackney Technical Institute, London, N.E.—The next session commences on Sept. 21. There will be evening lecture and laboratory courses in electrical engineering subjects, including electrical measurements, dynamos and motors, alternating currents, electrical design, &c. Prospectuses from the Principal.

Northampton Polytechnic Institute (London).—The full day courses in the theory and practice of mechanical and electrical engineering, &c., will commence on Monday, Oct. 5. Entrance examination on Sept. 30 and Oct. 1. The courses include periods spent in commercial workshops and extend over four years; they also prepare for the degree of B.Sc. in Engineering at the University of London. Three entrance scholarships of the value of £52 each will be offered for competition at the entrance examinations in September. In the technical optics department there are full and part time day courses. There are also evening courses in electrical and mechanical engineering, technical optics and artistic crafts, horology, technical chemistry and domestic economy. The classes of the day courses commence on Oct. 5, and those of the evening courses on Sept. 28. Enrolments for the latter commence on 14th inst. Full particulars as to fees, &c., can be obtained at the Institute or on application to the Principal, Dr. R. Mullineux Walmsley.

King's College (London).—The session 1908 9 commences on Sept. 30. In addition to the ordinary day courses in the faculty of engineering and applied science, there are evening classes in mechanical and electrical engineering, architecture and building construction, drawing mathematics, physics and other science subjects. There is a large staff of lecturers and demonstrators, and prospectuses, &c., from the secretary, Mr. Walter Smith, Strand, W.C.

University College, Bristol.—In the engineering department o this college there are courses for civil, mechanical, mining and electrical engineers and surveyors. Special facilities are offered in the way of college and engineering works scholarships. A diploma is awarded to students who pass the qualifying examinations and the associateship of the college is conferred on students who obtain a first-class senior diploma. The Institution of Civil Engineers accepts the preliminary certificate of the college in lieu of its entrance examination. Prospectuses, &c., from the registrar and secretary, Mr. Jas. Rafter.

Heriot-Watt Technical College.—On Wednesday Lord Rosebery formally opened the new engineering laboratories and workshops of this college, which have been erected and equipped at a cost of £12 000.

After referring to the history of the college, which was founded in 1821, Lord Rosebery said that most of them knew how large was the number of trained specialists employed by German commercial firms. They dealt with new inventions, they adapted and developed them to the purposes of their business, and he understood that firms in Germany combined to keep a staff of these specialists, sharing the results of their labours and sharing also in the cost of their support. They heard a great deal of the encroachment of Germany as regarded our own trade, but it might be worth while to inquire whether the employment of these specialists had not something to do with the advantages that Germany had in commerce, and whether it would not be worth while to utilise still more the services of such men. He could wish that the technical institutes in our great university towns would each specialise one side of their teaching to the extent that it would not be necessary to repeat it in other university towns, but that it would be carried to the highest pitch in each institute, being recognised by the other local universities as regards the acceptance of their students in these special branches.

Borough Polytechnic Institute (London).—At this institute a three years' course in electrical engineering is given, and there are also special courses in electric wiring instruction and design of electrical appliances and workshop fittings, advanced electricity and magnetism, &c. Classes commence on 28th inst. Prospectuses, which contain further particulars and a detailed syllabus of each course, from the Principal, Mr. C. T. Millis, 103, Borough-road, London, S.E.

L.C.C. School of Photo Engraving and Lithography.—A series of lectures has been arranged to be given by various specialists at this school on Wednesday and Thursday evenings (from Oct. 1 to April 1), at 8 p.m., upon subjects of interest to those engaged in any of the crafts concerned, with illustration, &c. Admission free, by ticket from the school, 6, Bolt-court, Fleet-street, E.C.

Argentina.—A report from Mr. Consul A. C. Ross on the trade of Buenos Ayres for 1907 states that the Argentine Grain Elevators (Ltd.), a British company, working in conjunction with the Buenos Ayres Cereal Association, has secured the right to erect 32 elevators

in the province, and 10 of these are to be erected within one year. A British firm (unnamed) has, it is stated, secured the contracts for the construction of these elevators.

At Bahia Blanca the new mole for the Great Southern Railway is completing. Two extensive grain elevators will form a portion of the equipment, and these will be worked entirely by electricity. The elevators are 185 ft. long by 88 ft. wide, and are provided with telescopic shoots, seven on each side of each elevator, which have together a capacity of 1,500 tons per hour, equal to 750 tons on each side.

At La Plata British capital is said to be awaiting the sanction of the law for converting the local horse tramways to electric traction.

Assessment Appeal.—The annual court for hearing appeals from the valuation of the assessor was held in Brechin on Monday, when the North of Scotland Electric Light and Power Co. appealed against the decision of the assessor raising the valuation of their works to £660, and asking that it be fixed at the same sum as last year (£200).

Mr. MIDDLETON appeared for the company, and objected to the method adopted by the assessor in fixing the valuation on a capital basis. The true method of reaching the valuation should have been a revenue basis, in keeping with the practice laid down in the superior Courts. The company had a number of other stations, and he submitted the capital cost and the valuations at which they had been fixed. At Montrose the capital outlay was £40,000 and the annual value £220; at Brechin the capital expenditure had been £34,000, and last year the value was £200; while at Inverness, which was only recently started on a capital expenditure of £29,000, their valuation was fixed at £225; but in Inverness the revenue returns were larger than in Brechin.

The President (Provost GUTHRIE) said it appeared that the point at issue was whether they were to proceed on the contractors' basis or on revenue.

The Assessor (Mr. CARNEGY) said he based his valuation on the decision given in the Bo'ness case in March last. At Brechin the valuation had been fixed on an arbitrary basis of £300. In the following year the company suggested £100, and it was agreed to enter it at £150. In 1903-04 it was raised to £200, and it had since stood at that figure. In the Bo'ness case, which was similar to the present one, the County Committee of Linlithgow had fixed the valuation on the basis of the capital cost at 3 per cent., and the Court of Session had upheld that decision. He had followed the same principle in the present instance. The total capital outlay (including the provisional order) had been £24,208, and at 3 per cent. that gave an annual value of £726, and he had knocked off £66, as there were always certain depreciations in new works. This valuation he had allocated as follows: Station £360, cables £300. The revenue method was generally adopted, but in the present case it would not be a fair one.

Mr. MIDDLETON said there was no official report of the case quoted by Mr. Carnegy, and there were peculiar circumstances connected with it which did not apply here. In the Hawick and Coatbridge cases, on which he relied, the circumstances were practically the same. He was prepared to submit figures to show that on the revenue basis £200 was sufficient.

Mr. CARNEGY said that whenever they could get a reasonable valuation on a revenue basis he would be prepared to accept it. If the Court desired to depart from the contractors' basis they could fix an arbitrary sum.

Provost GUTHRIE, in giving the decision of the Court, said they had agreed to fix the valuation at £400, without adopting any basis.

Mr. MIDDLETON gave notice of appeal.

Audit of Electric Lighting Accounts.—Bermondsey Council make further protest against the attitude of the Board of Trade in regard to the audit of electricity supply companies accounts. Other metropolitan boroughs are asked to co-operate.

Australasia.—The "Australian Mining Standard" says: "The report of Mr. W. G. T. Goodman, engineer to the *Adelaide* Municipal Tramways Trust, states that the construction of the track work was commenced by the contractors (Messrs. Smith & Timms) on May 21, and that the contract for the overhead equipment has been let to the British Insulated & Helsby Cables, who will no doubt carry it out in a first-class manner. It is expected that the North Adelaide line will be open by the end of 1908."

The A. E. G. Ilgner electric winder installed in the *Mount Lyell* mines early in the year has proved so satisfactory that the Mount Lyell Co. recently placed an order for an electric compressor with a capacity of 2,000 cubic ft. of free air per minute, and a final pressure of 90 lb. per square inch, the contractors being Thompson & Co., of Castlemaine, Victoria. The compressor will be driven by an A. E. G. 350 H.P. three-phase induction motor, with liquid starter, and a switchboard will also be supplied by the A. E. G. through their Melbourne agents (Stoecker & Fischer). In the same mines four Pearn treble ram electric pumps, each of 6,000 gallons per hour capacity, and driven by three-phase slip-ring 25 H.P. induction motors, are to be installed. The A. E. G. special three-core shaft cable, designed to withstand the action of the water in the mine, which contains copper in solution, is to be used.

A proposal that *Rolla* Shire Council shall raise a loan of £5,000 for establishing electricity works at Sunbury (Victoria) is under consideration, and the Victorian Government have offered to take current for the local Hospital for the Insane, on a seven years' agreement, at 7d. per unit for lighting and 3d. for power, with a minimum payment of £450 per annum, and to give the Shire Council the use of a site for a generating station rent free.

Footscray (Victoria) Council have decided to erect electricity works and to float a loan of about £19,000 for the purpose.

There is a difference of expert opinion as to the cause of an alleged "electrical fire" in *Melbourne*. Mr. W. Stock, electrical engineer to the Metropolitan Fire Brigade, believes the fire (which occurred on July 31 at Broken Hill-chambers) began at the bottom of a lift shaft, but Mr. H. R. Harper (city electrical engineer) is of opinion that it began at the top. Mr. Harper says that Mr. Stock's theory was based on the fact that a fuse at the bottom of the shaft was destroyed and its porcelain cover broken, but Mr. Harper, who thinks this was the effect and not the cause of the fire, says it is more likely that the fire started in the roof, that lighted wood fell upon and ignited rubbish in the lift cage and that the fuse went because the casing was burnt off the wires, causing them to short-circuit.

Austro-Hungarian Exports.—The value of electrical machinery and apparatus exported from Austria-Hungary to the United Kingdom in 1907 was £50,086, compared with £70,261 in 1906.

Belfast.—A draft agreement between the Corporation and the Cavehill and Whitewell Tramway Co. has been prepared providing for mutual running powers.

Birmingham.—The Council have referred to the Tramways committee two memorials in favour of extensions of the tramways into the Bordesley Green and Yardley-road districts.

Burslem.—An inquiry was held here last week into the Council's application for sanction to borrow £12,000 for extensions of the electricity undertaking. The electrical engineer (Mr. Ashton Bremner) gave technical evidence of the proposed extensions, the present financial position, the charges for current for power and lighting, &c.

Bury (Lancs.)—An inquiry was opened on Wednesday into the application of the Council for sanction to borrow £72,000 for the erection of a new generating station at Chamber Hall, for the extension of the mains, &c.

Canal and River Haulage Scheme for the Rhone Valley.—A scheme has been mooted in connection with the navigation of the River Rhone (France) for the construction of a system of overhead electric traction for boat haulage up and down this swift and powerful river. It is pointed out that there is a drawback to the system already in vogue on the Teltow Canal, near Berlin, owing to the liability of the trolley to be jerked free of the live wire by the sudden movements of the boat, but the British consul at Lyons (Mr. E. Vicars) states that two French engineers claim to have devised a means of overcoming this difficulty by interposing a sort of "vedette" between the vessel and the trolley, so that no oscillations or violent movements of the boat can reach the trolley, but are neutralised by the intervening "vedette." The electric energy used for traction will also be utilised to light the waterway so as to permit of navigation by night. Power stations, it is suggested, should be erected in the valleys of the various tributaries of the Rhone.

The scheme of Rhône navigation, to which the above refers, will form part of the elaborate plans for the construction of irrigation canals fed by the Rhône and its tributary the Isère. Great industrial results are anticipated from this scheme of irrigation which have a direct bearing upon the general question of the utilisation of the water courses of France. The swiftness of the river Rhône renders the utilisation of its waters of particular interest in connection with the generation of electric energy. It is now 35 years since a French company secured a concession for harnessing the waters of the river at Bellegarde, and since that date a company known as the "Jonage Co." (the Compagnie des Sources Motrices du Rhone) has supplied electric power to the district equal to 12,000 H.P. per 24 hours. The immense success of this great undertaking has led to a proposal that the construction of similar works on a smaller scale should be carried out over the whole course of the river from Lyons to the sea. Mr. Vicar points out that the water power of the Alps which to-day is harnessed for use in industrial work amounts to about 300,000 H.P. The lowest estimate of the power available is 12,300,000 H.P., while M. Traverniere, the chief engineer of transports, puts it as high as 15,000,000 H.P. In the Dauphiné district of France alone the electrometallurgical and electrochemical works utilise over 100,000 H.P.

Lyons is lighted by power from the Volta works at Moutiers belonging to the Grenoble Power & Light Co., which transmits 6,000 H.P. over an area of 112 miles, while from Lyons to Valence the whole Rhone Valley is provided with electric power from stations situate in the Departments of the Savoy and Isère. Even St. Etienne and Roanne, in the Department of the Loire, will before long be using electricity generated far away on the other side of the Rhone, in the Valley of the Drac, a tributary of the Isère. If the present rate of progress be maintained, in a few years the whole of France will be supplied with hydro-electric power from a few distributing centres.

Cheaper Telephones.—At the meeting of the Association of Chambers of Commerce at Cardiff on Tuesday, the chairman of the

Telephone committee (Mr. A. J. Hobson) presented an interim report.

Mr. Hobson stated that two members of the committee (one from London, Mr. Faithful Begg, and one from Liverpool, Mr. Lancaster) were found to be shareholders of the National Telephone Co. and the chambers who had sent them were asked to nominate two other members.

Dealing with the question of cheaper telephones, and especially in regard to the report and the position of the flat rate subscriber, Mr. Hobson asked why, in the bargain that should be made between the Association of Chambers of Commerce (on behalf of the consumers) and the National Telephone Co. and the Post Office, should the flat rate subscribers voluntarily limit themselves. There were three reasons—first, efficiency of the service; second, the measured rate was the only one in the Post Office view after 1911; third, it was necessary that effort should be made to prevent a wedge being driven in between the flat rate and the measured rate subscribers. The resolutions of the committee—four in all—were then submitted. The principal resolution, so far as the general public are concerned, was No. 3: "That, in the event of the negotiations resulting in an agreement with the Postmaster-General and the National Telephone Co., and requiring the introduction of a bill into Parliament, all Chambers approach their members of Parliament asking them to support such a bill."

The Lord Mayor of Bradford (Mr. John E. Fawcett) seconded the adoption of the committee's report and the resolutions.

Mr. Faithfull Begg (London) moved an amendment disagreeing with the committee's report. He complained that London and Liverpool were now unrepresented on the committee.

Mr. Lancaster (Liverpool) seconded the amendment. He said he was asked to join the committee, and his object was to see the telephone system of the country brought to the state of efficiency that had been attained in America. Other countries after struggling with the flat rate had to abandon it, the alternative being bankruptcy. The Governments of Germany and Austria without notice changed from the flat to the measured rates because they recognised that was the only honest system of telephone charges. In this country there seemed to be a fascination about the flat rate, but they might as well attempt to sweep back the Atlantic as to endeavour to continue the flat rate system. Many subscribers in the provinces took service in excess of the £10 rate.

The amendment was withdrawn by leave, and a further amendment, moved by Mr. Lancaster, that the matter be referred to the Executive Council, with a view of deciding what further steps it was desirable to take in the matter, was defeated.

The following resolution was carried unanimously: "That representations be made by the Executive Council of this Association to the Postmaster-General that no increase of telephone rates should be sanctioned until Parliament has had an opportunity of considering same after full inquiry and investigation of the National Telephone Co.'s books and accounts by a committee to be appointed for the purpose."

In connection with the above subject correspondence, which has passed between Mr. Lancaster and the Postmaster-General, has been published. In the first letter Mr. Lancaster inquired whether a total of 10,000 outward telephone calls per annum for a subscription of £10 could be contracted for by the Government to leave (*a*) a moderate profit to the Post Office or (*b*) without loss to the Post Office.

In reply the Postmaster-General stated that in his view a subscription of £10 a year with the right to originate 10,000 calls on a telephone exchange system in Great Britain would not only not leave a profit, but would certainly involve a financial loss. Further, in his opinion a line used during ordinary business hours to originate 10,000 effective calls would be overloaded owing to the number of inward calls which would find the line engaged. At present, although the average number of calls made by subscribers on one line was much less than 10,000, about 25 per cent. of the whole number of calls made on exchange systems in the larger towns were rendered ineffective chiefly in consequence of the overloaded condition of the lines of a limited number of large users. If 10,000 calls on each line were made on a considerable proportion of the lines in use the efficiency of the service would be very seriously impaired.

Mr. Lancaster next asked the Postmaster-General whether, based upon experience, the right to originate 5,000 local calls on an exchange line in Great Britain would be reasonable, and if it would leave a moderate profit to the Post Office.

In reply the Postmaster-General stated that in the experience of the Post Office, in existing conditions, 5,000 originated calls per annum made up a full load for the telephone line of an average subscriber who received as many calls as he originated, and whose calls were not spread fairly evenly over the day, but were for the most part concentrated on the busiest hours.

Crete.—In January last (Mr. Vice-Consul W. Smith reports) the Cretan Government called for tenders for the establishment of a telephone service in the island. The only tender received was from a Cretan firm, and as it was unaccompanied by the necessary pecuniary guarantee it was not entertained.

Darwen.—An inquiry was held here last week into the application of the Council for authority to borrow £4,300 for extensions of the electric light mains, &c.

Dockyard Cranes.—Messrs. Cowans, Sheldon & Co. have erected a 75 ton electric revolving crane on the extension works at Devonport.

The crane is provided with three purchases, two with a lifting power of 40 tons each and one of 10 tons, and four motors are provided (two 50, one 25 and one 20 H.P.) for working the crane, besides a small motor mounted on the top of the crane for moving in or out the roller frame in the head over which the purchase travels when it is desired to plumb the load over a particular spot. This feature will save moving a vessel to the necessary position. The three purchases are each fitted with an electrical and a mechanical brake. A second 75 ton crane of the same type is to be erected.

Dublin.—The Corporation have instructed the City Treasurer and the City Accountant to report to Council upon the general financial position of the Corporation electricity undertaking, &c.

East Ham.—The bridge carrying the Romford road tramways over the L. T. & S. Railway at Forest Gate does not satisfy the requirements as regards to the strength of cast-iron over bridges, and, therefore, the Board of Trade have refused to grant a certificate for the running of the tramway until the bridge is strengthened. Temporary arrangements have been made with West Ham Corporation for running the new section up to the western side of the bridge, where intercommunication is effected.

Edmonton.—In future the street arc lamps are to be kept alight throughout the night.

Electricity in Mining.—Recently a 200 kw. rotary converter was erected at the Sirena Mine, Guanajuato (Mexico), which supplies direct current to the various motors in and about the mine and for operating the electric locomotives which are used to haul the ore from the mine to the mill.

Exhibitions.—A canvass has recently been made of the chief industrial and commercial interests of Lyons (France), and it is probable that an international exhibiton will be held in that city in 1910. Lyons is the centre of the silk, velvet, ribbon and some other textile industries, and the motor vehicle industry is also a large one in the district.

The Tokio (Japan) International Exhibition, to be held from April 1 to Oct. 31, 1912, will include sections for electricity, civil engineering and transport, machinery and ships, mineralogy and metallurgy, education, "science," &c.

France.—At *Calais*, in view of the forthcoming International Exhibition, which is to be opened next spring, the subject of the local tramways is one of interest to intending visitors from this side of the Channel, who will be glad to know that the electric tramways of which Calais has been so long in need are being rapidly pushed forward, and it is expected that the lines will be opened for traffic coincident with the opening of the Exhibition. It has been advised for some years that the antediluvian horse tramway service of Calais should give place to a more up-to-date service.

The report of Mr. Consul Payton recently issued refers to the above matter and contains a mass of useful information concerning this the nearest point of juncture between England and the Continent. Calais is an important industrial centre of which, despite its nearness to our shores, comparatively little is known. Within a few miles of Calais the great manufacturing centre of Lille is situated, and it is remarkable what a varied range of engineering construction is carried on in the Lille district, where competition with our own metal industries is as keen as in any part of the world. The distance between Dover and Lille is less than that between London and Manchester.

Falkirk.—The price of electricity for private lighting has been reduced from 5d. to 4d. a unit, and in the case of lamps outside shops, &c., the charge will be 3d. per unit.

Farnham.—For some time negotiations have been proceeding between the Council and Mr. G. F. Roumieu as to the use of overhead wires for electricity supply, and last week the Public Works committee advised that Mr. Roumieu's plan did not comply with the conditional consent to overhead wires given by the Council, and, therefore, and they could not approve it.

An amendment, to refer the matter back, with power to invite Mr. Roumieu to meet the committee to discuss matters, was, however, carried.

Fatality.—On Monday evening Vincent Southam was killed at the Knoll Drift Pit, of the Wharncliffe Silkstone Collieries, Tankersley.

Deceased, with his father and others, were working on the night shift "ripping." Just before midnight some roof fell, bringing down the electric wires which conveyed current to the electric coal-cutting machinery and accidentally touched deceased. His father and fellow workers ran to his assistance, and found him entangled in the cable. He was at once removed, but died shortly after from the effects of shock.

Ghent Canal.—The United States Consul at Ghent states that a contract, dated Dec. 18 last, for the deepening of the harbour at Terneuzen, contained a stipulation that the new maritime lock at the Terneuzen end of the Terneuzen-Ghent canal should be opened in 300 days.

This lock is to be 459 ft. long and 17 ft. deep at low tide. It will be temporarily worked by hand power, but when completed will be operated electrically, as will all the bridges over the canal, the whole

length of which 20 miles) from Ghent to the sea, which will, in addition, be lighted by arc lamps at 490 ft. intervals. The narrowest part of the canal is 230 ft at the surface.

Gold Coast. During 1907 the telegraph line of the northern territories of the Gold Coast were extended by 148 miles (Salada to Talmak 78 miles, and Bole to Wa 70 miles). As soon as the more needed lines in Ashanti are completed, further extensions of the main telegraphic routes will be proceeded with. The value of the telegraph service in connection with the administration of the northern territories is pointed out by the Governor in his annual report for 1907, just published. With the extension of the telegraph follow in natural course the employment of the telephone, and many places in the northern territories of the Gold Coast are now in direct telephonic communication.

Harrogate.—In order to increase the demand for electric current for lighting small properties the Electric Lighting committee recommended the Council last week to adopt a fixed charge per quarter as follows:—2s. 9d. per quarter for every 30 watt lamp, subject to the amounts being paid quarterly in advance, all apartments fitted with light under this tariff to be adequately lighted by windows during daylight, the minimum number of lamps per tenement to be three; the number of applications to be limited to 20 existing customers and 20 new ones, to be taken in order of application.

Ald. CHIPPENDALE took exception to the recommendation, contending that the charges would not pay, and that it was unfair to offer advantages to a small number of customers.

The TOWN CLERK said that part of the proposal was illegal.

The borough electrical engineer (MR. GEO. WILKINSON) stated that he was certain the scheme would pay, and that the number of customers was limited at present because it was an experiment.

The recommendations were carried.

The MAYOR: The town clerk has ruled the proposal illegal, and it will be my duty to see it is not carried out.

Holyhead.—An inquiry was held here on Wednesday into the application of the Council for sanction to borrow £3,000 for electric lighting extensions.

Hospital Lighting.—Ashton-under-Lyme Guardians have decided to adopt electric lighting at the hospital, current being supplied by the Corporation at 2d. per unit.

India.—"Indian Industries and Power" states that J. Stone & Co. have secured a large contract for material for the electric lighting of carriages for the South Indian Rly. Co.

The East Indian Railway Co. have ordered from England a 600 kw. steam alternator, two Lancashire boilers, and two switchboard panels for their Lillooah carriage and wagon shops.

Japan.—An extensive hydro-electric power undertaking is approaching completion at Hakodate, the property of the Oshima Hydro Electric Power Co. Water is obtained from Lake Onuma, the total available power being 3,500 H.P. The company has already taken over the electric lighting of Hakodate, and will probably convert the present horse tramways to electric traction.

Johannesburg (South Africa).—Several extensions of the municipal electric tramways have recently been projected, including a line to Brixton which is estimated to cost £50,000. This extension is receiving influential support and will probably be sanctioned by the Council.

L.C.C. Tramways.—The differences between Fulham Borough Council and the L.C.C. as to the system of traction to be adopted on the tramways in Fulham have been settled, and the work of constructing the new tramway between Hammersmith and Putney Bridge on the overhead trolley system is to be begun at once. This will be a continuation of the Willesden to Hammersmith line, which was opened in June.

London Electric Power Bills.—Southwark Electricity committee will petition against the London Electric Supply and the London & Westminster and Kensington Electric Supply Companies Bills on the ground that if a general scheme for the co-ordination of electric supply throughout London is to be carried out, a serious injustice would be done to ratepayers in the absence of a clause making it obligatory to purchase such undertakings, as the Southwark Council's, at a fair value, before the plant is depreciated by cheap current being forced in competition.

Madeira. For many years past the question of introducing a telephone service in the lovely island of Madeira has been discussed pro and con by the Lisbon authorities. The subject is said to be again on the tapis. Electric lighting on the island has its friends and enemies and a rumour was recently current that a British company had been formed to take over the existing plant and to erect an entirely new installation, but nothing has yet been decided.

Marriages. At Glasgow on the 7th inst. Mr Robert Livingstone, of Preston, was married to Miss Margaret Boyd Thomson Mather.

On the 12th inst., at St Marylebone Parish Church (London) Mr. Chas. D. Taite, M.I.E.E., electrical engineer and manager of the Lancashire Electric Power Co., was married to Miss Eleanor Kathleen Corneille.

Mr. P. G. Petrifor, of the British L. M. Ericsson Mfg. Co., was on the 16th inst. presented by the members of the staff with a handsome marble clock upon the occasion of his marriage to Miss Gertrude West daughter of Mr. T. J. West, superintendent engineer North Midland Province, G.P.O.

Meat Curing by Electricity.—The Chicago "National Provisioner" states that a company has been formed to place on the market a process of curing meat by electricity. A model plant to demonstrate the process is being erected at Cleveland. It is said that the process does not necessitate any alteration of the method of soaking but accelerates the penetration of the meat by the salts. Bacon, for example, can be cured in two or three days instead of taking 20 days as now.

Monaco.—The "Daily Telegraph" states that the Monaco tramway system has been taken over by the Nice Littoral Tramway Co., and that important extensions of the system are being carried out.

This year express trams de luxe will run between Nice and Mentone, stopping en route at Beaulieu and Monte Carlo. On the west side of Nice the tramway is being extended from Cagnes to Antibes, where it joins the line running to Cannes. The latter has now been extended to La Napoule, about 5 km. beyond Cannes. It will thus be possible to travel from La Napoule to the Italian frontier by tramway, a distance of 50 miles. The line runs by the seashore nearly all the way, passing through scenery as beautiful as it is varied. On the Italian side tramway extension work is also being pushed forward. Branch lines are in course of construction, connecting the coast with all the principal inland towns; for instance, Cannes to Grasse, Cagnes to Vence, Nice to Luceram, Mentone to Sospel, and Ventimille to Vievola. These branch lines, which, however, will not be opened this season, will connect at the further terminus with the new Nice-Coni-Turin Railway, now being built, and will thus enormously facilitate the traffic between the Riviera and Northern Italy. The natural result of this tramway extension will be the rapid development of the many villages on the mountain roads into summer and even winter resorts.

Motor Drive in the Silk Industry.—The use of small motors in home workshops has for some years past been an important factor in the industrial life of Lyons (France) and adjacent manufacturing centres. In the same district unceasing efforts have been continuously made to keep the silk weavers who work at their homes in a small way within the walls of the city.

The method of conducting the silk weaving industry in this the chief centre of the world's silk trade is peculiar. The master weaver, who is in direct contact with the merchant and the master manufacturer of made up silk goods, himself does no actual weaving, but prepares the raw material and employs persons at their own homes chiefly to weave the material into the silks for which the Lyons district is very famous. The decline in the demand for the more luxurious and heavy silk goods has led to an extension of this decentralisation of the hand loom worker, and has introduced the small power loom in the manufacture of the lighter classes of goods, and this has for some time threatened the hand loom workers, and has moreover greatly extended the area over which the silk weaving on small power looms is conducted. To prevent the exodus of the workers from Lyons into the country districts around machinery was introduced and experimental workshops established, money was advanced to the motor weavers at low rates per interest, and experiments with the gas motor were started. This motor, however, proved to be costly and malodorous, and the owners of houses and small workshop property were unwilling to allow the gas motor to be set up on their property. As far back as 1895 the introduction of the electric motor began, and power was taken from the factories in the neighbourhood. Later this desultory method of obtaining power was obviated, and arrangements were made with the "Jonage" Company (Compagnie des Sources Motrices du Rhône) to supply electric power at a cheap rate. Success immediately followed, and by 1900 600 power looms driven electrically had been put in. So great was this success that a money-lending Society, under efficient control, concentrating other societies of the kind in the district, has been formed, and the latest development is an attempt to overcome the opposition of the landlords to the erection of machinery in their houses by the construction of special buildings for the home weaver where he can utilise the most suitable form of electric motor adapted to the most up to date form of power loom. There are in Lyons at the present time between 3,000 and 4,000 hand looms and about 7,000 power looms. In the country round Lyons there are about 36,000 hand looms and about the same number of power looms. The object now is to convert the great majority of these hand looms to the electrical drive.

At St Etienne, the centre of the French ribbon industry, the same problem presents itself. The gas motor was tried and failed, and as far back as 1891 the Loire Electrical Co came to the rescue with cheap electric power with the most gratifying results. It is regarded as settled that the extended use of electric power in silk weaving and ribbon making gives what is called the "home workshop" and the "demi usine" or small workshop a new lease of life, and has retarded that intense concentration of industrial operations which in France

finds little favour. Unfortunately, both the above industries are at the present time in a depressed condition.

National Telephone Staff.—Early in the week publicity was given to a statement by the National Society of Telephone Employes that there were at present heavy discharges of men employed by the National Telephone Co. as a result of the transfer to the State in 1911 of the company's plant and service.

It was stated that the company, owing to its life being limited to three years, would not expend capital upon which it could not see the return of the outlay and a margin of profit by the end of that period. Orders for telephones were (it was alleged) being refused by the hundred, and men who should be employed in the construction of lines were thrown idle, to swell the already overcrowded labour market. Already the number of men discharged, it was said, approached 1,000, and it was stated that 6,000 men would be discharged prior to 1911. The society argued that the remedy for the serious state of affairs which had arisen lay with the Government, who could either take into their employ the men discharged by the company, and construct the lines which the company were daily refusing, or they could, by financial assistance, keep going the constructional works which would be carried out by the National Telephone Co. but for its transfer to the State, and thus give employment to the men who were now being discharged.

An authoritative statement by the president of the National Telephone Co. (Mr. George Franklin) was published on Tuesday. Mr. Franklin admitted that it was true that there must be some limitation of expenditure in the closing years of the company's business, because the company could not go on spending capital which could not be productive within the period of the licence, and for which they might only receive a depreciated value. That was really the basis of the whole question. He doubted the statement that the discharges already approached 1,000. There had been discharges ; and, of course, there must be more as time goes on. The company, with all the willingness in the world, could not go on employing labour if they could not make anything productive out of it. The total number of employés affected before 1911 might approach between 5,000 and 6,000. He denied the statement that orders were being refused by the hundred. "We are," said Mr. Franklin, "undertaking all the orders we can. At present, as a matter of fact, we have a smaller number of unexecuted orders on our books than for many years past. That may be due to bad trade. The company are not in any way ceasing to give people who desire it a telephone service. What we are ceasing to do is to provide capital that will not be productive. The company were ready to do anything that was possible to meet the case. All that was required was that they should be satisfied that any money spent on behalf of the period subsequent to 1911 should be recouped to the company without loss. It would be a great advantage, he thought, to the Government if some method could be found, and probably some method might be found. The company had had to adopt this policy, but would welcome some way by which the control of the expenditure should be exercised by the Post Office and the company be recouped their expenditure.

The Post Office authorities deny that the number of dismissals is more than usual at the end of construction work. It is also stated that the Postal Telegraph Department is prepared to take over all employés who have been in the service of the National Telephone Co. for two years before Dec. 31, 1911. Moreover, it is finding employment now for temporary men who have been discharged.

Neath Cable Contract Dispute.—At the Council offices on Tuesday Mr. D. M. Davies, resident electrical engineer, and Mr. H, T. Sully, consulting engineer, sat as arbitrators in connection with a claim for the payment of £106. 17s. 6d. by the contractors for the laying of electric cables for the Council. Mr. E. Powell appeared for the Council, and Mr. J. L. Watts for the contractors. In the event of the arbitrators failing to agree, the matter will be referred to Mr. D. M. Jenkins, the borough engineer, who has been appointed umpire.

New Book.—Messrs. Cassell & Co. are issuing on Sept. 24 an entirely new technical serial entitled "Electrical Engineering," by Mr. Harold H. Simmons, A.M.I.E.E. While the treatment is elementary, the scope of the work is wide, reference being made to all the important applications with indication of the technical difficulties and their solution.

New Orleans.—The whole of the street railways in Pensacola have now been converted to electric traction on the overhead system.

Newquay (Cornwall).—The electricity works of the Newquay Electric Light Co., were inaugurated on Tuesday. At present current is supplied for public and private lighting in the Pentire estate. For public lighting there are 28 lights of 64 c.p. each.

Personal.—Mr. A. C. Ellis, general manager of the Metropolitan Railway Co., has resigned, and will retire in the early part of next year. Mr. Robert H. Selbie, secretary to the company, has been appointed to the vacancy.

Russia.—As Moscow Municipality had not the necessary funds for completing the conversion of the tramway system from horse to electric traction outside contractors were invited to tender, with the result that a preliminary contract was secured by a British firm. Later, the Municipality, it is announced, were able to raise the necessary capital by means of a loan floated by a British banking house, and the conversion of the tramway system and the construction of tramway extensions will be carried out by the Municipality, the firm of contractors to whom the contract fell receiving orders for cables, power-house machinery equipment, &c.

The telephone service of Moscow is a monopoly of a Swedish-Danish-Russian company which about eight years ago had some 500 subscribers, at the present time there are 25,000 subscribers, and the company are engaged in extending the service and providing exchanges to accommodate 50,000 subscribers. The rate of subscription at Moscow is as under:—private lines 71 roubles (£7. 10s.) per annum, public service £11 (within a 2-verst radius), beyond this distance the charges increase.

St. Helena.—The annual report of the Governor states that owing to the parlous state of the Colony's finances it was found necessary at the end of January to abolish the limited and inexpensive telephone system maintained by the Colonial Government since Nov. 1, 1906, to the great inconvenience of the community of the island. In this difficulty a few of the principal residents and officials, including the Eastern Telegraph Co.'s mess, arranged to maintain a small service, and the War Office handed over free of charge all stores other than instruments, which were loaned. There are two public stations maintained under this arrangement.

St. Pancras (London).—A joint committee which has been negotiating with the L.C.C. in regard to the electrification of the tramways from Euston-road to Holloway has approved the plans conditional upon wood paving being retained in the tramway tracks of Hampstead-road and High-street, Camden Town.

Sidmouth.—Mr. J. A. Purves, consulting engineer, is endeavouring to organise a local company to establish electricity works in this town. At a meeting of the Council last week Mr. Purves explained his proposals, and there was a general disposition to favour the scheme.

The liquidator (Mr. S. Cole) presided at a meeting of the Gratze Patents & Engineering Synd. (Ltd.) on Monday and stated that the company was formed in 1904 with an authorised capital of £10,000 to manufacture certain inventions of Mr. Gratze.

The company had not made a profit and the directors had decided that it was better to wind up. The assets had been valued at £1,353, provided the business was sold as a going concern. He was negotiating, and if he got his price he hoped creditors would get 12s. or 13s. in the £.

Smethwick.—The Council have consented to the transfer of the electric lighting order from the Birmingham and Midland Tramways to the Shropshire, Worcestershire and Staffordshire Electric Power Co., on the tramway company agreeing to pay £300 towards the cost of laying a new main.

Soothill Nether.—The Yorkshire Electric Power Co. have given an estimate to the Council for the electric lighting of three leading thoroughfares in the district.

Stoke-on-Trent.—An inquiry was held on Tuesday into the application of the Corporation for permission to borrow £15,365 for the electricity undertaking.

The town clerk (Mr. J. B. Ashwell) explained that in October last the Council applied for sanction to a loan of £9,400 to give a supply of electricity to Fenton, and in January application was made to borrow a further £5,965 for additional generating plant. As the inquiry had been postponed from time to time, the plant had been ordered and was now in course of erection.

A doubt was expressed by the inspector (Mr. H. R. Hooper) as to the wisdom of proceeding at once with the Fenton extension, in view of the projected federation of the Potteries towns, but the consulting engineer (Mr. John F. C. Snell) said that Fenton wanted a supply at once, and he saw no reason why the Fenton scheme should not be utilised in a scheme of concentration. He thought the time was not ripe for a concentration of steam plant, and that for some years to come at least the present steam stations would have to be continued. He thought a high-tension transmission scheme from one central station to the existing steam stations—using the latter as sub-stations—would be best.

The Inspector having suggested that the total amount applied for should be increased to £15,830, so as to cover excess expenditure, the inquiry terminated.

Taunton.—The Council have sanctioned the purchase of an additional engine for the electricity works at a cost of £300.

Tyneside Engineering Dispute.—This long standing dispute seems in a fair way towards settlement. A mass meeting of the Amalgamated Society of Engineers was held in Newcastle on Tuesday to hear a report from the delegates who attended the conference in London last week with the engineering employers, when a provisional agreement was drawn up for ending the strike. The terms, which included acceptance of the reductions asked for by the masters, and the setting up of a joint board, were explained, and the men were advised to accept the terms. The ballot takes place today, Friday.

Turkey.—The British Consul at Constantinople states that the withdrawal of the prohibition of importation of electrical instruments has been extended to telephones.

Wednesbury.—For some time past there has been friction between the Corporation and the Midland Electric Corpn. for Power Distribution.

For a number of years the Corporation took current in bulk from the company, but ultimately decided to generate their own current and to terminate the agreement with the company. The latter thereupon expressed intention of laying mains in the borough for retail supply, but owing to some difficulty this was not done, and now the company has served notice on the Corporation who are laying down plant that they do not propose to supply any more electricity. The preparations made by the Corporation electricity department are said to be in such a forward state that it was possible to take over the supply almost at a minute's notice without any serious hitch.

Wimbledon.—An inquiry was held here on Monday into the application of the Corporation to borrow £6,000 for the electricity undertaking. £1,059 was for excess expenditure and £4,941 was for the estimated requirements for mains, sub-stations, &c., until March next.

The borough electrical engineer (Mr. H. TOMLINSON LEE) said in 1906 it was estimated that for the following three years the Corporation would spend £17,887, but £18,040 had been spent in two years. The chief reason for that was that copper cost £121 per ton, instead of £86 as had been estimated.

Works Driving.—At the recent annual meeting of Steiner & Co. (Ltd.), print manufacturers, of Church, Blackburn, the managing director stated that with a view to economical and efficient working the company had incurred large capital outlay in providing electric power plant.

Electrical Trades' Football League.—This league will hold its first concert and presentation of medals on Nov. 7 at the Robertson Electric Lamp Works, Brook Green, Hammersmith. Full details will be announced later.

Outing.—The employes of the "Metalite" lamp department of the Bryant Trading Synd. had their annual outing on Saturday to Clacton-on-Sea.

Athletics.—On Saturday last eight of the employes of the Westminster Engineering Co. took part in a race between Ruislip and Hanger Hill, Ealing (10 miles).

Six of the starters finished the course, the winner (Bird) covering the distance in 1 hour 2 minutes. The time of the second (Curtis) was 1 hour 2½ minutes, and of the sixth 1 hour 16 minutes. The record time for the distance is 57 minutes.

ELECTRICITY SUPPLY AND TRAMWAY ACCOUNTS

Ayr.—The Council on Monday adopted the annual report of the burgh electrical engineer (Mr. Roland Marshall) which stated that revenue was £13,030 (decrease £110). Expenses £14,069 (increase £1,857). Net deficit £1,040 (against a surplus of £927 in previous year). There are 1,204 (1,098) consumers, with 55,774 (47,487) equivalent 8 c.p. lamps. 1,375,192 units were sold (increase 107,171).

Barrow-in-Furness.—The report of the borough electrical engineer (Mr. H. R. Burnett) and the accounts of the electricity department for the year ended March last show capital expenditure £110,872 (increase £2,027).

Revenue was £12,[illegible] against £11,[illegible], expenses £6,440 (£5,[illegible]) and gross profit [illegible] £6,453. Interest absorbed £[illegible],240 (£5,148) and sinking fund £3,[illegible] (£3,257), resulting in a deficit of £[illegible] (against £[illegible] profit last year). There are [illegible] private consumers, and the total connections are 69,749 (64,213) equivalent 8 c.p. lamps. [illegible] 121 motors connected with an aggregate horse-power of 864 (804). 1,444,631 (1,299,340) units were generated, 433,132 (415,406) supplied to private consumers for lighting and 221,830 [illegible] for power and heating, [illegible] for public lighting, [illegible] for traction. Total cost per unit were 1·474d. (1·356d.) and the average price obtained 2·806d. (2·912d.). The [illegible] load was [illegible] kw. [illegible] kw. and the load factor [illegible].

Bradford.—The tramways account for the year ended March last shows capital expenditure £[illegible] (increase £[illegible]).

Revenue was £[illegible] (against £[illegible]), expenses £167,[illegible] (£164,937) and gross profit £75,154 (£72,525). After providing for [illegible] of mortgage loans, income tax, rent of leased [illegible], sinking fund contribution, the net profit was £[illegible]. The population served was [illegible]. [illegible] passengers were carried, [illegible] car miles run [illegible] units of energy used. [illegible] per car mile. The total revenue per car mile was 10·[illegible]d. (11·0[illegible]d.) and working expenses [illegible]. The report of the general manager (Mr. C. J. Spencer) states that there was a decrease of nearly [illegible] in the cost of car repairs, although a much larger quantity of work was done, and power expenses have decreased £1,666 (or 0·75d. per car-mile), due to the introduction of meters on cars. The receipts of the parcels department have increased from £5,004 to £6,023. The report states that experience has shown that roof covers on cars earn sufficient money to warrant their adoption. 100 cars on one side of the city have been fitted with ampere-hour meters, and two cars fitted with Raworth regenerative control equipments are being tested in service. The impregnating plant for motor field coils is in operation and is proving very satisfactory, and will result in considerable saving in the upkeep of motors. The adoption of grooved trolley wire on two sections has resulted in considerable improvement in running.

Chesterfield.—The accounts of the tramways department for the year ended March last shows capital expenditure £69,722 (increase £1,263).

Total receipts were £12,155 per cent. (against £11,492), working expenses £6,799, capital charges £4,379, net profit (placed to reserve) £1,004. 2,449,961 passengers were carried (against 2,302,097 the previous year), 282,228 (275,417) car miles run and 370,237 units of electrical energy used (1·37 per mile). Total revenue per car mile was 10·34d. Working expenses (including power) 5·7813d. (5·32d.).

Greenock.—The accounts of the electricity department for the year ended June 30 shows capital expenditure £160,837 (increase £31,839).

Revenue was £22,820, working and general expenses £14,331 and gross profit £8,489. Capital charges were £8,118, leaving £371 net profit. The total balance in hand is £670. 4,236,661 (3,631,346) units were generated, 74,635 (76,530) supplied to public lamps, 735,582 (861,524) to tramways and 2,463,801 (1,743,751) to private consumers. The total maximum demand was 2,020 kw. (1,674 kw.).

Kilmarnock.—The report of the engineer and manager of the Corporation electricity supply and tramway departments (Mr. A. H. Burbidge) for the past year states that the income of the electricity department was £5,513.

Working expenses were £3,050 and gross profit £2,463. Capital charges, &c., were £2,840 and net deficit £353 (against £831 in previous year). Works costs were 1·025d. (1·17d.) per unit. It is stated that there are only three undertakings with lower works costs, and that all three receive larger sums for tramway current and pay less for rates and taxes. There are 229 (171) consumers with 19,680 (15,495) equivalent 8 c.p. lamps connected. 679,233 (569,589) units were sold. The use of forced draught apparatus and a cheaper class of coal has enabled the increased number of units to be produced at an additional working cost of only £130. A large number of metallic filament lamps have been fitted in consumers' premises during the year.

The passenger traffic receipts of the tramways department were £8,007 (against £8,245), the decrease being attributed to trade depression. Operating expenses were £6,456 (£6,2[illegible]), the increase being due to increased repairs and maintenance and higher wages bill. There was a net deficit of £1,852 due to the fact that a full year's sinking fund contribution has been debited against the tramways account for the first time, besides £610 towards the cost of obtaining the provisional order, and £250 for depreciation. 2,296,261 (2,331,277) passengers were carried and 306,170 (328,829) car miles run.

Kirkcaldy.—The annual report on the past year's working of the tramways department states that a scheme of mutual through running with the Wemyss Tramways Co. came into operation on Nov. 14 last, which obviates company and Corporation cars running close together.

The same number of car miles are to be run by the municipal cars on the Wemyss lines as are run by the company's cars on the Corporation lines. During the six months' working of this arrangement dealt with in the report the traffic receipts averaged 1d. per car mile higher than in the corresponding period of the previous year, which gives a net result of £767 to the good in the half year. It is claimed that Kirkcaldy is the only town of its size in Great Britain which has adopted with success long halfpenny stages throughout its system.

Melbourne (Victoria).—The accounts of the municipal electricity department for the year ended Feb. 29 show capital expenditure £[illegible],843 (increase £[illegible]).

Revenue was £[illegible] (against £81,190 in previous year); working expenses £42,766 (£35,660) and gross profit £49,599 (£45,529). Interest,

ELECTRICITY SUPPLY TABLES AND DATA.

sinking fund, &c., required £20,544, and of the balance £18,608 has been placed to depreciation and renewals, £5,005 transferred to capital account to recoup expenditure connected with changing over consumers' installations, £700 paid on account of loans flotation expenses and discount and £6,743 added to previous credit balance. There are 1,013 motors connected (2,847 H.P.), an increase of 392 H.P. 7,705,695 units were generated (increase 936,778), 2,977,183 sold to private consumers for lighting (increase 413,932) and 1,680,975 for power and heating (increase 457,145), the total sales, including public lighting, being 6,259,905 units (increase 947,748).

Swansea. At the annual inspection of the electricity works last week the chairman of the Electric Light committee (Councillor Sinclair) gave a sketch of the progress of the undertaking.

They started eight years ago (he said) with 96 consumers and now there were 1,216. The initial capital expenditure was £60,000, and at the close of last year it was £144,000. The revenue showed a proportionate increase. In the first year it was £4,571; last year it was £20,824. This year the committee were hoping to increase their revenue without increasing the cost. Last year the undertaking met all its financial obligations and they carried forward a net profit of over £800.

TRADE NOTES AND NOTICES.

TENDERS INVITED.

The directors of the *Metropolitan Railway Co.*, invite tenders for the supply of general stores, including electric wires and cables, electric lamps, carbons, fuses, ebonite, battery jars, zincs, &c., during twelve months ending Oct. 31, 1909. Manufacturers and others desirous of tendering should apply to the Secretary, Mr. R. H. Selbie, after the 25th inst. for forms of tender. Patterns and samples will be on view from Sept. 28 to Oct. 3, inclusive. Tenders must reach the Secretary, 32, Westbourne-terrace, London, W., not later than 10 a.m. of Monday, Oct. 5. See also an advertisement.

Tenders are invited by *Salford* Education committee for electric wiring of Halton Bank Council School, Pendleton. Specifications from the borough electrical engineer (Mr. V. A. H. M'Cowen), electricity works, Frederick-road, Pendleton. Tenders to the town clerk (Mr. L. C. Evans) by noon Oct. 5. See also an advertisement.

Tenders will be received at the office of the *Commonwealth of Australia* representative, 72, Victoria-street, Westminster, London, S.W., until noon, Oct. 19, for supply and delivery at that office of four complete sets of instruments (signalling and protecting), necessary for direct duplex cable working, for the Postmaster-General, Melbourne. Forms of tender, &c., can be obtained at the General Post Offices, Sydney, Melbourne, Adelaide, Perth, and Hobart, and at the Commonwealth office as above. Tenders (on forms supplied) to Capt. Collins, Commonwealth representative, 72, Victoria-street, Westminster, S.W. Further particulars are set out in an advertisement.

Tenders are invited for supply and erection of a power plant for the General Post Office, *Adelaide* (South Australia). Tenders, forms and specifications at the Commonwealth Office, 72, Victoria-street, London, S.W. See also an advertisement.

Tenders are invited for the supply and erection of installations for wireless telegraphy at *Launceston*, *Melbourne*, *King Island* (Bass Straits) and *Flinders Island* (Furneaux Group). Tender forms and specifications may be obtained at the Commonwealth Office, 72, Victoria-street, London, S.W. See also an advertisement.

Watford Council want tenders by noon Oct. 6 for supply and erection of 500 kw. turbo alternator, surface condenser with steam pumps, switchboard panel, economiser and high speed fan engine. Specification, &c., from the Engineer, Electricity Works, Watford.

Hull Corporation invite tenders for one year's supply of ironwork and of insulator bolts and cups for the telephone department. Tenders to the Town Clerk by 10 a.m. Sept. 23.

Ilford Council want tenders by noon Sept. 22 for supply of an overhead travelling crane for the electricity works. Forms of tender, &c., from the Clerk.

Pontypridd Council want tenders by Sept. 21 for supply of small paper-insulated and small vulcanised rubber-insulated cables. Forms of tender, &c., from the Electricity Department.

Birmingham electric supply department want tenders by Oct. 1 for 12 months' supply of coal.

Melbourne City Council invite tenders for supply of 12,696 ft. insulated copper cable. Copies of specification, conditions of contract and forms of tender from the agents for the Council (Messrs. McIlwraith, McEacharn & Co. Proprietary, Ltd.), Billiter-square-buildings, London, E.C., to whom tenders by noon Sept. 23.

The Direccion General de Obras Publicas, Madrid, will receive (until Sept. 26) offers for a concession for the construction of an electric tramway from the Plaza de Mosen Verdagner (Vallvidrera) to Torrente de Raventerola, *Barcelona*, to compete with an offer already made by Don Salvador Andreu, of Barcelona.

Offers are invited by Sept. 26 by the Direccion General de Obras Publicas to compete with an application by the Sociedad de Tranvias de *Barcelona* for a concession for an extension of their line.

The State Railway Administration, *St. Johann, Saarbrücken* (Germany) want tenders by 11:30 a.m. Sept. 28 for supply and erection of an electric turntable. Forms of tender, &c., from the State Railway Administration (Room 218), St. Johann, Saarbrücken, on payment of 5s. (not stamps).

The Finanzdeputation, *Hamburg*, want tenders by noon Sept. 25 for supply of 11 electric travelling cranes. Conditions of tender (price 15s.) from Secretariat II., Finanzdeputation, Hamburg.

The Egyptian Ministry of the Interior, *Cairo*, require tenders by noon Oct. 29 for erection and equipment of electricity supply works at Zagazig. Specifications, &c., may be seen at the Ministry of the Interior, Cairo.

Chilton (Yorks) Parish Council want tenders for an installation of incandescent electric lamps in Chilton-lane district. Specifications from the Clerk, 7, Dene Bridge, Ferryhill.

TENDERS RECEIVED AND ACCEPTED.

On the advice of their consulting engineers (Messrs. Kennedy & Jenkin), the Westminster Electric Supply Co. have placed an order for five surface condensers for their new power station in Horseferry-road with Willans & Robinson, Victoria Works, Rugby, at £7,072. 18s. 6d.

The Metropolitan Asylums Board have received 25 tenders for installing a storage battery, booster, switchboard and connections on board the training ship "Exmouth," and the tender of Johnson & Phillips at £302 has been accepted. The other tenders ranged from £304 (General Electric Co.) to £715 (S. Newton & Co.). The engineer-in-chief's estimate was £300.

Stoke Newington (London) Council have accepted the tender of the James Keith & Blackman Fan Co. for supply and fitting an electric fan and case, and air trunk for ventilating the electricity station.

The order for electric light fittings for the new Town Hall, Lancaster, has been placed with Veritys Limited by the contractors, Calvert & Heald, Lancaster.

St. Pancras (London) Council have accepted the tender of Dorman, Long & Co. for strengthening the stanchions of the old building at King's-road generating station.

Sunderland Council have accepted the tenders of Crompton & Co. and the Oliver Arc Lamp (Ltd.) for supply of arc lamp carbons.

Rochester Council have accepted the tender of W. S. Bemrose for wiring Eastgate House.

Worksop Council have accepted the tender of Elliott Bros. for a magnetic generator for use with testing set at £8. 5s. 6d.

IMPORTANT NOTICE.

Extra Copies of "The Electrician" Special Mining Issue (July 10th, 1908), are obtainable, price 1/- nett (post free U K., 1/4 ; abroad 1/6).

Heckmondwike Council have accepted the tender of W. T. Henley's Co. for laying a cable to the Co-operative Society's wholesale premises

Sydney (N. S. W.) City Council have accepted the tender of Noyes Bros. (at £23,338) for a battery of 300 Tudor cells (capacity 4,000 amperes per hour at one hour rate of discharge), British Westinghouse 5,000 volt motor charging booster set, two booster generators (each to boost 2,000 amperes at 150 volts), and a motor driven milking booster.

Sydney (N.S.W.) Council have also placed orders with Noyes Bros. for British Westinghouse alternating-current and direct current motors over 5 H.P.

The Postmaster-General's Department, Adelaide, S. Australia, have accepted the tenders of British Insulated & Helsby Cables for three switchboards, and about 11 miles of cable ; W. T. Henley's Co. for 8 miles of cable ; Western Electric Co. for 6¾ miles of cable ; and J. Bartram & Son for telephones, switchboards and cable.

Hampden (Victoria) Shire Council have accepted the tenders of British Insulated & Helsby Cables for cables and wires at £350 ; R. Hornsby & Sons, suction gas plant at £1,128 ; A. H. Wood dynamo, &c., £1,575 ; and A. Kelly, poles, struts, and stay poles, £189.

Melbourne Council have accepted the tender of Davies, Shepherd & Co., for supply of a water meter for new boilers at the electricity works.

An Order for the Bahamas.—Messrs. Crompton & Co. have received an order for an electrical installation at Nassau, capital of the Bahama Islands, placed by the Crown Agents for the Colonies for the electric lighting of the city. The consulting engineers are Messrs. Preece & Cardew. The contract includes supply and erection of all station plant, machinery and mains. The plant will consist of three 81 B.H.P. Y.E. type Crossley gas engines and suction producer plant, the engines being direct coupled through flexible couplings to three Crompton standard continuous current interpole dynamos each capable of developing 45 kw. at 200/220 volts when running at a speed of 200 revs. per min. All the necessary circulating water pipes, two electrically-driven centrifugal pumps for circulating the water, a balancer set, dealing with an out-of-balance current of 100 amperes in the middle wire, and a switchboard for the control of the three dynamos, balancer and feeders. The mains will consist of overhead bare copper conductors carried on steel cross arms mounted on wooden poles, on which brackets will also be mounted for carrying incandescent lamps for street lighting. The contract includes the running of all service mains to consumers. The system of supply will be three wire continuous current, 100 volts for lighting, and 200 volts for power. The work of erection will commence about the beginning of October.

Osram Lamp Contract.—Wimbledon (Surrey) Council have placed an order with the General Electric Co. for 1,300 high voltage Osram lamps for street lighting, and the electricity department has decided to substitute all incandescent lamps, now used in street lighting with "Osram" lamps..

BUSINESS NOTICES.

Messrs. Egerton Lowe & Co. have commenced business as electrical engineers and dealers in electrical supplies at South View-crescent, Sheffield, and ask for price lists from manufacturers of a.c. and d.c. generators, motors, transformers, metallic filament lamps and small high efficiency balancing and auto-transformers, &c.

The Armorduct Mfg. Co. state that they have secured the exclusive sale for Great Britain and the Colonies of the "Gral" high voltage metallic filament lamp. The lamp is manufactured from 40 c.p. upwards, the size being considerably below that of any similar lamp on the market.

Chas. F. Brown and H. Ivan Lewenz, trading as Hiller & Co., mechanical and electrical engineers, Romsey, have dissolved partnership.

The official address of the Institution of Engineers and Shipbuilders in Scotland will be 3, Elmbank-crescent, Glasgow, until Nov. 16, when the new premises of the Institution (at 39, Elmbank-crescent) will be ready for occupation.

Sales by Auction.—Messrs. Fuller, Horsey, Sons & Cassell will hold an open sale by auction at H.M. Dockyard, Devonport, on Tuesday, Oct. 6, and following days 10 tons white metal and manganese bronze, 56 tons zinc ashes and bottoms, 5 tons lead skimmings, foundry ashes, 1,200 tons iron scrap, 600 tons steel scrap, gunmountings, 50 tons old electric cable, quantity of electrical gear and stores, two overhead travellers, lathes and machine tools, &c. Catalogues (6d. each) may be had at the Dockyard, and of the auctioneers, 11, Billiter-square, London, E.C. See also an advertisement.

On Wednesday, 30th inst. at 1 p.m., Mr. Frank G. Bowen will sell by auction on the premises (Underhill-street, Arlington-road, Camden Town, N.W.) the nearly new electrical motor and general engineering plant, including 6 lathes, 3 spindle and other drilling machines, 4 motors and dynamos, tool grinders, brazing and other forges, shafting, pulleys, belting, &c. On view day prior to and on morning of sale. Catalogues may be had on the premises and of the auctioneer, 62a, Aldersgate-street, London, E.C. (Telephone P.O. 1861 Central.) See also an advertisement.

Sale by Tender.—East Stonehouse Urban Council invite tenders for the purchase of two gas engines, three dynamos, switchboards, piping, belting, &c., until recently used for the generation of electric current at the town hall. The plant may be seen in working order on application to the caretaker. Tenders by 4 p.m., Sept. 22, to the surveyor (Mr. C. H. Trounce), Town Hall, East Stonehouse, Devon. See also an advertisement.

Patents Development.—The proprietors of the following patents advertise that they are desirous of entering into arrangements, by way of licence or otherwise, for exploiting same and ensuring their full development and practical working in this country.

Patent No. 20,898/1905 for "Improvements relating to Electrolytic Apparatus"; and Patent No. 216.661 1905 for "Improvements relating to Sound Boxes for Phonographs, Telephones and the like." Applications to Messrs. Haseltine, Lake & Co., 7 and 8, Southampton-buildings, Chancery-lane, London, W.C.

Award.—The Union Electric Co. have been awarded a medal of the first class for their exhibit of motors, arc lamps, mining switch-gear, and measuring instruments at the Camborne Mining Exhibition which was held last week under the auspices of the Royal Cornwall Polytechnic Society.

CATALOGUES, &c.

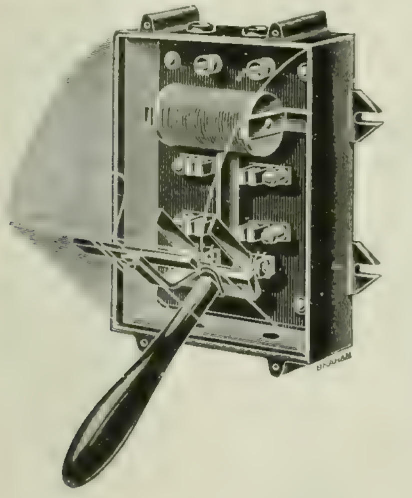
"*Excelsior*" *Conduits, Fittings, &c.*—The almost universal approval accorded to the metal conduit for electric light and power wiring has stimulated activity in this branch of business to an almost phenomenal extent. The excellent publication just issued by the New Brotherton Tube Co., Wolverhampton, abundantly testifies to this fact. The size of the book will at once commend itself to users. It is long and narrow, and the various tables of prices, &c., are set out in a manner which facilitates easy reference. The illustrations usually occupy one page and facing them is a tabulated set of sizes and prices. The first few pages are occupied by illustrations of the various shops in the company's extensive works in Commercial-road, Wolverhampton. These point to extreme activity on the part of the company, and from a photographic point of view leave nothing to be desired. (A complaint is often raised against photographs of industrial workshops, because instead of the workmen appearing as such, they are all placidly staring at the camera.) The list deals first with the various sizes of conduits, both screwed and unscrewed and of different gauges, which are manufactured. Then follows a number of pages devoted entirely to conduit fittings in the shape of inspection and draw-in boxes, angle boxes and elbows, &c. Switches, ceiling roses, wall plugs and combinations of the same then receive attention, together with special lampholder fittings and brackets. All these are designed for conduit wiring and for the bringing of the conduit right into the box itself. Distribution boards, special switches and switch plates also receive attention, followed by ironclad fuses and knife switches. Then come conduit accessories such as cramps, reducing nipples, earthing clips, hold-fast wall saddles, &c. The section devoted to special switches is made up of a material relating to the celebrated Lundberg combinations which will be found very useful by wiring contractors. Extracts are also given from the I.E.E. wiring rules, the B.O.T. regulations for medium pressures and the Phœnix Fire Office Rules. The concluding 60 pages of the catalogue are devoted to a tabulated extract from *The Electrician* Tables of Electricity Supply Undertakings dealing with stations in this country and the Colonies. These tables, which are the copyright property of "The Electrician" Printing & Publishing Co., have been inserted under special arrangement. Their inclusion certainly adds value to the Brotherton Co.'s list, as the columns extracted give just the information regarding voltage, cost of current, &c., which many electrical contractors frequently require to know. The catalogue is altogether worthy of the subject with which it deals.

Gas Engines and Producers.—Messrs. Davey, Paxman & Co., of Colchester, send us their latest catalogue, which is devoted to descriptions and particulars of their special types of gas engines and producers. It is interesting to note that after 50 years of the very widest experience as manufacturers of steam engines and boilers of all sizes, Messrs. Davey, Paxman & Co. decided five years ago to take up the manufacture of gas engines, and have recently put down extensions of their already large machine shop for producing engines of from $2\frac{1}{2}$ to 300 H.P. This extension to the great range of shops at Colchester is equipped with the latest and best automatic machinery for turning out engines cheaply and strictly to gauge. All the engines are of the horizontal type, and are fitted with two flywheels in sizes above $2\frac{1}{2}$ H.P. In the same list reference is made to the "Paxman" suction gas plant, with which the makers claim it is possible to produce 10 H.P.-hours for 1d. with fuel at 18s. 6d. per ton. The whole subject of gas engines and gas producer plant is of special interest at the present time, and the new catalogue under notice is published at a peculiarly opportune moment.

"Solar" Fittings.—Siemens Bros. Dynamo Works (Ltd.) have just issued price sheet No. 4A III. 7, giving particulars and prices of "Solar" fittings for "Tantalum," "Sun" and spherical carbon filament lamps.

Annealing Furnaces.—The British Insulated & Helsby Cables are sending out pamphlets Nos. P 54 and P 57 briefly describing the well-known Bates & Peard annealing furnaces for non-ferreous metals. An illustration is given in the second-named list of a small single-ended furnace for jewellers' use.

Automatic No-Volt Release Circuit-Breaker.—The accompanying illustration shows a new form of automatic no-volt release circuit-breaker for alternate current working put upon the market by Messrs. Cecil Hodges & Co., Balfour House, Finsbury Pavement, London, E.C. From a large and varied experience in the manufacture of switching apparatus Messrs. Cecil Hodges & Co. may be depended upon to accurately gauge the requirements of the industry in connection with the same. In view of the exacting conditions of the Board of Trade and the Home Office in their latest sets of rules and regulations for the employment of electricity in factories and workshops, it is well that installation contractors should be provided with designs which strictly conform to such requirements, and particular regard to this point has been observed with the apparatus under notice. We shall devote further space to this subject later.



Mawdsleys Limited.—The latest catalogue issued by Messrs. Mawdsleys Limited describes the well-known dynamos and motors manufactured by this company at their works at Dursley, Glos. The catalogue is of the loose leaflet form made up in a neat file with an attractive cover.

"Installation News."—The latest edition of this publication is principally devoted to booming the "Simplex" electric sign, a new line with the Simplex Co. to which reference has already been made in our columns. This is a line which should be taken up well during the coming winter. The signs have been worked out very tastefully and carefully, particularly in the matter of the diffusion of light, and it is stated that the face of the sign is evenly illuminated throughout. There is also an interesting article on lampholders.

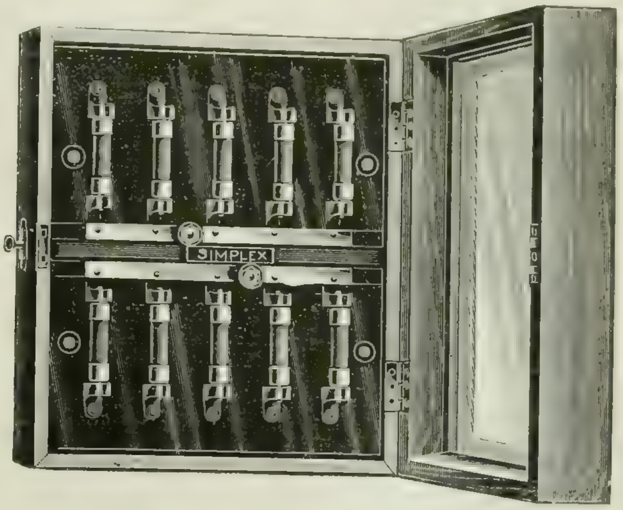
G.E.C. Specialities.—The publication department of the General Electric Co. has been very busy lately with pamphlets, booklets, &c., relative to the company's very varied products. Pamphlet No. L1,258 deals with the leading G.E.C. lines in electric bells, indicators, &c. It is of a size convenient for the pocket and should serve as a useful reminder of the prices and forms of the most commonly used articles in this field. Pamphlet N 1,268 is a single sheet with gummed edge for insertion in the company's osram lamp catalogue. It gives the price of high candle-power lamps ranging from 100 to 260 volts and from 200 to 400 c.p. An interesting testimonial is printed in leaflet from which we gather that a saving of £10. 13s. 5d. was effected during 12 months by a Glasgow tradesman using osram lamps.

SPECIAL NOTICE.

NOW READY.—Vol. LX. of "THE ELECTRICIAN" (1,016 pages), bound in strong cloth. Price 17s. 6d.; post free, 18s. 6d. Also ready Cases for Binding. Price 2s.; post free, 2s. 3d.

A complete set of "THE ELECTRICIAN" (1860 1865—1878 1908) can be supplied. A number of odd volumes and some odd old back numbers, to help in making up complete sets, are also now available.

Distribution Boards.—We have received from Simplex Conduits Ltd. a copy of section D of their catalogue which gives particulars and prices of distribution boards and switchgear. For some years the company have devoted a large department to the manufacture of distribution boards of all descriptions and to meet all requirements. The department has now been extended, and the company are prepared to manufacture fuses to any specification or requirements, and of any capacity. In the present catalogue a wide range of distribution boards, switches and fuses is listed, and the company state that they have adapted all their better quality boards for use with enclosed fuses. The illustration shows a distribution board suitable for 3-10 ampere circuits, with d.p. fuse, and wood case of best quality.



SIMPLEX DISTRIBUTION BOARD.

Spiral Chucks.—Mr. George Taylor, Bartholomew-street, Birmingham, forwards a copy of his latest list of spiral self-centring chucks which evidently have a considerable vogue amongst manufacturers. The feature of the device is simplicity of construction and absolute certainty of action, all the parts subject to wear being hardened.

Surveying Instruments.—A new list of surveying instruments issued by John Davis & Son, Derby, will interest many of our readers. All the company's well-known standard transit theodolites, levels, miners' dials, &c., are described.

Time Switches.—We have received from Messrs. Venner & Co. a copy of section 8 of their catalogue, which deals with type B switches, which are used principally in connection with the two-rate system of charging. It is stated that this system is rapidly advancing in favour, and the firm have now on their books between 70 and 80 stations that have the system in use. It is also claimed that the Venner switch is the only one which has received Board of Trade approval.

Arc Lamp Accessories.—The use of arc lamps for external work is greatly facilitated by the experiment of some form of hoisting and lowering gear. The publications just issued by the Union Electric Co. (Nos. 1,404 and 1,405) will be found to contain some interesting particulars of this class of apparatus, and we commend the list to the users of arc lamps generally.

Lamp Catalogue.—A handsome catalogue is shortly to be issued by Messrs. Drake & Gorham, 66, Victoria-street, Westminster, S.W. It is principally devoted to the subjects of metal filament lamps, Tantalum and Osram patterns, and switches and switchboards for small capacities. The lighting section of the catalogue has been very well done. Full details are supplied of the various sizes of the metal filament lamps mentioned, and there are also details of the special fittings with which the distribution of light from these lamps is made more effective. There is a good illustration of the applicability of Tantalum lamps for street lighting. The list is made up of a number of loose sections, and these are bound in a useful cover so that additions can be made from time to time.

BANKRUPTCIES, LIQUIDATIONS, &c.

A meeting to receive an account of the winding up of the British Uralite Co. (Ltd.), will be held on Oct. 13, at 16, St. Helen's-place, London, E.C.

A meeting to receive an account of the winding up of the Lancashire Electric Supply Co. (Ltd.) will be held on Oct. 20 at 4, Chapel-walks, Manchester.

PATENT RECORD.

APPLICATIONS FOR PATENTS.

NOTE.—*The undermentioned Applications (except those marked †) are not open to public inspection until after acceptance of Complete Specifications. Those marked † are open for inspection 12 months after the date attached to them, if they have not been published previously in the ordinary course. Names within parentheses are those of communicators of inventions. When Complete Specification accompanies application, an asterisk is affixed.*

May 20, 1908.

10,918 BEVIS & COATES. Electrical ignition apparatus.
10,928 TURNER. Protection of electrical circuits and apparatus.

May 21, 1908.

10,997 GARFITT & BAXTER. Electrically lighting the mouth and cavaties during dental or other surgical operations.
11,029 APPLEBY & DREW. Automatic call boards and apparatus.
11,030 HODGSON. Switches for electric lighting.
11,035 NEW IGNITION SYND. & SANDY. Batteries.
11,061 GREVILLE. Electric break or interrupter.
11,064 TIMAR & VON DREGER. Starting switches for electric motors. (Date applied for. 5/6/07.)*†
11,068 ROUTIN. Electro-mechanical regulators for electric generators, electric furnaces and the like. (Date applied for, 24/5/07.)*†

May 22, 1908.

11,099 HAMILTON. Apparatus for transmitting telegraphic signals.*
11,106 JOEL. Portable electric lamps.
11,119 BACHTEN & GALLAY. Dynamo for motor cars and other vehicles.*
11,128 HANKIN. Electric heating apparatus. (Date applied for, 27/5/07.)*†
11,134 & 11,136 STECKEL & THOMPSON. Induction clutches.*
11,135 BROWN. Telephony and telegraphy.
11,153 PATERSON & PORTEOUS. Cables.
11,158 JONES & BOWLER. Appliances for notifying the extinction of a lamp or other flame and/or automatically replacing it by an electric light.
11,161 B.T.-H. Co. (A.E.G., Germany). Dynamo electric-machines.*
11,163 PETERSEN & CALLENDER'S CABLE & CONSTRUCTION CO. Submarine signalling cable.
11,170 BROOKS & ALSTON. Induction coils.
11,175 KÖHLER & KÖHLER. Electromagnetic switch for tramway lines.*

May 23, 1908.

11,183 THOMAS & THOMAS. Circuit-breakers.
11,191 MABBETT. Generating electric light or power.
11,193 MCKAIG. Electric ring game.*

May 25, 1908.

11,288 BAKER & GUNSTONE. Mercury interrupters for alternating currents.
11,299 KLINGELFUSS. Measurement of intensity and tension of currents delivered by an induction coil.*
11,336 ELECTRIC CONSTRUCTION CO., & BUCHANAN. Dynamo-electrical machinery, subject to fluctuation of load.
11,339 PEMBER. Firing mines and the like by electricity.
11,344 B.T.-H. Co. & DAWSON. Electrical power transmission systems.
11,345 B.T.-H. Co. (G.E. Co., U.S.). Control of electric circuits and apparatus.
11,346 GAUTIER. Insulators for overhead systems. (Date applied for, 10/10/07.)*†
11,347 MERZ & REDMAN. Conductor rails.

May 26, 1908.

11,391 OLIVER. Electrical relay application.
11,401 [illegible] & EVERETT. Protective device for electric circuits.
11,432 [illegible] & HEIMER. Magneto-electric ignition apparatus. (Date applied for, 6/12/07.)*†
11,460 B.T.-H. Co. & ROBERTSON. Incandescent lamps.

May 27, 1908.

11,490 BARRETT & FERGUSON. Electrically heated laundry iron.
11,511 SIEMENS BROS. & CO. (Siemens & Halske A.-G., Germany). Electrical contact.*
11,512 SIEMENS BROS. DYNAMO WORKS, PAYNE, & SCHULZ. Switch arrangements for starting electric motors.*
11,517 SIEMENS-SCHUCKERTWERKE G.M.B.H. Continuous current machines. (Date applied for, 27/7/07.)*†

May 28, 1908.

11,[illegible] [illegible] & [illegible]. High tension distributor for electric ignition.
11,558 BARNES (Breslauer, Germany). Compounding alternating current generators.
11,564 [illegible]. Standard for arc lamps.
11,584 BEST, BEST, & BEST. Electrically igniting miners' safety lamps.
11,586 HEINRICHSDORFF. Igniting carriage gas-lamps by induced current.*
11,592 GRAY. Dynamo-electric generators and motors.
11,595 & 11,596 DRAKE & SMITH. Magnetic clutches.
11,600 RITTERSBERG & RUBERT. Filaments of Chinese ink for incandescent lamps. (Date applied for, 30/10/07.)*†
11,603 SIEMENS & HALSKE (A.-G.) Tungsten filaments. (Date applied or, 8/6/07. (Addition to 16,489/07.)*

NEW COMPANIES, STATUTORY RETURNS, MORTGAGES AND CHARGES, &c.

NEW COMPANIES.

BASTIAN QUARTZ LAMPS (LTD.) (99,444).—Reg. Sept. 8, capita £6,100 in 6,000 preference shares of £1 each and 2,000 deferred shares of 1s. each, to acquire from C. O. Bastian certain British patents relating to vapour electric apparatus, to grant licences in respect thereof (and particularly a licence to the Brush Electrical Engineering Co.) and to carry on the business of electricians, manufacturers of electrical lamps and apparatus, &c. Reg. by W. T. Hick, 2, Church-court, Clement's-lane, London, E.C.

STATE OF BAHIA SOUTH-WESTERN RAILWAY CO. (LTD.) (99,497)—Reg. Sept. 11, capital £200,000 in £1 shares, to adopt certain agreements to carry on the business of constructors and workers of railways, tramways, telegraph and telephone lines, &c., in Bahia or elsewhere in Brazil, to generate, supply and use electricity, &c.

STATUTORY RETURNS.

KIDDERMINSTER & DISTRICT ELECTRIC LIGHTING & TRACTION CO. (LTD.)—Capital in return to May 14 is £100,000 in £10 shares (5,000 preference), of which 4,700 ordinary and 3,000 preference have been taken up. £77,000 has been received. Mortgages and charges, £27,500.

NEW GENERAL TRACTION CO. (LTD.)—In return to July 14 capital is £370,000 in 50,000 preference and 24,000 ordinary shares of £5 each, all of which have been taken up. £5 per share has been called up on the preference and £250,000 has been received. £120,000 is considered as paid on the ordinary. Mortgages and charges, £325,700.

UNITED ELECTRIC TRAMWAYS OF MONTE VIDEO (LTD.)—Return to Jan. 29 gives capital as £800,000 in 40,000 preference and 40,000 ordinary shares of £10 each, of which 35,250 preference and 33,600 ordinary have been taken up. £70 has been received and £688,430 is considered as paid on 35,243 preference and 33,600 ordinary. Mortgages and charges, £800,000.

MORTGAGES AND CHARGES.

BRUSH ELECTRICAL ENGINEERING CO. (LTD.)—A trust deed dated Sept. 4, 1908, to secure £125,000 prior lien debenture stock has been registered. Property charged: Freehold and leasehold property in Loughborough, Leicestershire, and the company's other assets, present and future, including uncalled capital. Trustees, Electric & General Investment Co.

CITY NOTES.

MEMORANDA (Sept. 10).—Bank rate $2\frac{1}{2}$ per cent. (since May 28, 1908). Price of silver, $24\frac{1}{16}$d. per oz. Consols $85\frac{5}{8}$—$85\frac{3}{4}$ for money and $85\frac{11}{16}$–$85\frac{13}{16}$ for account. Consols Pay Day, Oct. 1; Stock and Shares Continuation Days, Sept. 28 and Oct. 13; Ticket Days, Sept. 29 and Oct. 14; Pay Days, Sept. 30 and Oct. 15.

PRICES OF METALS (London).—*Copper*, cash, $60\frac{1}{2}$; three months, $61\frac{1}{8}$. *Lead*, English, $13\frac{1}{2}$–$13\frac{3}{4}$; foreign, $13\frac{1}{4}$–$13\frac{5}{16}$. *Spelter*, foreign cash, $19\frac{1}{2}$. *Tin*, Fine Foreign, $130\frac{3}{4}$, three months, 132. *Iron*, Cleveland, cash, 51/4—51/5, three months, 51/0—51/$1\frac{1}{2}$.

ANGLO-ARGENTINE TRAMWAYS CO. (LTD.)—The directors have declared an interim dividend to June 30 of 5s. per share on the non-cumulative second preference shares, being at the rate of 10 per cent. per annum (less tax), payable Oct. 1.

Meetings of the various classes of shareholders were held on Wednesday, at which resolutions were passed giving the directors further powers with regard to the absorption of other undertakings in the Argentine. The chairman (Mr. J. E. Conoannon) said they now held the whole of the share capital of the Buenos Ayres Electric Tramways Co., and it was desirable that they should cause that company to be wound up as soon as possible with a view to the whole of its assets being merged into the Anglo-Argentine Co. To effect this it was necessary to place the board in a position to provide funds to pay off the 200,000 first 5 per cent. and the 30,000 second 5 per cent. debentures of the Buenos Ayres Electric Tramways Co.

BABCOCK & WILCOX (LTD.)—The directors have declared an interim dividend of 8 per cent. for the half-year ended June 30.

NEWCASTLE & DISTRICT ELECTRIC LIGHTING CO. (LTD.)—The directors have decided not to pay an interim dividend for the half-year.

STOCK EXCHANGE NOTICES.—The Stock Exchange committee have been asked to grant quotations to \$1,115,000 additional consolidated mortgage 5 per cent. 50-year \$1,000 coupon bonds of the *[illegible] Railway Co.*, and \$[illegible] additional general consolidated first mortgage 5 per cent. 50-year gold bonds of the *[illegible] Tramways Co.*

ELECTRIC TRAMWAY AND RAILWAY TRAFFIC RECEIPTS.

Line	Week ended.		Amount.	Inc. or Dec. (a)	Aggregate No. of weeks.	Aggregate Amount.	Aggregate Inc. or Dec. (a)
			£	£		£	£
Aberdeen Corporation	Sept	9	1,404	− 181	15	23,303	− 120
Airdrie	,,	4	248	− 19	35	7,836	+ 57
Anglo-Argentine	,,	5	25,139	+ 7,930	36	716,516	+ 124,178
Ayr Corporation	,,	12	302	− 22	17	7,038	− 24
Baker St. & Waterloo Ry.	,,	12	3,000	+ 935	11	31,405	+ 6,475
Barnsley	,,	4	169	2	35	6,277	+ 369
Barrow	,,	4	273	− 32	35	8,837	− 336
Bath Electric Trams, Ltd.	,,	9	842	− 150	36	26,841	− 1,911
Birkenhead Corporation	,,	13	1,079	− 38	...	...	..
Birmingham Corporation	,,	12	6,343	+ 61	24	159,[illegible]	+ 5,448
Birmingham & Mid.	Aug	28	867	− 4	31	28,543	+ 811
Blackburn Corporation	Sept	9	1,076	− 253	24	28,175	+ 691
Blackpool Corporation	,,	10	2,011	− 703	23	35,483	− 751
Blackpool and Fleetwood	,,	12	1,208	− 338	.	...	..
Bolton Corporation	,,	13	2,284	− 99	24	57,084	+ 922
Bombay	Aug	2	R33,951	+ R4,956	33	R1,170,261	+ R226,569
Bournemouth Corporation	...		...	...		..	...
Bradford Corporation	Sept	12	4,623	− 238	23	114,726	+ 598
Brighton Corporation	,,	13	1,052	− 115	24	24,355	+ 480
Bristol Trams & Carriage	,,	11	5,075	− 467	42	183,875	365
Burnley Corporation	,,	12	1,239	− 315	21	29,803	+ 611
Burton Corporation	,,	13	268	− 13	24	6,681	− 513
Bury Corporation	,,	13	1,125	+ 157	‡24	29,000	+ 1,683
Calcutta Tramways Co.	,,	12	R47,266	− R1,501	11	R513,144	− R7,672
Camborne-Redruth	...		...	...	...	..	...
Cardiff Corporation	,,	12	2,263	− 61	24	53,523	− 503
Cavehill	,,	4	84	− 6	35	3,293	+ 233
Central London Railway	,,	12	8,257	+ 3,724	11	78,031	+ 25,194
Charing C., Euston & H'stead	,,	12	3,390	+ 935	11	35,345	+ 7,825
Chatham & Dist. Lt. Rys.	,,	10	302	+ 76	36	27,913	+ 1,128
City & South London Rly.	,,	13	3,179	+ 30	11	32,421	− 1,160
City of Birmingham	,,	4	2,675	− 136	35	97,588	− 523
Colchester Corporation	,,	9	231	− 25	10	2,393	− 162
Cork Electric Trams Co.	,,	10	471	− 65	36	16,720	− 565
Croydon Corporation	,,	11	1,422	− 140	24	34,838	− 466
Devonport & Dist. Trams	,,	4	495	− 21	35	16,292	+ 37
Dover Corporation	...		...	...			...
Dublin & Lucan Railway	,,	11	150	− 10	10	1,656	− 79
Dublin United	,,	11	5,585	− 1,797	10	61,769	− 18,457
Dudley-Stourbridge	,,	4	886	− 103	35	29,693	− 1,252
Dundee Corporation	,,	9	1,291	+ 74	‡17	20,765	+ 1,294
East Ham Council	,,	12	937	− 53	24	20,981	− 1,213
Exeter Corporation	,,	11	372	− 2	24	7,974	− 171
Falkirk and District	...		...	...	...	...	...
Gateshead & Dist. Trams	,,	4	1,017	− 24	35	35,507	+ 142
Glasgow Corporation	,,	12	17,102	− 1,643	15	254,911	− 2,960
Glossop	,,	12	133	− 16	37	5,620	− 239
Gravesend − Northfleet	,,	4	226	− 58	35	7,543	− 1,154
Great Northern & City Rly.	,,	12	1,294	− 288	11	14,114	− 3,272
Gt. Northern, Piccadilly, &c	,,	12	5,040	+ 1,235	11	53,275	+ 10,820
Greenock & Port Glasgow	,,	4	549	− 154	35	18,926	− 4,564
Hartlepool Tramways	,,	4	271	− 74	35	8,598	− 1,715
Hastings Elec. Trams Co.	,,	11	1,456	− 226	11	15,639	− 1,448
Hong Kong	,,	12	$8,089	+ $481	37	$291,786	− $13,667
Huddersfield Corpn.	,,	12	1,528	− 137	24	39,197	+ 20
Hull Corporation	,,	12	2,436	+ 17	24	57,815	+ 34
Ilford District Council	,,	5	435	− 36	23	10,609	− 599
Ilkeston District Council	,,	9	142	− 11	23	3,404	+ 34
Ipswich Corporation	,,	12	449	− 48	24	10,174	− 305
Isle of Thanet Co.	,,	12	1,267	− 93	35	29,290	− 629
Jarrow	,,	4	107	− 27	35	3,816	− 494
Keighley Corporation	,,	10	152	− 46	10	1,754	− 57
Kidderminster & District	,,	4	122	− 21	35	4,118	− 226
Kilmarnock Corporation	,,	12	149	− 8	17	2,713	− 185
Lanarkshire Trams Co.	,,	10	1,179	− 320	36	46,674	+ 3,345
Lancashire United	,,	9	1,298	− 229	36	48,640	+ 2,204
Leamington	,,	4	181	− 3	35	6,013	+ 373
Leeds Corporation	,,	12	6,450	− 561	24	161,474	+ 3,888
Leicester Corporation	,,	12	2,130	− 135	11	25,194	− 5
Leith Corporation	,,	12	500	− 41	17	9,711	− 25
Lincoln Corporation	,,	12	116	− 4	24	2,893	− 82
Liverpool Corporation	,,	5	10,767	− 500	36	383,621	− 7,695
Liverpool Overhead Rly.	,,	13	1,391	− 149	11	16,088	− 2,354
*London County Council	,,	5	24,597	+ 3,085	†25	793,707	+ 85,120
London United	,,	12	7,657	− 429	36	246,439	+ 2,114
Lowestoft	,,	12	337	− 16	50	10,387	+ 125
Maidstone Corporation	,,	12	220	...	24	4,859	...
Mersey Railway	,,	12	1,846	+ 103	11	20,260	+ 430
Merthyr	,,	4	222	+ 2	35	7,450	+ 66
Metropolitan Dist. Railway	,,	12	9,130	+ 2,063	11	96,306	+ 15,870
Metropolitan Elec. Trams	,,	4	5,939	+ 352	35	200,440	+ 37,728
Middleton	,,	4	354	− 49	35	13,027	+ 417
Nelson Corporation	,,	12	131	− 72	§21	3,429	− 206
Newcastle-on-Tyne Corp.	,,	12	3,748	− 305	21	93,[illegible]	− 6,162
Newport (Mon.)	,,	12	611	− 67	24	16,379	− 1,040
Northampton Corporation	,,	11	169	− 9	§23	11,479	+ 655
Oldham, Ashton & Hyde	,,	4	610	− 69	35	21,102	− 262
Oldham Corporation	,,	13	1,865	− 205	24	49,630	+ 482
Perth (N.B.) Corporation	,,	9	154	− 26	17	2,800	− 145
Perth (W.A.) Elec. Trams	,,	11	1,257	− 14	37	50,645	− 1,127
Peterborough	,,	4	13[illegible]	− 6	35	4,532	+ 29
Portsmouth Corporation	,,	12	2,402	− 183	24	52,634	+ 48
Potteries	,,	4	1,813	− 56	35	63,705	− 1,107
Preston Corporation	,,	9	765	− 57	10	7,720	− 414
Rotherham Corporation	,,	10	625	− 46	13	14,502	+ 56
Rothesay	,,	4	329	− 22	35	8,533	− 42
Salford Corporation	,,	11	4,163	− 351	21	114,324	+ 1
Sheerness	,,	2	63	− 8	35	2,054	− 55
Sheffield Corporation	,,	13	5,420	− 210	†25	138,415	− 1,003
Singapore Trams	,,	12	$4,617	+ $341	...	...	..
South Metropolitan	,,	4	798	− 140	35	28,617	+ 303
South Staffs	,,	4	881	+ 6	35	31,018	− 593
Southend Corporation	,,	9	633	+ 20	24	19,111	+ 840
Southport Tramways	,,	4	325	− 62	35	10,278	− 619
Stalybridge, Hyde, &c., Jt. Bd.	,,	12	753	− 150	†24	19,243	− 546
Sunderland Corporation	,,	13	1,165	− 305	24	29,254	− 6,046
Sunderland District	,,	9	451	− 40	45	21,645	+ 1,576
Swansea Trams	,,	4	902	− 111	35	33,436	+ 1,121
Taunton	,,	4	46	− 7	35	1,470	− 87
Tynemouth and District	,,	4	280	− 51	35	8,495	− 555
Tyneside Trams Co.	,,	9	392	− 108	10	4,437	− 481
Wallasey District Council	,,	12	934	− 17	§23	22,429	+ 965
Walsall Corpn.	,,	12	530	− 34	37	19,662	+ 1,169
Warrington Corpn.	,,	10	374	− 15	23	8,892	− 146
West Ham Corporation	,,	3	2,118	− 203	23	51,703	− 3,017
Weston-super-Mare	,,	2	307	− 60	35	5,574	+ 9
Wolverhampton Co.	,,	4	434	− 68	35	16,108	− 691
Wolverhampton Corpn.	,,	9	730	− 42	11	12,418	+ 183
*Worcester	,,	4	309	− 24	35	9,393	− 63
Wrexham	,,	4	112	18	35	3,619	− 12
Yorkshire W.R. Trams	,,	13	1,192	− 66	36	45,269	...
Yorkshire Woollen District	,,	4	927	+ 87	35	32,410	− 1,125

(a) These comparisons are with the corresponding period last year. § Plus 3 days. ‖ Plus 2 days. * Partly electrical. † Minus 3 days ‡ Minus 2 days.

ELECTRICAL COMPANIES' SHARE LIST.

Share	Last Dividend	Name.	Price Wed., Sept. 16.	Rate % Yield-ed.	Dividend Due.	Business Week to Sept. 16. Highest.	Lowest.
		ELECTRICITY SUPPLY.		£ s. d.			
10	5 0	Bournemouth & Poole Elec. Sup. Ord.	10 −10½	6 13 6	Mar, Sept,		..
10	4 6	Do. 4½ per Cent. Cum. Pref.	9½ −10	4 10 0	Feb, Aug	9	—
10	6 0	Do. 6 per Cent. Cum. Second Pref.	10½ −10¾	5 6 0	Feb, Aug	1[illegible]	..
St.	4½%	Do. 4½ per Cent. Deb. Stock (red.)	101 −104	4 6 6	Jan, July	10[illegible]	..
5	3 6	Bromley (Kent) El. Lt. & Power Shares	4½ −5	5 10 0	April, Oct	..	..
St.	4½%	Do. Do. 1st Debs.	9[illegible] −99	4 11 0	May, Nov	.	..
5	4 6	Brompton & Kensington Elec. Sup. Ord.	6¾ −7¼	6 9 0	March....	..	..
5	3 6	Do. 7 per Cent. Pref.	6½ −7½	4 13 6	Mar, Sept	...	..
St.	4%	Central Elec. Sup. Co. 4% Guar. Db. Stock	99 −102	3 18 0	June, Dec	..	..
5	2 6	Charing Cross (W. End & City) El. Sup. Co.	3½ −4	6 5 0	Feb, Aug	.	..
5	2 3	Do. 4½ per Cent. Pref.	4 −4½	5 0 0	Feb, Aug	..	..
St.	4%	Do. 4 per Cent. Deb. Stock (red.)	93 −99	4 1 0	Jan, July	..	..
5	2 3	Do. City Undertaking 4½% Cm. Pref.	3¾ −4	5 12 0	Jan, July	3¾	..
5	2/0	†Chelsea Electric Supply Ord.	2¼ −3½	6 18 0	March ..	3	..
St.	4½%	* Do. 4½ per Cent. Deb. Stock (red.)	100 −103	4 [illegible] 6	June, Dec	.	..
10	5 0	City of London Electric Lighting Ord.	9½ −10½	5 17 0	Feb, Aug	8[illegible]	9
10	6/0	Do. 6 per Cent. Cum. Pref.	12 −13	4 12 0	Jan, July	..	..
St.	5%	Do. 5 per Cent. Deb. Stock (red.)	122 −125	4 0 0	June, Dec	..	..
St.	4½%	Do. 4½ per Cent. 2nd Deb. Stock (red.)	101 −104	4 6 6	Jan, July	..	..
5	2%	County of Durham Elec. P.D. Ord.	2¾ −3	3 9 7	April, Oct	..	..
5	5%	Do. 5 per Cent. non Cum. Pref.	3¾ −4½	6 5 0	April, Oct	..	..
10	4/0	County of London Elec. Supply Ord.	7½ −8½	5 17 6	Feb, Aug	7¾	..
10	6 0	Do. 6 per Cent. Cum. Pref.	10½ −10¾	5 9 6	Mar, Sept	10¾	10⅛
St.	4½%	Do. 4½% Deb. Stock (red.)	107 −110	4 2 0	Jan, July	1[illegible]	..
St.	4½%	Do. Second Deb. Stock	99 −102	4 8 0	May, Nov	10[illegible]	100
5	3 6	Folkestone Electricity Supply Co. Ord.	4¾ −5½	5 7 0	April, Oct		..
5	2 6	Do. 5 per Cent. Cum. Pref.	5 −5½	4 11 0	Mar, Sept	..	..
St.	4½%	Do. 4½ 1st Deb. Stock (red)	97 −100	4 10 0	Feb, Aug	..	..
5	4 6	Hove Electric Lighting Ord.	6 −6½	6 11 0	April, Oct	..	..
5	4/0	Kensington & Knightsbridge Ord.	7¾ −8¼	5 14 0	Feb, Aug	..	..
5	6%	Do. 6 per Cent. 1st Pref.	6 −6½	4 12 0	Jan, July	..	—
St.	4%	Do. 4 per Cent. Deb. Stock (red.)	94 −97	4 2 6	..		..
St.	4%	Kensingtn. & Kngtbg. Co. & Notting Hill Co. (Joint Station) 4% Deb. Stock (red.)	98 −102	3 18 0	April, Oct	—	..
St.	4½%	Kent Elec. Power Co.	86 −90	5 0 0	Jan, July	..	..
3	1 6	London Electric Supply Ord.	¾ −1¼	5 8 0	Mar, Sept	..	..
5	3 0	Do. 6 per Cent. Pref.	4¼ −4¾	6 9 6	Mar, Sept	..	..
St.	4%	Do. 4 per Cent. 1st Mort. Deb.	89 −92	4 7 0	Jan, July	..	..
5	2 6	Metropolitan Electric Sup. Ord.	4¼ −4¾	6 18 6	April, Oct	4[illegible]	4½
5	2 3	Do. 4½ per Cent. Cum. Pref.	4½ −5	4 10 0	Jan, July	..	..
St.	4½%	Do. 4½ per Cent. Deb. Stock 1st Mort.	105 −109	4 1 6	June, Dec		..
St.	3½%	Do. 3½ per Cent. Mrt. Deb. Stock (red.)	84 −89	3 19 0	Jan, July	..	..
100	4½%	Midland Elec. Corp. for P.D. 1st Mort. Db.	94 −97	4 12 6	June, Dec	.	..
10	4%	Newcastle & Dist. Elec. Ltg. Ord.	7½ −8	5 3 2	Feb, Aug	..	—
100	4½%	Do. 4½ per Cent. Deb.	94 −96	4 14 9	Jan, July	..	..
5	8%	Newcastle Elec. Supply Ord.	5⅛ −5⅜	7 12 4	Feb, Aug	..	..
5	5%	Do. 5 per Cent. non Cum. Pref.	5¼ −5⅝	4 15 8	Feb, Aug	..	..
100	4%	Do. 4 per Cent. Mort. Deb. red. 1907.	95 −97	4 3 4	Jan, July	..	..
1	3%	Northern Counties Elec. Sup.	—	..	Mar, Aug	..	..
100	4½%	Do. 4½ per Cent. Deb.	93 −95	4 15 9	Jan, July	..	..
10	6 0	Notting Hill Electric Ord.	11¾ −1[illegible]	5 10 6	March ..	..	..
5	2 6	Oxford Electric Ord.	5⅝ −6⅛	5 14 0	March ..	..	..
St.	4%	Do. 4 per Cent. Deb. Stock	95 −98	4 2 0	Jan, July	..	..
5	5 0	St. James' & Pall Mall Elec. Ord.	7 −8	6 1 6	Feb, Aug	..	..
5	3 6	Do. 7 per Cent. Pref.	6½ −7¼	4 16 6	Feb, Aug	..	—
St.	3½%	Do. 3½ per Cent. Deb. Stock (red.)	86 −90	3 18 0	Jan, July	89	..
5	..	Smithfield Markets Electric Sup. Ord.	¼ −¾	..	Feb	..	..
St.	4%	Do. 4 per Cent. Deb. Stock	68 −72	5 11 0	Feb, Aug	..	..
5	4 0	South London Electric Supply Ord.	2⅝ −2⅞	5 19 0	April ...	2⅞	..
1	0/6	South Metrop'n Elec. Lt. & Power Ord.	⅜ −⅝	4 0 0	..	..	..
1	0 8⅔	Do. 7 per Cent. Cum. Pref.	[illegible] −1[illegible]	5 18 0	Feb, Aug	..	..
St.	4½%	Do. 4½ 1st Db. Stk. Red.	100 −103	4 7 6	April, Oct	102	—
5	2 6	Urban Electric Supply Ord.	½ −1	..	April, Oct	—	..
5	2 6	Do. 5 per Cent. Cum. Pref.	1⅞ −2⅜	10 12 0	April, Oct	..	..
St.	4½%	Do. 4½ per Cent. 1st Mort. Deb.	82 −85	5 6 0	April, Oct	..	..
5	5 0	Westminster Elec. Sup. Ord.	7½ −8½	5 17 6	Mar, Sept	8¼	..
5	2,3	Do. 4½ per Cent. Cum. Pref.	5 −5½	4 2 0	Jan, July	..	..
		ELECTRIC RAILWAYS, TRAMWAYS, &c.					
St.	4%	Baker St. & Waterloo 4% Perp. Db. St.	92 −94	4 5 0	Jan, July	93¾	93½
1	..	Bath Elec. Trams Pref. Ord.	⅛ −⅜	10 13 0	April....	..	—
1	0/6	Do. 5 per Cent. Cum. Pref.	½ −¾	6 13 4	Jan, July	..	..
St.	4½%	Do. 4½ 1st Mort. Deb. Stock (red.)	85 −90	5 0 0	April, Oct	..	..
St.	4½%	B'ham & Midland Trams 4½ 1st Db. Stk.	93 −96	4 13 9	Jan, July	..	..
10	9%	Bristol Tramways & Carriage Ord.	10½ −11	8 3 6	Feb, Aug	..	..
10	4%	Do. Cum. Pref. (fully paid)	8¾ −9¼	4 6 6	..	..	..
St.	4%	Do. 4 per Cent. Debs.	96 −98	4 2 0	Feb, Aug	..	..
10	..	British Electric Traction Ord.	1¼ −1¾	..	June, Dec	—	—
10	3/0	Do. 6 per Cent. Cum. Pref.	3⅞ −4⅜	..	Feb, Aug	4[illegible]	3⅞
St.	5%	Do. 5 per Cent. Perpetual Debs.	98½ −99½	5 0 6	April, Oct	99½	98½
St.	4½%	Do. 4½ per Cent. 2nd Deb. Stock	76 −78	5 15 0	May, Nov	..	..
St.	3%	Central London Ordinary Stock	67 −69	4 6 6	Feb, Aug	69	67
St.	4%	Do. 4 per Cent. Pref. Stock	84 −86	4 13 0	Feb, Aug	..	..
St.	2%	Do. Deferred Stock	48 −51	3 18 0	Feb	50	48
100	4%	Do. 4 per Cent. Debs.	101 −104	3 17 0	Jan, July	101¾	..
St.	4%	Charing X, Euston & Hmpstd Per. Db. Stk.	82 −84	4 15 0	Jan, July	83¾	—
5	2/6	City of Birmingham Trams. 5% Cm. Pref.	4¼ −4¾	5 5 0	April, Oct	..	..
100	4%	Do. 4 per Cent. 1st Mort. Debs.	97 −100	4 0 0	April, Oct	..	..
St.	1½%	City & South London Rly. Con. Ord.	32 −33	4 19 0	Feb, Aug	32	32
St.	5%	Do. 5 per Cent. Perp. Pref. (1891)	111 −114	4 7 6	Feb, Aug	..	..
St.	5%	Do. (1896)	109 −112	4 9 3	Feb, Aug	..	..
St.	5%	Do. (1901)	107 −110	4 11 0	Feb, Aug	..	..
St.	5	Do. (1903)	102 −105	4 15 3	Feb, Aug	..	..
St.	4%	Do. 4 per Cent. Perpetual Debs.	100 −103	3 17 6	May, Nov	102¼	..
10	6/0	Dublin United Trams. Ord.	11½ −12½	5 4 0	Feb, Aug	..	..
10	6/0	Do. 6 per Cent. Pref.	12½ −13¼	4 10 6	Feb, Aug	..	.
10	..	Gt. Northern & City Rly. Pref. Ord. (4%	½ −1	..	Feb, Aug	.	
10	0/9	G. Northern, Piccadilly & Brompton Ord.	7¼ −7½	5 6 9	Feb, Aug	.	.
St.	4%	Do. 4 per Cent. Deb. Stock	91 −93	4 6 0	Jan, July	..	..
5	4/0	Hastings & Dst. Elec. Trams. 6% Cm. Pf.	3 −4	..	Mar, Sept	..	..
St.	4½%	Do. 4½ 1 Db. St.	92 −96	4 13 9	April, Oct	..	..
10	9%	‡Imperial Tramways Ord.	10 −11	7 7 3	Mar, Sept	..	..
10	6%	‡Do. 6 per Cent. Pref.	9½ −10½	5 11 0	Mar, Sept	..	..
St.	4½%	‡Do. 4½ per Cent. Debs.	90 −92	4 18 0	Jan, July	..	..
5	..	I. of Thanet E. T. & Lt. 5 per Cent. Pref.	⅞ −1⅜	..	Mar, Sept	..	..
St.	4%	Do. 4 per Cent. Deb. Stock	59 −61	6 11 0	Jan, July	66	—
10	6/0	Lanarkshire Tramways	9[illegible] −[illegible]	6 3 0	Feb, Aug	..	..
St.	5%	Lancs. Utd. Trams 5% Prior Lien Db. St.	92 −94	5 6 6	Jan, July	.	..
10	..	Liverpool Overhead Railway Ord.	1¼ −[illegible]	..	Feb, Aug	..	..
10	5%	Do. 5 per Cent. Pref.	5¾ −6¼	8 0 0	Feb, Aug	..	..
St.	4%	Do. 4 per Cent. Deb.	84 −85	4 13 0	Jan, July	..	..
10	5/0	London United Trams. 5% Cum. Pref.	5½ −6¼	8 0 0	Jan, July	5[illegible]	5⅛
St.	4%	Do. 4 per Cent. 1st Mort. Deb. Stock	75 −80	5 [illegible] 0	Jan, July	76	..
St.	..	Mersey Con. Ord. Stock	1 −3	—	Feb, Aug.	..	..
St.	..	Do. 3 per Cent. Perp. Pref.	8 −6	—	..	..	..
1	..	Metropolitan Elec. Tramways Ord.	[illegible] −¼	—		..	.
1	..	Do. Def.	[illegible] −[illegible]	..	April.. .	..	..
1	0/6	Do. 5 per Cent. Cum. Pref.	[illegible] −[illegible]	6 3 6	Feb, Aug	..	..
St.	4½%	Do. 4½ per Cent. Deb. Stock	92 −95	4 14 9	Jan, July	..	..
St.	½%	Metropolitan Railway Consolidated	36 −37	1 7 0	Feb, Aug	37½	35
St.	2½%	Do. Surplus Lands Stocks	65 −68	4 1 6	Feb, Aug	67	6[illegible]½
St.	3½	Do. 3½ per Cent. Preference	84 −87	4 0 6	Feb, Aug	84½	84½
St.	3½	Do. 3½ per Cent. "A" Preference	73 −76	4 12 0	Feb, Aug	..	—
St.	3½%	Do. 3½ per Cent. Convertible Pref.	71 −74	4 15 0	Feb, Aug	71½	.
St.	3½%	Do. 3½ per Cent. Debenture Stock	91 −93	3 15 3	Jan, July	92½	91½
St.	3½%	Do. 3½ per Cent "A" Ditto	88 −91	3 17 0	Jan, July	..	—

* In calculating the yield allowance has been made for accrued interest but *not* for redemption
† Ex Dividend ‡ The London Stock Exchange Committe have declined to quote

ELECTRICAL COMPANIES' SHARE LIST.—*Continued.*

ELECTRIC RAILWAYS & TRAMWAYS—*Continued.*

Share	Last Dividend	Name	Price Wed., Sept. 16	Rate % Yielded £ s. d.	Dividend Due	Business Week to Sept. 16 Highest	Lowest
St.	..	Metropolitan District Railway Ord.	13 —14	—	Feb, Aug	13⅝	11⅝
St	..	Do. Extension Pref. (5 per Cent.)	19 —22	..	Feb, Aug	20¼	20 1/16
St.	3½	Do. Asserted Ext. Pref. (Int. Guar. by Und. Elec. Rlys. Co. of London, Ltd.)	48 —52	6 14 6	Feb, Aug	..	..
St	3	Do. 3 per Cent. Consoltd. Rent-charge	73 —76	3 19 0	Jan, July	..	..
St.	4%	Do. 4 per Cent. Midland Rent-charge	98 —102	3 18 0	Jan, July	..	—
St.	1%	Do. Guar. Stock 4 per Cent.	49 —53	3 16 6	Mar, Sept	52	49
St.	6%	Do. 6 per Cent. Perp. Deb. Stock	116 —119	5 1 0	Jan, July	..	..
St.	4	Do. 4 per Cent. Ditto	71 —76	5 5 0	Jan, July	74	73½
6	..	New Gen. Tract. 6 per Cent. Cum. Pref.	¼—¾	—	May	..	—
1	0/9½	Potteries Electric Traction Ord.	¼—½	8 0 0	April, Oct	..	—
1	0/6	Do. 5 per Cent. Cum. Pref.	3/32—[illegible]	6 19 0	Feb, Aug	..	..
St.	4½%	Do. 4½ per Cent. Deb. Stock	93 —96	4 14 6	May, Nov	..	..
1	0/7½	S. Met. Elec. Trams. & Ltg. 6% Cm. Pref.	¾—1	6 0 0	Feb, Aug	..	..
St.	4%	Do. 4 per Cent. Deb. Stock	76 —80	5 0 0	Jan, July	--	..
100	5%	Sunderland Dist. Elec. Trms. 5% 1st Mt. Db.	78 —82	6 2 0	Jan, July	..	..
..	£1/0	Underground Elec. Rys. Co. of London	39 —43	..	June, Dec	41½	..
5	..	Yorkshire (W.R.) Elec. Trams. Ord.	⅞—1⅛	—	March ..	..	..
5	..	Do. 6 per Cent. Cum. Pref.	3⅛—3⅜	—	..	..	..
St.	4½	Do. 4½ per Cent. 1st Debs.	84 —87	5 3 0	Jan, July	86½	85¾

ELECTRIC MANUFACTURING, &c.

Share	Last Dividend	Name	Price Wed., Sept. 16	Rate % Yielded £ s. d.	Dividend Due	Business Week to Sept. 16 Highest	Lowest
	..	Aron Electricity Meter Ord.	[illegible]—11/16	..	..	..	..
1	1 4½	Do. 6% Cum. Pf. (ex on a/c arrears)	11/16—13/16	7 12 0	April, Oct	..	..
1	2/4½	Babcock & Wilcox Ord.	3¾—4	5 0 0	April, Oct	4	2⅞
1	0/7⅛	Do. Pref.	1½—1⅝	3 13 9	..	3	.
1	4 0	†British Insulated & Helsby Cables Ord.	6¼—6¾	7 8 3	July, Feb	6 3/16	6⅛
5	3/0	Do. 6 per Cent. Pref.	6 —6½	4 12 0	Jan, July	..	..
5	4½%	Do. 4½ per Cent. 1st Mort. Deb. (red.)	103 —106	4 5 0	Jan, July	..	..
St.	4½%	British Thoms'n-Houst'n 4½% 1st Mt. Db.	91 —96	4 14 0	Mar, Sept	..	..
St.	..	British Westinghouse 6 per Cent. Pref.	[illegible]/16—9/16	—	Feb, Aug	..	..
5	4%	Do. 4 per Cent. Mort. Deb. Stock	41 —46	8 14 0	Jan, July	..	..
St.	..	Brush Electrical Engineering	½	—	March ..	..	..
2	..	Do. 6 per Cent. Pref. non-Cum.	⅛—[illegible]	..	Mar, Sept	..	..
2	4½%	Do. 4½ per Cent. Perp. 1st Deb. Stock	68 —73	6 3 0	Mar, Sept	..	—
St.	4½%	Do. Perpetual 2nd Deb. Stock	50 —54	8 6 6	Jan, July	..	..
St.	10 0	Callender's Cable Con. Ord.	9¾—10¾	6 17 6	Jan, July	..	—
5	2/6	Do. 5 per Cent. Cum. Pref.	5¼—5¾	4 7 0	Jan, July	..	..
5	4½%	Do. 4½ per Cent. 1st Mort Debs. (red.)	107½—109½	4 2 0	Nov, May	..	..
St.	1/0	Castner-Kellner Alkali Co.	1 9/16—1 11/16	8 0 0	May, Nov	1⅝	1 9/16
1	4½%	Do. 4½ per Cent. 1st Mort. Deb. (red.)	103 —107	4 4 0	Feb, Aug	..	..
St.	0 9¾	Chadburn's (Ship) Telegraph Ord.	15/16—1 1/16	7 11 6	March ..	..	..
1	0/7½	Do. 6 per Cent. Cum. Pref.	15/16—1 1/16	5 13 0	April, Oct	..	..
1	0/8¾	Consolidated Electrical Co.	⅜—½	7 0 0	August ...	..	..
1	1/0	Consolidated Signal Co.	1⅛—1 [illegible]	9 12 0	April, Oct	..	..
1	0/7½	Do. 6 per Cent. Cum. Pref.	13/16—[illegible]	6 8 0	April, Oct	—	..
1	3/0	*Crompton & Co. (Nos. 1 to 85,000)	1 [illegible]—1 9/16	9 5 0	Jan, July	..	..
3	5%	Do. 5 per Cent. 1st Mort. Debs. (red.)	96 —99	5 1 0	Jan, July	..	—
100	0/7½	†Davis & Timmins	⅞—1⅛	..	Mar, Sept	..	..
1	2/0	Dick, Kerr & Co. Ord.	1¼—1½	6 13 4	Sept	—	..
5	0/7½	Do. 6 per Cent. Cum. Pref.	1 1/16—1 [illegible]	4 11 0	Sept	..	..
5	4½%	Do. 4½ per Cent. Deb. Stock	100 —103	4 7 6	Jan, July	..	—
St.	2/6	Edison & Swan United ("A" Sh.) (£3 pd.)	½—¾	..	Feb, Aug	..	..
5	4/2	Do. (£5 paid)	1½—2½	5 0 0	Feb, Aug	..	—
5	4%	Do. 4 per Cent. Mort. Deb. Stock (rd.)	76 —79	5 [illegible] 6	June, Dec	..	..
St	5%	Do. 5 per Cent. 2nd Deb. Stock	85 —87	5 15 0	Mar, Sept	—	..
St.	..	Edmundson's Elec. Corp. Ord.	⅛—⅜	..	Jan, July	..	..
5	..	Do. 6 per Cent. Cum. Pref.	½—1	..	May, Nov	¾	..
5	4½%	Do. 4½ per cent. 1st Mort. Deb. (red.)	59 —66	6 16 0	Jan, July	..	..
St.	..	Electric Construction Co.	⅜—⅞	..	Jan, July	¾	..
2	2/9	Do. 7 per Cent. Cum. Pref.	1½—2	7 0 0	July	—	..
2	4%	Do. 4 per Cent. Perp. 1st Mort. Debs.	66 —71	5 13 0	Jan, July	..	..
St.	5 0	General Electric (1900) 5% Cum. Pref.	7½—8	6 5 0	June, Dec	..	..
10	4%	Do. 4 per Cent. 1st Mort. Debs.	85 —90	4 9 0	Mar, Sept	..	—
St.	6/0	Henley's Telegraph Works Ord.	10¼—11¼	6 10 0	Feb, Aug	..	..
5	2/3	Do. 4½ per Cent. Pref.	5 —5½	4 2 0	Feb, Aug	..	..
5	4½%	Do. 4½ per Cent. 1st Mort. Deb. Stock	107 —109	4 2 6	Mar, Sept	..	..
St	5/6	India Rubber, Gutta Percha, &c., Wrks.	15½—16½	6 2 0	Feb, Aug	..	..
10	4%	Do. 4 per Cent. Debs. (red.)	99 —101	3 19 0	April, Oct	..	—
100	..	National Elec. Construction Co.	⅜—⅝	..	April	..	..
1	0/8¾	Richardsons, Westgarth & Co., Ltd. Ord.	7/16—9/16	7 2 0	Nov	[illegible]	..
1	0/7½	Do. 6 per Cent. Cum. Pref.	½—⅝	6 17 0	May, Nov	..	..
1	4½%	Do. 4½ per Cent. Perp. Deb. Stock	85 —88	5 2 0	Jan, July	..	..
St.	..	Simplex Conduits Ord.	1½	..	..	—	—
1	..	Do. 6 per Cent. Cum. Pref.	5¼	..	..	..	..
5	12/0	Telegraph Construction & Maintenance	32½—34½	6 2 6	Mar, July	34	32½
12	4%	Do. 4 per Cent. Deb. Bonds (1909)	101 —103	3 17 0	Jan, July	..	..
100	1 0	Vickers, Sons & Maxim, Ltd., Ord.	1 11/16—1 13/16	9 1 0	..	1 [illegible]	1¾
1	0/6	Do. 5 per Cent. non-Cum. Preference	1 —1⅛	4 9 0	..	1⅛	1 1/16
1	5%	Do. 5 per Cent. non-Cum. Preferred	100 —103	4 17 6	..	101½	..
St	4%	Do. 4 per Cent. 1st Mort. Db. Sk. (red.)	104 —106	3 15 0	June, Dec	105	104½
St	4½%	Do. 4½ per Cent. 2nd Mort. Deb. (red.)	104 —106	4 5 0	June, Dec	..	..
100	15/6	Do. 5 per Cent. 3rd Mort. Debs. Scrip.	103 —105	4 15 0	..	105½	103¾
100	10/0	J. G. White & Co. 6% Cm. Pref.	8½—9½	8 17 9	..	..	..
1	1/0	Willans & Robinson Ord.	¾—1¼	4 0 0	Apr, Oct	..	.
5	2/0	Do. 6 per Cent. Cum. Pref.	2½—3	8 11 6	Apr, Oct	2¾	2 [illegible]
100	4%	Do. 4 per Cent. 1st Mort. Debs.	72 —76	5 5 6	May, Nov	72¼	72

TELEGRAPHS.

Share	Last Dividend	Name	Price Wed., Sept. 16	Rate % Yielded £ s. d.	Dividend Due	Business Week to Sept. 16 Highest	Lowest
10	..	Amazon Telegraph	2 —3	—	June, Dec	..	—
100	5%	Do. 5 per Cent. Debs. (red.)	90 —93	5 7 6	June, Dec	..	..
St.	15/0	Anglo American	58 —61	5 16 0	F,My,Ag,N	60½	..
St.	30 0	Do. Preferred	104 —105	3 15 6	F,My,Ag,N	105	104½
St.	1%	Do. Deferred	17 —17½	5 17 6	F,My,Ag,N	17 1/16	17¼
St.	4%	Commercial Cable 4 per Cent. Deb. Stk.	89 —91	4 8 0	Jn,Ap,Jy,O	90½	..
10	6 0	Cuba Submarine Ord.	7½—8½	7 0 0	Feb, Aug	..	..
10	10/0	Do. Preference 10 per Cent.	16½—16¾	6 1 6	Feb, Aug	..	..
10	2/0	Direct Spanish Ord.	3 —3½	6 4 0	April, Oct	..	..
[illegible]	5/0	Do. 10 per Cent. Cum. Pref.	8 —9	5 11 0	April, Oct	..	..
[illegible]	4½%	Do. 4½ per Cent. Deb.	100 —103	4 7 6	Jan, July	..	.
20	5/0	Direct United States Cable	13½—13¾	6 2 6	Ja,Ap,Jy,O	13 [illegible]	13 [illegible]
100	4½%	Direct West India Cable 4½% Rg. Db. (rd.)	100 —102	4 8 0	June, Dec	..	..
St.	25/0	Eastern Ordinary	135½—136½	6 0 6	Ja,Ap,Jy,O	136½	136
St.	17 6	Do. 3½ per Cent. Pref. Stock	84½—86½	4 [illegible] 0	Ja,Ap,Jy,O	86	85
St.	4	Do. 4 per Cent. Mort. Deb. Stk. (red.)	103 —105	3 16 0	May, Nov	104½	..
10	2/6	Eastern Extension	12¾—13¼	5 5 6	Ja,Ap,Jy,O	13	12¾
St.	4%	Do. 4 per Cent. Deb. Stock	100½—102½	3 17 6	Feb, Aug	101½	..
100	4%	Eastern & S. African 4% Mort. Deb. 1900	99½—101½	3 18 6	Feb, Aug	..	..
..	4%	Do. 4% Mauritius Sub. Debs. (red.)	101½—103½	3 16 6	May, Nov	..	..
10	[illegible]	G. N. of Copenhagen, with Coupon 74	28 —30	6 13 6	Jan, July	29½	28½
100	4½	Halifax & Bermuda 4½% 1st Mt. Dbs. (red.)	100 —102	4 8 0	June, Dec	..	..
[illegible]	[illegible]	Indo European	66 —69	5 12 0	May, Nov	.	..
[illegible]	$1	Mackay Companies Common	68 —72	5 11 0	Ja,Ap,Jy,O	..	..
[illegible]	$1	Do. Preference	68 —72	5 11 0	Ja,Ap,Jy,O	..	..
1		Marconi's Wireless Teleg. Co.	[illegible]—¼	..	April	..	..
100	4	Pacific & European Tel. 4% Guar. Dbs. (red.)	99 —102	3 18 0	June, Dec	..	—
1	[illegible]	West Coast of America	1 [illegible]—1 [illegible]	4 5 0	May	.	—
[illegible]	4	Do. 4 per Cent. Debs.	99 —102	3 18 0	Jan, July	..	..
[illegible]		West India & Panama	½—[illegible]	..	May, Nov	..	..
[illegible]	6/0	Do. 6 per Cent. 1st Pref.	8 —8½	7 1 0	May, Nov	8 [illegible]	..
[illegible]	[illegible]	Do. 6 per Cent. 2nd Pref.	8¼—9¼	..	May, Nov	..	..
100		Do. 5 per Cent. Debs.	101 —103	4 17 0	Jan, July	.	..
10	[illegible]	Western Telegraph	13½—14	6 0 0	Mr,Jn,O,D	13¾	13⅝
1	4	Do. 4 per Cent. Deb. Stock (red.)	101 —103½	3 16 6	June, Dec	101½	..
St.	4	Western Union Teleg. $1,000 4½% Bonds	[illegible]	4 11 0	..	..	..

TELEPHONES.

Share	Last Dividend	Name	Price Wed., Sept. 16	Rate % Yielded £ s. d.	Dividend Due	Business Week to Sept. 16 Highest	Lowest
100	2¾	Amer. Telephn. & Telegh. Cap. St.	132 —136	5 18 6	..	..	..
..	4%	Do. Coll. Trust $1,000 4 per Cent. Bds	92 —94	4 16 6	Jan, July	..	..
St.	5%	†Anglo-Portug'se Tel. 5% 1st Mt. Db. Stk.	99 —102	4 18 0	Mar, Sept	..	..
5	5 0	Chili Telephone	8 —8½	4 14 0	August ..	..	—
1	0/7½	Monte Video Telephone Ord.	1 —1⅛	6 4 0	Nov	1 [illegible]	..
1	0/6	Do. 5 per Cent. Pref.	⅞—1	5 [illegible] 0	May, Nov	..	..
St.	6%	National Co. Pref. Stock	108½—110½	5 8 6	Feb, Aug	110	109
St.	6%	Do. Def. Stock	118 —120	5 0 0	Feb, Aug	118⅞	118
10	6/0	Do. 6 per Cent. Cum. 1st Pref.	10½—11½	5 4 6	Feb, Aug	..	..
10	6/0	Do. 6 per Cent. Cum. 2nd Pref.	10½—11½	5 4 6	Feb, Aug	..	..
5	2/6	Do. 5 per Cent. non-Cum. 3rd Pref.	5⅝ —5¾	4 7 0	Feb, Aug	5 [illegible]	5⅝
St.	3½%	* Do. Deb. Stock 3½ per Cent. (red.)	98½—100½	3 9 6	June, Dec	98⅝	..
St.	4%	Do. 4 per Cent. Deb. Stock (red.)	102½—104½	3 15 6	Jan, July	103½	102½
1	1/0	Oriental	1¾—1⅞	5 16 3	April, Oct	1 [illegible]	..
1	0 7½	Do. 6 per Cent. Cum. Pref.	1 3/16—1 5/16	4 11 6	April, Oct	..	..
St.	4%	Do. 4 per Cent. Red. Deb. Stock	89 —92	4 7 0	Jan, July	..	..
St.	4½%	Telephone Co. of Egypt 4½% Db. Stk. (red.)	99 —102	4 12 0	Jan, July	..	—
5	5/0	United River Plate	6¾—7¼	5 10 0	July	6⅞	..
5	2/6	Do. 5 per Cent. Cum. Pref.	5 —5½	4 11 0	June, Dec	..	..
St.	4½%	Do. 4½ Deb. St. Red.	102½—104½	4 5 6	Jan, July	..	..

FINANCIAL, INVESTMENT, &c.

Share	Last Dividend	Name	Price Wed., Sept. 16	Rate % Yielded £ s. d.	Dividend Due	Business Week to Sept. 16 Highest	Lowest
5	3/0	Elec. & Gen. Investment 6% Cum. Pref.	3½—4	7 10 0	Jan, July	..	..
10	5 9	Globe Telegraph & Trust	10⅝—11⅛	5 8 0	Sp Dc Mr Ju	10 [illegible]	10 [illegible]
10	3/0	Do. 6 per Cent. Pref.	13⅝—14⅛	4 5 0	Sp Dc Mr Ju	13 [illegible]	13⅝
10	6%	Submarine Cables Trust (Cert.)	129 —132	4 11 0	April, Oct	..	..

COLONIAL AND FOREIGN ELECTRIC RAILWAYS, TRAMWAYS, &c.

Share	Last Dividend	Name	Price Wed., Sept. 16	Rate % Yielded £ s. d.	Dividend Due	Business Week to Sept. 16 Highest	Lowest
5	3/0	Anglo-Argentine 6% Cum. 1st Pref.	6¼—6½	4 12 6	April, Oct	6 [illegible]	6⅝
5	5/0	Do. 10% Non-cum. 2nd Pref.	8 11/16—8 15/16	5 14 3	Jan, July	8 [illegible]	—
St.	6%	Do. Permanent 6% Deb. Stock	143 —148	4 1 0	June, Dec	..	—
St.	5%	Auckland Elec. Trams. 5% Deb. (red.)	103 —106	4 14 3	Jan, July	104¾	..
5	4/0	Brisbane Electric Trams. Invest. Ord.	4⅝—4⅞	4 2 6	May	..	..
5	2/6	Do. 5 per Cent. Cum. Pref.	4⅞—5⅛	4 17 6	May, Nov	5 1/16	5 [illegible]
St.	4½%	Do. 4½ per Cent. Db. Prov. Certs.	100 —104	4 6 6	Jan, July	103¾	103
St.	8%	British Columbia El. Ry. Df. Ord.	137 —141	5 13 0	Mar, Sept	139¾	138
St.	30 0	Do. Pref. Ord. Stock	116 —120	5 0 0	May, Nov	117	115¾
St.	5%	Do. 5% Cum. Perp. Pref. Stock	105 —109	4 11 6	Jan, July	107½	..
40	4½%	Do. 4½ per Cent. 1st Mort. Debs.	101 —104	4 6 6	April, Oct	..	..
100	4½%	Do. Vancouver Power Debs.	100½—103½	4 7 0	Jan, July	..	—
St.	4½%	Do. 4½% Perp. Con. Deb. St.	102 —105	4 0 6	—	104½	..
St.	5%	Buenos Ayres Elec. Trams (1901) Ltd. Deb. St.	97 —102	4 18 6	Ja, Jul ..	..	..
5	..	Buenos Ayres Grand National Ord.	2½—3	..	..	2 11/16	..
5	2/6	Do. 5 per Cent. Cum. Pref.	4½—4⅞	5 8 0	Feb, Aug	—	..
100	5½%	Do. 5½ per Cent. Pref. Debs.	100 —105	5 4 6	Jan, July	..	..
100	6%	Do. 6 per Cent. 1st Deb. Bonds.	101 —106	5 13 0	April, Oct	..	..
St.	5%	Buenos Ayres Lacroze Trams 1st Mt. Db.	95 —97	5 3 0	Mar, Sept	96½	..
St.	6%	Buenos Ayres Port & City Tram. 1st Mt. Deb. Stock £75 Paid	61 —65	6 12 0	Feb, Aug	..	..
5	2/6	Calcutta Tramways (1 to 137,610)	5½—6	5 0 0	Mar, Sept	..	..
100	2/6	Do. 5 per Cent. Cum. Pref.	4⅞—5½	4 13 0	Jan, July	--	..
1	4½%	Do. 4½% 1st Deb. Stock (red.)	101 —104	4 6 6	Jan, July	104	102½
St.	..	Cape Electric Tram Shares	⅛ ⅜	..	..	..	—
5	1/3	City of Buenos Ayres Trams Co. (1904) Sh.	5⅝ —5⅞	4 5 3	F, My, A, N	5 [illegible]	5 [illegible]
St.	4%	Do. 4 per Cent. Deb. Stock	99 —103	3 17 [illegible]	June, Dec	..	..
.	5%	Colombo Tr. & Ltg. 5% 1st Mt. Db.	90 —93	5 6 6	May, Nov	..	—
100	5%	Electric Traction Co. of Hong Kong 5 per Cent. 1st Mort. Debs.	85 —90	5 10 0	June, Dec	..	..
1	5%	Havana Elec. Ry. Con. Mt. 5% $1,000 50 year Coup. Bds.	85 —90	5 11 0	Feb, Aug	..	..
1	..	Kalgoorlie Elec. Trams Sh.	½—[illegible]	..	..	..	..
100	5%	Do. 5 per Cent. "A" Deb. Stock	86 —89	5 12 0	Jan, July	..	—
5	6%	Do. 6 per Cent. "B" Ditto	65 —70	8 11 6	Jan, July	..	..
5	1/0	Lisbon Elec. Trams. Ord.	1 —1¼	4 0 0	July	..	..
100	0/7½	Do. 6 per Cent. Cum. Pref.	1 —1¼	4 16 0	Jan, July	..	..
St.	5%	Do. 5 per Cent. Reg. Mort. Debs.	92 —97	5 3 0	Jan, July	..	..
St.	5%	Madras Elec. Trams. 5% Deb. Stk.	93 —96	5 4 0	Jan, July	..	..
.	5%	Manila Elec. Ry. $1,000 Gold Bonds	84 —88	5 14 0	Feb, Aug	..	..
100	4/.½	Mexico Trams Co. Com. St.	124 —126	3 17 0	..	125	123
500	5%	Do. Gen. Con. 1st Mort. 5% Gold Bds.	92½—93½%	5 7 0	..	93⅜	92½
St.	4½%	Montreal St. Ry. Sterling 4½ per Cent. Debs. (1922) (Nos. 601 to 2,000)	100 —102	4 8 0	Feb, Aug	102½	..
1	1/0	Perth Elec. Trams Ord.	[illegible]	6 13 6	May	..	..
St.	5%	Do. 1st Mt. Db. Stock	101 —104	4 16 0	Jan, July	..	—
5	3/0	Rangoon Elec. Trams & Supply Co. 6% Cum. Pf.	5⅛—5⅝	5 6 6	..	..	—
St.	4½	Do. 4½% 1st Mort. Deb. Stk.	95 —100	4 10 0	..	90½	90½
..	$7½	Sao Paulo Tramway, Light & Power Co. $100 Stock	155 —159	5 13 0	..	157½	156
..	5%	Do. 5 per Cent. 1st Mt. $500 Db.	99½—100½	4 19 6	June, Dec	100¼	100
100	4½%	†Toronto Ry. Co. 1st Mt. 4½% Ster. Bonds	97 —99	5 1 0	Feb, Aug	98⅜	98

COLONIAL AND FOREIGN ELECTRICITY SUPPLY &c.

Share	Last Dividend	Name	Price Wed., Sept. 16	Rate % Yielded £ s. d.	Dividend Due	Business Week to Sept. 16 Highest	Lowest
5	8 0	Adelaide Elec. S'ply Co. 6% Cu. Pr.	4¾—5½	5 14 0	Mar, Sept	..	..
10	6/0	Bombay E. S. & T. 6% Cm. Pf.	9¾—10¾	5 16 3	..	10 [illegible]	10 [illegible]
St.	4½	Do. 4½ per Cent. Deb. Stk. (red.)	94 —96	4 13 9	Jan, July	94½	..
5	4/9	Calcutta Elec. Supply Ord.	6 —7	5 14 0	April, Oct	6½	..
100	7 2	Canadian Gen. Elec. Co. Com. St.	107 —111	6 7 0	..	109½	108
100	5%	Castner Electrolytic Alkali Co. (of U.S.A.) 1st Mort. Stl. Debs.	92 —97	5 2 6	Jan, July	..	..
500	5	Elect. Development Co. of Ontario	84 —87%	5 15 0	..	87	..
5	..	Elec. Ltg. & Trac. Co. of Aust. 6 per Cent. Cum. Pref.	2 —2½	..	Feb, Aug	..	..
St.	5%	Do. 5 per Cent. Deb. Stock	83 —85	5 13 9	Jan, July	86½	..
St.	5%	Elec. Supply Co. of Victoria 5 per Cent. 1st Mort. Deb. St.	90 —93	5 7 6	Jan, July	92	..
St.	6%	Indian Elec. Sup. & Trac. Co. Constn Deb. St. Rd.	30 —40	15 0 0	Jan, July	..	..
10s.	0 3	Kalgoorlie Elec. Power & Ltg. Ord.	⅛—¼	..	..	[illegible]	..
1	0/7½	Do. 6 per Cent. Cum. Pref.	⅛—¼	8 0 0	April, Oct	[illegible]	..
St.	5%	Madras E. S. Corp. 5 per Cent. Constn Deb. St.	85 —90	5 11 0	April, Oct	..	..
500	6%	Mexican Elec. Light Co. 6% 1st Mort. Gold Bonds	90 —91½	5 10 0	..	90½	88½
St	$1	Mexican Lt. & Power Co. Com. St.	78½—7[illegible]	..	—	78	77
500	5%	Do. 5% 1st Mort. Gold Bnds.	93 —94	5 5 6	..	94¼	93½
100	6/2	Montreal Lt. Ht. & Power Co. Cap. St.	105 —109	5 10 0	F, My, A, N	107½	106
1	1/7½	River Plate Electricity Co. Ord.	1¼—1½	4 16 0	April	1½	1½
1	1 2½	Do. 6 per Cent. non-Cum. Pref.	[illegible]—1 [illegible]	6 13 0	May	..	..
St.	6%	Do. 6 per Cent. Deb. Stock	98 —101	4 19 0	Jan, July	100	..
5	3/0	Rosario Elec. Co. 6% Pref. (1 20,000)	4½—5¼	5 14 0	April, Oct	..	..
100	$1	Shawinigan Water & Power Co. Cap. St.	82 —86	4 15 3	..	83½	82
..	5%	Do. 5 per Cent. Bds.	103 —105½	4 15 6	Jan, July	104½	104
..	[illegible]	Victoria Falls Power Co. Pref.	[illegible]	—	Jan, July	[illegible]	

* In calculating the yields allowance has been made for accrued interest but not for redemption. † Ex dividend. ‡ The London Stock Exchange Committee have declined to quote these.

CONTENTS.

THE ELECTRICIAN INDUSTRIAL SUPPLEMENT.

Electrician No. 1583.
Indust. Suppt. No. 27.
Gratis to Subscribers.

SEPTEMBER 18, 1908.

…PPLEMENT is issued Gratis to Subscribers to "The Electrician."
…XTRA COPIES can be obtained, price 4d. per copy post free.

Breakdowns of Machinery.

THE vast amount of machinery in use to-day in this country alone may well give pause to the mind of the engineer, while to the layman capable of appreciating such things it may reasonably be a matter for amazement. Bald ungarnished statistics, however, convey little or nothing of the real importance of machinery in industrial affairs. One must turn to the reports of insurance companies for those details which go to show the influence exerted by steam, gas and oil engines and electric motors on the conduct of industrial processes. Incidentally we may remark here that these reports are little more than searchlight rays piercing the darkness representing the large amount of machinery remaining uninsured. Still, the scrutiny made possible by the reports in question is of immense value in throwing light on the operating side of industrial prime movers and power agents.

In many respects the insurance companies are to be sympathised with, as the task they assume is a somewhat thankless one. Without wishing to cast any reflection upon users of machinery generally, the temptation to disregard the recommendations of the insuring company must at times be great—greater, in fact, in direct proportion to the age and efficiency of the plant in question.

The comprehensive annual reports of those insurance companies who assume responsibility for boilers, engines of all classes, dynamos, motors, &c., are an excellent reflex of the performance of such plant, and should be a guide to power users, both present and prospective, in the selection of machinery and apparatus.

A careful perusal of the report just issued by Mr. Michael Longridge, chief engineer of the British Engine, Boiler & Electrical Insurance Co., presents many striking contrasts amid a mass of enormously valuable data regarding the breakdowns of the machinery included in the scope and purview of the company's business. The many readers into whose hands the report will have already come will each draw widely varying conclusions. We propose in what follows to look at the data and other information in the light of electric power supply development. We may approach the subject somewhat prejudiced in favour of the electric motor, but we find ample justification in the fact that in industrial circles this power agent has proved its superiority to such good purpose over steam, gas and oil engines.

Considering the record of breakdowns of the first mentioned both boilers and engines, one is impressed with the few fatal boiler accidents together with the frequent references to failures of beam engines. The engineer with a leaning towards modern designs of power plant and apparatus will wonder why such engines remain in service. The danger to life and limb incurred by the failure of a heavy beam engine should be sufficient to suggest its abandonment, particularly as such engines date back into what we may term the "prehistoric past" of engineering. This fact is strongly hinted at by the significant remark in the report before us that the age of certain broken-down beam engines was unknown. It is difficult to grasp the fact that, in a growing age of rotary prime movers, such mechanical enormities as beam engines are permitted to drag painfully at the tail of the Car of Progress. Our own feelings are that engines of this kind disappear slowly from industrial circles owing to the acuteness and tenacity of competition. In the conduct of works in which no attention is paid to advances in engineering and machinery, the plant is kept in spite of, rather than because of, modern improvements. The management get the idea that a factory equipment must be run for all it is worth, without regard to the provision of a fund for the gradual replacement of the old by the new. Then there is also the kind of company which operates on the fringe of industry, harrying it, so to speak, from without, with goods made on obsolete machinery run by practically derelict power plant. Unfortunately the doings of these coyottes are not recorded in the reports of insurance companies, for the simple reason that no respectable guarantee undertaking would have any dealings with them. Until a wholesale process of concentration of productive plant and machinery is entered upon this state of things must always ensue.

Turning again to Mr. Longridge's report, we find much food for reflection in his references to the breakdown of gas engines. The risks run by gas engine users are certainly greater than those of steam users, as there still seems to be no relying on the flywheels or the connecting rod big ends. The breakdowns referred to in the report relate chiefly to the breaking of big end bolts followed by next door to complete wreckage of the engines. The piston can generally be relied upon to knock its way out at the cylinder end, taking a quantity of valve gear and other "gadgets" with it on a voyage of discovery. These little trips away from the path of duty cost the unfortunate owner of the gas engine dear. The remarkable thing about these vagaries of gas engine parts is their harmless nature.

Flywheels and other sundries leave the engine room by widely different exits and varying velocities without "passing a soul on the way."

The first item in the gas engine section of the report will doubtless be read feelingly by all gas engine users. We reproduce it in full: "Five horizontal gas engines with cylinders varying from $7\frac{3}{4}$ in. diameter by 14 in. stroke to $7\frac{1}{4}$ in. diameter by 13 in. stroke, running at about 200 revs. per min. with lighting gas from the town main. All five were situated in one works and belonged to one owner. One evening the driver was called away as he was stopping the engines and in hurrying to obey the summons forgot, or to save time neglected, to open the jacket drains. On returning the following morning he found four of the five cylinder jackets cracked from end to end and full of ice. Mishaps of this kind occur every winter, generally during the Christmas or New Year holidays, or on Sundays, even among insured engines, whose owners are warned both when the insurance is effected and on the approach of cold weather every year."

That portion of the report which relates to electrical machinery might, prima facie, be taken as a certain indictment against the electric motor in particular and electric power in general. Numerous instances of the failure of motors from various causes are given, and the majority of them are attributable to careless handling, severe operating conditions and poor workmanship. None of the breakdowns occasioned serious external damage, such as invariably accompanies the failure of gas engines or boiler explosions. In the report, 24 cases of motor and dynamo breakdowns are given, and three only of these related to alternate current machines and to motors only. The simplicity of the alternating current motor explains this paucity of failures and incidentally is one of the best testimonials which could be found for motors and machinery of this type. The large balance of direct current breakdowns shows a predominance of armature and commutator troubles which clearly mark these as the weakest parts of direct current motors. A table epitomising the breakdowns accompanies the report and presents many instructive figures. In motors, for instance, 28 per cent. of the breakdowns are attributed to dirt and neglect, and no less than 23 per cent. to age and deterioration. The latter is something of a recommendation, as it points to long and arduous service. Bad workmanship and poor design account for 18 per cent. and the only large remaining item is a figure of 26 per cent. labelled "unascertained." The starters, which are equally as important as the motors themselves, show a record of 35 per cent. against the unascertained column of causes of failure, while 27 per cent. is the tale of age and deterioration. A starter is often sadly neglected, yet only 16 per cent. of the failures are put down to this cause. Of the actual parts in controllers and starters giving the most trouble, 60 per cent. of the failures lay to the charge of resistances, another fact which confirms the recognised weakness of this section of the apparatus. Automatic appliances get the discredit of 13 per cent. of failures, contacts and switch arms 8 per cent. and miscellaneous (which might be "any old thing") 19 per cent. These figures should be committed to memory by every maker of motors and starting apparatus, though we do not doubt that they are seized upon with avidity and many lessons drawn from the valuable data and advice given.

From the user's point of view the report is even more instructive in that it affords ample testimony of the reliability of the electric motor under severe industrial conditions. In common with all other class of machinery the electric motor appears to suffer at the hands of the workman, but not infrequently it maintains its speed and operating efficiency in spite of bad treatment. This serves to show that it is in many ways independent of the treatment it receives.

Electric Power in Textile Mills.

THE forthcoming Manchester Electrical Exhibition should do more than stimulate trade and domestic interest in electric lighting and heating. There is, of course, a need for an increase in the sale of electricity to this class of consumer, and with vigorous business methods things should go ahead. But lighting consumers, though perhaps less difficult to obtain than heretofore, are not such producers of revenue as they used to be now that metal filament lamps have cut down sources of income from this quarter.

Suppliers of electrical energy must turn to the power consumers to maintain the station load and flatten out the peak due to the lighting consumer. In Lancashire, the textile industry naturally presents the best prospect of custom, and station engineers may console themselves with the thought that the methods for mill driving by electric motors are now fairly well standardised, and in approaching the factory owner they can go armed with data and figures, also illustrations of actual plant installed.

In a recent issue of *Cassier's Magazine* some consideration was given to the matter of textile mill driving which presents data concerning the isolated plant aspect of the question. This is, if anything, equally as important as the supply of power from some outside source, so that the treatment of the subject may be read with interest.

In this article C. J. Cavanagh considers the matter more specifically, and points out wherein electric driving is

better than the others. The requirements of the textile industry are characteristic. The materials worked with are neither coarse nor heavy, but extremely fragile, and consequently the machines required to work them must be sensitive and as free from cyclic variation as possible. In the cotton industry, the evenness of turning is of first importance, and this necessity is much more emphasised in the jute and flax industries, where the materials worked have not the elasticity of cotton. It is the ability thus obtained to run the mill constantly at full load, thus securing an increased rate of production, that justifies the installation of an electrical equipment, because the interest on capital charges for an electrical system will increase the cost of power; and a well-installed, carefully-maintained rope drive will give rise to very small frictional losses. However, in addition to the improved running conditions secured by the electrical system, this method brings advantages to a growing mill, as changes can be wrought easily and expansions effected with convenience. There is no loss in transmitting power to idle machines, and a hot bearing affects only the particular machine on which it occurs; in a mechanical drive, when a hot bearing may shut down a whole line shaft and stop production, the loss which it causes become severe. In selecting a type of motor for a textile mill, two complicating conditions are met. The polyphase induction motor is simple in operation and is sparkless; but its speed cannot easily be regulated. The direct current motor, on the other hand, is ideal for speed regulations and simple in operation, but sparking at the commutator cannot always be avoided. In a textile mill, where the air is full of fluff, sparking introduces some danger. In deciding between group or individual driving, the commercial factor enters largely into the question. With some machines, the power absorbed is so small that it is not advantageous to make use of an individual drive as these low-rated motors run at high speeds and generally necessitate some form of reducing gear. This increases the cost and the losses and the liability to breakdown. In some cases the nature of the load renders group driving imperative. The ideal method of supplying power for the mills would be the erection of a central station, from which power would be distributed through a group of local mills. This would not only decrease the capital outlay by the mills, but would result in a more reliable and more efficient station. The type of prime mover most used to-day in textile mills is the steam engine, but the steam turbine has a distinct advantage in the uniformity of rotation, and hence is coming into use. The gas engine offers the mill a very efficient prime mover, but until greater reliability is secured it will not make very great headway.

Electricity and . . Water Purification.

IN this country it is our good fortune to have a pure water supply in the greater number of our large towns. Ordinary methods of filtration seem to suffice for the removal of impurities, and the presence of harmful "cultures" appears to be practically unknown. America, in common with Continental countries, is apparently not in the same position as ourselves, judging by an article on the purification of water by electrical means, which appeared in a recent issue of the *Electrical World*. In this the treatment of infected water by an ozonising process is considered and the method adopted by the Gerard Ozone Co. is described. An installation of considerable proportions has recently been put down at the Homœpathic Hospital, Pittsburg.

This plant has a capacity of about 250,000 gallons per 24 hours, and it is now treating 100,000 gallons during each 10 hour day at an approximate cost for electrical power of 1s. No attendance is required beyond an occasional visit from the engineer in charge of the hospital power plant, so that it is practically self-operative when once put in operation. The two most significant features of this plant are its low maintenance cost and simplicity of operation.

The process is as follows: Atmospheric air, after being passed through a drier, is ozonised during its passage through the Gerard apparatus; it is then mixed with the water to be purified in an injector and a further degree of mixing secured by allowing the water to flow up through a tower in which a number of perforated trays are arranged one over another. As the water overflows at the top of the tower in a small cascade any remaining ozone is removed, and the pure sterilised water is conveyed to the general distributing tank for use as desired. At first it has a slightly milky appearance, due to the entrained air, but this soon passes away, leaving the water clear and sparkling.

Power for operating the ozonisers is supplied by a 110 volt single-phase 60 cycle generator direct connected to a 3 H.P. direct current motor. The alternating current is led from the switchboard over two 1 kw. transformers, with 10,000 volt secondaries connected in parallel on high-tension 'bus bars. Disconnecting switches are provided, so that the load can be divided between each transformer or all carried by a single one if desired.

The ozonising apparatus is grouped in five units, three used for the purification of water and two for general purposes throughout the hospital. Any unit can be cut in or out as desired by manipulating the disconnecting switches.

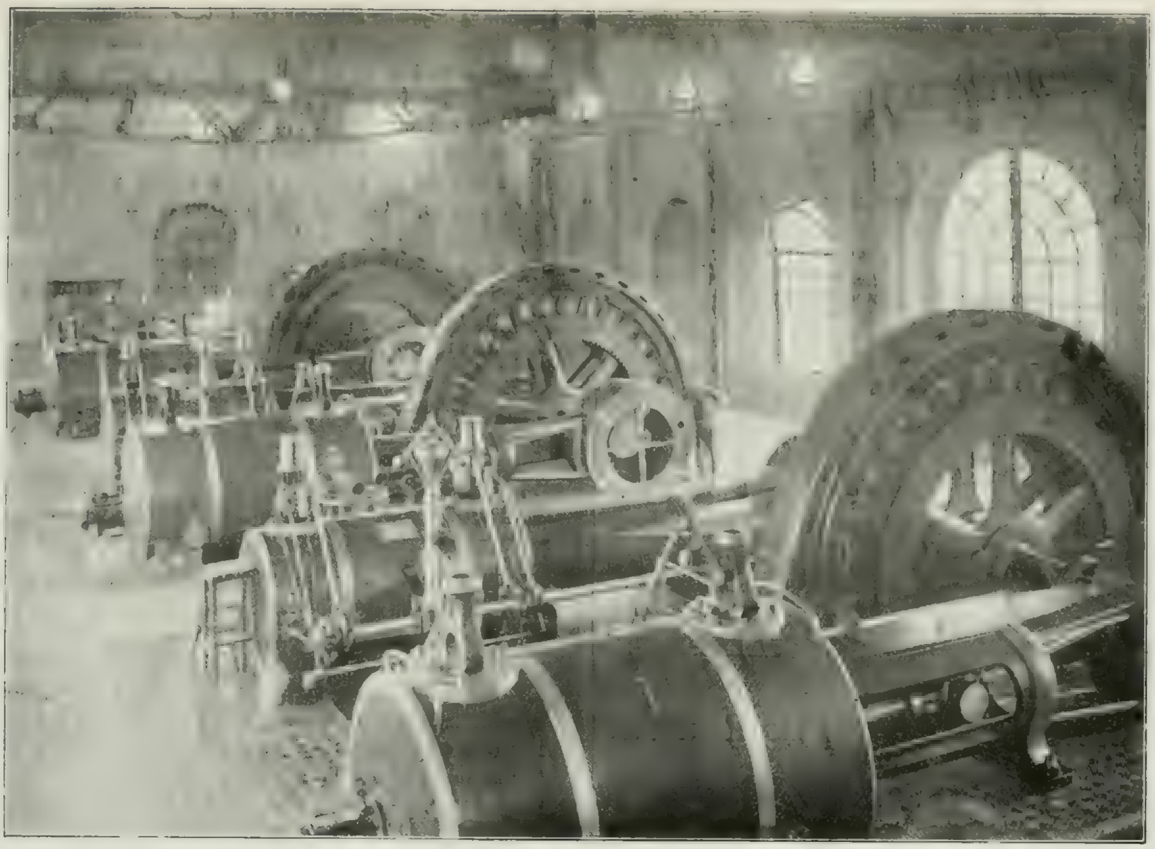


Fig. 1.–Interior of Power House, Tongshan Mine.

Electric Pumping Plant in China. . . . . . .

LACK of enterprise and non-appreciation of modern developments are the usual indictments against the Chinese. They are even supposed to have a supreme contempt for all kinds of machinery, depending for preference on their own prehistoric contrivances. Some interest, therefore, attaches to an electric pumping plant which has recently been installed at the Tongshan mine of Chinese Engineering & Mining Co. The plant is a pioneer

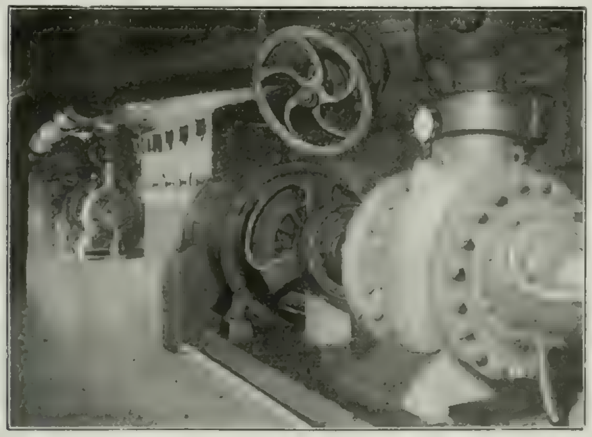


Fig. 2.–Pump Room, Sixth Level, Tongshan Mine.

installation in the Far East, and was put down by Mr. A. S. Cross, who describes it in a recent issue of the Faraday House *Journal*. The total capacity of the power plant is 4,800 H.P. in three units of 1,600 H.P. each. Steam boilers to the number of 12, working at 150 lb. pressure, furnish steam for three engines (*see* Fig. 1) coupled direct to alternators of the revolving field type. The engines are

compound with cylinders placed on each side of the central generator. The alternators give three-phase energy at 2,000 volts at 25 cycles. Excitation is furnished by three motor-generators, each of 130 H.P., and a 26 kw. steam unit.

The switchgear has received special attention, being built on the hand-operated distance-control method, with oil switches for the high-tension circuits. The main feeders are controlled from a separate group of panels to those connected with the main alternators. There is also a separate distribution board for the lighting of the mines.

The plant has been primarily installed for pumping purposes to keep the mine free of water. A three-core paper-insulated cable, with lead covering and wire armoured, is taken down the shaft to the fourth and sixth levels, in which the pumps are installed. A spare cable with control gear and instruments is also provided. In the sixth, or lowest level, are two Sulzer centrifugal pumps direct coupled to A.E.G. motors of 180 H.P., running at 1,460 revs. per min., and direct coupled to the 2,100 volt transmission circuit. The motors are of the squirrel cage rotor type, and are fitted with forced ventilation. They are started by auto-transformers. The pumps are of the four-stage type, and raise the water to the fourth level, at which three units of the same size are installed. One of the four stages is, however, dispensed with at this level to correspond with the head of 400 ft., against which the water must be raised to the surface. One unit in each level is held in reserve, and a spare water main has also been put in. One of the pumps is shown in Fig. 2.

In addition to the above plant, motors are also being installed for fans, a saw mill, brick yard, workshops, &c.

It is stated that there is a somewhat similar installation at Linsi Colliery, where nine boilers and two generating sets are in operation.

Electric Foundry Equipment.

MANY of our large cities and towns can boast the possession of a few foundries, isolated shops, here and there which are not run on any pretentious scale and which cannot afford an expensive equipment. In contradistinction there are, of course, many larger establishments practising the founders' art, probably forming one department of an extensive organisation, in which the cost of plant is not of overwhelming importance. In both cases, however, the merits of the electric motor are worthy of attention, particularly as it can be applied to the driving of a class of machine peculiarly suitable for electrical operation. We refer to the blower for the cupola.

The driving of cupola blowers by motors is no new thing, but where power can be purchased from outside a factory the running of this class of machine can be entered upon with prospects of complete success. Being used intermittently the motor can be switched on and off as required without any standing losses. In large iron works where cranes, capstans, machine tools, hoists, &c., are electrically driven, the conversion of the blowers from steam to electric becomes merely a matter of course.

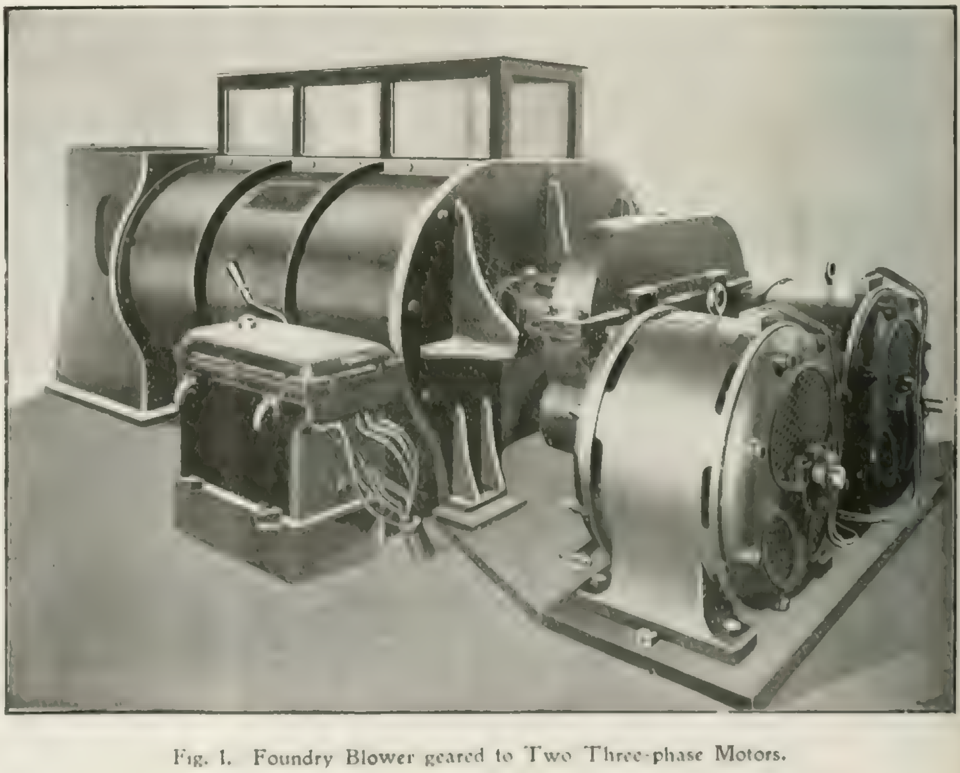


Fig. 1. Foundry Blower geared to Two Three-phase Motors.

Messrs. Smith, Patterson & Co. (Ltd.), Blaydon-on-Tyne, are now almost entirely driven by electric power, and the foundry equipment of blowers is very interesting. Three machines are installed, of different capacities, the smallest being driven by one more and the others by two. In the latter case the motors are electrically connected to a common starter and are geared together through the impeller gearing, an arrangement which reduces the stress on the teeth of the driving wheels. With belt driving it is not uncommon for one belt to slip, in which case the whole load may be thrown on one belt, and the gearing between the impellers may be required to take up a severe driving strain, running the risk of breakage.

The single blower referred to is Baker's patent with a capacity of 234,000 cubic ft. of air per hour against a pressure of 0·75 lb. when run at 130 revs. per min. A 20 H.P. Westinghouse motor drives the blower through a raw-hide pinion and a cast-iron spur wheel.

The double motor blower is an interesting application of the motor drive. The general arrangement is shown in Fig. 1, which brings up clearly the principal details. The two motors each develop 15 H.P. at 570 revs. per min., and the blowers are capable of an output of 270,000 cubic ft. of air per hour against a pressure of 1 lb. The speed is 175 revs. per min. Raw hide pinions transmit the drive from the motor shafts, and the blower spindles are connected by spur wheels. The oil-immersed starter for the control of the motors may be seen in the foreground.

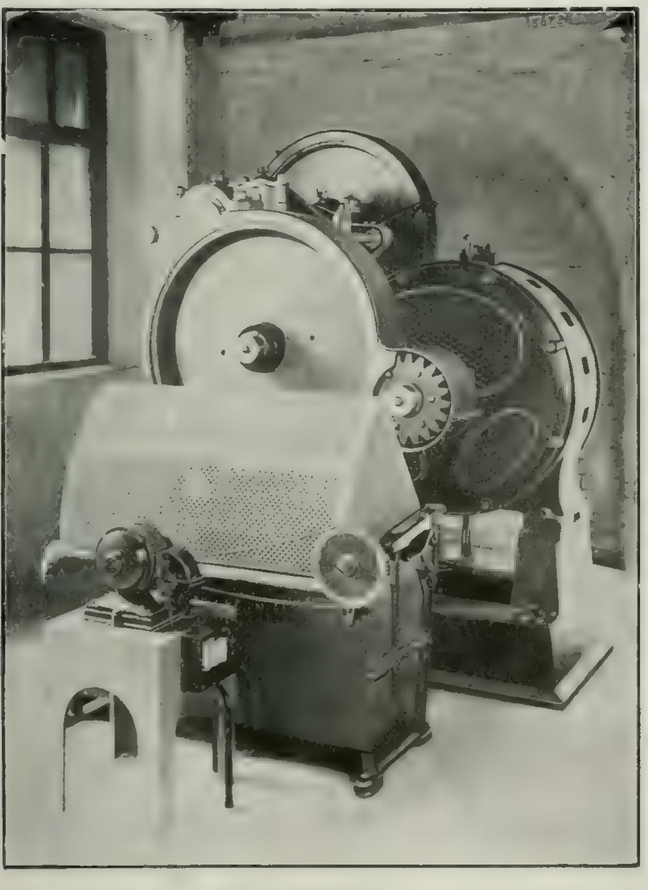


Fig. 2.—Three-throw Ram Pump, showing Motor and Automatic Controller.

The blowers supply air to six cupolas, each of which will bring down 10-14 tons per hour, the output of a pair of cupolas being 320 tons per week. As the running speed does not require to be varied, induction motors are used, and afford a satisfactory power agent for the work in question.

Dealing with the question of power required approximately, 5 H.P. is needed for every 1,000 cubic ft. of air required at 1 lb. pressure. Some 30,000 to 33,000 cubic ft. of air is usually made for the melting of 1 ton iron.

At the same foundry is installed an interesting example of a three-throw pump, this being required in connection with hydraulic cranes, capstans, &c., about the works. The pump is a ram pattern machine, with 4 in. diameter plungers, 10 in. stroke. It is driven through double reduction gearing by a 75 H.P. three-phase slip-ring motor of Westinghouse make. The motor speed is 575 revs. per min., and that of the pump 52 revs. per min., the duty being 4,800 gallons per hour against a pressure of 800 lb. per square inch.

The feature of the pumping unit is the control of the motor by the rise and fall of the hydraulic accumulator. Fig. 2 illustrates the pumping equipment with the controller in the foreground. A liquid resistance of the dipping plate pattern is used, and the movement of this is governed by a small motor, the circuit of which is controlled by a switch actuated by the tappets on the accumulator. The control of this small motor is effected in such a way that when the main motor is running at full speed the controller motor is stopped. When it it required to stop the pump the small motor circuit is closed again by the accumulator tappets, but the motor runs in the reverse direction, and gradually raising the dipping plates out of the water in the controller. As will be seen by the illustration, the small motor is coupled by chain to the controller movement and is mounted on a pedestal in front of the controller itself. 20 seconds is allowed for the start, and the controller will start the motor eight times in half an hour against full-load torque.

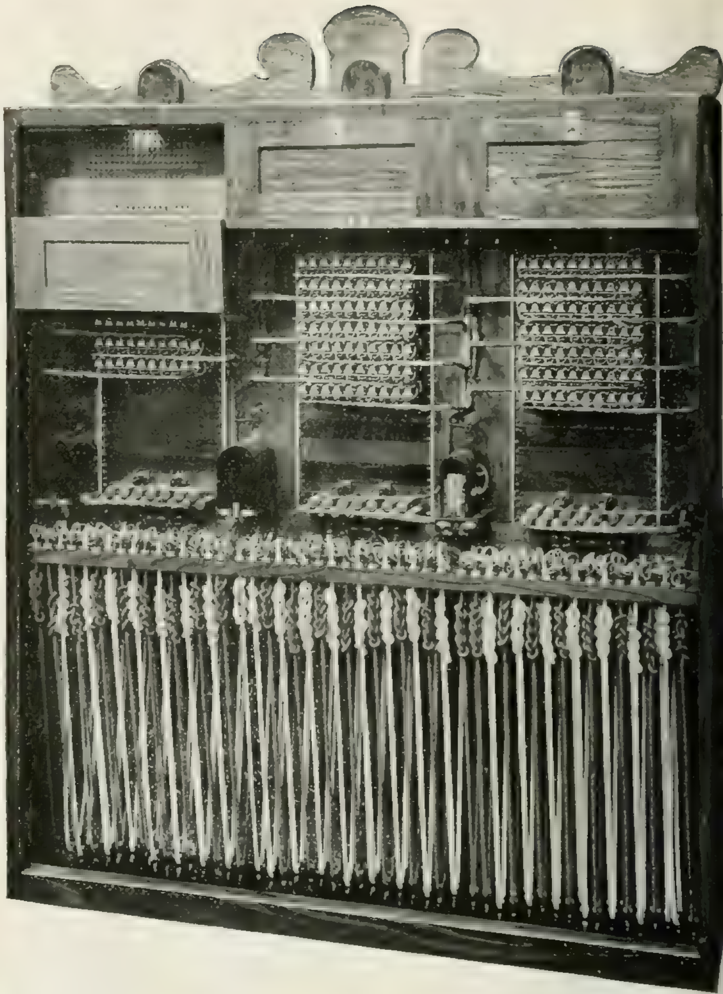
The whole of the power required on Messrs. Smith, Patterson's works is obtained from an outside source.

Telephone Switchboards.

AMONG the switchboards manufactured by the British Insulated & Helsby Cables (Ltd.) the "Express" switchboard has some novel features. The well-known drop or shutter indicator in general use is restored by the finger, and has a night bell contact or relay spring exposed, and is, therefore, liable to be put out of order when manipulating the apparatus or when dusting down the board.

In these new switchboards a new indicator jack has been introduced, the indicator part of which is automatically restored by the insertion of a plug and has no parts exposed that are likely to be put out of order either owing to the movements of operating or when the board is being cleaned. The idea of an indicator combined with a jack is not novel, but in nearly all existing patterns the shutter is liable to be dropped by the movement of the plugs and cords or by the operator's sleeve. In the new indicator a portion of a drum shows at a rectangular opening in the front plate and completely closes the orifice, so that there is no room for dust to enter, and the relay contact is at the rear.

The indicator is of the gravity type, and in the normal position the counterbalance weight is on the front of a line vertical with the axis. The drum is made of non-magnetic material, and the section showing normally at the opening is coloured black and the section to be exposed for a call is silvered or coloured white. On the periphery a tapered section of iron is inserted with the point towards the pole of the electromagnet; when, therefore, a current is passed through the coil the iron is attracted and revolves the drum until the counterbalance is to the rear of a line vertical to the axis, and when the current is removed the drum continues to revolve by gravity until it comes to rest on the relay or night bell contact. This relay contact is of substantial make and also acts as the restoring spring when the plug is inserted into the jack underneath the drum to answer a call; the upper line spring lifts the restoring spring (these being insulated from each other) and restores the indicator to the normal position.



Back view of 200-line Telephone Switchboard.

200-line "Express" Telephone Switchboard, front view.

These indicator jacks are fitted at 1 in. centres in strips of 10, as shown on the illustration. This form of indicator when used for the ring-off signal is combined with the speaking and ringing key, so that it is associated directly with the cords and with the keys, and it is believed that this is the only board that has this valuable relationship, so that the operating is very speedy and approximating to the facilities obtained on a common battery switchboard. When the ring-off signal is obtained the operator momentarily throws the speaking key to the speaking position to restore the indicator to the normal.

These boards are suitable for either magneto or battery calling and clear, and are made in any sizes from a five line wall pattern board up to a 300 line floor pattern non-multipled board, and are also used for small multiple exchanges. The illustration shows these boards fitted with galvanometers, testing jacks and plugs, so that the lines and the cords may be tested by the operator. The boards are also supplied without this testing apparatus.

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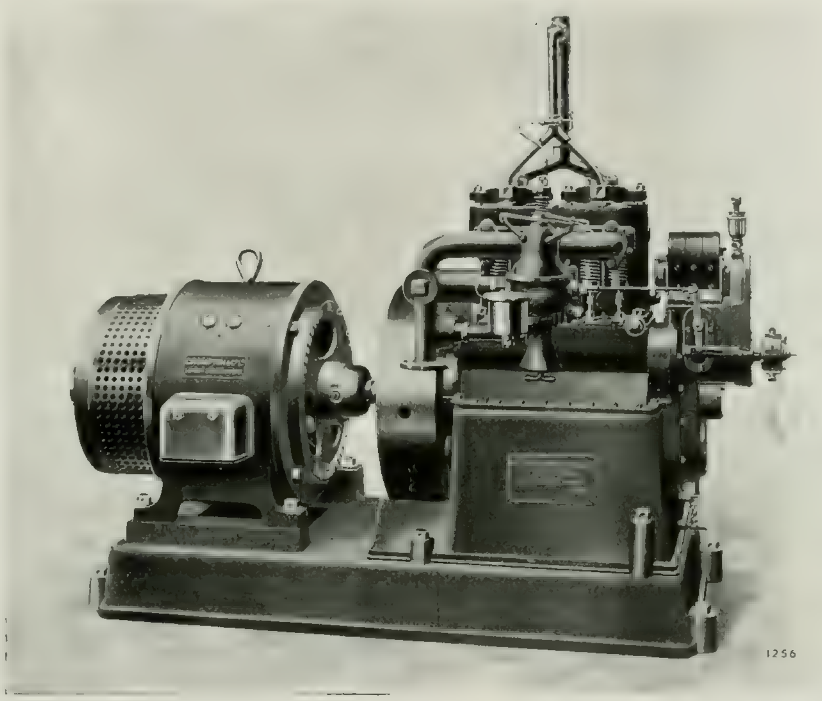

OIL-DRIVEN DYNAMO AS USED IN COUNTRY HOUSE AND OTHER SMALL INSTALLATIONS.

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(N.S. 161.)

BELFAST—Grosvenor House, [illegible] Place.
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Dick Kerr Plant in Collieries.

THAT the interest of the colliery manager is thoroughly aroused in electrical plant is evidenced by the number of mines in which power plants are in operation. The number of collieries in which motors are operated for power companies' mains is also considerable and is tending always to increase. The experience of electrical manufacturers in equipping collieries and mines during the past decade has set up standards of plant and apparatus which are now valuable to both mining engineer and manufacturer alike. In fact, the general effect of standardisation is to increase the efficiency of plant and expedite its installation and application to certain recognised operating conditions. The colliery manager is now better able to repose confidence in electrical machinery and apparatus when he observes the success of the makers' efforts to standardise in a line of machines intended for mining service. The net effect of these influences is favourable all round because the action of colliery engineers is frequently mutual, consequently the installation of modern plant in one district is likely to be taken as a precedent for similar action in another.

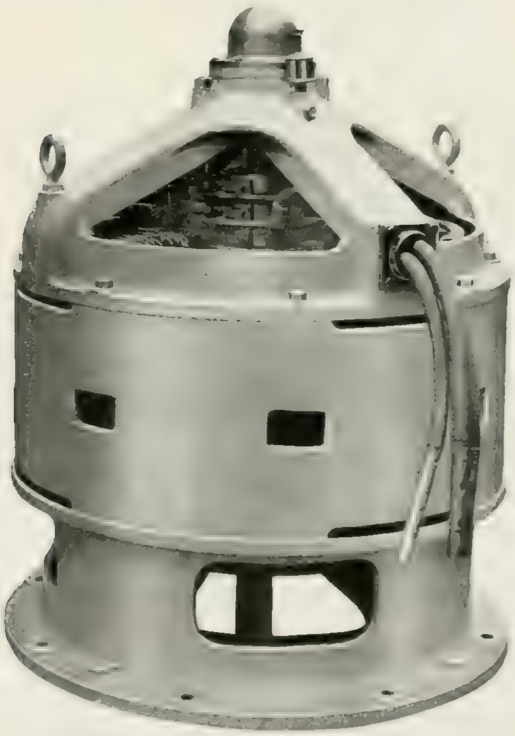

Fig. 1.—Standard Dick Kerr Motor, Vertical Pattern, for Pump Service.

It is worthy of record that the peculiar conditions of working in British mines has been studied by home engineers and manufacturers, and are met by electrical plant, the design and construction of which is undoubtedly best suited to these conditions. While there may be, and probably are, points of similarity in the mining practice of different countries there are certain peculiarities indigeneous to a particular country or even a particular district which must be studied on the spot, and which can only be properly grasped by home engineers. For this reason there are essentially many British mines and collieries into which the standards of British engineers should find their way, if the best possible results are to be obtained. We may therefore turn to some of the work which Messrs. Dick, Kerr & Co. have recently done in this important province, feeling that it cannot fail to attract the attention of the engineers and managers of our own collieries and mines.

In a pamphlet issued by the company at the recent Mining Exhibition a record is given of the more important contracts which have been entrusted to the firm for colliery power plant and motor equipment. In this interesting publication comment is first made on the generation of power and the choice of prime mover which devolves upon the management under such circumstances. Special reference is made to the gas engine and exhaust steam turbine which are both regarded as likely to figure prominently in the mining power house of the immediate future. Already they have supplied four large generators for coupling to gas engines, and have in hand a 750 kw. turbo-generator for operating in South Wales under exhaust steam conditions. The turbine is to be of the mixed pressure type, working either with live or exhaust steam. In the same system will be included two 400 kw. motor generators for transforming the direct current energy from the power house to three-phase power at 3,300 volts 25 cycles for transmission into the workings. Other types of Dick Kerr generators have been applied for colliery working, being direct coupled to

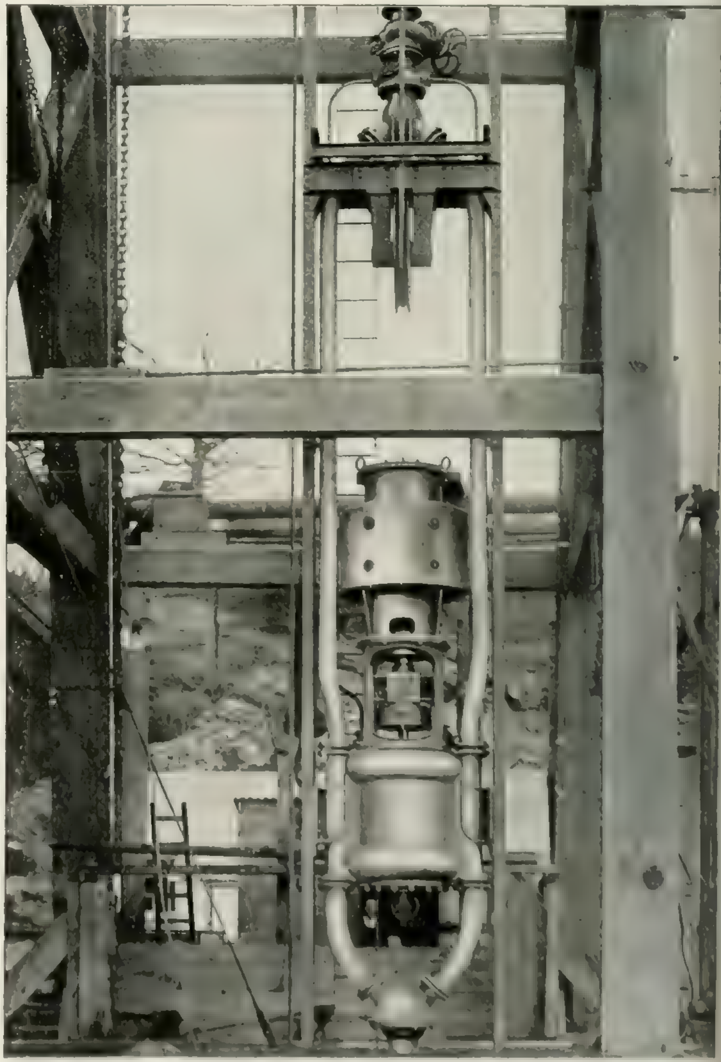

Fig. 2. 150 H P. Motor, coupled Direct to Sinking Pump.

high-speed engines. A good instance is a 300 kw. alternator at Newstead Colliery, this plant supplying energy at 650 volts 50 cycles to plant on the pit bank and in the workings.

Considerable attention has been paid by Dick Kerr & Co. to the question of pump motors for mining service. Standard motors direct coupled to centrifugal pumps for ordinary duties have been made up to 600 H.P., the latter being a notable instance in which the motor was placed between two large pumps. Attention has also been paid to sinking pump motors and a typical machine of 150 H.P. is shown in Fig. 1. This particular pattern is not totally enclosed but is suitable for ordinary vertical pump service. Fig. 2 illustrates a large vertical sinking pump in operation during the sinking of a mining shaft. The motor is rated at 150 H.P. and has a normal speed of 1,450 revs. per min. It is a standard three-phase machine operating on a 500/550 volt circuit. The duty of the pump is 35,000 galls per hour which is raised to a height of 500 ft. The motor and pump are slung on chains in the ordinary way, and can be conveniently lowered down the shaft.

Another interesting instance of Dick Kerr mining motor applications is shown in Fig. 3 in which two 400 H.P. motors are driving ventilating fans. It will be noticed that rope driving has been adopted, and that the slip-rings are outside the main bearings.

A brush lifting device is also provided for use when the motors are running at full speed. The equipment is simplicity itself and much more compact than any arrangement of steam driving.

An encouraging feature of the use of electric power in mines is the tendency to increase the sizes of the motors for coupling direct or for rope or belt driving of mining machinery. Small motors, which now are looked upon as almost insignificant were once the order of the day, and were regarded as something of a wonder at that. Now there seems to be no limit to the duties which may be imposed on electric motors. The attack on the steam winder is already gathering strength, and it is merely a matter of time for it to culminate in the displacement of steam by the electric motor.

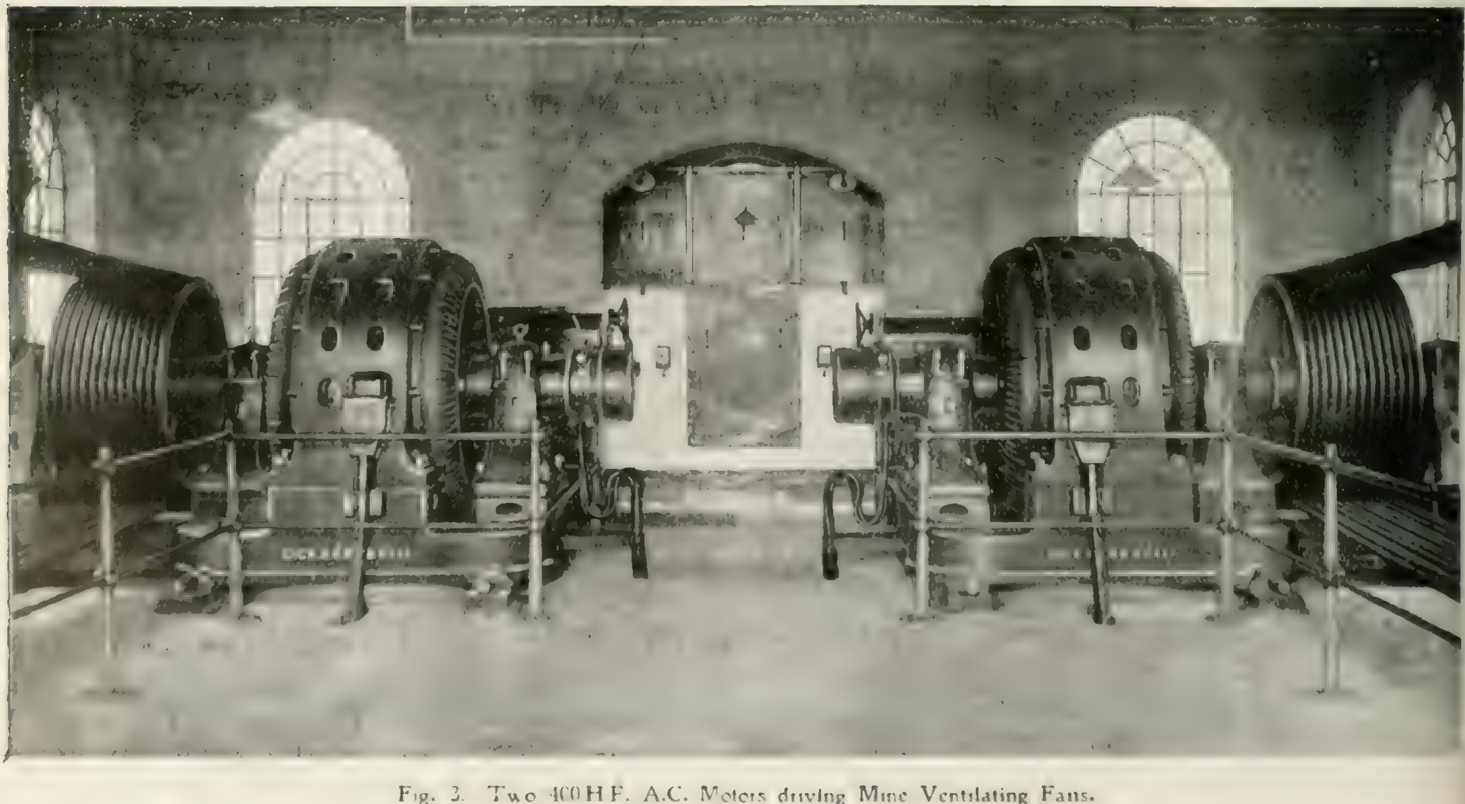

Fig. 3. Two 400 H.P. A.C. Motors driving Mine Ventilating Fans.

Sundry Motor Applications.

WE have often referred in these columns to the adaptability of the electric motor to the driving of almost every class of industrial machinery. The actual range of such machinery now operated by electric power is most extensive, and is being constantly added to month by month. Certain classes of industrial plant exist purely on account of the electric drive and without it they would not be possible.

A booklet recently issued by Messrs. Mavor & Coulson contains a large number of illustrations typical of what can be done with the electric motor in various industries and trades. The list includes colliery and mining plant, engineering workshops, iron and steel works, shipyards, factories, textile mills, &c.

We have selected several of the illustrations from this booklet as they will serve to put on record some typical examples of motor driving under actual operating conditions. The motors illustrated are the manufacture of Messrs. Mavor & Coulson, who have had many years practical experience of electric power plant.

Fig. 1 shows the adaptability of the electric motor to machine previously designed for driving by means of separate steam engines. This punching and shearing machine is now driven through a belt on to the flywheel, on which the crank may still be seen, by a moderate speed motor of the protected type, the motor being bolted to the floor. The cut-off switch, starter and speed regulator are mounted on a metal framework above the motor in the space originally occupied by the steam engine.

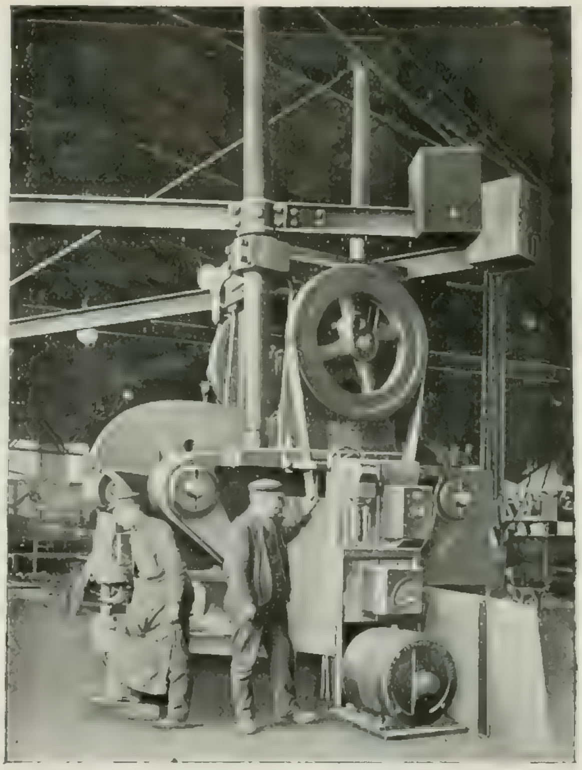

Fig. 1.--Motor driving Shears and Punch.

The "hot" saw illustrated in Fig. 2 is one of a number installed in a large steel works, and is used for cutting up into standard lengths steel angles, channels, bars, &c., as they emerge from the cast on the series of rolls through which they are drawn from the ingot. The saw is driven, through a heavy link belt, by a high-speed continuous

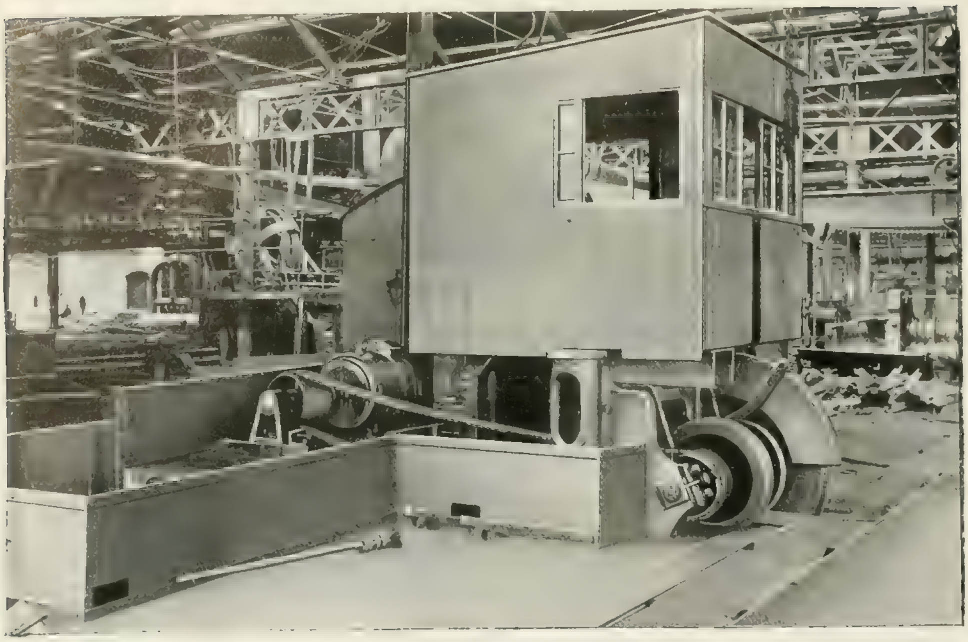

Fig. 2.—Motor driving Hot Saw in Steel Works, through Link Leather Belt.

The bellows in the installation described above are situated in the roof of the cathedral at the opposite end of the building to the keyboard of the organ, and the motors are started by the organist by means of starting switches placed at one side of the keyboard.

The planing of the wooden decks of ships is one of the most laborious and unpleasant operations which fall to the lot of a ship's carpenter, and even the extra wages which is allowed for this work does not overcome the dislike for it. The machine illustrated in Fig. 4 will, under ordinary circumstances, attended by a man and two apprentices, plane 400 sq. ft. of deck in one hour. By hand labour, an area of 45 sq. ft. of deck is a fair day's work for a carpenter. The machine and attendants will, therefore, do as much work in one hour as eight or nine men will do in one day.

The motor is a direct current machine, is started by means of a small lever, which will be noticed on one of the handles of the machine. The machine is also fitted with a three-phase motor of the squirrel-cage type for use on alternating current circuits. These machines are, we understand, in use in most of the leading shipbuilding yards in the world. We have no particulars of operating cost before us, but we need hardly say that the economy effected is very great. The equipment also has the advantage of simplicity, and the motor and starter are of standard make.

current motor of the protected type. The steel to be cut is moved along the floor in front of the saw by means of "live" rolls which are operated by a separate motor.

The organ blowing equipment at the Glasgow Cathedral was one of the first in this country to be operated by electricity. It consists of three sets of bellows—high, medium and low pressure (Fig. 3). Each set is driven by an electric motor, of the continuous current protected type, through worm gear which is enclosed in an oil bath, the worm wheel being fixed on the end of the crank shaft operating the bellows. The two motors seen in the illustration are driving the high and medium pressure bellows.

The length of the low-pressure bellows, which are just visible at the right-hand side of the illustration, is twice that of the other two sets, and prevents a view of the third motor being obtained. The speed of the motors is automatically controlled by the bellows themselves, which as they rise and fall operate a rheostat. The weight and rope connected to one of the rheostats may be seen on top of the centre set of bellows.

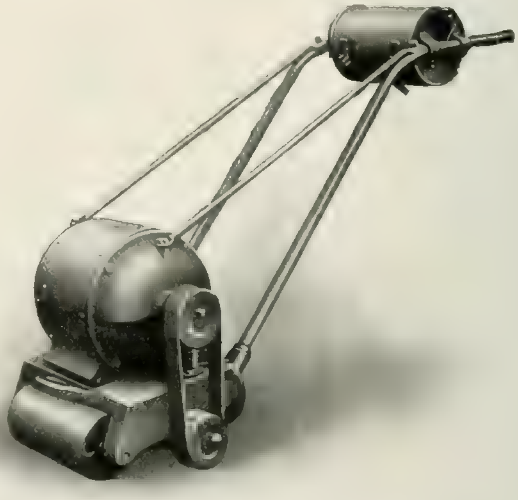

Fig. 4. D.C. Motor driving Deck Planing Machine.

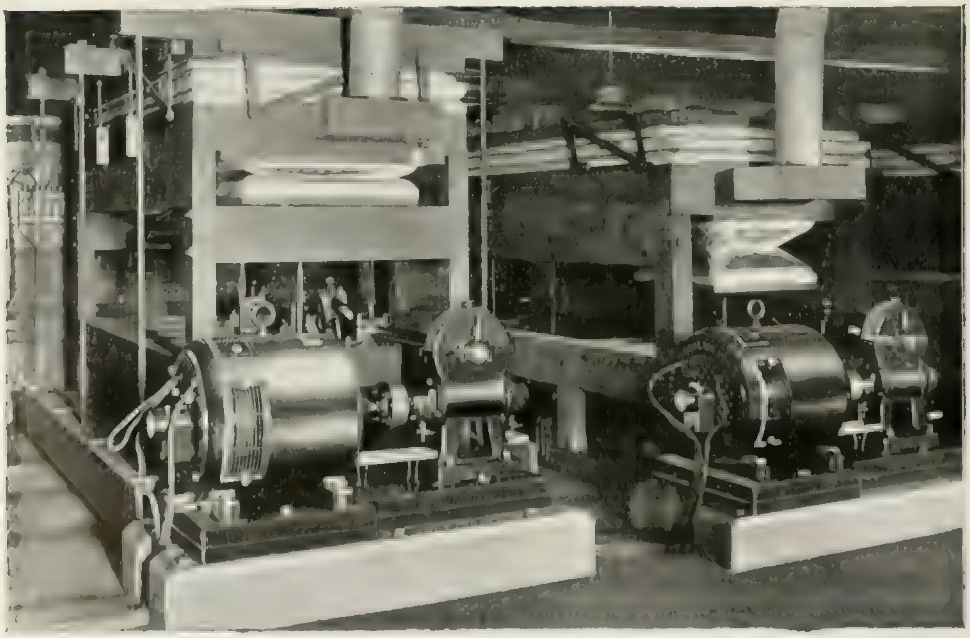

Fig. 3.—Two of Three Motors blowing Organ in Glasgow Cathedral.

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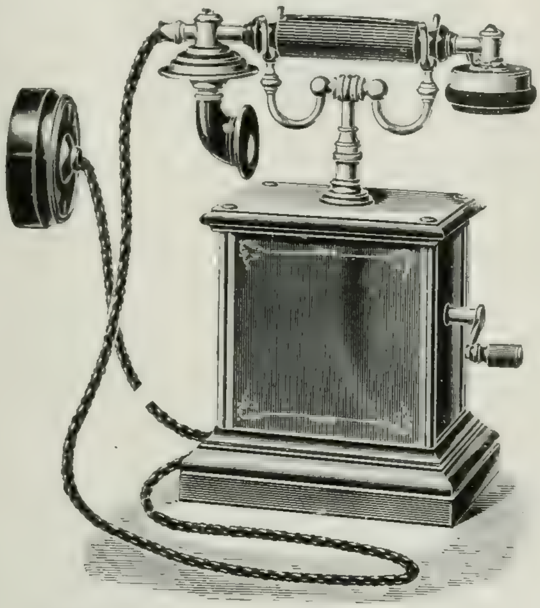

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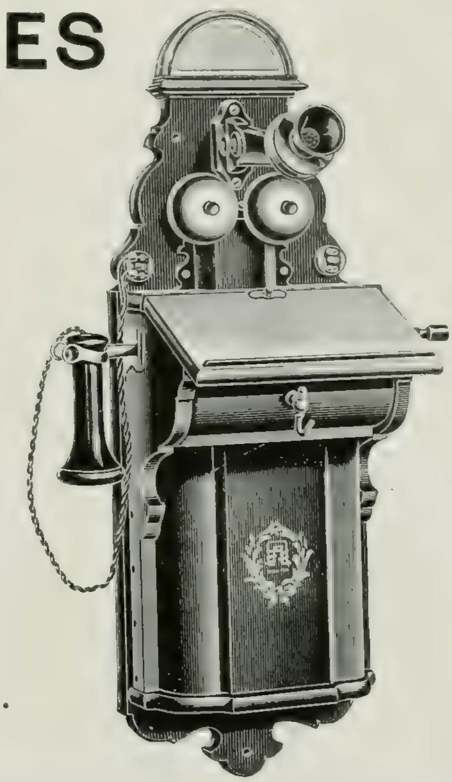

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TRADE MARK

The Camborne Exhibition: Union Electric Exhibit.

An interesting exhibition, organised chiefly in the interest of the mining industry, has recently been held at Camborne, in Cornwall. From the electrical point of view the Exhibition possessed considerable interest, and the products of the Union Electric Co., Park-street, Southwark, London, S.E., occupied a prominent position. The company had not only a well-equipped stand in the centre of the Exhibition, but also a large motor working an air compressor supplied by Messrs. Reavell & Co. They also supplied the whole of the arc lamps for illuminating the Exhibition itself, both inside and outside, and part of the street approaches, which looked brilliant in the extreme. The company's "Excello" and "Kohinoor" lamps were also much in use for the lighting of a number of the other stands.

Coming back to the Union Electric Co.'s stand itself, amongst the heavy machinery was a direct-coupled plunger pump, with triple cylinder, 3 in. diameter, 6 in. stroke, capable of delivering 1,375 gallons of water per hour against a high head. Owing to want of space the pump was not shown in operation, but we understand it will be transferred from Camborne to Manchester and there be actually at work as part of the Union Electric exhibits at the forthcoming Electrical Exhibition.

Another exhibit was a direct-coupled electrically-driven centrifugal pump, arranged for raising 80 gallons of water per minute against a head of 80 ft. These outfits are constructed to work in connection either with hand starters or with automatic starters, so that they may be used either for pumping out or for filling tanks.

Besides the foregoing, the company also showed a range of their polyphase and direct current motors. Various forms of suitable starters were shown upon the stand. These consisted chiefly of two classes, the air-cooled pattern and the oil-cooled pattern, the latter being particularly favourably where very heavy loads are to be encountered during starting or where a gassy atmosphere is present.

The company also exhibited a large number of arc lamps, chiefly of their well-known Excello pattern. The best known example of the Excello arc lamp lighting is, of course, Oxford-street, London, which is without doubt the most important shopping thoroughfare in the world, and it speaks volumes for the quality of the lamps that it was selected by the consulting electrical engineer for this important thoroughfare.

The Excello arc lamp has the great advantage of giving a large amount of illumination for a small consumption of electricity, burning long periods without renewal of carbons, and for doing its work with regularity and without skilled attention of any kind. The company inform us that they have supplied these lamps to over 70 different electric lighting authorities in the United Kingdom alone, while they have exported lamps to all parts of the world.

Another lamp shown was the Kohinoor, also highly efficient and burning for long periods without renewal of carbons.

It is interesting to know that the company's works have constructed over 170,000 arc lamps of various kinds and that everything used in the arc lamp is made on the interchangeable system, so that spare parts can be sent by reference number by post at very short notice.

At the moment of going to press the company inform us that they have been awarded a medal of the first class for the excellence of the display of their products.

THE ELECTRICIAN INDUSTRIAL SUPPLEMENT.
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Manufacturers, Contractors, Central Station Engineers, and those interested in Electrical Industrial Developments are cordially invited to contribute original matter to the SUPPLEMENT, and when suitable this will be inserted as space permits.

Filing Case for "The Electrician" Industrial Supplement.

The INDUSTRIAL SUPPLEMENT is holed for filing, and we are distributing cases which will hold twelve issues. On request a case will be sent to Consulting, Manufacturing, or Contracting firms; to Chief or Resident Engineers of Electricity Supply, Traction or Power Stations; to any firm of Merchants or Agents; to Railway, Tramway, Dock, Harbour, or other companies interested in the applications of Electric Power, &c., to their undertakings; and to other large consumers of electrical energy, either at home, in the Colonies, or abroad.

A portion of each issue of the SUPPLEMENT is reserved for special circulation oversea.

Editorial.

Business Campaigns. The electricity supply authorities up and down the country will no doubt be preparing themselves for a busy lighting season. With the many and improved forms of metallic filament lamps on the market they should keep very active in the winter months in fighting gas, more particularly in the shops, and incidentally in domestic circles. In summer when lighting matters are insignificant more attention is no doubt paid to the motor load. But winter is equally opportune for the pushing of power supply, especially during the weeks preceding and succeeding the festive season. If care is taken to worry out the particulars it will be found that in numerous trades motors can be temporarily put down to do duty in capacities which are beyond the hope of gas or steam engine; electric pulley blocks, for instance, for dealing expeditiously with goods in need of urgent dispatch. A motor here and there to relieve the congestion in bakeries, laundries, printing works, may well be put down, even if there is a steam or gas plant in regular operation. The emergency value of the electric motor is a powerful advertisement for electric power. It seldom fails to impress a power user. In fact it will do more to convert him for gas and steam than months of hard campaigning. In a well-organised selling department of an electricity supply authority, this should be one of the foremost axioms in carrying on of a vigorous programme in the interest of power supply. We do not hesitate to say that during the approaching winter if supply departments will have this important field of development in mind, they will lay the foundation of much useful business for the coming year.

The Field Telephone.

THE extreme portability of the telephone is one of its most valuable and delightful features. Instruments which can be carried in the hand, without the least difficulty, or which may be hung by a shoulder strap and swung into position for use at will are now standardised and their speaking qualities are unimpeachable. Portable telephones are not, of course, new, but they are only just beginning to find their true position. It is but natural that they should be favoured in military operations because of their reliability and compact form. The modern scout becomes not merely the eyes of the army. He is also its ears, for everything coming to his notice is at once communicated to headquarters, if he is telephone equipped. A valuable contribution to the ease and efficiency of the portable telephone is the enamelled wire which reduces the bulk required for transport and represents practically an ideal conductor for this class of work.

Some considerations upon the general utility of the field telephone have recently been published by the International Electric Co., who have developed a special pattern for portable use. In a pamphlet dealing with the field telephone the uses of this instrument are enumerated. There certainly seems to be a great future before the telephone for military service seeing that it can be quite readily employed where the telegraph and semaphore, or heliograph would be quite useless. In military operations the telephone may be used between bodies of troops during the initial stages of

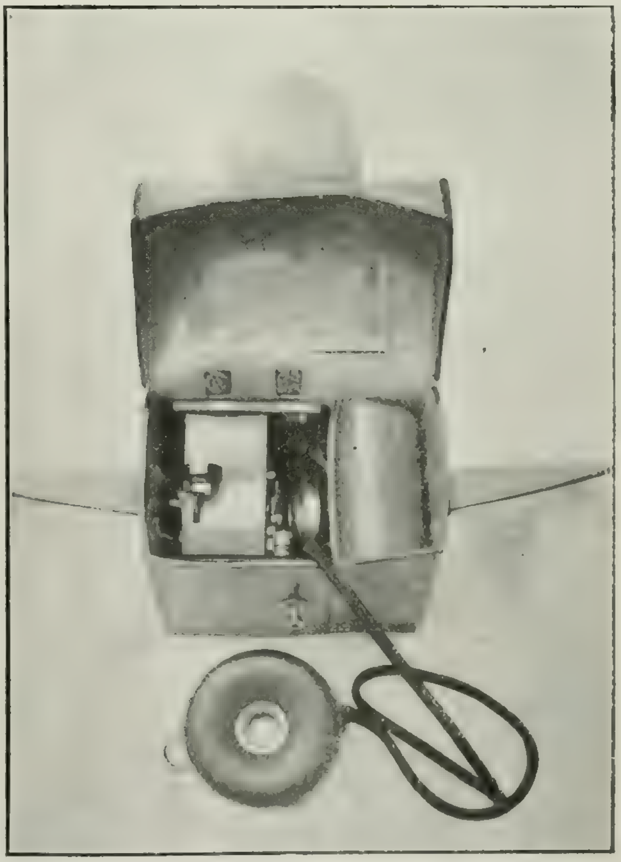


Fig. 1.—Field Telephone showing Satchel opened.

Fig. 2.—Field Telephone in Use.

an attack, within a defensive position, in an outpost line, between artillery and ammunition columns, from observation kites or balloons to the ground for facilitating railway service on field lines. These are only a few of the more important purposes to which the telephone can be put.

Considered generally the advantages of the telephone in field service may be summarised in three words, secrecy, speed, simplicity, and these advantages are undoubted compared with visual signalling or telegraphic service. There is also no limit to the speed at which messages can be received and taken down. Practically no transcription is necessary, and no special staff is required. The training of scouts in the use of the telephone should be a very simple matter, especially as the apparatus is not complicated and has no "cranky" features about it.

Coming now to the details of the field telephone put forward by the International Electric Co., dealing first with the method of calling. A buzzer is strongly recommended in preference to a trembling or polarised bell. Only a small battery is required, and in case of a defective line causing bad speaking, phonic buzzing with the Morse code can be used to maintain communication, assuming, of course, that the scout is a telegraphist. Another thing, a telephone and a telegraphic buzzer can be kept working simultaneously with Morse signalling on a single line. This method also considerably lightens the equipment by dispensing with generator induction coil, &c. The electrical equipment proper comprising what is known as the "Medhurst" telephone, consists of transmitter, receiver, Morse key, switch, buzzer, dry cell and condenser. The transmitter is of the interchangeable sealed capsule type, which makes repairs, necessitated by a defective microphone, a mere matter of inserting another capsule. The instrument is sufficiently sensitive to transmit words spoken into the leather satchel containing the apparatus (*see* Fig. 1). In the replacement of a new capsule for a defective one, no connections are disturbed, the act of screwing down a covering ring being sufficient to restore the circuit. We understand that the capsule microphone has been immersed in water 24 hours without any signs of moisture penetrating the diaphragm. The current consumption of the microphone is also said to be low, the circuit being actually broken while the operator is listening. A double watch receiver with adjustable clamped diaphragm forms part of the outfit. It is very sensitive and may be adjusted for accurate hearing while in use, the adjustment being subsequently locked by a set screw. Where listening may be disturbed by extraneous noises a telaupad of soft rubber is placed over the receiver. The buzzer is made up of a coil and armature mounted within a special ebonite compartment. Primary and secondary are wound on a sparking coil, each layer of wire being insulated with paraffin paper. Two dry cells, furnishing about three volts, are powerful enough for signalling over long distances. An adjusting screw is pro-

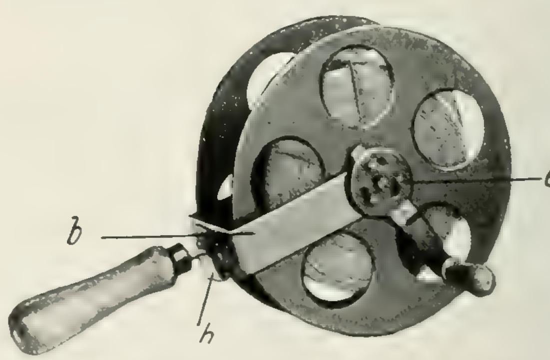


Fig. 3.—Drum for Carrying 550 yards of Field Telephone Wire.

vided for obtaining notes in the buzzer to synchronise with the receiver diaphragm, and the armature contacts have substantial platinum tips. The battery consists of two Obach dry cells, this being the pattern used by the War Office. A condenser made according to Mansbridge's patent and enclosed in a fibre-covered partition completes the equipment.

When in use the receiver only is withdrawn from the satchel (*see* Fig. 2), all speaking being done in an ordinary voice. The instrument can be withdrawn from the satchel without disturbing any connections, these being made by means of rubbing strips.

In connection with the system a line of field exchanges is also put forward. These allow for the interconnection of

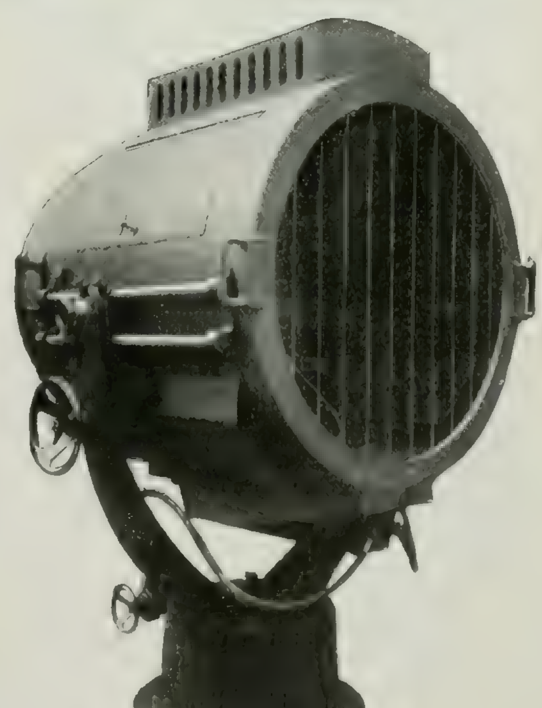
outlying parties with different sections of a camp and greatly facilitate the use of the field telephone. By a special system of connections calling may go on while two sub-lines are in conversation and the speaking will not be overheard.

A special drum for carrying the connecting wire is also made (*see* Fig. 3) and this will hold 550 yards of single stranded field cable. In the illustration *e* shows the screws for uniting the drum cheeks, *b* is the carrier, and *h* the detachable handle for the drum.

Ships' Searchlights.

SINCE the introduction of electric power plant on board ships, the use of searchlight projectors has gradually extended to practically all classes of vessels from the largest warship down to the small trading tramp steamer, and a searchlight has in consequence become to be regarded as one of the essential items in the complete equipment of a ship.

The various uses to which a ship's searchlight is put may be briefly summarised as follows :—For warships for locating the position of the enemy both in making and repelling attacks and for signalling ; for merchant vessels for navigating difficult waters, picking up buoys, &c. ; in the special service of passing through the Suez Canal for which definite requirements are laid down by the canal authorities ; for yachts for general purposes ; and for ferry boats and floating bridges, &c.

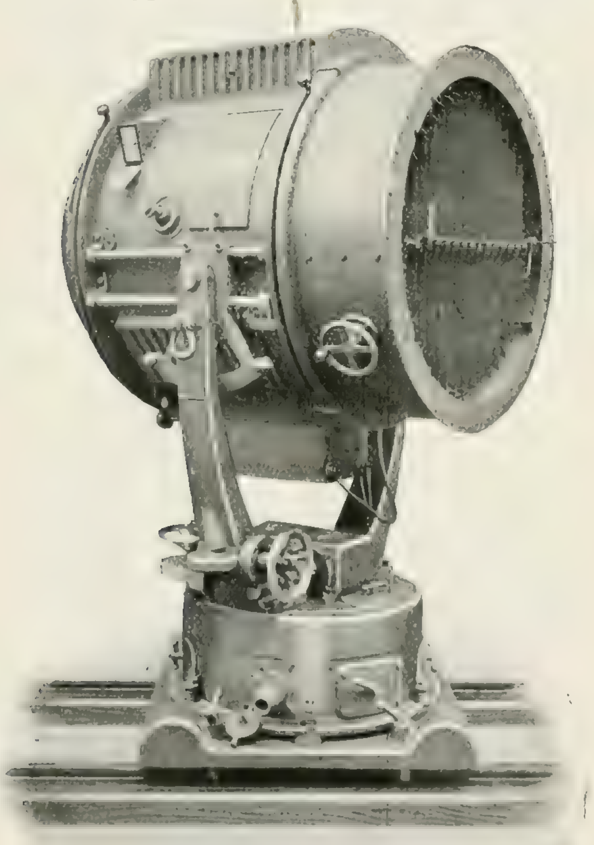


Deck Pattern Searchlight.

To meet these varied requirements, Messrs. Siemens have embodied their long experience in this class of work in the production of a complete line of searchlights, from the large

and fully-equipped warship pattern, fitted with electrical control of both training and tilting motions, and with every accessory and attachment that could under any circumstances be required, down to the smallest and simplest yacht type projector of 10 in. diameter.

One of the most complete types of projector for warships is the Siemens type "G.J." This pattern is usually sup-



Search-light mounted on Travelling Bogie.

plied in sizes 30 in. and 36 in. diameter—the latter size being the largest hitherto installed on board ship for general purposes. The G.J. projectors can be furnished either with or without electrical control, and special attachments can be added if desired such as Iris diaphragm shutter immediately behind the front door for cutting off the light; Iris diaphragm shutter for protecting the mirror from cooling too rapidly and placed immediately in front of the mirror; double dispersing lens with rack and pinion motion for obtaining parallel or divergent beams at will; venetian louvred flashing shutter for signalling; arc centerer for adjusting the arc from outside the projector; combined ammeter and voltmeter with glow lamp for illumination; electric bell for signalling from the point of control; spring buffers under the base of projector to minimise the effect of vibration; and for the heavier projectors a carriage can be supplied with rollers by means of which the complete projector can be easily moved.

Usual fittings, such as automatic lamp, glass silvered parabolic mirrors, adjustable trunnions, &c., make up the complete projector.

The Siemens "M.P." pattern projector has been designed principally for use on merchant vessels for which a simple form of projector is required. In order to meet all requirements as to size and current capacity the M.P. projectors are made in the following sizes:—10 in., 12 in., 14 in., 16 in., 20 in. and 24 in. diameters. The last two sizes are somewhat large for ordinary merchant vessels, and the sizes which appear to be most in demand are the 12 in. and the 16 in. sizes.

The projectors can be supplied either with lamps for combined automatic and hand feed, or for hand feed only, and in either case the lamps are of the Siemens patent horizontal type.

Standard projectors are fitted with mirrors of the glass silvered parabolic type suitably mounted in a detachable frame, and so ventilated as to minimise the danger of fracture from sudden changes of temperature. The normal working current of the lamps and the focus of the mirrors in the M.P. projectors have been, after extended tests, so fixed with relation to each other as to obtain the maximum projection of light with the minimum expenditure of electrical energy, thus reducing both the weight and cost of the projector and also the cost of working expenses.

The M.P. projectors can be supplied on either long or short base, and either with or without current collector rings. The lamps are readily removable from the barrel and both mirror and front door are detachable—the fixing to the body being by means of the ordinary bayonet joint. Mirrors of the metallic parabolic type are sometimes preferred in place of glass mirrors, and can be fitted in all cases if required.

The Siemens sand tube type of line resistances can be readily arranged to suit the voltage of the circuit on which the projectors are to work, the ordinary standard resistances absorbing from 60 volts to 120 volts.

Industrial Prospects of the Electric Furnace.

THERE is an old proverb which says something about good things coming slowly, "biding their time" so to speak. If the saying be applied to electrical development it comes to rest quite naturally on the electric furnace and its kindred associations. At the very birth of electrical industry the electric furnace was heralded in with great hopes of an immediately prosperous future. Those hopes have alas! remained unfulfilled despite the lapse of three decades. To day the electric furnace may be regarded as something of an appanage of the steel industry. It may be used, if desired, to refine certain smelted ores for

the production of some special steels. Beyond this it has not been carried by the world's rising tide of steel making. The electric furnace finds itself in company with the modern blast furnace by sheer weight of merit to which must be added a dash of good fortune consequent upon the spell which anything "electric" holds over the minds of engineer and financier alike. In a way the problem of the electric furnace resembles that of aerial navigation. Both are immensely fascinating, each has enormous industrial and commercial possibilities and both appear to be equally elusive as to their practical solution.

The development on a large and successful commercial scale of hydro-electric plants should give a fillip to the electric furnace. Unfortunately the difficulties encountered in establishing a remunerative centre of electric furnaces appear to be of a primary rather than a secondary character. It is a principle—sound economical yet practicable—which is required. This is the primary trouble. Finance, and engineering at present attend upon the *savans* of the electric furnace to know what progress they are making. The twin brother of the electric furnace—the hydro-electric power plant—is in readiness for its tardy relation to gather strength and come into business partnership, and this in all the more important countries in the world. What is badly needed is the initial impetus. Once this can be given, the combination of these two important members of the industrial world will proceed apace. Experiments have already shewn, that given a reliable and economical plant, the electric furnace can be made to compete with the blast furnace. It is less costly to instal, is easily controlled as to quality of output, is cheap to repair and breakdowns are not fatal. In considering the comparatively tardy development of the electric furnace, it must not be forgotten that it is not a revolutionary device. Its output cannot be regarded as phenomenal, though the quality of its product is beyond dispute. At best it can only transform what is now a singularly dingy and dismal industry under the regime of coal, into a cleaner, healthier and more desirable industry. When we say more desirable we mean more attractive to a better class of workman. Again the blast furnace is greatly due to the exigencies of an iron and steel age. The demand is enormous, the production must be rapid, the quality as a whole may not be of great account. With new conditions may arise and undoubtedly will arise the need for what we may term "electric steel" or even "electric metals." This will give the electric furnace its opportunity. At present it must just keep in step with the march of events until the time comes for it to forge ahead of its present rivals.

Street Lighting and Time Switches. . .

THE advent of a practical metal filament lamp has materially enhanced the prospect of street lighting with incandescent electric lamps. Despite the attempts to introduce the carbon filament lamp for street lighting by the use of special reflectors and grouping of the lamps, the results obtained have been quite out of proportion to the cost involved. The illumination is poor and in a general way unsatisfactory. The difficulty really

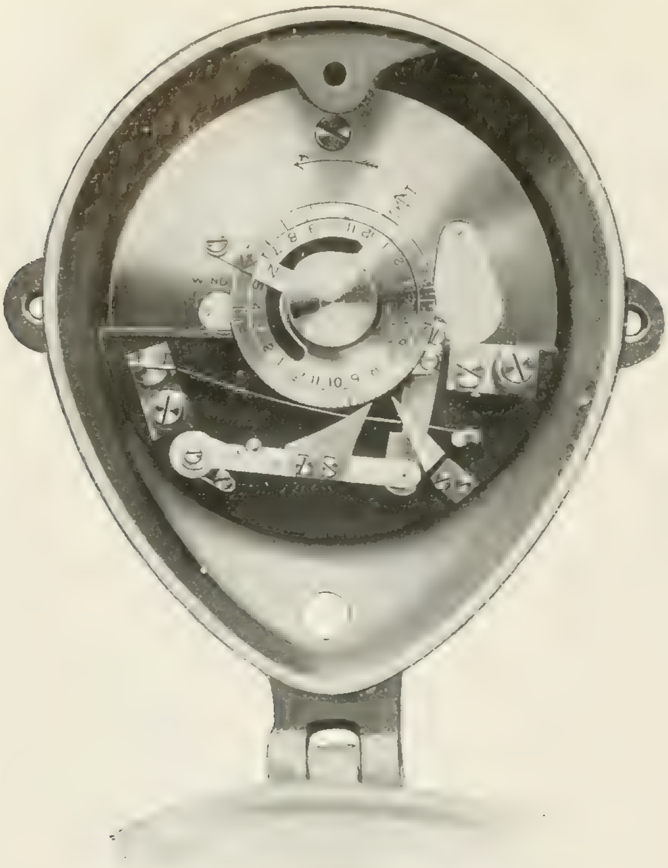


Fig. 1.—Lamp Post Time Switch, open.

has been to furnish an illuminant which would act as an intermediary between the incandescent lamp and the arc, either open or flame.

The possibilities before the metal filament lamp for street lighting opens up anew problems which, by reason of the decadence of the incandescent street lamp, have receded into the background. One of the most interesting is that of controlling the burning of the lamps when they are in circuit with the ordinary distributing mains. The metal filament lamp revives the question of the conversion of side street lighting from distributors and the conversion of these lamps from gas by degrees. Aside from questions of the economy and life of such lamps must be considered the matter of turning lamps on and off, seeing that there is no independent control from the central station. The most obvious solution of the difficulty is the use of a time switch, given, of course, a sufficiently reliable and inexpensive form of this apparatus. A device of this class controlling one or more lamps and attached to the lamp post itself, will dispense with the necessity of having a man going round, lighting the lamps one by one. It also confers the special advantage of bringing up all the lights simultaneously, or practically so, just as if they had been switched on from the station.

For some time past, Messrs. Venner & Co. have manufactured time switches for use with a two-rate meter system, shop window lighting (after hours), &c., and we understand that the design has proved very successful in practice. Numerous adjustments can be fitted to the switches, and they can be used in conjunction with remote controlled switches for dealing with heavy currents. A type of this switch was described in the Supplement for March, 1908. Recently the firm has introduced a switch which can be used for the control of street lamps. It is known as the "R.B." type and is illustrated in Fig. 1. The general con-

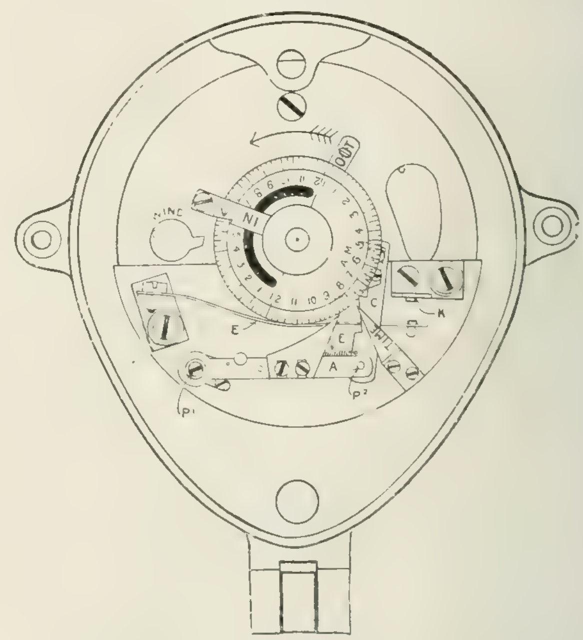


Fig 2.—Details of Working Parts of Time Switch.

struction is similar to the standard type of switch. The method of operation will be understood from Fig. 2, which is a diagrammatic arrangement of the working parts. Referring to the figures, the hand "In" engages with the inclined plane on arm A and presses the latter down, taking with it lever C, which is pivoted on A at P^2. As soon as

the detent on C gets below the projection on strip E, C is pulled in by spring F. The hand "In" then releases A, which is rapidly returned to its normal position by the coiled spring round its pivot P^1. C and E are thus carried rapidly up and the latter makes firm contact with K. Later, hand "Out" engages with C and trips it away from E, which springs back to its original position, thus quickly breaking circuit. The switch has a maximum capacity of $1\frac{1}{2}$ amperes at 250 volts.

Special attention has been paid to the clock, which is, after all, the life and soul of the apparatus. A time switch may be inexpensive to purchase, but if fitted with a poor clock, will prove very costly in upkeep. The quality is similar to that used in standard Venner time switches, but as the run required is comparatively short, a fusee drive is not required, consequently the price is reduced. It is hand wound, and has a fully jewelled lever escapement, including jewelled pallets to prevent rust and wear, and it is entirely enclosed in a spun brass dust-proof cap. A Brecquet hair-spring is used, to reduce the wear on balance-wheel pivots to a minimum. Thus full protection is given against the three great enemies of clocks—dust, rust and wear. The movement is non magnetic, compensated for temperature, completely insulated from switch, and runs 14 days on one winding. There is no pendulum, and no fear of error or stoppage if the switch is not fixed exactly vertical. The dial is marked off in quarter-hours, but the hands can be set to any desired intermediate position.

A 12 months' guarantee is given with the switch. The whole apparatus is fitted in an iron case with sliding lid. It may be fixed to the post by a simple clamp or placed inside the lantern. In the latter case the enclosing case is not required, and this reduces the initial cost somewhat. The weight of the switch in case is $7\frac{1}{4}$ lb. Fig. 3 shows one method of attaching the switch to the lamp post.

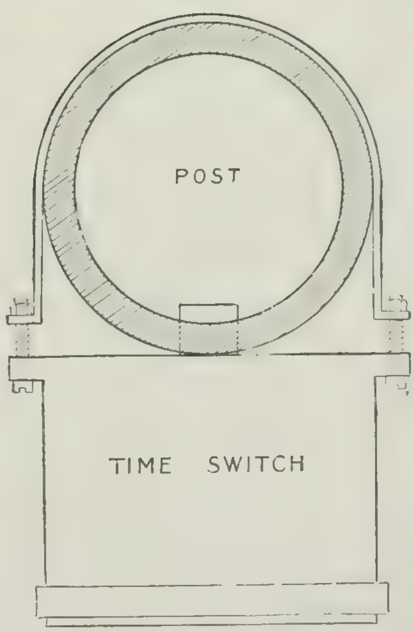


Fig. 3.—One Method of Fixing Switch to Lamp Post.

The company states that the switch is cheaper than manual labour, and incidentally calls attention to the fact that it does not get ill or demand a rise in wages, does not call for holidays or switch lights off too late or on too early because it does not require time to get round.

Electric Power Episodes.

II.—On Emergencies.

I ALWAYS believe in the emergency motor. It's a "bully" idea to live in expectancy of a man's steam or gas plant breaking down while you hang around with a motor in both hands, so to speak, awaiting the signal to begin.

Naturally you must use diplomacy. Some power users are superstitious. You see, in the first place, you've got to be on friendly terms with them, so they know you when you start "hanging round," probably praying that the cylinder end will blow out or the flywheel burst or some other unholy thing happen to the machinery that's keeping your motors out.

I recall a little indiscretion which nearly cost me dear.

I had left B.'s bakery one morning and was hardly off the shop door step when a dull thud came from the direction of the bakehouse followed by falling bricks. I looked round the corner and saw a hole in the wall through which the remains of a connecting rod and half the piston were apparently straining to make the acquaintance of the street, jostling each other for first place. Through the inevetable crowd, B. who had "emerged" from the ruins saw me, and without thinking what he was doing, threw a broken brick at me. I ducked, and the missile accepted the safety offered by a passing cab, entering the vehicle through the closed window.

The crowd diverted to hear the vituperant jehu as a variation of the bakehouse incident.

Amid the din B—— shouted, "It's all your fault. I dreamt last night we were using your beastly motors and you were politeness itself. These dreams go by rule of contrary. And here you are, leering on the 'bust up' which answers your prayers that you might get electric power in anyhow, anywhere and anywhen."

"Anything else?" I said.

"Yes, a lot more. I always was superstitious, therefore suspicious, and for months I've had the impression you wanted this to come. So you could get your motors in quick enough. I believe you did something to that engine."

He looked with longing at the heap of ammunition handy in the brick heap, but his attention was diverted to the now nearly breathless cabman.

"How much?" said I to the exasperated one.

"Five bob, sir, and a shilling damage to the cushion."

I paid the fellow, much to the surprise of B——, and was walking off when he ran after me.

"Come into the shop," he cried, dragging at my arm.

"I want a telephone," I answered.

"What for."

"Don't you want to run to-night?"

"What, the bakery? Gad! wish I could, but your cursed luck has done me for a few days at least, and during the busy season, too. Confound you again!"

"If you'll stop swearing and the exudation of much useful perspiration, I will undertake to start the shop again in a couple of hours," I said, quietly.

As it happened, we could do it easily, but I kept out of B——'s way when it was nearly done. I dislike melting bakers falling across my chest. Still, he was genuine enough after it was all over and in running order.

It would be as well here to caution my confrères engaging in the charming pastime of catching the wayward power consumer, against too great a reflection on the importance of emergency motors. If you are not careful, the ramifications of the subject, many and varied as they are, will lead you into temptation. You drift along a path beset with pitfalls, for do not your cogitations cause your mind to dwell upon every conceivable germ of the disease of "breakdown," and trace the tortuous deviations of its development through innumerable stages each the forerunner of the evil to come? Don't tempt yourself, even if calm reflection refuses to dispel the idea that a very small bolt here or a pin there if withdrawn, "in due season," would hasten the blessed moment when the electric power benison will be conferred on some unwitting tradesman.

Mind you, the emergency motor is a splendid device with which to "heap coals of fire" on your enemy's head. I am reminded of the case of M——, who persistently frustrated all my advances upon the entrenchments within which were his steam and gas engines. He refused to listen to anything I could say, after my first explanation of the principles and practice of electric driving. He took finally to blasphemy, and put into the shade my own poor attempts at the practice of this art.

Outside his works we had an electric pumping plant used in connection with a special storage scheme for the town water supply. When this was put down, I attempted to draw M——'s attention to the versatility of the electric motor, but he so changed the colour of the atmosphere that I had to grope my way out of the room.

When his works caught fire and his water supply fell short, combined with the fact that the fire brigade was delayed through the failure of an axle, M—— must have felt what can best be described as "putrid." The works were not insured—another of his little foibles.

It didn't take us long to switch that pump on to the flames, and I at least thought that the gratitude of M—— would

find expression later in a great sympathy for electric power and all connected with it. Though the fire was due to his gas plant, the engines were only slightly damaged. We put in a large motor to do duty during repairs and were served with a sharp notice to remove it when things were in order again. M—— didn't even thank me or the department for our attentions, and grumbled loudly at the bill for current to the motor. We did not charge him for the hire.

Such is human nature.

Practical Electric Welding.

THE applications of electric power to industrial operations are steadily undergoing a process of extension. The electric welder has always possessed considerable attraction for the manufacturer, because so many processes now performed by hand could be undertaken more cheaply with a machine of this class. In our issue of January, 1907, we described briefly the main features of the Prescot Welder, made by British Insulated & Helsby Cables (Ltd.). The same firm has recently issued another edition of their publication devoted to details descriptive of the welder and applications of it in practice. We may recall the fact that the Prescot Welder has been put forward for the successful welding of steel (weldable), iron, brass, and copper in sizes ranging from 2 in. to $\frac{7}{8}$ in. diameter, the latter being the maximum diameter for the last mentioned metal.

In the Prescot works of the company upwards of 200 tons of copper is rolled every week, the bulk being drawn into wire from $\frac{3}{8}$ in. diameter downwards. In this an enormous number of welds is made. Joints in iron and steel armouring for insulated cables are also made by welding. The practice adopted is to bring the tool to the work, not vice versa as is more frequently done. Some 22 welders are employed in the various shops and these serve all the requirements of the works. Skilled labour is not required, boys being employed for operating the machines when not engaged on other work. Only a few hours' practice is needed to initiate these youths into the operation of the machine.

We understand that welds can be made with the Prescot welder which will stand the rolling and drawing processes needed to work the material down to smaller sizes.

Alternating current is used for the welder circuits, a transformer with a low voltage and heavy current secondary being employed. Where direct current only is available a motor generator is employed for converting purposes. The primary voltage is not brought within reach of the operator only the very low voltage of the secondary being applied to the welding terminals, and even these are carefully insulated.

Turning now to the various forms of welders made by the company, No. 4 is a machine with great range, and is suitable for dealing with iron and weldable steel wires from 0·005 in. to 0·25 in. diameter. Between the welding jaws is a pawl which keeps them apart and while the pawl is in position the automatic cut out cannot be closed. This device is a safeguard against accidental burning of the metal being welded. The machine is capable of welding gold, silver, nickel, and german silver. Numerous adjustments are possible with the machine, the cut off, the distance between the jaws, the pressure required for various metals, &c. A record of these adjustments can be made and kept for future reference. A single weld occupies five seconds and the

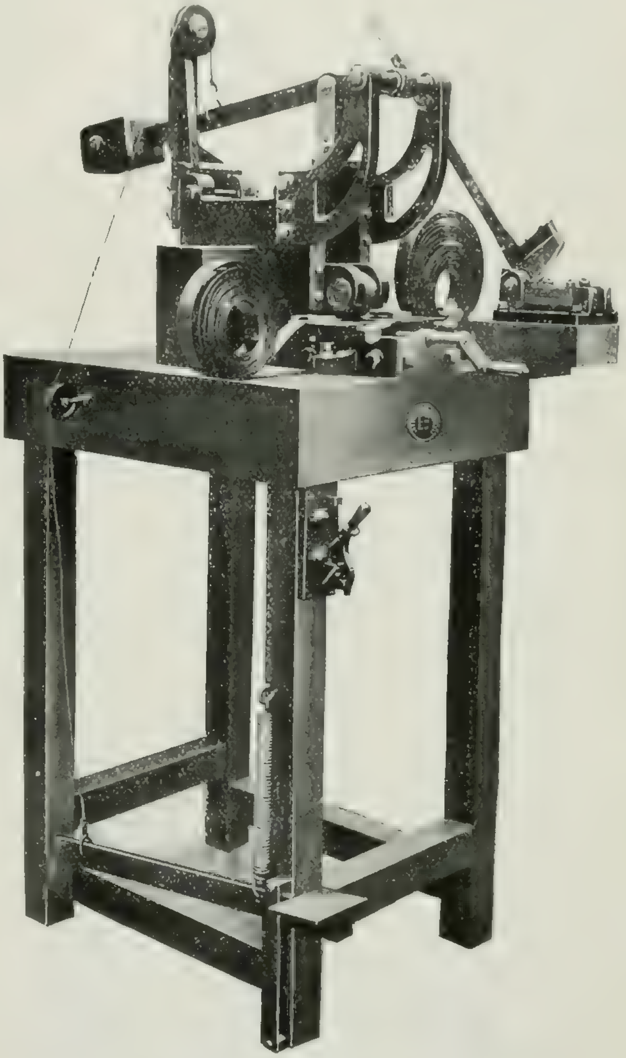


Fig. 1.—Prescot Steel Tape Welder.

maximum power required during this period is 3 H.P. With electrical energy at 1d. per unit, 1,000 welds can be made at a cost of sixpence. The weight of this size welder is 200 lb., and the overall dimensions are 16 in. by 15 in. by 17 in. high.

A large pattern requiring 32 H.P. for a thirty seconds weld is also made. This is suitable for copper and brass up to

0·625 in. diameter, and iron and weldable steel up to 1·25 in. diameter. This machine is hand operated, and has been designed for general jobbing work.

In Fig. 1 we illustrate the No. 12 welder, specially designed for dealing with mild steel tapes used for armoured cables. The maximum power required is 8 H.P. for thirty seconds, the time of a single weld. The weight is 534 lb. An automatic rim welder is shown in Fig. 2, this machine dealing automatically with perambulator rims. All the operations of gripping, switching on, heating, welding, switching off, swaging and releasing are performed automatically and successively after a pressing of a pedal. The machine comes to rest when the completed rim is released. The duty of the machine can be varied as follows: diameter of rim 8 in. to 40 in., thickness of rim, $\frac{1}{8}$ in. to $\frac{5}{32}$ in. width of rim $\frac{5}{8}$ in. to 1 in. Ten to 15 welds per minute can be carried out, and the maximum power required during a weld is 11 H.P., this including the power needed to operate the machine. The total weight is 2,147 lb.

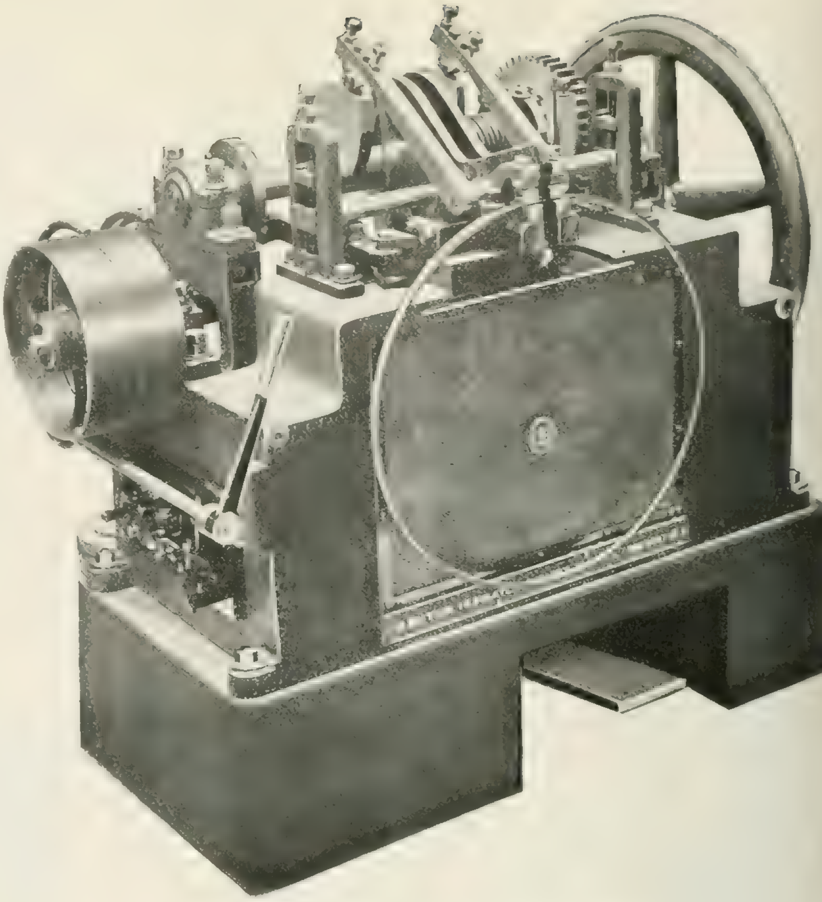


Fig. 2.—Prescot Electric Rim Welder.

A most interesting machine is an automatic chain welder with which chain links are welded up automatically. Previous to passing through the welder the chain is made up with another machine. The machine is belt driven, and is provided with three shafts, one driven continuously by a pulley as long as the machine is in operation, while the other two make, periodically, one revolution only. The unwelded chain is fed through the left-hand channel to the welding point, where each link in turn is gripped by the upsetting levers and the contact pieces. At this juncture the primary circuit is closed and a clutch is thrown out of gear to bring the cam shafts to rest. The current when passing from one contact piece to the other, by means of the interposed portion of chain, heats and softens that part of the link which is to be welded. The weights suspended on a toggle lever then come into action and make the weld by upsetting the link. At the same time the clutch puts into motion the cam shafts, which switch off the current and close the swaging levers on the link while it is still at welding heat and still under the pressure of the upsetting toggle, thus ensuring a thoroughly sound weld. The chain is now fed along, and the next link is brought to the welding point, where it is gripped and welded; and so the cycle of operations is repeated as long as the chain is fed into the machine. The swaging process leaves, at the weld, a thin fin, which is removed by a shearing device. Each chain has, of course, to pass twice through the machine, as only every other link can be dealt with at one passage. The size to which the link is upset in the welding can be accurately adjusted for every kind of chain, thus securing uniformity of all the links in a chain. The primary coil of the transformer is wound in steps, whereby the time required for heating the links, and consequently the output of the machine, may be varied as desired. The number of welds per minute is 10 to 12, and the maximum power required during welding operation is about 13·5 H.P. (driving of the machine included).

Prospective users of welders will be able to obtain reliable data from the makers regarding operating cost efficiency as the company has tried welders for some time now in its works under severe operating conditions.

Electric Power in Schools.

THE concentration of the forces of erudition particularly upon centres known as "public" schools raises questions of architecture and engineering which do not crop up in the smaller variety of teaching establishments. One of the most important problems which has a distinctly electrical aspect is that of ventilation and school cleaning. It is almost needless to point out the need for adequate ventilation and the use of methods which do more than dislodge or disturb dust without actually removing it. We may also take it for granted that the correct solution of the problem is the use of electric fans and vacuum cleaners. The actual field represented by this work is most extensive as the fringe of the matter has probably only been touched by a few isolated installations.

In the case of Council schools the question of power supply is settled at once. Most large towns have an electric service. The rest is easy. The ventilating fans would need to be a permanent fixture of the building. They could be run when desired by those in charge of the rooms in which they were fixed. The vacuum cleaner might reasonably be a portable affair which could be made common to a number of schools. By suitable timing arrangements the cleaner could be made to do a maximum of duty at the various schools. This would reduce the capital expenditure considerably.

Schools situated beyond the range of electricity mains are not infrequently equipped with power plant and machinery of some kind, so that, in the case of old installations, an extension unit or two would furnish the energy required for the increased load of fans and cleaners.

School authorities, such as Town Councils, need have no hesitation on the score of lack of ventilating plant or vacuum cleaners of a standard type, well tested in the hard school of experience, to meet all their requirements. In the initial stages of development in this field the Council may, and probably will, need strong pressure from the makers of such machinery to ensure its installation in schools just built or several years old. With new schools the matter should rest with the architect, not for the particulars of the scheme, but for its specification in his plans and supervision during construction. We know that architects like to have their say in everything concerning the structure for which they are made responsible, but they cannot be experts in everything. The matter of ventilation has been in the hands of experienced men for many years past, and they can be relied upon to deal adequately with their own pet subject; and in this the electrical engineer is assured of their hearty co-operation. For is not the electric motor indispensable for the driving of fan and vacuum cleaner alike?

Electric Mining Drill.

NOW that an electric generator is an essential part of an up-to-date colliery equipment the many advantages to be obtained by adopting electric mining drills are worthy of careful consideration. They are much more efficient than compressed-air machines, do away with the necessity of running special air tubes, as they can be worked off the electric lighting mains, and further the increased efficiency of a long-distance transmission with electricity as compared with compressed air, must also be taken into consideration. Messrs. Kramos Limited, of Bath, have placed on the market the machine shown below, which has been designed by experts in mining tools, and embodies all the points necessary to ensure its success. It consists of a totally-enclosed motor of the multipolar type, with former wound armature, the shaft of which is geared on to the feed bar, which can be either hollow or solid. The feed is automatic, and can be varied, reversed or thrown out of gear as desired by simply adjusting a nut. The machine is mounted on a steel upright, and can swivel in any direction. The drill will bore anthracite, hard coal, shale, slate, rock salt or any medium rock, and is made for direct or polyphase current in two sizes, one with a 3 H.P. motor, which bores a 2½ in. to 3 in. diameter hole in anthracite at 7 ft. per minute, and one with 2 H.P. motor, which bores 2 in. holes at this speed. In harder materials the speed is, of course, reduced.

Index to Advertisers.

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CONTENTS OF THE CURRENT NUMBER.

NOTES.

The Bournemouth Tramway Accident.

THE brake question, that is, in its electric tramway aspect, is prominently raised twice in our present issue. Firstly, in a letter from a correspondent, the substance of which we give in our Notes columns; and, secondly, in the Report to the Board of Trade on the Bournemouth tramway accident. The latter was the most serious accident that has occurred on any electric tramway in this country, and the Inspector's Report will receive very close attention on the part of all tramway managers and electrical engineers, the more so as it raises several points of considerable interest. As regards the primary cause of the car getting out of control, this is stated to be the incorrect position of the reversing barrel of No. 1 controller at the rear end of the car, which rendered the electrical braking equipment useless. The Inspector attributes the displacement of this reversing barrel to the undue slackness of the gear, but in this view he is not supported by the traffic manager. The accident will serve, however, to draw attention to the need for careful adjustment in all controller apparatus, although the remedy suggested by Major PRINGLE, of opening all controllers at every terminus and examining the barrels to see that the latter are in their correct position seems somewhat drastic and unnecessary.

THERE is no doubt that the Inspector's insistence on all cars in service having their full braking equipment in working order will receive the approval of the public, technical and non-technical alike. In certain cases this course will probably result in a small loss of revenue, due to a car being temporarily taken off the road, but this sacrifice is scarcely to be considered where safety is of paramount importance. We regret to notice a certain spirit of economy in the management in regard to small matters; we do not suggest that a municipal undertaking should not be run economically, but economy should certainly take a second place in regard to safety, more particularly in a municipal undertaking, which, in the very nature of things, is not run with the sole object of profit. It is unfortunate that the driver of the car did not at once apply his hand-brake on finding that his electric brake was out of order, instead of losing valuable time in endeavouring to bring the latter into operation, so that eventually, when the hand-brake was applied, the excessive speed of the car rendered it practically useless. We think it cannot be too strongly impressed on all motormen that they should, on the first indication of failure of any brake, instantly apply one of those held in reserve. This is especially important where the service brake is electric, since the conditions under which tramcars are operated render a broken connection or faulty contact at all times a possible cause of failure.

AN unusual feature in connection with the Report, and one possessing certain advantages in cases such as the present, where important issues are involved, is that its publication has been followed by reports of the various officials of the Bournemouth Council concerned in this unfortunate affair. The question as to how far divided control over a municipal tramway undertaking is permissible is a large one, and we hope to refer to it again on a future occasion: for the present we need only draw attention to the fact that Major PRINGLE impresses on the Bournemouth Council the desirability of appointing a general manager to control the whole department. Among the points of disagreement, we notice that Mr. C. BARBER, the engineer and traffic manager, disagrees with the opinion expressed by Major PRINGLE that cars should not

be stabled indiscriminately at any depôt. Whilst admitting, however, that Mr. BARBER states an important reason for adopting this procedure, we think that more satisfactory results will accrue if the cars are always examined by the same staff, on whom all responsibility for the condition of the cars can be placed, provided that, in addition, careful superintendence is given at frequent intervals to the work of those engaged on the repair and upkeep of the equipment. As regards other questions raised in connection with the equipment of the cars, we must refer our readers to the abstract of the Report given elsewhere in this issue.

Timely Criticism.

WE regret feeling compelled to raise the voice of criticism in regard to the arrangement of the stands at the forthcoming Electrical Exhibition at Manchester. Our complaint will, we believe, be echoed by many of the exhibitors. We feel strongly that an attempt should have been made to consider the *ensemble* of the Exhibition, and that the erection of a series of cubicles and boxes, which are now so conspicuous a feature of the interior, should certainly have been obviated from the start. In the interest of all the exhibitors we think this could have been done, and might, moreover, have been provided for in the regulations. The exhibitor has, of course, a general right to do as he pleases with regard to the construction of his own stand, but in taking space at an exhibition of this character some regard should have been paid to the general appearance of the interior of the building as a whole. It is difficult, we realise, to apportion the blame for the state of affairs which we deplore, but whether it be with the Committee of the Exhibition, the management, or the exhibitors, blame certainly attaches to one of these, if not to all, for the conglomeration of boxes and similar wooden structures which leave everything to be desired, from the artistic showroom point of view. We would suggest that, where a building is to be specially erected for the purpose of an exhibition, a general ground plan should be prepared as a guide for exhibitors in constructing their stands, and the regulations should embody some advice from the management on the subject.

London Underground Railways.

THE problem of underground travelling in London is one that is taking a long time to assume uniform conditions. There have been many disturbing causes, and some of the difficulties no doubt have been due to the British temperament, which differs somewhat from that of other nationalities. In America it has always been found that improved travelling facilities brought their own reward in the shape of very much increased traffic and consequent prosperity. It was this idea that prompted the large network of underground railways now existing in London, but when they were completed it was found that the results were by no means what would have been expected from American experience. Consequently, the conditions on the railways themselves, which have, no doubt, been complicated by the advent of the motor omnibus, have been varied from time to time in order to find a suitable solution by the method of trial and error. On the Central London Railway fares were raised some time ago, and this course has also been adopted on some of the other lines; season tickets are now being abandoned and strips of ordinary tickets are being issued instead; and finally, it has been decided on the Bakerloo and Piccadilly Railways to introduce a "rush hour" service with a headway of $1\frac{3}{4}$ and 2 minutes respectively on these two tubes. We think that this is probably a move in the right direction. The capital expenditure per mile on such railways is so extremely high that the only possible way of making them financially successful is to work them at as high an output as possible. If the public realise that at certain hours of the day there is practically no waiting whatever, and that, in all probability, seats will be available for all comers, the railways may reap their due reward.

The Paris Telephone Exchange Fire.

THE effects of the fire which on Sunday evening last completely destroyed the Paris Central Telephone Exchange, known as the Gutenberg, is by no means confined to that city, or even to France itself. In fact, due to the dependence of the business community in every city on the telephone for the transaction of a great part of its business, the occurrence is of world-wide importance, since Paris was for a day or two entirely cut off from telephonic communication with London, Berlin, Brussels and other centres; and for some time to come considerable difficulties are likely to be experienced in sending messages to or through the French capital. An idea of the magnitude of the fire may be gathered from the fact that the damage is estimated at £800,000. An unfortunate feature of the occurrence is that the exchange had only just been equipped on the central battery system. The outbreak is said to have originated among the cables in the basement and to have run up the cables from floor to floor. It is surprising that, although nearly the whole fire brigade of Paris are said to have been on the scene of the conflagration, all attempts at subduing the fire were fruitless. The difficulty in coping with this fire emphasises the importance of using fireproof material, but unfortunately this is not an easy matter, and thus other precautions are more than usually necessary. Those who have visited exchanges of the National Telephone Co. will remember the very comprehensive system of fire alarms there in use, so that any outbreak may be dealt with in its earliest stages. Where so much is involved, not merely for the telephone undertaking itself but for the business community at large, such precautions cannot be too elaborate.

Personal. The *London Gazette* for September 18th contains an announcement that the Home Secretary has appointed Mr. Robert Nelson an inspector of mines, with the title of Electrical Inspector of Mines, under the Coal Mines Regulation Acts 1887 to 1900, and has instructed him to also act as an inspector for the purposes of the Metalliferous Mines Regulation Acts 1872 and 1875 and of the Quarries Act, 1894, and has further appointed him an inspector of factories and workshops for the purposes of the Factory and Workshop Act 1901.

Cable Interruptions and Repairs.

	Date of Interruption.	Date of Repair.
Las Palmas—Arrecife	May 18, 1908 ...	—
Jedda—Suakim	July 27, 1908 ...	—
Paramaribo—Cayenne.......	Sep. 3, 1908 ...	—
Pontianak—Saigon	Sep. 16, 1908 ...	—
St. Vincent—Barbados	Sep. 16, 1908 ...	Sep. 17, 1908
Syra—Rhodes	Sep. 17, 1908 ...	—
Dardanelles—Constantinople	Sep. 20, 1908 ...	—

International Telegraph and Telephone Engineers' Conference. On Tuesday the Hungarian telegraph authorities gave a banquet in honour of the first International Telegraph and Telephone Engineers' Congress now sitting at Budapest. M. Kossuth (Minister of Commerce) proposed the toast of the Congress, the members of which, he said, made distance disappear and brought the nations closer together. Major W. A. J. O'Meara, R.E., C.M.G., Chief Engineer of the Postal Telegraph Department, one of the British delegates, replied, and gave the toast of Hungary.

Railway Accidents in 1907.—The report of the Board of Trade in connection with the accidents occurring on the railway lines of the United Kingdom has just been issued. Only a very small number of accidents have occurred on electrified lines; four persons were killed and 17 injured through coming in contact with "live" rails, whilst one railway servant was killed and 31 injured by electrical shocks obtained by contact with electrical apparatus other than the "live" rail. It is interesting to notice that of the four fatal cases mentioned above, three relate to persons trespassing on the railway; but owing to the precautions taken by the companies and to the possible dangers becoming more widely known, even this small list of accidents is not likely to be increased in the immediate future.

The Arc Lamp and Wireless Telegraphy.—A communication of some interest, relating to "speaking arcs," has just been made to the German Press by a scientific observer in Brunswick as follows:—

I have recently been able to observe a singular phenomenon exhibited by an arc lamp in my laboratory. This was the fact of its emitting clear and intelligible Morse signals in a piping, hissing tone, which I was able to uncode as the invitation to open communication sent by the radio-telegraphic station in this town, which works with undamped oscillations. Without the aid of any wire or other receiving apparatus, I was thus able to hear all the messages which were dispatched from the station, simply by lighting my arc lamp. In respect of this phenomenon I have carried on investigations with arc lamps situate a distance of 3 km. from the wireless station here, and have encountered the same phenomenon in the same degree of strength.

One evening I observed this effect during the course of a lantern lecture: the Morse signalling was audible throughout the whole hall, so much so as to prove a disturbance to the audience, the mechanician in charge of the lamp striving in vain to stop the hissing noise.

Wireless Telegraph Notes.—It is announced that wireless telegraph stations are being built by the German Government at Cologne and Königsberg. This is in addition to the station which is rapidly attaining completion at Göttingen.

The battleship "Hibernia," flagship of the admiral second in command of the Channel Fleet, has been refitted with a high-power wireless equipment, with a view to communication being established as a regular feature between this section of the British Fleet and the Admiralty authorities at Spring Gardens, London. The work of re-equipping the "Hibernia" with the new high-power apparatus in place of its former low-power installation constitutes, we understand, a record in speed for this class of work, the vessel being due to return to its position in the fleet within 48 hours of being berthed at Devonport for the re-equipment. An interesting series of experiments with wireless apparatus installed on board the "King Edward VII." battleship is to be carried out as soon as the "Hibernia" rejoins the Fleet.

A correspondent at Barcelona writes: Four wireless telegraph stations have now been established in Spain, situated respectively in Almeria, Melilla, Chamartin and Guadalajara. The two first establish communication between the Peninsula and Morocco, 200 km. distant, with waves of 300, 600, 900 and 1,200 metres in length. The antenna mast at Almeria is 58 metres high and that at Melilla 51 metres. The electric generators have a capacity of 2 kw., but under normal circumstances are used at a power of 150 watts, which is found sufficient for the object in view. The stations at Chamartin and Guadalajara communicate with each other at a distance of 50 km., with masts of 51 and 27 metres in height using a power of 0·4 kw. At Chamartin, waves are used of 350, 510 and 1,050 metres in length and in Guadalajara of 600 metres. The call signals of the above stations all appertain to the War Office (Ministry of War) and are as follows: Almeria, "Alm"; Melilla, "Mel"; Chamartin, "Ch"; and Guadalajara, "Gu."

The Union Internationale de Tramways et de Chemins de fer d'intérêt local and the Question of Brakes.—In regard to the discussion of the brake question during the recent Congress at Munich, a correspondent writes to us as follows:—

The reports of the three commissioners differed considerably, and several members suggested that the matter was not ripe for decision; but the friends of the big electric manufacturing firms knew that they could reckon upon a sufficient number of votes and so carried through a resolution which seems to be the most ridiculous pronouncement which could have been made. This resolution states that in the opinion of the experts assembled the ordinary hand-wheel brake is sufficient for ordinary conditions, but that for heavy cars, long and steep gradients, narrow roads and high speed a mechanical (electric) power brake should be used, and if there are several trailers an electric or pneumatic brake, which are to be considered equivalent.

The electric brake is defined in the three reports, all of which make out that the rheostatic brake should be considered a good service and emergency brake. One commissioner leaned more towards the air brake and also published results of solenoid and magnetic brakes. This course can only be understood when proper value is placed upon the suggestion that the manufacturers interested in the electric brake on one side, and in the pneumatic brake on the other, had much to do with the appointment of these commissioners.

Another consideration had also much to do with the disposition of many members to pronounce the present braking arrangements satisfactory: viz., the desire to be able to protect themselves against interference by the Government and municipal authorities, who frequently press tramway companies to equip their cars with more modern brakes.

I think that a protest should at once be raised against such manoeuvres, and that it should be made clear to tramway managers that the public safety is the supreme consideration. If they cannot find braking appliances which make it safe to travel at 16 miles per hour, the speed will have to be reduced to 12 or 8, as the case may be.

How careless was the treatment of the whole question can be seen from the way in which most important points were not even touched upon by the commissioners, none of whom mentioned a word about the expenses arising from accidents which could be materially reduced by good brakes.

On inquiry I found that an insurance premium of about 8 per cent. of the *gross* revenue was paid by the German tramways to insurance companies, until they started a mutual insurance system. But they still pay about 4 per cent. of their gross revenue for accidents.

I understand from a well-known British expert that the highest premium paid in Great Britain is 2 per cent., and this under very severe conditions of dense and fast traffic, heavy cars and greasy roads. On this basis, he said that in a town like Munich, where the rails are perfectly clean, the insurance premium should be nearer ½ than 1 per cent. Again, no account was taken of skidding, and every tramway manager knows what heavy expenses this and sanding causes. As you showed in a recent issue, skidding can be prevented by efficient track brakes. Are they to be banished from Continental systems because they are not on the price lists of certain manufacturers?

I trust that at any rate British tramway managers will not overlook the financial importance of these two items, if they are properly put before them.

Institution of Electrical Engineers.—The annual dinner is to be held on Thursday, October 22nd, in the Grand Hall of the Hotel Cecil, London, at 7 p.m.

Electrical (Territorial) Engineers.—Capt. E. Gardiner, Capt. J. L. Burbey (to be supernumerary) and Lieut. J. G. Heaven, of the 2nd Gloucestershire Royal Engineers (Volunteers), have been appointed to the South Midland Divisional Telegraph company, South Midland Divisional Engineers, with precedence as in the Volunteer Force.

The following orders have been issued by the officer commanding the London Division:—The headquarters (Regency-street, Westminster, S.W.) will open for the winter's training on October 5th. Medical inspection of recruits will take place every Tuesday, commencing on September 29th, and intending recruits should reach headquarters as soon after 6 p.m. as possible.

ARRANGEMENTS FOR THE WEEK.

MUNICIPAL TRAMWAYS ASSOCIATION CONFERENCE AT NOTTINGHAM.

FRIDAY, September 25th (to-day).

10 a.m. Meeting of Managers' Section.
10:30 a.m. Business Meeting of the Association in the Council Chamber at the Exchange Hall.
1:30 p.m. Excursion to Belvoir Castle.

THE IRON AND STEEL INSTITUTE.

MONDAY, September 28th, to FRIDAY, October 2nd.
Autumn Meeting at Middlesbrough.

THE PRODUCTION OF CHEAP POWER BY SUCTION GAS PLANTS.*

BY PHILIP W. ROBSON.

Summary.—The author first gives particulars of the actual cost of working suction gas plant, and makes a comparison with electric supply from public mains, also comparing the electric motor rather unfavourably with the gas engine as regards liability to breakdown. A detailed description is given of the working of suction producer plant, and of the conditions affecting its efficiency. The author concludes that the claims of suction gas plant for the production of power are well founded.

In the two years which have intervened since Prof. Dalby first described the suction gas producer before this Association, the demand for such apparatus has shown a steady and continuous growth both in this country and abroad. It is safe to say that in the great majority of cases experience in the actual working of combinations of gas engines and suction producers has given the greatest satisfaction to the user, for they have proved to be both convenient and reliable as a means of deriving cheap power; and there are good reasons for believing that as the possibilities of the system become more fully understood its application will be increasingly extended.

It is interesting to note that though the idea of working producers on the suction principle was first worked out in France by M. Benier, and afterwards continued to a comparatively small extent in Germany, the real development of suction producers on a large commercial scale only took place when British engineers devoted themselves to their design and manufacture, and the extent to which trade in them has increased during the last four years is remarkable.

There are several reasons for this, the chief of which undoubtedly is that the modern gas engine and suction producer can, in fact, give power to small users and to large users for factory and electric driving more cheaply than it can possibly be obtained by other means. To illustrate this point I have selected three typical cases where the load demand and general requirements are widely different, and in each case the figures given represent average ascertained costs over at least a 12 months' period of working.

Ascertained Total Power Costs with National Gas Engines.

—	Case A. Cement works.			Case B. Weaving shed.			Case C. Small factory.		
Size of installation in B.H.P.	450·0			300·0			20·0		
Average working load, B.H.P.	360·0			220·0			7·8		
Total B.H.P.-hours per annum.	2,726,000			610,500			21,200		
Initial total cost of installation (including foundations)	£4,230			£2,640			£250		
Total annual charges:	£	s.	d.	£	s.	d.	£	s.	d.
Interest and depreciation	423	0	0	264	0	0	25	0	0
Repairs & sundries	50	0	0	30	0	0	3	10	0
Fuel	1,298	4	8	135	4	2	15	11	0
Oil	135	3	10	10	0	0	2	0	0
Water (taken from canal in cases A & B)	...			...			7	5	0
Attendance, &c.	423	17	4	135	0	0	12	10	0
Total	2,330	5	10	574	4	2	65	16	0
Total cost per B.H.P.-hour.	0·205d.			0·225d.			0·745d.		
Equivalent cost per Board of Trade unit†	0·245d.			0·27d.			0·79d.		

The significance of the above figures will be appreciated from the fact that if in case A current was taken from a public supply at ½d. per unit, the total cost of power would be £4,708 per annum. As the actual working costs with suction gas are £1,907, the difference between the latter and the cost of electricity at the assumed low rate of ½d. per unit represents a saving of £2,801 in favour of the gas plant installation. This saving would entirely defray the initial cost of the latter in a little over eighteen months.

Nor can it be said that this economy has been obtained at the sacrifice of reliability, for, in the weaving shed referred to, the engine has been started up punctually every morning without fail, and the only stoppage in 12 months was that due on one occasion to a heated connecting rod brass. In the case of the cement works, rotary kilns are being operated, and the engines are regularly run for periods of from six weeks to two months night and day without stoppage. As I have said, these cases are typical.

It is also important to notice how the gas engine compares with its competitors, the electric motor and the steam engine, in the rate of breakdowns. Mr. Michael Longridge, in his last annual report, gives the following figures relative to engines and motors insured by his company:—

Rates of Breakdowns.

Steam engines	1 in 8·1
Electric motors	1 in 8·2
Gas and oil engines	1 in 12·4

from which it would appear that, broadly speaking, gas and oil engines may be considered 50 per cent. more reliable in actual practice than steam engines or electric motors. I refer here mainly to units up to 100 B.H.P. per cylinder.

We have been greatly aided in the successful development of these producers through having a suitable fuel at hand in England and Scotland and in several parts of Ireland. Up to the present, for reasons which will be explained later, suction producers have only been made to work on a commercial scale with non-bituminous fuels, such as anthracite and coke, both of which are easily obtainable in the industrial centres of the kingdom. In England, Welsh anthracite was obtainable until two years ago for about 20s. per ton, at which figure there was no difficulty in obtaining the much advertised "10 B.H.P. for one penny" in fuel cost. With the rise in the price of anthracite, gas plant makers adapted their apparatus to work with gas coke, which can be bought at from 10s. to 15s. per ton, and as the consumption of such coke in a well-designed producer need not exceed 25 per cent. more than anthracite for the same power, it will be seen that it is in any case more economical to use it. It may be remarked incidentally that those responsible for gas works are grateful for this new market for their coke, which, during the summer months at any rate, can, in many towns, only be disposed of with difficulty. In Scotland, suitable anthracite can be obtained at from 10s. to 15s. per ton, and the local supplies of anthracite in most of our colonies and in France and Spain are now being successfully used for suction producers, whilst in other countries charcoal is plentiful and comparatively cheap. Speaking generally, therefore, the fuel problem both at home and abroad now presents little difficulty to those who have carefully studied the matter.

The principle of working all suction producers is similar: the gas inlet valve on the engine cylinder is directly connected to the producer, which usually consists of the furnace or generator coupled to a cooling vessel or scrubber. During the suction stroke of the cycle the inlet valve of the engine is opened, and the gas accumulated in the intervening pipes between the engine and the producer is drawn forward into the working cylinder together with a proper proportion of air. A corresponding amount of mixed air and steam flows into the furnace of the producer and reacts there with the fuel, with the result that gas is evolved of an amount equal in volume (after being cooled in the scrubber) to that drawn away. Hence the yield of gas entirely depends upon the suction effect exerted by the engine through the gas inlet valve; the latter being in turn under the automatic control of the engine governor in the extent to which it is allowed to open causes the amount of gas to be automatically regulated to suit variations of load. All the attention that is necessary, therefore, whilst the plant is working is to keep the generator charged with fuel—an operation occupying from two to three minutes every two hours.

A typical combination of engine and producer is shown in Fig. 1, and it is easy to realise from the great simplicity of the combined arrangement why, in correctly designed gas producers of this class, so large a measure of practical success has been attained. In such a producer as that illustrated, the required steam is raised from the sensible heat of the gases after leaving the furnace on their way to the scrubber, and the air required for gasifying the fuel is partially saturated with this steam before it enters the furnace.

The conditions under which combustible gas is produced in the generator so as to give the best efficiency have been carefully investigated. Obviously, the fuel must be gasified in such a way as to lose a minimum quantity of its heat in the producer, so that as large a balance as is possible is available for useful work in the engine. The only burnable gas which can be obtained in the usual way by the partial combustion of the carbon constituents of the fuel is carbon monoxide (CO) as expressed by the equation

$$2C + O = 2CO \quad \ldots \quad (a)$$

but the production of this gas is attended by an evolution of 30 per cent. of the heat of the carbon reacted on. Unless this heat were to

* Paper read before Section G of the British Association at Dublin.

† This means that if current were delivered from a public supply to a motor of 90 per cent. efficiency in cases A and B, and a motor of 80 per cent. in case C, the rate of charge for such current would have to be [illegible] to give the equivalent cost per B.H.P.-hour mentioned above. If, however, the standing charges in respect of the motor and [illegible] installation generally are added, the rate would have to be [illegible] to equal the gas engine installation in economy.

a large extent recovered the efficiency of the producer would, obviously, be very low, and besides the cumulative effect of a continual liberation of heat in this degree would be to set up a very high temperature in the producer which would tend to the formation of excessive clinker and which would also cause many other difficulties.

A simple practical means of utilising this heat and enriching the gas at the same time is by the method so generally adopted now of saturating or partially saturating the air passing to the furnace with steam. This steam reacts with incandescent carbon in two alternative ways—

$$C + 2H_2O = CO_2 + 2H_2 \quad . \quad . \quad . \quad . \quad . \quad . \quad (b)$$

$$C + H_2O = CO + H_2. \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (c)$$

In both of these reactions a combustible gas results, and they both require heat to enable them to take place. This is supplied by the liberated heat just referred to, which results from the direct combination of the oxygen of the air with the carbon of the fuel to form carbon monoxide, and hence, broadly speaking, the degree in which the reduction of steam according to either of the foregoing equations can take place with advantage depends entirely on the amount of heat available from the production of monoxide in the primary reaction according to equation (*a*).

The decomposition of steam in the presence of heated carbon, however, begins at a comparatively low temperature (between 500°C. and 600°C.) and hence if too much steam is used the fire becomes unduly cooled, which is undesirable for reasons which will be presently considered.

A further advantage which follows from the use of steam is the enrichment of the gas made, for the hydrogen evolved by the reaction (*b*) and the monoxide and hydrogen in reaction (*c*) are combustible gases produced apart from reactions with atmospheric oxygen, which in all cases carries with it four times its volume of nitrogen. This latter is a diluent in all producer gas and passes through the furnace unchanged. Hence the use of steam simultaneously effects three useful and necessary functions in the producer: It prevents the working temperature of the furnace from becoming excessive, in so doing it absorbs that large proportion of heat liberated by the union of the carbon of the fuel with the oxygen of the air passing to the furnace, and, thirdly, by producing carbon monoxide and hydrogen direct, the proportion of combustibles in the gas yielded by the producer is largely increased in proportion to the amount of inert nitrogen drawn in along with the air.

By neglecting the radiation losses and also the heat losses in the scrubbers, it is possible to make a simple calculation of the conditions under which the whole of the heat of the fuel can be accounted for in the gas produced, and such a calculation is useful in enabling us to understand more clearly how a suction producer actually works. Since there are alternative ways in which the steam may be split up as given above in equations (*b*) and (*c*), it is convenient to consider separately the combination of reactions which these equations represent when taken together with the primary reaction $2C + O_2 = 2CO$.

It will be found that if we combine the latter equation with equation (*b*) in the following proportions the total heat of the carbon reacted on is accounted for in the gas produced—

$$\left.\begin{array}{l} 2C + O_2 = 2CO \\ 0{\cdot}95C + 1{\cdot}9H_2O = 0{\cdot}95CO_2 + 1{\cdot}9H_2 \end{array}\right\} \quad . \quad . \quad . \quad . \quad (d)$$

The composition of the producer gas which will be formed by these combined reactions is as follows, and assuming that the relative weights in the equation are taken in pounds, and the volume of gas produced in cubic feet, the total volume of each constituent will be—

CO	715	cubic ft. or	22·6	per cent. by volume.
CO_2...............	339·6	.. ..	10·725	..
H	679·25	.. ..	21·45	..
N	1,430·0	.. ..	45·2	..
	3,163·8		100·00	

The calorific value of this gas will be 151·5 B.Th.U. per cubic foot.

The weight of steam per lb. of carbon	0·965 lb.
Air required per lb. of carbon	50·5 cubic ft.
Total volume of gas produced	3,163·875 cubic ft.

Similarly, by combining the primary reaction with that represented by equation (*c*) in the following proportion we account for all the heat in the carbon:—

$$\left.\begin{array}{l} 2C + O_2 = 2CO \\ 1{\cdot}18C + 1{\cdot}18H_2O = 1{\cdot}18CO + 1{\cdot}18H_2 \end{array}\right\} \quad . \quad . \quad . \quad . \quad (e)$$

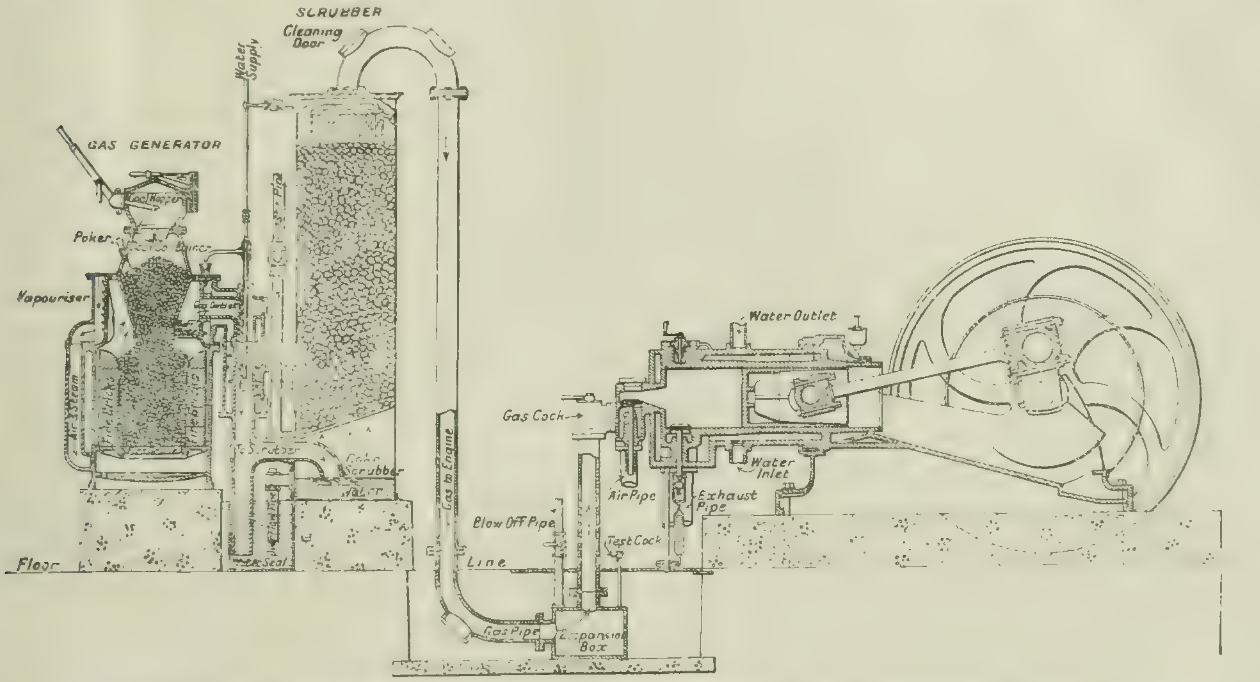

Fig. 1.—Typical Arrangement of Gas Engine and Suction Gas Plant Combination (National).

The composition and volume of the gas produced will be as follows:

CO	1,136·8	cubic ft. or	38·06	per cent. by volume
H	420·25	.. ..	14·06	..
N	1,430·0	.. ..	47·88	..
	2,987·0		100·00	

The calorific value of the gas per cubic foot will be	179 B.Th.U.
The weight of steam per lb. of carbon	0·577 lb.
Air required per lb. of carbon	46·8 cubic ft.
Total volume of gas produced	2,987 cubic ft.

In making the foregoing calculations it is assumed that the heat required for steam raising purposes is obtained from the fuel consumed in the generator and hence in establishing a heat balance the amount of heat required to vaporise the water has been deducted from the left-hand side of the equation in both cases. The only apparent difference in the efficiency of these two systems, therefore, lies in the fact that in the first more steam is used than in the second. It will be noted that the gas produced in the latter case is considerably richer than in the former.

It is found, however, that there are further considerations which influence the efficiency of gas producers. At temperatures of 500°C. and over, it is well known that carbon monoxide and steam, and also carbon monoxide and carbon dioxide, may react with each other, such reactions being reversible and depending upon temperature. These reversible reactions are usually written as follows:—

$$CO_2 + H_2 \rightleftarrows CO + H_2O. \quad . \quad . \quad . \quad . \quad . \quad (f)$$

$$C + CO_2 \rightleftarrows 2CO \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (g)$$

In both cases the reaction tends from right to left at temperatures *under* 800°C., above which they take place in the opposite direction; in other words, the carbon monoxide tends to become destroyed in a certain degree as the temperature of the producer is lowered. Further, the combined reaction according to equation (d) also tends to take place rather than the alternative according to equation (e) as the temperature falls. It is obvious, therefore, that in order to get the highest working efficiency the steam supply should be regulated so that the temperature of the fire in the producer is kept as high as possible without making excessive clinker seeing that a richer gas thereby results and the reversible reactions tending to the destruction of carbon monoxide are avoided. Prof. Bone and Mr. Wheeler recently demonstrated the truth of this statement in an exhaustive series of experiments on a Mond producer. The fuel used contained 78 per cent. of carbon, and by varying the amount of steam in the air blast from 0·45 lb. to 1·55 lb. of steam per pound of coal gasified, the efficiency of the producer, including the steam for blowing engine, was found to fall from 77·8 to 66·5 per cent. Similar comparative results may be expected from a suction producer, and this drop of efficiency would appear to be due chiefly to the influence of the reversible reactions referred to. The efficiency of a good suction producer varies from 85 to 90 per cent., according to the conditions under which it is worked.

The importance of properly proportioning the steam supply will be appreciated; otherwise, the best results cannot be obtained, and this is one of the points to which further attention might with advantage be given by gas plant designers. Given a properly designed producer, however, the conditions of highest efficiency can be automatically and continuously obtained without the slightest trouble week in and week out whilst the plant is being worked by an ordinary attendant.

In all suction producers directly connected to the engine and automatically regulated thereby, successful working depends also upon the absence of any serious restriction to the flow of gas from the furnace to the engine cylinder. If there is a restriction for any reason, the weight of charge drawn into the working cylinder of the

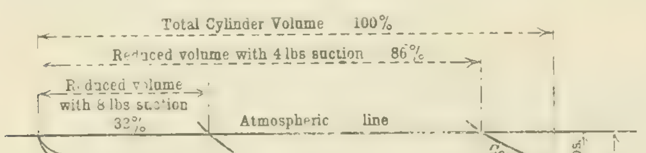

Fig. 2.—Suction Diagram from Working Cylinder, showing the Effect of Increase of Back Pressure.

engine is reduced and a loss of power results which may make all the difference between success and failure. The effect of increasing the negative suction pressure on the volume of charge is shown in Fig. 2, from which it will be seen that by increasing the suction pressure from −4 lb. to −8 lb. the volume of the charge is reduced 53 per cent. The very simple form of generator and scrubber in the ordinary suction plant using non-bituminous fuel makes it possible to aviod undue restriction; even when gas coke or poor anthracite is used, each of which yields a certain amount of tarry matter and consequently requires the addition of a suitable tar extractor to the scrubber shown in Fig. 1, the suction pressure can be kept sufficiently low to prevent the volume of charge becoming unduly diminished.

From these remarks it will be understood that simplicity in all directions is the essential condition for successfully working any producer by the suction effect of the engine, and, this being so, the difficulty of treating bituminous fuels in the simple type producer shown in Fig. 1 will be appreciated. Bituminous fuels contain upwards of 30 per cent. of volatile matter, which distil off at such temperatures as are found in the upper part of a suction producer. If the coal container in Fig. 1 were charged with the coal whilst the producer was at work a considerable proportion of the volatiles would be distilled and would pass away along with the gas made in the lower part of the furnace before the fresh fuel reached the active zone of combustion. Now, of these volatiles [illegible] per cent. and upwards is tarry matter, which condenses out as the temperature of the gas is lowered in the scrubber and [illegible]. The latter would quickly become choked up, and in addition, so large a proportion of tar would be carried forward to the engine that the successful working of the latter would be [illegible]. It is this tar difficulty which is the main trouble to be dealt with in making a successful suction producer to work with bituminous fuels, for the addition of extra cleaning apparatus to extract the tar in a sufficient degree would necessarily have the effect of greatly increasing the frictional resistance to the passage of the gas from the generator to the engine, and would otherwise destroy that simplicity of arrangement which we have seen to be essential.

Attention has naturally been turned, therefore, to various methods by which the tar trouble can be eliminated, with the hope that it might prove possible to transform the condensable tarry vapours into fixed gases in the generator, so that the difficulty of tar extraction and additional cleansing apparatus generally could not arise at all. Attempts have been made to decompose the tar by working the producer on the down-draught principle, which has the effect of compelling the volatiles to pass through the hot zone of the furnace before leaving the producer. By another plan the gas outlet is in the middle of the producer and air is supplied both at the top and at the bottom, the action which is aimed at being to use the upper half of the producer as a down-draught furnace for distilling and fixing the volatiles, while the lower half is supplied with the residual coked fuel and works as an ordinary up-draught furnace. It is, however, extremely doubtful whether a successful solution of the difficulty will be arrived at by either of these two methods. In pressure producers many plans for reducing the tar within the producer by passing the volatiles through the hot zone of the furnace have been carefully tried from time to time, but without a sufficient measure of practical success to warrant the permanent adoption of any of them for use with bituminous steam coal such as is available here. There appears to be no reason for thinking that modifications of these proposals when applied to suction producers will prove to be more efficacious.

The calculations previously given in this Paper would appear, however, to suggest a better method for attacking the problem. It has been shown that all the sensible heat liberated by the combustion of the carbon of the fuel with the oxygen of the air could be absorbed by the reduction of the steam passing into the furnace along with the air, and that the precise amount of steam which can be reduced depends entirely on the amount of heat which is so liberated. Further, when we account for the whole heat of the carbon in this way and take into full consideration the diluent effect of the nitrogen which is unavoidably present, a gas of sufficient calorific value results for effective use in the engine cylinder.

There would, therefore, seem to be no reason why the furnace of the producer should not be devised in such a way that the volatiles are absolutely burnt out after being distilled, the heat of this combustion being afterwards recovered by the decomposition of steam under the conditions already described. The final heat balance would be exactly similar to that established by the combined equations already given, and in practice a gas of about 150 B.Th.U. calorific value might reasonably be expected, and which is quite suitable for engine work. By such a method the tar would undoubtedly be eliminated, whilst the efficiency of the system would be high. There are several designers at work on producers of this character, and when the proper proportions and other practical details are understood a considerable measure of success may be hoped for; the simplicity of the cooling and scrubbing arrangements under this system gives good promise of the feasibility of evolving a practical suction plant for use with bituminous fuels. The ordinary plant, however, for gas coke or anthracite may still be expected to hold the field for units up to 100 B.H.P.

The utilisation of lower grade fuels, such as peat, for power purposes has a special interest for Ireland. Peat as a fuel yields a large percentage of volatile matter, and it will be realised from what I have just said that the design of gas plants for use with such fuels is in a transitional stage at the present time. Something is being done abroad with large pressure plants using peat and working with bye-product recovery apparatus, and the practical results obtained with such installations will be watched with attention here. As these developments are progressing it seems to me that meanwhile those who are interested in the peat industry might with advantage give further attention to cheap methods of deriving it. Coal mining has become a highly specialised science and a thoroughly organised industry, but, from the point of view of similar organisation and specialisation, comparatively little has yet been done in the case of peat. Under such conditions there is small chance of peat meeting with general acceptance here whilst such fairly cheap supplies of coal are available. Whilst practice in producers suitable for peat tends to change so rapidly, and pending success in cheap methods of deriving the peat itself, it may not, perhaps, prove to be altogether a disadvantage that large power schemes depending on peat as fuel are postponed for a little while.

Reviewing the present position of suction plant [illegible] as a means of deriving cheap power, I think it is now generally admitted by those who have looked carefully into the matter that the claims made in respect of their convenience, economy and reliability are well founded. The fact that these results can be so easily obtained

by an apparatus of such simplicity has a special significance at the present time when the question of municipal and other public electricity supply undertakings is receiving so much attention from the point of view of the desirability or otherwise of supplying cheap power to manufacturers. It is becoming increasingly recognised by leading electrical engineers that it is exceedingly difficult, and in many cases impossible, to supply current for power purposes from central stations at rates sufficiently low to favourably compete with the cost to the consumer if he generates his own power, but as attention has recently been so fully drawn to this aspect of the matter in a comprehensive Paper read before the Institution of Electrical Engineers by Mr. J. F. C. Snell, it is only necessary to briefly refer to it here. Mr. Snell has emphasised the present inability of most electricity undertakings to meet a large demand for power at sufficiently low rates to hold their own with users' own plants, and I understand his remedy to mean the remodelling of central power stations, the writing down of the capital expenditure already incurred in connection with them, and the elimination of independent electricity stations in the smaller towns in favour of a central installation supplying a group of towns.

I think Mr. Snell, who speaks with competent knowledge of electricity undertakings generally, does well to frankly face the position, but in view of such facts relative to the economy and reliability of gas power as I have ventured to refer to here, it will be conceded that there are adequate grounds for the serious doubts which some of us feel as to the wisdom of embarking on the many millions of expenditure which the general adoption of his proposals would entail. The ultimate effect of such proposals, which are chiefly framed with the object of supplying power to factories as distinguished from general electric lighting, would be nothing more than an attempt to do for the power user what he can carry into effect on better terms for himself by the use of gas engines and suction gas producers.

Another important point is that the growing tendency which exists to remove factories out of the large town areas must tend to continually increase the distribution costs of electricity supply, thus making the chances of a margin of profit on any rate which it would be to the advantage of the user to accept even more remote. On the other hand, particular location has little or no influence on the successful and economical working of gas producers.

So far as the British Isles are concerned, all power must be derived from coal, which is almost our only source of energy at the present time. The fundamental problem, therefore, is to utilise the heat energy of the fuel as efficiently as possible at each point of application, and when power users, both small and large, have at their hand in suction gas plant installations a simple apparatus for so doing, which is practically as efficient as the largest central station plant, the latter is at a great disadvantage when heavy distribution charges have to be added to the cost of power production at the station. With the foregone important considerations underlying all problems of power supply from a central source, there would appear to be no pressing need for heavy expenditure on the part of public bodies in order to provide cheap power for manufacturers. I venture to suggest that these facts are of special importance in the case of our municipalities which already have to meet such numerously heavy and greatly increasing monetary demands in connection with those objects and undertakings for which in any case they must accept responsibility.

ELECTROCHEMISTRY AT THE BRITISH ASSOCIATION MEETING.

Ions.—In the Chemical Section of the British Association at their meeting in Dublin, Prof. Armstrong again introduced his favourite topic, the "Ionic Theory." Ever since the origination of the ionic theory of electric dissociations, Prof. Armstrong has been an extremely violent opponent of it. Nor was he much less violent in the manner in which he introduced the subject and discussed it in Dublin. He considered that the assumption of independent ions in solution had no experimental foundation for the theory to rest upon. He put upon the board the equation for interaction of sodium hydroxide with hydrochloric acid, and said that some people are so imbued with the idea of ions that even the infants in the elementary schools prate of it. In his opinion, it was not proved that, in solution, hydrochloric acid was dissociated into H cations and Cl anions. He ventured to believe that, contrary to the dissociationists, hydrochloric acid when dissolved in water was associated with the water molecules, and he wrote upon the board the symbol to express this as $H_2O<{Cl \atop H}$.

Association between the water molecule and the hydrochloric acid molecule would be feeble and under electrical stress the Cl and the H atoms were split off, wandering the one towards the anode and the other towards the cathode. Why was it that in studying solutions we only examined the one class—viz., dilute solutions? Many of the phenomena met with in physical chemistry were attributed to dissociation of water itself into H and OH ions. Thus hydrolysis was supposed to be due to this cause. But as hydrolysis of sugars could be caused by enzymes, and there were hundreds of enzymes, yet only one particular enzyme was able to cause this hydrolysis. Therefore, there was no proof that hydrolysis was brought about by ionised water. But the physical chemist referred all hydrolysis to ions of water. Water which absolutely would not conduct the electric current had never been obtained, but he believed that if it were obtained absolutely pure it would be a complete non-conductor. The old name for oxidation meant acid producer, as it was supposed that acids contained oxygen. He thought that it was a good thing to come back to the old name, because as we could have no acid or no acid reaction without the presence of water which contains oxygen, therefore the oxygen was the acid producer. A very good discussion followed the reading of Prof. Armstrong's Paper. Sir Oliver Lodge first suggested that Prof. Armstrong and the physical chemists were no longer so very far apart. The physical chemist, for example, had no objection to the association of ions with water molecules. They, however, would prefer to imagine a large number of the water molecules hanging on to each ion. Further, he had no actual objection to the way in which hydrochloric acid in aqueous solution had been written by Prof. Armstrong.

Prof. Donnan said that Prof. Armstrong spoke very strongly against the ionic theory, which had been so extremely useful as a hypothesis, and through which much valuable work had been done, but he gave no other theory to take its place. It was very easy to condemn a theory, but the condemnation was of little value if no other theory was put forward to replace the one disapproved of.

Dr. Wilsmore said that physical chemists first of all studied dilute solutions, because, although this was a difficuult problem, it appeared less complicated than that of strong solutions. Since solutions obeyed Ohm's law, therefore the conception of the manner in which they conducted electricity was probably accurate. He furthermore wished to know how Prof. Armstrong would explain conduction in fused salts. Sir William Ramsay considered that it was practically impossible to discuss the subject of Prof. Armstrong's address, because, although he had talked of ions, he had entirely omitted to mention electrons, and, therefore, as physical chemists considered that ions were probably a collection of electrons, he did not see how it was possible to discuss the matter.

Rapid Electro-deposition of Metals.—There were two Papers before the British Association upon this subject which has come so very much forward of late, the first one being by Dr. H. J. S. Sand. He not only showed and described his apparatus, but gave a demonstration in which he showed the separation of copper from antimony. It will be remembered that Dr. Sand rotates his cathode very rapidly and regulates the E.M.F. to be employed by means of an auxiliary cell containing mercury, mercurous sulphate and sulphuric acid. Having regulated the voltage he then puts as high a current through the electrolysing cell as the voltage at his disposal will allow. Now, as different metals have different electrical deposition values—that is to say, require a different potential to deposit them—it is possible by graduating the potential to throw out first one metal and then another, and the chief value in Sand's work is the introduction of this auxiliary electrode for analytical purposes. One of the main difficulties in electro-analysis up to the present has been to devise good methods of separation, whereas when dealing with pure metals there is no difficulty in carrying out determinations; with mixtures difficulties often arise. In a great many cases, therefore, it has been customary to carry out the separations, partially electrically and partially chemically. Another difficulty in regulating the potential is that most metals are deposited at a lower pressure than

hydrogen, but if hydrogen and a metal are deposited together the tendency is for the metal to come down in a spongy condition. By regulating the potential even such metals as bismuth and tin, which have always shown a tendency to deposit badly, can be deposited without difficulty. On the other hand, a certain amount of difficulty is introduced by the greater complication of the apparatus, as one must either work with a capilliary electrometer or else with a potentiometer. The method, however, admits of great rapidity, and doubtless, therefore, will gradually come into use.

Dr. Sand has deposited and separated silver, mercury, copper, bismuth, lead, cadmium and zinc, and not only have the metals been singly deposited, but they can be separately deposited when they all occur together, or when any two of them are in the same solution. Quite recently the author had succeeded in depositing and separating tin and antimony, which substances have always been very tiresome to analyse when they occur together. In this case the antimony can be deposited out in 20 minutes, and after this the tin in 80 to 90 minutes.

Dr. F. M. Perkin and Mr. W. Hughes also contributed a Paper upon somewhat similar lines. The apparatus employed is a good deal more simple than that of Sand, and it is also cheaper. It consists of a spiral anode which is rapidly rotated within a cylindrical platinum gauze cathode. The authors also described how this apparatus can be employed with an auxiliary eleotrode. While Dr. Sand usually employs an electrometer for measuring his potential, Perkin and Hughes have used a potentiometer.

ELECTRIC TRACTION ON RAILWAYS.*

VIII.—MOTOR TRUCKS.

BY PHILIP DAWSON.

(*Continued from page 751.*)

Summary.—In this article the author deals with the design of trucks suitable for geared motors. For railway work bogie trucks are almost universally used, and various types and makes are here described, those with pressed steel side frames being most in favour in this country. The method of suspending the motors and their position are also discussed.

The severe strains to which motor car axles are put have already been referred to in a previous article, but particular attention must again be drawn to the fact that if only one brake block is used per wheel, *i.e.*, one on one side only, instead of two per wheel, one on either side, a very considerable additional strain will have to be borne by the axle. Amongst the reasons which have induced many purely electric railway men to prefer the single instead of the double brake shoe arrangement may be mentioned the additional wearing parts, and hence increased maintenance due to doubling the number of brake blocks per train, as well as the considerable difficulty, which, owing to the space occupied by the motors, is often found in finding room for the additional brake rigging necessary.

In deciding on the design of truck to be used there are many points to consider, many of which may clash with each other. Such things have to be fixed as wheel base, diameter of wheels, minimum clearance between lowest point of truck or motor and top of rail. All these and many other points must be carefully studied before any decision can be come to, attention being given to such governing conditions as length of car proposed to be used, construction gauge, height of platforms at stations, weight of bodies and electrical equipment to be carried, &c. Particular attention is called to the desirability of using as large wheels and as long a wheel base as is consistent with reasonable cost of construction and design. Experience has shown that very severe strains accrue at the points where the transoms are connected to the sole bars, probably due principally to the tendency of racking in consequence of the motors not driving centrally on the axles as well as to the distribution of the weights. The results as regards fracture or loosening of joints in this case depends not only on the design of the trucks and the quality as well as amount of material used and crossbracing, but also very largely on

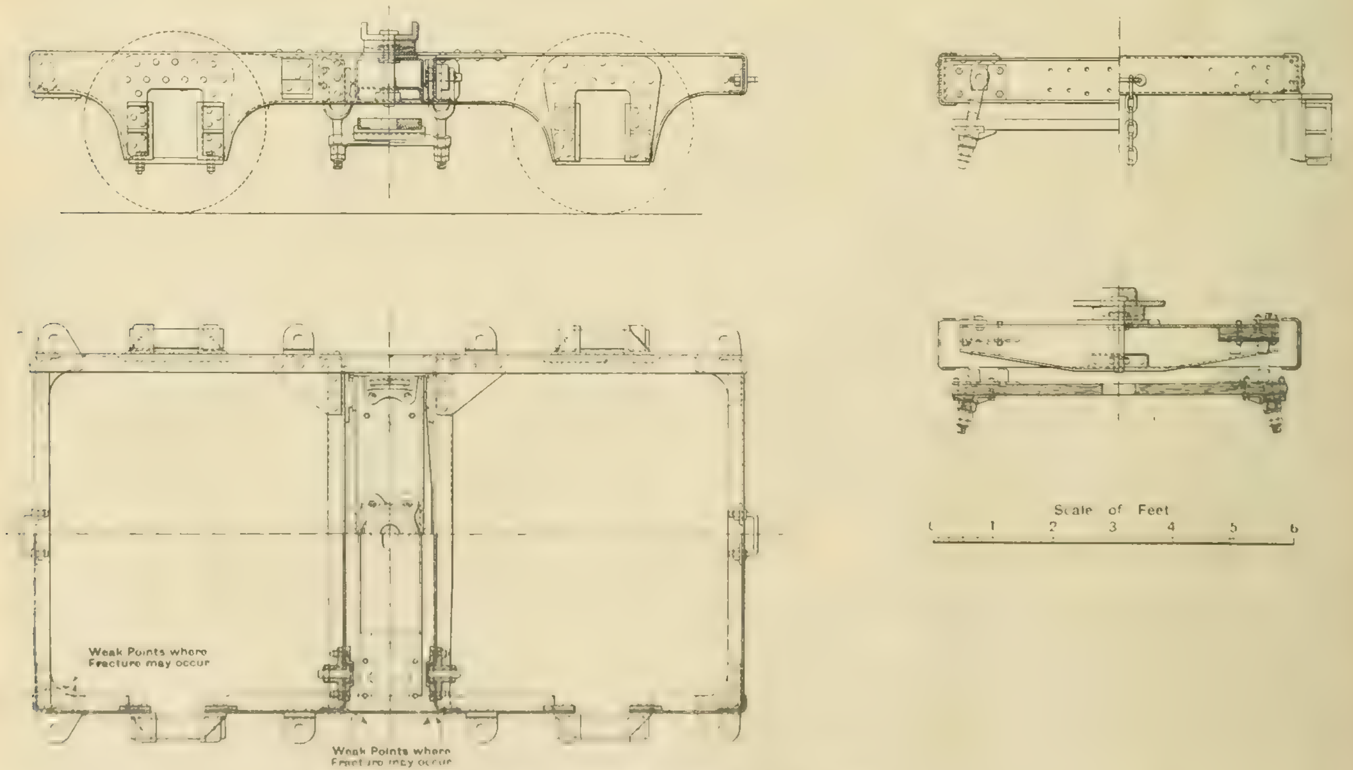

Fig. 11. Details of Pressed Steel Truck.

the method of suspension adopted for the motors. Another weak spot is that at the end of the trucks, in the case of those using elliptic springs, when the elliptic spring support is fixed to the end of the sole bar. For this reason it may be advisable not to use pressed steel members for the end towards its centre, where the transoms are located, be made as stiff as possible in the horizontal direction. Furthermore, it is advisable to bring the point of support of the truck from the elliptic spring away from the end of the truck.

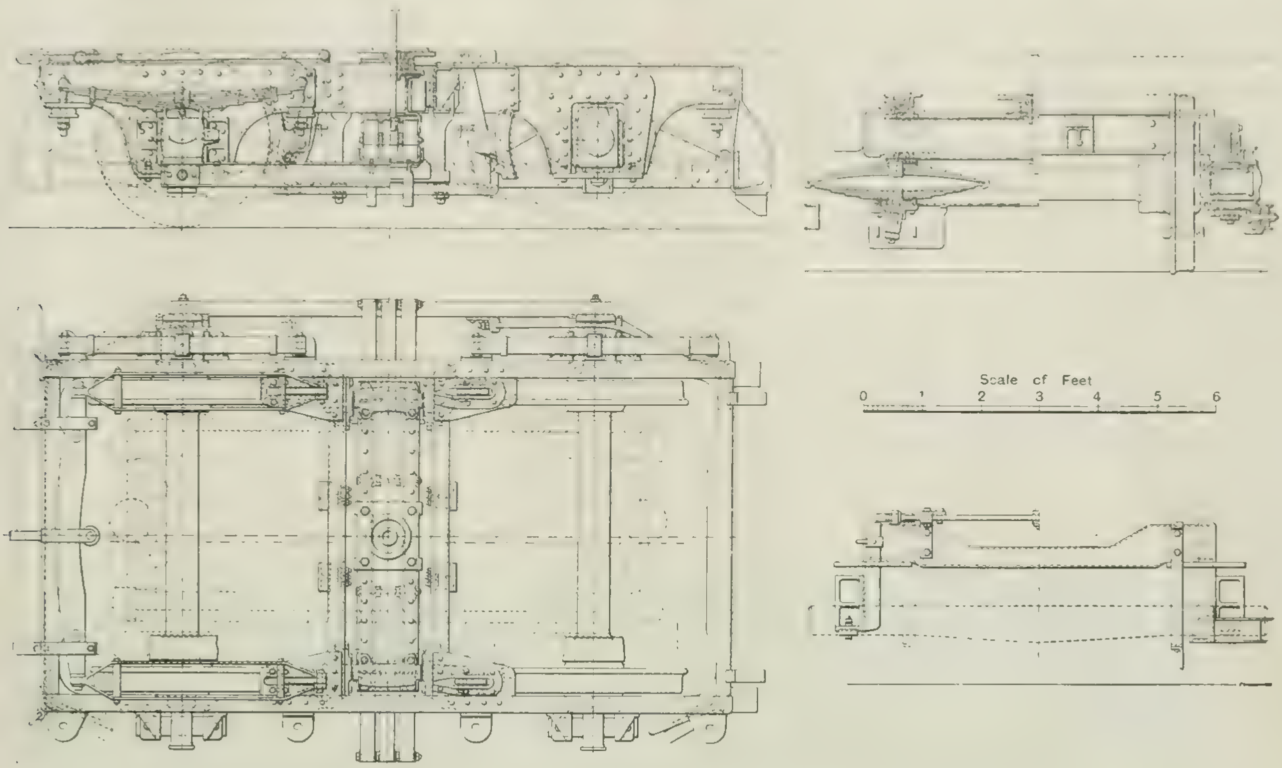

Fig. 12.—Fox's Pressed Steel Motor Carriage Bogie for the Metropolitan Railway.

frames and the transoms as at the points where they are riveted to the sole bars there lies a considerable source of weakness. A pressed corner, particularly if thickish metal is used, cause great stresses if a sharp angle is required; on the other hand, the absence of a sharp angle causes a liability to bend backwards and forwards which will eventually result in fracture. The transoms should therefore not only be of very rigid design and construction, but also so fixed to the side frames or sole bars as to make the joint as rigid as possible. Furthermore, the sole bar itself should,

These weak spots, which of course become conspicuous when large motors and heavy carriages, with possibly rough track, come into consideration, are clearly seen by examining Fig. 11, which represents a standard type of pressed steel truck which, given proper conditions as regards size of motors, weights to be carried, speeds to be run and quality of permanent way, has given satisfaction.

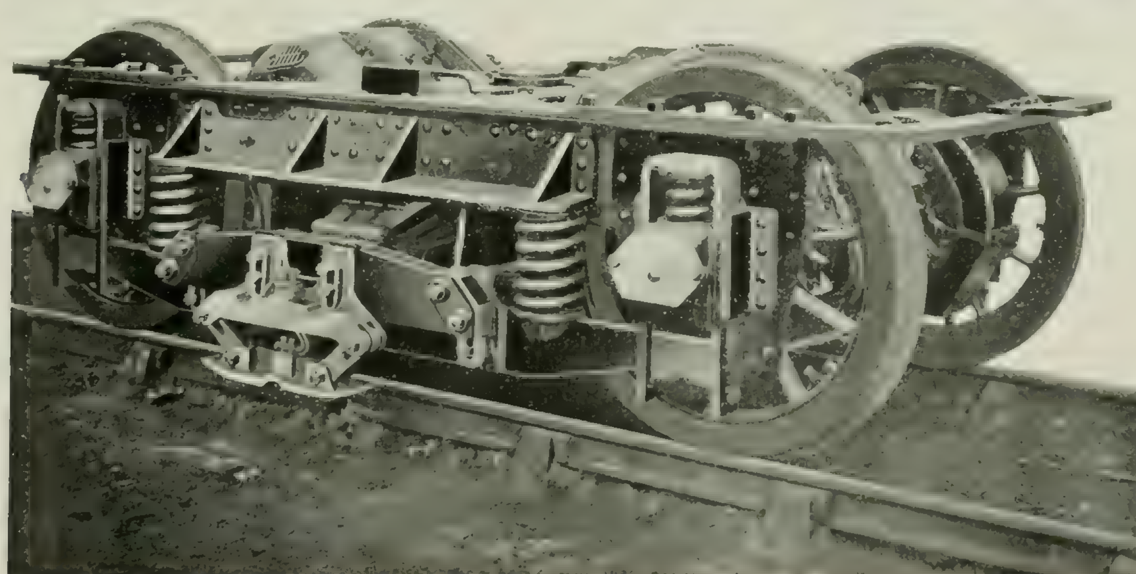

Fig. 13.—Lancashire and Yorkshire Electric Motor Truck equipped with 2 × 150 h.p. Dick Kerr Motors.

In approaching these designs of pressed steel frames although strengthening of sole bars may not only be desirable but essential, it must be remembered that owing to the

very small radii to which the flanges must be pressed, the thickness of material to be used is limited, and $\frac{11}{16}$ in. appears to be the greatest thickness which from present experience pressed side frames should be manufactured, although it has been suggested in some quarters that thicknesses of one inch might be reached. The former is a large increase on past practice, which has been to use material $\frac{7}{16}$ in. in thickness.

As regards the swing bolster, this can be supported off the spring plate, either by double elliptic or by coil springs, the disposition of the latter varying according to circumstances. Fig. 12 shows the standard motor trucks which were adopted by the Metropolitan Railway, but which experience has shown require a certain amount of strengthening and stiffening. The method of springing the spring bolster in double elliptic springs is here clearly shown.

Another weak spot and one which requires careful consideration, especially when only one brake block per wheel is used are the jaws of the frame forming the axle guards and to which the horn blocks are riveted. This is particularly the case where equalisers are used, and where the sole bars are not carried either on elliptic springs resting on the top of the axle boxes, or on helical springs either carried on the top or else at either side of the axle boxes; in which case care should be taken to see that the lower extremities of these axle guards are thoroughly well braced together. Where only one brake block is used per wheel, the next point to be considered is what is the most advantageous place to hang the blocks either inside the wheels or outside. From the point of view of easy and cheap maintenance it would appear that outside hung brake blocks are the most advantageous, and this is the principle generally adopted in the United States of America. It has, however, the disadvantage that as generally constructed, when applied, such brakes pull down one end of the bogie frame and push up the other, thus producing considerable additional strain in the bogie frame and increasing the load on the journals. The use of inside hung brake blocks decreases the disadvantages mentioned above, but when there is room, and with careful design room can always be found, and notwithstanding the increased cost of brake rigging maintenance, two blocks per wheel are undoubtedly the most advantageous from all points of view.

In fitting brake rigging, and arranging the run, it must be borne in mind that all wearing parts should be easily accessible and arrangements must be made to take up wear easily and to provide for an even, gradual, and equal application of brake pressure under all possible conditions of working. As only heavy railway work is considered, it can be taken for granted that either pressure or vacuum automatic air brakes will be used and the brake rigging has hence to be designed with this end in view.

Besides the pressed steel built-up trucks, which have been, so far, the only ones referred to, there are others, such as those used by the District Railway, the side frame or sole bars of which are of cast steel, and Fig. 1 referred to previously illustrates a truck with cast steel side frames, as manufactured by the Brush Company. Another form of truck is the one entirely built up of standard steel sections; such a truck is illustrated in Fig. 3, previously referred to.

A compromise between British and American practice is shown in the truck designed by Mr. Hoy for the electric rolling stock for the Lancashire & Yorkshire railway and illustrated in Fig. 13. In this case the sides consist of deep section steel angle on which are riveted cast steel stiffening pieces and cast steel axle guards or horn blocks. The end cross members consist of a simple flat steel bar bolted to the ends of the side frames. The cast steel stiffening piece rest through spiral springs on a bottom equalising bar fitted to a steel stirrup which encircles the axle box on three sides and rests on the top of it through a short stiff coil spring. A swing bolster rests on double elliptic springs supported from the transoms. To stiffen the truck still

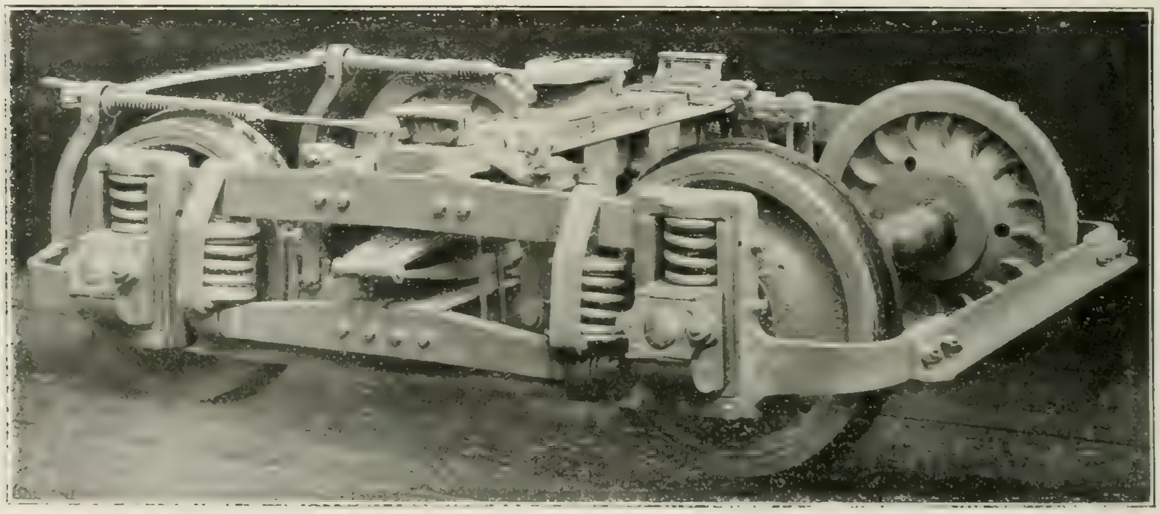

Fig. 14—Brill Truck

Table I.—*Data of some Brill High-speed Electric Trucks.*

Name of Purchasing Company.	Wheel base.		Track gauge.		Diam. of wheels.	Diam. of Journal.	Weight of car body.	Weight of each bogie with wheels & axles.
	ft.	in.	ft.	in.	in.	in.	lb.	lb.
Strang Gas Elec. Co.	7	0	4	8½	36	5 9	89,000	11,800
Boston Elevated Ry.	6	1	4	8½	34	4½ 8	34,000	12,170
Oneida Railway Co.	6	6	4	8½	37	4½ 8	31,000	11,000
Utica and Mohawk Valley Railway ..	6	6	4	8½	36	5 9	32,000	11,535
Rochester, Syracuse & Eastern Rly. ..	7	0	4	8½	37	5 9	40,000	11,975
Milan Gallarate Ry.	7	5	4	8½	41	6 9	45,000	6,500*
New Jersey and Sea Shore Rly. ..	7	0	4	8½	36	5 9	50,000	14,400
Brill High-speed Trucks for Steam Railway Service.								
Buenos Aires Western Rly. ..	7	6	5	6	37½	8 4¼	54,000	8,580
Gt. Western Rly. of England .	9	0	4	8½	43½	9 4¼	56,000	8,135

* Without wheels and axles.

further a steel plate is riveted over the centre of the truck, the guides on which the body sits and which regulate the movement of the body having holes cut in this plate to pass through.

Fig. 14 represents a bogie of the Brill type. It differs in many respects from all other standard types of bogies. The side frame consists of forged steel with axle jaws complete. The end members are rolled steel and are bolted to the projecting ends of the forged steel side frame. These side frames are supported from the tops of the axle boxes through helical springs. The bolster in its turn rests on double elliptic springs supported from the usual spring beam. This however, instead of being hung by means of links from the transoms, is carried by two beams which have the functions of equalisers, and which in their turn are hung from coil springs fixed in stirrups hung from the side frames and free to swing sideways. Table I. gives some data concerning Brill trucks, both for steam and electric service.

(To be continued.)

PORCELAIN INSULATORS AND THEIR ACCESSORIES.

THE TIPTON AND HANLEY WORKS OF MESSRS. BULLERS, LIMITED.

It will require a very little effort to impress upon the average engineer the present-day value and importance of electrical insulators. The development of transmission lines, at home and abroad, has concentrated the attention of engineers and specialists on the production of a piece of electrical apparatus which at one time was regarded as insignificant and even unreliable. In the early days of the electrical industry the enthusiasm of the potter had to be aroused to the possibilities of or no future worth speaking of. It is not our intention, however, to take up our readers' time in rhapsodising on this extremely important subject. We wish rather to direct attention to the organisation and works of one of the largest insulator producing firms in the world, and to describe in some detail the processes of manufacture through which this important electrical product and its accessories have to pass.

Messrs. Bullers, Limited enjoy the unique distinction of

Fig. 1.—General View of the Foundry, Tipton Works.

the development of the porcelain insulator. That it was thoroughly aroused and ultimately assumed a responsibility of its own is a fact which the history of electrical porcelains bears out at every turn.

Insulators are no longer the product of what we may call a "side show" in the pottery trade. They form a distinct and definite branch of pottery, and are recognised as a specialised production to be handled only by men whose experience extends back many years. We should have little difficulty in dissertating at considerable length on the possibilities of the porcelain insulator and the part which it is likely to play in deciding the ultimate success or failure of hydro-electric transmissions. Similarly, the task would be a light one to prove that without the patient research of present-day makers of insulators and the vast amount of data which they have been able to collect and put into the practice of this important branch of work, hydro-electric transmissions would have little making not only the actual insulator itself but also the metal fittings and supports with which it is attached to pole, house side, steel tower or roof. These two products are naturally distinctive in character, and therefore require separate works. In Messrs. Bullers' case these are located in the potteries at Hanley and in the Black Country at Tipton, near Wolverhampton. Through the courtesy of the management of the company we were recently accorded the privilege of going over both these works.

THE IRON WORKS, TIPTON.

From an engineering aspect the works at Tipton are of greater importance than those at Hanley, and consequently they may be placed first in this description.

The whole of the ironwork connected with the support of insulators for every purpose is made at these works. The product varies largely in size and shape, while the quantity

dealt with is necessarily large, many thousand single pieces being handled at a time. Situated as they are in the very heart of the Black Country, the works can draw upon the surrounding district for its iron and coal supplies and also the right kind of labour to work them. This naturally finds a reflex

FIG. 2.—A CORNER OF THE MACHINE SHOP.

in the quality of the finished article and on the promptness of deliveries made to the consumer.

The buildings stand on a site of about 8 acres, which adjoins the canal and the London & North-Western Railway, both of which afford transport facilities for raw materials and finished products. The shops themselves do not occupy the whole of the ground site, there being plenty of room for extensions and also for the storage of materials. With the exception of the galvanising shop the whole of the buildings are adjacent to each other, and comprise a large foundry, annealing ovens, machine shop, smiths' forge, and bolt and nut shop. There are also extensive stores for both raw materials and finished goods, while in addition there is a separate building in which non-electrical work is carried out. All these buildings are connected by a light tramway, which greatly facilitates the transport of material, &c., from one department to another.

THE FOUNDRY.

Considering the processes successively, the foundry first claims attention. This department is housed in one of the largest shops in the works, the building being roomy and well lighted. A view of the interior is shown in Fig. 1. The castings are mostly light in weight so that rapid moulding is called for and in this work the men have not only become very proficient but they are also very smart. Quite a feature of this department is the machine moulding. At least a dozen machines fitted with expensive patterns are employed, and the excellence of the finish obtained in the castings, as well as the uniformity of the results seems to fully justify the large outlay involved on this class of foundry plant. The floor area of the foundry is approximately 850 sq. yds. The department is kept constantly going. The iron is carefully selected to give a mixture producing strong tough castings, particularly those which are subsequently annealed to render them malleable.

FIG. 3.—GENERAL VIEW OF THE GALVANISING SHOP.

The preparation of the sand, so often overlooked, is here a most important feature, sand mills, mixers and riddlers all play their part in producing the smooth surface which is so much desired in electrical work.

The Annealing Ovens. The annealing ovens adjoin the foundry and there are nine of these ovens, which are kept busy day and night treating the many kinds of castings which require annealing. The articles are

Fig. 4.—View in Aisle of Hammer Shop.

placed in air-tight pans which in turn are arranged in stacks in the ovens in the best position to come under the action of the fire. Most of the light brackets for telegraph insulator supports at the top of a pole are malleable iron castings, as are also many other patterns.

The dressing shop, which adjoins the foundry and oven shops, presents a busy scene; here the castings are dressed on emery wheels and by hand, after being treated in special "tumbling" barrels.

The Machine Shop. A great amount of machine work has to be done on many of the standard parts turned out at these works. Insulator pins, pole brackets, stays, and other pole fittings and insulator supports may be ranged among the many different pieces of iron and steel work which pass hourly through the machine shop. This is a long building separate from the main block, and is equipped with both special and standard types of tools, principally lathes and drills. A portion of the building is used as a fitting and assembling shop. To ensure accuracy with the insulator threads, special screwing tools have been designed to render the process more or less mechanical. Limit gauges are supplied within which the workman must keep. A general view of one of the groups of lathes is given in Fig. 2. The amount of work completed by this department cannot be properly appreciated by the size of the parts dealt with so much as by their great quantity and the number of operations required on each part. The design of the tools used does not call for any special comment, though it was evident from examples of quite modern tools that the management are keenly alive to the importance of keeping up-to-date.

After leaving the machine shop a great deal of the work is galvanised in the shop set apart from the main buildings for this purpose. A view of the interior of this shop is shown in Fig. 3. What is known as the "hot" process is employed, and a good coating of zinc is deposited on the parts treated. Our illustration shows one of the dipping tanks in the foreground.

The Hammer Shop. The shop which gives the appearance of the greatest activity and which also furnishes very audible evidence of its existence is that known as the hammer shop. A view looking down the main central aisle of this is depicted in Fig. 4. We understand that the shop is one of the largest of its kind in the Black Country. The equipment presents two striking contrasts, to use the term striking in no sense as a pun. Pitted against each other in this shop are the old and new, represented respectively by hand and machine labour. The former may be seen ranging itself on each side of the aisle in the picture. The machines are in the background. Each group is engaged upon the forging of rods, bolts, pins, shackles, &c. The work of the hand brigade is smart and almost fevered, and it has one redeeming merit, it can always be depended on for quality. Man and boy at the forge and treadle hammer work with a hurried rhythm which bespeaks skill and zeal. The machines maintain an incessant chatter, which makes the movements of the man seem quicker than they are. But they expedite the work on pieces such as insulator pins in a manner impossible with hand labour. Each machine has four dies into which the heated rod is thrust in turn, the eccentric motion keeping the hammers going all the time. The output is of course dependent on the man, who must be exceptionally smart to follow the workings of the metal in the dies. The village blacksmith section of the shop in the shape of a smithy is still retained, a number of forges and strikers doing

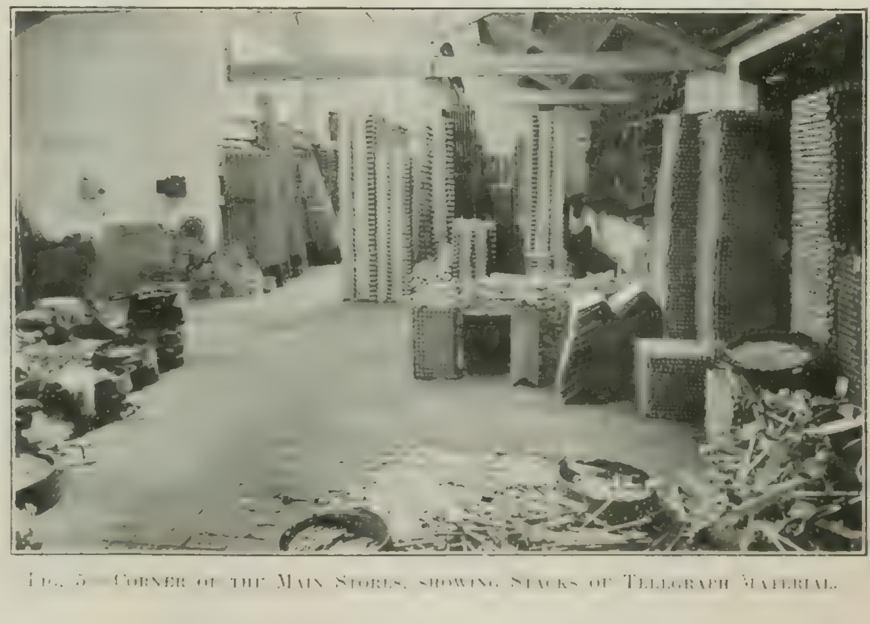

Fig. 5.—Corner of the Main Stores, showing Stacks of Telegraph Material.

the heavy work for which the machines are not suited. The machine tool equipment includes pneumatic hammers and hot saws, also a cold saw for cutting up steel angles, &c.

To give some idea of the capacity of this shop it will suffice

to say that nearly 2,000,000 insulator bolts have been turned out in one year.

Some idea of the vast amount of detail work put through the various shops may be gathered from the interior view of the main stores, shown in Fig. 5. In the background will be noticed a pile of guy wire tighteners for telegraph and telephone poles. At a conservative estimate the weight of these would be about 100 tons. One end of the stores serves also as a packing department, a bay being sunk in the floor, which is above the road level, to admit of a cart being backed in for loading. Suitable tackle is provided for raising and lowering the cases, poles (all kinds of iron and steel poles are supplied by this firm), &c., on to the lurry. Having regard to the very large quantities of metal parts of similar design required for telegraph and telephone work it will readily be understood that heavy stocks must be kept upon call.

Other departments of interest which we inspected were the Pattern Shop, Tool Department and Stores and Switch Cover Painting Shop.

The works are driven by Crossley Gas Engines, using Mond gas and developing about 200 H.P. The firm, however, also use several motors for isolated machines or for those engaged on intermittent work. The Dowson Gas Plant is an interesting feature. Messrs. Bullers make all the gas here for heating their ovens and furnaces in different parts of the factory.

In a works of this description, although the amount of repetition work is large and processes are accordingly stereotyped, it is nevertheless essential to keep a close watch upon the conduct of affairs. The offices of the works managers and the chief draughtsman form the theoretical centre of gravity of the establishment, and on this the whole fabric should turn smoothly. In the case of the works manager a special system has been drawn up by which the progress of every works order through the shops can be traced from day to day. Card indexing and duplicate forms make this possible, and our inspection of specimen entries impressed us with the simplicity yet extreme accuracy of the methods adopted. The records also show what is being done at Hanley with the "pot end" of a particular order, the execution of which may need to synchronise with that being undertaken at Tipton. In similar manner the drawing office keeps track of progress in both the works of the company, while it also presides over the drawings used in each. This centralisation of the drafting work is necessary because two distinct products turned out from separate works must ultimately be assembled with absolute accuracy. The shrinkage of insulators during manufacture makes the matter of greater importance, because a check must be kept on this, and no divided responsibility is possible when it is in the hands of a central department. Such dissimilar materials as iron and porcelain may be readily enough worked independently, but to make them safe partners is something of a problem, though its solution by Messrs. Bullers, Limited has all the appearance of being completely successful.

(*To be concluded*)

THAMSHAVN-LOKKEN SINGLE-PHASE RAILWAY.

Although but slow progress is being made with railway electrification in this country, this is far from being the case on the Continent. Probably our abundant supply of cheap fuel and absence of water power may have a good deal to do with the hesitation of English railway companies in carrying out schemes of electrification. In countries, however, where water power is abundant, and consequently a cheap supply of electrical energy obtainable, electric traction offers so many advantages that there need be no surprise at the number of lines which have been converted to electrical working.

The first railway line in Norway to be converted to single-phase working is that from Thamshavn, on Orkedals Fiord, to the Lokken mines, a distance of about 17 miles inland, which was opened for public traffic on July 15th last. The line skirts the river Orkla for some considerable distance and then rises rapidly to Lokken.

Power Supply.—The hydro-electric power station has been erected in an adjacent valley at Skyennald Fossen, and also supplies current for lighting Thamshavn and other villages adjacent to the railway, and also for operating mining

Fig. 1.—View Showing Method of Supporting Overhead Line.

machinery at Lokken. The supply is three phase at 15,000 volts and 50 frequency, and for converting this to a pressure more suitable for traction purposes a sub-station has been erected at

Fig. 2. Section Insulator on Thamshavn Railway.

Thamshavn, where the supply is transformed to single-phase current at 6,600 volts, 25 frequency, for feeding the overhead trolley line. For this purpose two motor generators, each of

250 k.v.a. capacity and capable of giving 500 k.v.a. for short periods, have been installed. The motors of these machines run with three-phase current supplied at 600 volts, this being type. Coupled to the same shaft is also an exciter for supplying the necessary current to the fields. The line voltage is kept constant by means of an automatic voltage regulator.

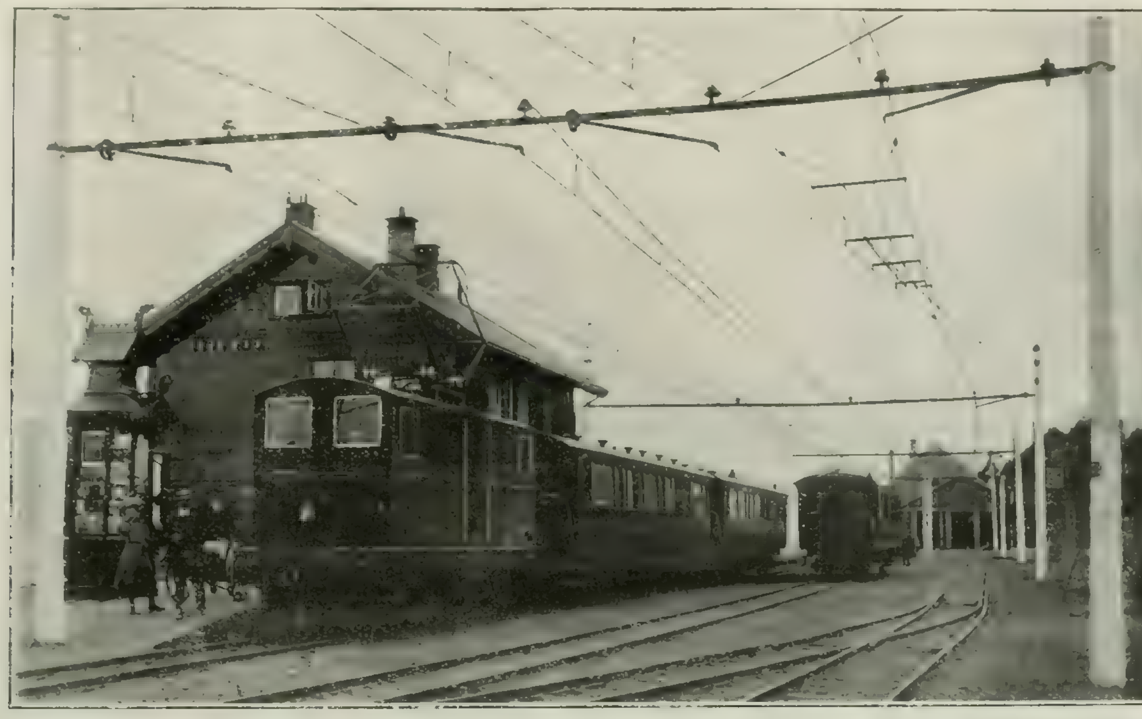

Fig. 3.—View of Thamshavn Station Showing the Arrangement of the Overhead Line.

obtained from two three-phase oil-insulated transformers, the potential at the primary terminals being 15,000 volts and at the secondary terminals 600 volts. The motors are of the three-phase induction type fitted with slip rings, and a liquid rheostat is arranged for starting purposes, whilst the generators to which they are direct coupled are of the single-phase revolving field

Track.—The gauge of the track is 1 metre, and the rails, which weigh about 44 lb. per yard, are fastened with spikes and steel tieplates to the wooden sleepers. For bonding purposes 50 sq. mm. copper bonds are used. The greater part of the route is level and practically straight, but towards Lokken several sharp curves and steep gradients (up to 4 per

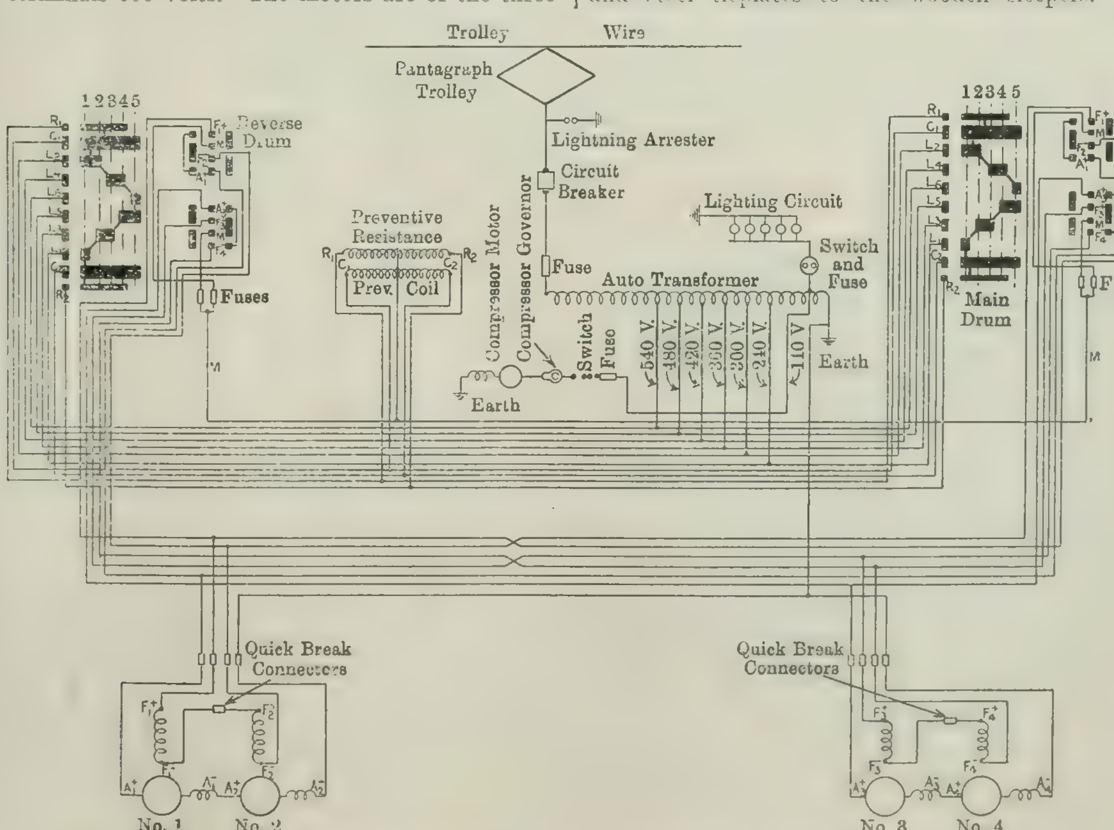

Fig. 4.—Diagram of Locomotive Connections.

cent.) are encountered. Single track is laid throughout except at the stations, of which there are seven, including the two terminal stations at Thamshavn and Lokken.

Overhead Line.—The overhead line has been erected on the Westinghouse single catenary system, and is carried by bracket arms fixed on wooden poles, as in Figs. 1 and 2, except at stations, where a pole is placed each side of the track and a cross-arm extends across the whole width of the track, as in Fig. 3, which shows a passenger train in the station at Thamshavn The wire consists of hard-drawn grooved copper of 65 sq. mm. cross section and is suspended about 18 ft. above ground level, by vertical hangers, from a seven-stranded steel cable carried on insulators. These hangers are fitted with clamps which grip the upper half of the trolley wire and are arranged so that they can be easily detached when necessary. The wooden poles are spaced about 68 ft. apart on curves and up to 150 ft. apart where a straight run is obtained. The brackets are arranged so that the trolley wire nowhere deviates more than 9 in. from the centre of the track.

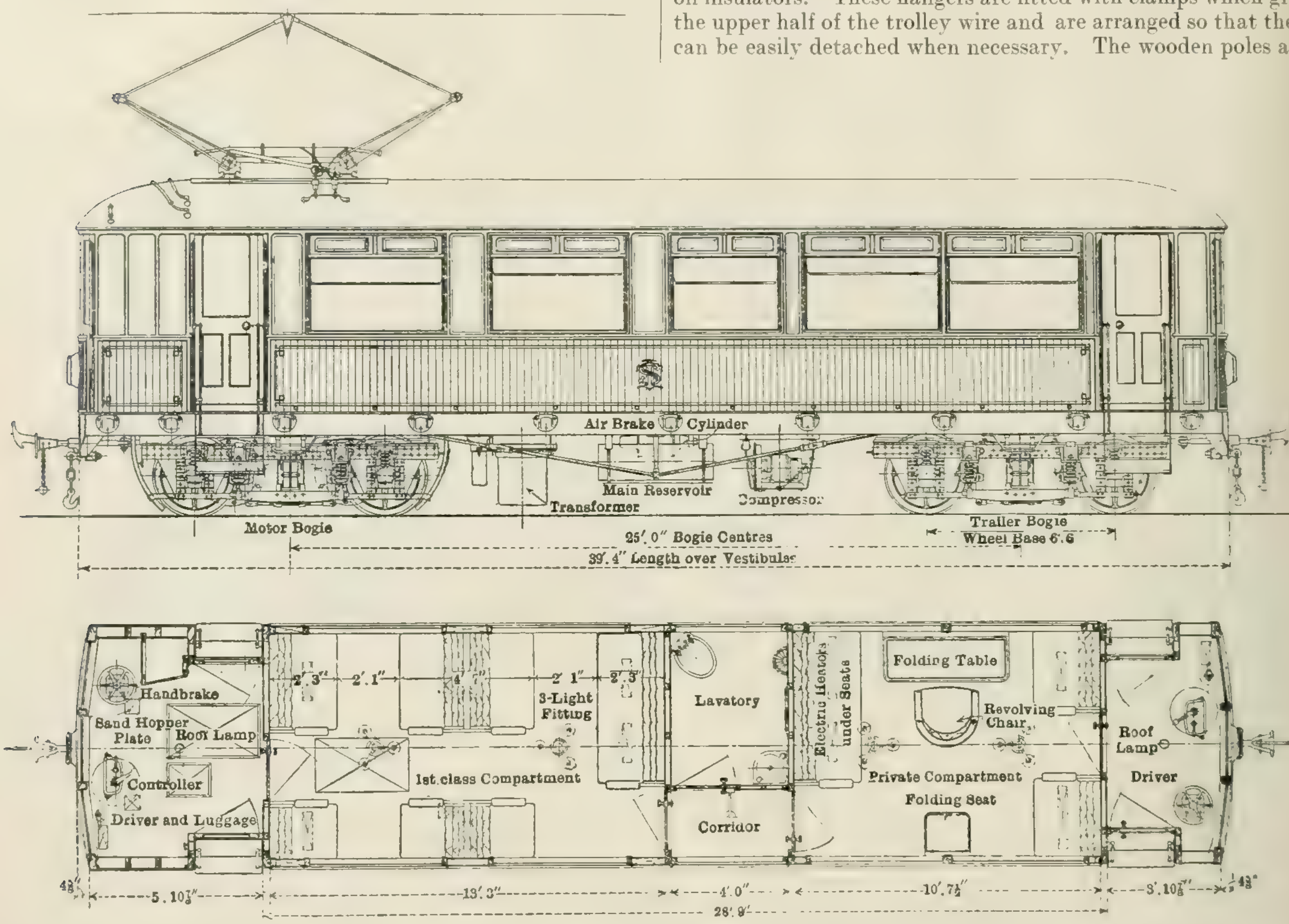

FIG. 5.—PLAN AND ELEVATION OF PRIVATE SALOON BOGIE MOTOR CARRIAGE.

FIG. 6.—WESTINGHOUSE LOCOMOTIVE ON THAMSHAVN RAILWAY.

FIG. 7.—END ELEVATIONS OF PRIVATE SALOON BOGIE MOTOR CARRIAGE.

No feeders have, in the first instance, been installed, as it is thought that the trolley wire will have sufficient carrying capacity for present requirements. It has, however, been divided into six sections by means of section insulators, one of which is shown in Fig. 2. In order to obtain a "through-connection" each section insulator is temporarily short-circuited by a high-tension switch, which can be opened and closed by means of a hook carried at the end of a bamboo pole. For blowing out the arc the contacts are of the usual horn type, as seen on the left-hand side of the pole shown in Fig. 2.

Electric Locomotives.—Three electric locomotives, each weighing 20 tons and equipped with four motors carried on two bogies, have been supplied. These are fitted with the usual Westinghouse equipment, including non-automatic air brakes. One of these locomotives is shown in Fig. 6, and also in Fig. 3, connected to a train in Thamshavn station. A pantagraph bow collector is fitted on the roof and is raised and lowered by compressed air, connection being made, by an insulated cable, through an automatic circuit-breaker to a transformer fixed inside the cab of the locomotive. As the high-tension wiring on each locomotive is only 10 ft. long, it will be seen that the greatest possible security has been provided against breakdown, and as an additional security against danger from shock the whole of the high-tension apparatus is enclosed by an earthed metal screen. From the diagram of connections given in Fig. 4 it will be seen that an auto-transformer is used and a number of tappings brought out and connected to the two controllers, one at each end of the car. It will also be noticed that the motors are arranged in two groups, each group comprising two motors permanently connected in series. A cut-out is arranged in each controller, so that either group of motors may be entirely disconnected if this is at any time necessary. The single-phase motors are of the Westinghouse series-compensated type, and each is capable of developing 40 H.P. for one hour without the normal temperature rise, being exceeded. The pinions on the motor shafts have 14 teeth, whilst the gear wheels contain 76 teeth, and the diameter of the driving wheels is 2 ft. 9 in. Each locomotive develops a maximum tractive effort of 8,000 lb. when starting from rest and of 6,500 lb. when running at 10 miles per hour.

Motor Car.—In addition to the locomotives described above, a special saloon motor car has been provided for the use of the directors of the company. The details of its construction are given in Figs. 5 and 7, and it will be seen that it is luxuriously fitted up. The body is supported on two trucks, one of which is fitted with two 40-H.P. motors identical with those on the locomotives.

The contracts for carrying out of the whole equipment described above were obtained by the British Westinghouse Electric & Mfg. Co., to whom we are indebted for the particulars and illustrations contained in this article, through their agents in Norway, the Elektrisk Bureau of Christiania; but they sub-let the contracts for the locomotive bodies and frames and for the rolling stock to Messrs. W. G. Bagnall, of Stafford, the United Electric Car Co., of Preston, and the Skabo Railway Carriage Works, of Christiania. We understand that the whole of the work was carried out in less than a year, and that the electrification has proved a great success.

ELECTRICAL EXHIBITS AT THE FRANCO-BRITISH EXHIBITION.—IV.*

The exhibit of Messrs. J. STIRK & SONS consists of high-speed electrically driven tools. The machines are shown in operation, the work consisting of Messrs. Sanderson Bros. & Newould's high-speed steel. Special attention may be called to the high-speed lathe which will remove metal at the rate of over 10 cwt. per hour. This machine, which is illustrated in Fig. 1, has 10 in. centres and is electrically driven by a 30 H.P. motor, being also fitted with 16 gear changes giving a range of spindle speeds from 10 to 250 revs. per min. in fine gradation. Two handles operate the changes and, by the gate arrangement used, it is impossible to put two into gear at the same time. The headstock and bed are cast in one piece, ensuring the greatest possible rigidity. All the gearing is of forged steel and machine cut. The quick running shafts have ring oiling bearings, and there is an improved friction clutch arrangement allowing the machine to be stopped without stopping the motor. This is useful in measuring work, changing tools, &c. The lathe complete weighs about 7 tons and is capable of taking a cut in 0·3 carbon steel $\frac{3}{8}$ in. deep, $\frac{1}{8}$ in. feed, at 70 ft. per minute. Another interesting machine is a 48 in. vertical boring and turning mill driven direct by a 13 H.P. motor. Two tool posts are provided, each with swivelling slide and counterbalance arrangement. Independent self-acting positive feeds are fitted for each head, giving nine changes of feed in any direction. The drive is by gear box giving 18 changes of speed, and the final motion to the table is by multiple thread worm. This is a special

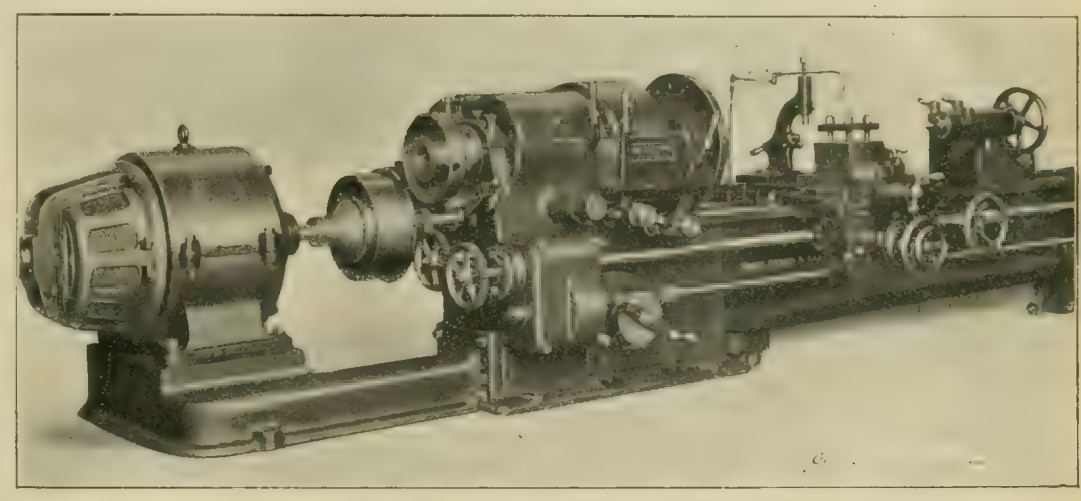

FIG. 1.—HIGH-SPEED LATHE BY MESSRS. J. STIRK & SONS.

feature, ensuring perfectly steady drive and, as will be seen from the finished work, a total absence of chatter. A high-speed electrically-driven radial drilling machine also possesses points of interest.

Messrs. J. BUCKTON & Co., of Leeds, exhibit in operation on their stand a spring balanced table planing machine (see Fig. 2), in which they claim to have successfully solved the problem of driving planing machines at a very high speed without the consumption of excessive power. The principle underlying the design of the machine is that of balancing the forces by recoil springs. At reversal the springs absorb the energy of the moving parts, and return it during the period of acceleration, thus constituting a complete regenerative system. These springs produce beneficial results other than the large saving of power that they effect. Much time is saved by the promptitude with which the machine reverses and attains its full speed. The reversal is extremely accurate; although the machine may be cutting at 60 ft. per minute and returning at 180 ft. per minute, not more than $\frac{1}{8}$ in. clearance is required between the tool and any projection above the surface being planed. This accuracy is attained without having regard to modification either of stroke or cut. The two springs abut each against one of the cross bars of the bed or gantry; screws pass through these springs, and lie along the whole length of the bed. Heavy bronze nuts are adjustable on these screws, and knockers attached in fixed positions to the underside of the moving table, impinge on these nuts. Any length and position of stroke is obtained by altering the position of the nuts upon the screws by turning the latter. The length of stroke is adjustable

* Previous articles appeared in our issues of July 3 (p. 455), July 24 (p. 568), and August 28 (p. 766).

...own to 12 in., and may be varied while the machine is running. Such adjustments do not disturb the synchronism of the belt striking motion with the spring compression.

When the machine is electrically driven, as in the case of the one exhibited in the Machinery Hall, the electric motor is allowed to run at full load when taking the maximum cut permissible, since no overload occurs at the moment of reversal. As will be seen from Fig. 3, which is a diagram showing the amount of power absorbed by the motor when the planing machine is taking a heavy cut, the load-factor is very good, differing in this respect from that obtained with the usual planing machine.

Besides this planing machine, Messrs Buckton are showing an autographic stress strain recording apparatus fitted on to one of their 30-ton vertical single lever testing machines, the system exhibited forming a new departure, inasmuch as the poise weight of the testing machine is stationary, and balanced by a spring which puts the whole steelyard into perfectly sensitive, though stable, equilibrium, and no records appear upon the stress strain curves which can possibly be attributed to the dynamic effects of a moving poise. The whole operation is automatic and entirely independent of the operator, whilst an exact record is obtained right up to the point of fracture, and the yield point and maximum load, the amount of stretch at maximum load, and the amount of stretch due to local elongation, are all made visible.

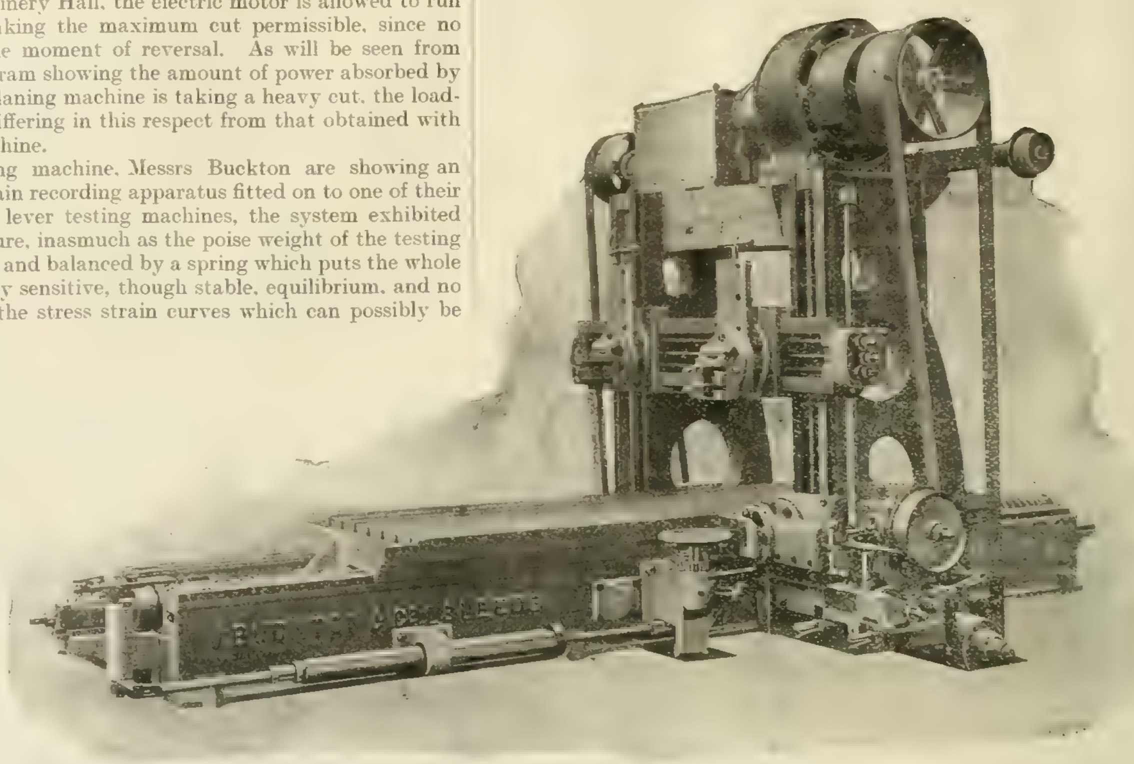

Fig. 2.—Regenerative Planing Machine by Messrs. J. Buckton & Co.

Messrs. J. Hetherington & Sons have a number of electrically-driven machines on their stand. In most cases the design is such as to accommodate conveniently the electric motor. As an example of the compact, self-contained arrangement adopted by this firm, we may refer to Fig. 4, which shows a 14 in. centre, sliding, surfacing and screw-cutting lathe, driven by a 40 h.p. Westinghouse motor. It will be noticed that the starting switch, main switch, ammeter, &c., are all fixed to the machine and are in a very convenient position for the attendant. The motor runs at constant speed, and reduction gearing allows of 24 changes of speed being obtained on the fast headstock, 12 of these being for high speed cutting, and 12 for ordinary speed cutting (or finishing purposes), all the speeds being in geometrical progression. The approximate horse power required, when cutting at 100 ft. per min. on work of diameter equal to height of centres, is 44.

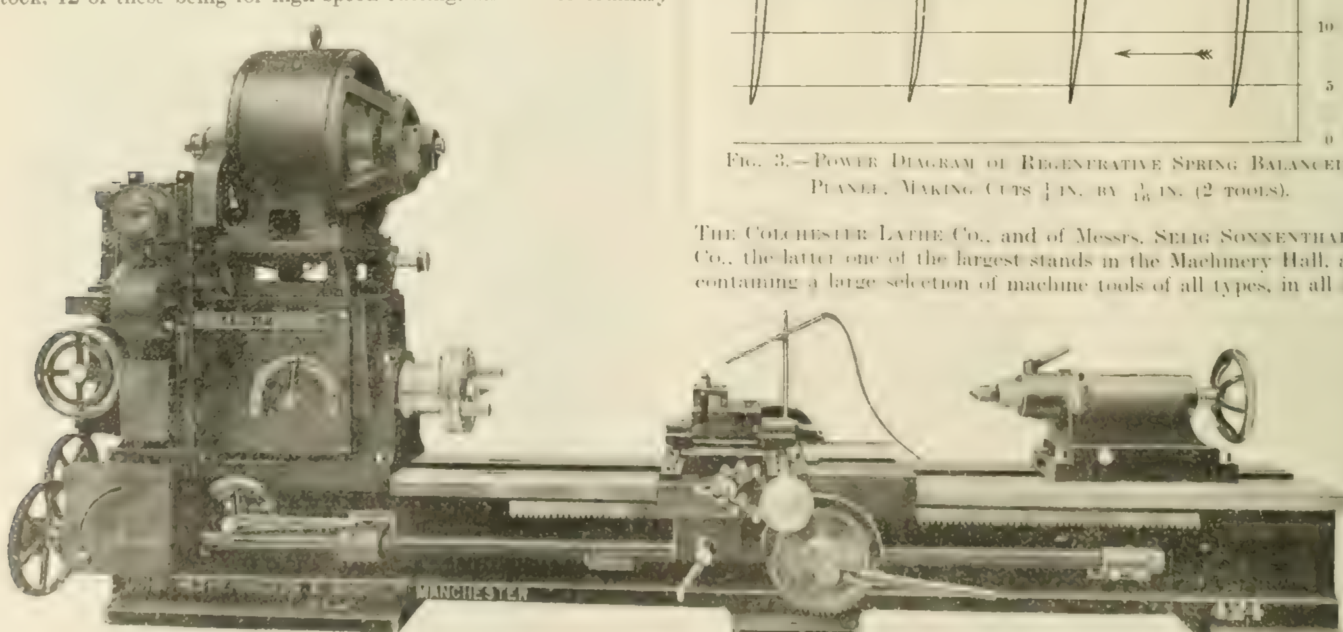

Fig. 4.—Electrically Driven Lathe by Messrs. J. Hetherington & Sons.

As will be evident from the descriptions of the exhibits which have appeared in this and previous issues, English machine tool manufacturers have taken full advantage of the publicity given to their manufactures by exhibiting in the Machinery Hall, and they are certainly most in evidence and in marked contrast to some other branches of engineering. Of machine tool exhibits to which we have not previously referred, since they do not involve any points of unusual electrical interest, mention must be made of the stands of

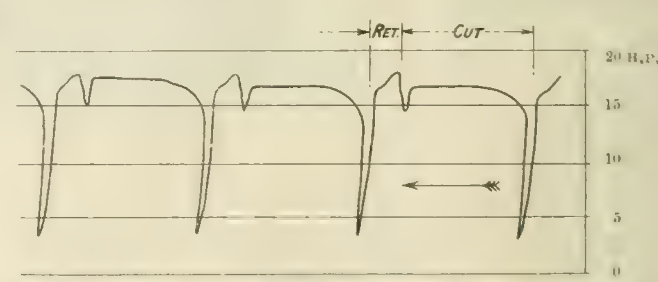

Fig. 3.—Power Diagram of Regenerative Spring Balanced Planer, Making Cuts $\frac{1}{4}$ in. by $\frac{1}{16}$ in. (2 tools).

The Colchester Lathe Co., and of Messrs. Selig Sonnenthal & Co., the latter one of the largest stands in the Machinery Hall, and containing a large selection of machine tools of all types, in all but one instance driven from shafting. The exception is the "Selson" special drilling machine in which an electric motor with main switch, fuse and starting switch are all fixed to the frame of the machine, and a short Hans Renold chain serves for driving purposes, the gear

being enclosed in a gear box. The machine is fitted with a traversing tool and adjustable bottom table and it is intended for high speed and heavy cuts.

It is rather surprising that more English made boilers are not shown. A model one is exhibited by Messrs. BABCOCK & WILCOX, who also show a bucket conveyor in operation whilst one or two boilers of the marine type are also noticeable. The CLAY CROSS CO., of Chesterfield, are exhibiting an economiser. Each top box is fitted with a "master lid" which enables the remainder of the internal lids to be removed through the seating of the master lid, thus doing away with the necessity of removing the top branch pipes. An advantage of this "master lid," which the makers claim is possessed by no other lid, is that it can be removed from the top box through its own seating.

At the far end of the Machinery Hall the railway companies of England have a few exhibits. The only one of electrical interest is a coach of the METROPOLITAN RAILWAY CO., of the standard type with compartments, which has been converted for electrical working and fitted with the British Westinghouse electro-pneumatic control and equipment. These coaches are, of course, well known and have already been described in *The Electrician*. On the same stand is one of the standard motors used by this Company, and a pressed steel motor bogie manufactured by the Metropolitan Amalgamated Railway Carriage & Wagon Co., as was illustrated in Fig. 5, on p. 749 of our issue of August 28.

In addition to the "road train" which carries passengers in the Exhibition grounds, a stand near the railway exhibits in the Machinery Hall contains several Renard road train trucks arranged so that the method of transmitting the drive to all the wheels of the train is clearly shown.

In an inconspicuous corner of the Machinery Hall Messrs. SHERARD COWPER-COLES & CO. have a stand on which are exhibited specimens of aluminium welds by the Cowper-Coles process, also samples of ores suitable for the electrolytic centrifugal process, together with many examples of the interesting work carried on by this firm, such as electro galvanising, &c.

Additional exhibits have recently been placed in the reception room of the London electric supply companies. These include "Watson" prepayment meters manufactured by the ROCHDALE ELECTRICAL CO., both continuous and alternating current patterns being shown, the former for pennies, and the latter for shillings, and a show case of Simplex conduit with bends, junction boxes, &c. Among the stands which have been erected in connection with this exhibit of the supply companies, we noticed in addition to those which have been already described, that of the BRITISH THOMSON-HOUSTON CO., who are showing an interesting collection of electrical cooking and heating apparatus, electrical irons and kettles forming a prominent part of the exhibit, whilst B.T.-H. 25 volt metallic filament lamps and a small transformer are also noticeable. The "Igranic" switches of the ADAMS MFG. CO. have been so often described that they are well known to our readers, and it will suffice to say that they are prominently shown on an adjoining stand, whilst Messrs. O. C. HAWKES also have an interesting exhibit of electric radiators and stoves, and Messrs. DUNCAN WATSON & CO. are now showing a portable air suction dust-remover, electrically driven, and designated the "Aspirator."

THE BOURNEMOUTH TRAMWAY ACCIDENT.

One of the most serious tramway accidents of recent years was that which occurred on May 1st at Bournemouth, by which 7 persons lost their lives and 26 more were injured. It will be remembered that the car in question attained a dangerously high speed and left the rails at a curve, finally plunging over a bank and falling on its side.

In his report to the Board of Trade, Major J. W. Pringle first gives the particulars of the car and its braking equipment, which consisted of a hand wheel brake, an electromagnetic track brake, and the braking effect obtained by reversing the motors and using power either in series or on the highest (parallel) notch. Then follows a description of the route, which, the inspector considers, cannot be described, from the point of view of gradient or curvature, as exceptional for tramway working.

Judged by the number of fatalities, this accident is the most serious which has occurred on tramways in the United Kingdom. The general circumstances, however, are not peculiar. A long steep incline, a car out of control attaining a dangerous velocity, and consequent derailment on a curve at the foot of the hill these are features common to most tramway accidents. The deplorably long list of killed and injured in this case was due, firstly, to the large number of passengers who happened by reason of the warm weather, to be travelling on the upper deck of the car, and, secondly, to the unfortunate contingency that, just at the point of derailment, there was nothing more substantial than the kerb of the footpath and a light iron railing to prevent the car from plunging down the embankment and overturning

Particulars of the running of the car previous to the accident and on the day of the accident are then given. It will be remembered that at 3 p.m. Driver Copelin, in trying to reverse from No. 1 end, locked the controller, so that the car was sent into Parkstone depôt to be attended to. Inspector Rushton examined the controller, found the motor barrel out of position, readjusted it, replaced the pinion gear which had overridden, and tested the controller by means of the handles, finding it to work correctly. Driver Copelin took the car out again at 3:30, and during the remainder of the afternoon the magnetic brake worked satisfactorily. At 5:20 p.m. Driver Wilton took charge of the car, and proceeded on his fateful journey as follows:—

Wilton left the terminus at Poole, on his eastward journey to Bournemouth about 6:10 p.m., driving from No. 2 end. As far as the conduit pit in Poole-road, about 4½ miles from the terminus, the journey was uneventful. No emergency stops were made, and there is no steep decline, so that Wilton is perfectly certain that he did not use the magnetic brake on this return journey. The hand-brake was sufficient for all purposes, and acted well. The car was brought to rest at the conduit pit, and the plough attached to the underground conductor. Wilton restarted the car, by using one or two notches of power, until a speed of three or four miles an hour was attained. Power was then shut off, and the car allowed to run a little distance without power. He applied three notches of magnetic brake opposite the Pembroke Hotel, in the vicinity of an arc lamp post on the left of the roadway, which is situated about 65 yards from the conduit pit. There was no effect, and Wilton's first impression was that he had missed making contact on the notches. He worked further notches on the brake side, and used sand, but there was still no effect. By this time the car was close to the usual stopping place at Par's Corner, and had attained a speed of ten or twelve miles an hour. He realised that the brake had failed; but was so confident that it was only a temporary failure, that he brought his controller handle from the brake into the "off" position and allowed the car to run freely round Par's Corner. He then reapplied the magnetic brake in the same manner notch by notch, but again without effect. A little more than half way between Par's and Robson's Corners, *i.e.*, about 280 yards from the top of the hill, Wilton applied his reversing power, by bringing his controller handle into the "off" position, moving the reversing key into the backward position, and then using power, notch by notch, as far as the 5th. This had no retarding effect, although the automatic canopy switch was blown, and the car had attained a speed of 20 to 25 miles an hour at Robson's Corner. Wilton then used his hand-brake, which he had held in position ready, to apply it all down the hill, but the speed was so great that there was little or no retardation, and the car left the rails on the curve above Fairlight Glen House, as has been described, about 460 yards from the starting point at the top of the hill. Wilton's explanation for relying so long upon his magnetic brake was that on another occasion, about a year previous, the magnetic brake failed the first time he tried it, but worked beautifully on the second attempt. If he had known that the magnetic brake was not to be relied on, he could have taken the car down the hill in safety with the hand-brake only.

Wilton had been a permanent driver for over four years and bears an excellent character. An inspector on the car is of opinion that the wheels did not skid down the incline and estimates the speed at derailment as 25 miles per hour. Other estimates by passengers and witnesses place the speed at from 12 to 30 miles an hour. The inspector then gives particulars of his measurements of the rail groove, &c., after the accident, and says that trials on the particular curve showed that speeds of 12 to 13 miles an hour could be attained by different cars without derailment.

These trials prove at all events that, notwithstanding the large amount of wear on the rails in proximity to the site of the accident, as regards speed, there was a considerable margin of safety beyond the authorised limit of 6 miles an hour, provided the wheel flanges were in fair condition. At the same time it is not possible, I think, to avoid the conclusion that the worn condition of the rails at the point of derailment and of the flanges was to some extent a contributory factor in the case.

I examined car No. 72 on the afternoon of May 2, before it had been moved from the position it occupied after the accident. It was then lying on its right side on the embankment. The hand-brake was applied—two and three-quarter turns of the chain being wound round the spindle—and the blocks were bearing on all wheels. It required special effort to turn the spindle further. The hand-brake rigging, springs, &c., were intact, and apparently in good order. The cast-iron wheel blocks, especially those of the pony wheels, showed very considerable wear, but appeared to be in proper adjustment. There was plenty of sand, which

had been upset all over the car when it overturned. The sand valves and sand pipes were in order. At No. 2 (leading) end both handles were in position on the controller, the reversing key being in the "backward" position, and the large handle at the last (seventh) brake notch. The automatic canopy switch was "out." No. 2 controller as regards contacts, fingers, mechanism, &c., was in good condition, and the movements of the large handle, and reversing key, actuated the barrels and made contacts with the fingers in the proper manner. I found one of the leads attached to the coil of the off rear magnetic brake shoe broken, the break being of old standing; the insulation of the other lead to the same coil was damaged. Inside the car the leads to this shoe were disconnected. Only three out of the four magnetic shoes were therefore available for use. So far as I could judge, the adjustment of the shoes was correct, and the release springs were in working order. Some of the steel blocks, which form the magnet poles of the shoes, were worn away to within half an inch of the holders.

There was some indications of "flats" on the treads of some of the wheels, but the marks were all so slight that it was evident that the wheels could not have skidded for any appreciable distance on the journey down the hill.

At my request all the electrical and magnetic circuits and earth connections were tested for continuity by Mr. Bulfin, borough electrical engineer. All were found correct with the following exceptions:—(1) Rear (No. 1 end) off magnetic shoe coil, the lead to which (as described above) was found broken. (2) The earth cable to the case of No. 1 motor was found torn away from its socket, the severance in this case being clearly the result of the overturning of the car. To make these tests the cover of No. 1 controller was removed by Mr. Lait, depot superintendent and Foreman Robinson, on the evening of May 2. They found the reversing or motor barrel of this controller was not in its proper "off" position, but midway between "off" and "reverse," and that there was contact made with several of the reversing fingers. It was not realised at the time what effect this position of the reversing barrel in No. 1 controller would have when the magnetic brake was applied from No. 2 controller. Nothing was therefore said at the time by these witnesses to anyone else regarding the wrong position of the barrel. They easily turned or jarred the barrel back into its proper "off" position. But the fact, which the evidence establishes, that, when Wilton lost control of the car, the reversing barrel at No. 1 end was making contact with the reversing fingers, explains the failure of both the magnetic brake and the reversing power. The effect of this contact (with this type of controller), whilst the car was being driven from No. 2 end, would be to short-circuit the armatures of the motors, and prevent the generation of current by the motors. Consequently there would be no magnetisation of the steel blocks forming the shoes, and no attraction would be set up between the shoes and the rails. Similarly there would be no retardation when the reversing key was placed in the backward position, and the controller handle used in the highest power notches.

There are two possible causes to account for the incorrect position of the reversing barrel of No. 1 controller:—(*a*) Ill-use or mismanagement of the handles by Driver Wilton. (*b*) Wear and tear of the moving parts of the mechanism, resulting in excessive slackness and freedom of movement in the barrel itself. Ill-use of the handles, *i.e.*, rotating them together, instead of separately, would cause overriding of the teeth in the gearing and result in locking the controller. This, no doubt, was what occurred to the same controller at 3 p.m. on the day of the accident, when Driver Copelin was in charge. It was then necessary, in order to unlock the controller, to throw the barrels out of gear, and replace the pinion wheel in its proper position.

Mr. Turner, electrical engineer to the British Westinghouse Electric Co., gave evidence to the effect that, when he examined, at the request of the Corporation, the controllers of car No. 72, there was a marked difference in their condition. The gearing and motor barrels of No. 2 were in good order, and no slack movement was observable beyond that which is always to be found in similar gearing. The mechanism of No. 1 controller was in a very slack condition, one of the motor barrels was so loose on its spindle that contact could be made with two or three fingers on either side by moving it with the hand. Granted contact with two fingers on the reverse side at No. 1 controller, the brake effect and reversing power when applied at No. 2 controller would be neutralised. It was possible, by sharply swinging round the controller handle at No. 1 end into the off position, to make contact on the reverse side, without any overriding of the teeth in the gearing, and this could occur without the knowledge of the driver. The looseness in the working of No. 1 controller noticed by several of the witnesses may be accounted for by the fact that the original reversing barrel, supplied with the controller in 1906, had been replaced by another and older barrel, which had seen previous service. This barrel, besides having been subject to more wear and tear, may possibly have fitted the new controller with less accuracy.

My general conclusions on the whole case are as follows:—(1) The initial cause of the car getting out of control on this occasion was the incorrect position of the reversing barrel of No. 1 controller at the rear end, which rendered useless all the electrical braking equipment whilst the car was being driven from No. 2 controller. (2) Consequently the only available means of checking the speed of the car down the hill was the hand-brake with its wheel blocks. These were in good order, and if Wilton had recognised at an earlier moment, say when he was reaching [illegible], that the magnetic brake and reversing power were useless, he could, by careful management of the hand brake, and the use of sand, have negotiated the remainder of the decline in safety. (3) The incorrect position of the reversing barrel was not, in my opinion, due to mismanagement of the handles by the driver, but to looseness in the mechanism of the controller, due to wear and tear and want of proper maintenance.

Wilton's failure to recognise more quickly that his electric brakes were useless does not, in my opinion, amount to more than an error of judgment; and he deserves credit for remaining at his post till the last moment.

To fairly apportion the responsibility for permitting the car to go on service in such an unreliable condition is a difficult matter. The system of stabling cars indiscriminately at any of the four depots, in order, as I understand, to suit the convenience of the traffic, is largely at fault. No particular set of men can be held wholly responsible for the maintenance of a car which goes one night to one depot, and somewhere else the next. The system weakens responsibility by distributing it over all the depots. More especially as regards controllers, which are only subject to a bi-weekly examination, is it a bad system. A man who is only occasionally, and possibly at long intervals called upon, as in the case of Grimwood on April 29, to examine the controllers of a particular car, is likely to shirk the responsibility for putting a car out of service for renewals. The records of any particular car must also be more difficult to maintain. Mr. Barber, traffic manager, who is responsible for this system, considers, on the other hand, that it tends to greater efficiency and public safety, as it engenders competition between the men in the discovery of faults. But the fact remains that the system is against common, if not universal, practice on tramway undertakings.

The particular controller must for some time past have been in an unreliable condition. That its condition was not discovered by any of the controllermen, foremen, or Inspector Rushton, argues either insufficient examination or want of knowledge. Possibly the latter alternative may be the correct reason, as none of the subordinate staff questioned, or the depot superintendent, were aware what effect the incorrect position of a reversing barrel (with this type of controller) would have upon the electrical braking equipment. They would therefore be unaware of the necessity for guarding against undue looseness or slackness. More careful instruction in the method of examining controllers is necessary, and more practical supervision.

There are a number of other matters to which I wish to call the attention of the Corporation. These are:—(*a*) No cars should be permitted to be on service without their full brake equipment. Mr. Barber has had trials made to show that the stopping effect on a large car with four magnetic brake shoes in use is but little better than with three only. This may be admitted, but public safety demands the highest possible efficiency, and not the second best. It is only on the understanding that the full equipment is available that the Board of Trade license working. In this particular case there were no magnet coils in store, and there was no evidence to show how long the shortage existed. But if the Corporation had given the necessary authority for keeping such necessary articles in store, the responsibility rests with the depot superintendent and his staff. (*b*) The position of the sand pipes in the large cars can be improved. On No. 72 they were placed 24 in. from the wheel contact. Dry sand delivered at such a distance will of necessity fall clear of the rails on a curve, and even on a straight road be more liable to be blown away from the desired spot by any current of air. The distance should be reduced by one-half at least. (*c*) The rails on the curve where derailment took place require to be renewed, preferably with a wider groove than that originally used. I have referred to the worn condition of these rails and recognised that there was sufficient margin of safety for the speed authorised. But all curves at the foot of long steep declines are danger points, and for this reason it is of importance that the rails on such curves should be carefully watched and replaced when they show considerable signs of wear. (*d*) As regards the magnetic brake, it is now generally recognised that it should not be reserved only for emergency purposes, and for descending steep gradients, but should be in common use. When used for coasting gradients, the common practice, as set forth in the "Instructions to Motormen" issued by the British Westinghouse Co., is to set the controller handle immediately to the last braking notch and move it back as may be required. I see no reason why the practice in Bournemouth should be otherwise. (*e*) The training of drivers is not given the attention it deserves. At most tramway centres a regular school is maintained for the training of men, which contains full scale models of all the electrical equipment and wiring on a car. Batches of selected men are put through a regular course, first of technical education, and afterwards of practical driving under a qualified instructor, and the men are examined both in theory and practice. The method at Bournemouth of giving a conductor a permit to learn driving, during his spare time, from any permanent driver is not a satisfactory substitute. (*f*) The organisation of the tramway department is open to criticism. So far there has been no regular manager at Bournemouth. The control seems to have been divided between the borough engineer, the traffic manager, and others. No one officer is responsible to the Corporation for the administration of the whole undertaking. This cannot be a satisfactory arrangement. I strongly advise the Corporation to make a change in the organisation, by selecting in open competition a properly qualified general manager, and giving him control over the whole department. The critical period for tramways is not during the first three or four years, when equipments, &c. are comparatively new. It is later on, when mechanism begins to wear out and renewals have to be made. Previous experience of some length is then of first importance.

I recommend the Board of Trade to make the following alterations (1) and additions (2) and (3) to the regulations now in force:—(1) The compulsory stopping-place in Poole Hill on the downward journey should be at the arc lamp-post before reaching the Pembroke Hotel. (2) So long as the magnetic or other track brake is not used for ordinary stops it shall be applied, to test its effectiveness, before reaching any steep gradient down which the brake is used for coasting. (3) All controllers at every terminus, before the handles are removed, shall be opened and the barrels examined for their proper "off" position.

In view of the fact that the whole question of braking is now under consideration by two Committees, I do not propose at this moment to make any recommendation regarding the addition of a mechanical method for applying the shoes of magnetic brakes.

After consideration of the above report by Major J. W. Pringle, the officers of the Bournemouth Council who are concerned with the tramways department, made reports to the Council in connection with the points raised by Major Pringle. These reports have been published by the Council in order that erroneous impressions may not be obtained by the public; and we give the following extracts from them at the request of the Council. Mr. F. W. Lacy, borough engineer, observes :—

Major Pringle now recommends a wider groove than that originally used and in this connection I should like to call the Committee's attention to the correspondence between myself and the Board of Trade previous to the construction of these curves. This correspondence proves that on behalf of the Corporation I pressed the Board of Trade to allow an extra width of groove round all sharp curves. The Board, however, notwithstanding my repeated appeal, insisted that the groove in the rails should not exceed $1\frac{1}{8}$ in. and the conduit slot 1 in. It is only fair to add, however, that it is practically impossible to construct this curve so as to make it safe for a run-away car to negotiate, because to do so the levels of the road would have to be altered so as to make it hardly safe for slow and ordinary traffic.

The cars were originally fitted with hand-brakes and usual electrical brakes, but after the inspection of the line by Major Pringle in December, 1902, the Board insisted that the cars to be used in service on the Poole Hill should be fitted with track brakes. As the trucks of the cars were so hampered with gear owing to the conduit system, it was impossible to fix a mechanical track brake, and the Committee were compelled to have recourse to an electrical track (or magnetic) brake as fitted, which the Board of Trade approved of. In the opinion of your consulting engineers, the traffic manager and myself, these track brakes were quite unnecessary, and, in fact, only tended to further complicate the driving. The Board of Trade were accordingly appealed to but without effect, and their certificate was only granted subject to the brakes being fitted, which was accordingly done.

The organisation of the Tramway Department is seriously criticised by Major Pringle, but I would point out that he took little or no evidence on this point. Mr. Barber, the traffic manager, has the sole control of the whole system so far as the public safety may be said to be concerned, with the single exception of the maintenance of the track which is in my charge. He reports direct to the tramway committee and receives his instructions direct from that committee on all matters affecting the stores, maintenance of rolling stock, overhead equipment, traffic management and working generally. The borough electrical engineer is responsible for the supply of the current in exactly the same way as the Electricity Company is responsible for the supply of current on the Poole and Christchurch lines. I cannot see why it is necessary for the traffic or general manager to have control over the tramway generating station any more than he should have control over the Company's stations at Branksome and Christchurch, and I am of opinion that it would be inadvisable to increase his responsibilities in that direction. With regard to the maintenance of the track, I am of opinion that if for no other reason than to avoid dual control of the highway it is advisable for the borough engineer to maintain the track. It is obviously his duty to construct it, and with all due respect to electrical engineers, I think that the life-long experience of borough engineers should be at least as valuable as the comparatively recent experience of electrical engineers or tramway managers in such matters. At the same time I admit the necessity for carefully considering any suggestion of the traffic manager as to repairs, and especially so in connection with all danger points.

Mr. C. Barber, the engineer and traffic manager, disagrees with Major Pringle as to the condition of the controller, and considers it was in a reliable condition on the morning of the day of the accident, and that it probably became strained on the road. The Westinghouse Company admit that some of the rocker arms of the gear connecting the main and reversing barrels are knocked into shape, so that they are more liable to bend again when subjected to strains likely to occur when the handles are moved quickly. A special notice is displayed on each depot notice board, and in this notice are the words, "Every care must be taken that the reversing drum does not make contact when in the 'off' position." Regarding the stabling of cars Mr. Barber remarks :—

The main route service between Christchurch, Bournemouth and Poole is worked by cars stabled at the Central, Boscombe and Parkstone depots. In arranging the hours of labour of the drivers and conductors, it is very advisable that the Bournemouth men finish their turns of duty in Bournemouth, and the Parkstone men in Parkstone. Owing to the length of the route, on some turns of duty it is necessary for the men to change cars at certain places in order to effect this. It thus happens that a car taken out of the Central depot in the morning may be given into the charge of men from Parkstone depot during the day and taken into that depot at night and vice versa. Again, it has been the practice to change small cars for large cars in order to accommodate the traffic at certain times, and this also may lead to a car running into a different depot to that from which it came out. In order to adopt the method advocated of the same cars always being attached to the same depots, a much more rigid and less economical system, from the traffic point of view, would be necessary.

Mr. Barber gives details of the course adopted for the maintenance of the cars, for which purpose 100 men are employed. He also says :—

I quite agree with Major Pringle's remark that the full equipment of a car being available is the ideal state of affairs, but there must be occasions when a car is running without its full equipment, as, for instance, when a failure occurs in service and the car continues to run without the failure showing itself. I would draw the attention of the Committee to the fact that the particular magnet was put out of use in order to render the car serviceable because the magnet had become defective. A stock of spare magnets was usually kept in reserve, but owing to a period of wet weather and an unprecedented fall of snow just previous to the disaster, this stock had been exhausted by replacements.

The car was of standard pattern and had been passed by the Board of Trade. There is great difficulty, owing to the cross-beams of the car and the brake gear on the truck, to fit the sand tubes nearer the wheels.

The magnetic brake has not been kept for emergency purposes only, but has been in common use for service stops. As to the method of using it when about to descend a hill, I would remark that I was aware of the printed card of the Westinghouse Company relating to its use. As the result of failures on previous occasions, the London manager of the Westinghouse Company himself came down to me but never took exception to the manner of using it nor mentioned the method of application now recommended, nor did their representative who followed him, although he spent some days in Bournemouth watching the drivers applying it. I find that the largest system, and the system that is generally considered to be the most efficient in the country, namely, Glasgow, follows the same practice as is in use in Bournemouth.

Major Pringle's description of the method adopted in Bournemouth for training drivers is not complete. No man takes charge of a car until the chief inspector has proved him efficient. In addition to this, the men gain a practical knowledge of the various parts of the equipments through acting as assistants to the regular depot staff engaged upon the overhaul and repair of the equipments when on relief duties.

With regard to Major Pringle's statement that "the critical period of tramways is not during the first three or four years, when equipments, &c., are comparatively new. It is later on when mechanism begins to wear out and renewals have to be made." I would remark that my experience goes to prove far different to this, as from the very commencement mechanism requires attention and adjustment, and many parts of the equipment require renewal within the first six months. I would remind the Committee that the system of tramways in Bournemouth was opened in 1902, six years ago, and that the system is, or was until quite recently, the only combined trolley and conduit system in the kingdom. This combined system introduced very many difficulties and complications, both in the car equipments and in working generally. That these difficulties were met and overcome is testified to by the reputation, second to none, which the system has gained for itself. The remarkable freedom from serious accidents previous to the disaster on May 1, 1908, has often been a matter of favourable comment.

With regard to the last line of the paragraph,* namely, "previous experience of some length is then of first importance." I would remind the Committee that my tramways experience dates from the very commencement of electric traction in this country, some 12 years back, and that with electric light and power experience since then, my whole time has been taken up in actively following every branch of tramway work. Prior to coming to Bournemouth I was for four years chief assistant to the borough electrical engineer and tramways manager of Blackburn as regards tramway work.

In conclusion, I would wish to state that I consider Major Pringle's report is scarcely fair towards myself. During the course of the inquiry all the information which he required, and much that he did not ask for, was given freely to him by me, either in the box or in conversations at the depot and elsewhere, whereas I am afraid the impression was created that information was only available when pressed for.

I think it would only be fair, before the Council take any action such as Major Pringle recommends, that they should consult some experienced and unbiassed tramway manager with a view to obtaining a report upon the organisation and working of the system generally.

BOOKS RECEIVED.

(Copies of the undermentioned works can be had from *The Electrician* office, post free, on receipt of published price, adding 3d. for books published under 2s. Add 10 per cent. for abroad or for foreign books.)

"Hydro-Electric Practice." By H. A. E. G. von Schon. (London : J. B Lippincott Co.) 25s. net.

"Proceedings of the Royal Society." Vol. LXXXI. No. A547. Series A, Mathematical and Physical Sciences. (London : Harrison & Sons.) 3s.

"Electric Furnaces." By Wilhelm Borchers. Translated by Henry G. Solomon. (London : Longmans, Green & Co.) 7s. 6d. net.

"The Management of Dynamos." By G. W. Lummis-Paterson 4th edition. (London : Crosby, Lockwood & Son.) 4s. 6d. net

* "Organisation of department" in B.O.T. report.

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"THE ELECTRICIAN" INDUSTRIAL SUPPLEMENT

With "THE ELECTRICIAN" for Sept. 14, 1906, was issued the first of a series of "Industrial Supplements," to be published from time to time with "THE ELECTRICIAN." The twenty-seventh issue of the Supplement was issued (Gratis) with the number of "THE ELECTRICIAN" for Sept. 18.

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THE COTTON STRIKE.

The stoppage of some 75 per cent. of the textile mills in Lancashire may at first sight, and from an engineering standpoint, appear something of a calamity. An examination of the facts, however, reveals a spirit of optimism on the part of both employers and operatives. The organised workers, rejoicing in strike pay, seem indifferent as to the prolongation of the struggle. The employers likewise backed by heavy reserve funds, survey the situation quite serenely and even go so far as to state that a temporary lull in production will put money in their pockets. If this is really the case, we may expect that the engineering staff of many mills will be glad of the opportunity of effecting repairs to machinery which long intervals of running have only made possible at week ends. There may also quite reasonably be something of a rush to instal not only new textile machines, but also more modern methods of driving them. The electrical engineers who haunt the mill owners of Lancashire during times of industrial peace should look upon the "war" as something of a blessing, They can now break down the excuse for temporising so often voiced by the textile engineers, that electric driving is very convenient and even most desirable, but that they are so busy making money by the older methods, they have no time to put in electric motors. If the strike is to continue for a month, that is ample time in which to put in a few motors, say, in mills actually steam driven, but with top floors, far distant from the engine, running under most inefficient conditions. Assuming a protracted struggle, the case for electric driving may be forced well home, and mill owners may be induced to deflect some of their reserve into the more profitable channels of improving their mills.

This aspect of the serious dispute in the cotton districts is not without substantial basis for argument. Many new mills have sprung up in Lancashire during the last three years—a period of almost unexampled prosperity—and those which are not electrically driven have put in quite modern plant, both textile and steam, which will expedite and cheapen production. Older mills will feel keenly the competition of these newer factories, even though their equipment is but little behind that of their rivals in speed and efficiency. During times of running the pace is so hot that anything in the shape of a general "shut down," in order to instal motor equipment, would be impossible. Given the consent of the management to the new method of driving, only "breathing space" is needed to get the plant in. The present strike has all the appearance of affording such a lull in every-day mill activities. At any rate, this may be taken as a sign to begin a vigorous campaign having as its object the installation of electric power plant in mills. The electrical forces are well organised, shops are slack, and in many cases suitable motors, starters, &c., can be quickly delivered complete from assembled stock. It is the manufacturer, of course, who is more keenly interested in the present opportunity, though electricity supply authorities would do well to press the claims of the electric power service upon mills within their areas. It is probable that more may be done in this way by getting in a few motors here and there, than in the wholesale equipment of entire mills. The thin edge of the wedge counts for much with electric driving. Once motors are installed they are appreciated, and the management want more of them later on. If the strike does not collapse prematurely, the forthcoming Electrical Exhibition at Manchester should assist greatly in bringing this unique opportunity to the notice of interested employers.

Regarded from a financial point of view, the prospects of the investment of the required capital are good. Motor driving has proved its capacity for increasing output, and it also improves the quality of the yarn in spinning work. In a general way it should furnish the mill management with a valuable asset with which to face the future on the close of the strike.

REVIEWS.

(Copies of the undermentioned works can be had from *The Electrician* Office, post free on receipt of published price, adding 3d. for books published under 2s. Add 10 per cent. for abroad or for foreign books.)

Experimental Electrical Engineering. By V. KARAPETOFF. (London: Chapman & Hall.) Pp. xxxiv.-779. 25s. 6d. net.

Nowadays, when the market is flooded with inferior electrical literature, it is a great pleasure to come across a really good book. This is such a work. The author is not giving us clippings from other books put together indiscriminately, but his own original work. The stamp of originality is the more to be valued as the subject may easily lead a writer to copy others. The description of machinery and apparatus, the use of measuring instruments and laboratory work generally are all subjects which have been treated many times before, and a certain amount of repetition is almost unavoidable. Yet the reader has throughout the impression that what Mr. Karapetoff describes is the result of his own observation, and that the instructions he gives are the result of his own practical experience. This literary honesty makes the book so eminently readable.

Primarily the book is intended to serve as a guide to students in American colleges to their laboratory work, but even engineers already in practical work will find it a useful companion. Naturally, most of the apparatus described is of American origin; thus we miss certain instruments, such as the Ferranti and Chamberlain and Hookham meters, the Crompton and Feussner potentiometers, the Sumpner wattmeter; but as equivalent instruments are fully described and their principles clearly explained, the omission of a few of the instruments to which European engineers are more generally accustomed is not a very serious matter.

Broadly speaking, the contents of this book of 770 large octavo pages may be divided into three parts: A descriptive portion, an exposition of the scientific principles underlying the working of the machine or apparatus, and, finally, instructions for its use in the laboratory. To illustrate by an example: In Chapter XXVI., on armature windings, the author gives illustrations showing various workshop methods of placing the windings, making end connections, and so on. This is the descriptive part which will enable the student to understand the mechanical construction of the armature belonging to the machine he is going to test. To enable him to understand the electrical features the author gives winding diagrams and tables, whilst the various tests are treated in other chapters. This sub-division of the subject has the advantage that the reader can quickly find the information he wants. If he knows all about the winding and is only at the moment interested in the question of testing he will find in Chapters XVII. and XVIII. full information; if he wants to investigate some defect he will find something about the possible troubles to be expected at the end of Chapter XVI. Again, the questions connected with regulation and voltage drop, including the use of regulating apparatus such as the Tirrill, the use of balancers and so on, are discussed in a separate chapter. Thus each subject, as far as possible, is treated independently and cross references are only used where absolutely necessary. In consequence of this arrangement of the matter the book may be used as a true guide to testing work and also as a source of information as to construction and theory. The theoretical part is represented in very simple manner. No higher mathematics is required to follow it, but an extensive use is made of vector diagrams in those parts which treat of alternating currents.

The preface is well worth reading. Here the author develops his method of training students in laboratory work, and advocates a system which he calls the "concentric disposition of the course." He contrasts this with what he calls the "usual" method (though it may be doubted whether it is usual in English colleges), which consists in giving the student a complete training in one particular subject, say continuous current machinery, before taking him on to alternators. The concentric method, in the author's nomenclature, means the arranging of tests without specialisation from the first. A student is taken through the more elementary tests, not only on continuous current dynamos, but also on alternators, transformers, measuring instruments and motors, and when he has done these he is given more advanced tests on the same subjects. This is essentially the correct method. The student should in the first instance try to become familiar, not with one particular type of machine or instrument only, but with the objects and methods of electrical engineering generally. When he has thus obtained, as it were, a bird's-eye view of the whole field which his work will eventually cover, he will be in a position to undertake the more intricate and difficult parts of the work. This is, as a matter of fact, the system adopted in English teaching institutions and it is satisfactory to find the author advocating it. With his general remarks on electrical laboratory work English teachers will also agree. He counsels his students to read up the test before they come to the laboratory, to make their own connections from wall diagrams, to plot results on squared paper during the test so that errors may be detected and rectified before students leave the laboratory, and to write up their reports in a clear and concise manner.

GISBERT KAPP.

Elementary Electrical Engineering By JOHN H. SHAXBY. (London: Blackie & Son.) Pp. vi.+189. 3s. net.

While we are in agreement with the author in thinking that artisans engaged in electrical work should be familiar with some of the scientific principles underlying that work, yet we

are by no means convinced that Mr. Shaxby's book will contribute much towards the attainment of this end. The reason is that no difference is apparent between his work and the numerous volumes put before the public by other authors during the past 10 or 15 years. It is not specially deserving of censure, and there is equally no reason why it should be unduly praised; it just reaches the ordinary level of such works and sets out in simple language a few of the broad principles governing the action of certain electrical apparatus in everyday use.

THE MANCHESTER EXHIBITION.

Judging by the scene of activity at the building which will house the electrical exhibits at Platt's Fields, Manchester, there will be on view a goodly show of products drawn from electrical factories in all parts of the country. Most of the local firms are supporting the Exhibition, and this is as it should be, because Manchester is a recognised centre of electrical manufacturing activity. From the display of posters in the city and suburbs the show is being fairly well advertised, though we think the Corporation is not making full use of its facilities in this direction. The sub-stations of the Electricity Department, which frequently front the main road, are as yet innocent of posters, while the tramcars—one of the finest avenues to the public—remain silent on the subject of the forthcoming Exhibition. Can it be that the Tramways committee is treating its neighbour, the Electricity Department, as an ordinary advertiser and insisting on space being taken at prevailing rates? It is not too late to suggest that the Exhibition and its objects be made better known.

The site is certainly well situated, and from the point of view of tramway service could not be better placed. London visitors, now endeared to the "taxi," will be able to indulge in this speedy method of locomotion to their heart's content.

Entering last week the building which has been erected for the Exhibition we were disappointed to find that little or no thought has been bestowed either upon the natural lighting of the place or on the artistic arrangement of the stands. Apart from a few narrow slits along the centre of the roof, the building is practically unlighted, and exhibitors will need to incur heavy lighting bills if they are to show up their stands to advantage. The aisles are, of course, lighted by flame arcs, but these will only serve to throw into deep shadow any stand screened by partitions from the rays of the lamps. Perhaps Manchester's reputation for gloom and darkness is responsible for this lack of daylight, or it may be the organisers are anxious that visitors shall see electric lamps at all times. This offence, if it merits classification as such, can, however, be passed over lightly, though we shall be interested to hear what comments are made by exhibitors on their accounts for energy at the close of the Exhibition.

On the matter of the arrangement of the stands we feel more strongly. The managers appear to have thrown discretion entirely to the winds, and have permitted, or even encouraged, the wholesale erection of wooden structures, which serve no other purpose than to provide labour for carpenters and trade for timber merchants. In a building the dimensions of which are barely adequate for the purpose, more than ordinary care is required in the display of the exhibits. At Olympia (London), where floor space is no object, pagodas, enclosed show rooms, and box offices of various kinds are permissible, and even desirable. Some exhibitors, in spite of these facilities, none the less prefer to have a skeleton sign over their stands, and no other boundary separating them from their neighbours than a rope. Now, for a small exhibition, the open stall should be the rule rather than the exception. Wood partitions are objectionable enough in suggesting a "hands off" policy in competition, but in a building crammed with stalls they should be decried and not encouraged.

From our recent inspection of the Manchester Exhibition building we fear that much of the symmetry of the exhibits and the pleasing grouping which characterises, say, a motor vehicle exhibition—practically the ideal of effective display—will be lacking. We do not wish to pose as carping critics at this early stage, before the opening of the Exhibition itself, but we must say that a valuable opportunity has been lost by the Organising Committee for creating a good impression of the Exhibition from the outset. In a year of exhibitions there is plenty of material to go upon. The Franco-British Machinery Hall furnishes a good example in contrasts—the open character of the British section and the "cribbed, cabined and confined" nature of the French section. We are not overlooking the fact that partition erecting provides employment, but in temporarily giving work to a few it has damaged the interests of the many. Some firms exhibiting at Manchester have resisted the tendency of the management to encourage partitions by insisting on an open stall. They will score over others who have erected really beautiful structures which lack dignity and lose their attraction because of the surrounding welter of wooden cubicles and unsightly boxes. Had the exhibits been arranged in a co operative spirit on what we may call the "open access" system—to borrow a public library term—the Manchester Exhibition would have gone down to electrical posterity as a model of its kind and one which embodied in a practical manner the idea of co-operation rather than "dog-in-the-manger" competition.

The railway arrangements for Manchester during October will be found on another page of this issue.

TYPEWRITING AND TYPESETTING BY WIRELESS TRANSMISSION.

In our issue of May 1 last we described a system for the wireless transmission of photographs, invented by Mr. H. Knudsen, the principle of which was the "dusting" of a photographic negative with a metallic powder so as to raise the dense parts of the negative. When, therefore, a style was passed over the negative in a series of consecutive parallel paths, it closed the relay circuit controlling the transmitting instrument in passing over the raised parts of the negative. In this way impulses were sent to the receiving instrument, where a coherer served to impress them on the relay circuit controlling a similar style, which was passed over a glass plate with a blackened surface, and pressed upon the latter whenever the coherer responded to the transmitter. The two styles were kept in synchronism, and the style of the receiving instrument being fixed normally in a raised position, *i.e.*, only lowered on the receipt of each impulse, traced out a "negative" of the original picture.

At the demonstration of this apparatus which took place a few days previous to the above date, Mr. Knudsen made the interesting announcement that he hoped to be able to set type on a Linotype machine by wireless means. This forecast was to some extent realised by a second demonstration which took place at the Hotel Cecil on Thursday last week. After giving a further exhibition of the method of transmitting photographs, Mr. Knudsen removed the photographic transmission accessories from his machines, and fitting in their place a key board on the transmitter and a typewriter in connection with the receiver, successfully received on the typewriter a message tapped out on the transmitting keys.

At this stage it is necessary to explain that the apparatus shown was by no means intended to be the final apparatus suggested by the inventor, but only a model fitted for convenience to his photographic transmission apparatus for demonstration purposes. Mr. Knudsen is at present only completing the details of his actual apparatus, which he hopes to be able to exhibit in operation at an early date. Sufficient was shown, however, to demonstrate the practicability of the arrangement, though it was evident that its utility is not as great as might have been expected. The principle of the arrangement is as follows: On the transmitting instrument a small carrier, to which is fixed a contact spring, passes over a series of stops representing the letters of the alphabet, whilst a similar carrier moves in synchronism over a series of contacts in the receiving instrument. Any impulses sent from the transmitter at any particular position of the carrier operate, by means of a coherer and relay, a solenoid connected to the corresponding contact of the receiver. The solenoid sucks down a small iron plunger on to the particular lever of the typewriter and so records the individual letter of the alphabet sent.

The impulses are not transmitted by the depression of the keys at the transmitting instrument—in fact the keys for several letters

may be successively depressed before the carriage with its contact-maker passes over them. The process of working is as follows: On depressing a key of the transmitter key board, a small pin is raised and left in the path of the contact-maker. In passing over this pin and closing the induction coil circuit, thus giving the necessary waves, the contact-maker pushes the pin down into its normal position and passes on to any other pins which may be raised. The contact carriage is fixed to an endless band passing over rollers and driven by a small motor or clockwork, so that after passing over the whole series of pins it returns underneath to the starting position. An important point, and one which obviously lowers the speed of transmission, is that a complete cycle of the contact maker is necessary, if a letter is immediately repeated. Similarly, the process is slow if the letters in a word are arranged in the reverse order to the keys. Thus if the keys were arranged in the usual alphabetical order from A to Z, the word "BEGIN" could be transmitted by one cycle of the contact maker, since the letters would be reached successively in passing forward along the key board, whilst the word "TRIED" would require 5 cycles of the contact-maker, as only one letter could be transmitted in each cycle, the letters in the word being in the reverse direction to the arrangement of the keys.

This difficulty has been minimised to some extent by the inventor, as in his actual machine three contact-makers will be spaced round the moving band, and will move at a considerable speed over the contacts. Also two or three keyboards may be fitted, as it were, in series. Even so, however, it is obvious that the rate at which words can be spelt out will be slow.

An important point is the accurate synchronising of the transmitting and receiving apparatus. This is provided for by stopping both the moving bands after each cycle. The transmitter band is re-started automatically by the clockwork movement after a pause, and sends an impulse which immediately starts the band of the receiving instrument. In this way slight differences in speed of the two bands do not result in cumulative errors.

From this brief description of the experimental apparatus shown, it will be seen that by substituting a Linotype machine for the typewriter, it is possible to set up type by the wireless transmission of impulses, but it is obvious that, with the system described above, the process must be slow, and we doubt if its advantages are very great, since much editorial revision, as well as expansion and abstraction, is usually required in preparing manuscripts or messages for the printer. It must be admitted, however, that the system is ingenious, and we wish Mr. Knudsen every success in the perfection of his invention, which for certain classes of printing and newspaper work would find considerable use.

THE PROPOSED ELECTRIFICATION OF THE MELBOURNE SUBURBAN RAILWAYS.

In our last issue we gave a brief abstract of the report of Mr. C. H. Merz on the proposal to convert the suburban railways of Melbourne to electric traction. In view of the importance of this subject at the present time, we are pleased to be able to give the following additional particulars from this report :—

The primary object of the report is to determine whether the substitution of electric traction for steam traction on the Melbourne suburban system is financially justifiable. This involves a decision as to how, from an engineering point of view, such a change should be carried out, and the consideration of the advantages it offers the public. The work is divided into three progressive stages, in order to facilitate the discussion of various questions, as follows :—Stage I. The Port Melbourne, St. Kilda, Sandringham and Broad Meadows branches; route length 29 miles. Stage II.—Stage I. and, in addition, the Camberwell and Williamstown branches; route length, 65 miles. Stage III.—The complete scheme, including, in addition to Stage II., the Sunshine, Coburg, Preston, Heidelberg, Dandenong and Mordialloc branches; route length, 124 miles. While separate estimates are given for the conversion of the Port Melbourne and St. Kilda branches only, it is recommended that nothing less than stage I. be first converted.

The report is divided into five sections:—(*a*) The general problem and the system of electric traction recommended. (*b*) Power production and the supply of power to the trains. (*c*) Rolling stock for electric service. (*d*) Incidental considerations. (*e*) Estimates of capital outlay, revenue, and expenses and conclusions. Besides giving estimates of the result of operating the whole system electrically, the Report gives detailed estimates for the different stages.

In the introductory letter Mr. Merz points out that the steady growth of the suburban traffic will make it necessary for the railways to provide additional facilities before very long, in any case, and the present is therefore a good time for examining the possibilities of electric traction. So many heavy suburban lines in Europe and America have been converted to electric traction that there is nothing experimental about the present proposal and the results obtained on these other systems enable a pretty close estimate to be made of the results obtainable in Melbourne.

Melbourne Suburban System.—The Report shows that the Melbourne suburban system is a very much more important part of the railway system as a whole than is the case in most great cities and this is clearly proved by the following table :—

Table I.—*Victorian Railways. Analysis of Passenger Traffic.*

Year ended June 30. 1906.	Track mileage.	Train mileage.	Passenger journeys.	Passenger receipts.
Suburban system*......	298	2,772,669	59,477,123	£595,669
Remaining system	4,006	4,080,135	5,218,252	903,118
Total	4,304	6,852,804	64,695,375	£1,498,787
Suburban percentage ...	6·92	40·5	92·0	39·7

While possibly the Melbourne system is not unique in this respect, it is doubtful, he says, if on any other large railway system the metropolitan traffic forms so large a proportion of the whole passenger business dealt with, either as regards train mileage or receipts. In numbers, of course, the suburban trains exceed the other trains in most great cities, but while in London, for instance, the long-distance trains entering the metropolis on an ordinary day number about 500 out of a total of 8,000 or some 6 per cent., in Melbourne they form only 4·5 per cent. of the total. The best comparison is that of the train mileage: if all the railways having termini in London be considered, it will be found that the suburban train mileage on those railways is less than 20 per cent. of their total train mileage; in New York the proportion is even less. In Victoria, however, the suburban train mileage forms as much as 40 per cent. of the total train mileage. In short, whereas in Europe and America the suburban passenger business of the chief railways is in general of less importance than the main line business, the Victorian Railway system may be considered as divided into two parts—the suburban and the remainder. The lay-out of the system bears witness to the great importance of the suburban business, special and distinct tracks for the radial lines having been laid right into the city to a greater extent than in any other place.

The preponderance of suburban passenger traffic over the country traffic has continued for some years in Melbourne and, looking as far as possible into the future, it appears likely to continue. This seems to be due: Firstly, to the large population of Melbourne (526,400) compared with that of the whole State, amounting to 42·5 per cent. as compared with London 20 per cent., Edinburgh 7·3 per cent., Paris 6·9 per cent. and Berlin 5 per cent. Secondly, to the fact that people live away from the centre of the city and are scattered over a wider area than is general even in American cities, and certainly to a greater extent than is usual in England or even on the Continent of Europe. This is apparent from the density of population which, in Melbourne is 2,064 per square mile as against 9,510 in Greater London, 11,195 in New York, 19,060 in Edinburgh, and a still greater density in Paris and Berlin. In Sydney, Perth and Wellington the populations are all denser than in Melbourne. Thirdly, in large measure, to the fact that a large part of the business which, in a European or American city, would be dealt with by electric tramways or separate electric railway systems is dealt with in Melbourne by the suburban railways. In London the suburban systems that form part of main line railways carry less than one-fourth of the total suburban passenger traffic, the remainder being handled by separate and exclusively suburban railway systems and by tramways and omnibuses. In Sydney the suburban railways carry only one-fifth of the total suburban traffic and account for less than one-third of the total revenue from the suburban passenger business, in Paris and New York the ordinary railways carry an even smaller proportion of the total suburban traffic of those cities; in Melbourne, out of the total traffic handled by the tramways and suburban railways, the railways now account for more than one-half. This in spite of the fact that the cable tramway system in Melbourne is really excellent. The fact that the tramway system is a cable system is no doubt in favour of the suburban railways securing a larger proportion of the longer distance suburban traffic than would be the case if the tramways were electrically operated. This arises, not only from the higher speed possible with an electric tramway system in the outskirts, but also because a cable tramway system is necessarily restricted in regard to facility of extension and ability to deal commercially with light and infrequent traffic. A cable tramway is expensive to build, and hence unremunerative to operate, unless there is a demand for a more frequent service of cars than is the case on the outskirts of a large town. These drawbacks of a cable system, viz., the high first cost and the difficulty of extending it and of operating it economically with an infrequent service, prevent new lines, and especially long lines, being built so readily as with an electric system.

The growth of travel in Melbourne and suburbs, except during the depression in 1902-4 has been continuous and marked; thus, whilst 159 journeys per annum per head of population were made on the railways and tramways in 1898 with an average receipt of £1·64 per annum per head of population, these figures in 1907 were 236 and £2·20 respectively, the passenger journeys per annum on the railways having increased from 38,912,263 to 64,162,344 and on the tramways from 36,245,280 to 60,558,098 during the above period.

Electrical operation necessitates a higher capital expenditure than steam operation but it gives a considerable saving in operating expenses

* The figures given for the suburban system in Table I. include the returns for race and special traffic, and also those for certain outlying sections not comprised in Stage III. above, viz., Sunshine to St. Albans, Heidelberg to Eltham, and Mordialloc to Frankston.

and many other advantages, of which the principal are as follows:—*From the Public Point of View.*—(1) Regular and more frequent service throughout the day. (2) Greater punctuality, due to the greater ability of an electric train to make up lost time. (3) General improvement in the smoothness and safety of working, due to the automatic controlling devices whose adoption usually accompanies electrification. (4) Prevention of fires on property adjacent to the line arising out of sparks from locomotive uptakes. (5) Practical abolition of smoke, steam and dust, and a great reduction of noise. (6) Possibility of shortening the time of journeys below any thing possible with steam. (7) Improved lighting and cleanliness of carriages and stations. (8) Satisfactory regulation of the heating of coaches. *From the Railway Manager's Point of View.*—(1) Higher schedule speed, enabling a larger mileage to be obtained from a given amount of rolling stock and a greater number of trains to be operated over a given length of track. (2) Continuous and regular movement of trains and, in consequence, (3) More economical employment of train crews. (4) Greater flexibility in making up trains to meet the varying requirements of the traffic, both throughout the day and on special occasions, such as race days.* (5) Ability to reverse trains at termini immediately without engine shunting, thus reducing the time wasted, the tracks occupied and the signal and point movements, and entirely dispensing with shunting locomotives and in consequence.* (6) Increase in capacity of termini, and postponement of terminal extensions.* (7) Elimination of the lighting up of locomotives, and of the inefficient water, coal handling, auxiliary, lighting and heating appliances. (8) Use in the power station of a cheaper fuel than can be used in locomotives. (9) Supply of electric power at a low price available for a number of purposes, such as railway workshops, cranes and capstans, for which an independent installation would not be justifiable or economical. (10) Reduction in repairs and an increased life of track due to the weight of the driving machinery being distributed throughout the train instead of being concentrated as in the steam locomotive.* (11) Reduced cost of painting, and increased life of metallic structures near the railway due to absence of corrosive fumes. *From a Profit Point of View.*—(1) Reduction of operating expenses even for the same train mileage, and considerably greater saving in the expenses per train mile when the mileage is increased. (2) Increase of revenue due to an increase of traffic. (3) Improved earning power of capital sunk in lines, stations and rolling stock, due to the increased traffic capacity, thus saving capital expenditure which would otherwise be necessary to meet growth of traffic. The problem to be decided is how far these advantages will counterbalance the large capital expenditure.

Schedule Speed.—The characteristic feature of electrical operation is the possibility of increased schedule speed. The average length of run on the Melbourne system is about five-eighths of a mile and the average time taken rather more than 2½ min. With electrical operation it would be possible to accelerate the trains much more rapidly than with steam and reduce this to about 2 min. Numerous attempts have been made on other railway systems to obtain high acceleration with steam locomotives but it has not been very satisfactory. In actual operation it is usual to take advantage of the high acceleration possible with electric traction and for economy's sake to accomplish as much as possible of the run by coasting. It is always possible in emergency, as when it is desired to make up time, to cut down coasting and keep the current on until the brakes are applied. The present schedule speed of the Melbourne system averages about 16 miles an hour and with electric traction it is proposed to increase it to 20 miles an hour. Table II. shows how this compares with other electric railways.

Table II.—*Schedule Speed and Length of Average Run on Various Electric Railways.*

Railway.	Length of single line (miles).	Av. dist. between stops (yards).	Sched. speed (miles per hr.).
Boston Elevated	16	2,400	13·0
Central London	13	840	14·0
Lancashire & Yorkshire (Liverpool and Southport)	69	2,290	30·0
Liverpool Overhead	13	670	19·0
London Metropolitan District	56	1,042	15·7
Manhattan Elevated	118	1,775	14·7
New York Central (New York)	85	4,600	21·0
New York Subway	55	2,030	16·0
North Eastern (Tynemouth Branches)	73	2,000	20·5
North Western Elevated (Chicago)	25	1,320	16·0
Prussian State Rly. (Hamburg–Altona)	[illegible]	2,190	19·1
Pennsylvania Railroad (West Jersey)	160	8,800	28·8
Paris Metropolitan	30	540	16·2

To obtain this increased schedule speed the trains must be started more rapidly, but the acceleration must not be so great as to be uncomfortable to passengers or to cause the wheels to slip. The general principles [illegible] discussed apply to electrical operation whatever the system [illegible] multiple-unit, third rail or overhead wire, direct [illegible] current. The selection from these of the particular system to be adopted requires a close consideration of the relative capital and [illegible] conditions.

System of Train Operation.—If the suburban railways be converted to electrical traction the system which it is recommended should be adopted [illegible]

The [illegible] the adoption of the multiple-unit system of ele[illegible] [illegible]

is that known as the multiple-unit system of train operation. One advantage of using this system compared with using an electric locomotive to draw a train in the ordinary way, as with steam traction, is that a train of any desired size can be rapidly made up with the certainty that the motor equipment will be sufficient to draw it. A locomotive, on the contrary, is designed for a given speed and weight of train and has often too much or too little weight to pull—hence multiple-unit operation tends to much greater punctuality. Another great advantage of multiple-unit operation compared with the use of a locomotive is that at crowded termini when the direction of the train has to be reversed, it is only necessary for the motorman to change into the driving cab at the reverse end. There is no locomotive to be shunted. Again, if it be necessary, owing to the variations in the amount of traffic, to reduce the capacity of any train, the unnecessary coaches are uncoupled and the reduced train proceeds into traffic, the uncoupled portion, operated from one of its own driving cabs, being run into a siding without the aid of any shunting locomotive. The normal train recommended by Mr. Merz for Melbourne would be made up of an equal number of motor and trailer coaches—that is to say, the unit is a two-coach train. On outlying routes, of course, the traffic will sometimes be dealt with by a single-coach train, but on busy routes, especially at morning and evening, the trains will consist of two, four, six or eight coaches.

Proposed Train Service.—This depends upon the growth of traffic. The Government's railway department estimates that by the year 1912, the first complete year of electrical operation, the traffic, if steam working be retained, will have increased by 20 per cent., but that if electric operation be adopted the increase will be not less than 25 per cent., possibly more. A time-table has therefore been prepared on this basis, and is given in the Report. It shows the number of trains per day for the various routes in 1906 with steam service, and in 1912 with electric service—the latter figure in many cases being about double the former; also the average time per journey and the percentage increase in schedule speed, this varying from 10 to 36 per cent. and averaging 23 per cent.

There is one feature of electrical operation to which special attention has been devoted in drawing up this timetable and that is the desirability of keeping a uniform and frequent service of trains on each line throughout the day. It is, of course, necessary to insert additional trains at the busy times, and this has been done, but as electrical working, compared with steam working, allows of such a uniform service of trains being run at a minimum of expense, it is, in the opinion of Mr. Merz, very desirable—in fact, essential—that such a uniform and frequent service should be maintained throughout the day. This is obviously a great convenience to the travelling public; they can rely on catching a train without having to consult a timetable and are encouraged to travel at all times—not merely at the accustomed times of rush traffic but during the, at present, slack portions of the day. Apart from this convenience to the public, it is most profitable to the railways to encourage, as far as possible, travelling at times of light traffic. Every additional train run at busy times ultimately means additional capital expenditure and operating expenses on power station, feeders, sub-stations and rolling stock; it also results in difficulties in arranging for the necessary motormen and guards. Such additional trains, however, are necessary since it is the duty of the railway to cope with the traffic presented, but the capital having been once spent very little extra expense is entailed by maintaining a uniform and regular service throughout the day. Such a service undoubtedly promotes travel during the slack hours when every additional passenger represents revenue which is practically all profit as compared with additional passengers carried during rush hours. This—the difference between the profit made out of a passenger depending upon the hour of the day at which he travels—is true of all systems, but the difference is greater with electrical working than with steam working, because with electrical working the capital charges (which depend upon the maximum rather than upon the average traffic) are of more importance relatively to the operation expenses than they are with steam. Again, with electrical operation, and especially with the multiple-unit system which Mr. Merz recommends for the operation of the suburban service, it is possible to run short trains at regular and frequent intervals with maximum economy. With electrical working, therefore, a frequent service should be maintained throughout the day.

(*To be concluded*).

CORRESPONDENCE.

ELECTROLYTIC EXTRACTION OF COPPER.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: My attention has been drawn to the claim Mr. Scott Anderson is making to have solved the problem of extracting copper from its ore by a wet method and recovering the copper from the solution by electrolysis. In the accounts that have been published he does not give any indication of how the inherent difficulties have been overcome—viz., the roasting of the ores and the purification of the electrolyte.

There is nothing new in the four operations described by Mr. Scott Anderson—namely, crushing, roasting, lixiviation and electro depositing.—I am, &c.,

Westminster, S.W., Sept. 17. SHERARD COWPER COLES.

[We quite agree with the remarks of Mr. Cowper Coles.—ED. *E.*]

SYMBOLS FOR PHYSICAL QUANTITIES.

TO THE EDITOR OF THE ELECTRICIAN.

SIR: Now that there has been some opportunity for discussing this question may I be permitted to summarise the arguments that have been raised for and against the creation of new symbols?

The most common objection is, "They are like Chinese characters; we could never remember them." But there is no necessity to remember them. How many of us can remember what symbol Rankine uses for kinetic energy? Is it not sufficient if we see it when we refer to his book? Every considerate writer to-day gives a list of the symbols which he uses. If every writer used the same symbols we should soon become familiar with those with which we were most concerned, and for the rest, we could refer to the list just as at present.

Some objectors do not see why the list we have at present is not sufficient. Let them try to make up a list of symbols for the 200 physical quantities for which symbols are wanted. After they have satisfied themselves (if such a thing is possible) let them try to convince some one else to adopt that list.

There are about 20 letters, such as m for "mass," t for "time," &c., upon which there is almost universal agreement. One or two dozen more stand a fair chance of being agreed upon. Beyond these there is hopeless confusion, simply because all the good letters are exhausted.

As to the difficulty of printing new symbols, it is of interest to know that 25 of the leading technical journals of the world published an article containing five new symbols given as examples without any difficulty. Several of them have expressed the view that there is no difficulty from the printer's point of view. The types supplied to them—which, by the way, cost 1d. for 30—were all of the same size, and yet each paper printed the text of the article in its usual standard type. The publisher of the *Elektrotechnische Zeitschrift* thinks that there would be no difficulty in arranging with a typefounder to make matrixes, from which all printers could be supplied with type. Each printer would keep in stock those types which commonly occurred in his paper, and could get others on short notice. About 30 new symbols would be sufficient for articles on electro-technical science.

Two papers have objected that the symbols cannot be set up on a Linotype machine. It is, however, usual at the present time to set up mathematical expressions by hand.

Several critics have pointed out that the new symbols should be simple and bold in outline, so that they cannot be easily mistaken for one another. This, of course, is an important matter to bear in mind.

I agree with M. Galliot that the name of the symbol should be, where possible, the name of the physical unit represented. Where the name of the unit cannot be employed, a word of one syllable might be chosen, as, for instance, "stroke" for the length of a piston stroke.

Some critics say that the number of symbols required would be too great. As to that, we can make just as many as convenient. The symbol ⌁ became universal almost as soon as it was printed. Let us have a few more as good as that one; we are badly in need of them.—I am, &c.,

Cheshire, Sept. 19. MILES WALKER.

Electric Traction in the Simplon Tunnel.—The *Engineer* reports that electric traction in the Simplon Tunnel has proved so satisfactory that the Administration of the Swiss Bundesbahnen has decided to purchase the fixed plants as well as the four electric locomotives built by the firm of Brown-Boveri on the model of the Italian "Zara" type of locomotive. Messrs. Brown-Boveri had undertaken to provide the electrical plant and to restore the tunnel for steam traction if, after a given period, it was found that steam traction would be preferable. Experience having proved that the electrical system was satisfactory, the general management saw no reason why it should not be continued. The cost of electrical haulage is higher than the average costs of steam traction, but against this disadvantage is the important consideration that, when using steam locomotives, in course of time the ventilation becomes very troublesome.

MUNICIPAL TRAMWAYS ASSOCIATION.

SEVENTH ANNUAL CONFERENCE.

(FROM OUR OWN CORRESPONDENT.)

Nottingham.

Nottingham has been the centre of many conventions this year, two of these being electrical in every sense of the term. The annual convention of the I.M.E.A. was held in this city, and proved as successful as its predecessors. Now the tramway men are assembled in more or less solemn conclave, and Nottingham plays the part of host again. Despite this strain upon its hospitality the 200 tramway engineers now in the town find no lack of welcoming officials. The usual compliments are being paid each other by tramway managers, and one hears discussions of time-worn engineering subjects relating to tramway affairs. Like the convention of the supply engineers the occasion is being made good use of for a profitable interchange of ideas on crucial points of tramway management, brakes, track repair and maintenance, &c., and many interesting opinions are advanced.

The Conference opened on Wednesday morning with a meeting of the Executive committee at the Exchange Hall at 10 o'clock. This was immediately followed by a reception by Ald. J. A. H. Green, Deputy Mayor, who was supported by the Sheriff and the Chairman of the Tramways committee.

Mr. J. Aldworth, General Manager, Nottingham Tramways, and President of the Association, then gave his address.

PRESIDENTIAL ADDRESS.

Mr. Aldworth, after referring to the growth of the Association, suggested that the time had now arrived when the status of the Association should be raised, and that the Executive Committee should be instructed to take the necessary steps to secure its incorporation. In this way the Association would carry more weight when dealing with matters connected with Parliament and the Board of Trade. The most important question before the members during the year had been that of brakes and safety appliances for cars. The Brakes Committee of the Association had held many meetings and visited many undertakings, besides inspecting numerous designs, so that it was hoped the results would tend to prevent accidents.

After referring to matters under consideration by the Executive Committee, and to the good relations existing between tramway committees and their employés, Mr. Aldworth described the changed conditions brought about by the modern electric tramways. He considered that a satisfactory sign of the times was that much less was now heard of the demand for halfpenny fares and stages, although unfair criticism of some undertakings appeared in the Press from time to time. On the question of intercommunication much broader views were now being taken, as was evidenced by the continued increase in the number of municipalities which had entered into working agreements for this purpose.

A matter deserving of serious consideration was an improved method of collecting and checking fares, which must be simple, efficient and cheap. In this connection, the "pay as you enter" car indicated progress in Canada and the United States. The most important requirement of a successful tramway system was a thoroughly good permanent way. The greatest difficulty occurred on lines which had been in use for some years. In Nottingham the matter had received very careful attention, and as a result of experiments, extending over several years, it had been decided to repair defective joints by cutting away the worn portion of the thread and inserting a flat plate of special steel, which bridged the rail joint and rested on both rails. The ends were splayed and dovetailed into the rails. During the three years since the first joint was so treated not a single plate had worked loose, notwithstanding that there had been a two and a-half minutes service running over the route.

It was possible that we had followed American practice too closely, and he thought that there was scope for investigating the advantages of the "bow trolley," which was so largely used on the Continent, in contrast to the practice in America and this country.

In regard to the petrol motor 'bus, the general verdict was unfavourable, and although the Electrobus with accumulators was cleaner and more comfortable, there was much uncertainty as to the actual cost of operation. The merits of the "trackless trolley car" were now receiving careful attention, and it was satisfactory to know that one of our municipalities intended giving the system a trial. He hoped that ere long we should be in possession of reliable information as to the results of its working under British conditions. If these vehicles could be made to pay their way, and at the same time gradually create such a traffic over the routes on which they were

used as would justify the laying down of tramways, their introduction would prove a valuable factor in the extension and linking up of tramway systems. Another subject which was becoming more and more urgent was the drafting and adoption of a new series of bye-laws and regulations, since the existing ones were now rather out of date, and he hoped that the members of the Executive Committee would consider this matter.

This was immediately followed by a Paper on

"Some Through Running Problems and Their Solutions" by Mr. H. E. BLAIN (West Ham).

Mr. Blain classified the main principles upon which through-running should be based for the mutual advantage of the authorities concerned. That there were great advantages there was no doubt. Mr. Stephen Sellon some years ago had given figures showing the effect of introducing through-running between Newcastle and Tyneside. Prior to the arrangement the Newcastle cars in one month brought 48,796 passengers up to the terminus, beyond which the Company carried 11,414, there being thus 37,382 who did not get on to the second vehicle. In a month of similar season conditions, but *after* through-running facilities had been provided, 48,409 passengers arrived from Newcastle at the point mentioned, 36,305 of whom went on over the Company's lines, the number dropped being thus reduced from 37,382 to 12,104. Travelling in the reverse direction, 16,070 passengers were carried prior to through-running, and 29,930 afterwards. In the case of Birmingham and Aston, which had had through-running facilities, a break at the boundary became necessary owing to the electrification of the steam tramways, and the number of passengers in Aston dropped by 50 per cent. When the Edinburgh section of the Edinburgh and Leith Tramways was cabled, the loss of traffic to the two tramways, owing to the cessation of through facilities, amounted to £6,000 per annum. There was no doubt that one of the strongest reasons for the establishment of a Central Traffic Board in London was the importance of through running and the unwillingness on the part of certain authorities to provide proper facilities for the purpose.

Mr. Blain divided through running agreements into four classes as follows:—(1) Foreign lines leased and operated by another authority. (2) Cars run by both authorities, and each passenger receiving two tickets. (3) Cars run by both authorities to the extent of the mileage to which they were entitled, the respective areas being taken to be of equal earning value, and each authority retaining the receipts taken on their own cars. (4) Cars run by both authorities and receipts proportioned upon an agreed basis.

Details were given in the paper of a large number of cases of through-running. The expedient advocated by the late Mr. C. R. Bellamy that the crews of through-running cars should be changed at the boundary between the two districts had almost entirely fallen into disuse. After considering examples in each of the classes above mentioned, Mr. Blain gave a number of points which should be considered in drawing up an agreement between two authorities.

The members and a number of ladies then adjourned to the Victoria Station Hotel, where they were the guests at a luncheon given by the Nottingham Tramways committee. The Deputy Mayor presided, and, after the Royal toast, proposed the toast of "The Visitors," to which Alderman H. Linsley (Salford) responded. Mr. A. Baker (Birmingham) gave the toast of "The Nottingham Corporation Tramways Committee," and indulged in reminiscences of the horse car days in the city, when the normal service of three cars was doubled to cope with the enormous cricket and football crowds to Trent Bridge!

A visit was paid to the car sheds at Trent Bridge during the afternoon, and also to the St. Ann's Well power station. At the former place several interesting tramway novelties were shown in operation. One of these was a rotating advertising device, inside the car at each end, which comes into action when the driver passes the first notch of the controller at starting. The apparatus is simple and inexpensive and should prove a useful source of revenue. It is made by Messrs. Gent & Co., of Leicester. In another part of the shed a motor planer for rail joints was exhibited by the Railway & General Engineering Co., of Nottingham. The object of the planer is to recess the rail to a depth of about ¼ in. to allow of the insertion of a renewable plate over the joint which may have become badly sunk through hammering. The plate removes this and, should it in turn become worn, can be easily renewed, as it is merely dovetailed into the running rail. The planer is a portable tool which can be operated from the trolley wire direct. The motor develops 2½ H.P., and we understand that a plate can be inserted complete (all cleared away) in 2½ hours. On a car running up and down the shed was shown the Freund mechanical track brake, which was described in our issue of September 11th.

In the evening the members were entertained by the Nottingham Corporation at a reception at the Castle.

THE PHOTOMETRIC STANDARD OF THE NATIONAL PHYSICAL LABORATORY.*

BY R. T. GLAZEBROOK, M.A., D.SC., F.R.S.

The photometric standard of the National Physical Laboratory is a 10 c.p. Vernon Harcourt pentane lamp certified by the Gas Referees. The light given by any flame standard of this kind depends to some extent on the pressure and humidity of the atmosphere in which it is burning; and for many purposes, in particular the photometry of glow lamps, it is necessary to specify these factors with care. For gas photometry this is less needed, as flame lights are probably all affected in the same direction by changes of pressure and moisture; hence it was not until the photometry of glow lamps became important that careful measurements of these effects were made in the first instance by Dr. Liebenthal of the Reichsanstalt. One set of such experiments was laid before this Association at Cambridge in 1904 by Mr. C. C. Paterson, and these, so far as humidity is concerned, led him to the formula: candle-power $=10+0\cdot066\ (10-e)$, where e is the number of litres of aqueous vapour present in a cubic metre of air. It will be observed from this that the lamp has its standard value when $e=10$, or in other words the standard condition of humidity is 10 litres of moisture per cubic metre.† This condition was chosen because it was found that this was very approximately the average humidity during the three years 1897–8–9 both at the Observatory Department of the National Physical Laboratory, and at the Meterological Office. The humidity in this case was measured by the ordinary wet and dry bulb thermometer without any artificial ventilation as generally employed in this country, and the usual formula of reduction was used.

At the Reichsanstalt, in Berlin, however, an Assmann ventilated wet and dry bulb instrument is in use, and at the International Commission on Photometry, held at Zürich in 1907, an instrument of this class was recommended. This and the endeavour to clear up certain outstanding differences has led to a more complete investigation by means of different hygrometers of the amount of moisture actually present under the so-called standard conditions, viz., 10 litres as measured by the ventilated wet and dry bulb instrument when the observations are reduced by the ordinary formula; and the result has been to show that in the extremely still air of the photometer room there is a difference of as much as 20 per cent. between the indications of the ventilated and unventilated hygrometers, whilst the methods which were tried indicated generally intermediate readings.

According to the Assmann instrument recommended at Zürich, which may probably be taken as giving the more nearly correct result, the moisture actually present is only 8 litres per cubic metre when the unventilated wet and dry bulb instrument makes it to be 10 litres. If, then, we stipulate that e in Mr. Paterson's formula is to be measured by the Assmann instrument, it becomes candle-power $=10+0\cdot066\ (8-e)$‡ and the standard condition of humidity at which the lamp has the value 10 c.p. is very approximately 8 litres of moisture per cubic metre instead of 10 by the other method. Objections may be urged to changing in this manner the nominal standard condition. The International Photometric Commission, on the recommendation of the Laboratory, accepted 10 litres as the normal standard condition of humidity for the Vernon Harcourt lamp, and agreed on figures based on this for the ratios of various light standards; and it may be said that these should not now be changed. If this view be maintained, however, it would entail an alteration of about 1·3 per cent. in the photometric standard of the Laboratory which has been adopted by the Engineering Standards Committee as the standard for glow lamps photometry, and hence in the many secondary standards which in the past three or four years have been compared with this. In view of the difficulties and confusion caused by such a change it seems best for this and other reasons explained below to maintain the Laboratory standard unaltered as to its light value and to adopt 8 litres of moisture per cubic metre as the standard condition of humidity. I am glad to say that the Gas Referees concur. Prof. Boys writing to me on May 28, 1908 says: "My colleagues agreed that the degree of humidity represented by 8 litres of water vapour

* Report presented to Section A of the British Association, at Dublin.

† See also the last paragraph of this Report.

‡ A complete series of experiments has shown that the constant 0·066 in the formula holds both for the ventilated and unventilated instruments.

in a cubic metre of air as measured by the Assmann apparatus, seeing that it is commonly met with in this country, is one which may very properly be taken as standard, and they recognise the advantage for international purposes of the very simple relationships of the three primary standards which follow from the selection of this degree of humidity." Prof. Boys's last sentence relates to an important consequence of the change, first pointed out to us in correspondence with the Bureau of Standards of America.

Experiments on the ratio of the Hefner to the Pentane lamp were made during 1906–1907 in France, Germany and England and communicated to the International Commission on Photometry at Zürich. Dr. Liebenthal working at the Reichsanstalt found for the ratio of the hefner candle to the pentane candle, when burning under identical conditions of moisture, pressure, &c., the value 0·909, while Mr. Paterson's value at Teddington was 0·907. Messrs. Perot and Laporte found a slightly higher figure. Between ourselves and the Reichsanstalt there is exact agreement, but the standard condition at the Reichsanstalt is 8·8 litres of moisture and that at Teddington was 10 litres as measured by the unventilated hygrometer and since found to be 8 litres measured by the ventilated instrument. In either case, to get the ratio of the standard hefner candle to the standard pentane candle a correction is required for the difference in the standard humidity value, which can be obtained from Mr. Paterson's formula, and the above result that

$$\frac{\text{Hefner candle at 8·8 litres}}{\text{Pentane candle at 8·8 litres}} = 0{\cdot}908.$$

Taking 10 litres as standard we have

$$\frac{\text{Hefner candle at 8·8 litres}}{\text{Pentane candle at 10 litres}} = 0{\cdot}915$$

and this is the result accepted at Zürich with a margin of + or − 1 per cent. If we accept the readings of the Assmann hygrometer and treat 8 litres as the standard condition for the pentane lamp, then

$$\frac{\text{Hefner candle at 8·8 litres}}{\text{Pentane candle at 8 litres}} = 0{\cdot}903$$

and this figure is so near to 0·900 that we may certainly say for practical purposes within + or − 1 per cent, that the standard hefner candle is nine-tenths of the standard pentane candle. Moreover, according to comparisons between the French Standard, the Carcel lamp and the pentane lamp made by the same observers, the value of

$$\frac{\text{Bougie decimale* at 10 litres}}{\text{Pentane candle at 10 litres}} = 1{\cdot}03.$$

* The bougie decimale is taken as 0 104 of a carcel.

If, however, we take the pentane at 8 litres, this becomes

$$\frac{\text{Bougie decimale at 10 litres}}{\text{Pentane candle at 8 litres}} = 1{\cdot}006$$

or within sufficient approximation for all practical purposes the two are equal. So that, on this basis, and to a sufficient approximation for all practical work, the standard pentane candle is equal to the bougie decimale and each is ten-ninths of the hefner candle.

These constitute the very simple relationships to which Prof. Boys alludes and afford, we hope, a strong ground for accepting 8 litres as the standard value for humidity for the pentane lamp, and for asking the International Commission at the proper time to revise their decision to take the value 0·915 as the ratio of hefner to pentane candle, based as it was on the information which was laid before them by the Laboratory.

The change does not completely remove the discrepancy which is known to exist between the ratio of the hefner to the pentane candle as found by direct comparison and through the intermediary of electric lamps. This ratio, obtained by carrying lamps, carefully selected, between the Reichsanstalt and the National Physical Laboratory by various observers is as follows:—Paterson (1905) 0·891, Fleming (1905) 0·886, Sharp (1905) 0·890, Hyde (1906) 0·894, mean 0·890. The difference between this and 0·903 as found by direct comparisons is over 1 per cent., and though the discrepancy has been reduced considerably by the change in the latter ratio from 0·915, something still remains to be discovered. This point we hope, with the co-operation of the Reichsanstalt, to investigate further.

There is another point with regard to the measurement of the humidity to which allusion should be made. In our work at the National Physical Laboratory we have generally defined this as the number of litres of moisture in a cubic metre of pure dry air. Dr. Vernon Harcourt has pointed out, however, in a letter that it is usual to consider the total volume of all the gases concerned, and that it would be more in accordance with chemical practice to take the ratio of the number of litres of moisture in an actual volume of 1 cubic metre including the moisture, CO_2 and other gases which might be present. The practice we have followed is that of Dr. Liebenthal, whose well-known researches were the first on this subject. With the degree of accuracy to which we are working, either method leads to the same result. It may possibly be well in future to adopt the plan generally approved by chemists, provided other countries concerned agree.

A NEW LAMPHOLDER INTERIOR.

Of all electrical accessories the most important is undoubtedly the lampholder. Many and varied are the phases through which its "interior anatomy" has passed. At one time the *bête noire* of the lampholder was its plungers, but these have improved to the extent that they are now above criticism. The exordium once applying to them has long remained with the screw terminals at the back. Those terminals have been the curse of the apprentice and the stumbling block of the wireman since the industry was born. The tale of stray flexible strands has oft been written in smoke and flame on the lampholder carrying the offending interior.

But a new interior just being put on the market by Messrs. Drake & Gorham promises to sink these troubles into the oblivion of the past. Its object is to make the terminals at the back self-closing upon the conductor inserted into them, and this object has been successfully attained. Screws are not needed. The "flex" or wire is bared and cleaned and pushed into the receptacle directly in line

FIG. 1.

with the contact plunger. The act of pressing the wires in, or of pushing the fitment against the wires, is to cause the ball clutch inside the contact to tightly grip the wire. The insulation may be bared back just far enough to rest against the clip contact, so that no loose ends need project and cause "shorting."

Fig. 1 shows the interior with the wires being inserted, and Fig. 2 illustrates front and back views of the fitting. It will be noticed that the porcelain body is of solid design and that the two contacts are well embedded in insulating material. The porcelain has no thin projections which might be chipped off by careless handling. A Faraday House test showed that the insulation resistance between the terminals and between the terminals and holder was greater than 140,000 megohms in each case, the test pressure being 500 volts. A test pressure of 2,000 volts, 50 periods, was applied for half-an-hour without result. The same authority tested the grip of the plunger contact and found that a 35/40 flex could not be withdrawn with a pull of 10 lb., and with a 70/40 or 1/18 S.W.G. wire, the contact resisted successfully a pull of 20 lb.

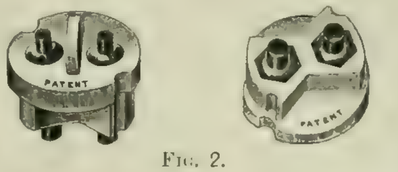


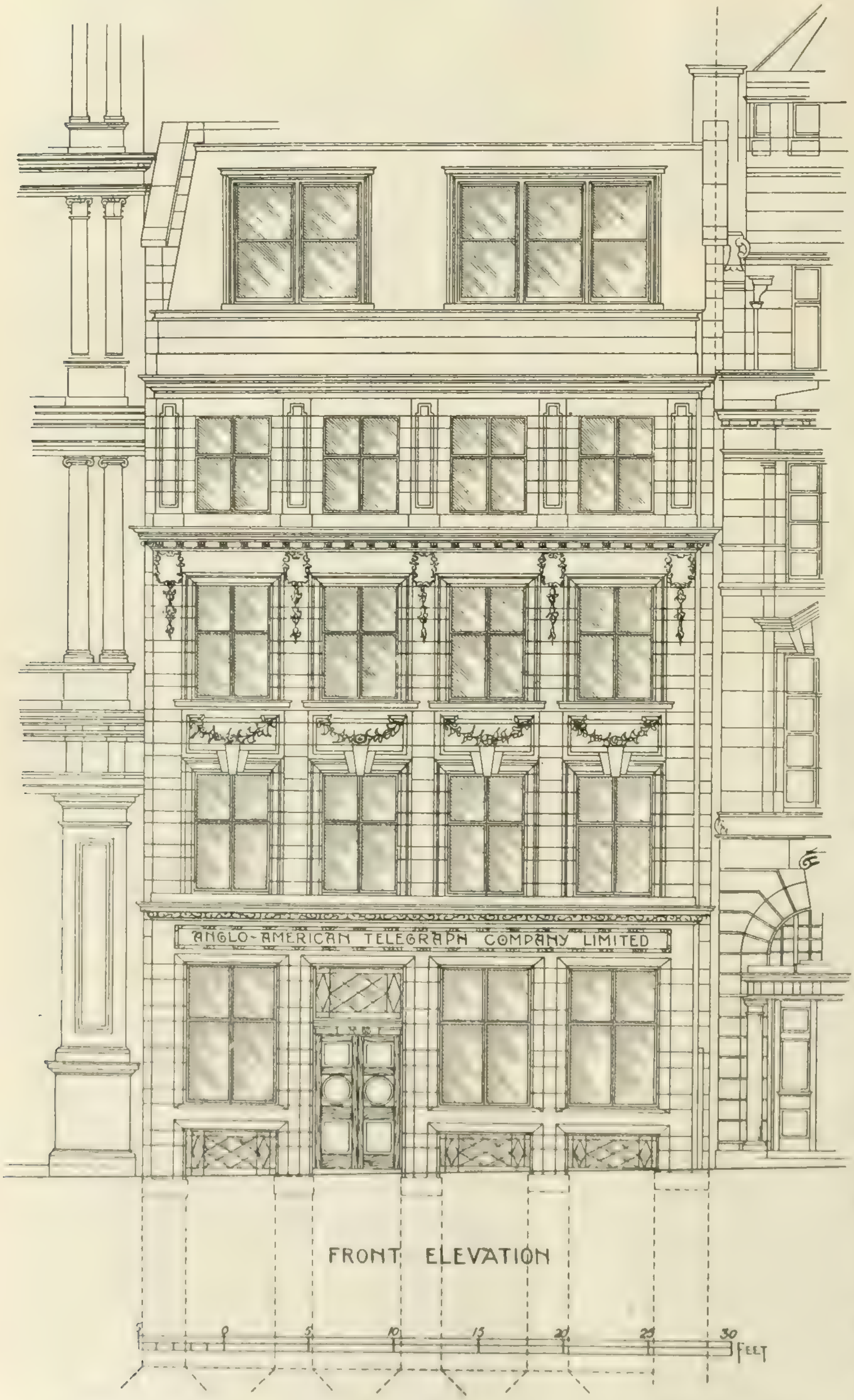
FIG. 2.

The withdrawal of the wire is effected by slight pressure on the plunger contact itself, thus distending the ball clutch and causing the release of the conductor.

A Graphite Oil Lubricant.—The *Electric Railway Journal* states that whilst both the crystalline and amorphous varieties of graphite are widely used for lubricating purposes, the crystalline product is claimed to be superior in its lubricating qualities because of its density, fewer impurities and greater tenacity and hardness. After extended use, the clay in amorphous graphite, from which it is impossible to free it, is supposed to increase instead of diminish friction. However, the very hardness of crystalline graphite heretofore made it impossible to reduce it to a degree which would make it an impalpable powder, so that it remained in suspension in oils. This two-fold object is said to be attained in a product called "Graphlio," which has been placed on the American market. The raw material is a flaked graphite reduced extremely fine (about 225 mesh), free from grit and made up of 95 per cent. carbon and 5 per cent. silica. This finely divided graphite is then treated with a secret preparation which reduces it to a semi-liquid state ready for mixture in the approximate proportion of 1 lb. "Graphlio" to 20 gallons of oil. It is stated that the introduction of this material in combination with any oil will effect 40 to 60 per cent. saving in the cost of lubrication.

NEW LONDON STATION OF THE ANGLO-AMERICAN TELEGRAPH CO., 63, OLD BROAD STREET, E.C.

The building of which we give a perspective view has been built for the special purposes of the Anglo-American Telegraph Co. (Ltd.), who are removing their main London station offices from the corner of Throgmorton street to the new premises, a few doors further up Old Broad street, opposite to the City Carlton Club. Old Broad street and adjacent thoroughfares have been the home of all the Atlantic cable companies, and it is fitting that with the necessity for the Anglo-American Company's station premises to be changed they should remain in this well-known thoroughfare. It would be difficult to find a more eligible site than that of the new building, which forms a worthy accession to a line of office premises which in recent years has been entirely reconstructed on most modern principles.



We congratulate the officials of the Anglo Company, the architect (Mr. Arthur C. Blomfield, M.A.), and the builders (Messrs. Howell J. Williams, Limited), and we wish the company a continuance of their excellent public service and also of the prosperity of which the company has had no more than its fair share. The Anglo-American is the pioneer Atlantic company, and telegraph men especially will be interested in the illustration which we are enabled to give of the new station.

FIRES ON UNDERGROUND RAILWAYS.

In our last issue we gave an account of the report made by Lieut.-Col. H. A. Yorke and Mr. A. P. Trotter to the Board of Trade in connection with the fire on the City & South London Railway. Attached to this report were the following requirements of the Board of Trade in regard to the precautions to be taken against the risk of accident by fire on underground electric railways :—

Stations and Permanent Way.

1. Sleepers to be of hard wood, not creosoted, and to be laid in concrete or ballast, and covered with a layer of gravel or finely broken stone free from dust, the ballast to be finished to a level surface so as to form a convenient roadway for passengers in case of emergency. If ballast is not used, the space between the rails to be covered with granolithic slabs, or slabs of a similar material, to form as wide a roadway as possible for passengers. No timber planks to be used.

2. Tunnels to be provided with lights capable of being turned on from the stations at either end of each section, and, if necessary, at some intermediate points. The lighting circuits to be independent of the traction supply.

3. Separate entrances to and exits from each platform of the stations to be provided, and to be situated as nearly as possible in the middle of the platforms.

4. All stairways, passages and exits from the stations to be conspicuously lighted. Not less than 25 per cent. of the lights in these places to be supplied from an independent source. If necessary, the exits to be made more conspicuous by the use of coloured lights in addition to white lights.

5. Platforms not to be made of wood, and woodwork to be eliminated as far as possible from signal-boxes, lifts, offices, &c., below ground.

6. Efficient hydrants, hose and fire prevention appliances to be provided.

7. Ventilating ways to be provided wherever possible from the stations and the tunnels to the surface.

Equipment.

8. Cars to be constructed of metal: woodwork to be reduced to a minimum and to be non inflammable. Hard wood to be used in preference to soft. Interior fittings, panels, seats, &c., to be of incombustible material.

9. No main electric cable to be carried through the train, and motors to be placed on the front and rear carriages only. No motor to be situated in the middle of the train.

10. Means to be provided at both ends of every train to enable passengers to alight from the cars in case of emergency. Oil lamps to be carried in every train.

11. Indiarubber or other inflammable insulating materials to be avoided as much as possible, and the outer covering of cables to be uninflammable material that will not give off smoke.

12. Means to be provided for enabling a driver at any part of the tunnel to put himself into telephonic communication with the adjacent stations.

MANCHESTER EXHIBITION ARRANGEMENTS.

Within a few days the great Electrical Exhibition at Manchester will be opened, and many of our readers will be making arrangements for visiting the show, which promises to be a success so far as a large number of fine exhibits and an excellent locale for the exhibition can make it a success. Manchester is the centre of a vast network of industrial enterprise, and differs greatly from the metropolis in that London is, in the main, a great wholesale and export distributing centre. This should give Manchester at least an equal chance with London to ensure the success of the Great Electrical Exhibition which is preparing at Platt's Field, within easy reach of the very centre of the city. Several of the principal lines of railway of the country put the visitor down within a few minutes ride of the exhibition building. The Palatine-road tramcars pass the exhibition grounds, and run at intervals of two or three minutes from very early morning to late at night from and to different parts of the city. The chief Manchester hotels are located nearer the centre of the city, and the tramcar service is equally available. In fact Manchester offers as good facilities in this and many other respects as London, and visitors may, therefore, be fully satisfied that their travelling and creature comforts within the city are well provided for.

The only question, therefore, that remains to be decided is the route the visitor will select for his journey to Manchester, and this will, in the main, depend upon the locality in which the intending visitor finds himself on starting his journey. In compiling the following particulars of various routes to Manchester we have to acknowledge the assistance of the railway companies concerned, and we trust the information will prove useful: –

Great Central Railway. This railway, whose excellent service starting from Marylebone, taps many of the largest manufacturing centres of the country, will be favoured by many visitors to Manchester, and especially by those whose stay will be a short one, from the fact that the company's station at Fallowfield is quite close to Platt's Field, where the Manchester Electrical Exhibition building is erected. Visitors from London and all the main line stations on the Great Central Railway can, if they so desire, travel to Fallowfield station via Guide Bridge, and there is also a good regular service of trains between Manchester (Central) and Fallowfield. On the Great Central line, as we have said, many important centres are touched en route to Manchester. These include Aylesbury, Rugby, Leicester, Loughborough, Nottingham, Chesterfield and Sheffield, at all of which places business friends can meet or affiliated associations can join the service of corridor restaurant cars, which are a popular feature in connection with this service. On the main line between Manchester and Liverpool several important towns are served, where electrical men starting from Liverpool for Cottonopolis will be able to join. These are notably Warrington, St. Helens and Wigan. The Great Central have two main line stations at Manchester—London Road and Central. Besides the well-known centrally situated London hotel at Marylebone, there are Great Central hotels at Nottingham (the Victoria Station Hotel), at Sheffield (Royal Victoria Station Hotel), while visitors who come to our shores from the Continent in the company's regular service from Rotterdam, Antwerp and Hamburg have the Yarborough Hotel at Grimsby, the Royal Hotel at Grimsby Docks and the Yarborough Hotel at New Holland to serve their every requirement. At all the main stations on the company's lines refreshment rooms are established and luncheon and tea baskets are served on all trains. The best trains for those starting from London to Manchester are the 8:45 a.m., which stops at all the main stations mentioned above, the 12:15 p.m., the 3:20 p.m. (the quickest train of the day), 4:30 p.m. and 6:20 p.m.; while for night travellers there is a train at 10 p.m., reaching Manchester at 3:28 a.m. Cottonopolis is not unlike the metropolis, in that those who are interested in the markets of a great city will find in Manchester much to interest them in the early morning when the market business is in full swing.

London & North-Western Railway.—This line commences its daily service from Euston Station to Manchester with a train at 5 a.m., reaching London Road at 10 o'clock, followed by trains at 7:10, 8:30 (Irish mail, breakfast and luncheon cars), 10:10, 10:30 (luncheon car express), 12:10 p.m. (luncheon car express), 12:15 (luncheon car), 12:25, 1:30, 2:40, 4:5, 4:10, 5:35, 6:5 (tea and dining car), 8:0, 8:45, 10:0 and 12 midnight (sleeping saloon train, arriving Manchester 5:25). The company's complete time-table must be consulted for the principal stopping places of these trains, but it may be noted that these include Rugby and Crewe. Equal facilities for obtaining refreshment on board the trains are provided on the return journey.

Midland Railway.—A service of fast corridor expresses is run from London to Manchester by the Midland route from St. Pancras, via Bedford, Leicester, Derby, Chinley and Manchester (Central Station). Trains leave St. Pancras at 10:0 a.m., 12 noon and 2:30, 4:30, 5:35, 6:30 p.m. and 12:15 midnight. Luncheon cars form part of the first two trains in the day, a restaurant car is attached to the 2:30 p.m., dining cars to the 4:30, 5:35 and 6:30 and a sleeping car on the 12:15 midnight, which reaches Manchester at 5:20 a.m. All trains call at Leicester, the 2:30, 4:30, 6:30 and midnight trains at both Bedford and Derby and the 4:30 at Chinley. Arrived at Manchester by this route passengers will find the Midland Hotel in that city one of the best patronised and most important centres.

Great Northern Railway. The service of trains to Manchester by the the Great Northern line, leaving King's Cross, commences with the 8:15 a.m., which has a restaurant car, arriving at Manchester at 12:13 p.m. The 1:40 p.m. has a restaurant car as far as Retford. There are also trains at 12:30 p.m. and 4 0 p.m. All these stop at Peterborough, Grantham and Retford. The 6:5 p.m. has a dining car to Sheffield and stops at Grantham, and the 10:45 p.m. arrives at Manchester at 3:12 a.m.

Great Western Railway.—From sunny Penzance to less sunny Manchester a train service with the great Midland city is established by the Great Western Railway Co., whose trains call at many of the principal main line stations on their comprehensive route. Trains leave Penzance at 6:35 a.m., 10 a.m., 12 noon, 4:35 p.m. and 8:45 p.m., and travel via Falmouth, Plymouth, Torquay, Exeter, Taunton, Weston-super-Mare, Bath, Bristol, Hereford, Shrewsbury, Crewe and Manchester (London Road). The service also taps Truro, Ilfracombe, Weymouth, Yeovil, Frome, Cardiff, Newport, Aberdare and Merthyr, some of them busy industrial centres. By a train not mentioned in the above list, which leaves Plymouth at 8:30, a luncheon car is included from Bristol to Crewe, and by the 10 a.m. from Penzance a luncheon and dining car is included between Plymouth and Bristol to Crewe. On the return journey equal facilities are given for luncheon, tea and dinner on board several of the trains.

Great Eastern Railway.—From this company's services along the East Coast frequent connection is made by means of through carriages from the following stations in the Eastern counties to Manchester:—Bury St. Edmunds, Ely, Ipswich, March, Norwich (Thorpe), Parkeston and Yarmouth. As in the case of all the lines which have no direct service into Manchester, the published time book of the G.E.R. must be consulted for the times and trains. It may be mentioned that the company's well-known service to the Continent will serve Manchester via Parkeston.

London & South-Western Railway.—There is a service to Manchester connecting up Bournemouth and all the principal stations on the Bournemouth section of the main line of the L. & S.W. Railway through to Willesden Junction, where the service joins that of the London & North-Western. Passengers between Weymouth and Bournemouth are served by a train which leaves Bournemouth Central at 10:21 a.m. and goes through to Manchester and Liverpool, on week days only. Through carriages are run between Manchester (London-road) and Winchester, Southampton, Bournemouth (Central and West), and luncheon cars are included in this service from Willesden to Crewe and Stafford to Willesden.

South-Eastern & Chatham Railway.—The through service on this company's line makes a useful connecting link between the South-East of England and the Midlands. The service connects up with the L. & N.W. and Midland Railways, and there is also a service from Redhill, Dorking, Guildford and Aldershot North Camp, which runs via Reading and the Great Western and Great Central Railways to Manchester, but in this case passengers have to change either at Oxford, Banbury or Woodford. This train leaves Redhill daily at 1:6 p.m. and is due at Manchester at 9:22.

London, Brighton & South Coast Railway.—There will doubtless be visitors from the South Coast who will take advantage of the service which now runs regularly between Eastbourne and Brighton and Manchester over the L.B. & S.C. Company's line, joining up at Willesden with the London & North-Western system. The popularity of this service is shown by the fact that trains take this journey daily.

North-Eastern Railway.—On this line a restaurant car service was initiated at the beginning of July between Newcastle, York, Normanton, Darlington, and Manchester and Liverpool, which service is worked alternately by the L. & Y. and the N.E. companies. Equal facilities are offered on the return journey. The North-Eastern Company have, from Darlington, provided through carriages with Manchester on some of their trains, which will be found of great service. These through carriage arrangements are particularly advantageous to visitors to Manchester whose time in the Midland city is likely to be short, and who will doubtless readily avail themselves of such facilities. Hull, Newcastle and York are all served with through trains to Manchester and Liverpool in this service.

Caledonian Railway.—Visitors from Scotland to Manchester will find the service afforded by the Caledonian Railway, in conjunction with the L. & N.W., most comfortable and convenient. Corridor luncheon car expresses leave Aberdeen at 6:45 a.m. and 10:5 a.m., Dundee West at 8:10 a.m. and 11:35 a.m. and Perth 9:5 a.m. and 12:15 p.m. These trains call at Forfar, Stirling and Coatbridge, and have direct connections from such places as Montrose, Brechin, Arbroath, Inverness, Elgin and Oban. Day passengers can also leave Aberdeen at 1:10 p.m., Dundee West at 3:30 p.m. and Perth at 4:4 p.m. From Glasgow Central the day express trains are 10:10 a.m., 2:0 p.m., 4:30 p.m. and 5:55 p.m., and from Edinburgh (Princes-street) 10:5 a.m., 2:0 p.m., 4:15 p.m. and 6:0 p.m. Luncheon cars are run on all these trains, with the exception of the 5:55 p.m. from Glasgow and 6:0 p.m. from Edinburgh. For night travellers the most suitable train is that leaving Aberdeen 7:25 p.m., Forfar 8:53 p.m., Dundee West 8:45 p.m., Perth 9:35 p.m., Stirling 10:20 p.m., Glasgow Central 10:55 p.m., and Edinburgh (Princes-street) at 10:50 p.m. This train has excellent connections from Montrose, Brechin, Arbroath, Inverness and Motherwell, and sleeping accommodation is provided from Glasgow Central.

Excursions to Manchester.—We understand from the Organising Managers of Manchester Exhibition that arrangements have been made with certain of the railway companies for a series of cheap excursions to Manchester from various centres.

MUNICIPAL, FOREIGN & GENERAL NOTES.

APPOINTMENTS VACANT AND FILLED.

Liverpool Education committee require a head master for the Preparatory Trades Day School, to act also as superintendent of Evening Technical Classes. Salary £250 to £300 per annum. Applications, with references, &c., to the Director of Technical Education, Central Technical School, Byrom-street, Liverpool, by noon Oct. 2. See also an advertisement.

A working electrician is wanted for testing and inspecting small electrical apparatus. Must be proficient in the use of measuring instruments. See advertisement.

An engineer and manager is wanted for a large generating station in the Midlands. See advertisement.

Bermondsey Council have appointed Mr. Cragg, of Putney, engineer-in-charge at the electricity works, in succession to Mr. Hogarth promoted.

Mr. J. Milton, shift engineer at Battersea, has been appointed chief assistant engineer to the Wycombe (Borough) Electric Light & Power Co., and Mr. W. H. Healy, draughtsman at Battersea, has been appointed to succeed Mr. Milton at a salary of £120 per annum.

Mr. G. Shaw Scott, M.Sc., has been appointed Secretary of the Institute of Metals. The head offices of the Institute will be in London, but the temporary offices are at the University of Birmingham.

EDUCATIONAL NOTICES.

Armstrong College (Newcastle-on-Tyne).—The session 1908-9 will commence on Sept. 28. There are complete courses of instruction in mechanical, civil, electrical and marine engineering, naval architecture, mining, metallurgy, &c. Particulars from the secretary (Mr. F. H. Pruen).

Battersea Polytechnic (London, S.W.).—At this polytechnic there are day and evening courses of instruction. The day courses include preparation for the B.Sc. in engineering of the University of London and the polytechnic diploma in (*a*) mechanical, (*b*) electrical and (*c*) civil engineering. The evening classes include preparation for the B.Sc. in engineering, associateship examination of the I.C.E., &c. Prospectus on application to the Secretary.

Northampton Polytechnic Institute (London).—The full day courses in the theory and practice of mechanical and electrical engineering, &c., will commence on Monday, Oct. 5. Entrance examination on Sept. 30 and Oct. 1. The courses include periods spent in commercial workshops and extend over four years; they also prepare for the degree of B.Sc. in Engineering at the University of London. Three entrance scholarships of the value of £52 each will be offered for competition at the entrance examinations in September. In the technical optics department there are full and part time day courses. There are also evening courses in electrical and mechanical engineering, technical optics and artistic crafts, horology, technical chemistry and domestic economy. The classes of the day courses commence on Oct. 5, and those of the evening courses on Sept. 28. Enrolments for the latter commence on 14th inst. Full particulars as to fees, &c., can be obtained at the Institute or on application to the Principal, Dr. R. Mullineux Walmsley.

Borough Polytechnic Institute (London).—At this institute a three years' course in electrical engineering is given, and there are also special courses in electric wiring instruction and design of electrical appliances and workshop fittings, advanced electricity and magnetism, &c. Classes commence on 28th inst. Prospectuses, which contain further particulars and a detailed syllabus of each course, from the Principal, Mr. C. T. Millis, 103, Borough-road, London, S.E.

South-Western Polytechnic (Chelsea, London, S.W.)—A complete three years' course in electrical engineering is held during the day and a four years' course in the evening. There are courses of lectures and practical work in elementary, intermediate and advanced electrical engineering, electrical design, instruments and lamps, alternating and polyphase currents, electric wiring and fitting, calculus for engineers, &c.

Merchant Venturers' Technical College Bristol.—Courses of instruction in civil, mechanical, electrical and mining engineering, chemistry, &c., are provided at this college. The courses prepare for the matriculation and B.Sc., and D.Sc. degrees (including engineering) of the University of London. There are well equipped laboratories and workshops for practical work, &c. Calendars (6d.) or short prospectuses (free) can be obtained from the Registrar.

City of Bradford Technical College.—The calendar of this College for the 27th session (1908-9) contains particulars of the courses of instruction in mechanical and electrical engineering, physics, chemistry, mathematics, &c. There are day and evening classes and well-equipped laboratories for practical work.

East London College.—We have received a copy of the calendar for the 1908-9 session. The courses of instruction prepare for the matriculation and the degrees in Science and Arts of the University of London.

The Drapers' Company have voted special grants for making important additions to the equipment of the engineering department, the staff and students of which have carried out a series of tests of vanadium and other special steels which are being largely used in the construction of high-speed engines. The recent installation in the electrical engineering department of an 11 kw. rotary converter of special design should be of service to senior students and to those seeking to carry out standardisation experiments. In the faculty of arts two students succeeded in obtaining the degree of M.A. in mathematics. In the faculty of science one student gained the D.Sc. and another B.Sc. for research in branches of chemistry, a subject which is particularly well developed at the college. In the internal honours examinations the College did well in science (three first classes) and almost as well in engineering (where two first classes were won), although the faculty of engineering is much smaller in point of numbers than that of either arts or science.

Argentina.—The "Review of the River Plate" states that Mr. Glynn has applied to the Minister of the Interior for a 20 years' concession for electricity works in Gallegos.

Association of Chambers of Commerce.—At the autumnal conference of this Association held at Cardiff last week the following resolutions were approved:—

Proposed Ministry of Commerce.—On the motion of Mr. C. CHARLETON (London), a resolution was adopted expressing disappointment that the Government had not yet taken action, as foreshadowed in the King's Speech of Feb., 1905, with reference to the conversion of the Board of Trade into a Ministry of Commerce on modern and representative lines, and urging that this long-delayed measure should be proceeded with in the session of 1909.

Compulsory Registration.—Resolutions urging the compulsory registration of the names of persons carrying on business in other than their own names, and, further, favouring registration on the same lines as in almost all other European countries—namely, local registration.

The latter resolution was only carried by 60 votes to 52.

Parcel Post Rates.—A resolution favouring the reduction of the foreign parcel post rates, so as to enable British exporters to compete on equal terms with traders in other countries.

Cable Rates.—Mr. J. A. LECKIE (Walsall), moved for a further reduction in foreign and colonial cable rates, and that, as a commencement, the cost of messages between this country and France, Belgium, Holland, and Germany be reduced to 1d. per word, and the cost of messages to and from the Colonies be materially reduced.

Mr. GEORGE SHIPWAY (Birmingham), seconded.

Mr. P. E. J. HEMELRYK (Liverpool), said he would resist any reduction in the cost unless there was an assurance that the reduction would not interfere with efficiency. He suggested a rider "provided that such reduction does not interfere with the efficiency of the Continental service."

Mr. LECKIE accepted this alteration, and the motion was adopted.

Telegraph Charges to Sweden.—A resolution by Mr. AXEL WELIN, president of the Swedish Chamber of Commerce, that the Postmaster-General be asked to reduce the telegraphic charges to Sweden to the level of other countries, was agreed to.

Underground Telegraph Cables.—A Liverpool resolution recommending the provision of underground telegraph wires to Land's End to obviate the frequent interruptions by storms to the telegraphic service service for the East was adopted.

Beckenham.—An inquiry was held on Tuesday into the application of the Council for sanction to borrow £1,750 for substituting electric lighting (by metallic filament lamps) for the present method of street gas lighting.

Bray (Co. Wicklow).—Mr. T. P. Bradshaw has sent in his resignation of the chairmanship of the Electric Light committee, in consequence of alleged lack of interest in the undertaking by other members of the Council. He is to be asked to reconsider his decision.

Brazil.—Mr. Vice-Consul Fletcher states that tenders will shortly be invited for the operation of the State electricity supply and tramway undertakings at Manaos.

Mr. Fletcher further says the wireless telegraphy experiments between Manaos and Para seem to have ended in failure.

Church Lighting.—The parishioners of St. Mary Stoke, Ipswich, have had their church fitted for electric lighting by Osram lamps, as a memorial of the late rector, Canon Tompson.

Clacton.—The Council have applied for sanction to a loan of £1,000 for additional electric plant, cables, &c.

Croydon.—It was reported to the Council on Monday that the company which in February last contracted to erect three coal

bunkers and one ash cover and receiving hopper, together with the constructional steel work at the electricity works, had failed to execute the work with due diligence and expedition, and the Lighting and Electricity committee recommended that, after seven days' notice to the contractors, the Corporation take the works wholly out of their hands and re-contract with some other person or persons.

Dublin. Dr. Murray has given notice of motion for the next meeting of the Corporation to have all the streets in the city in which electric mains have been laid lighted by electricity. The Lighting committee have also been considering this question, and are of opinion that the time has arrived when they should obtain at least a share of the ordinary street lighting.

Dumfries.—Mr. W. W. Lackie, Glasgow city electrical engineer, is to report to the Council on the question of taking over the local electricity works from the India Rubber, Gutta Percha & Telegraph Works Co.

Dundee.—Sanction has been received to a further loan of £40,000 for the electricity undertaking. Tenders have been accepted for the erection of the new Clepington sub-station building at £1,800.

On Monday the Electricity committee considered a report from the city electrical engineer (Mr. H. Richardson) on stair and close lighting in which he proposed that the department should offer to light a property for a certain sum—in the case of a close and stair requiring four good lights for 24s. per annum, payable by the landlord, who would probably come to some arrangement with his tenants. The advantages would be that the department would be responsible for putting on and off the lights exactly at an hour fixed by the Council, varied to suit the time of year, and that it would not be possible for an evildoer to put the lights out. It would put an end to the problem of stair lighting, and equally satisfy the Council, the police authorities and owners and tenants, and would generally tend to a most satisfactory state of affairs at a price which, it must be admitted, erred, if anything, on the side of cheapness. The committee approved the scheme and agreed to remit the matter to the Lighting committee

Electrical Contractors' Association.—A meeting of the northern section of the Electrical Contractors' Association will be held at the Manchester Exhibition on Oct. 17 at 11 a.m., to be followed by a propagandist meeting open to all electrical contractors. The Central Board Meeting is to be held at the Exhibition on Oct. 16 at 11 a.m.

Elland.—An inquiry was held on Wednesday into the application of the Council for sanction to borrow £3,000 for extensions of the electricity undertaking.

It was explained that on account of the increased demand for electricity it had become necessary to remove the destructor and put in a new boiler, but the inspector (Mr. Bicknell) pointed out that the refuse destructor had been installed but five years ago, and he was afraid the L.G. Board would not allow the cost of removal, because it might recur.

Fair Wages Clauses.—At a meeting of Manchester Trades' Council last week it was reported that the Co-operative Wholesale Society had agreed to adopt in contracts given out by them, a fair-wages clause, proposed by the representatives of the Electrical Trades' Union, as to the payment of local trade union rates of wages, with the exception of a condition that preference shall be given to trade unionists. The Electrical Trades' Union delegates were not satisfied with the concession made by the Society, but the Council ultimately decided to accept it.

Felixstowe.—The Council last week further considered the recommendations of the Lighting committee with regard to the purchase of the rights and undertaking of the Suffolk Electric Supply Co. (set out in our issue for Sept. 11).

The chairman of the committee (Mr. Cowles) moved the adoption of the committee's recommendations.

The chairman of the Council (Mr. Mason) said the capital account of the Council's undertaking stood at £12,404, and if they gave £8,000 for the company's undertaking that would make £20,404. The engineer had estimated that the cost of new works would be £7,500, and there were works for which they had already obtained powers, and which would cost £3,146. He moved that an estimate be obtained from the consulting engineer (Mr. R. P. Wilson), and if he agreed with the estimate of £7,500 for new works the Council should offer the company £8,000 for the whole of their undertaking and interest in Felixstowe.

Mr. Cowles withdrew his motion and the amendment was adopted.

Hammersmith (London).—The electrical engineer (Mr. G. Gilbert Bell) has reported on the contract placed with the British Thomson-Houston Co. in July, 1904, for a Curtis turbine for £9,145.

The machine was put into commission in Sept., 1906, and has been in almost constant use since Jan., 1907, having run 9,118 hours and generated 6,546,210 units during that time. In one or two important details (viz., noise and heating) it is said to be not quite in accordance with specification, and Mr. Bell does not feel justified in taking it over as it is and signing the final certificate for £799. 10s. In order to overcome both these points, the contractors are prepared to rebuild the alternator free of charge and hand the machine over in accordance with specification, and this offer has been accepted. The Electricity and Lighting committee has accepted the offer of the B.T.-H. Company to increase the output of the Curtis turbine from 1,500 kw. to 2,000 kw., when they are rebuilding the machine, for the sum of £550, and to supply the spare parts required for £136.

Handsworth.—The Council has decided to increase the salary of the electrical engineer (Mr. F. A. Nixon), from £350 to £400 per annum.

Hope. Efforts are being made by Mr. A. O. Griffiths and Mr. R. Allen to organise a company to establish electricity works. At a recent meeting of ratepayers a sub-committee was appointed to select a site for the works.

India.—The hydro-electric works at Jhelam were officially inaugurated on Wednesday by Col. Sir Francis E. Younghusband, K.C.I.E., in the presence of the Maharaja of Kashmir and numerous guests. In addition to lighting, the electrical energy is to be utilised for dredging the river Jhelam, for working the silk factory at Srinagar and other industrial purposes.

Inquest. At Lancaster on Saturday an inquest was held on Chas. Buxton, foreman painter in the employ of the Butterley Iron Co., who was killed at Castle Station on Friday last.

A fellow painter named Anderton said he was working along with deceased in painting a standard carrying the electrical equipment of part of the Midland Railway Co.'s line. Deceased had arranged the precautionary measures that were adopted. When they got the warning that the current was coming on witness jumped off on to the roof. Deceased, who was about 3 ft. from the live wire, said "I'll get out of the road" and was doing so when he fell. He put his hand on insulator and his body was badly burnt.

Thos. Stirzaker, flagman, said when deceased put his hand on the insulator a blue light came out, and he fell with one leg over the top of the girder and the other through it. His hand was still on the insulator, and he fell backwards with his shoulder touching the live wire underneath.

Mr. H. W. Spendlow, electrician in charge of the overhead equipment, deposed that only persons with permits from himself were expected to work about the electrical equipment. No one in his department knew that deceased was working there. He was not in their department. The voltage of the current at the time of the accident was 6,600. With that voltage, if the deceased put his hand on the insulator within ⅝ in. of the wire the current would go through his body. There was no reason electrically why the signals should not be worked independently of the switching on of the current.

Mr. C. McLean, civil engineer, Derby, who designed the overhead electrical equipment, deposed that there was 10 ft. on one side and 4 ft. on the other of safety on the standards. But if the insulator was out of order the whole girder would be alive. The Butterley Co. generally advised them when they were going on a certain job, and he made arrangements to protect them. He had no advice as to their coming on that particular job, and consequently no arrangements were made for the men's protection so far as the company was concerned.

The Coroner said at first it seemed as if there was some want of care in the arrangements, but if anybody was to blame in that connection it was the deceased himself.

The jury returned a verdict of accidental death, adding that there was no one to blame.

Institute of Metals.—All the preliminary organisation work in connection with this Institute has now been completed, and a permanent secretary has been appointed.

The headquarters are to be in London, where a permanent secretary and offices will be maintained. Meetings will also be arranged from time to time at various provincial centres, and a journal will be published, with original Papers and abstracts of current literature. The new secretary (Mr. G. Shaw Scott, M.Sc.) will enter upon his duties at once, in order that he may co-operate with a local committee at Birmingham, of which Mr. Baeddicker (Hy. Wiggin & Co.) is chairman and Councillor G. P. Poppleton hon. secretary. Plans have been drawn up for the forthcoming meeting, to be held on Nov. 11 and 12. According to the provisional programme, Papers are to be read on both mornings, the sessions of the Institute being held at the Technical School, Suffolk-street, Birmingham. Visits will also be made to works of interest in the district.

L.C.C. Tramways.—A new line to Putney Bridge is to be constructed along West-hill, Wandsworth, and Upper Richmond-road, with some single line branches en route. The estimated cost is £53,740.

The Council propose to reduce East-road, Hoxton, to a single line tramway and to construct a line through Shepherdess-walk for the City–Highbury service so as to obviate the expense of widening East-road. Petitions are being signed against the proposal. A similar proposal will, we anticipate, be made with regard to Bridport-place in connection with the City–Green Lanes service.

Bermondsey Borough Council have been informed that the Highways committee of the London County Council will recommend the Council to seek, in the 1909 Parliamentary session, authority in respect of the route from Tooley-street to Evelyn-street, Deptford, and for authority to construct five diversions and extensions.

Manchester. The foundation stone of the new tramcar shed at Princess-road, Moss Side, was laid on Tuesday. The shed will accommodate 250 cars and provision has been made for future extensions.

Marriage.—The marriage took place on the 16th inst. at All Saints' Church, Child's Hill, of Mr. Geo. R. Webb, M.I.E.E., (head storekeeper to the Gt. Indian Peninsula Railway Co., Bombay, and eldest son of the late Mr. F. H. Webb) to Miss Gladys Mary Gawthrop.

Morecambe.—The Council have accepted a loan of £7,663 at 3¾ per cent. for tramway purchase purposes, and have applied to the Board of Trade for consent to the purchase of a portion of the Morecambe Tramways Co.'s undertaking. A provisional order to lay additional tramways will also be applied for.

North-East Coast Engineers' Strike.—The engineers who have been on strike have decided to accept the terms of settlement referred to on p. 887 of our last issue, and about 4,000 of the 6,000 men directly affected will resume work on Monday next.

Obituary.—We regret to announce the death, which occurred at Herne-hill, London, on 18th inst., of Mr. Fras. B. Heaphy, A.M.I.C.E., station superintendent at the South London Electric Supply Corpn.'s station at Loughborough.

Patent Litigation.—We are asked to state that the proceedings instituted in 1907 by the Johnson-Lundell Electric Traction Co. (Ltd.) against Raworth's Traction Patents (Ltd.) and several of their customers for alleged infringement of patents have been discontinued by agreement, a declaration to the effect that "in no single instance have defendants supplied or fitted up an equipment containing any infringement of the Lundell patents" having been accepted by plaintiffs.

Pembroke (co. Dublin).—At Friday's meeting of the Roads committee the electrical engineer (Mr. Price) was instructed to erect arc lamps in a portion of Ringsend. A number of applications for electrical energy for power and heating were dealt with.

Lampeter-Aberayron Light Railway.—It is announced that the construction of this line will be commenced early next month.

P.O. Telephone Service.—The new telephone exchange at Kingston-on-Thames, which is to take the place of the old one at the Post Office, has just been completed. The number of subscribers is about 1,000, and the work of transferring these from the old to the new exchange was performed in about one minute. Provision has been made at the new exchange for 2,700 subscribers.

Private Fire Brigades.—The London Private Fire Brigades Association, comprising 850 members, held its fourth annual competition at the Guildhall on Saturday last. A solid silver challenge shield, worth over £100, is presented by the Corporation of London for the encouragement of good work among these brigades. Teams representing 15 brigades competed, and at the conclusion of the competition Councillor J. H. Lile announced that the shield had been won by the Robertson Electric Lamp Co.'s brigade, the three first teams being:—Robertson brigade, 360⅗ sec.; Bradbury, Wilkinson & Co. (Printers), 403⅗ sec.; R. H. & S. Rogers (Rotherhithe), 410⅗ sec. The Lord Mayor presented the shield and silver medals to the winning team, congratulating them on the fact that they were the first team to win the shield for the second time.

Rossendale.—Bacup and Rawtenstall Corporations have agreed to purchase the undertaking of the Rossendale Valley Tramways Co. within the two boroughs for about £33,000. The price of the Bacup portion is £10,300 (including cars and engines) and Rawtenstall Corporation will lend that amount to Bacup on mortgage. Rawtenstall Corporation are to reconstruct the tramways in Bacup, to work the steam tramways and to take the receipts until the electrification is accomplished.

Sedgefield (co. Durham).—The Council have made an arrangement with the Mainsforth Colliery for the electric lighting of Chilton-lane.

Technical Training for the Army In pursuance of a scheme of technical training which was started last year, a series of trade classes will be held during the coming winter in the Aldershot command.

A circular has been issued to the troops pointing out the difficulty of finding employment after leaving the Service, and the importance of possessing some technical knowledge. The classes will be open especially to all non-commissioned officers and men whose colour service has nearly expired, and for the instruction a very small fee will be charged. The courses include instruction in a number of trades and callings, including care of electric light plant and of gas and oil engines, electric wiring, blacksmithing, fitting, turnery, carpentry, traction engine work, motor driving and construction, &c.

Trackless Trolley Tramways. The members of the Manchester sub-committee (recently appointed to collect information on the trackless trolley system of transit) have issued their report on their recent visit to the Continent.

At the outset, the report deals with the problem of transit facilities for suburban districts, which, briefly stated, is:—

(a) How far is it desirable and advantageous to extend the tramway system into the suburban and thinly populated outside districts, having due regard to the financial stability of the undertaking? and

(b) When a reasonable limit of extension has been reached and some means of transit is desired beyond that limit, what is the best system to adopt?

As to the first question, it may be pointed out continues the report) that the cost of operating tramways may be divided into (a) running expenses per car mile, which remain approximately constant, no matter how the total car-mileage increases, and (b) standing expenses per car-mile, which vary in inverse ratio to the car-mileage run. It is, therefore, the standing expenses which largely, if not entirely, determine the economic limit of tramways.

The report continues: With a half-minute service the standing expenses in Manchester are 0·138d. per car-mile only, whereas with a half-hour service they reach 3·26d. per car-mile. Taking the surplus receipts (after deducting running expenses) at 2½d. per car-mile, it would appear that a 9-minute service is the economic limit. When dealing with the question of extension of a tramway system, however, the earnings and expenses of the extension must not be viewed as if such extension were a separate undertaking to be operated apart from the general tramway system. It must be remembered that, generally speaking, extensions tend to increase the value of the existing lines right from the centre of the city, and, therefore, the economic limit may be placed at a less frequent service than nine minutes. It may be safe to say that the economic limit would probably be reached on routes which would provide suitable revenue for a commencing service of, say, 10 to 15 minutes—provided that the length of the extension is not too great compared with the length of the existing line measured from the centre of the city.

The chief value of tramways lies in the fact that metal wheels running on metal rails afford the cheapest known form of traction, and that fundamental advantage of tram haulage over any other form of haulage on ordinary roadways—no matter how well the roads may be paved—will always exist, and should never be lost sight of. It clearly illustrates the fact that tramways increase the carrying capacity of the public streets, and this is of great importance in crowded cities, where the traffic tends to become more and more congested. If we were to "scrap" our tramways to-morrow and substitute motor omnibuses, we should have to put at least 1,000 of such vehicles on the streets to provide for the "peak" loads at the "rush" hours which are now carried by our 500 tramcars, the carrying capacity of the omnibuses being approximately only half that of the tramcars. What we ought to aim at is to do everything possible to lessen the street congestion—not to increase it. The traffic problem and the question of providing more street accommodation in the heart of the city is every year becoming more important. It is a problem which the Corporation before long will be called upon to seriously consider and deal with.

From a financial point of view it can easily be shown that, notwithstanding the heavy expenditure on track construction and maintenance, tramways are economically far in advance of motor omnibuses for handling passenger traffic in large cities and towns. In Manchester we run our tramcars at a total "all in" cost of 10d. per car-mile. That is the average cost for running 500 cars, nearly half of which are bogie cars, each with a capacity for 80 passengers, and a large proportion are fitted with top covers, which renders them capable of being used to their full capacity in wet and inclement weather. The cost includes the payment of a large sum in rates to the city in respect of the tramway track, and it also includes the expense of maintaining the roadway between the metals and for 18 in. on the outer sides; in other words, it includes the cost of maintaining practically half the width of the principal streets of the city. It further includes all fixed charges for interest and sinking fund on capital, and a large sum for reserve, renewals and depreciation. If our income reaches 11d. per car-mile, it gives us a surplus (available for relief of rates) of 1d. per car mile and this on our mileage amounts to £70,000 per annum. If motor 'buses were adopted, we should have to pay no rates for the use of the roads, nor should we be called upon to contribute anything towards road maintenance. The standard type of 'bus now in general use has a seating capacity for 34 passengers only, and it is not provided with a covered top. We know from the experience of several towns where motor 'buses have been in operation for some time that their total "all in" cost of operation, including working expenses, depreciation, interest and sinking fund, is not less than 1s. per 'bus mile, and at least 1,000 'buses would be required to meet the demands at the "rush" hours in Manchester. That would entail the running of a much greater mileage than is necessary with tramcars for handling the same amount of traffic, and hence decreased earnings per mile would be the result. With less earnings and increased working expenses the result would be disastrous. In short, the adoption of motor buses for city traffic would result in a large increase in fares, an increased cost of road maintenance, increased traffic congestion and less efficiency all round. Many people, unacquainted with the practical side of tramway working, are of opinion that the ideal system of operation would be by automobiles working independent of a central power station. There is really no good foundation for this theory. The work which a tramcar has to do varies considerably at different times of the day and at different periods of the year. In winter, when the track is in a bad condition, the tractive effort required reaches its highest

point, but this may only occur for a few weeks. It is better and more economical to generate energy to provide for these "peak" loads in large quantities in a central power station than to provide each separate vehicle with an equipment for generating or for storing its own energy, which may only be called upon for its maximum output a few times a year, but which will have to be carried about by the cars all the year round. The motors in our tramcars are capable of dealing with these exceptional loads, and whilst the cheapness of generation in central stations is somewhat neutralised by having to transmit the energy through feeders to the trolley lines, yet on the whole the advantages of such stations for the working of large tramway systems are altogether too great for us to think of generation in small quantities in automobiles.

The only field for the motor-'bus is (*a*) in towns or cities where tramways are not permitted, or (*b*) in suburban districts where the traffic is not sufficiently great to warrant the laying down of tramway rails, and in the latter districts it will have a competitor in the trackless trolley. The granting of licences to private individuals to run motor-omnibuses in the southern suburbs of Manchester is naturally of interest to the tramways department. We have, however, sufficient knowledge of the earning capacity of the proposed routes for which the 'buses have been licensed to say that if the licensees intend running their 'buses all the year round they will not, in the sub-committee's opinion, earn sufficient to meet their expenses. It may possibly be advantageous for a corporation or a company operating a large tramway system to run motor or other omnibuses in the suburban districts to act as feeders for their undertaking, but for private individuals to undertake the running of such 'buses in these thinly populated districts—as an independent business concern—the proposition is altogether a different one. For providing means of transit beyond the economic tramway limit the trackless trolley system claims consideration. Briefly, trackless trolley cars are vehicles operated by electric motors obtaining their energy from overhead trolley lines, which are in duplicate—positive and negative. It is an attempt to adapt the ordinary trolley system of traction for thinly populated districts, avoiding the expense of track laying and possible road widenings. The vehicles are, of course, subject to the usual disadvantage of all vehicles which run on the ordinary roadway instead of on rails—namely, that the tractive effort is greater, the difference between the two varying, of course, according to the condition of the road surface.

Particulars are given of several lines in Germany. In Mülhausen (Alsace) the most up-to-date system of the trackless trolley has been equipped. The local authority desired to provide a means of transit along a suburban route, a distance of about a mile. The gradients on the route are somewhat severe, the steepest being 1 in 12. After considering motor omnibuses, and after inspecting the operation and ascertaining the results of the trackless trolley system in Monheim and Ahrweiler, they determimined to adopt that system. The overhead equipment consists of four trolley lines, two positives and two negatives. This does away with the necessity, when cars are passing, of one of them pulling off their trolleys or providing special passing places. The cars are very similar to those at Ahrweiler, with the exception that they are somewhat lighter in construction (weighing only 54 cwt.) and have only one trolley boom. This is fitted with a special double-pole connection for taking current from the trolley line. The line is not in operation at present, not yet having been passed by the State Government, but the local authority gave the members of the deputation a trial run over the system. On account of the steep gradient, the cars have been fitted with specially constructed brakes and a run-back preventer. The current is supplied to the trolley wire at 500 volts, and the price is 1d. per unit.

The result of our inspection and investigation convinced us that in the towns we visited they had succeeded in getting what they set out to obtain—namely, a means of transit at the lowest possible operating costs—costs which the small revenue from the sparsely populated districts just about cover. It was interesting to see the improvements effected between the earlier and the later constructed lines, and the following is a brief summary of the system as developed to date :—

A lightly constructed overhead equipment with bracket-arms and four trolley lines fed with electrical energy carried by overhead cables. Specially designed overhead fittings for ensuring the safe working of the positive and negative lines.

Small single-deck cars equipped with single motors, with a front axle drive. Controllers of the barrel type, with five power notches and four rheostatic brake notches. To minimise maintenance expenses, rubber tyres fitted on the front wheels only. Single trolley booms, with a double shoe attachment for taking current from the trolley lines. Trailer cars used during the busy hours.

Before inspecting the system in actual operation in Germany, the sub-committee state that they felt that if they can take advantage of obtaining electrical energy from a central power station at a reasonable cost, and if we can adopt tramway motors—which, after many years' development, have reached a high state of perfection, and are comparatively inexpensive to maintain—we should be proceeding along safe lines, and our visit has to a large extent confirmed these views. The system as seen by us in Germany will require some modification to fulfil English conditions. The type of 'bus would have to be materially altered. The front axle drive which the Germans have adapted renders the steering gear somewhat ineffective. 'Buses driven from the back axle, with all four wheels rubber-tyred, would be necessary for our requirements.

On the subject of finance the report says: It is a common practice to compare operating costs of passenger-carrying vehicles on a car-mileage basis, but nothing may be more misleading if care is not exercised. In tramway working the "car-mile" is a valuable unit for comparing receipts and expenditure results from year to year for the same tramway system, but it is a somewhat rough-and-ready unit for comparing the results of operation in different towns, where the type and carrying capacity of the cars, the average speed attained, the number of "part day" cars put into service for the "rush hours" and other local conditions as to rates of pay, &c., may be widely different. When, however, we come to other vehicles, outside tramways, the adoption of the "car-mile" as a unit for comparison is likely to be still more misleading. Trackless trolleys would be cheaper to operate than internal combustion motors, mainly under two heads—general maintenance and depreciation.

The committee report that they consulted the Board of Trade on the subject of the powers necessary for equipping and running the trackless trolley, and they advised that a suitable clause should be inserted in the bill which will be promoted by the Corporation in the next session of Parliament, and the committee, therefore, recommend that this course be adopted.

The Tramways committee have considered the report, and passed a resolution thanking the sub-committee for their report and recommending that a suitable clause empowering the committee to run trackless trolley cars be inserted in next year's Corporation bill.

The Board of Trade have informed Dundee Corporation that they see no objection to the trackless trolley system being introduced. The Tramways committee considered on Monday a proposal to make an experiment by connecting Forfar-road and Fairmuir by the system, but finally deferred consideration of the whole question.

"Unemployed" Relief Projects.—Leeds Tramways and Electricity committee propose to start the construction of the tramway from Horsforth to Guiseley (instead of leaving it until next spring, as originally intended), in order to avoid discharging a considerable number of men next month.

Mr. Glyde, a labour member of Bradford City Council, intends to move "that £10,000 be voted for the unemployed out of the profits of the electricity, tramway, gas and water departments."

Watford.—The Council are inviting tenders for extension of plant to meet the winter's load of 1909-10.

Wednesbury.—In reference to the paragraph under this heading in our last issue (p. 888), the manager and engineer of the Midland Electric Corpn. for Power Distribution (Mr. J. Hardie McLean) has written a letter of explanation, in which he points out that both the Corporation and his company possess provisional orders for the supply of electricity in Wednesbury.

An agreement was entered into in October, 1902, for the supply in bulk by the company to the Corporation. Ultimately the latter decided to generate their own current and to terminate the agreement. On Dec. 13 last the company gave notice to the Corporation that, owing to their resolution asking the Board of Trade to revoke the company's order (which the Board refused) the position of affairs was completely altered, and the directors of the company felt that they had no alternative but to give three months' notice to determine the agreement. Subsequently, however, the company agreed, at the request of the Corporation, to continue to supply until the Corporation's station was in a position to give the supply. For a fortnight or so before supply was disconnected very little energy had been taken by the Corporation, and for three days none whatever. Although it was impossible to obtain any information by inquiries made at the generating station of the Corporation, still it was evident that the Corporation generating station was in working order, and supply was accordingly disconnected. The notice referred to in our note was the ordinary notice served prior to this company opening the streets to lay mains in Wednesbury, and the work will be commenced immediately.

West Ham.—At the recent L.G. Board inquiry into the application of the Council for sanction to a loan for extensions of the electricity undertaking, the question was raised as to charge for supplied current to largest consumers.

The officials offered to give the figures to the inspector privately, but they declined to assent to the production of the particulars publicly, and consequently the inquiry was adjourned. Two of the customers now object to the terms of their contracts being made public, and the Electricity committee have adopted a suggestion by the borough electrical engineer (Mr. A. Hugh Seabrook) to engage an electrical expert to examine the contracts with a view to supporting him in his evidence at the adjourned inquiry, and also advising the committee on the sufficiency or otherwise of the charges made for the supply of current.

15 cells are to be added to the battery at the generating station, at a cost of £75. A bulk supply for lighting and power is to be given to the Lamson Paragon Works at 1¼d. per unit net. In reference to the question of meeting the deficiency on the accounts of the electricity undertaking for the year ended March 31, 1908, the committee have decided that the amount of the deficit be provided for in the rate estimates for the next half-year.

Workhouse Lighting.—North Dublin Union have received an offer from Dublin Corporation for the supply of electricity for lighting the workhouse and other Union buildings and the gas company have offered a reduction in the price of gas to retain the contract. The Guardians have deferred their decision.

York It was reported to the City Council on Tuesday that the Board of Trade had eliminated from the light railway order the clause empowering the Council to sell the order, and the Council were recommended to invite tenders for (*a*) constructing the tramways for the Corporation, and (*b*) for constructing and working the tramways.

Ald. Wragge (chairman of the Tramways committee) said the poll of citizens as to the construction and running of the system, either by the Corporation or its being leased, would soon be taken.

Ald. McKay protested against tenders for the work being invited when there was the possibility that the vote of the citizens might prevent any one of such tenders being accepted, and an amendment that the committee submit advertisements for tenders to the Council in committee before it was placed before the contractors was agreed to.

ELECTRICITY SUPPLY AND TRAMWAY ACCOUNTS

Hampstead (London).—The accounts of the electricity department for the year ended March last show capital expenditure £399,933, increase £9,003.

Revenue was £66,084 (against £65,094), working and general expenses were £34,535 (£32,586) and gross profit £31,549 (£32,586). Interest and sinking fund required £28,066 (£28,904), leaving net profit £3,483 (£3,683). £2,130 (£2,113) has been applied to relief of rates and £3,525 (£2,206) carried forward. 6,580,186 (5,964,312) units were generated, 4,010,454 (3,784,542) supplied to private consumers for lighting and 344,520 (269,267) for power and heating and 250,304 (249,956) to public lamps. The maximum supply demanded was 3,556 kw. (3,457 kw.). The equivalent 8 c.p. lamps connected have increased from 289,872 to 306,712. Works costs were 1·8d. (1·15d.) per unit, due to increased cost of coal. Total working and general expenses 1·79d. (decrease 0·01d.). Total expenses (including capital charges) were 3·25d. The average price obtained for private lighting was 3·31d. (3·402d.).

Kingston-on-Thames.—The Borough Accountants' annual report states that the capital expenditure on the electricity undertaking to March last was £100,343, increase £1,999. After paying interest and sinking fund charges (£6,095), there was a net deficit of £885 on the year's working. Receipts for current were £154 less than in the previous year.

Warrington.—The accounts of the tramways department for the year ended March last show capital expenditure £102,087 (increase £172).

Revenue was £20,133 (11·019d. per car-mile), power cost £3,504 (1·917d.), total expenses (not including capital charges) £11,787 (6·451d.), gross profit £8,346 (4·568d.) and net profit (placed to reserve) £2,580 (1·412d.). 5,026,444 passengers were carried, 438,519 car-miles run and 560,569 units used.

Mr. Telfer (the manager) states that the whole of the cars have now been fitted with meters for a whole year, and the result has been highly satisfactory, the units used per car-mile having been 1·22, compared with 1·42 in the previous year. The bonus paid to motormen amounted to £36. 6s., and the saving effected was £533. 5s. 5d.

TRADE NOTES AND NOTICES.

TENDERS INVITED.

Melbourne (Victoria) City Council invite tenders for supply of 770 electricity recording meters and 157 maximum demand indicators. Copies of specification, conditions of contract and forms of tender from the agents for the Council (Messrs. McIlwraith, McEacharn & Co. Proprietary, Ltd.), Billiter-square Buildings, London, E.C., to whom tenders by noon Oct. 13. See also an advertisement.

Tenders will be received at the office of the *Commonwealth of Australia* representative, 72, Victoria-street, Westminster, London, S.W., until noon, Oct. 19, for supply and delivery at that office of four complete sets of instruments (signalling and protecting), necessary for direct duplex cable working, for the Postmaster-General, Melbourne. Forms of tender, &c., can be obtained at the General Post Offices, Sydney, Melbourne, Adelaide, Perth, and Hobart, and at the Commonwealth office as above. Tenders (on forms supplied) to Capt. Collins, Commonwealth representative, 72, Victoria-street, Westminster, S.W. Further particulars are set out in an advertisement.

Tenders are invited for supply and delivery to the Postmaster-General's Department in *Western Australia* of telegraph and telephone material. Tender forms and specifications may be obtained at the Commonwealth offices, 72, Victoria-street, London, S.W. See also an advertisement.

Tenders are invited for the supply and erection of installations for wireless telegraphy at *Launceston, Melbourne, King Island* (Bass Straits) and *Flinders Island* (Furneaux Group). Tender forms and specifications may be obtained at the Commonwealth Office, 72, Victoria-street, London, S.W. See also an advertisement.

The directors of the *Metropolitan Railway Co.*, invite tenders for the supply of general stores, including electric wires and cables, electric lamps, carbons, fuses, ebonite, battery jars, zincs, &c., during twelve months ending Oct. 31, 1909. Manufacturers and others desirous of tendering should apply to the Secretary, Mr. R. H. Selbie, for forms of tender. Patterns and samples will be on view from Sept. 28 to Oct. 3, inclusive. Tenders to the Secretary, 32, Westbourne-terrace, London, W., 10 a.m., Oct. 5.

Mountain Ash Council want tenders by Oct. 5 for erection of an electrical sub-station, supply and erection of switchgear and transforming apparatus and overhead mains for the electric lighting of Ynysybwl. Specifications from the Surveyor or the consulting engineer (Mr. B. J. Day), 3, Park-place, Cardiff.

Tenders are invited by *Salford* Education committee for electric wiring of Halton Bank Council School, Pendleton. Specifications from the borough electrical engineer (Mr. V. A. H. M'Cowen), electricity works, Frederick-road, Pendleton. Tenders to the town clerk (Mr. L. C. Evans) by noon Oct. 5.

Watford Council want tenders by noon Oct. 6 for supply and erection of 500 kw. turbo alternator, surface condenser with steam pumps, switchboard panel, economiser and high speed fan engine. Specification, &c., from the Engineer, Electricity Works, Watford.

Great and Little Unsworth Parish Council want tenders for lighting roads by electricity. Particulars from the Clerk, New Washington, Co. Durham.

Ilford Council want tenders by noon Oct. 6 for six months' supply of Welsh coal for the electricity department. Forms of tender from Mr. A. H. Shaw.

Warrington Electricity and Tramways committee want tenders by noon Oct. 7 for supply of flame arc lamps. Specifications from Borough Electrical Engineer.

Harrogate Corporation require tenders for supply of 26 two-arm and 2 four-arm fittings for high candle-power incandescent lamps. Particulars from Borough Electrical Engineer.

Tenders are invited for supply and erection of a power plant for the General Post Office, *Adelaide* (South Australia). Tender forms and specifications at the Commonwealth Office, 72, Victoria-street, London, S.W.

The *Parahyba* (Brazil) State Government want tenders by Nov. 25 for lighting and for potable water supply and drainage works for the city of Parahyba do Norte. Deposit of five contos of reis (about £200) required from tenderers. Telegraphic information from the Secretary of State (Senhor P. da Cunha Pedroza), Parahyba, Brazil.

Army Contracts.—Notice is given by the Director of Army Contracts (Mr. H. De la Bère) that tenders for specified quantities of various articles of manufacture are invited from time to time, including chemicals, chinaware, clocks, copperware, electrical stores, indiarubber goods, ironmongery, lamps and lanterns, leather goods, scientific instruments, telegraph poles (iron), tents, timber, tinware, tools, traction plant, vehicles, welded steel tubes, woodware, &c. Manufacturers who wish to be invited to tender for Army requirements should state the particular articles which they manufacture and the names of at least two well known firms or public bodies who

have purchased from them and are in a position to certify as to the quality of their productions. No application is necessary from firms whose names are already on the War Office list. Applications to the Secretary, War Office, London, S.W. Further particulars are given in an advertisement.

TENDERS RECEIVED AND ACCEPTED.

Coventry Corporation recently placed an order with the Union Cable Co. for cables to the value of about £2,000.

On Tuesday the chairman of the Electric Light committee (Ald. West) explained that the contract was placed in Germany because it was found that, when quotations were asked for from English firms of cable makers, the committee got exactly the same prices from every one, and he believed there was an arrangement. They, therefore, decided to obtain prices from Germany, which were considerably less than those of the English makers. He was satisfied the cable supplied was the same in every case, whether made by an English or by a foreign firm. Mr. Halliwell deprecated putting contracts into the hands of German firms, but the Council confirmed the committee's minutes.

Messrs. A. Reyrolle & Co. have obtained the contract for two years' supply to Manchester Corporation of semi-enclosed and totally-enclosed motor starters of the following sizes: 15, 20 and 30 h.p. This contract is for the company's well-known "Wait on the first stop until the motor starts" type.

Crompton & Co. recently supplied motors, switchboard, instruments, &c., for use at A. & T. Burts' electrical and general engineering works, Dunedin, N. Z. Current is taken from the City mains at 3,000 volts and transformed by three Berry transformers to 400 volts.

The Electric Construction Co. are supplying transformers and motors to the Bengal-Nagpur Railway Co., for whose Khargpur workshops the Brush Co. recently supplied a number of motors.

Watford Council have accepted the tender of the Worthington Pump Co. for condensing plant at £620; that of L. R. Ensor for extension of cooling water supply, £696; and that of Babcock & Wilcox for superheaters to two boilers £260, and for new links to a stoker at £38.

Maidstone Council have accepted the tender of Cory & Sons for coal (Scotch screened washed peas), at 10s. 11d. per ton, for the electricity works.

Hammersmith Electricity and Lighting committee have accepted the tender of the Improved Wood Pavement Co. at £42 for oak block flooring for a new switchboard.

The Western Electric Co. have supplied a 100-line switchboard to Ararat (Victoria) telephone exchange.

Finchley Council have accepted the tender of Whipp & Bourne for switchgear at £336. 10s.

Knighton Guardians have accepted the tender of W. A. Cadwallader for electric bell and telephone installation, at the Workhouse.

The Postmaster-General's Department, Hobart, Tasmania, have accepted the tenders of the Western Electric Co. for material for common battery switchboard; of the International Electric Co., for Common battery wall telephones; of the North Electric Co. for double pole receivers and cords; and of the Wallaroo and Moonta Mining and Smelting Co. for about 173 tons sulphate of copper.

Regenerative Control.—Rawtenstall Council have decided to place an order with the United Electric Car Co. for 16 tramcars, fitted with Westinghouse motors and Raworth's regenerative control. This is said to be the first instance in which a line will be completely equipped with regenerative motors.

BUSINESS NOTICES.

Dr. C. C. Garrard has resigned the position of manager of the instrument and transformer department of Ferranti Limited in order to take up that of manager of the switch department of the General Electric Co. at Manchester.

Mr. Thos. C. Baddeley has left London to take up the management of Mr. Sydney A. M. Rose's factory in Melbourne for the manufacture of Rose's patent electric recording target in the Commonwealth of Australia.

Sale by Auction.—Messrs. Edward Rushton, Son & Kenyon are instructed by Mr. E. Musgrave, trustee in the failure of W. T. Garnett's Cable Co., to sell by auction (at Barkerend Mills, Bradford) in one lot as a going concern, on Thursday, Oct. 8, at 3:30 p.m., valuable electric cable-making plant and machinery, the stock-in-trade and effects, &c. The plant includes numerous armature and stranding machines, plant of a very varied character, stock-in-trade, comprising about 60 miles of cables, large quantity of flexible silk and cotton-covered wires, bell cords, 4,500 lb. compound rubber, 3,000 lb. plain copper wire, 4,000 lb. tin ditto, 2,500 lb. mercerised polished and soft cotton, 300 lb. silk, quantity of worsted, jute, raw materials, stores, &c. Printed particulars and other information may be had from the auctioneers, 13, Norfolk-street, Manchester, or from the trustee, Mr. E. Musgrave, C.A., 1, Bank-street, Bradford. See also an advertisement.

Plant for Sale.—Messrs. G. Elliott & Co., Machinery Depot Long-lane, Bermondsey, London, S.E., have for sale two 150 i.h.p. Marshall compound vertical engines, coupled to Crompton dynamos, 90 kw. at 100 volts, 200 revs. per min. See also advertisement.

Factory Site for Sale.—Messrs. Green & Son, auctioneers, have an extensive site (about 3¾ acres) close to a railway station, and suitable for the erection of engineering works, to be let on building lease. The site is outside the L.C.C. area. Further particulars from Messrs. Green & Son, 72, King-street, Hammersmith, London, W. See an advertisement.

Patents Development.—The proprietors of the following patents advertise that they are desirous of entering into arrangements, by way of licence or otherwise, for exploiting same and ensuring their full development and practical working in this country.

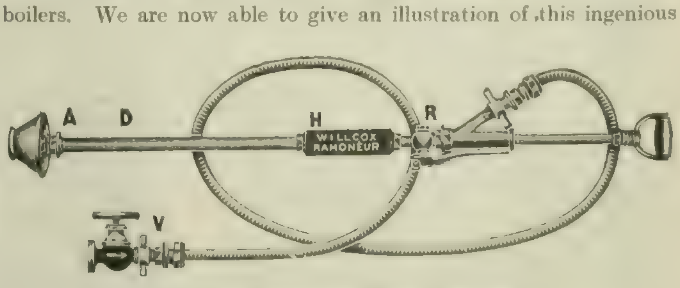
Patent No. 20,898/1905 for "Improvements relating to Electrolytic Apparatus"; and Patent No. 21,661/1905 for "Improvements relating to Sound Boxes for Phonographs, Telephones and the like." Applications to Messrs. Haseltine, Lake & Co., 7 and 8, Southampton-buildings, Chancery-lane, London, W.C.

"Excello's" Excelsior.—The Union Electric Co. have received the following gratifying expression of thanks from the organisers of the exhibition recently held at Camborne:—

Royal Cornwall Polytechnic Society, Camborne, Sept. 19, 1908.
The Union Electric Co. (Ltd.), Park-street, London, S.E.
Dear Sirs,—The president and council of the Royal Cornwall Polytechnic Society have desired me to express their appreciation of the illumination of the exhibition held at Camborne, Sept. 8 to 19, 1908, and to thank you officially for the loan of the apparatus and lamps used for the above purpose, which in a great measure contributed towards the success of this exhibition.—E. W. Newton, Secretary.

CATALOGUES, &c.

Tube Cleaner.—In a previous issue we commented on the merits of the Willcox-Ramoneur hot-air cleaner for water and fire tube boilers. We are now able to give an illustration of this ingenious



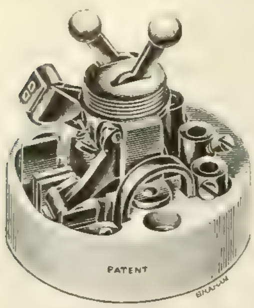
Willcox-Ramoneur Tube Cleaner.

apparatus and may recall the fact that in addition to its merit as an efficient mechanism it operates at a very much lower cost than cleaners of the turbine class. This claim is set out in some excellent literature on the device, which Messrs. Willcox & Co., Southwark-street, London, S.E., will send to interested engineers on request. The accompanying illustration is practically self-explanatory, where A is a cone-shaped head, D a steam tube, V is a steam valve, H a movable hand hold, R a lever valve.

Resistances.—The Union Electric Co. are issuing list No. 1,403, which contains particulars of "Union" resistance apparatus for arc

lamp circuits. A great number of resistance designs are listed and all the requisite technical data, as well as illustrations typical of everything described, prices and over-all dimensions are given.

The "Twinob" Switch.—Until Mr. Lundberg can startle the electrical industry with something novel in the accessory line he "lies low." His "Twinob" switch is certainly a real "startler," and a welcome one at that. Our readers will be familiar with the two-switch combination on a rectangular block which is usually an eyesore in rooms where perforce it has to be used. The adjoining illustration will explain how the "Twinob" switch does away with all the time and trouble usually required to put up two or more switches at one point. Virtually the switch is "two in one," and the partnership is effected without enlarging the size of the base. So much can be done with the switch that we could fill a column telling its story. Our readers who are interested (and we know they will be many) should take the opportunity of writing Messrs. A. P. Lundberg & Sons, Liverpool-road, London, N., for their latest list on this little marvel of a switch. It will be shown at Manchester.



Lundberg's "Twinob" Switch.

"*Watkin*" *Switches.*—Messrs. Pearson & Co., 51, Mossley-street, Manchester, send us a leaflet illustrating the "Watkin" switch and electric current controller. The switch is a new patent apparatus for reducing and saving current; it can (it is claimed) be used on either direct or alternating current circuits, and is said to be "the only means of regulating electric current to save 80 per cent. when turned down." It is suitable for use with metallic or carbon filament lamps, fans, electric heaters, electric cooking stoves, motors, &c. The switch will connect up with the existing switch or take its place.

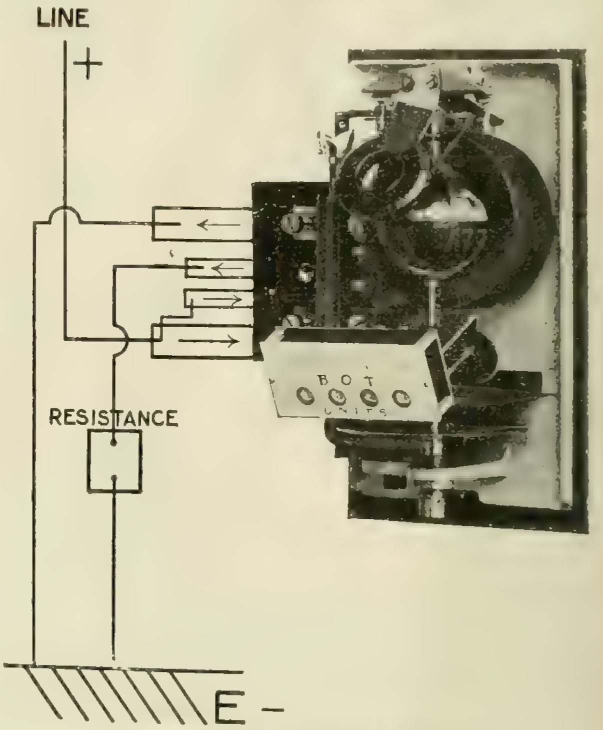
Prescot Specialities.—We have received from the British Insulated & Helsby Cables (Ltd.) a batch of eight leaflets dealing with their specialities. Leaflets P 64, P 66, P 69, P 70, and P 74 deal with house service boxes; P 65 is devoted to four-way boxes; P 68 gives particulars and prices of aluminium, copper, lead, tin and special Prescot alloy fuse wires; and P 71 contains illustrated particulars of the Prescot feeder and distributor pillar (Downe & Black's patent). This pillar occupies a pavement space of 2 ft. 6 in. by 1 ft. 10 in. only, and is designed for dealing with the distribution of 500 kw. by the three-wire system. All these leaflets are holed for filing.

Electrical Accessories.—We have received from the Armorduct Mfg. Co. their new (1908) illustrated catalogue of electrical accessories, wherein is listed a large variety of lampholders, cutouts, switches, switch-covers, wall blocks, instruments, arc lamp carbons, dynamo and motor brushes, lamps, fixtures, fittings, shades, bells, pushes, telephone instruments, insulators, wiremen's tools, &c. This section of the company's catalogue is neatly got up and is holed for hanging or filing.

Coal Cutters.—Messrs. Mavor & Coulson's card calendar for September contains data relating to two "Pick-Quick" electric coal cutters during three months' working.

Holmes Motors and Electric Light Fittings.—We have received from Messrs. J. H. Holmes & Co. two sections of their catalogue, one containing particulars and prices of the "Holmes-Clayton" alternating current motors, the other being devoted to the firm's "Universal" electric light fittings.

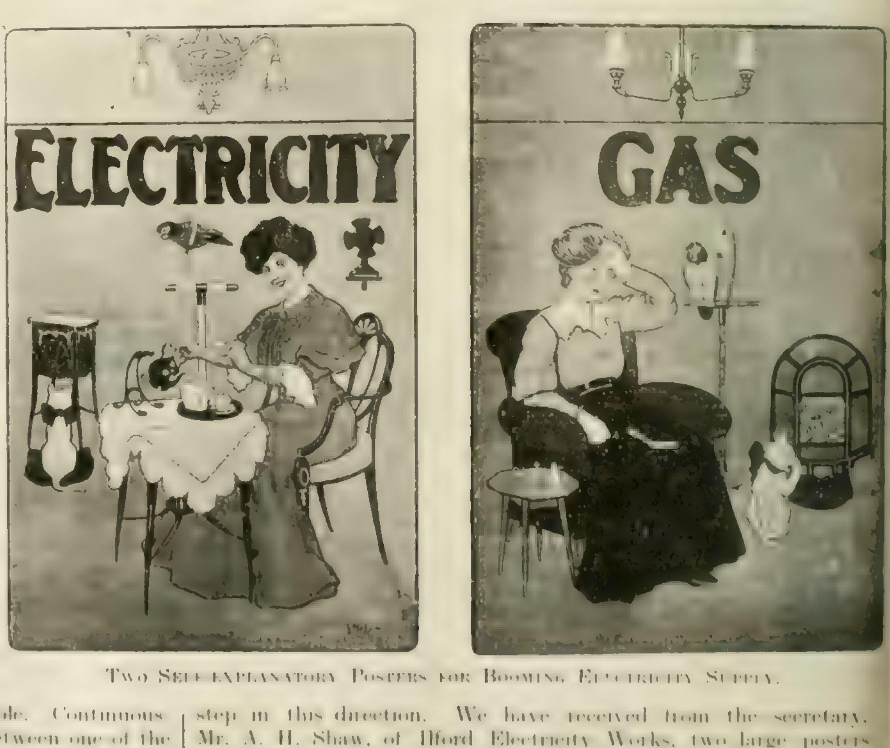
Meters.—A neatly printed and well-illustrated pamphlet comes from Siemens Brothers Dynamo Works, giving particulars of the various types of meter manufactured by the company, accompanied by instructions for their use, and diagrams of connections. All the integrating meters described in the pamphlet are motor meters, and so constructed that the consumption of energy is relatively small. All the meters are provided with jumping figures which facilitate the readings, errors of reading being impossible. Continuous current meters are standardised for the voltage between one of the outers and the middle wire in order to keep down as much as possible the watts absorbed in the shunt circuit, but they can, if required, be supplied to go across the outers. The alternating current meters can be calibrated for any frequency between 25 and 100. Several diagrams and figures of connections of meters for polyphase current and also traction meters are included. The illustration shows a



Siemens G.K.B. Traction Meter.

Siemens G.K.B. traction meter with diagram of connections for ordinary traction circuit with negative earthed.

Electricity Supply Posters.—Electricity supply engineers have been a long time in following the example of the gas companies in spreading posters on the hoardings up and down their districts of supply. Advertising of this character is costly, and it is difficult to decide whether it has any definite result. In the case of electricity, however, we think it should do a large amount of good, and the Associated Municipal Engineers of London are therefore to be congratulated on taking what is practically the first organised step in this direction. We have received from the secretary, Mr. A. H. Shaw, of Ilford Electricity Works, two large posters (excellent reproductions of which are given herewith) which compare the respective effects of electricity and gas upon the average docile domesticated female. The gas picture portrays in a



Two Self-explanatory Posters for Booming Electricity Supply.

IMPORTANT NOTICE.

Extra Copies of "The Electrician" Special Mining Issue (July 10th, 1908), are obtainable, price 1/- nett (post free U K., 1/4; abroad 1/6).

striking manner the demoralising influence of the deadly agent either as an illuminant or as a domestic heater. The influence of the fumes of gas is shown as not confined to the lady herself, who forms the central figure of the picture, but to have spread to her pets in the shape of a cat and a parrot. In contradistinction the electricity picture is all life and energy, and the lady engaged in tha congenial occupation of preparing the cup that cheers by means of an electric kettle. Both the cat and the parrot are all smiles and "everything in the garden is lovely." We are left to assume a smile on the face of the cat, as that animal has turned its face to the genial glow of the radiator. Of the parrot's glee there is no reasonable doubt, but why, we ask, is the small fan out of action? We think the posters will not only influence the sales of electricity in a district, but will create something of a sensation in "gaseous" circles.

BANKRUPTCIES, LIQUIDATIONS, &c.

First meetings of creditors and contributories of Electrical Instrument Manufacturers (Ltd.) will be held on Oct. 2 at 14, Bedford-row, London, W.C.

Deed of Arrangement.—A deed of arrangement has been executed by the executors of the late Jas. Plucknett (trading as James Plucknett & Co.), electricians, &c., 1, St. Nicholas Church-street, Warwick. Unsecured liabilities £1,953, assets £2,273, secured creditors £2,517. Mr. A. E. Sherry, 131, Edmund-street, Birmingham, is trustee.

PATENT RECORD.

APPLICATIONS FOR PATENTS.

NOTE.—*The under-mentioned Applications (except those marked †) are no open to public inspection until after acceptance of Complete Specifications Those marked † are open for inspection 12 months after the date attached to them, if they have not been published previously in the ordinary course. Names within parentheses are those of communicators of inventions. When Complete Specification accompanies application, an asterisk is affixed.*

May 28, 1908.

11,608 LIRONI. Trolley wheels.
11,610 NEW IGNITION SYND., ROUSE, & SANDY. Batteries.
11,633 ALLGEMEINE ELEKTRICITATS-GES. Alternating current dynamo-electric machines of the commutator type. (Date applied for, 29/5/07.)*†
11,634 B.T.-H. Co., & WEDMORE. Electric distributing systems.

May 30, 1908.

11,758 DARRAH & HACKETT. Electric lighting of roundabouts and the like.
11,806 LINDQUIST. Alternating current electromagnet.*

June 1, 1908.

11,833 JENNISON. Enclosed indicating fuses.
11,838 REYNOLDS. Rail joint for railways and tramways.
11,857 BRUNTON. Electrical signalling apparatus.
11,870 HARTMANN-KEMPF. Apparatus of the resonance type for indicating or measuring the frequency of electrical alternations. (Date applied for, 31/5/07.)*†
11,871 PARSONS & LAW. Commutators for dynamo machines.
11,895 WALTON. Compositions for insulating and other purposes.

June 2, 1908.

11,927 FINNEY. Brakes for tramway cars and other vehicles.
11,932 POUNSFORD & LOVE. Automatic switch for producing changes of design in electrical illumination.
11,933 STORM & SIMPSON. Automatically electric signalling apparatus.
11,944 SOMERS & CROWLEY. Electrolytes for storage batteries. (Date applied for, 9/5/08. Comprised in 10,078 9/5/08.)
11,945 MITCHELL. Surface contact electric traction systems. (Date applied for, 31/1/08. Comprised in 17,532, 31/7/07.)*
11,979 B.T.-H. Co., & WEDMORE. Electrical distributing systems.
11,986 WOOD. Circuit controllers for railway signals.
11,988 SCHMIDT. Receptacles with deposits of radium-stone or radium preparations.

June 3, 1908.

12,009 HOOKHAM. Electricity meters.
12,044 KAPP. Transformers
12,050 SIEMENS BROS. DYNAMO WORKS (Siemens-Schuckertwerke G.m.b.H., Germany). Fuses fitted with indicating arrangements.*
12,080 WRIGHT. Controlling electromotive force of dynamo-electric machinery.*
12,092 MATTICOLI. Improvements in rotary motors. (Date applied for, 3/6/07.)*
12,097 RORKE & RORKE. Make-and-break devices. (Date applied for, 4/6/07. Comprised in 12,967, 4/6/07.)
12,099 SEFTON-JONES. (Douglas, India.) Control of induction motors.
12,104 B.T.-H. Co. (G.E. Co., U.S.). Electrically-operated switches.

June 4, 1908.

12,105 SCHATTNER & AMBERTON. Electric controllers.
12,135 WERNER. Telephones.
12,140 SHARMAN. Wireless telephony and telegraphy.
12,142 BOULT. (Electrical Mfg. Co., U.S.) Automatic cut-outs.*
12,152 HALL. Magneto-electric ignition apparatus.
12,161 JONES. Electro-deposition of metals upon aluminium.
12,170 HEADLEY, WALTON, & LAWLEY-PINCHING. Switches.*
12,175 RORKE & RORKE. Switch for controlling electrical circuits. (Date applied for 3/1/08. Comprised in 12,967, 4/6/07.)*
12,183 B.T.-H. Co. (G.E. Co., U.S.). Alloys useful as electric resistance conductors.

June 5, 1908.

12,191 ABBOTT. Electric cooking and heating apparatus.
12,194 MURRAY. Supporting incandescent lamp filaments.
12,196 DUGDILL. Pliers for rotating electric shade carriers.
12,211 HOPE. Iron-clad switches and switch fuses.
12,225 CONRADI. Luminous electric lighting and bell switches.
12,229 BEIN. Automatic cut-out apparatus for arc lamps.
12,234 LÖNDERBY & BAND. Disinfecting apparatus for telephones.
12,249 PICKARD. Electric motor giving reciprocating motion.
12,250 ISARIA-ZAHLER-WERKE G.M.B.H. Electricity meters. (Date applied for, 11/5/07.)*†
12,267 B.T.-H. Co. (G.E. Co., U.S.) Asymmetric conductors.
12,268 B.T.-H. Co. (G.E. Co., U.S.) Shaft bearings.

June 6, 1908.

12,280 STATTER. Electric safety appliances.
12,296 EVERSHED & VIGNOLES, & VIGNOLES. Shunts for ammeters.*
12,297 VINCENT & HARRISON. Reversible motor.
12,302 WILKINS & MUIRHEAD & Co. Magneto-electric ignition apparatus.*
12,325 WOODBRIDGE. Electrical distribution. (Date applied for 2/10/07.)*†
12,326 STERN. Regulating apparatus for induction motors. (Date applied for, 12/6/07.)*†
12,336 ROOST. Indicating meter for controlling duration of telephone conversations.*
12,340 PHŒNIX DYNAMO MFG., Co. & POHL. Compounding or over-compounding alternators.
12,352 NOBBS, NOBBS, jun., & ROSENTHAL. Electric radiator.*

SPECIFICATIONS PUBLISHED.

1907 SPECIFICATIONS.

16,092 ALLGEMEINE ELEKTRICITATS GES. Alternating current machines of the commutator type. (Date applied for, 13/7/06.)
17,796 FRICKER. Electric sign or display apparatus for advertising.
18,013A KESSLER & JELICH. Contact arrangement and stand for incandescent lamps. (Date applied for, 8/8/07.)
18,245 RANSFORD (Compagnie Parisienne des Voitures Electriques procédés Krieger). Electric vehicles.
18,308 ELLISON & JACOBS. Telephonic and like calling apparatus.
18,842 PICKARD. Means for receiving intelligence by electric waves. (Date applied for, 30/8/06.)
19,447 MOORE. Electric automatic time switch mechanism.
19,702 AKTIESELSKABET DRAMMENS ARMATURFABRIK. Valves. (Date applied for, 10/9/06.)
19,734 GROSS. Electric arc lamps.
19,891 BOURDIL. Automatic safety device for overhead lines. (Date applied for, 7/9/06.)
19,907 HAY, COUPER, & LINDSAY. Portable electric vulcanizing apparatus.
20,119 MARCONI & MARCONI'S WIRELESS TELEGRAPH CO. Transmitters for wireless telegraphy.
20,229 ALLGEMEINE ELEKTRICITATS-GES. Electric motor starters and regulating rheostats. (Date applied for, 12/9/06.)
21,535 MAICHE. Transformers. (Date applied for, 6/12/06.)
21,860 SIEMENS BROS. DYNAMO WORKS. (Siemens Schuckertwerke Ges.) Insulating transformers and other electric apparatus.
23,329 FELTEN & GUILLEAUME-LAHMEYERWERKE (A.-G.) Causing an electric current of variable direction to flow always in one direction only. (Date applied for, 22/10/06.)
23,585 FAIRWEATHER. (Gluhlampenwerk Anker Ges.) Metallic filaments. (Rights not granted.)
23,778 DAY. (Fabrik Elektrischer Zünder Ges.) Resistances.
24,017 ARCIONI. Measurement of electrical power.
24,753 SIEMENS BROS. & CO. (Siemens & Halske A.-G.). Means for rectifying alternate currents.
25,123 ARCIONI. Electricity meters.
25,206 HARRISON (Electric Railway Improvement Co.). Homogeneously uniting metal bodies by heat.
25,350 ARENAS Y GARCIA. Dynamo-electric machines of the homopolar type. (Date applied for, 2/8/07.)
25,444 BARRETO. Electrical ignition devices.
25,830 LOEBL & BRITISH EVER READY ELECTRICAL CO. Switches.
26,621 CUMONT & COMPAGNIE DE SIGNAUX ELECTRIQUES POUR CHEMINS DE FER. Signal and point mechanism. (Date applied for, 7/12/06.)
27,073 SIEMENS-SCHUCKERTWERKE-GES. Electrical driving of machinery subject to variable loads. (Date applied for, 8/12/06.)

27,379 Amalgamated Radio Telegraph Co. (Seibt). Radio-telephony.
28,204 Lance. Spark plugs.
28,516 Johnsson (Felten & Guilleaume Lahmeyerwerke A.-G.). Electrical driving gear especially for motor road vehicles.

1908 Specifications.

66 Little. Arc lamp electrodes. (Date applied for, 5/1/07.)
290 Siemens Bros. & Co. (Siemens & Halske A.-G.) Multiple switches, particularly for automatic telephone exchange selectors.
608 Garforth & Bousfield. Switch boxes or cases.
878 Siemens Bros. Dynamo Works (Elektrizitäts-A.-G. vorm. Schuckert & Co.). Arrangement on electricity meters for determining maximum consumption.
1,073 Bonnevie. Compensating elastic suspension devices for vehicles. (Date applied for, 19/1/07.)
1,613 Schmid. Apparatus for noting down telephone conversations.
1,615 Belin. Electrical apparatus for reproducing at a distance pictures or designs produced in slight relief. (Date applied for, 24/1/07.)
1,914 Thompson. Train controlling mechanism for automatically applying the brakes. (Date applied for, 18/5/07.)

COMPANIES' MEETINGS AND REPORTS.

DICK, KERR & CO. (LTD.)—The profits earned during the 12 months' trading to June 30 last amount to £59,558. 4s. 5d. Out of this has been paid debenture interest and trustees' fees, and there has been reserved the sum required to provide for premium payable on redemption of debenture stock. These items absorb £12,831. 11s. 3d., leaving £46,726. 13s. 2d., added to £79,140. 4s. from last year, making £125,066. 17s. 2d. available for appropriation as under: To pay the 6 per cent. preference dividend (£18,300) and a dividend of 10 per cent. on the ordinary shares, less tax (£26,000), carrying forward £81,566. 17s. 2d. In view of the continued severe competition in all departments, the directors consider the result of the year's trading not altogether unsatisfactory.

UNITED ELECTRIC CAR CO. (LTD.)—At the meeting last week Mr. R. H. Prestwich, in moving the adoption of the directors' report, said the result of the year's working was disappointing in view of the profit which was made during the previous year. The directors were unable to recommend a dividend on the ordinary shares. There had for some time been a stagnation in electric traction, which was affecting all car builders, as well as electric equipment manufacturers. He hoped the position of affairs was only temporary, but he regretted to say that instead of improving they had got worse, with the result that the company's output last year was less than half of what it was for the preceding year. In view of the greatly decreased output without a corresponding decrease in expenses—which was quite impossible—the directors considered it satisfactory that an actual profit had been earned. Every possible effort had been made to reduce expenses without adversely affecting their interests. With regard to the coming year, he regretted he could see no signs of an immediate improvement, as trade generally was in a very depressed state. The directors were endeavouring to dispose of the new works at Manchester and Hadley which they purchased some years ago, and which had not proved remunerative. With regard to the Preston works, the directors, looking into the future, had good hopes.

WESTERN UNION TELEGRAPH CO.—This company have issued their report for the quarter ending Sept 30, 1908. The following statement, dated Sept. 9, shows the condition of the company at the close of the quarter ended June 30, 1908: There was a surplus on April 1, 1908, as per last quarterly report, of $13,744,804.49, and the net revenues for the quarter ended June 30, 1908, were $1,579,660.95, making $15,324,465.44. After deducting for dividend of ¾ per cent., paid on July 15, $497,546.50, and interest on bonded debt, $133,062.50, there was a surplus on June 30 of $14,693,856.44. The net revenues of the quarter ending Sept. 30, based upon nearly completed returns for July, partial returns for August, and estimating the business for September, will be about $1,100,000, and, after adding that amount and appropriating for interest on bonded debt $133,062.50, and $497,789.50 for a dividend of ¾ per cent., which the committee propose to declare on capital stock, a surplus of $15,163,004.44 will remain.

NEW COMPANIES, MORTGAGES AND CHARGES, &c.

NEW COMPANIES.

RADIO & ELECTRIC POWER CO. (LTD.) (99,543.)—Reg. Sept. 16, capital £10,000 in £1 shares, to carry on the business of electricians, workers of radio-telegraphy, engineers, suppliers of electricity, manufacturers of and dealers in apparatus for automatic telegraphy and telephony, &c. Private company. Reg. office, 103, Fenchurch street, London E.C.

RAILWAY & TRAMWAY DEVELOPMENT CO. (LTD.) (99,544.)—Reg. Sept. 16, capital £50,000 in £1 shares to acquire any concessions, [illegible] rights, &c., for the construction, leasing or working with railways, tramways, light railways or other public works, to construct, establish, maintain and work [illegible] electric lines, electric power and supply works, &c. Reg. office, 5, London Wall buildings, London, E.C.

MORTGAGES AND CHARGES.

BUDE ELECTRIC SUPPLY CO. (LTD.)—Particulars of £2,500 debentures created by resolution of April 14, 1908, have been filed pursuant to sec. 10 (3) of the Companies' Act, 1907, amount of present issue being £700. Property charged, company's undertaking and property, present and future, including uncalled capital. No trustees.

W. T. GLOVER & CO. (LTD.)—Statement of total amount outstanding on July 1 in respect of mortgages and charges created prior to that date and not required to be registered under sec. 14 of Companies' Act 1900 has been filed. Particulars, debentures dated 1899, securing £60,000.

S. JEVONS (LTD.)—A statement of the total amount outstanding on July 1 in respect of mortgages and charges created prior to that date and not required to be registered under sec. 14 of the Companies Act, 1900, has been filed pursuant to sec. 12 of the Companies Act, 1907. Particulars, Mortgage, dated 1903, securing £1,000.

MOUNTAIN & GIBSON (LTD.)—Issue on Aug. 25 of £200 and on Sept. 11 of £5,000 debentures, part of series of which particulars have already been filed.

NAIROBI ELECTRIC POWER & LIGHTING CO. (LTD.)—Issue on Sept. 9 of £600, part of series of which particulars have already been filed.

VERITYS LIMITED.—Statement of total amount outstanding on July 1 in respect of mortgages and charges created prior to that date and not required to be registered under sec. 14 of Companies Act 1900 has been filed. Particulars, mortgages dated 1896 to 1901, securing £11,200.

RECEIVERS AND MANAGERS.

MONORAIL PORTABLE RAILWAY CO. (LTD.)—Notice of appointment of C. C. H. Millar, 7, Martin's-lane, Cannon-street, E.C., as receiver and manager, on Sept. 9, 1908 (under powers contained in certain debentures) has been filed pursuant to sec. 11 (2) of Companies Act, 1907.

CITY NOTES.

MEMORANDA (Sept. 24).—Bank rate 2½ per cent. (since May 28, 1908) Price of silver, 24d. per oz. Consols $85\frac{7}{8}$—$85\frac{15}{16}$ for money and $85\frac{3}{8}$—$85\frac{3}{4}$ for account. Consols Pay Day, Oct. 1; Stock and Shares Continuation Days, Sept. 28 and Oct. 13; Ticket Days, Sept. 29 and Oct. 14; Pay Days, Sept. 30 and Oct. 15.

Prices of Metals (London).—*Copper*, cash, $59\frac{7}{8}$; three months, $60\frac{1}{16}$. *Lead*, English, $13\frac{3}{4}$—$13\frac{1}{2}$; foreign, $13\frac{1}{8}$—$13\frac{1}{4}$. *Spelter*, foreign cash, $19\frac{1}{2}$—$19\frac{5}{8}$. *Tin*, English, 130—132; Fine Foreign cash, $130\frac{5}{8}$, three months, 132. *Iron*, Cleveland, cash, 51/3, three months, 51/2—51/4.

AMALGAMATED RADIO-TELEGRAPH CO. (LTD.)—A private meeting of this company was held on Saturday last.

AMERICAN TELEPHONE & TELEGRAPH CO.—The net earnings (after payment of interest) for the eight months ended Aug. 31 amounted to $13,196,000, an increase of $2,434,000 compared with the corresponding period of 1907.

DIRECT SPANISH TELEGRAPH CO. (LTD.)—The Board have decided to pay, in addition to the dividend at the rate of 10 per cent. per annum on the preference shares, an interim dividend at the rate of 4 per cent. (tax free) on the ordinary shares, both for the half-year ended June 30, payable Oct. 1.

DIRECT WEST INDIA CABLE CO.—At the meeting last week the report and accounts, abstracted in our issue for Sept. 11, were adopted.

FOLKESTONE ELECTRICITY SUPPLY CO. (LTD.)—The directors announce an interim dividend of 4 per cent. (2s. per share), less tax, on the ordinary shares for the half-year ended June 30.

HALIFAX & BERMUDAS CABLE CO.—The report and accounts, abstracted in our issue for Sept. 11, were adopted at the meeting last week.

HOBART ELECTRIC TRAMWAY CO. (LTD.)—A dividend of 5 per cent. for 1907 has been declared, £768 being carried forward.

KALGOORLIE ELECTRIC POWER & LIGHTING CORPN. (LTD.)—The directors have declared a dividend on the preference shares at the rate of 6 per cent. per annum for the six months to Sept. 30.

SIR W. G. ARMSTRONG, WHITWORTH & CO. (LTD.)—The directors announce an interim dividend at the rate of 10 per cent. on the ordinary shares, tax free.

STOCK EXCHANGE NOTICES.—The Stock Exchange committee have been asked to appoint a special settling day in and grant a quotation to scrip (fully and partly paid) for £500,000 4½ per cent. debenture stock of the *Toronto Power Co. (Ltd.)* and to grant quotations to £1,000,000 5 per cent. prior lien bonds, £2,800,000 4 per cent. bonds of 1933, and £4,900,000 6 per cent. income bonds of the *Underground Electric Railways Co. of London (Ltd.)*.

VIENNA.—It is announced that the Union Bank of Vienna has acquired the undertaking of the Internationale Elektricitäts-Gesellschaft. The bank takes over all assets and liabilities, and will exchange one share of the company for 1/5th of its own shares, with participation in the dividends beginning from Jan. 1, 1909. The International Co. recently sold its electric lighting plant to the City of Vienna for K 20,000,000, and the Union Bank now proposes to organise a special electrotechnical department under the management of the former directors of the International Co.

ELECTRIC TRAMWAY AND RAILWAY TRAFFIC RECEIPTS.

Line	Week ended.	Amount.	Inc. or Dec. (a)	Aggregate No. of weeks.	Aggregate Amount.	Aggregate Inc. or Dec. (a)
		£	£		£	£
Aberdeen Corporation	Sept 16	1,436	– 151	16	24,741	– 273
Airdrie	,, 11	216	– 23	36	8,051	+ 35
Anglo-Argentine	,, 16	24,921	+ 7,924	37	741,437	+ 132,102
Ayr Corporation	,, 19	562	– 208	18	7,601	– 232
Baker St. & Waterloo Ry.	,, 19	3,215	+ 1,010	12	34,020	+ 7,485
Barnsley	,, 11	174	...	36	6,451	+ 368
Barrow	,, 11	247	– 75	36	9,084	– 411
Bath Electric Trams, Ltd.	,, 16	818	– 206	37	27,659	– 2,117
Birkenhead Corporation	,, 20	1,088	+ 4	...	...	...
Birmingham Corporation	,, 19	6,129	+ 113	25	157,085	+ 5,592
Birmingham & Mid.	,, 4	865	– 21	35	29,409	+ 790
Blackburn Corporation	,, 16	1,150	– 31	25	29,325	+ 596
Blackpool Corporation	,, 17	1,895	– 70	24	37,378	– 983
Blackpool and Fleetwood	,, 19	1,022	+ 175	...	...	...
Bolton Corporation	,, 20	2,394	+ 91	25	59,479	+ 1,014
Bombay	Aug 27	R34,410	+ R3,748	34	R1,204,701	+ R230,317
Bournemouth Corporation.	Sept 16	1,962	– 188	24	44,212	– 2,988
Bradford Corporation	,, 19	4,551	– 319	24	119,280	+ 279
Brighton Corporation	,, 20	1,040	– 45	22	25,405	+ 435
Bristol Trams & Carriage	,, 18	5,149	– 401	43	189,024	– 769
Burnley Corporation	,, 19	1,208	– 6	25	31,011	+ 605
Burton Corporation	,, 20	268	– 11	25	6,949	– 551
Bury Corporation	,, 20	1,273	+ 16	‡25	30,273	+ 1,696
Calcutta Tramways Co.	,, 19	R49,750	+ R1,316	12	R562,894	– R6,356
Camborne-Redruth	,, 19	144	+ 1	38	4,839	+ 184
Cardiff Corporation	...	...	...			...
Cavehill	,, 11	81	– 40	36	3,374	+ 193
Central London Railway	,, 19	8,309	+ 3,570	12	86,343	+ 28,764
Charing C., Euston & H'stead	,, 19	3,485	+ 1,000	12	38,830	+ 8,825
Chatham & Dist. Lt. Rys.	,, 17	874	+ 43	37	28,787	+ 1,171
City & South London Rly.	,, 20	2,986	+ 216	12	35,407	– 911
City of Birmingham	,, 11	2,719	– 176	36	100,307	– 699
Cork Electric Trams Co.	,, 17	466	– 79	37	17,186	– 641
Croydon Corporation	,, 18	1,396	– 156	25	36,234	– 622
Devonport & Dist. Trams	,, 11	499	– 17	36	16,791	+ 20
Dover Corporation	,, 19	252	– 7	25	6,135	– 213
Dublin & Lucan Railway	,, 18	158	+ 2	11	1,814	– 78
Dublin United	,, 18	5,254	– 1,971	11	67,023	– 20,399
Dudley-Stourbridge	,, 11	844	– 226	36	30,537	– 1,478
Dundee Corporation	,, 16	1,212	+ 17	†18	21,978	+ 1,312
East Ham Council	,, 19	853	– 91	25	21,864	– 1,302
Exeter Corporation	...	...	...	...	...	...
Falkirk and District	...	...	...	...	...	...
Gateshead & Dist. Trams	,, 11	1,006	– 20	36	36,514	+ 121
Glasgow Corporation	,, 19	17,948	– 867	16	272,859	– 3,387
Glossop	,, 19	128	– 16	38	5,748	– 315
Gravesend—Northfleet	,, 11	234	– 65	36	7,777	– 1,220
Great Northern & City Rly.	,, 19	1,295	– 285	12	15,424	– 3,557
Gt. Northern, Piccadilly, &c	,, 19	5,210	+ 1,340	12	58,485	+ 12,160
Greenock & Port Glasgow	,, 11	501	– 213	36	19,430	– 4,776
Hartlepool Tramways	,, 11	248	– 106	36	8,846	– 1,821
Hastings Elec. Trams Co.	,, 17	1,347	– 147	12	16,936	– 1,596
Hong Kong	,, 19	$7,828	– $159	38	$299,614	– $13,826
Huddersfield Corpn.	...	...	...	...	...	...
Hull Corporation	,, 19	2,485	+ 135	25	60,301	+ 169
Ilkeston District Council	,, 16	118	– 16	24	3,553	+ 18
Ipswich Corporation	,, 19	467	...	25	10,641	– 317
Isle of Thanet Co.	,, 19	984	– 26	36	30,274	– 655
Jarrow	,, 11	114	– 54	36	3,930	– 547
Keighley Corporation	,, 17	152	– 12	11	1,907	– 69
Kidderminster & District	,, 11	113	– 32	36	4,231	– 258
Kilmarnock Corporation	,, 19	159	+ 2	18	2,872	– 184
Lanarkshire Trams Co.	,, 17	1,290	– 44	37	47,964	+ 3,301
Lancashire United	,, 16	1,379	– 53	37	50,034	+ 2,109
Leamington	,, 11	184	– 14	36	6,197	+ 360
Leeds Corporation	...	...	...	...	...	...
Leicester Corporation	,, 19	2,194	– 17	12	27,388	– 22
Leith Corporation	,, 19	508	– 7	18	10,219	– 31
Lincoln Corporation	,, 19	118	+ 3	25	2,897	– 79
Liverpool Corporation	,, 12	10,781	– 182	37	394,405	– 8,177
Liverpool Overhead Rly.	,, 20	1,320	– 151	12	17,408	– 2,505
*London County Council	,, 12	36,503	+ 3,780	†26	830,210	+ 88,910
London United	,, 19	7,532	– 182	37	253,971	+ 1,933
Lowestoft	,, 19	285	– 26	51	10,672	+ 100
Maidstone Corporation	,, 19	237	...	25	5,096	...
Manchester Corporation	,, 19	15,010	– 417	25	379,918	+ 10,174
Mersey Railway	,, 19	1,843	+ 57	12	22,103	+ 487
Merthyr	,, 11	224	– 1	36	7,674	+ 66
Metropolitan Dist. Railway	,, 19	9,670	+ 2,237	12	105,976	+ 18,107
Metropolitan Elec. Trams	,, 11	6,825	+ 1,077	26	207,265	+ 38,806
Middleton	,, 11	319	– 93	36	13,347	+ 324
Nelson Corporation	,, 19	146	+ 5	§25	3,575	– 261
Newcastle-on-Tyne Corp.	,, 19	3,896	– 88	25	96,995	– 6,191
Newport (Mon.)	,, 19	656	– 55	25	17,036	– 1,074
Northampton Corporation	,, 18	459	+ 4	§24	11,937	+ 669
Oldham, Ashton & Hyde	,, 11	619	– 16	36	21,721	– 278
Oldham Corporation	,, 20	1,879	– 97	25	51,559	+ 385
Perth (N.B.) Corporation	,, 16	154	– 27	18	2,954	– 172
Perth (W.A.) Elec. Trams	,, 18	1,254	– 25	38	51,899	– 1,169
Peterborough	,, 11	131	– 13	36	4,663	+ 15
Portsmouth Corporation	,, 19	2,121	– 158	25	51,755	– 61
Potteries	,, 11	1,818	– 83	36	65,523	– 1,150
Preston Corporation		...	...	...	...	..
Rotherham Corporation	,, 17	611	– 7	[illegible]	15,116	+ 49
Rothesay	,, 17	196	– 226	36	8,729	– 268
Salford Corporation	,, 21	1,593	– 289	25	119,132	– 288
Sheerness	,, 9	65	– 6	36	2,120	– 61
Sheffield Corporation	,, 20	5,182	– 210	†26	143,897	– 1,211
Singapore Trams	,, 19	$8,983	– $3	...	...	...
South Metropolitan	,, 11	921	– 79	36	29,157	+ 230
South Staffs	,, 11	955	– 60	36	31,973	– 653
Southend Corporation	,, 16	597	+ 26	25	12,709	+ 877
Southport Tramways	,, 11	317	– 113	36	10,595	– 762
Sta'yb'dge, Hyde, &c., Jt. Bd.	,, 19	725	– 97	†25	19,968	– 693
Sunderland Corporation	,, 20	1,192	– 221	25	30,446	– 6,271
Sunderland District	,, 16	482	+ 2	46	22,127	+ 1,578
Swansea Trams	,, 11	956	– 39	36	31,402	+ 1,001
Swindon Corporation	,, 16	145	– 42	...	...	..
Taunton	,, 11	44	– 5	26	1,314	– 92
Tynemouth and District	,, 11	216	– 89	36	8,740	– 652
Tyneside Trams Co.	,, 16	395	– 109	11	4,831	– 590
Wallasey District Council	,, 19	881	...	§24	23,323	+ 966
Walsall Corpn.	...	...	...	...	...	..
Warrington Corpn.	.	...	...	...	...	..
West Ham Corporation	,, 10	2,192	– 219	24	53,896	– 3,266
Weston-super-Mare	,, 9	225	– 113	36	5,799	– 103
Wolverhampton Co.	,, 11	431	– 77	36	16,539	– 771
Wolverhampton Corpn.	,, 16	778	– 60	15	13,186	+ 117
*Worcester	,, 11	361	+ 14	36	10,554	– 18
Wrexham	,, 11	110	– 12	36	3,759	– 24
Yorkshire W.R. Trams	,, 20	1,268	+ 10	37	16,536	..
Yorkshire Woollen District.	,, 11	866	+ 12	36	33,276	– 1,114

(a) These comparisons are with the corresponding period last year. § Plus 3 days. ‖ Plus 2 days. * Partly electrical. † Minus 3 days ‡ Minus 2 days.

ELECTRICAL COMPANIES' SHARE LIST.

Share	Last Dividend	Name.	Price Wed., Sept. 23.	Rate % Yielded. £ s. d.	Dividend Due.	Business Week to Sept. 23 Highest.	Lowest.
		ELECTRICITY SUPPLY.					
10	5 0	Bournemouth & Poole Elec. Sup. Ord.	10 –10½	6 13 6	Mar, Sept,	10	..
10	4 6	Do. 4½ per Cent. Cum. Pref.	9½–10	4 10 0	Feb, Aug		–
10	6 0	Do. 6 per Cent. Cum. Second Pref.	10½–10⅞	5 6 6	Feb, Aug	10½	..
St.	4½%	Do. 4½ per Cent. Deb. Stock (red.)	101 –104	4 6 6	Jan, July	..	..
5	3 6	Bromley (Kent) El. Lt. & Power Shares	4½–5	5 10 0	April, Oct	..	..
St.	4½%	Do. Do. 1st Debs.	96 –99	4 11 0	May, Nov	97¾	..
5	4 6	Brompton & Kensington Elec. Sup. Ord.	7¼–7¾	6 3 0	March....	..	..
5	3 6	Do. 7 per Cent. Pref.	6½–7½	4 13 6	Mar, Sept	..	..
St.	4%	Central Elec. Sup. Co. 4% Guar. Db. Stock	99 –102	3 18 6	June, Dec	..	..
5	2 6	Charing Cross (W. End & City) El. Sup. Co.	3¾–4	6 5 0	Feb, Aug	.	..
5	2 3	Do. 4½ per Cent. Pref.	4 –4½	5 0 0	Feb, Aug	4	..
St.	4%	Do. 4 per Cent. Deb. Stock (red.)	93 –99	4 1 0	Jan, July		..
5	2 3	Do. City Undertaking 4½% Cm. Pref.	3½–4	5 12 0	Jan, July	..	..
5	2/0	†Chelsea Electric Supply Ord.	2¾–3¼	6 18 0	March ..	..	..
St.	4½%	* Do. 4½ per Cent. Deb. Stock (red.)	100 –103	4 7 6	June, Dec	..	..
10	5/0	City of London Electric Lighting Ord.	9½ –10½	5 17 0	Feb, Aug	9¾	..
10	6/0	Do. 6 per Cent. Cum. Pref.	12 –13	4 12 0	Jan, July	12½	..
St.	5%	Do. 5 per Cent. Deb. Stock (red.)	122 –125	4 0 0	June, Dec	..	..
St.	4½%	Do. 4½ per Cent. 2nd Deb. Stock (red.)	101 –104	4 6 6	Jan, July	..	..
5	2%	County of Durham Elec. P.D. Ord.	2¾–3	3 9 7	April, Oct	..	..
5	5%	Do. 5 per Cent. non Cum. Pref.	3¾–4½	6 5 0	April, Oct	..	..
10	4.0	County of London Elec. Supply Ord.	7½–8½	5 17 6	Feb, Aug	7¾	..
10	6 0	Do. 6 per Cent. Cum. Pref.	10⅞–10⅞	5 9 6	Mar, Sept	10¾	10½
St.	4½%	Do. 4½% Deb. Stock (red.)	107 –110	4 2 0	Jan, July	108	107½
St.	4½%	Do. Second Deb. Stock	99 –102	4 8 0	May, Nov	..	..
5	3 6	Folkestone Electricity Supply Co. Ord.	4¾–5¼	5 7 0	April, Oct	4¾	..
5	2 6	Do. 5 per Cent. Cum. Pref.	5 –5½	4 11 0	Mar, Sept	..	..
St.	4½%	Do. 4½ 1st Deb. Stock (red)	97 –100	4 10 0	Feb, Aug	..	..
5	4/6	Hove Electric Lighting Ord.	6 –6½	6 11 0	April, Oct	6½	..
5	4/0	Kensington & Knightsbridge Ord.	7¾–8¼	5 14 0	Feb, Aug	..	..
5	6%	Do. 6 per Cent. 1st Pref.	6 –6½	4 12 0	Jan, July	..	–
St.	4%	Do. 4 per Cent. Deb. Stock (red.)	94 –97	4 2 6	..	.	..
St.	4%	Kensingtn. & Kngtbg. Co. & Notting Hill Co. (Joint Station) 4% Deb. Stock (red.)	98 –102	3 18 0	April, Oct	–	..
St.	4½%	Kent Elec. Power Co.	86 –90	5 0 0	Jan, July	..	..
3	1 6	London Electric Supply Ord.	⅞–1⅛	5 8 0	Mar, Sept	..	..
5	3 0	Do. 6 per Cent. Pref.	4½–4¾	6 9 6	Mar, Sept	..	..
St.	4%	Do. 4 per Cent. 1st Mort. Deb.	89 –92	4 7 0	Jan, July	..	..
5	2 6	Metropolitan Electric Sup. Ord.	4¼–4¾	6 16 6	April, Oct	..	..
5	2 3	Do. 4½ per Cent. Cum. Pref.	4½–5	4 10 0	Jan, July	4¾	..
St.	4½%	Do. 4½ per Cent. Deb. Stock 1st Mort.	105 –109	4 1 6	June, Dec	.	..
St.	3½%	Do. 3½ per Cent. Mrt. Deb. Stock (red.)	84 –89	3 19 0	Jan, July	..	..
100	4½%	Midland Elec. Corp. for P.D. 1st Mort. Db.	94 –97	4 12 6	June, Dec	96½	96
10	4%	Newcastle & Dist. Elec. Ltg. Ord.	6¾–7½	5 14 4	Feb, Aug	–	–
100	4½%	Do. 4½ per Cent. Deb.	94 –96	4 14 9	Jan, July	..	..
5	8%	Newcastle Elec. Supply Ord.	5⅜–5½	7 7 6	Feb, Aug	..	..
5	5%	Do. 5 per Cent. non Cum. Pref.	5⅝–5⅝	4 10 0	Feb, Aug	–	..
100	4%	Do. 4 per Cent. Mort. Deb. red. 1907.	95 –97	4 3 4	Jan, July	..	..
1	3%	Northern Counties Elec. Sup.	—	..	Mar, Aug	–	..
100	4½%	Do. 4½ per Cent. Deb.	93 –95	4 15 9	Jan, July	..	..
10	6 0	Notting Hill Electric Ord.	11¾–12¼	5 10 6	March ..	..	..
5	2,6	Oxford Electric Ord.	5⅞–6⅛	5 14 0	March ..	..	..
St.	4%	Do. 4 per Cent. Deb. Stock	95 –98	4 2 0	Jan, July	..	..
5	5 0	St. James' & Pall Mall Elec. Ord.	7–8	6 1 6	Feb, Aug	..	..
5	3 6	Do. 7 per Cent. Pref.	6½–7½	4 16 0	Feb, Aug	..	–
St.	3½%	Do. 3½ per Cent. Deb. Stock (red.)	86 –90	3 18 0	Jan, July	..	..
5	..	Smithfield Markets Electric Sup. Ord.	¼–¾	..	Feb	..	..
St.	4%	Do. 4 per Cent. Deb. Stock	68 –72	5 11 0	Feb, Aug	..	..
5	4.0	South London Electric Supply Ord.	2½–2¾	5 19 0	April	..	..
1	0/6	South Metrop'n Elec. Lt. & Power Ord.	⅝–⅞	4 0 0	..	..	–
1	0 8⅖	Do. 7 per Cent. Cum. Pref.	1–1⅛	6 4 0	Feb, Aug		1
St.	4½%	Do. 4½ 1st Db. Stk. Red.	100 –103	4 7 6	April, Oct	102	–
5	2/6	Urban Electric Supply Ord.	½–1	..	April, Oct	–	..
5	2/6	Do. 5 per Cent. Cum. Pref.	1⅛–1⅜	10 12 0	April, Oct	..	..
St.	4½%	Do. 4½ per Cent. 1st Mort. Deb.	82 –85	5 6 0	April, Oct	..	..
5	5,0	Westminster Elec. Sup. Ord.	7½–8½	5 17 6	Mar, Sept	..	..
5	2/3	Do. 4½ per Cent. Cum. Pref.	5 –5½	4 2 0	Jan, July	..	–
		ELECTRIC RAILWAYS & TRAMWAYS.					
St.	4%	Baker St. & Waterloo 4% Perp. Db. St	94 –96	4 3 3	Jan, July	94½	94
1	..	Bath Elec. Trams Pref. Ord.	⅛–⅜	10 13 0	April	–	–
1	0/6	Do. 5 per Cent. Cum. Pref.	½–¾	8 13 4	Jan, July	..	–
St.	4½%	Do. 4½ 1st Mort. Deb. Stock (red.)	85 –90	5 0 0	April, Oct	..	..
St.	4½%	B'ham & Midland Trams 4½ 1st Db. Stk.	93 –96	4 13 9	Jan, July	94½	..
10	9%	Bristol Tramways & Carriage Ord.	10½ –11	8 3 6	Feb, Aug	..	..
10	4%	Do. Cum. Pref. (fully paid)	8¾–9	4 9 0	..	..	..
St.	4%	Do. 4 per Cent. Debs.	93 –98	4 2 0	Feb, Aug	..	..
10	..	British Electric Traction Ord.	1 –1½	..	June, Dec	1	–
10	8/0	Do. 6 per Cent. Cum. Pref.	3¾–4¼	..	Feb, Aug	4	3⅞
St.	5%	Do. 5 per Cent. Perpetual Debs.	98½ - 99½	5 0 6	April, Oct	99½	98
St.	4½%	Do. 4½ per Cent. 2nd Deb. Stock	76 –78	5 15 0	May, Nov	76⅛	..
St.	3%	Central London Ordinary Stock	68 –70	4 6 0	Feb, Aug	70	68
St.	4%	Do. 4 per Cent. Pref. Stock	81 –86	4 13 0	Feb, Aug	..	..
St.	2%	Do. Deferred Stock	50 –53	3 15 6	Feb	52	50½
100	4%	Do. 4 per Cent. Debs.	101 –104	3 17 0	Jan, July	..	..
St.	4%	Charing X, Euston & Hmpstd Per. Db. Stk.	84 –86	4 13 0	Jan, July	85¼	83½
5	2/6	City of Birmingham Trams. 5% Cm. Pref	4½–4¾	5 5 0	April, Oct	..	..
100	4%	Do. 4 per Cent. 1st Mort. Debs.	97 –100	4 0 0	April, Oct	.	..
St.	1½%	City & South London Rly. Con. Ord.	32½ –33½	5 0 0	Feb, Aug	33¼	32¾
St.	5%	Do. 5 per Cent. Perp. Pref. (1891)	111 –114	4 7 6	Feb, Aug	..	..
St.	5%	Do. (1896)	109 –112	4 9 3	Feb, Aug	–	..
St.	5%	Do. (1901)	107 –110	4 11 0	Feb, Aug	..	..
St.	5%	Do. (1903)	102 –105	4 15 3	Feb, Aug	..	..
St.	4%	Do. 4 per Cent. Perpetual Debs.	100 –103	3 17 6	May, Nov	101½	..
10	6/0	Dublin United Trams. Ord	11½ –12½	5 4 0	Feb, Aug	..	..
10	6/0	Do. 6 per Cent. Pref.	12½ –13½	4 10 6	Feb, Aug	..	..
10	..	Gt. Northern & City Rly. Pref. Ord. (4%)	½ –1	..	Feb, Aug	.	
10	0/9	G. Northern, Piccadilly & Brompton Ord.	7¼ 7¾	5 6 9	Feb, Aug	.	..
St.	4%	Do. 4 per Cent. Deb. Stock	92 –94	4 5 0	Jan, July	93½	92¼
5	4/0	Hastings & Dist. Elec. Trams. 6% Cm. Pf.	3 –4	..	Mar, Sept	..	..
St.	4½%	Do. 4½ Db. St.	92 –96	4 13 9	April, Oct	..	..
10	9%	‡Imperial Tramways Ord.	10 – 11	7 7 3	Mar, Sept	..	..
10	6%	‡Do. 6 per Cent. Pref.	9½ –10½	5 11 0	Mar, Sept	..	..
St.	4½%	‡Do. 4½ per Cent. Debs.	90 –92	4 18 0	Jan, July	..	..
5	..	I. of Thanet E. T. & Lt. 5 per Cent. Pref.	⅞–1⅛	..	Mar, Sept	..	..
St.	4%	Do. 4 per Cent. Deb. Stock	59 –61	6 11 0	Jan, July		–
10	6/0	Lanarkshire Tramways	9½–9¾	6 3 0	Feb, Aug	9½	..
St.	5%	Lancs. Utd. Trams 5% Prior Lien Db. St.	92 –94	5 6 6	Jan, July		..
10	..	Liverpool Overhead Railway Ord.	1½ –1¾	..	Feb, Aug	..	..
10	5%	Do. 5 per Cent. Pref.	5 – 5½	9 2 0	Feb, Aug	..	..
St.	4%	Do. 4 per Cent. Deb.	84 –85	4 13 0	Jan, July	..	..
10	5.0	London United Trams. 5% Cum. Pref.	5¼ –6¼	8 0 0	Jan, July	5⅝	5½
St.	4%	Do. 4 per Cent. 1st Mort. Deb. Stock	75 –80	5 0 0	Jan, July	..	..
St.	..	Mersey Con. Ord. Stock	1 –3	—	Feb, Aug.	..	..
St.	..	Do. 3 per Cent. Perp. Pref.	8 –6	—	..	..	..
1	..	Metropolitan Elec. Tramways Ord.	½–¾	—	.	..	..
1	.	Do. Def.	½–¾	..	April.. .	..	..
1	0/6	Do. 5 per Cent. Cum. Pref.	15⁄16–1⅛	6 3 6	Feb, Aug	1	..
St.	4½%	Do. 4½ per Cent. Deb. Stock	92 –95	4 14 9	Jan, July	..	..
St.	½%	Metropolitan Railway Consolidated	37 –38	1 6 6	Feb, Aug	38	36½
St.	2¾%	Do. Surplus Lands Stocks	65 –68	4 1 6	Feb, Aug	67½	65½
St.	3½	Do. 3½ per Cent. Preference	84 –87	4 0 6	Feb, Aug	84	..
St.	3½	Do. 3½ per Cent. "A" Preference	73 –76	4 12 0	Feb, Aug	–	..
St.	3½%	Do. 3½ per Cent. Convertible Pref.	72 –75	4 13 0	Feb, Aug	..	
St.	3½%	Do. 3½ per Cent. Debenture Stock	91 –93	3 15 3	Jan, July	92½	91½
St.	3½%	Do. 3½ per Cent. "A" Ditto	88 –91	3 17 0	Jan, July	88½	..

* In calculating the yield allowance has been made for accrued interest but *not* for redemption † Ex Dividend. ‡ The London Stock Exchange Committe have declined to quot these.

ELECTRICAL COMPANIES' SHARE LIST.—*Continued.*

ELECTRIC RAILWAYS & TRAMWAYS—*Continued.*

Share.	Last Dividend	Name.	Price Wed., Sept. 23.	Rate % Yielded. £ s. d.	Dividend Due.	Business Week to Sept. 23. Highest.	Lowest.
St.	..	Metropolitan District Railway Ord.	12½—13½	--	Feb, Aug	13½	12¾
St.	..	Do. Extension Pref. (5 per Cent.)	20—24	..	Feb, Aug	..	..
St.	3½	Do. Assented Ext. Pref. (Int. Guar. by Und. Elec. Rlys. Co. of London, Ltd.)	48—52	6 14 6	Feb, Aug	..	..
St.	3%	Do. 3 per Cent. Consoltd. Rent-charge	74—77	3 18 0	Jan, July	75½	..
St.	4%	Do. 4 per Cent. Midland Rent-charge	99—103	3 17 6	Jan, July	101½	101
St.	1¼	Do. Guar. Stock 4 per Cent.	51—55	3 12 9	Mar, Sept	..	..
St.	6	Do. 6 per Cent. Perp. Deb. Stock	116—119	5 1 0	Jan, July	..	..
St.	4	Do. 4 per Cent. Ditto	71—76	5 5 0	Jan, July	73½	—
5	..	New Gen. Tract. 6 per Cent. Cum. Pref.	¼—¾	--	May	..	—
1	0/9¾	Potteries Electric Traction Ord.	¼—½	8 0 0	April, Oct	..	—
1	0/6	Do. 5 per Cent. Cum. Pref.	19/32—23/32	6 19 0	Feb, Aug	..	..
St.	4½%	Do. 4½ per Cent. Deb. Stock	92—95	4 14 9	May, Nov	94	..
1	0/7½	S. Met. Elec. Trams. & Ltg. 6% Cm. Pref.	¾—1	6 0 0	Feb, Aug	..	..
St.	4%	Do. 4 per Cent. Deb. Stock	76—80	5 0 0	Jan, July	..	..
100	5%	Sunderland Dist. Elec. Trms. 5% 1st Mt. Db.	78—82	6 2 0	Jan, July	78	..
..	21/0	Underground Elec. Rys. Co. of London	42—46	..	June, Dec	43½	..
5	..	Yorkshire (W.R.) Elec. Trams. Ord.	⅞—1⅛	—	March ..	..	..
5	..	Do. 6 per Cent. Cum. Pref.	3—3½	—	..	3	..
St.	4½	Do. 4½ per Cent. 1st Debs.	84—87	5 3 0	Jan, July	..	..

ELECTRIC MANUFACTURING, &c.

Share.	Last Dividend	Name.	Price Wed., Sept. 23.	Rate % Yielded. £ s. d.	Dividend Due.	Highest.	Lowest.
1	..	Aron Electricity Meter Ord.	[illegible]	..	..	..	..
1	1/4⅝	Do. 6% Cum. Pf. (ex on a/c arrears)	11/16—13/16	7 12 0	April, Oct	..	..
1	2/4½	Babcock & Wilcox Ord	3 13/16—4 1/16	4 18 8	April, Oct	3 31/32	[illegible]
1	0/7½	Do. Pref.	1½—1⅝	3 13 9	..	..	..
5	4/0	†British Insulated & Helsby Cables Ord.	6¼—6¾	7 8 3	July, Feb	..	—
5	3/0	Do. 6 per Cent. Pref.	6—6½	4 12 0	Jan, July	..	..
St.	4½%	Do. 4½ per Cent. 1st Mort. Deb. (red.)	103—106	4 5 0	Jan, July	..	..
St.	4½%	British Thoms'n-Houst'n 4½% 1st Mt. Db.	91—96	4 14 0	Mar, Sept	..	..
5	..	British Westinghouse 6 per Cent. Pref.	7/16—9/16	--	Feb, Aug	7/16	⅝
St.	4%	Do. 4 per Cent. Mort. Deb. Stock	41—46	8 14 0	Jan, July	..	..
2	..	Brush Electrical Engineering	½	—	March ..	..	..
2	..	Do. 6 per Cent. Pref. non-Cum.	⅛—⅜	..	Mar, Sept	..	..
St.	4½%	Do. 4½ per Cent. Perp. 1st Deb. Stock	68—73	6 3 0	Mar, Sept	..	—
St.	4½%	Do. Perpetual 2nd Deb. Stock	50—54	8 6 6	Jan, July	..	..
5	10/0	Callender's Cable Con. Ord.	9¾—10¾	6 17 6	Jan, July	11	10
5	2/6	Do. 5 per Cent. Cum. Pref.	5¼—5¾	4 7 0	Jan, July	5 9/16	..
St.	4½%	Do. 4½ per Cent. 1st Mort Debs. (red.)	107½—109½	4 2 0	Nov, May	..	..
1	1/0	Castner-Kellner Alkali Co.	1 9/16—1 11/16	8 0 0	May, Nov	1 11/16	1 19/32
St.	4½%	Do. 4½ per Cent. 1st Mort. Deb. (red.)	103—107	4 4 0	Feb, Aug	..	..
1	0/9⅝	Chadburn's (Ship) Telegraph Ord.	15/16—1 1/16	7 10 6	March ..	..	..
1	0/7½	Do. 6 per Cent. Cum. Pref.	15/16—1 1/16	5 13 0	April, Oct	..	..
1	0/8[illegible]	Consolidated Electrical Co.	⅜—½	7 0 0	August ...	..	..
1	1/0	Consolidated Signal Co.	1¼—1 7/16	10 8 6	April, Oct	..	..
1	0/7½	Do. 6 per Cent. Cum. Pref.	⅞—1	6 0 0	April, Oct	—	..
3	3/0	*Crompton & Co. (Nos. 1 to 85,000)	1 5/16—1 9/16	9 5 0	Jan, July	..	..
100	5%	Do. 5 per Cent. 1st Mort. Debs. (red.)	98—101	4 19 0	Jan, July	100	99
1	0/7½	†Davis & Timmins	⅞—1⅛	..	Mar, Sept	⅞	..
5	2/0	Dick, Kerr & Co. Ord.	1 5/16—1 7/16	6 19 0	Sept	1 5/16	..
5	0/7½	Do. 6 per Cent. Cum. Pref.	1—1¼	4 16 0	Sept ..	..	..
St.	4½%	Do. 4½ per Cent. Deb. Stock	101—104	4 6 6	Jan, July	..	—
5	2/6	Edison & Swan United ("A" Sh.) (£3 pd.)	½—¾	..	Feb, Aug	..	..
5	4/2	Do. (£5 paid)	1½—2½	5 0 0	Feb, Aug	..	—
St.	4%	Do. 4 per Cent. Mort. Deb. Stock (rd.)	76—79	5 1 6	June, Dec	..	..
St.	5%	Do. 5 per Cent. 2nd Deb. Stock	85—87	5 15 0	Mar, Sept	—	..
5	..	Edmundson's Elec. Corp. Ord.	⅛—⅜	..	Jan, July	..	..
5	..	Do. 6 per Cent. Cum. Pref.	¾—1	..	May, Nov	[illegible]	[illegible]
St.	4½%	Do. 4½ per cent. 1st Mort. Deb. (red.)	59—66	6 16 0	Jan, July	..	..
2	..	Electric Construction Co.	[illegible]	..	Jan, July	..	..
2	2/9¾	Do. 7 per Cent. Cum. Pref.	1 5/16—1⅞	8 0 0	July	—	..
St.	4	Do. 4 per Cent. Perp. 1st Mort. Debs.	65—70	5 14 0	Jan, July	..	..
10	5/0	General Electric (1900) 5% Cum. Pref.	7½—8	6 5 0	June, Dec	..	..
St.	4%	Do. 4 per Cent. 1st Mort. Debs.	85—91	4 9 0	Mar, Sept	..	—
5	5/0	Henley's Telegraph Works Ord.	10¼—11¼	6 10 0	Feb, Aug	11	..
5	2/3	Do. 4½ per Cent. Pref.	5—5½	4 2 0	Feb, Aug	..	..
St.	4½%	Do. 4½ per Cent. 1st Mort. Deb. Stock	107—109	4 2 6	Mar, Sept	107¼	..
10	5/0	India Rubber, Gutta Percha, &c., Wrks.	16½—16½	6 2 0	Feb, Aug	16⅜	16 13/16
100	4%	Do. 4 per Cent. Debs. (red.)	99—101	3 19 0	April, Oct	..	—
1	..	National Elec. Construction Co.	⅜—⅝	..	April	..	..
1	0/9¾	Richardsons, Westgarth & Co., Ltd. Ord.	7/16—9/16	7 2 0	Nov	½	..
1	0/7½	Do. 6 per Cent. Cum. Pref.	¾—⅞	6 17 0	May, Nov	..	..
St.	4½%	Do. 4½ per Cent. Perp. Deb. Stock	85—88	5 2 0	Jan, July	..	..
1	..	Simplex Conduits Ord.	1½	..	..	—	—
5	..	Do. 6 per Cent. Cum. Pref.	5¼	..	..	..	—
12	12/0	Telegraph Construction & Maintenance	32—34	6 5 0	Mar, July	33½	32⅞
100	4%	Do. 4 per Cent. Deb. Bonds (1909)	101—103	3 17 0	Jan, July	..	..
1	1/0	Vickers, Sons & Maxim, Ltd. Ord.	1 13/16—1 15/16	9 1 0	..	[illegible]	1¾
1	0/6	Do. 5 per Cent. non-Cum. Preference	1—1⅛	4 9 0	..	1⅛	1
St.	5%	Do. 5 per Cent. non-Cum. Preferred	100—103	4 17 6	..	103	102⅝
St.	4%	Do. 4 per Cent. 1st Mort. Db. Sk. (red)	104—106	3 15 0	June, Dec	..	..
100	4½%	Do. 4½ per Cent. 2nd Mort. Deb. (red.)	104½—106½	4 4 6	June, Dec	105⅝	..
100	15/6	Do. 5 per Cent. 3rd Mort. Debs. Scrip.	103—105	4 15 0	..	104½	104
10	10/0	J. G. White & Co. 6% Cm. Pref.	8½—9½	8 17 9	..	..	..
5	1/0	Willans & Robinson Ord.	¾—1¼	4 0 0	Apr, Oct	..	..
5	3/0	Do. 6 per Cent. Cum. Pref.	2½—3	8 11 6	Apr, Oct	2½	2¾
100	4%	Do. 4 per Cent. 1st Mort. Debs.	72—76	5 5 6	May, Nov	..	..

TELEGRAPHS.

Share.	Last Dividend	Name.	Price Wed., Sept. 23.	Rate % Yielded. £ s. d.	Dividend Due.	Highest.	Lowest.
10	..	Amazon Telegraph	2—3	—	June, Dec	..	—
100	5%	Do. 5 per Cent. Debs. (red.)	90—93	5 7 6	June, Dec	..	..
St.	15/0	Anglo American	58—61	5 16 0	F,My,Ag,N	..	..
St.	30/0	Do. Preferred	103½—104½	5 16 6	F,My,Ag,N	104⅛	103¾
St.	1%	Do. Deferred	16¼—17	5 17 9	F,My,Ag,N	[illegible]	[illegible]
St.	4%	Commercial Cable 4 per Cent. Deb. Stk.	89—91	4 8 0	Jn,Ap,Jy,O	89¼	..
10	6/0	Cuba Submarine Ord.	7½—8½	7 0 0	Feb, Aug	..	..
10	10/0	Do. Preference 10 per Cent.	15¾—16¼	6 1 6	Feb, Aug	..	..
5	2/0	Direct Spanish Ord.	3—3½	6 4 0	April, Oct	..	..
5	[illegible]	Do. 10 per Cent. Cum. Pref.	8—9	5 11 0	April, Oct	..	..
100	4½%	Do. 4½ per Cent. Deb.	100—103	4 7 6	Jan, July	..	..
20	[illegible]	Direct United States Cable	13¼—13¾	6 2 6	Ja,Ap,Jy,O	..	..
100	4½%	Direct West India Cable 4½% Rg. Db. (rd.)	100—102	4 8 0	June, Dec	100	..
St.	[illegible]	Eastern Ordinary	[illegible]—138½	5 0 6	Ja,Ap,Jy,O	137½	136
St.	[illegible]	Do. [illegible] per Cent. Pref. Stock	84½—86½	4 [illegible] 0	Ja,Ap,Jy,O	86	85
St.	4	Do. 4 per Cent. Mort. Deb. Stk. (red.)	104—[illegible]	3 16 0	May, Nov	..	..
10	2/6	Eastern Extension	12¾—13¼	5 5 6	Ja,Ap,Jy,O	13	12¾
St.	4%	Do. 4 per Cent. Deb. Stock	[illegible]	3 17 6	Feb, Aug	102	..
100	4%	Eastern & S. African 4% Mort. Deb. 1909	99—101	3 18 6	Feb, Aug	..	..
25	4%	Do. 4% Mauritius Sub. Debs. (red.)	101½—103½	3 16 6	May, Nov	..	..
10	5/0	G. N. of Copenhagen with Coupon 74	[illegible]—29½	6 11 0	Jan, July	29⅞	
100	4½	Halifax & Bermuda 4½% 1st Mt. Db. (red.)	100—[illegible]	4 8 0	June, Dec	..	..
[illegible]	[illegible]	Indo-European	66—69	5 1[illegible] 0	May, Nov	..	..
[illegible]	£1	[illegible] Companies Common	68—72	5 11 0	Ja,Ap,Jy,O	[illegible]	..
1[illegible]	£1	Do. Preference	68—72	5 11 0	Ja,Ap,Jy,O	.	..
1		[illegible] Wireless Telg. Co.	[illegible]	..	April	[illegible]	[illegible]
[illegible]	[illegible]	[illegible] 4% Guar. Dbs. (red.)	[illegible]—102	3 18 0	June, Dec	..	—
[illegible]	[illegible]	West Coast of America	[illegible]—1	4 5 0	May	.	—
1[illegible]	[illegible]	Do. 4 per Cent. Debs.	[illegible]—102	3 18 6	Jan, July	..	..
[illegible]		West India & Panama	[illegible]	..	May, Nov		.
10	[illegible]	Do. 6 per Cent. 1st Pref.	[illegible]	[illegible] 1 6	May, Nov	[illegible]	..
10	[illegible]	Do. [illegible] Pref.	[illegible]	..	May, Nov	.	..
100	[illegible]	Do. [illegible] per Cent. Debs.	101—103	4 17 0	Jan, July	.	..
[illegible]	[illegible]	Western Telegraph	13¾—14¼	4 15 6	[illegible]	13⅞	13⅝
St.	4	Do. 4 per Cent. Deb. Stock (red.)	[illegible]	3 16 6	June, Dec	102½	101⅞
..	4	Western [illegible] 4½% Bonds	[illegible]	4 11 0	..		..

TELEPHONES.

Share.	Last Dividend	Name.	Price Wed., Sept. 23.	Rate % Yielded. £ s. d.	Dividend Due.	Highest.	Lowest.
100	2$	Amer. Telephn. & Telegh. Cap. St.	129—133	6 0 0	..	..	..
..	4%	Do. Coll. Trust $1,000 4 per Cent. Bds	92—94	4 6 6	Jan, July	..	..
St.	5%	†Anglo-Portug'se Tel. 5% 1st Mt. Db. Stk.	99—102	4 18 0	Mar, Sept	..	—
5	5/0	Chili Telephone	8—8½	4 14 0	August ..	..	..
1	0/7½	Monte Video Telephone Ord.	1—1⅛	6 4 0	Nov	1 1/16	..
1	0/6	Do. 5 per Cent. Pref.	⅞—1	5 0 0	May, Nov	..	..
St.	6%	National Co. Pref. Stock	108½—110½	5 8 6	Feb, Aug	110	[illegible]
St.	6%	Do. Def. Stock	118—120	5 0 0	Feb, Aug	119	[illegible]
10	6/0	Do. 6 per Cent. Cum. 1st Pref.	10¾—11¼	5 6 6	Feb, Aug	[illegible]	..
10	6/0	Do. 6 per Cent. Cum. 2nd Pref.	10¾—11¼	5 6 6	Feb, Aug	..	..
5	2/6	Do. 5 per Cent. non-Cum. 3rd Pref.	5 9/16—5 11/16	4 8 0	Feb, Aug	[illegible]	[illegible]
St.	3½%	* Do. Deb. Stock 3½ per Cent. (red.)	98½—100½	3 9 6	June, Dec	98½	..
St.	4%	Do. 4 per Cent. Deb. Stock (red.)	102½—104½	3 15 6	Jan, July	103	102½
1	1/0	Oriental	1¼—1⅜	5 16 3	April, Oct	[illegible]	..
1	0/7½	Do. 6 per Cent. Cum. Pref.	1 3/16—1 5/16	4 11 6	April, Oct	..	..
St.	4%	Do. 4 per Cent. Red. Deb. Stock	89—92	4 7 0	Jan, July	—	..
St.	4½%	Telephone Co. of Egypt 4½% Db. Stk. (red.)	99—102	4 12 0	Jan, July	..	..
5	5/0	United River Plate	6¾—7¼	5 10 0	July	..	—
5	2/6	Do. 5 per Cent. Cum. Pref.	5—5½	4 11 0	June, Dec	5¼	..
St.	4½%	Do. 4½ Deb. St. Red.	103—105	4 5 9	Jan, July	..	..

FINANCIAL, INVESTMENT, &c.

Share.	Last Dividend	Name.	Price Wed., Sept. 23.	Rate % Yielded. £ s. d.	Dividend Due.	Highest.	Lowest.
5	3/0	Elec. & Gen. Investment 6% Cum. Pref.	3½—4	7 10 0	Jan, July	..	..
10	5/9	Globe Telegraph & Trust	[illegible]—11¼	5 8 0	Sp De Mr Ju	[illegible]	[illegible]
10	3/0	Do. 6 per Cent. Pref.	13⅝—14⅛	4 5 0	Sp De Mr Ju	13⅞	.
10	6%	Submarine Cables Trust (Cert.)	129—132	4 11 0	April, Oct	..	..

COLONIAL AND FOREIGN ELECTRIC RAILWAYS, TRAMWAYS, &c.

Share.	Last Dividend	Name.	Price Wed., Sept. 23.	Rate % Yielded. £ s. d.	Dividend Due.	Highest.	Lowest.
5	3/0	Anglo-Argentine 6% Cum. 1st Pref.	6¼—6½	4 12 6	April, Oct	6⅜	..
5	5/0	Do. 10% Non-cum. 2nd Pref.	8 11/16—8 13/16	5 14 3	Jan, July	[illegible]	—
St.	6%	Do. Permanent 6% Deb. Stock	143—148	4 1 0	June, Dec	..	..
St.	5%	Auckland Elec. Trams. 5% Deb. (red.)	103—106	4 14 3	Jan, July	104¾	103
5	4/0	Brisbane Electric Trams. Invest. Ord.	4⅝—4⅞	4 2 6	May	4⅝	..
5	2/6	Do. 5 per Cent. Cum. Pref.	4⅞—5⅛	4 17 6	May, Nov	..	..
St.	4½%	Do. 4½ per Cent. Db. Prov. Certs.	100—104	4 8 6	Jan, July	103⅜	..
St.	8%	British Columbia El. Ry. Df. Ord.	136—140	5 14 0	Mar, Sept	..	.
St.	30/0	Do. Pref. Ord. Stock	117—121	4 19 0	May, Nov	120½	118
St.	5%	Do. 5% Cum. Perp. Pref. Stock	105—109	4 11 6	Jan, July	107¾	107
40	4½%	Do. 4½ per Cent. 1st Mort. Debs.	101—104	4 6 6	April, Oct	.	..
100	4½%	Do. Vancouver Power Debs.	100½—103½	4 7 0	Jan, July	102½	—
St.	4½%	Do. 4½% Perp Con. Deb. St.	103—106	4 0 0	—	105	..
St.	5%	Buenos Ayres Elec. Trams (1901) Ltd. Deb. St.	97—102	4 18 6	Ja, Jul ..	..	.
5	..	Buenos Ayres Grand National Ord.	2½—3	..	..	..	..
5	2/6	Do. 5 per Cent. Cum. Pref.	4¼—4⅝	5 8 0	Feb, Aug	—	.
100	5½%	Do. 5½ per Cent. Pref. Debs.	100—105	5 4 6	Jan, July	..	..
100	6%	Do. 6 per Cent. 1st Deb. Bonds.	101—106	5 13 0	April, Oct	106	..
St.	5%	Buenos Ayres Lacroze Trams 1st Mt. Db.	95—97	5 3 0	Mar, Sept	..	..
St.	6%	Buenos Ayres Port & City Tram. 1st Mt. Deb. Stock £75 Paid	61—65	6 12 0	Feb, Aug	..	..
5	2/6	Calcutta Tramways (1 to 137,610)	5½—6	5 0 0	Mar, Sept	5⅜	5
100	2/6	Do. 5 per Cent. Cum. Pref.	4⅞—5½	4 13 0	Jan, July	[illegible]	..
1	4½%	Do. 4½% 1st Deb. Stock (red.)	102—105	4 5 9	Jan, July	104⅞	..
St.	..	Cape Electric Tram Shares	⅛—⅜	..	..	..	—
5	1/3	City of Buenos Ayres Trams Co. (1904) Sh.	5⅜—5⅝	4 5 3	F,My,A,N	..	.
St.	4%	Do. 4 per Cent. Deb. Stock	99—103	3 17 [illegible]	June, Dec	..	..
..	5%	Colombo Tr. & Ltg. 5% 1st Mt. Db.	90—93	5 6 6	May, Nov	..	—
100	5%	Electric Traction Co. of Hong Kong 5 per Cent. 1st Mort. Debs.	85—90	5 10 0	June, Dec	..	..
1	5%	Havana Elec. Ry. Con. Mt. 5% $1,000 50 year Coup. Bds.	85—90	5 11 0	Feb, Aug	..	..
1	..	Kalgoorlie Elec. Trams Sh.	[illegible]	..	..	..	
100	5%	Do. 5 per Cent. "A" Deb. Stock	85—89	5 12 0	Jan, July	..	—
5	6%	Do. 6 per Cent. "B" Ditto	64—69	8 14 0	Jan, July	..	
5	1/0	Lisbon Elec. Trams. Ord.	1—1¼	4 0 0	July	..	..
100	0/7½	Do. 6 per Cent. Cum. Pref.	1—1¼	4 16 0	Jan, July	..	
St.	5%	Do. 5 per Cent. Reg. Mort. Debs	92—97	6 3 0	Jan, July	..	
St.	5%	Madras Elec. Trams. 5% Deb. Stk.	93—96	5 4 0	Jan, July	95	94
.	5%	Manila Elec. Ry. $1,000 Gold Bonds	84—88	5 14 0	Feb, Aug		..
100	4/[illegible]	Mexico Trams Co. Com. St.	123—125	4 0 0	..	124	123
500	5%	Do. Gen. Con. 1st Mort. 5% Gold Bds.	92—93½	5 7 6	..	93	[illegible]
St.	4½%	Montreal St. Ry. Sterling 4½ per Cent. Debs. (1922) (Nos. 601 to 2,000)	100—102	4 8 0	Feb, Aug	..	
1	1/0	Perth Elec. Trams Ord	[illegible]—¾	6 13 6	May	..	..
St.	5%	Do. 1st Mt. Db. Stock	101—104	4 16 0	Jan, July	102¾	102
5	3/0	Rangoon Elec. Trams & Supply Co. 6% Cum. Pf.	5⅜—5⅝	5 6 6	..	..	—
St.	4½	Do. 4½% 1st Mort. Deb. Stk.	95—100	4 10 0	..	..	.
..	[illegible]	Sao Paulo Tramway, Light & Power Co. $100 Stock	150—154	5 17 0	..	[illegible]	[illegible]
..	5%	Do. 5 per Cent. 1st Mt. $500 Db.	99¼—100¼	4 19 9	June, Dec	[illegible]	[illegible]
100	4½%	Toronto Ry. Co. 1st Mt. 4½% Ster. Bonds	97—99	5 1 0	Feb, Aug	..	

COLONIAL AND FOREIGN ELECTRICITY SUPPLY &c.

Share.	Last Dividend	Name.	Price Wed., Sept. 23.	Rate % Yielded. £ s. d.	Dividend Due.	Highest.	Lowest.
5	8/0	Adelaide Elec. S'ply Co. 6% Cu. Pr.	4¾—5¼	5 14 0	Mar, Sept	..	
10	6/0	Bombay E. S. & T. 6% Cm. Pf.	9¾—10¼	5 16 3	..	[illegible]	
St.	4½	Do. 4½ per Cent. Deb. Stk. (red.)	94—96	4 13 9	Jan, July	94½	.
[illegible]	4/9	Calcutta Elec. Supply Ord.	6—7	5 14 0	April, Oct	..	
100	7/2	Canadian Gen. Elec. Co. Com. St.	106—110	6 8 [illegible]	..	107½	[illegible]
100	5%	Castner Electrolytic Alkali Co. (of U.S.A.) 1st Mort. Stl. Debs	92—97	5 2 6	Jan, July		
500	5%	Elect. Development Co. of Ontario	86—88½	5 15 9	..		
5	..	Elec. Ltg. & Trac. Co. of Aust. 6 per Cent. Cum. Pref.	2—2½	..	Feb, Aug	..	
St.	5%	Do. 5 per Cent. Deb Stock	83—88	5 13 9	Jan, July	..	
St.	5%	Elec. Supply Co. of Victoria 5 per Cent. 1st Mort. Deb. St.	90—93	5 7 6	Jan, July	[illegible]	
St.	6%	Indian Elec. Sup. & Trac. Co. Constn Deb. St. Rd.	30—40	15 0 0	Jan, July	..	
100	0/3	Kalgoorlie Elec. Power & Ltg. Ord.	⅛—¼	..	..	—	
1	0/7½	Do. 6 per Cent. Cum. Pref.	⅜—½	8 0 0	April, Oct		
St.	6%	Madras E. S. Corp. 6 per Cent. Constn Deb. St.	85—90	6 11 0	April, Oct	..	
500	6%	Mexican Elec. Light Co. 6% 1st Mort. Gold Bonds	[illegible]—101	5 1[illegible] 6	..	[illegible]	[illegible]
St.	$1	Mexican Lt. & Power Co. Com. St.	[illegible]	..	..	[illegible]	[illegible]
500	5%	Do. 5% 1st Mort. Gold Bonds	[illegible]	5 8 6	..	[illegible]	[illegible]
100	[illegible]	Montreal Lt. Ht. & Power Co. Cap. St.	[illegible]	5 1[illegible] 0	F,My,A,N	[illegible]	[illegible]
1	[illegible]	River Plate Electricity Co. Ord.	[illegible]	4 1[illegible] 0	April ..	[illegible]	
1	[illegible]	Do. 6 per Cent. non-Cum. Pref.	[illegible]	5 13 0	May		
St.	6%	Do. 6 per Cent. Deb. Stock	[illegible]	4 18 0	Jan, July	[illegible]	
5	3/0	Rosario Elec. Co. 6% Pref. (1-20,000)	4¾—5¼	5 14 0	April, Oct		
100	$1	Shawinigan Water & Power Co. Cap. St.	81—[illegible]	4 16 3	—	[illegible]	[illegible]
.	5%	Do. 5 per Cent. Bds.	103—105½	4 15 6	Jan, July	104	[illegible]
..	6%	Victoria Falls Power Co. Pref.	—	—	Jan, July		

* [illegible]ating the yields allowance has been made for accrued interest but not for redemption. † Ex dividend. ‡ The London Stock Exchange Committee have declined to quote these.

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CONTENTS OF THE CURRENT NUMBER.

NOTES.

The Manchester Electrical Exhibition.

There will be a concentration of electrical men upon Manchester, during the month of October, at the Electrical Exhibition at Platt Fields. The first provincial exhibition since Olympia, it comes, much as did its celebrated predecessor, at a period of trade depression, though the situation now is rather more acute than at the period to which we refer. By all the axioms of advertising, an exhibition held on a falling market, though a risky proceeding, is fraught with possibilities which give hopes of brighter prospects than when business is good. When trade is bad, advertise; in other words, hold exhibitions, and this is what Manchester is doing. The records of many electrical firms who exhibited at Olympia go to show a marked increase in business subsequent to the close of the exhibition. Interest in electrical matters was stimulated, and the consumer was thus encouraged to make greater use of electrical devices. Many people were given "furiously to think" what electric lighting was and what it could do for them. The net result was a mild boom in electricity supply in the London and Greater London areas. Now we hope that something akin to this will happen in Manchester and Lancashire. It is wanted and wanted badly. When the Exhibition is opened we shall judge better of the prospects of such developments. On the eve of opening, hopes of future good run high. Of the exhibits themselves we give a brief summary elsewhere, and in subsequent issues during the run of the Exhibition we shall deal with all the main features of interest. At this juncture we wish the venture all the success it deserves.

Tramway Accidents.

Certain sections of the daily Press have recently been much concerned about the number of accidents to pedestrians and other users of the roads caused by the excessive speed of motor vehicles. In fact, a short time ago the drivers of motor omnibuses in the East End of London who were unfortunate enough to cause an accident to other users of the road were recipients of rough treatment at the hands of the public. Complaints are also made in the Press as regards the running of the London County Council tramcars along the Embankment, the position of both tramway tracks close together on one side of the thoroughfare resulting in a certain amount of danger to pedestrians crossing the road, who are liable to be confused by the four streams of traffic proceeding alternately in each direction. The dangers of the London streets, however, sink into paltry insignificance in comparison with those of New York. The Public Service Commission there appointed has been collecting from the railway and tramway companies of the city monthly statements of the number of accidents upon the various lines, and has issued a report tabulating the accidents recorded. From this it appears that for the first six months of this year the average monthly roll of accidents was 4,788, resulting in injuries to approximately 3,000 persons every month, including 35 deaths and nearly 200 serious cases of fractured limbs, &c. According to *Engineering News*, by far the greater proportion of these accidents occur on the subway, surface and elevated street railways, corresponding to our tubes and tramways. As 90 per cent. of the accidents are due to persons being struck by cars, or to accidents in alighting from or boarding cars, it would appear that the American public need educating in the art of "hustling" without running unnecessary risks. As regards London, there is no doubt that the public will have to accustom themselves to the altered traffic conditions, and that the increasing use of automobiles and the accelerated services which have just come into operation on the tubes will all tend to arouse the public to an appreciation of rapid transit, provided it can be obtained without unnecessary risk to life and limb.

FROM the above report it appears that the number of accidents arising when persons are entering or leaving cars amounts to about one-fourth of the total, and in this connection it is interesting to notice the experience at Chicago with cars of the "pay-as-you-enter" type, to which we referred in our issue of November 8th last. During the six months ended July 31, 1908, according to figures in the *Electric Railway Journal*, the total number of accidents on the lines in Chicago over which this type of car is run showed a decrease of 16·2 per cent. over the corresponding period of last year, whilst accidents occurring at the steps of cars were almost entirely eliminated. Also statistics for Chicago, Cook County and the State of Illinois show a decrease of 31·37 per cent. in the number of accidents over the whole system of tramways concerned, and this is believed to be largely due to the "pay-as-you-enter" cars now operating on a large number of the routes, 300 cars of this type being in use in Chicago alone. As will be seen from the report, in our last issue, of the meeting of the Municipal Tramways Association, the president, Mr. J. ALDWORTH, referred to this type of car and considered the system an excellent one when a uniform fare is in operation, although it would not be applicable to the conditions generally prevailing in this country. At this Conference engineering matters were not discussed to any great extent, attention being paid rather to management topics, which are, of course, of equal importance, although we cannot give so much space to them in the columns of *The Electrician*.

The Postmaster-General's Report.

THE Postmaster-General's Annual Report, from which we give extracts elsewhere in the present issue, contains several points of interest. With two departments handling wireless telegraphy and telephones respectively the report is necessarily progressive. During the past year 39 licences were granted under the Wireless Telegraph Acts, and of these it is noticeable that 37 were for experimental purposes. The Marconi Company has ceased to occupy the position of contention that it once held, and we do not doubt that the Postmaster-General, as mentioned in the report, is glad to be able to say that the Marconi Company has accepted the present position of affairs and has decided to co-operate with the Government in giving effect to the Convention and regulations annexed to it, rather than to take up an impossible position of antagonism. In regard to telephones, it is interesting to note that the reduction of fees for trunk calls between 7 p.m. and 7 a.m. has resulted in a large increase in the number of calls, sufficient not merely to make good the loss in revenue caused by the reduction, but to bring about an actual increase of about 12 per cent. Managers of generating stations will look with envy on the ease with which a differential rate to improve the load factor can be put into force on a telephone system. A further move in the same direction, shortly to take effect, is the booking of calls for fixed times in the evening. The agitation in regard to telephone rates naturally receives some comment. The Postmaster-General mentions that he has endeavoured to dispel the view that the object of the Government was to make an exorbitant profit out of the monopoly which it will enjoy after 1911. We do not suppose that this will quiet all criticism, but it would be worth while for those who are continually urging the adoption of an unsound tariff to remember that the yearly loss on press telegraph messages, owing to an unremunerative tariff, is very large, amounting last year to £225,000, which has, of course, to be met by the taxpayers. It is scarcely desirable to repeat this policy in the telephone department.

The Marseilles Congress.

CONGRESSES, like exhibitions, undoubtedly have their uses, though it will be admitted that they may sometimes be classed as useless instead of useful. Just as we suffer very often from too many exhibitions, it is also possible to suffer from too many congresses, which sometimes merely give an artificial stimulus to writers of Papers. If a congress happens to be international in its aspirations it becomes a still more serious matter; indeed, it is desirable for a congress to be really international or to make no attempt to be so. From the account of the Marseilles International Congress which will be found on another page, we are inclined to think that this has rather failed to be truly international. Although some countries were well represented, others were by no means so, and thus any resolutions passed fail to carry the weight which they would if the representation had been truly international. In addition to this the numerous sections varied very much in the amount of work allotted to them. Some sections had programmes more extensive than the time warranted, and in others there was practically nothing to be done. Under these circumstances we cannot help thinking it unfortunate that the promoters of this exhibition should have attempted an international congress at all. Such gatherings are required at comparatively long intervals and should not be held unless there is a general feeling that they are really necessary, and only with such support that the resolutions adopted are of international value.

Memorial to the late Lord Kelvin.—It is announced that Mr. A. Bruce Joy has been selected by the committee for the memorial of the late Lord Kelvin to execute the statue to be erected at Belfast.

International Congress on Electrical Units and Standards.—As already announced in *The Electrician*, this conference will assemble in London on the 12th inst. The delegates will be entertained by the Lord Mayor to luncheon at the Mansion House on October 16th, and it is hoped that a number of them will also be present at the annual dinner of the Institution of Electrical Engineers on the 22nd.

Formulæ for Mutual and Self Inductance.—The issue of the *Bulletin of the Bureau of Standards* for August is largely devoted to a consideration by Messrs. E. B. Rosa and L. Cohen of the various formulæ in connection with mutual and self inductance. The Paper is divided into two parts, the second part consisting of a number of examples illustrating and testing the formulæ brought together in the first part of the Paper.

Cable Interruptions and Repairs.

	Date of Interruption.	Date of Repair.
Las Palmas—Arrecife	May 18, 1908 ...	Sep. 26, 1908
Jedda—Suakim	July 27, 1908 ...	Sep. 28, 1908
Paramaribo—Cayenne	Sep. 3, 1908 ...	—
Pontianak—Saigon	Sep. 16, 1908 ...	—
Sitia—Rhodes	Sep. 17, 1908 ...	—
Dardanelles—Constantinople	Sep. 20, 1908 ...	Sep. 25, 1908

University of London.—Sir Arthur Rücker, F.R.S., has been presented by the administrative staff of the University of London with a silver rose bowl on his retirement from the office of Principal. The presentation was made by Mr. Philip J. Hartog, the academic registrar. Dr. H. A. Miers has entered upon his duties as successor to Sir Arthur Rücker.

Corps of Royal Engineers (Territorial).—The announcement of the promotion to a majority in the London Air Line Telegraph Company of Capt. J. H. S. Phillips, and of his transfer from the London Division Electrical Engineers, has been cancelled.

W. D. Elwin has been appointed Second Lieutenant in the Electric Light Company of the Dorset Royal Engineers (T).

Municipal Tramways Association.—At a business meeting of this Association held on Friday last, Mr. A. L. C. Fell (London County Council tramways) was elected president and Mr. C. J. Spencer (Bradford Corporation tramways) vice-president for the ensuing year. In accordance with the usual practice, it is anticipated that the next annual conference will be held in London, as this is the place where the president holds office.

Iron and Steel Institute.—As announced in our last issue, the autumn meeting of this Institute began on Tuesday last at Middlesbrough, under the presidency of Sir Hugh Bell. The Mayor of Middlesbrough (Councillor T. G. Poole) welcomed the visitors, and after suitable acknowledgment by the President, the reading and discussion of the Papers submitted were commenced. It was announced that Sir Hugh Bell will be succeeded in the presidency by Sir Wm. T. Lewis, a prominent South Wales ironmaster.

The Institution of Municipal Engineers.—At a meeting of the Executive committee of this Institution it was decided that, recognising the great possibilities of an Institution of Municipal Engineers in the widest sense of the term, men holding important appointments under local authorities as electrical, gas, mechanical and water engineers should be eligible for election to membership of the Institution. Further particulars of the aims and objects of this Institution can be obtained from the Secretary at 10, Eagle-place, Piccadilly, London, W.

Electric Traction on the Russian Railways.—It is announced that a conference will shortly be held in Russia to discuss the advisability of introducing electric traction on the principal main lines. The general managers and chief engineers of the various railway systems in that country have been invited to attend. It is proposed to consider the conversion of the following lines: (1) From St. Petersburg, via Vilna and Kieff, to Odessa; (2) St. Petersburg, via Moscow and Charkow, to Sebastopol; and (3) St. Petersburg to Warsaw.

Railway Accident in Berlin.—A serious accident occurred on the Berlin Elevated Railway on Saturday last, resulting in the death of 17 persons and in the injury of an equal number. Readers of *The Electrician* will remember that one of the features of this railway is a triangular junction near the Potsdamer Bahnhof. It was at this point that the accident occurred, one train taking the other practically broadside on. One car was tipped over the viaduct and several of the others were badly damaged. The accident is said to have been due to one of the drivers over-running a signal and not to any electrical effect.

Legacies to Learned Societies.—Reuter's correspondent in Berlin announces that the Academy of Sciences (in that city presumably) has received a legacy of £1,500,000, being the entire fortune of a millionaire named Samson, who recently died at Brussels.

In a letter to the President of the Académie des Sciences, M. Jean Becquerel announces that his father has left 100,000fr. (£4,000) to that institution. This sum has been bequeathed by the donor in memory of his father and grandfather who, like himself, were members of the Académie. The use to which the money is to be put is left to the discretion of the Académie.

"Electrical Engineering."—We have received a copy of Part I. of a new serial of the above title which is being issued by Messrs. Cassell & Co., and which is to be completed in 14 fortnightly parts. The work has been written by Mr. H. H. Simmons, A.M.I.E.E., lecturer in electrical engineering at Finsbury Technical College, and will ultimately be published in one volume of over 900 pages, when we may have an opportunity of reviewing it. From the summary of the contents which accompanies Part I. we notice that the complete volume will contain 13 sections, and will cover practically the whole science of electrical engineering, including telegraphy, telephony, electro-deposition of metals, electric traction, electric lighting and meters, transmission and distribution, switchgear, &c. In the convenient fortnightly parts it will probably appeal to a large number of artisans and other workers in the electrical trades.

Wireless Telegraph Notes.—The *Elektrotechnische Zeitschrift* states that Mr. Poulsen has been experimenting between Lyngby and Esbjerg with some equipment which is similar to the well-known Wheatstone apparatus used in ordinary telegraphy. By its means, it is said, a transmitting speed of 100 words per minute can be reached, and the inventor hopes shortly to increase this to 150 words per minute. Experiments are also being carried out between Lyngby and Newcastle.

The same journal announces that a "wireless" station has been opened at Nieuport in Belgium. This is said to be the first to be put in operation in that country.

It is announced that the Admiralty have leased from Ipswich Council 4 acres of land upon which an extensive wireless telegraph station is to be erected and equipped, especially for communication with vessels on the North Sea. Electrical energy will be taken from the Corporation electricity department, whose works adjoin the land acquired by the Admiralty.

Mr. Marconi has stated that the duplicate station in the Atlantic service is to be completed by the end of the year, and that an overland wireless system across Canada is to be the next development he proposes to take in hand.

The Scientific Control of Fuel Consumption.—The keynote of Prof. H. E. Armstrong's Paper on this subject, read at the autumn meeting of the Iron and Steel Institute at Middlesbrough, is the cut-throat policy pursued with regard to the world's raw materials, especially fuel, both coal and oil. He is of the opinion that, in allowing the unrestricted export of our manufacturing life, we are parting with our heritage at a very small fraction of the potential value. He therefore pleads for something more than the mere occasional control of fuel consumption, whether in ironworks or elsewhere, and for the introduction of a new attitude towards the problems of combustion and fuel economy. In this connection ignorance has not a little to do with our difficulties, and is helped by our calm contempt of the complexities surrounding the whole subject of combustion. It has, however, been shown that moisture is a necessary factor, but the process is by no means simple, and scarcely anything is known of the influence of surfaces on the interchanges involved in combustion. This subject is of great importance from a practical point of view, on it depending the way in which fuel is utilised. The author then passes on to consider the methods at present in use for converting our fuel into energy, and shows that they are, on the whole, highly inefficient, while the direct conversion of the energy latent in fuel into electric energy presents many difficulties. In conclusion, he appeals for more chemistry in engineering and for a more rigid control of our irreplaceable stores of fuel.

ARRANGEMENTS FOR THE WEEK.

FRIDAY, October 2nd (to-day).

IRON AND STEEL INSTITUTE.

Conclusion of the Autumn Meeting at Middlesborough.

MONDAY October 5th.

SOCIETY OF ENGINEERS.

7.30 p.m. Meeting at the Royal United Service Institution, Whitehall. Paper on "The History of Mechanical Traction on Tramways and Roads," by Mr. H. Conradi.

GLASGOW ELECTRICITY DEPARTMENT.

The results obtained by the Glasgow electricity department during the financial year ended May 31, 1908, are, in our opinion, as nearly ideal as possible. The undertaking had a turnover of over a quarter of a million, and the surplus after all charges had been paid, including £50,000 for depreciation, was only £910. This amount has been carried to the reserve fund, which now stands at £22,214. As shown in more detail below, the gross revenue was £253,401, the working expenditure £115,316, the capital charges £51,061, and the sum set aside for depreciation £50,151, making the total expenditure under all headings £252,491.

As a result of the year's operations and from the fact that the contracts for coal for the coming year have been fixed at rates considerably less than those of the previous year, the committee have proposed a reduction in the charges for current both for private and public lighting. The uniform charge for lighting to domestic consumers, churches and public schools (under certain restrictions) have been reduced from 3½d. to 3d. per unit and the charge for street lighting from £14 and £12 per lamp per annum to £12 and £10 respectively. Energy for heating is charged at 1½d. per unit for amounts up to 1,000 hours per annum of maximum demand and ¾d. per unit afterwards. Advantageous prices are also given to power users depending on the particular case.

Considerable additions have been made to the plant at the various power stations. These include a 4,500 H.P. turbine with the necessary additional steam raising plant, while a 5,500 H.P. set is on order for use during the coming winter. When these sets are in working order the capacity of the station will be 28,000 H.P. At the Pollokshaws station a 5,500 H.P. turbo-generator has been added, bringing the capacity of the station up to 16,200 H.P. Three 1,000 kw. and one 500 kw. rotary convertors have been put in commission at the various sub-stations. In addition to this plant there are four large consumers whom it has been found convenient to supply through transforming plant placed on their own premises. This plant has an aggregate capacity of 2,000 H.P. 23½ miles of feeders and 8½ miles of distributors have been laid during the year.

We give below an analysis of the expenditure during the past financial year together with the cost of working per unit sold both for last year and for 1906-7 :—

		Cost per unit sold. 1907-8.	1906-7.
Generating Costs.			
Fuel and carting	£42,869 4 4	0·314d.	0·249d.
Oil, waste, &c.	2,679 4 11	0·020d.	0·026d.
Salaries and wages	13,013 9 5	0·095d.	0·101d.
Repairs and maintenance	8,360 14 10	0·061d.	0·079d.
Units purchased from Tramways department	—	—	0·065d.
Total Generating Costs	**£66,922 13 6**	**0·490d.**	**0·520d.**
Distribution Costs.			
Repairs and maintenance	£8,198 7 3	0·060d.	0·082d.
Salaries	2,789 12 2	0·020d.	0·023d.
Attending and repairing public lamps	3,833 0 8	0·029d.	0·034d.
Total Distribution Costs	**£14,821 0 1**	**0·109d.**	**0·139d.**
Management Costs.			
Salaries	£5,826 1 1	0·043d.	0·057d.
Establishment charges	4,389 5 1	0·032d.	0·027d.
Stationery, printing	1,414 17 8	0·010d.	0·013d.
Rents, rates and taxes	21,943 1 10	0·160d.	0·212d.
Total Management Costs	**£33,573 5 8**	**0·245d.**	**0·309d.**
Total Costs (*ex* Cap. Charges)	**£115,316 19 3**	**0·844d.**	**0·968d.**
Capital Charges.			
Depreciation	£50,151 5 11	0·367d.	0·381d.
Interest	54,714 17 3	0·400d.	0·452d.
Sinking fund	32,308 6 8	0·236d.	0·220d.
TOTAL CAPITAL CHARGES	**£137,174 9 10**	**1·003d.**	**1·053d.**
TOTAL COSTS (including Capital Charges)	**£252,491 9 1**	**1·847d.**	**2·021d.**
TOTAL RECEIPTS from all sources	**£253,401 18 9**	**1·854d.**	**2·049d.**
BALANCE carried to Reserve Fund	**£910 9 8**	**0·007d.**	**0·028d.**

During the year the capital expenditure amounted to £147,798, the principal items being £56,897 for machinery and plant and £59,093 for mains and cables.

The capital account to May 31, 1908, is given below :—

Capital Account.		Per kw. installed.	Per cent.
Land and buildings	£227,698 0 5	£8·45	13·47
Machinery and plant	477,177 2 9	17·68	28·78
Accumulators	9,642 19 1	0·33	0·52
Mains and cables	905,580 13 11	33·56	53·48
Meters	51,183 8 7	1·89	3·00
Electrical instalments	1,447 4 2	0·05	0·07
Laboratory plant	1,320 17 2	0·04	0·06
Furniture	2,713 17 7	0·10	0·15
Transformers on consumers' premises	8,320 10 6	0·30	0·47
Total Capital Expenditure	**£1,685,083 14 2**	**£62·40**	**100·00**

The magnitude of the undertaking can be seen from the fact that 26 consumers have an annual consumption exceeding 100,000 units, and, as the aggregate consumed by them is 8,221,934 units, the excess over 100,000 must in some cases be considerable. The units generated amounted to 40,153,676, as against 32,052,937 in 1906-7. All these units were generated from the department's three stations at Port Dundas, Pollokshaws-road and Kelvin-side. No units were purchased from the tramways department, as against 1,644,468 so obtained in 1906-7.

The number of consumers was 16,926, as compared with 15,497 at the end of 1906-7, being an increase of 1,429, or 9·22 per cent. during the year. There were 303 lighting consumers who consumed the equivalent of 5 hours or more per day of their maximum demand throughout the year, the consumption under this head amounting to 2,309,145 units in all. The total number of motors supplied off the Corporation mains was 3,853, with a total horse-power of 23,748, as compared with 3,302, with a total horse-power of 19,805 in 1906-7. The number of units consumed for power purposes was 15,222,859, of which 4,450,327 were sold at 1½d. per unit, 1,582,292 at 1d. per unit and 9,190,240 at ¾d. per unit. The total number of arc lamps in regular use was 837, the same number as last year, and the quantity of electricity consumed for street and stair lighting was 1,707,485 units, as compared with 1,655,005 units during the preceding year. The number of equivalent 8 c.p. lamps connected to the mains on May 31, 1908, was 1,551,997, as compared with 1,404,553 at the corresponding date last year, being an increase of 147,444. The number of units consumed by private consumers per lamp fixed averaged out month by month, according to the date of connecting up, was 20·77, as compared with 19·42 last year. The maximum load upon the generating stations during the year occurred on December 16th last, when it was 22,186 kw., as compared with 19,646 kw. in the previous year, being an increase of 12·93 per cent.

Commercial Lectures on Electrical Engineering.—At the Handelshochschule, Berlin, arrangements have been made for the delivery during the winter session of a series of lectures on the commercial and business aspects of applied electricity by Dr. Alfred Berliner, manager of the Siemens-Schuckertwerke A.G. After a preliminary survey of the early history of electrical engineering, the lectures will deal with the economic aspect of electricity supply and its influence on the trade and industry of a district, the relations of capital and labour in the manufacturing branch of electrical engineering, the location of works, the selection and purchase of raw materials and fuel, the organisation of selling departments, the position of "cartels" and syndicates, &c. The finance of electrical engineering will also receive due attention.

THE MANCHESTER ELECTRICAL EXHIBITION.—I.

A GENERAL SURVEY OF THE EXHIBITS.

Since the great Electrical Exhibition held at Olympia in 1905 there has been no aggregation of electrical machinery and apparatus on a large scale, either in London or the provinces. Manchester is setting a good example to the greater of our industrial centres by opening to-morrow an extensive display of almost everything electrical, from a piece of coal to a metal filament, in a special building on Platt Fields, a suburb on the south side of the city. The idea of the Exhibition appears to have originated with a number of municipal engineers in Lancashire, more particularly the moving spirit among them being Mr. S. L. Pearce, chief engineer to the Manchester Corporation electricity department, who brought his *confrères* into line, and, with the co-operation of the Electrical Manufacturers' Association, succeeded in gaining support for such an Exhibition. Matters proceeded apace, and the accumulated efforts of all concerned over many months will culminate in the opening of the show to morrow. The whole of the available space has now been allotted. The total number of stands amounts to some 320, occupied by over 270 actual exhibitors. On Monday next the Lord Mayor of Manchester, the Mayor of Salford, and some 25 other mayors from the towns supporting the exhibition in this immediate district will pay a visit to the Exhibition and be entertained at lunch by the management.

So little interest attaches to the building that, apart from the fact that it was erected expressly for the Exhibition, and is made almost entirely of wood, it calls for no comment. The actual floor area is over 100,000 sq. ft., and over 270 exhibitors have been accommodated. The whole of the energy for lighting, heating and power is furnished by the Manchester Corporation, who have a sub-station in the centre of the building, equipped with transforming machinery. In addition to high and low tension switchboards, which have been supplied by Messrs. Ferranti Limited, there are three converting units, one a Bruce Peebles motor converter, another a G.E.C. motor-generator and a third a British Westinghouse rotary converter. The latter company also supplied the transformers for their machine. Each modern type of sub-station plant is, therefore, represented in this equipment, and a most imposing collection it makes. The E.H.T. switchgear (6,600 volts) is of the concrete cell type built up vertically in compartments, which terminate in the 'bus bar chambers at the top of the column. Oil switches, placed immediately behind the control handle, and provided with suitable overload relays, are provided in the equipment. The low-tension board is of the usual steel framework pattern with black enamelled slate panels, carrying all fittings, switches, &c., at the front, and terminals, cable connections, &c., at the back. The distribution is carried out by feeders run across the roof principals to Reyrolle distribution fuse boxes in various parts of the building. All the sub-circuit wiring and feeders are overhead and well in sight and in each case are insulated from their supports by porcelain insulators.

Separate mains have been run for lighting and power, and meters and suitable switches are placed on each stand.

The General Committee consists of the following :—

President : The Earl of Derby. *Vice-Presidents :* The Lord Mayor of Manchester, the Mayor of Salford and Sir Wm. Preece, K.C.B. *Chairman :* Councillor W. Kay (Deputy Chairman, Manchester Corporation Electricity Committee). *Deputy Chairman :* Councillor W. Barrett (Chairman, Salford Corporation Electricity Committee). *General Committee :* A. A. Day (Bolton), T. Roles (Bradford), S. J. Watson (Bury). *Representative of Supply Companies :* C. D. Taite (Lancashire Power Co.). *Representatives of the Institution of Electrical Engineers :* M. B. Field (Ferranti Limited) and C. P. Sparks. *Representative of the Municipal Electrical Association and Nottingham Corporation* : H. Talbot. *Representatives of the National Electrical Manufacturers' Association* : H. H. Berry (Berry, Skinner & Co.), F. H. Nalder (Nalder Bros. & Thompson) and H. Oppenheimer (International Electric Co.). *Representatives of the Electrical Contractors' Association :* J. McDermott (Lancashire Electric Engineering Co.) and Rashleigh Phipps (Rashleigh Phipps & Co.) *Representatives from the General Exhibitors :* H. Bevis (General Electric Co.), C. H. Bishop (Edison & Swan, Ltd.), D. N. Dunlop (British Westinghouse Co.), T. J. Grainger (Sunbeam Lamp Co.) and B. Longbottom (Electromotors Limited). *Consulting Electrical Engineers :* S. L. Pearce and V. A. H. McCowen. *Honorary Consulting Electrical Engineer* : S. G. Castle Russell. *Consulting Architect :* Albert Jennison. *General Manager :* C. S. Northcote. *Secretary :* W. Davenport.

THE EXHIBITS.

For the convenience of our readers we are devoting our present report of the Manchester Exhibition to a *résumé* of the exhibits so that it may serve as a guide to the chief items of interest. We think they will also be assisted by the classification we have adopted, in which the groups of various kinds of plant and apparatus on view are arranged. Our arrangement commences with prime movers for generating electricity, and proceeds through the whole range of apparatus for utilising electrical energy.

PRIME MOVERS.—The exhibits of prime movers include steam turbines and gas, oil and petrol engines. The most imposing exhibit is that of Messrs. JOHN MUSGRAVE & SONS, of Bolton, who have put down a 750 H.P. turbine direct-coupled to a Siemens 600 kw. three-phase alternator. The high-pressure end of the turbine is exposed to view by substituting for the upper half of the cast-iron casing one of glass through which the running and guide wheels can be seen. The machine is kept in motion by an electric motor, and is complete in every respect as to governor, tachometer, steam and vacuum gauges, oil pumps, &c. In another part of this issue (p. 949) will be found a special description of this turbine, which is of the Zoelly type. It is a duplicate of a set at present installed at Falcon Mill, Bolton, a factory of some 100,000 spindles. On another part of the stand is an electrically-driven barring gear, intended for a 4,000 H.P. cross compound vertical engine—the sixth installed—at the City of London Co.'s Bankside station. A superheater attached to the end of a Lancashire boiler completes the exhibit. Other firms interested in the steam turbine among the exhibitors are the Messrs. C. A. PARSONS & Co., who exhibit models of turbines ; the BRITISH THOMSON-HOUSTON Co., the BRITISH WESTINGHOUSE Co. and JAMES HOWDEN & Co.

The heavy oil engine is represented by MIRRLEES, BICKERTON & DAY, of Stockport, who have a three-cylinder Diesel engine running on their stand. The engine develops 150 B.H.P. and is direct-coupled to a direct current generator by the LANCASHIRE DYNAMO & MOTOR Co. Artificial load is fitted on the stand, so that the set can be run on varying loads as well as on different kinds of oil. The cost of running with oil at 65s. per ton is stated as 0·26d. per kilowatt-hour at full load. The company have recently built new works at Stockport for the production of engines of the Mirrlees-Diesel type from 35 to 200 B.H.P. for speeds varying from 400 to 200 revs. per min. A 600 B.H.P. engine is at present being built. In another part of the Exhibition the DIESEL ENGINE Co. is showing an engine in operation direct-coupled to a dynamo. The running gas engine exhibits include a four-cylinder suction plant by CROSSLEY BROS. and several horizontal engines by the NATIONAL GAS ENGINE Co. J. HALCROW makes an exhibit of striking photographs of the Nurenberg gas engine for blast furnace and coke oven gas. Among the pictures is a diagram depicting graphically how these sources of power can be made use of. Messrs. W. J. BATES & Co. also have a gas engine exhibit in which several machines are shown in operation. The petrol engine is represented by a combined set running on the stand of Messrs. DRAKE & GORHAM, the dynamo of this supplying light to Messrs. GOODALL'S electric house which adjoins the stand. Included in our group of prime movers we must place steam boilers and their accessories. Messrs. GALLOWAYS LIMITED have an extensive exhibit, which includes a patent Galloway flue 7 ft. diameter, a front end plate for five-flued boiler, two wrought-steel steam superheaters and a quantity of steam boiler fittings. There is also a model of a complete Galloway boiler and a selection of photographs. Messrs. E. GREEN & SON show their world-famed economiser in model form, with motor attachment driving the scrapers, while their other specialities, among them the Wakefield steam pump, can be inspected. Superheaters are represented on a large scale by the exhibit of Messrs. McPHAIL & SIMPSON, Wakefield. This includes some 17 distinct pieces, ranging from a complete superheater to tubes of various kinds and specimens of the material from which the tubes are made. Among the tubes are examples taken from a Babcock & Wilcox boiler which had been in use continuously day and night for 10 years, despite the fact that the steam was regularly at 700°F. In connection with prime movers the KEY ENGINEERING Co. will show photographs of the Ehrhardt & Sehmer gas engine which has been described in detail in our columns.

The steam engine builders' exhibits include an engine by Messrs. BROWETT, LINDLEY & Co., Patricroft. It is of the quick revolution type with forced lubrication. Piston valves control the admission and exhaust of the steam, and the engine is double acting and may be built with cylinders from one to three in number. Messrs. W. SISSON & Co. also are exhibiting their single-crank enclosed engine for direct coupling to dynamos. This engine is an enclosed high speed machine, specially designed for use with superheated steam. It is built in sizes up to 1,800 B.H.P. The engine is stated to be economical both at heavy and light loads. Boiler-house auxiliaries in the shape of stop valves, mechanical stokers, &c., are shown in various ways by J. HOPKINSON & Co ; J. PROCTOR ; SANDERS, REHDERS & Co. (Sarco CO_2 recorders), ALEXANDER WRIGHT & Co., GEORGE KENT

J. E. LEA, &c. The latter is showing his recorders for the measurement of water passing over weirs or notches. A recorder with notch tank has been set up and is in operation demonstrating the action of the recorder. A full description of the instrument appeared in *The Electrician* (Vol. LXI., p. 143).

ELECTRIC TRANSMISSION.—Under this heading must be placed those exhibits directly or otherwise engaged in the transmission of electricity from the station to the distribution points. The BRITISH INSULATED & HELSBY CABLES have a large stand upon which have been erected a section of a 20,000 volt transmission line, comprising a single pole and two H terminating poles. These poles are 11 in. diameter, and both copper and aluminium wires are attached to them. The observer sees the line as if he was at a point 10 ft. from the ground. Directly opposite this exhibit is an important one by Messrs. BULLERS LTD., who make a feature of their ironwork for insulator supports of the porcelain insulators themselves. In our last issue we described the Tipton works of this company, and in the present issue will be found an account of the company's Hanley pottery works. The transmission line insulators shown include some of the largest made, measuring 14½ in. diameter and 20 in. high. They are designed for a working pressure of 80,000 volts and a pressure test of double this amount; insulator and pin complete weigh 70 lb. A testing transformer forms part of the exhibit, and insulators in artificial rain will be submitted to pressures up to 75,000 volts. Messrs. R. W. BLACKWELL & Co., who are well known as contractors for overhead tramway construction, have included in their exhibit a full size transmission line A pole, which is typical of a number erected by the firm in the Newcastle district and elsewhere. Porcelain insulators for duty up to 80,000 volts and specimens of lightning arresters are being shown. The HOWARD ASPHALT TROUGHING Co. (stand No. 229) take the opportunity to give prominence to the merits of their system of laying underground cables. The features of the system are explained by a number of well grouped samples showing sections of the troughing complete with cables in position.

SWITCH AND MOTOR CONTROL GEAR.—The exhibit of large switchgear and motor starters and controllers is an extensive one, particularly as regards the latter. Messrs. FERRANTI LIMITED, in addition to the high and low-tension boards in the Corporation sub-station, show electrically and mechanically operated switches in operation on the stand adjoining. These are on standard Ferranti lines, and embody similar details to those switches at present in operation in many of the largest stations in this country. On the same stand are numerous specimens of Ferranti motor-starters for direct current motors, the resistance units being practically indestructible and without coils or wires of any kind. Messrs. A. REYROLLE & Co. have on their stand two 6,000 volt ironclad panels, in which all high-tension conductors are completely enclosed. Their starter exhibit is very complete, and a practical demonstration with a motor under brake load will be given of the good qualities of the starter. Such accessories as ironclad plugs, tubular fuses, wall plugs, distribution boxes, &c., will also be features of the exhibit. The Merz-Price system of feeder protection will also be shown under actual working conditions. Messrs. ECKSTEIN, HEAP & Co. are conspicuous in this class of exhibit with a fine show of switchgear and motor-starters of various kinds. The latter particularly include a line of alternating current starters and solenoid switches which are being extensively employed in industrial motor installations. These switches are of the oil type, and are electrically operated either from a distant or near point. One particular pattern acts as a no-volt release switch. The Waverley series of ironclad switches should attract attention, as also should the firm's display of direct current circuit-breakers and switchboards. The stand is shared with ELLIOTT BROS., of Lewisham, London, to whose exhibit we refer under the head of instruments in another column. A large display of switchgear is being made by Messrs. PARMITER, HOPE & SUGDEN, a number of the specialities being ironclad. Certain novelties are being introduced, notably Hope's patent spring or switch fuse. This has quick make and break, both independent of the operating handle, and the break is independent of the main spring. It is gas-tight and interlocked to comply with mining regulations. Motor-starters and starting panels are also a feature of the exhibit. Messrs. WILLMAN, SLAYER & HEAD, who are well known as makers of special controllers for steel works motors and ladle cranes, have embodied a number of these controllers in their exhibit. The controllers are self-contained and the resistance is an integral part of the frame. A feature has been made of a special blow-out fitted to the moving arm of the controller, and only one lever is used for controllers of the reversing type. This is important when a man is operating a charging machine for a steel furnace. Types of this controller are being exhibited, together with numerous accessories and smaller motor starters, among the latter the Dukey controller, which enjoys a considerable vogue. Messrs. [illegible] & BOYDELL are showing the "S.B." contact plugs, which are of the expanding pattern and are made for double and single contacts. By the turning of the handle the plug is tightly expanded in its socket, and can only be withdrawn by turning the handle in the opposite direction. All holes are parallel and no taper on the holes is required. Messrs. BERRY, SKINNER & Co. have a comprehensive exhibit of their well-known ironclad switchgear, including the fool-proof switch-fuse, which practically revolutionised this class on the occasion of its introduction some years ago. The UNION ELECTRIC Co., in the midst of a comprehensive exhibit of their specialities, have a large switchboard set up, together with a quantity of their high-tension ironclad [illegible] oil break switches. These will be found to embody many [illegible] features with which engineers should take an opportunity [illegible] acquainted. Messrs. WHITE & BOLENS make a good [illegible] of large circuit breakers for direct current control [illegible].

standard patterns of both large and small sizes being on view. The well known "Stellite" controllers, motor starters and ironclad switches, will be found on the stand of the ELECTRIC & ORDNANCE ACCESSORIES Co. This stand is near the main entrance and will be found replete with many interesting examples of electrical machinery and apparatus. The ADAMS MANUFACTURING (stand No. 130) have grouped together a wide selection of their Igranic starters and controllers. These are both hand and solenoid operated and include the smallest patterns for light motors and complex gears, for the control of machines of heavy duty. A hydraulic accumulator which is kept charged by an automatically controlled motor is a feature of the exhibit. BERTRAM THOMAS, who are among the pioneers of circuit breakers and switchgear, have assembled a quantity of their standard products among which will be found a number of novelties. Among these will be noticed an adjustable time limit device, automatic starting switches, solenoid operated switches and a line of air pressure limit switches. Messrs. BRAY, MARKHAM & REISS make a display of their starting switches, most of the patterns being of the ironclad type. By the use of these starters the motor can only be brought up to speed slowly. Motor starting switches will also be found at the exhibits of the B.T.-H. Co., GENERAL ELECTRIC Co., and MARPLES LEACH & Co. Most of the above mentioned firms have starting switches and control gear attached to motors and motor driven apparatus in different parts of the exhibition. Messrs. BROOK HIRST & Co. are exhibiting their starters in conjunction with a number of running motors.

MOTORS AND MOTOR-DRIVEN MACHINERY.—By far the most interesting of the exhibits from the respective points of view of the engineering and lay visitor are the electric motors and the machinery to which they are coupled. We hope that the Exhibition will prove an education in itself to power users accustomed to steam, oil and gas engines, where these are employed as power agents. The opportunities for electric power supply in a vast industrial area such as that of Lancashire should stimulate the makers of motors and motor-control gear into a special effort, while the Exhibition is open, to push business in this quarter. The wedge has been well driven in already, but much yet remains to be done before it is pushed home. Without statistics of the small industries in Lancashire at present run by gas, steam and other engines we cannot frame any opinion of the length of time required to convert these to motor driving, but there is plenty of scope if zeal and enterprise are forthcoming.

The LANCASHIRE DYNAMO & MOTOR Co. (stand No. 47) make a comprehensive display of alternating current and direct current motors and other dynamo-electric machinery. Included in this is a 25 H.P. 400 volt 50 period three-phase motor of the semi-enclosed type, with short-circuited rotor of special construction. Copper discs with radial arms are coupled to the rotor rods, and these arms act as fan blades, setting up a cooling current of air. The machine is back geared (Fig. 1), the pinion being of forged steel and the spur wheel of cast-iron; both were supplied by the POWER PLANT Co., who are gear specialists. Other motors are an 18 H.P. semi-enclosed shunt-wound back-geared motor, a 26 H.P. motor of the same pattern, and a standard four-pole motor. An interesting machine is a shunt-wound totally-enclosed pipe-ventilated motor (Fig. 2), having a speed variation of 3 to 1 with shunt regulation. The motor will develop 4 B.H.P. at any speed between 370 and 1,120 revs. per min. The heavier plant shown includes a flywheel equalising set, a motor driven winch and a combined motor-driven fan, the latter being of the "Sirocco" upcast type, with a capacity of 8,000 cubic ft. of air per min. In different parts of the Exhibition the company has 18 motors ranging in size from 3 H.P. to 75 H.P. driving various kinds of machinery. There are also three generators of 13, 100 and 165 kw. capacity on the stands of Messrs. Charles Price & Son, Mirrlees, Bickerton & Day, and Browett, Lindley & Co., respectively. The motors mentioned have an aggregate capacity of 240 H.P.

The exhibit of Messrs. ELECTROMOTORS (stands Nos. 133 and 161) is typical in every way of what can be done with direct current motors ranging in size from ¼ to 50 H.P. In the lay-out of the exhibit the management have had an eye to artistic and effective arrangement, and are to be congratulated on the result they have obtained. In addition to a large number of the firm's standard motors, motor combinations of pump, fan, haulage, lift gears, &c., are shown in different parts of the stand. There is also an interesting application of motor driving to textile machinery, two different types of winding frames being on view. These are of the quick traverse pattern for winding cotton or other yarns. Each machine is controlled by its own motor. Many of our readers will remember that at Olympia Exhibition Messrs. Electromotors had fitted up an automatic controller, which stopped and started the various motors on the stand in turn. This arrangement has been followed on a more elaborate scale at Manchester, and will doubtless attract as much attention as it did in London. A 5 cwt. friction hoist and an open electric pulley block are included in the exhibit, and also a drum haulage set for hauling at 4 miles per hour, this being driven by a 5 H.P. motor. Fig. 3 shows a small dynamo coupled to a two-cylinder petrol engine. Messrs. SIEMENS BROS. DYNAMO WORKS (stands Nos. 86 and 97) show specimens of their alternating current and direct current motors in a comprehensive exhibit, which includes practically the whole range of their specialities. Among the motor exhibits is an interesting loom motor developing ½ B.H.P., and running at 1,000 revs. per min. on a 400 volt 50 cycle circuit. This is shown driving one of Messrs. Robert H. Hall & Sons' looms, and is fitted with a spring belt tightening arrangement (Fig. 5). Three alternating current motors are shown of 50, 3 and ¼ H.P. respectively, the first mentioned being wound for 500 volts. A number of small shunt motors are shown, among which is a "Dental" motor developing ⅛ B.H.P. at 200 revs. per min., this being complete with stand, universal joint spindle and flexible shaft. A large number of double fans are also shown, and several of the company's motors are in use on different stands about the Exhibition. Messrs. MAWDSLEY'S LTD. (stand No. 284A) show several types of their well known

" zone " dynamos and motors, these including lift and crane motors, a back-geared motor and a motor-generator. We understand that these machines are complete in sizes ranging from $\frac{1}{4}$ to 250 H.P. THE CONSOLIDATED PNEUMATIC TOOL CO. (Stand No. 225) who have specialised in electrically-driven portable tools for many years, have a large display of drilling machines and magnetic drilsl. These machines range in capacity from a small breast drill, capable of drilling holes $\frac{3}{8}$ in. diameter in steel, to large machines for drilling up to 3 in. in the same metal. The company are also showing several of their electrically driven wire rope hoists and grinders (Fig. 6). The UNION ELECTRIC CO. (stands No . 175 & 231) make a big show of motors on their stands, the machines exhibited ranging in size from $2\frac{1}{2}$ to 32 H.P. in the direct current types, and a number of three phase machines from $2\frac{1}{2}$ to 12 H.P. are also shown. The parts of these machines are strictly interchangeable, and we understand that the motors

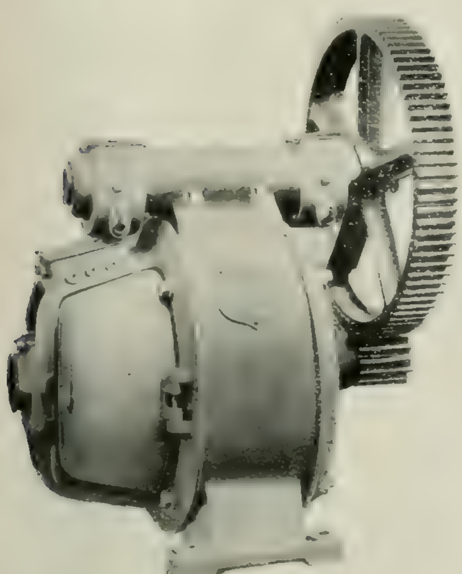


FIG. 1.—" LANCASHIRE " BACK-GEARED MOTOR.

are capable of carrying heavy overloads with low temperature rise. Many of these machines have been applied for factory driving and other industrial purposes. The alternating current machines are made both with and without slip rings. The motor driven specialities are represented by a number of machines. There is a direct coupled pressure pump, a centrifugal pump and an air compressor, the latter being of Messrs. REAVELL & CO.'s make, and the motor is of the Union enclosed ventilated type. The CRYPTO ELECTRICAL CO. (stand No. 302) make a good display of alternating current motors ranging in size from $\frac{1}{8}$ to 16 H.P. They also show a line of direct current motors from $\frac{1}{8}$ to 3 H.P.. The principal

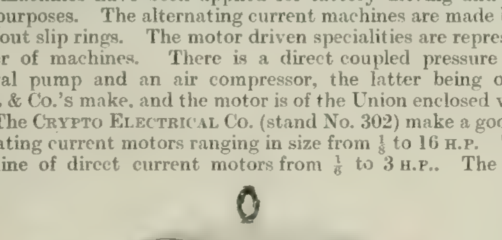


FIG. 2—PIPE-VENTILATED D.C. MOTOR EXHIBITED BY LANCASHIRE DYNAMO AND MOTOR CO.

speciality of this firm is a special range of alternating current to direct current rotary transformers, the smallest size having an output of 100 watts. Both the motor and dynamo are fitted in the same frame. They also have on the stand several alternating current to direct current motor-generators, one of which is transforming the 400 volt three-phase supply to direct current for lighting the Osram lamps which illuminate the stand. Rotary converters for charging accumulators from alternating current mains are also shown.

The principal exhibits of motor driving relate chiefly to machine tools. The BATEMAN MACHINE TOOL CO. (stand Nos. 90 & 91), who have a reputation for high-speed planers, are showing a 36 in. by 36 in. by 10 ft. patent top speed planer, driven by a Siemens motor Three cutting speeds of 20, 40 and 60 ft. per min. are provided, the return speed being 180 to 190 ft. per min. Messrs. ALFRED HERBERT (LTD.,(stands Nos. 87 & 96) show

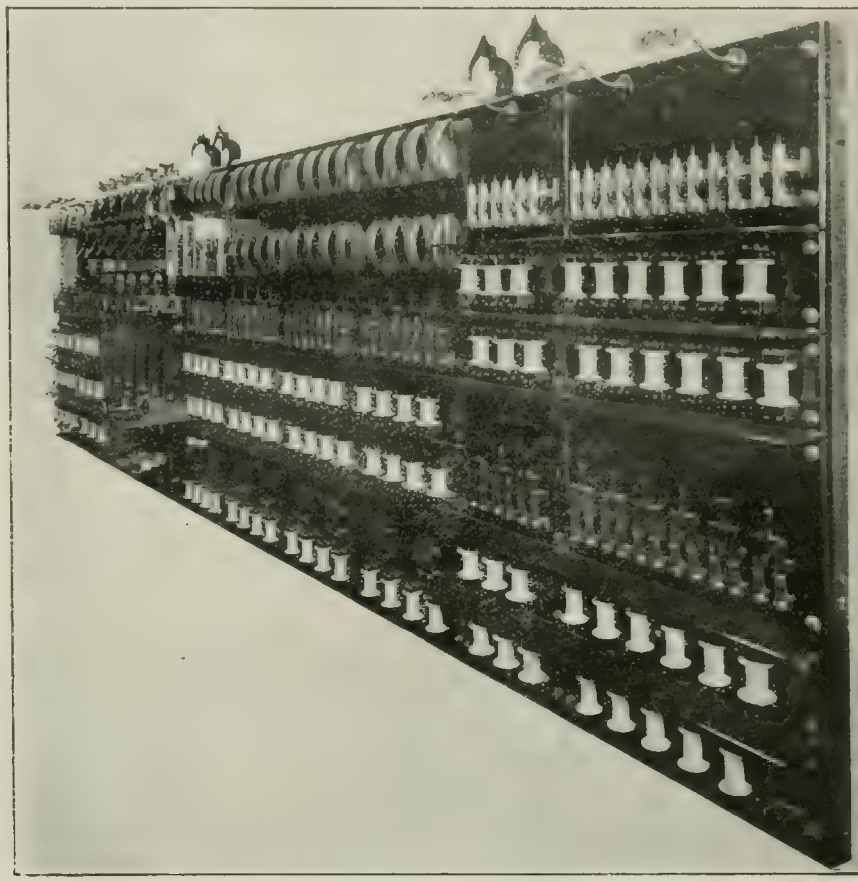


FIG. 3.—FERRANTI L.T. SWITCHBOARD (INCOMPLETE) IN THE EXHIBITION SUB-STATION.

a " Hexicon " turret lathe driven by a constant-speed motor fixed on the floor, and connected up to the machine by belt. This lathe will be shown in operation making heavy reductions in diameter at high speeds and coarse feeds. The lathe will admit bars up to $2\frac{1}{4}$ in. in diameter, and has a working stroke of 30 in. Other tools represented are an automatic turning lathe, a ball-bearing sensitive drilling machine, horizontal milling machine, and a vertical milling machine. Messrs. FRANK PEARN & CO. (stands Nos. 178 & 228) have a number of pumps on show driven by electric motors, these being in motion under working conditions. A 35 H.P. Westinghouse motor drives a three-throw ram with a capacity of 9,600 galls. per hour against a head of 600 ft. Another pump of similar capacity is coupled to a B.T.-H. motor of $17\frac{1}{2}$ H.P. A similar double ram pump of 6 in. stroke and a capacity of 2,560 galls. per hour, against a head of 220 ft. is shown coupled to a 4 H.P. G.E.C. motor running at 1,000 revs. per min. A 9 H.P. motor of the same make and speed is coupled to a three-

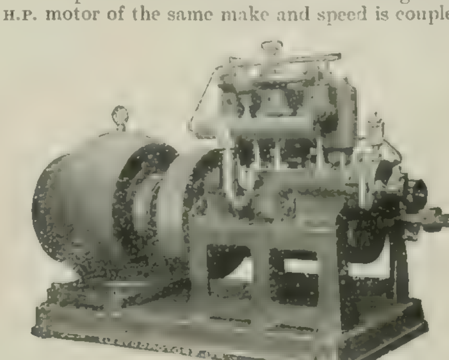


FIG. 4. —" ELECTROMOTORS " DYNAMO COUPLED TO PETROL ENGINE.

throw ram pump. An 8 H.P. " Electromotors " motor drives a single-throw pump with a capacity of 270 galls. per hour. The exhibit is one of the most complete in the Exhibition of electrically-driven pumps, and indicates in a striking manner what can be done with the electric motor for this class of duty. On another part of the stand is a high speed surfacing, boring, milling and drilling machine (Pearn's patent), driven by $5\frac{1}{2}$ H.P. " Electromotors " motors running at 650 revs. per min. This machine tool is one of the novelties of the Exhibition and will be shown in operation on various kinds of work. Other machine tools shown are those of Messrs. POLLOCK & MCNAB) stand No. 110), CUNLIFFE & CROOM

stand No. 296), MAYER & SCHMIDT (stand Nos. 8 and 55), THOMAS ROBINSON (stand Nos. 23 and 45), STANDARD MACHINE WORKS (stand No. 239), and AUTOMATIC MACHINE CO. (stand Nos. 255 and 256). Users of fans and ventilating apparatus will be interested in the exhibit of Messrs. JAMES KEITH & BLACKMAN Co. (stand No. 74), who are well known in this particular sphere. We understand that the firm is making the first public exhibit of a low-pressure blower or extractor for moving large volumes of air. This machine is silent in running and the form of blades is such as to equalise the discharge of the air over the whole area of the wheel. The machine has no internal stays and both fan cases and wheels are electrically riveted and welded throughout. In addition to this new blower a wide range of the firm's standard fans and blowers will be shown under actual running conditions. The K.B. electric forge blowers for alternating current and direct current motors should attract considerable attention as they are extremely light and compact. Messrs. MATTHEWS & YATES (stand No. 109) have a comprehensive exhibit of their Cyclone specialities which will doubtless be a centre of interest to station engineers. Five electric propeller fans will be shown in operation. The range of Cyclone fans and blowers is a very extensive one, and the operations of Messrs. Matthews & Yates will include dust-extracting and refuse-collecting plants on the exhaust principle. A large number of installations of this character have been carried out in various parts of the world, and full details will be furnished at the stand. These dust-extracting plants have been applied to saw mills, textile factories, paper works, collieries, &c., with every success. Most of the machinery in the Exhibition driven by electric motors is operated by belt, but the exhibit of Messrs. HANS RENOLD (stand No. 40) comes as a strong reminder to power users that the chain has a field of its own, and can be efficiently employed for the transmission of power, particularly where heavy loads have to be dealt with. The firm manufacture as well as driving chains the necessary sprockets, cutters, &c., for these. They are giving prominence on their stand to silent chains for high-speed driving,

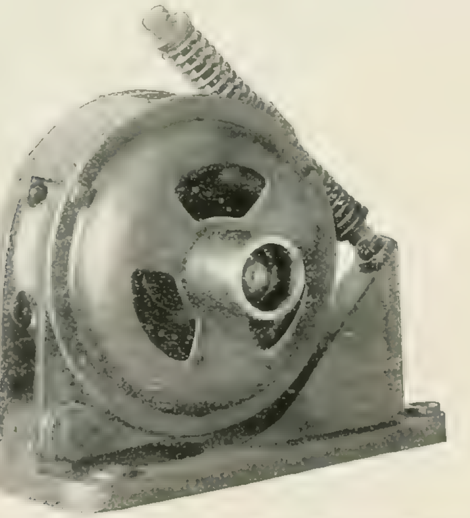


FIG. 5. SMALL SIEMENS MOTOR FOR TEXTILE MACHINERY.

roller chains for medium speeds, and block chains for low speeds. A motor-driven rotoscope with a silent chain running at 1,000 ft. per min. will be one of the features of the exhibit, the arrangement of the device being such that by looking through an eye-piece the actual contact of the chain and wheel teeth can be observed, just as if the chain were standing still. This rotoscope was fully described in *The Electrician*, March 15, 1907, p. 852. The company has specimens of its silent chains running on three of the machine tool and one of the printing machine exhibits in the Exhibition. The CLIPPER BELT HOOK CO. (stand Nos. 300A and 301A) are showing their well-known belt hooks and tools on the "Clipper" system. The device is an extremely simple one, and we understand is very largely used by power consumers. The POWER PLANT CO., gear specialists, make a striking display of machine cut and cast gears of every discription. They are the sole makers of machine cut double helical gear wheels with staggered teeth, under Wust's patents. Specimen wheels and gears are on view many of them being shown in operation. The special helical gear mentioned above can be made in sizes up to 14 ft. diameter, 30 in. face, a wheel of this size being capable of transmitting 1,500 H.P. at 30 revs. per min. The ELECTRIC & ORDNANCE ACCESSORIES CO. on a large and attractive stand near the entrance, show several types of direct current motors, both individually and coupled to "Ordnance" fans. The latter are very economical in energy consumption, and efficient in the moving of large volumes of air.

ARC LAMPS.—In addition to the "Oriflamme" lamps referred to above, a large number of different types of arcs are being shown. The [illegible] ELECTRIC CO. (stand Nos. 175 & 231) make a bold display with their famous "Excello" arcs. Eight of these are fitted in the roof of their stand, four being on a direct current circuit and four on an alternating current. The management state that the placing of these two types of lamps side by side has been done to prove that the alternating current "Excello" lamp is equally as satisfactory as its direct current brother. The lamps are shown burning both yellow and white flame carbons, the latter being, of course, suitable for the illumination of coloured goods. Two sets of arc lamps are also hung from the roof for colour-true shadowless illumination. The eight arches which comprise the boundaries of the stand are fitted at their apexes with "Koh-i-noor" arc lamps of a new type, and the other exhibits of arc lamps include a range of the enclosed pattern, several of which are made specially for photographic purposes. Messrs. DRAKE & GORHAM are making a feature on their stands (Nos. 127 & 164) of a display of "Jandus" regenerative flame arc lamps. These have an effective life of 70 hours with one pair of carbons and have the advantage of being simple in construction while they can be trimmed easily. Messrs. SIEMENS BROS. DYNAMO WORKS (stand Nos. 86 & 87) have a number of arc lamps on view, notably the "Lilliput" lamp, which is exhibited in four different sizes. It is of the enclosed pattern, and intended specially for shop window lighting. The "Arco" flame lamp is to be seen at the stand of Messrs. J. & H. GROSVENER (stand No. 210). This lamp has a number of interesting features which will doubtless appeal to visitors.

The "Angold" flame arc lamp exhibited by the GENERAL ELECTRIC Co. should attract considerable attention on account of its long burning life. This is stated to be 70 hours, and is obtained by the use of a magazine fitted to the lamp. The "Flamgold" arc lamp (1908 pattern) is also being shown and it will embody several improvements by which a stated feed, evenness of burning and absence of strain on the lamp mechanism are secured. The General Electric Co.'s shuntless arc lamps of the enclosed pattern will also be on view. From a general lighting point of view Messrs. GOODALL'S (stand No. 163) electric house will probably attract the greatest attention. This has been built in the bungalow style, rough cast, with red tiled roof and overhanging door canopy. Entrance is obtained by a "Sesame" door, which opens when the visitor steps on the mat. There are several rooms which have been artistically furnished, and different schemes of lighting have been worked out in each. The kitchen is fitted up entirely with electric heating and cooking apparatus as well as a number of machines for boot and knife cleaning, chopping, mixing, &c. Messrs. DRAKE & GORHAM have been responsible for the lighting installation throughout the house and for the fittings in the drawing room, hall, kitchen and bedroom. A small petrol engine driving a dynamo and operating in conjunction with a battery of accumulators comprises the plant required to light the house and furnish

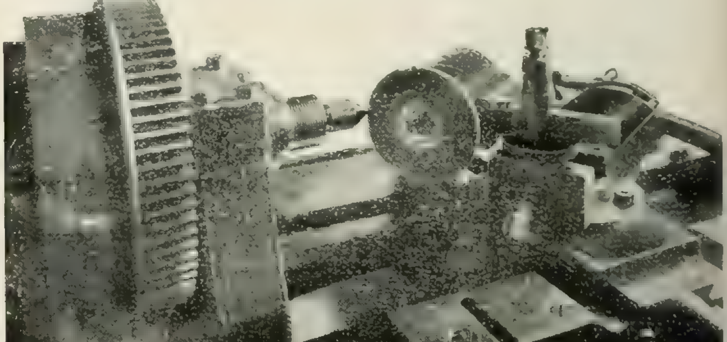


FIG. 6.—ELECTRIC GRINDER AT WORK ON LATHE CENTRE (CONSOLIDATED PNEUMATIC TOOL CO.).

energy to the other apparatus. The Victor Flame arc lamp which has converging carbons above the arc is shown on the stand of the ELECTRIC & ORDNANCE ACCESSORIES CO., in a most effective position near the entrance.

LIGHTING EXHIBITS.—Before dealing with the lighting exhibits, which are, naturally, very extensive, we may remark upon the general illumination of the Exhibition. The approach to the Exhibition is lighted by a number of flame arc lamps on the main gates. On the road frontage are a number of festoons of incandescent lights arranged on the fairyland system. These are also strung from the main gates to the Exhibition building on poles, every alternate one of which carries a flame lamp. The main pinnacle of the building is crowned by a group of flame arcs, as are also the side towers. Lamps on the same fairyland system have also been arranged to connect these points, so that the general illuminating effect at night will be very attractive. Over the main entrance is a large sign "Electrical Exhibition," which is also illuminated. The lamps used are Robertson with carbon filament and a colour scheme has been worked out with them. The bulk of this work has been carried out by Messrs. PEARSON & CO., electrical contractors, Manchester. The interior of the building is lighted by 28 "Oriflamme" lamps supplied by Messrs. OLIVER ARC LAMPS, Woolwich. This type of lamp has now taken up a distinct position both for street lighting and for interior illumination. It is of the magazine pattern, and has a burning life of from 36 to 40 hours with each trim, the magazines holding from six to nine pairs of carbons. The lamps have been hung over the main halls and will furnish an abundance of light both at night and during the dark days.

INCANDESCENT LAMPS.—The metal filament lamp will, of course, be one of the great attractions of the Exhibition, and many different types will be on view, including a number of lamps which are appearing this season for the first time. Messrs. SIEMENS BROS. DYNAMO WORKS have a show case containing samples of standard tantalum lamps and parts of the lamp illustrating the process of manufacture. Their own stand is brilliantly illuminated with these lamps, and quite a considerable number

have been installed on and about the stands of other exhibitors. The display is altogether a particularly fine one, and should assist in materially bringing this lamp before the notice of users of electrical energy. The GENERAL ELECTRIC Co. are also well to the fore with the Osram lamp, which is to be seen on their stands (Nos. 132 & 162) in both the high and low voltage patterns. It will also be noticed during a tour of the Exhibition employed for the illumination of every class of electrical machinery and apparatus. Messrs. EDISON & SWAN (Stands Nos. 22 & 46) are making a feature of their "Metfil" lamp, which practically makes its bow to the electrical public this season for the first time. It is manufactured in sizes suitable for most of the standard voltages, the higher voltage lamps giving also a high candle power. The SUNBEAM LAMP Co. (Stands Nos. 200 & 201), who have achieved a reputation as makers of carbon filament lamps are bringing out the "Sunbeam" metal (Tungsten) lamps, which are a recent development and are produced in a full range of pressures from 25 to 250 volts. The efficiency is stated by the makers to be 1¼ watts per c.p. The makers claim practical immunity from breakage during transit, owing to the form of the filament and the shortness of the bulb. The same company also make a large display of their standard Sunbeam lamps, accessories, and fittings. They have also arranged for a show of advertising specialities in the shape of flashing and other signs. Messrs. G. M. BODDY & Co. (Stand No. 198) are exhibiting a metal filament lamp which was brought well to the front during the last lighting season and is known as the "Metalik." This also enjoys the now common range of voltages for this type of lamp, its efficiency being also similar. We understand that for the lower voltage lamps the candle-power has also been reduced. The exhibit has been so arranged that the

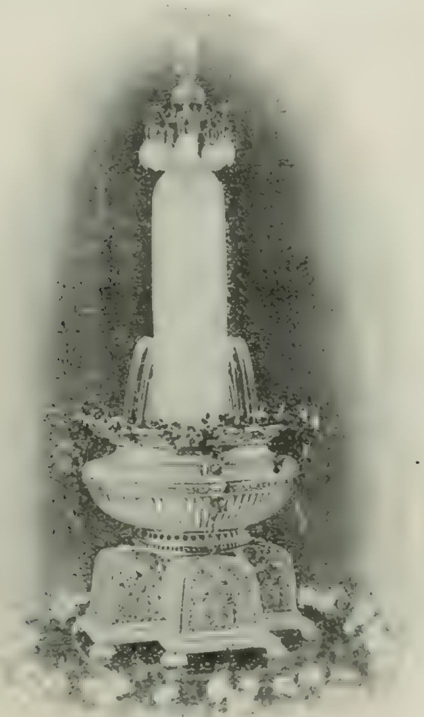


FIG. 7.—KEITH-BLACKMAN ELECTRIC FOUNTAIN.

efficiency of the lamps will be practically demonstrated. Messrs. DRAKE & GORHAM (Stands Nos. 127 & 164) make a display of metal filament lamps of the Tantalum and Osram types, both on their own stand and in the electric house adjoining. Messrs. FALK, STADELMANN (Stand No. 145), who have introduced this season a new metallic filament lamps known as the "Serius-Efesca," are exhibiting this lamp in various sizes and voltages. The feature of the lamp is a special method of supporting the filament by means of small central forks, which tend to press it slightly out of the vertical and render it comparatively free from risk of breakage due to vibration. The splaying of the filament also assists in the downward distribution of the light. ROBERTSON ELECTRIC LAMPS, LTD., will have the only electric lamp making exhibit, and this will closely resemble their display which attracted so much attention at Olympia. Certain processes cannot be shown owing to the stringent regulations governing public exhibitions. The firm has recently acquired a large English glass works and a model of one of the glass cones at these works will be on view.

HEATING AND COOKING APPARATUS.—Visitors to the Exhibition will find that several interesting exhibits of electric heating and cooking apparatus have been arranged, and these will be shown in actual operation. The GENERAL ELECTRIC Co. is making a good display with its "Archer" system of electric cooking utensils, and also of its ovens and stoves. In addition, it has an extensive assembly of radiators, from which selections can be made to suit the pockets of almost every class. Most of the large firms are making a display of radiators, which will not fail to attract attention. Messrs. PEARSON & Co. have an electric oven in operation on their stand (No. 258), which will be presided over by an experienced cook. The preliminary particulars of the Exhibition which have come to hand do not appear to contain any details of novelties in the cooking apparatus line, but these may possibly show themselves during the Exhibition. The various demonstrations which will be given should stimulate interest in electric cooking and heating, and doubtless many consumers of electrical energy will take steps to instal a kettle or saucepan, or some small article which will ultimately lead to an installation on more comprehensive lines.

Under the head of electric heating we may include welding apparatus, a display of this being given on the stands (Nos. 28 and 41) of the BRITISH INSULATED & HELSBY CABLES. Two forms of the "Prescot" welder, Nos. 4 and 6, are being shown in actual operation. One of these is welding brass up to 0·4 in. in diameter, or iron and steel up to 0·75 in. diameter. It is being supplied with current from one phase of the three-phase mains of the Exhibition at 400 volts 50 cycles. An exhibition of "spot-welding," a method recently introduced to replace riveting in sheet iron and hollow ware, will also be given with this machine. The No. 4 welder is a smaller machine, which will also be shown in operation.

INSTRUMENTS, METERS &c.—Although the primary exhibits are intended to excite popular interest, engineers and electrical men will find a good show of meters and instruments in different parts of the exhibition. Messrs. FERRANTI LIMITED. have a collection of their well-known meters on their stand which adjoins the substation. The meters are for alternating current and direct current circuits, both in consumers' premises and for switchboard use. A large number of Ferranti instruments are also to be seen on the switchboards in the substation. A special show of meters is being made by VENNER & Co., who are the selling agents for Chamberlain & Hookham meters. The exhibit includes two rate meters, prepayment meters, an electrolytic meter (Holden's patent), and a special meter which is being retailed at 10s. Venner time switches are also to be much in evidence, the exhibit of these including patterns for street lighting, two rate service, shop window and staircase lighting, &c. On the same stand will be shown a quantity of Credenda conduits including fittings and accessories. Messrs. SIEMENS DYNAMO WORKS make an exhibit of meters both for station service and consumers' premises. A feature is being made of two meters, as used by the Manchester Corporation, for alternating current and direct current work, one meter being of 200 amps. capacity at 650 volts, and the other of 4,000 amps. at 1,500 volts. A polyphase meter for unbalanced loads is among the meters shown. ARON ELECTRICITY METER, LTD. (stand No. 131) also show house and switchboard meters of standard pattern, for alternating current and direct current loads. Two types, motor and clock meters are on view and a display of electrically wound clocks, time switches, hour counters, and taximeters is being made. Messrs. ELLIOTT BROS., whose exhibit is combined with that of ECKSTEIN, HEAP & Co., their Manchester agents, will be found to have a comprehensive collection of electrical instruments on view. This includes their standard types of moving coil instruments, ammeters, voltmeters, &c., for switchboard use, portable instruments, recording instruments, both fixed and portable. A feature of the latter is the "Century" pen, which has a full capacity of ink, and will make a clear mark on the paper. Leakage indicators, photometers, testing sets, transformers and shunts, sparklet fuses, telegraph apparatus and die castings practically complete the exhibit. NALDER BROS. & THOMPSON are showing all their standard patterns of instruments, moving coil and permanent magnet types for both direct current and alternating current circuits. The celebrated "ohmer" is being exhibited to advantage; as is also the Ayrton & Mather electrostatic voltmeter, which does duty in so many of our high-tension stations. The Drysdale wattmeter, another well-known instrument may be inspected in detail. Novelties are a telethermometer for cold storage warehouses and ships, and a "jigger" switch which is to be used in conjunction with a new method of charging on what is known as the "limit demand system." The firm's switchgear and circuit-breakers are also among the exhibits. The SYNCHRONOME Co. are showing their well-known synchronised clocks on the Hope-Jones system. The INTERNATIONAL TIME RECORDER Co. and the DEY TIME REGISTER make interesting exhibits of workmen's recorders, and systems of bookkeeping, &c., in connection with them. The "Adnil" synchronising clock is another instrument exhibited by MARPLES, LEACH & Co. The UNION ELECTRIC Co.'s stand will be found to contain many interesting examples of measuring instruments, these being the product of the famous firm of HARTMANN & BRAUN. There is a switch pillar carrying a new sector flange instrument and a double range frequency meter, the whole being fitted with illuminated dials. Hot wire instruments in some variety are a feature of this part of the company's exhibit.

Largest Steam Engine in the World.—The *Practical Engineer* in a recent issue gives a description of a 25,000 H.P. engine for the United States Steel Corporation, which has been erected in the engine shops at West Allis, near Milwaukee. The engine, which runs at 200 revs. per min., is of Allis-Chalmers design and is of the horizontal twin-tandem rolling mill type. It is stated to be nearly double the size of the next largest engine ever built, and, notwithstanding its huge size, it is arranged to be quickly reversed, as it is intended for operating the rolls in a steel mill.

THE MANUFACTURE OF PORCELAIN INSULATORS AND THEIR ACCESSORIES.—II.

MESSRS. BULLERS LIMITED, POTTERY WORKS, HANLEY, STAFFS.

The preceding article dealing with the products of the Tipton works of Messrs. Bullers Limited, will have given some idea of the character of the metal work required for the support of porcelain insulators of various kinds. We now propose to deal with the Hanley works of the Company at which the actual insulators themselves are manufactured. These works are the largest of their kind in the country, being almost exclusively devoted to the production of electrical porcelains. Many modern engineering works lend themselves to an imposing arrangement of the shops and their adjacent buildings. A pottery is so essentially linked with the past that the unpretentious character of its buildings need excite no comment. After all, high quality of product is the main object in view, and so long as this is obtained with a reasonable amount of accommodation for workmen and machinery nothing else is required.

The materials which are used as the basis of electrical porcelains require peculiar treatment and special processes by which they are worked up into the forms required. It may seem singular that practically the whole of the raw material used in the manufacture of porcelain is shipped from various parts of the country in such a form that it is ready on delivery for the immediate use of the potter. The china and ball clays which largely enter into the composition of porcelain are delivered from the canal side into bins, and are at once drawn upon by the works. In the first instance, in order that the various clays may be properly mixed to form the different bodies, they have to be reduced to what is technically known as "slip," and the first process is the passing of the clay through a mixer, which goes by the name of a "blunger." Water is employed for the reduction of the mass to a liquid state and pumps are used to transfer it from the blunger house to the slip house. This latter is a separate building in which the slip undergoes treatment for the extraction of water and reduction to a workable state. After mixing the slip passes through a number of sieves which extract all foreign bodies and lumps and allow the liquid to pass into the "ark" (the name given to a large trough), in a fine milky state. The fluid encounters a group of permanent magnets in its passage, the object of these being to remove any minute particles of iron which may be present. The slip is then pumped into a number of presses, which are also fitted up in the same building, each press having from 24 to 36 separate compartments. These compartments are lined with a fabric bag which assists in the extraction of moisture and prevents the material adhering to the sides of the press. After being subjected to great pressure the press is unscrewed and the material in the shape of a stiff clay is removed in a series of layers. The illustration in Fig. 1 depicts this process. From the pressures the mixture is transferred to a pug mill which furthers the process of integration and assists in rendering the mass more homogeneous. From the pug mill the material exudes as a rectangular bar and in this form it is removed to the wedging and throwing house. A view of the interior of the latter is shown in Fig. 2. The wedging process consists in the raising of a heavy lump of clay above the head by the wedger and the bringing of it down heavily upon a stone slab. Several large pieces are cut up and treated in this way when they are ready for the thrower whose bench adjoins the wedging stone.

FIG. 1. REMOVING CLAY FROM PRESSES IN "SLIP" HOUSE.

Despite the fact that the potters' wheel is practically the earliest form of device for the throwing of clay it is still retained in the potteries with no other modification than that of the substitution of mechanical for hand power. The thrower has control over the speed of the wheel, this being regulated by an adjustable disc drive. The process of throwing is by far the most interesting, and certainly the most skilful, of any through which the clay passes. It is most fascinating to watch, and one can only marvel at the degree of accuracy with which the various pieces are turned out. The thrower has only his hands to guide him, but his long experience and sensitive touch is sufficient to gauge accurately the amount of material to be removed or left on the piece which he is working. He is assisted by one girl who places the lump on the wheel and also removes the final shape.

FIG. 2.—THROWING HOUSE, WITH "WEDGING" STONE IN FOREGROUND.

One of the main secrets of porcelain manufacture appears to be a judicious control over the shrinkage of the material during the early stages of its formation. From an electrical point of view the shapes vary so considerably that no small amount of skill is required to accurately gauge the time required for the drying of each specimen. It will be obvious to our readers that in the preliminary processes of the formation of the slip and the throwing of the shape the material retains a considerable quantity of moisture. This must be expelled by drying, and it is this drying process which needs such close watching. From the throwing house all specimens are removed on trays to the drying rooms immediately below, and in the case of pieces which have thin webs projecting from a solid body, care must be taken to ensure an even evaporation of moisture by damping the thinner portions while the heavier mass is going through a slow process of drying.

From the drying room the pieces are raised by a lift to the turning shop, which is a long building equipped with a large number of special lathes. These machine tools are power

driven, but otherwise all subsequent operations are performed by hand. The turning of the dried porcelain is almost exactly similar to that of turning wood, and the material shaves off in an almost identical manner. To ensure accuracy special tools, jigs, and holders are provided, so that the skill of the workman is depended upon as little as possible. Of course, a considerable amount of experience is required and most of the men employed in the turning shop have been at work there for many years. Screw threads, grooves, and special shapes are formed in the insulator at this stage, and the necessary allowances for shrinkage are always made. An interesting tool is that employed for the cutting of threads in the screwed tubes, which are often employed for resistances for motor starters, &c.

Fig. 3.—View looking Down Aisle in Turning Shop.

Fig. 3 gives a good general idea of the turning shop, the lathes being behind the partitions seen in the picture.

From the time that ware leaves the turning shop it is subjected to the most crucial inspection and is closely watched from stage to stage. The process of drying has also to be carried further, and subsequent to this the insulators are carefully inspected for cracks and flaws of various kinds. The men engaged on this work do nothing else, and they certainly have the critical eye judging from the manner in which they reject many apparently sound specimens. Previous to being fired the ware is at this stage stamped with any special marks which require to appear on the surface of the insulator. A process of fettling must also be gone through, this comprising the damping of the surface of the insulator and lightly smearing off any projections or superfluous material. Figs. 4 and 5 show the interiors of the drying room for turned pieces and the inspection and fettling shop.

Fig. 5.—View in Fettling and Inspection Shop.

The porcelain is now sufficiently dry to be sent to the biscuit ovens, and in this condition is carefully packed in fire-clay boxes called saggers which act as receptacles for the pieces in the firing kiln. The latter is a huge structure resembling somewhat the familiar brick kiln and is open at the top. The heat is admitted from external fires with flues leading into the lower part of the kiln. The saggers are piled up one on the other as high as possible in the kiln and the whole of the available space is filled. The kiln is then sealed and the process of firing is commenced. About a week is required to gradually raise the temperature of the ware and also to gradually lower it again. The operation is one which calls for considerable skill on the part of the man in charge, as the shape of the pieces and their

Fig. 4.—View of a Portion of the Drying Room, showing Turned Pieces arranged on Shelves, &c., for Drying.

degree of hardness will to some extent depend upon his regulation of the temperature during firing.

There is another important department at the Hanley works in which the throwing and turning processes play no part. This is known as the press department, all its products emanating from a series of special presses in which the required form is given to the porcelain by special dies. Ceiling roses, switch bases, fuse holders, and many of the porcelain articles which figure in electrical accessories are manufactured in this way.

Fig. 6.—Portion of the Dipping Shop for Applying the Glaze to Insulators.

A special die is made and inserted in an ordinary hand press. The materials in powdered form are placed lightly in one half of the die and the other half is pressed down heavily by the screw action of the apparatus. The movement of a pedal when the pressure has been taken off raises the completed shape from the die. The press is one which is rather difficult to describe without drawings, but it certainly reflects great credit upon the management. Considerable ingenuity has been

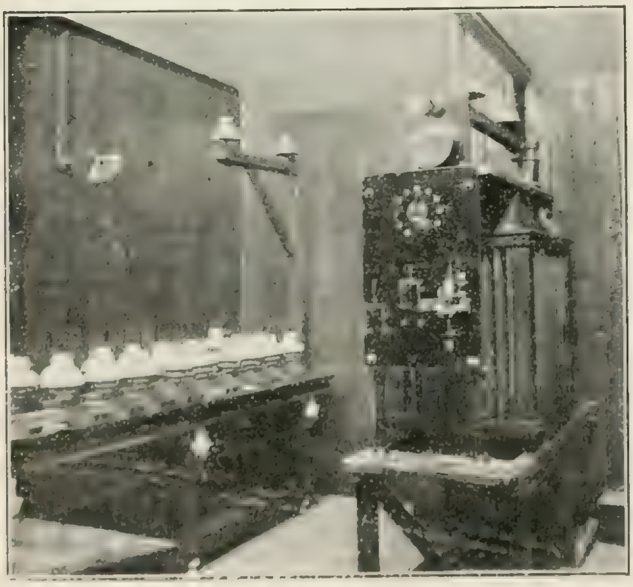


Fig. 7.—Testing Transformer for Applying Pressures between 4,000 and 60,000 volts to Insulators.

shown in the making of the dies, and in the arrangement of the parts so that they can be readily removed when once the form is given to the piece being worked upon. Many extremely intricate shapes are produced in this way and at a cost far below that which would obtain if the work were laboriously done by hand. The process is one which also considerably reduces the cost of electrical accessories in which porcelain is employed. All the particles in the press room, previous to firing in the kilns, require to undergo the same drying process as those coming from the throwing and turning departments, and our remarks upon the latter also apply to these special pieces.

After being fired all the pieces must again be carefully inspected for cracks, flaws, webs, burns, &c., and any defects immediately condemn the faulty article. The pieces are now passed to a separate building on the works in which they are carefully cleaned previous to passing into the dipping house. In the case of screwed insulators the pot is carefully gauged by being run down on to a standard metal thread. All pieces which do not pass the requisite tests are thrown out.

In the dipping house the glaze which is necessary to keep the insulator clean is applied (Fig. 6). The process is a perfectly simple one and consists in the dipping of the article into a trough containing the glazing liquid. From the visitor's point of view there appears to be nothing dangerous in the operation. Much has been said and written on the subject of lead poisoning dangers to those engaged in the potting trade. We understand that the operation in itself is not dangerous but that considerable risk obtains with careless employés. When meals are taken with unwashed hands, or the operator is slovenly in keeping himself or herself clean, then there is a risk of lead poisoning. Where the necessary precautions are taken, and

Fig. 8.—View in the Test Room, showing Group of Insulators of Various Sizes, including one for Long-Distance Transmission Lines, in the Foreground.

these are continually impressed upon the operatives by the employers, cases of lead poisoning are few and far between. After dipping, the pieces are laid up to dry, and then they must be subjected to a further firing in the kiln to complete the glazing process. This is carried out in much the same way as the firing of the biscuit porcelain already described. When the pieces emerge from the glost-kiln they are ready for testing and shipment. The testing department is equipped with a high pressure transformer, the pressure of which can be varied from 1,000 to 60,000 volts. During the pressure test the insulators are placed upwards in a bath of water and pressure is applied in such a way that any crack or other flaws will generally result in a puncture of the porcelain. Fig. 7 shows the transformer used for all pressure tests, and Fig. 8 is a general view of the test room, with a group of representative insulators in the foreground.

After passing the severe tests of the electrical department the insulators are carefully packed in straw in barrels and boxes ready for shipment.

In conclusion we may say that we were much impressed with the modern character of the equipment and organisation of both the Tipton and Hanley works of Messrs. Bullers Limited. At a time when the decadence of the British electrical industry

is decried, engineers may point to an establishment which has adapted its methods to modern conditions and achieved a reputation second to none for excellence of material and quality of product.

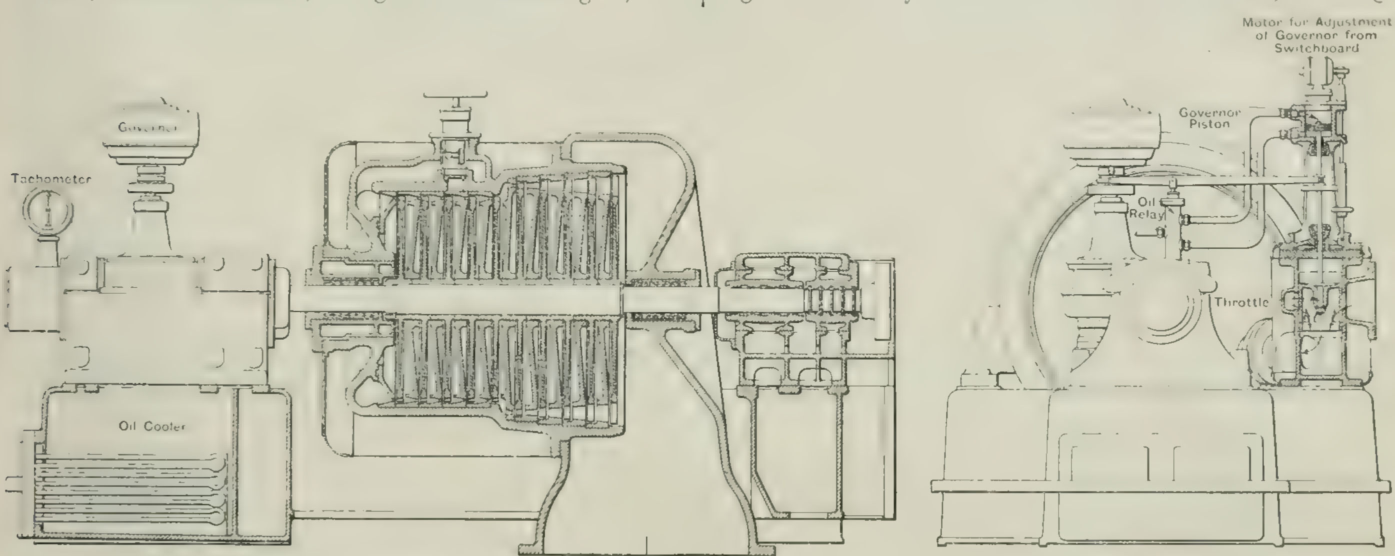
Our best thanks are due to Mr. H. Dagnall, managing director of the company, for arranging the trip to the two works and for personal attention to our wants during the visit, and to Mr. T. W. Harris and Mr. E. H. Chambers, co-directors, for taking us through the shops at Hanley and Tipton respectively.

THE MUSGRAVE-ZOELLY STEAM TURBINE.

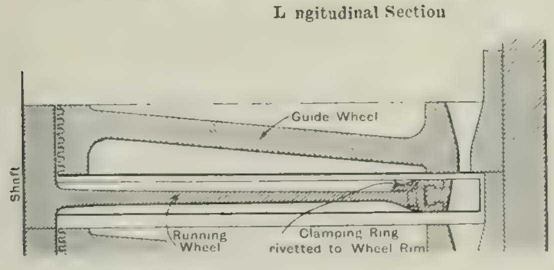
Most of our readers will be familiar with the large Musgrave engine for the driving of dynamo-electric machinery. Developed at a time when the electric lighting business needed an efficient and reliable steam prime mover and ultimately constructed in sizes never previously contemplated, the Musgrave vertical cross-compound engine has held the field in this country for the past decade among the generating units of our largest stations. Messrs. John Musgrave & Sons (Ltd.), Globe Iron Works, Bolton, date their business, as engineers and millwrights, back some 70 years. The fruitful experience of such a period of manufacturing activity is embodied in the design and construction of the engines for which the firm has a world-wide reputation. In the light of these facts we feel sure that engineers and electrical men generally will be interested to know that Messrs. Musgrave & Sons have recently completed the first Zoelly turbine ever made throughout in this country as distinguished from the assembly of parts manufactured abroad. Messrs. Musgrave, in common with two other engineering firms in this country, hold a licence to make turbines under the Zoelly patents and have recently completed arrangements for their extensive manufacture in both large and small units. The large engineering shops comprising Globe Iron Works, Bolton, will be the venue of these developments, a fact which is the more interesting because this large establishment is the home of the famous reciprocating engine already referred to. We were, through the courtesy of the management, permitted to go go through these works last week, and were much impressed both with their magnitude and splendid equipment of machine tools. The buildings, though old in the matter of years, are roomy and well lighted, and practically the whole of the productive plant and machinery has been kept in touch with modern improvements. Electric driving is in vogue almost everywhere, including most of the cranes and all the machine tools; the larger of the latter have independent motors.

The foundries are by far the most important buildings in the works, and the experience of the staff and workmen finds practical expression in many fine castings of engine cylinders, bedplates, columns, flywheel bosses, valve boxes, rope pulleys, large gear wheels, &c. Much of this work is turned remarkably clean from the mould, bespeaking those years of practice which alone bring skill in the founder's art.

During our tour through the shops we noticed a quantity of heavy steam engines in various stages of construction. Conspicuous was a triple-expansion horizontal engine of 750 B.H.P. which will make only 40 revs. per min. We also saw the shaft and a few of the yet undelivered parts of a 4,000 H.P. vertical engine for the City of London Co.'s Bankside station, this being the seventh engine of this size and make at this power house. Another interesting piece of work is a 140 ton rope pulley. This has a diameter of 30 ft. and is grooved for 26 driving ropes. The speed is 30 revs. per min., and the wheel will be driven from a 5 ft. 6 in. pulley on the shaft of an electric motor. The large wheel is built up in segments bolted together. We saw several of these rigged up for the turning of rope grooves.



Longitudinal Section — End Elevation.



Enlarged section of Wheel and Nozzle Plate.

FIG. 1.—GENERAL ARRANGEMENT OF MUSGRAVE-ZOELLY STEAM TURBINE.

The firm also has a large boiler works at Westhoughton, near Bolton. We found here a most complete plant in operation for plate bending, drilling, flanging, riveting, &c. A number of large Lancashire boilers were being completed when we went through the shops. A feature of the boiler is a dished furnace end-plate with externally flanged grate holes, which may be fitted at slight extra cost. The construction does away with front gusset stays inside the boiler, leaving the end free of rivet holes and places liable to give trouble. The works are electrically operated throughout, a horizontal engine of some 500 H.P. driving a pair of Dick-Kerr generators by means of ropes. The entire equipment is quite modern, and includes a powerful electric locomotive which connects the works with the adjacent railway. It was found that a steam locomotive could not negotiatiate the heavy grade into the works with a heavy load, either of plates or boilers, particularly as the length of line has a curve of some 20 ft. radius. Upwards of 1,400 men are employed at the two works in Bolton and Westhoughton.

The foregoing notes cannot, of course, do full justice to the shops and works equipment of Messrs. Musgrave & Sons, but

they will, we hope, serve as a fitting introduction to the following remarks on the Zoelly steam turbine which the firm is arranging to manufacture. The general principles of this turbine may be familiar to many of our readers, but they will

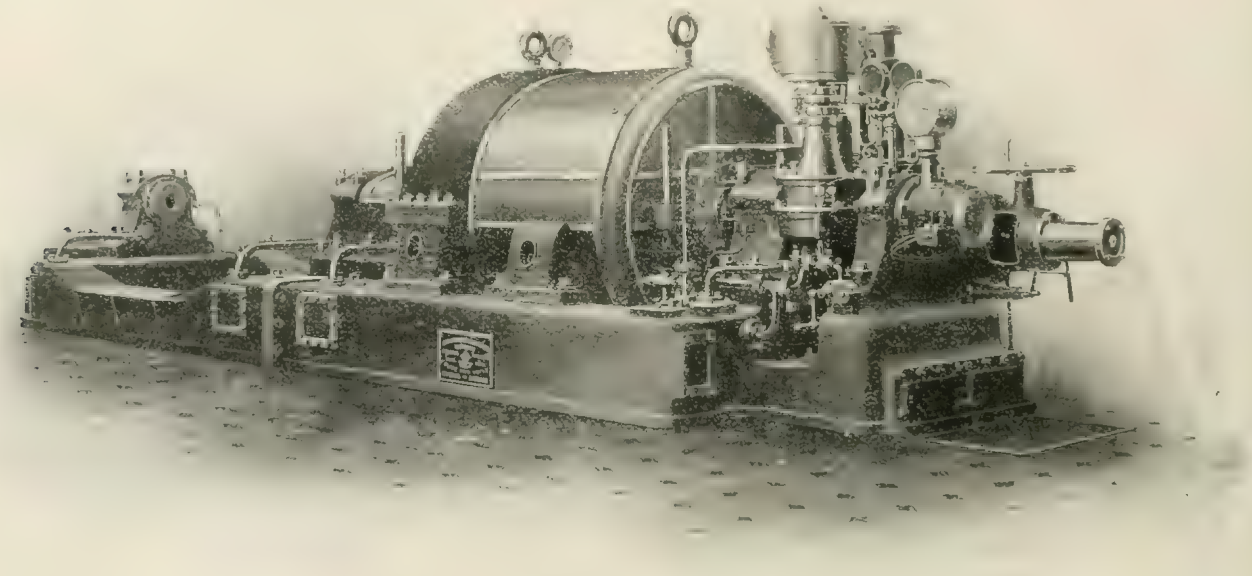


FIG. 2.—750 B.H.P. MUSGRAVE-ZOELLY TURBINE.

bear reiteration here. The turbine operates at a high speed and is, therefore, essentially a compact machine. The early types employed two separate cases for the high and low-pres-

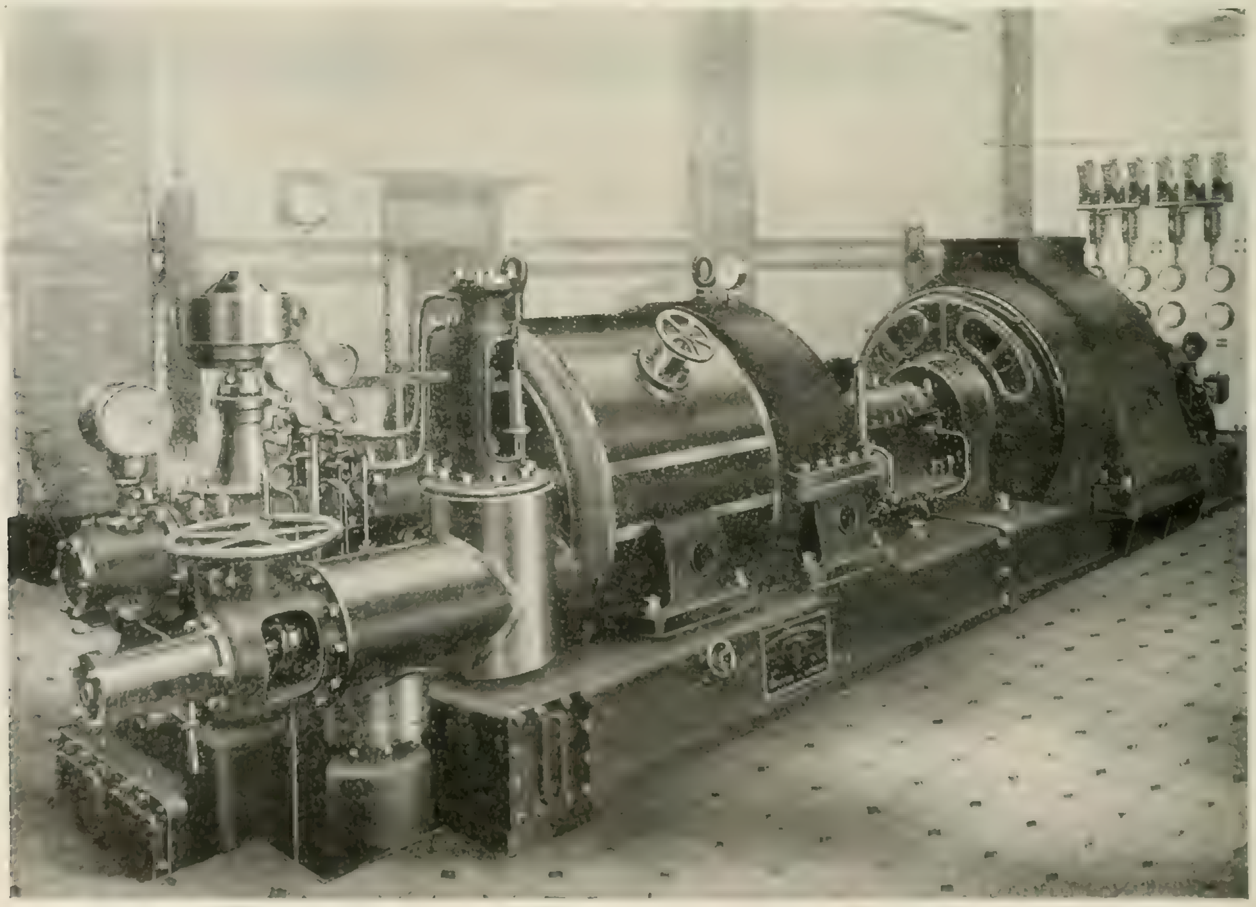


FIG. 3. GENERAL VIEW OF TURBO ELECTRIC SET INSTALLED AT FALCON MILL.

sure running wheels but in the latest pattern only one casing is used. The sectional drawing in Fig. 1 shows how the combination has been effected and also what a small amount of floor space the turbine occupies. Steam is applied to the running wheels and fixed nozzles on the parallel flow principle, each wheel representing a descending pressure stage. It will be seen that there are ten running wheels, so that the initial steam pressure is expended down to the condenser vacuum in this number of stages. The fixed nozzles convert the steam pressure into velocity, which is utilised on the moving blades, these changes taking place at a gradually falling pressure until the last wheel is reached. A glance only at the drawing in Fig. 1 is needed to show that the small number of running

wheels reduces, at a stroke, the number of blades to an almost irreducible minimum, a fact which will be appreciated by every engineer operating turbines of the reaction type. There are no balancing pistons because axial thrust is not developed in the running parts, owing to the fact that the pressure of the steam is not lowered in the wheels but in the stationary guide nozzles.

In general construction the turbine is as simple in all its details as the principle upon which it operates. Fig. 2 shows a completed turbine of 750 H.P. with bed plate for the electric generator, this machine being at present installed in the Falcon Spinning Mill, Bolton. The guide apparatus or fixed nozzles are cast into discs, which are of steel at the high-pressure end, and cast iron at the low pressure. These discs, in two halves, are then accurately fitted into the machined interior of the casing, which is also in two portions, being divided along a horizontal line, to facilitate inspection. A detail of a portion of the fixed guide wheel is shown in Fig. 1. In the moulding of the disc previous to casting in the guides, unless the correct angle of guide blades is inserted the pattern will not draw out, so that an automatic check on the accuracy of the blade setting is by this means provided.

The running wheels, which rotate at a high speed—as high as 3,000 revs. per min. in a 600 H.P. unit—are of forged steel, annealed several times to remove all forging stresses. The wheel is forged in one piece with the boss and is turned and polished all over. At the periphery is a T-shaped recess, formed respectively by the wheel rim and a removable clamping ring. In the recess the blades are placed and spaced apart by distance pieces. The clamping ring is then tightly riveted in position, and it holds the blades and distance pieces securely in the peripheral recess. The clamping ring closes on the running wheel at a square dovetail joint below the line of the recess, and this shoulder removes all outward thrust, due to centrifugal force, from the rivets holding the clamping ring. When finished the blades and wheel are practically a solid piece, the angle of the blades being maintained absolutely constant by this construction. The blades of the running wheels and those forming the guide nozzles are of nickel steel of the finest procurable quality.

The speed of the turbine is controlled by an oil relay governor, or "servo-motor." An enclosed governor actuates a small two-way piston valve, which admits oil under pressure to a piston the rod of which is extended through glands to the throttle valve. The effect is to cause the throttle to be raised or lowered according as oil is admitted above or below the piston. The device is stated to be extremely sensitive and a speed diagram which was taken on a Horn tachograph showed that when almost all the load was thrown off an 850 kw. machine the speed of the latter did not vary more than 2½ per cent., and this for only a few seconds. A speed adjustment is fitted to the governor and this may be moved by hand or by electric motor controlled from the switchboard. A speed variation above 10 per cent. of normal brings into action an emergency governor which cuts off steam and shuts down the machine.

As to the operation of the turbine we are informed that it does not require a long period for warming up and that it is not susceptible to wide temperature variations. It calls for little attention as its lubrication is automatic and its speed, owing to the sensitive governor, is practically constant. For this latter reason the parallel running of alternators is readily facilitated. The steam consumption is low and does not increase with the running life of the machine. The turbine is also economical of oil, that for the bearings being circulated under pressure. No oil is turned into the steam space, so that the condensed water may be returned to the boilers.

Visitors to the Manchester Electrical Exhibition, which is to be opened to-morrow, will have an opportunity of seeing one of Messrs. Musgrave's turbines on their stand. This is a 750 H.P. machine, and a duplicate of that installed at the Falcon Mill and already referred to above. We shall have occasion to deal further with this machine in our detailed reports of the Exhibition itself.

In conclusion we may be permitted to remark that the splendid reputation of Messrs. Musgrave as engine builders—a reputation which may cause a feeling of pride and satisfaction to all British electrical engineers—will stimulate the interest of users of steam power plant in their future movements as makers of steam turbines. The motto on the firm's trade mark is "Sans changer," but this must be taken to apply to their stability as an organisation, and to the character of their reputation, rather than to a slavish adherence to old-time methods or types of engineering productions. It seems but natural that the Musgrave name-plate, now attached to many noble scions of the race of reciprocating engines, should have pride of place in many of the power houses of the present and immediate future, which does homage only to the steam turbine.

AN IMPERFECTION IN THE USUAL STATEMENT OF THE FUNDAMENTAL LAW OF ELECTROMAGNETIC INDUCTION.[1]

In our issue of April 3rd we gave an abstract of a Paper on the above subject, read by Mr. Carl Hering before the American Institute of Electrical Engineers, in which the author pointed out that the usual statement of the fundamental law of the induction of currents by variation of magnetic flux is not universally true, and he described an experiment whereby magnetic lines of force might be linked with a circuit without any E.M.F. resulting. In connection with the discussion on this Paper the following interesting communications have been sent in to the American Institute of Electrical Engineers :—

C. P. STEINMETZ (communicated) remarked that the Paper was interesting in that it drew attention to a looseness in the form of expressing this law which was frequently the cause of serious misunderstanding, and the waste of much energy and time. For instance, in the attempts to invent a coil-wound unipolar machine much useless effort could have been avoided by a clearer distinction between the general law and the special case of its application to a continuous closed conductor. While Mr. Hering's experiment was interesting in showing an instance of a closed electric circuit in which the number of interlinkages with the lines of force change without inducing an E.M.F., it was not startling to the writer, as the reverse case, the electromagnetic induction of an E.M.F., in a closed circuit, without any change of the number of interlinkages of the circuit with the magnetic flux, was illustrated by practically every unipolar machine. There were thousands of kilowatts of such machines now in commercial operation. Maxwell and J. J. Thomson's statement, as quoted by Mr. Hering, were not the most general expressions of the law of induction, but its formulation for the special case discussed by these scientists, of a turn moving with regard to the magnetic field. Mathematically speaking, Maxwell's law was the integral expression derived from the general or differential law by integration over the whole circuit, under the "terminal" or "limit" conditions of continuity of conductor and continuity of motion, and did not apply to Mr. Hering's experiment, or to the general design of unipolar machines, which did not fulfil the conditions of continuity of motion, but had parts of the conductor sliding over other parts. Faraday's expression, of cutting of lines of magnetic force by the conductor, was the general law ; but in its application to unusual cases it must be kept in mind that the "line of magnetic force" was merely a pictorial representation of the magnetic field in space, as characterised by the two constants, intensity and direction. This pictorial representation, when carried so far as to apply to its physical existence, might lead to wrong conclusions ; for instance, when discussing whether the lines of magnetic force of a revolving magnet moved with the magnet or stood still. Assuming, for instance, a bar magnet of circular section $x^2+y^2=r^2$, revolving around its axis, z. Then in any point in space, outside of the magnet as well as inside, the intensity as well as the direction of the magnetic field was constant—*i.e.*, the magnetic field was constant or stationary in space, regardless of whether the magnet stood still or revolved. Assuming a second system of co ordinates with the same axis z as the magnet, and with the other two axes x_1 and y_1 stationary with regard to the magnet, and revolving in space with the revolutions of the magnet, then with this co ordinate system, x_1, y_1, z, the magnetic field at any point, inside of the magnet as well as outside, was also constant in intensity and in direction—*i.e.*, was stationary. Or, in other words, while the two co-ordinate systems x, y, z and x_1, y_1, z_1 revolved with regard to each other, the magnetic field of the magnet was constant in intensity and in direction—*i.e.*, it was stationary with regard to either. Physically, this was nothing exceptional ; it merely meant that the condition of stress, which was called magnetic field, was unvarying in its distribution in space as well as with regard to the revolving magnet. Picturing the magnetic field as lines of magnetic force, it would mean that the lines of force were at the same time stationary in space and also revolving with the magnet. This suggested that all pictorial representations, no matter how useful, might occasionally become ambiguous. In such cases the only safe way was to go back to the entities proper, in the present case, the magnetic

field as a quantity characterised by intensity and direction. Unfortunately, in teaching, instead of the general law of induction, there was frequently given to the student, its specific application to the turn or closed continuous conductor as more convenient to illustrate and to understand. While in the introduction to the elements to electrical engineering this was permissible, to get a complete understanding of the phenomena of induction it must be supplemented by an exact discussion of the general induction law—*i.e.*, the mathematical formulation of Faraday's pictorial representation.

A. E. Kennelly (communicated) thought the experiment described in the Paper was both interesting and instructive. Although it illustrated the proper application of the law of induction when applied to electric circuits, it did not in his opinion controvert the existing law when properly interpreted—*i.e.*, when interpreted as intended to be expressed by its founders, Faraday, Maxwell and others. When it was stated that the E.M.F. round a circuit was equal to the time-rate of change of the flux linked with that circuit, it was inherently assumed that the circuit was not interrupted and then established around a new boundary. It meant, as he understood it, that the circuit contained a simply connected region of magnetic flux, through which the boundaries might be flexibly caused to wander at will. Maxwell specifically ruled out the case of multiple-connected regions by a special proposition to that effect. In Mr. Hering's experiment, the boundary of the circuit was cut at one point, and simultaneously a second circuit embracing flux was introduced at the gap in such a manner that by sliding along the boundaries of the second circuit the magnetic flux might be caused to disappear from the embrace of the first circuit without any intersection of flux by the edge of that circuit. This, to his mind, was juggling with terms, just as though the circuit were cut and then re-closed through a quiescent loop linked with a magnet. Manifestly, no current would be induced through the galvanometer by reason of that change, although in one sense of the word "circuit," all of the flux in the loop had suddenly been introduced into the circuit. The instructive value of the experiment lay in clearing up the question as to which was the primordial proposition: that E.M.F. was induced (1) by the movement of magnetic flux across the boundary, or (2) by the introduction of flux into a loop or circuit. As ordinarily stated, the two propositions were as closely connected as the propositions concerning the priority of the chicken and the egg, because flux could not cut the boundary of a loop at any point without altering the flux contents of the loop, nor could the flux in a loop alter without cutting the boundary somewhere. The experiment showed, however, that where flux came into a field from a balloon, as distinct from walking over a fence, no E.M.F. was induced, and this indicated that the cutting was the primordial conception, to which enclosing was secondary. Of course this cutting E.M.F. occurred as much in insulators as conductors, but could ordinarily be revealed only through the use of conductors. When, therefore, a closed circular solenoid, or anchor-ring, was wound with a primary and with a secondary coil, they knew that in the steady state, if the solenoid was properly wound, there would be no external magnetic flux due to current in either winding; but the change of internal flux due to change of current in one winding induced E.M.F. in the other, as in the ordinary transformer. At first sight, this would look as though there were change of enclosing flux without any cutting, but in the light of this experiment it seemed clear that this was not the case. There must be cutting of flux passing from outside to inside of the secondary coil, but, incidentally, all the external flux cancelled off, or became zero in the final steady state. Summing up, then, he thought that this experiment showed that when the ordinary proposition was enunciated concerning induction of E.M.F. with change of flux enclosed in a circuit, it should be borne in mind that the circuit was not to be juggled with by interrupting it and changing it from a simply connected to a multiple connected space. It must consist of a single, continuous boundary which, it it moved, moved continuously through simply connected space. In this understanding he thought they would all agree.

Elihu Thomson (communicated) agreed with Dr. Kennelly in his view of the state of the case. By passing the spring clip over the magnet leg the circuit was virtually opened so far as magnetic induction was concerned, and an immovable section of conductor was substituted in the gap where all the flux to be cut then existed. The conclusion that the real physical substance of the circuit (the matter of the circuit) must cut or be cut by the lines was in accordance with his view of the subject. There were innumerable phenomena which had confirmed that idea of what was really the circuit to be considered. Otherwise, in fact, the circuit was more metaphysical than physical, a sort of mental image only. He was glad Mr. Hering had tried the experiment, as it would tend to clear up matters which had troubled students in unipolar induction. He had long regarded Faraday's view of line cutting as much preferable and more universal than the theory of linkages simply. The unipolar dynamo was quite practicable for large units of 220 to 550 volts or more, understanding that greater collector losses offset the commutation difficulties with ordinary types and that magnetic losses would probably exceed the calculated losses considerably. There seemed to be one universal law which might be expressed as follows: "It is not possible without chemical or thermo-electric action to generate a continuous current in a closed circuit without sliding contacts," or "A magnetic induction machine for direct currents must have a commutator or sliding contacts of some sort." The experiment might be modified by boring holes through the magnet and inserting copper pins, the ends of which would be traversed by the ends of the spring clip. Manifestly, since there would be no movement of these pins, there could be no E.M.F. generated when they were traversed. In a magnetic blow-out arrester the static stress was exerted at full intensity across the narrower part of the gap in spite of the powerful field surrounding it. As soon, however, as the first slight spark jumped the gap (at the narrower part of course) the gases traversed by the current were deflected. Not, however, until the matter carrying the current had actually bridged the gap did the deflecting action of the field begin. If the current were assumed to be a flow of electrons (negative) from one molecule to the next contiguous and so on, it was easy to understand why the matter of the circuit was the thing concerned and not merely an assumed line or direction. It might be proper to regard the experiment as involving a form of unipolar induction, inasmuch as it was not possible to use a coil of numerous turns but one of a single turn. If the coil were to be used, it would have to be made up of loops which could open and pass over the magnet by riding upon a series of pins, insulated from each other, projecting through the magnet section, as suggested by him in a modification. Some 25 or 30 years ago he leaned to the more generalised view of Maxwell's law referred to in the Paper, but gradually grew out of it and adopted Faraday's view of line cutting as the essential thing. The lines must be cut by the moving conductor, or the lines must move and cut the conductor in order to generate an E.M.F., and the P.D. arose in only that section of the conductor which cut, or was cut, by the lines. He thought he should have to modify the universal law, which he proposed above, a little in view of Dr. Bruger's direct current machine. Inasmuch as the resistance of a coil of bismuth wire might be changed by a magnetic field, it was evident that if the magnetism was so used as to increase the resistance of the bismuth when a current in one direction would be induced in it or a part of the circuit in series with it, and if, when the opposite pulse was induced, the resistance of the bismuth were lower, this would amount to a partial commutation, but would be accomplished without slipping contacts or any ordinary form of commutator. In his Paper, many years ago, on "Magnetism in its Relation to Induced E.M.F. and Current," read before the American Institute of Electrical Engineers, he rather emphasised the view that a line of force could only finish by collapsing to a point or infinitesimal closed chain, and could never be broken or opened. By this view, to his mind, they had the only possible explanation for the varied phenomena of induction—*i.e.*, they had the only possibility of getting any good physical conception of what took place.

W. S. Franklin (communicated) considered that what was said in the Paper concerning the law of induced E.M.F. was entirely correct. He had never looked upon Maxwell's statement of this law in a way which would lead him to think of it as not strictly correct. It had always seemed to him that the differential equations of the electromagnetic field in stationary and in moving media covered the ground completely, without any possibility of a misunderstanding. His point was this: He did not believe that those who accepted Maxwell's generalisation had forgotten the idea of actual cutting of lines of force by the material of the electric circuit; but it might be said they were likely to be led to forget it because of the form of Maxwell's statement of the generalised Faraday law. Perhaps that was true, and yet the difficulty reduced to its simplest terms was the difficulty of partial differentiation; a physical condition was a function of several independent variables, such, for example, as space and time. One was obliged to think of one variable only changing at a time, but one should never for this reason surrender the knowledge that all things changed together.

P. H. Thomas (communicated) thought the experiment was not conclusive for the following reasons: In drawing off the loop, as long as the ends were rubbing on the sides of the magnet, the lines of force might be said to be still within the loop. When next those ends came in contact, preliminary to their separation from the magnet, the galvanometer became short-circuited and protected from any influence of a later change of lines in the loop. In other words, the original loop became two loops by being connected across the middle. None of the lines of force was evidently in the lower loop; all were in the upper loop. The upper loop was then broken by withdrawing the wires entirely from the magnet, which, of course, would give no deflection. What had really been done, if he understood the experiment, was that a portion of the original loop containing the galvanometer (but none of the lines) had been cut off by short-circuiting, from the whole loop while it still contained the lines, and then the main loop had been opened.

W. P. Graham (communicated) thought it was perhaps open to question whether the statements of the law of electromagnetic induction by Maxwell and by J. J. Thomson, as quoted by Mr. Hering, were sufficiently precise, and most would regard the interpretation of Maxwell or Thomson as a quibble. He, however, agreed entirely with Mr. Hering that, in presenting the law of induction to a class of students, the cutting of the flux by the conductor was the point to be emphasised and that Faraday's statement of the law was to be preferred.

BOOKS RECEIVED.

(Copies of the undermentioned works can be had from *The Electrician* office, post free, on receipt of published price, adding 3d. for books published under 2s. Add 10 per cent. for abroad or for foreign books.)

"Tin Plate Work." By R. H. Clarke. (London: The Technical Publishing Co.) 1s. 6d.

"Modern Power Gas Producer Practice and Applications." By Horace Allen. (London: The Technical Publishing Co.) 6s. net.

"La Télégraphie Sans Fil et la Télémécanique." By E. Monier. Fourth Edition. (Paris: H. Dunod & E. Pinat.) 2fr.

PRODUCER GAS.*

BY J. EMERSON DOWSON.

The author first gives some historical particulars of the progress made in gas producers, referring particularly to the brothers Siemens and Dr. Mond.

For furnaces heated by producer gas large flames are required, and the gas is burnt in large quantities; also when it is taken direct from the producer to the furnace, it retains a considerable amount of sensible heat, and the tarry vapours which accompany the gas are not condensed; they burn with the gas, and increase its calorific power and flame temperature. Many other kinds of heating work require the use of burners and small flames, and for these it is essential that the gas should be clean and of good quality. When burners are used it is also important that the gas pressure at the burners should be constant, so that the heat given off by the flames may be kept uniform, or varied at will by cocks on the supply pipes. For this reason the gas must be passed through a gas holder, or its pressure must be regulated in some equally efficient manner; the author recommends a gas holder as better than any other device. The applications of producer gas are numerous and varied, but in proportion to the immense amount of heating required in the various industries throughout the kingdom, I cannot help feeling that still more progress would have been made if manufacturers and others knew a little more about the subject technically. Often they do not seem to understand the treatment of gas or what can be done with it. For instance, it not infrequently happens that persons who have a gas plant to serve an engine think that they can take a branch pipe from the main to the engine for some heating work, and they then wonder why the flames jump, and why the result is unsatisfactory. In some cases they have condemned the gas when the only fault was their own want of knowledge.

Undoubtedly the greatest development in the use of producer gas has been with gas engines, especially during the last few years. A gas engine was worked for the first time with producer gas in 1879, the gas being made in a plant I devised; it was a small engine, and developed only $3\frac{1}{2}$ B.H.P. It consumed about five times more producer gas than it would have consumed of ordinary town gas, although theoretically the comparative consumption of the two gases should have been as 4:1. Until the last few years the producer gas used for gas engines was generally made with a jet of steam at pressure which injected the air required, but sometimes air at pressure was forced into the producer by means of a fan or blower. The gas made in either of these ways leaves the producer at pressure, and is now generally known as "pressure" gas. In some of the early gas producers used for furnace work air was drawn into the producer by suction—notably in the case of the Siemens producer—and in recent years the idea of working the producer by suction, instead of by pressure, has been reverted to in connection with gas engines. The author traces the development of the "suction plant" and emphasises the fact that the chemical reactions on which the production of gas made with steam and air depends are identical in all types of producers. The names "pressure" and "suction" gas are not ideal, they are not scientific, but they are conventional terms which have been generally adopted to convey definite meanings; and it will only lead to confusion if these meanings are misunderstood or the terms are wrongly used.

The calorific power of pressure gas made with a jet of superheated steam is usually considerably higher than that of suction gas. In the former the percentages of hydrogen and carbon monoxide are higher, while the percentage of nitrogen is lower; and if the gas is to be used for heating purposes in small burners, or in blow pipes, it is better to use pressure gas than suction gas. In many operations it would in fact be almost impossible to use suction gas, as after the gas had been washed and cooled its flame temperature would be too low, especially if air at pressure were used to burn the gas. But for driving gas engines, suction gas is extensively used with excellent results, provided the engines are properly adjusted for it. Suction gas contains a smaller percentage of combustible gas than pressure gas contains; and although it requires less air for its combustion, the loss from fluid friction is greater, and for these reasons an engine worked by suction gas develops a lower maximum power than it would with pressure gas. This loss in maximum power is not important in a small or moderate-sized engine, but it is more serious in an engine of, say, 200 H.P. or upwards, and for a given power larger cylinders must be used for suction gas. On the other hand, the fuel consumption in a complete pressure gas plant with an independent boiler is higher than in a suction plant, and its heat efficiency is necessarily lower than that of a suction plant which produces its own steam. If, however, the steam for the pressure plant is raised by the sensible heat of the gas produced, as is often done, the fuel consumption and the heat efficiencies of the pressure and suction plants are alike. We may therefore assume that under these conditions the heat liberated by the exothermic reactions is recovered in each case to about the same extent by the endothermic reactions.

In considering the two types of plant, our general conclusions may be as follows: A suction plant has certain practical advantages—it costs less and occupies a smaller ground space, but the gas made in it is not so strong as in the older form of pressure plant, and in some cases this advantage of the latter is important. The fuel consumption per horse-power-hour and the labour required are the same in both types of plant, provided the steam required is raised without an independent boiler. The consumption of water is the same in both types. It is also worth mentioning that where there are several engines to serve, the arrangement of the gas pipes is greatly simplified, and their cost is proportionally reduced, when the gas can be taken from a small gas holder instead of from several suction plants.

Regarding the economical and commerical aspects of the subject, I may state generally that the results obtained are most encouraging. In large furnace work many operations are now performed with producer gas which cannot be accomplished with solid fuel, and there are many others which can be performed with solid or gaseous fuel; with the latter the heat is not only more regular and more easily controlled, but the work done costs less, and the wear and tear of the furnaces is also less. In many industrial processes where jets of gas are required, producer gas is now used instead of ordinary town gas, and the saving effected is usually from 50 to 60 per cent., including fuel, wages and repairs. In engine work there are now hundreds of thousands of horse-power working regularly and satisfactorily with producer gas. In this connection the gas plant has come to stay, and steam power has a serious rival; in some cases the pressure type is better than the suction type; in others suction is better than pressure. Each has its own province, and in each the consumption of anthracite is now guaranteed not to exceed 1 lb. per B.H.P.-hour under a full or three-quarter load. With low loads the consumption is a little more. As to the nature of the fuel required for producer gas; for engines or for heating with small burners the best and cleanest gas is made with anthracite, as it does not yield tar; this not only simplifies and cheapens the plant, but it also reduces the cost of labour in working. Where anthracite is too dear, ordinary gas coke can be used, provided that it is well carbonised, that it does not contain too much sulphur, and that it is not mixed with pieces of coal. Non-caking bituminous coal is almost invariably used for large furnace work, and there are some plants which make gas from this fuel for engine and other work. But these plants are rather complicated and costly, and they cannot be used for small powers. They require constant attendance, whereas a plant working with anthracite or coke can be left for several hours—what is gained by using the cheaper bituminous coal for small plants is lost by the additional cost of labour, &c. It is probable that in the course of time these drawbacks will be overcome, but for the present anthracite and coke can be used, and with these the adoption of producer gas continues to advance most satisfactorily.

* Abstract of a Paper read before Section G of the British Association, at Dublin.

POSTMASTER-GENERAL'S ANNUAL REPORT.

The fifty fourth annual report of the Postmaster-General has just been issued and gives particulars of the business carried on by the Post Office during the year ended March 31, 1908. The following extracts from the report are of more particular interest to electrical engineers:

Telegraphs.—During the year ended March 31, 1908, 85,969,000 telegrams passed over the Post Office wires, as compared with 89,493,000 in 1906-7, a decrease of 3.9 per cent. The total value is £2,736,746, a decrease of £19,782 over 1906-7. The estimated value of the railway and canal free telegrams is £56,550 against £59,600 in 1906-7, that of the Government free telegrams £20,150 against £22,700 in 1906-7. The decrease in the number of telegrams is, to some extent, apparent only. I was not altogether satisfied with the system upon which telegraph statistics were compiled, and during the year under review much attention was given to the subject. The basis of computation has been somewhat altered, with the view, primarily, of giving a more accurate presentment of the amount of work actually done by the Post Office in connection with telegrams. It had, I think, previously been overrated; for instance, credit had been taken separately for identical messages sent but once over the wire for delivery, say, at two, three, or more addresses in the same town. The over-estimate thus caused was specially noticeable in the case of press messages. The decrease in the number of ordinary telegrams is most marked in the case of London local traffic, and is due no doubt to the increasing popularity of the telephone. The loss to the State on press

messages, which pass at the special rates prescribed by the Telegraph Act of 1868, may be estimated at about £225,000 a year. During the year the telegraph system has been extended to 275 offices in country districts and in the areas of the larger towns. There are now in the United Kingdom 10,862 telegraph offices at Post Offices, and 2,402 at railway stations and other public places. The Metropolitan intercommunication switch in the central telegraph office was completed in November last by the final installation, which added 308 offices to the system and brought the total number up to 520. Steady progress has been made with the underground telegraph line between Edinburgh and Glasgow. The line to the West of England will, I hope, reach Penzance in the financial year 1908–9, with a spur to Plymouth as well as to Weston-super-Mare. Underground lines from Birmingham (southwards) and from Bristol (northwards) are being put in hand, with a view to a line hereafter between those two cities; and progress is also being made with the underground line which is to connect Newcastle-on-Tyne with Leeds, and so with the main underground system. The section from Newcastle to Durham has been completed. The number of foreign telegrams sent to and from the United Kingdom during the year (exclusive of certain telegrams dealt with entirely by cable companies) was practically the same as the number sent during 1906–7, viz., 9,147,000. During the year two additional channels have been provided between the United Kingdom and France, and one between the United Kingdom and Switzerland, by the use of a type of apparatus (already in operation on three of the Anglo-French wires) which permits of several channels being worked by means of a single wire. Experiments have also been made with a view to the adoption of fast-speed apparatus on certain of the Anglo-Netherland and Anglo-German wires. The International Telegraph Conference, which has just concluded its labours at Lisbon, although not falling within the year 1907–8, is referred to. No very important changes have been made by the Conference; but various smaller measures have been agreed to which will help to facilitate international telegraphy and will be to the advantage of the public. As regards Code telegraphy the Conference, while maintaining the privilege of using artificial words, has adopted measures designed to check the tendency shown in some codes to depart altogether from a reasonable standard of pronounceability. As regards rates, arrangements were made for a reduction of ½d. a word, as from July 1, 1909, in the charges for telegrams between the United Kingdom and 13 countries in the European system, of which the principal are as follows (the present rate in each case being put in brackets):—Austria-Hungary (3d.), Bulgaria (4d.), Greece (6d.), Italy (3d.), Malta (4½d.), Roumania (3½d.), Sweden (3½d.), Switzerland (3d.), and Turkey (6½d.).

Wireless Telegraphy.—During the year 39 licences (covering 58 installations) have been granted under the Wireless Telegraphy Acts. Of these 37 were for experimental purposes and two for private business purposes. Since the end of the financial year I have licensed installations at Liverpool for general public communication with ships, and installations at Heysham Harbour and Parkeston Quay for public communication with the packets of the Midland and Great Eastern Railway Co. respectively. The licences in existence at present, or about to be granted, are as follows:—Commercial purposes 8 licences (25 stations); private business (including lightships) 5 licences (11 stations); experimental 77 licences (116 stations); minor cases in which permission has been given by letter 59 licences. Under the Order in Council of February 29, 1908, licences have become necessary for radio-telegraphic installations on board British ships on the high seas. Licences are in preparation, and will shortly be issued to a considerable number of ships. The formal ratification of the Radio-Telegraphic Convention signed at Berlin in November, 1906, has now been deposited; and the Government has also adhered to the Convention on behalf of the whole of the British Empire, except Newfoundland, which has decided not to adhere for the present, and the Orange River Colony, which, as an inland country, sees no necessity for adhesion. The Convention has been ratified by the great majority of the other signatory Powers, and came into operation on July 1, 1908. The Marconi Company has, I am glad to say, accepted the position, and decided to co-operate with the Government in giving effect to the Convention and the Regulations annexed to it. The Post Office has continued during the year to collect and deliver the Marconi Company's telegrams to and from ships at sea under the arrangements settled in 1904. The total number of outward telegrams dealt with during the year was 1,725, as compared with 1,140 in 1906–7, and of inward telegrams 20,067 as compared with 15,853. Under the new arrangements, consequent on the coming into operation of the Convention, telegrams can now be forwarded (with the charges prepaid) from foreign countries for transmission to ships through the Marconi and other stations open for public traffic in this country, while telegrams can similarly be forwarded from this country for transmission through any foreign or colonial station so open. In connection with the Convention, a new Post Office station (which will have a range of about 250 miles) is being erected at Bolt Head, Devonshire, and will shortly be opened for public communication with ships. The Post Office stations for communication between Tobermory and Loch Boisdale (Marconi system), and between Hunstanton and Skegness (De Forest system), have continued to work satisfactorily during the year.

Telephones.—The number of telephone trunk wire centres open on March 31, 1908, was 551, as compared with 533 on the corresponding date in 1907. During the year 312 new trunk circuits were provided, bringing the total number in use up to 2,385, containing about 80,000 miles of double wire. The capital expenditure on the purchase and development of the trunk wire system up to March 31 last amounted to £3,946,[illegible], including an expenditure during the past year of £570,106. The total number of conversations which took place over the inland trunk wires during the year 1907–8 was 21,993,113, showing an increase of about 11 per cent. upon the number for the previous year. The gross revenue derived from the inland trunk service was £535,104 as against £480,658 in 1906–7, an increase of 11·3 per cent. The average value of each conversation was slightly more than in 1906–7, namely, 5·84d., instead of 5·82d. The receipts from the Continental Telephone Service for the year 1907–8 were £21,187 as against £20,166 for the previous year. I am glad to be able to report that the reduction of fees above 6d for trunk calls made between 7 p.m. and 7 a.m., which took effect on October 1, 1906, has resulted in a large increase in the number of calls. Not only has the loss of revenue been made good, but there has been an actual increase of about 12 per cent. Even now, in spite of the issue of many notices and circulars, the arrangement is not as well known as it should be. It is intended shortly to allow calls to be booked for fixed times in the evening in order to facilitate arrangements for social and business communication. During the year 101 Post Office telephone exchanges were opened in the provinces, and 93 public call offices connected with the Post Office trunk line system were opened at places where the number of prospective subscribers was not sufficient to warrant the opening of an exchange. It is found that a call office often becomes the nucleus of a small exchange. During the past year additions have been made to the system of rural call offices to which I referred in my last report, in the districts of Easingwold, Moreton-in-Marsh, Chipping Norton, Richmond (Yorks), Uppingham, in England, and at Dunkeld, Hawick, and Peterhead in Scotland.

The total number of subscribers to the Post Office provincial telephone exchanges on March 31, 1908 (excluding those at Glasgow and Brighton) was 11,579, as compared with 10,010 on March 31, 1907: and the number of exchange telephones rented increased during the year from *13,232 to 15,785. This increase in the number of subscribers is the result of the normal development of the provincial telephone system of the Post Office. There has been a slight decrease in the number of the subscribers to the system taken over in 1906 from the Corporations of Glasgow and Brighton. On March 31, 1908, the number of exchange telephones on the Glasgow system was 12,151, and the number on the Brighton system was 1,768. Steps are being taken to put the systems on a better footing. I have introduced a new scale of telephone rates, based on the principle of a measured service; and, as required by the agreement of February 2, 1905, the rates of the National Telephone Co. and those of the Post Office have been assimilated in competitive areas. The consequent abolition of the unlimited service rate for business houses in the provinces has given rise to considerable comment. I am glad to have had the opportunity during the year of discussing on more than one occasion with representatives of the Chambers of Commerce of the United Kingdom the reasons which led to the adoption of the new tariff; and I have endeavoured to dispel the view that the object of the Government was to make an exorbitant profit out of the monopoly which it will enjoy after 1911, when the system of the National Telephone Co. passes into the hands of the Post Office. With reference to the future development of telephony in this country, I have stated in the House of Commons that the telephone business of the Post Office should, in my opinion, be conducted in such a way that the revenue should be sufficient to provide for current expenditure of all kinds, for the maintenance and renewal of plant, and for a moderate return on the capital expenditure. The present tariff is to some extent experimental; and further experience under the new conditions which will arise after 1911 will show whether it requires modification. Much interest has been shown during the year in the method adopted by the Post Office in recording calls made by subscribers. I am glad to say that a committee of the London Chamber of Commerce, which made a thorough investigation of the system in use at the larger exchanges of the department, have satisfied themselves that the measures taken to secure the accuracy of the accounts rendered to subscribers are efficacious, and that the percentage of error, which is very small, is in favour of subscribers and not of the Post Office. The system formerly owned by the Corporation of Swansea has now passed into the hands of the National Telephone Co. The number of telephones connected with the exchanges of the two municipal telephone systems in existence in England on March 31 last were 2,445 at Hull, and 2,545 at Portsmouth. The sum received as rental in respect of private wires was £185,269, as compared with £183,008 for the preceding year.

The number of telephones connected with the Post Office telephone system in the Metropolitan area increased during the past year from 41,236 to 48,032, and additional subscribers are being connected at the rate of about 160 a week. The City Exchange, situated in the same premises as the Central Exchange, was opened during the year, and new exchanges have been established at Southall and Hornsey. It has also been found necessary to enlarge the London trunk exchange in order to provide accommodation for the additional circuits which, owing to the rapid development of the trunk system, will shortly be brought into use. There were 534 Post Office call offices open in the London area on March 31 last, and the number of calls made from call offices increased by nearly 55 per cent. during the past year. The length of the underground pipes which had been laid in the metropolitan area for telephone purposes up to March 31 last was 2,227 miles, 197 miles of which were laid during the year. Cables containing 383,070 miles of wire have been laid, including 95,862 miles rented by the National Telephone Co., and 43,548 miles provided for telegraphs, private wires, &c. The lines of the present subscribers and the junction lines connecting exchanges amount to 136,979 miles, and 102,357 miles of wire remain available for the future development of the telephone system. About 65,280 miles of telephone wire were laid by the Post Office in the Metropolitan area during last year.

Accounts, for the year ended March 31, 1908, of the income and expenditure relating to the London service, the provincial exchange system and the trunk system, are printed in an appendix (O). The year's

* The figures for 1906–7 have been adjusted.

working of the whole telephone system shows a balance of £498,355, after payment of working expenses. This balance is composed of £253,647 from the trunk lines, £220,794 from London exchanges and £23,914 from provincial exchanges. The amount of royalty received during the year from the National Telephone Co. was £269,789, and from other licensees £2,677. Having regard to the transfer of the National Telephone Co.'s system to the State at the end of 1911, I am making arrangements so far as practicable to prevent unnecessary duplication of plant during the period which still remains for the dual development of the telephone system in this country.

The following estimated figures show the increasing extent to which the telephone is being used for sending messages for onward transmission as telegrams and express or ordinary letters :—Telegrams 4,089,900 increase over 1906 77·7 per cent. ; express letters 116,000, increase 29·9 per cent. ; ordinary letters 14,600, increase 1·7 per cent.

Wayleaves.—Wayleave and tree-cutting difficulties still continue to cause embarrassment and expense to the Post Office, with resultant delay in the execution of telephone and telegraph works, and disappointment to individual subscribers and indeed to the inhabitants of whole districts. The objections raised appear often to proceed merely from a general dislike to overhead lines without reference to the particular circumstances of the case. The cost of underground work is in most cases many times as great as that of overhead lines ; and where only one or two subscribers are served by a line the cost of underground work is prohibitive if cheap telephone rates are to be maintained. Further, I must repeat, that in the present state of electrical science, it is not practicable to place trunk telephone wires underground without in a great measure reducing their effectiveness ; and I am consequently compelled to press for open routes where long-distance trunk wires are concerned. The Act which was passed during the present session will, I hope, diminish to some extent my difficulties as regards wayleave and tree-cutting. But generous co-operation on the part of the public bodies and landowners of the country must always be of the utmost importance in the extension and maintenance of electrical communication. It may be interesting to record in this connection that the Post Office has to deal at present with 946,165 miles of wire, distributed as follows:—Public telegraph wire, 274,183 miles; telephone wires, 482,394 miles ; leased and other wires maintained by the Post Office, 189,588 miles. These wires are—aerial 403,778 miles, underground 530,307 miles, and submarine 12,080 miles.

THE NEW ENGINEERING LABORATORIES AND WORKSHOPS AT THE HERIOT-WATT COLLEGE, EDINBURGH.

The new engineering laboratories and workshops of the Heriot-Watt College have been erected on a site immediately behind the main existing building, and the total area covered by them is about 11,940 sq. ft., apportioned as follows :—Pattern shop, 1,508 sq. ft. ; engineering workshop, 1,676 sq. ft. ; smith's shop, 790 sq. ft. ; engineering laboratory (heat engines), 4,520 sq. ft. ; applied mechanics laboratory, 2,080 sq. ft. ; strength of materials laboratory, 1,366 sq. ft. Very special attention has been given to the equipment of the engineering laboratories, and while the plant may not be on so lavish a scale as in some institutions, it is believed that for teaching purposes it will be quite adequate.

The new buildings are mainly of steel construction, while the interior surfaces of the outer wall are faced with white enamelled brick ; the various laboratories and engineering workshop are separated from one another by means of glass and pitch pine partitions, and for evening work illumination is provided by 20 flame arcs, incandescent lamps being utilised for special lighting. The floors are covered throughout with wood blocks laid on a concrete bed.

The steam raising plant consists of a Stirling water tube boiler fitted with Meldrum's furnace. This boiler is capable of supplying sufficient steam for the whole plant if in operation at one time. In addition there is a small locomotive-type boiler, which has been removed from the old laboratory and is to be used when only a small section of the plant is to be worked.

Considerable attention is to be devoted to the use of superheated steam, and for this purpose the laboratory is provided with an independently fired superheater made by Messrs. Babcock & Wilcox. Separate mains have been erected for saturated and superheated steam, and the engines are designed so that either kind of steam may be used. The steam pipes which are of steel with welded flanges have been supplied and erected by Messrs. Stewarts & Lloyds.

The outstanding feature in the new laboratory is the experimental steam engine which has been specially built by Messrs. Marshall, Sons & Co. It is similar in general design to their well-known coupled compound type, but it has been adapted for experimental work, and can be made to work under varying conditions. At full load this engine is capable of developing about 90 H.P. It can be run condensing or non-condensing, as required. The high and low pressure cylinders are 7 in. and 13 in. diam. respectively, with a stroke of 20 in. ; the normal speed being 120 revs. per min. The flywheel is placed midway in the space between the two cylinders, and the crankshaft is provided with flanged couplings on either side of the flywheel, so that by disconnecting one or the other of these couplings, either side of the engine may be run as a separate unit. Two governors of different types are fitted—one to each side of the engine, and a suitable reducing valve is provided to be used when the steam is supplied to the low pressure cylinder direct from the boiler. Both cylinders and the receiver are completely jacketed, and can be supplied with either saturated or superheated steam ; this supply is quite independent of the main supply to the engine. Suitable appliances are provided for measuring the steam condensed in the jackets. The surface condenser was made by the Worthington Pump Co., and is connected to an Edwards air-pump driven by an electric motor. The circulating water is measured by means of a Kennedy water meter. The power is absorbed by a rope brake, and suitable indicating gear is fitted to both cylinders. The temperature of the steam at various points will be taken by means of electric thermometers manipulated from a central switchboard. In erecting the engine every care has been taken that all parts may be readily accessible, and there is ample space round it to accommodate a large class of students at one time. The steam and exhaust valves on both cylinders are of the double beat type operated by Messrs. Marshall's patent trip gear. This engine represents the latest and most improved type of modern practice in reciprocating engines, and should prove of great benefit to the students who will eventually work with it.

The other engines which formed the equipment of the old laboratory, have been overhauled and removed to the new buildings. They comprise a 30 H.P. compound engine—condensing or non-condensing —by Marshall, Sons & Co., fitted with a surface as well as a jet condenser ; a 10 H.P. De Laval turbo-dynamo, arranged to work with either saturated or superheated steam ; and a 16 H.P. vertical high speed engine. In the near future it is proposed to put down a steam driven air compressor, which will form a most valuable source of experiments for the mining as well as the engineering students.

Special attention is to be devoted to the experimental study of internal combustion engines, and this section of the laboratory is already equipped with a 8½ B.H.P. gas engine supplied by the Campbell Gas Engine Co., and arranged to work with either town or producer gas. The rest of the plant consists of a 6 B.H.P. " Blackstone " oil engine ; a 14 B.H.P. two-cylinder marine-type motor engine, to work with either petrol or paraffin ; and an 8 B.H.P. motor car engine. Test plates have also been laid down to receive other engines that may be sent to the College from time to time for testing purposes. All the above engines have been specially built for experimental work.

The generator of the suction gas plant, from which the producer gas to supply the above gas engine is obtained, is mounted on a large platform weighing machine so that the consumption of fuel may be measured with accuracy ; the connection between the generator and scrubber is made through telescopic pipe joints with water seals.

The two travelling cranes which traverse the laboratory have been presented to the College by Messrs. Carrick & Ritchie, and Messrs. Carrick & Son, respectively. Another important feature will be the testing of motor cars to obtain the power developed at the road wheels. For this purpose a special test bench is to be erected. The laboratory is also provided with complete apparatus for analysing flue and exhaust gases, and for determining the calorific power of coal, gas and oils.

Cable Traction.—Advantage has been taken of the reconstruction of the city of San Francisco, following the disastrous fires of April, 1906, to change most of the then existing cable tramways to electrical working, except in the case of a few steep routes. A recent issue of the *Electric Railway Journal* contains a description of this work of reconstruction, and in connection with this subject our contemporary remarks :— " San Francisco and Chicago were the last of the large cities to change from cable to electric power, and while there are still a few cable lines in service in the East as well as the Far West, the years 1907 and 1908 witnessed the practical passing of this motive power for street car operation in this country. The two most important lines abroad are in Edinburgh and Melbourne. In the former a change to electricity has been delayed for local reasons, although frequently discussed. In Melbourne, electricity will undoubtedly be adopted after the expiration of the existing franchises, a few years hence. Thus the motive power which was first demonstrated to be applicable to street railway conditions in San Francisco 36 years ago, and was widely adopted throughout the country between 1880 and 1890, has finally succumbed, except under a few extreme conditions of grade, to its younger rival."

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'THE ELECTRICIAN' INDUSTRIAL SUPPLEMENT.

With "THE ELECTRICIAN" for Sept. 14, 1906, was issued the first of a series of "Industrial Supplements," to be published from time to time with "THE ELECTRICIAN." The twenty-seventh issue of the Supplement was issued (Gratis) with the number of "THE ELECTRICIAN" for Sept. 18.

POWER RESOURCES.

The present age is essentially one of power. Wherever it is possible, labour is dispensed with, and operations which were previously carried out individually by manual power are combined with the object of dealing with them collectively in a more efficient manner by mechanical power. In addition, there is, of course, the increasing growth of factories of one kind and another, and thus the progress of power during the last few years has been enormous. The use of electric light has necessitated the use of steam power in large quantities, and in this way lighting also has come to be regarded as power when effected by electrical energy, whereas this is not the case if gas is utilised.

Figures relating to such developments are not easily obtainable, and such statistics as are available are certainly of the most approximate kind. Mr. H. ST. C. PUTNAM has given some interesting figures in regard to the United States in a Paper read recently before the American Institute of Electrical Engineers. In this Paper the total capacity of prime movers in the United States is estimated at 30,000,000 H.P. Of course, the average load is far less, and, owing to what electrical engineers term the "diversity factor," the total average load probably does not exceed one third or one quarter of the total given. It appears that in the United States the amount of power used is doubled in about every 10 years, and there is a corresponding increase in coal production, railroad gross earnings, freight ton-mileage, passenger mileage and the value of agricultural products. Of the 30,000,000 H.P. just mentioned about 26,000,000 H.P. is produced by steam engines, 3,000,000 H.P. by water motors, and 800,000 H.P. by gas and oil engines. The electric motor cannot, of course, be regarded as a prime mover, but it is remarkable that out of the 30,000,000 H.P. about 9,000,000 H.P., or 30 per cent., is utilised electrically. This figure does not include electric power generated in isolated plants and used for other than manufacturing purposes. Whereas the total power in use is doubled every 10 years, the utilisation of electric power is doubled every five years.

This rapidly increasing use of power leads Mr. PUTNAM

to inquire as to the natural power resources of the United States. It appears that the water power there available exceeds 30,000,000 H.P., and, assuming that a certain amount of storage is provided, has been estimated to be as high as 150,000,000 H.P. In the event, therefore, of the coal supply failing, water power in the United States would be sufficient to meet the demand in one form or another. Looking to the future, Mr. PUTNAM suggests that the question is one requiring Government regulation, so as to prevent waste of power and in order to develop the natural resources to the greatest possible extent.

There is a noticeable tendency at the present time for Governments to take action in this matter. For example, the Canadian Government will not permit power to be supplied to an indefinite extent from the Canadian Falls at Niagara to consumers on the American side of the Falls. The Bavarian Government is about to use water power in that country for railway purposes, and, similarly, the Swedish Government is holding a tight hand on Sweden's water power. There is a certain doubtful wisdom in the view that posterity has done nothing for the present generation and that, consequently, this generation should do nothing for posterity; and British engineers, when they look into the future, must feel a certain uneasiness in realising the almost total absence of water power in this country to supply our industrial needs as our national stores of mineral wealth, in the shape of coal, diminish in area and output. We may entertain the pious hope that tidal power will have come to our rescue ere the period of coalfield exhaustion arrives.

OBITUARY.

SIR SAMUEL CANNING, KT., C.E.

The death occurred on Thursday last, at the age of 85, of Sir Samuel Canning, upon whom the responsibility of laying the Atlantic cables of 1865, 1866, and 1869 devolved. Sir Samuel was a pioneer in both the manufacture and submersion of the most important lines of submarine telegraph cables from their initiation in 1850 to the end of the last century. He was among the first of Atlantic cable engineers, and was successful in the laying of the first cable of 1858. To his skill and energy much of the success of the Atlantic expedition of 1866 was due. It was Sir Samuel who perfected the paying-out and the recovering and grappling machinery for that cable which so materially aided in its successful laying and the recovery of the cable lost in the previous year. He was the engineer connected with the laying of the cables between England, Gibraltar, Malta and Alexandria, and he laid other important lines connecting up sections of the Mediterranean system. He received the honour of knighthood in 1866, a gold medal from the Liverpool Chamber of Commerce in March, 1867, and later the insignia of the Order of St. Jago d'Espada from the King of Portugal.

Sir Samuel was the son of Mr. Robert Canning, of Ogbourne St. Andrew, Wiltshire, was born in 1823, and was educated at Salisbury. From 1845 he was engaged in civil engineering work, largely connected with railways, and especially with extensions to the Great Western Railway. This brought him into close touch with pioneer land telegraph operations. In 1850 the development of submarine telegraph enterprise engaged his attention, and he applied his ingenuity to the design and construction of cables and of appliances for laying, buoying and picking them up from deep waters. He first assisted in 1856 in laying the cable from Cape Breton to Newfoundland, and next year was one of the chief assistant engineers to Mr. (afterwards Sir) Charles Bright on the construction and laying of the first Atlantic cable. 1865 found him engineer to the Telegraph Construction & Maintenance Co., in which capacity he superintended the manufacture and laying of the Atlantic cables of 1865 and 1866. He was engineer-in-charge in connection with the recovery of the 1865 cable on the "Great Eastern," and for this work he received the honour of knighthood from Queen Victoria. He had been a member of the Institution of Civil Engineers since 1876.

The funeral took place on Tuesday at Kensal Green, the first part of the service being held at the Church of St. Mary Abbot, Kensington, London. The chief mourners were Lady Canning (widow), Miss Canning (daughter) and Mr. Canning (son). Others present included Mr. H. Canning and Major L. Canning (nephews), Mr. G. Canning, Mr. H. C. Clifford, Mrs. Young, Mr. George Sutton, Mrs. P. Thomas, Mr. Charles Bright, Mr. F. R. Lucas, Mr. E. Boutcher, Mr. C. Neate and Mr. W. A. Hodgkinson (New Zealand). The service was conducted by Prebendary Pennefather (the vicar), assisted by the Rev. T. H. Masters, vicar of East Meon, and a nephew of the deceased knight.

THE DESIGN OF UNDERGROUND MAINS AND NETWORKS.*

BY J. R. DICK, B.Sc.

(*Continued from page 825*).

Summary.—The author considers the general design of a low-tension network. Having determined the probable positions and amounts of the loads, the sections of conductors are selected in accordance with temperature and pressure drop limits. Stepping of distributor cables is not necessarily advantageous. Elasticity of networks: In designing the feeder system certain methods, here given, for the composition and resolution of currents taken from distributors are useful. Graphical methods are considered, and a law for determining the best feeder areas.

The small saving in copper, shown theoretically to be possible by varying the cross-section, may not be practically attainable. There are many objections to it, even if the steps are comparatively few and not infinitely numerous as the formula requires. The primary difficulty is to provide suitable cross-sections from the standard sizes available, not to mention the expense of extra jointing.

Another difficulty arises if the distribution of current in the network is altered. It sometimes happens that a feeder has to be run to the middle point of a long distributor a considerable time after it is laid, in order to supply an unexpected demand for current. If, unfortunately, the two parts of it had originally been tapered down to zero at their cutting point they would be rendered entirely unsuitable for distributing the current from the new feeder, for it is axiomatic that the distributors meeting at a feeding point should have their aggregate cross-section at least equal to that of the feeder. In an interconnected network it is impossible to guarantee that large equalising currents may not flow in the distributors, as this depends on the variations of the loads and pressures in different districts. Were their cross-sections based on the law of minimum volume they would obviously possess little value as equalising mains. Nevertheless, in a district where there are long distributors terminating at a natural boundary and never likely to be fed from both ends it might be advantageous to introduce several steps in the sizes. Where the system is in vogue of supplying distinct feeding areas from independent feeders, and consequently the distributors are not intended to be connected across at the cutting points except in emergencies, it might also be permissible to have graduated conductors. Except in rare instances the disadvantages would outweigh any saving to be obtained by adhering to the theoretical counsels of perfection implied in the formulæ.

One of the reasons for discussing this example somewhat fully is to show that, even where the voltage drop is fixed by the conditions of running, there is scope for effecting an

 From a forthcoming book by Messrs. J. R. Dick and F. Fernie.

economy by selecting suitable cross sections for the conductors, so that the fixed voltage drop is divided up among them in certain proportions.

If the feeding points are given the whole of the network can be split up into branches fed at one end only, by the useful approximation of assuming the line of demarcation between any two feeder areas to be such that the current supplied to any installation is drawn from the feeder nearest to it. In other words, the cutting points, through which the line of demarcation passes, lie midway electrically between each feeder.

A further assumption is obviously embodied in thus splitting up the network—*i.e.*, that the feeding points are all regulated to the same pressure, and consequently there are no equalising currents flowing from one feeder area into another. The cross-sections of each of the branches can then be calculated from the formulæ already obtained, in all of which it was understood that the full load currents were being taken from the mains when the voltage drop was at its permitted maximum value. As such a state of things never occurs in practice, the amount of copper in the mains is more than is required for actual working, and the greater this margin is the more "elasticity" is the system said to possess. The elasticity fulfils the same function as special regulation, for it then becomes immaterial what fractions of the total demand may be in use simultaneously. The distributing mains, in contradistinction to feeders, must all be self-regulating by the possession of sufficient elasticity. It is unnecessary, however, to provide for a perfect elasticity which would be obtained if the switching of the *full* load on or off with constant feeding pressure did not cause a drop exceeding the limit. It is so rare to have all the connected load in use at one time that the elasticity can be reduced to 40 or 50 per cent. of its perfect value without serious risk. Various means are adopted for maintaining the elasticity without an excessive amount of copper, the principal one being to interconnect the network so that the lightly loaded parts may help those more heavily loaded. Feeders are an example of inelastic conductors as broadly considered the drop of pressure in them has no effect on the general network owing to their being regulated at the station to give a constant voltage at their feeding points. The distinction between the two classes of conductors will be rendered clearer from the following example.

Suppose it is required to supply current to a number of large consumers scattered irregularly over a district where it is permissible to run overhead wires, or underground cables independently of the street plant then the arrangement requiring least copper would be that in which each consumer is connected by the shortest route direct to the central station. The current densities in each conductor can also be fixed at their most economical values, derived from Kelvin's law. If they are of different lengths this necessitates a special regulation for each so that the voltage at each consumer's terminals may be the same. In order to show that such a system requires a minimum weight of copper, it has only to be observed that any other mode of supplying any one of the loads from the central station involves going round two sides of a triangle of which the direct feeder would form the third side.

Instead of an ordinary network the system would be reduced to a set of independent feeders radiating from the station, like the lines of a telephone exchange, and all the distributors would be eliminated. Unfortunately, this arrangement, involving the minimum of copper, might not be the cheapest, as the total length of cable laid (being the sum of all the feeders) might be considerably more than if they were employed with a network, and the expense of laying them might counterbalance the nominal saving in copper.

Such a system would be, under our definition, absolutely inelastic. None of the feeders could assist each other in the event of fluctuations occurring at different points, and the only regulation possible would be by adjusting the pressures on individual feeders at the station. An alternative method of feeding the same consumers in the positions given would be to connect them all to one distributing main large enough to prevent the drop of pressure at the most distant exceeding the prescribed amount, when all the full loads were on. In this case the elasticity would be perfect but the amount of copper required would be very heavy. In general practice where a network is supplied by feeders the properties of both classes of conductor are utilised.

From the formula already established for a uniformly loaded distributor radiating direct from the central station or other point of supply it will be seen that the volume of copper $\left(\frac{1}{2}\frac{cl^3}{Kv}\right)$ increases as the cube of the distance. Thus its range is severely limited, if regard is given to the capital cost.

In this case the effect of employing one or more feeders can be easily demonstrated.

If l be the original length supplied direct from S (Fig. 6) and if it is then divided in two and the further portion has a feeder run to its mid point the relative volumes of copper in the two arrangements illustrate some important principles. The same proviso as to the total drop at any point not exceeding v applies to both.

The volume of copper in (1) is $\frac{1}{2}\frac{cl^3}{Kv}$.

The volume in (2) will depend on what proportion of the voltage drop v takes place in the distributor b and feeder F

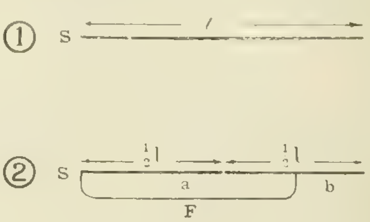


Fig. 6.

respectively, but it can be shown that if $\frac{3}{4}v$ is spent in the latter and $\frac{1}{4}v$ in the former the total volume is a minimum.

Volume of the section $a = \frac{1}{16}\frac{cl^3}{Kv}$,

" " " b = [illegible] $\frac{cl^3}{Kv}$.

Volume of feeder (carrying current $\frac{1}{2}cl$)

$\frac{1}{2}\frac{cl}{Kv}$ [illegible] l^2 [illegible] $\frac{cl^3}{Kv}$.

or altogether $\frac{1}{2}\frac{cl^3}{Kv}$, the same as the original main without the so-called feeder.

It is evident that both feeder and distributor here come under the definition of perfectly elastic mains, and the result given above indicates that no saving in volume of copper can be effected by using an elastic conductor as a feeder. In this particular instance there would be a positive disadvantage in employing a feeder owing to the additional cost of laying it.

If, however, we make the feeder inelastic by allowing a considerable voltage drop in it and provide for this by giving it a high E.M.F. at the station 'bus-bars and by suitable regulation maintain the standard pressure at the feeding point a great diminution in volume of copper is the result. If v_f in the feeder is made equal to $6v$ and the full drop v is allowed from the feeding point to the ends of its distributors, the total copper becomes—

Volume a = [illegible] $\frac{cl^3}{Kv}$.

Volume b = [illegible] $\frac{cl^3}{Kv}$.

Volume F = [illegible] $\frac{cl^3}{Kv}$.

or altogether [illegible] $\frac{cl^3}{Kv}$.

These approximate figures are sufficient to show that by the association of both classes of conductor an enormous saving in the amount of copper can be effected. The only relative dis-

advantages of this arrangement are the cost of the power required to furnish the E.M.F. lost in the feeder, and the trouble and expense of regulating the voltage. An important application of this simple principle is seen in the return feeders for tramways which are uneconomical for their purpose unless provided with an auxiliary E.M.F. from a booster.*

Before studying the question of where feeders in general ought to be placed there are certain useful methods for the composition and resolution of currents taken off distributors which it is well to be familiar with, as they are frequently required.

Let AB be a distributor supplied at both ends either direct from two feeders or as an interconnector of the network (Fig. 7). Its cross-section is uniform, the total resistance being R and the load currents and resistances measured from A are $c_1 \ldots c_n$ and $r_1 \ldots r_n$ respectively. The P.D. between A and B which are supposed to be at different pressures is $V_1 - V_2$. With an irregularly distributed load like that indicated one of the essentials is to know the position of the cutting point where the current changes its direction and begins to be supplied from B as well as A. This is obviously the point of maximum drop in the conductor.

For the purpose of the investigation any point such as C_2 can be assumed in the first instance and the current flowing in the distributor between c_1 and c_2 called x.

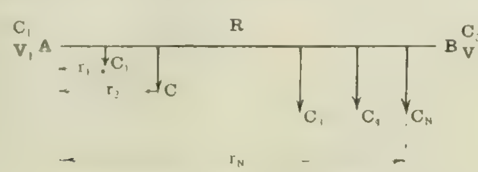


FIG. 7.

Then C_1, that part of the total current supplied from A

$$= c_1 + x \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (1)$$

and at the point B $\quad C_2 = c_n + c_{n-1} + \ldots c_2 - x \quad . \quad . \quad (2)$

As the drop from either end has to be the same at the cutting point—

$$V_1 - c_1 r - x r_2 = V_2 - c_n(R - r_n) - c_{n-1}(R - r_{n-1}) \ldots - (c_2 - x)(R - r_2)$$

and $V_1 = V_2 - R\,(c_n + c_{n-1} \ldots (c_2 - x)) + c_n r_n + c_{n-1} r_{n-1} \ldots + c_2 r_2 + c_1 r_1$.

Substituting from (2)

$$V_1 = V_2 - RC_2 + \Sigma_1^n (cr),$$

$$\therefore \quad C_2 = \frac{V_2 - V_1}{R} + \frac{\Sigma_1^n (cr)}{R},$$

and $$C_1 = \Sigma_1^n c - \frac{V_2 - V_1}{R} - \frac{\Sigma_1^n (cr)}{R}.$$

Instead of dealing with the individual currents $c_1 \ldots c_n$ their resultant can be found from a similar formula to that for finding a mass centre. If R_1 is its distance from A

$$R_1 = \frac{\Sigma_1^n (cr)}{\Sigma c}, \text{ taking moments about A,}$$

and $$R_2 = \frac{\Sigma_1^n (cr)}{\Sigma c}, \text{ taking moments about B.}$$

In the above equations, instead of $\Sigma_1^n cr$ the equivalent $R_1 \Sigma_1^n c$ can be used without altering the values of C_2 and C_1. This proves that the resultant can be taken instead of the individual currents without any influence on the network beyond A and B, and even if these points are at different voltages the expression for C_2 and C_1 can be written in the forms

$$C_2 = \frac{V_2 - V_1}{R} + C \cdot \frac{R_1}{R},$$

$$C_1 = \frac{V_1 - V_2}{R} + C \cdot \frac{R_2}{R}, \text{ where } C = \Sigma_1^n c.$$

If the voltage is the same at each end $V_2 = V_1$, and the values of C_2 and C_1 are inversely proportionate to their distances from the resultant point. If

$$\frac{V_1 - V_2}{R} = C \cdot \frac{R_1}{R}$$

there would be no component current from B and $C_2 = 0$.

This simply means that the whole of the current taken by the consumers is supplied from A and the P.D. between the two points A and B is that caused by the load currents acting from A only. The rule may be stated generally as follows: The current entering one end of a distributor fed at both ends at different pressures may be considered as made up of two parts. The one part is the component of the load currents and the other is the current which would flow in the distributor if its ends were maintained at the actual P.D. without any of the load currents. This rule embodies the principle of what has been called the superposition of currents and it is of great use in the analysis of networks, as will be seen later. The cutting point or point of minimum voltage is found by subtracting the various load currents c_1, c_2, &c., from C_1 until the difference becomes negative. The point where this occurs is always at one of the loads and the proportions of it supplied from A and B respectively are given by the above method.

For instance, if in the figure the components are $C_1 = 31$ and $C_2 = 39$, the cutting point will be at K, and the proportion fed from A of the load of 10 amperes is $31 - 20 - 5 = 6$, and from B is $39 - 10 - 10 - 15 = 4$.

The point where the resultant current acts and the cutting

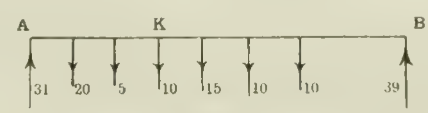


FIG. 8.

point are not coincident unless the loads are equal and equally spaced. If a number of consumers on the same main are to be fed by one feeder only its best position is obviously where the resultant current would act. As the drops to the farthest load on each side of it are equal they have minimum values, and the sections of the distributors are the smallest possible. This will be apparent when it is remembered that a displacement of the feeder from this position involves a greater drop on one side than formerly, and provision must be made for this drop by increasing the voltage at the feeding point.

(To be continued.)

* See Paper by Mr. H. F. Parshall, *Proc.* Inst.E.E., June, 1898.

POWER SUPPLY AND ITS EFFECT ON THE INDUSTRIES OF THE NORTH-EAST COAST.*

BY C. H. MERZ.

Summary.—The author describes the extensive system of electrical power supply in the counties of Northumberland and Durham and the extent of its application in shipyards, engineering works, rolling mills and coal mines. He then discusses the possibilities of utilising the "waste energy" from coke ovens and blast furnaces, and shows that this can best be done in co-operation with a power company. In this connection he summarises what has already been done by the Newcastle and Durham power companies and gives drawings showing the arrangement of the generating stations.

The author first summarises the nature and extent of the staple industries of the north-east coast, and refers to Fig. 1, showing the district served by the north-east coast power companies. Particulars of the Carville station (described in *The Electrician*, Vol. LIII., p. 424 *et seq*) follow and of the growth of the system of mains. The companies concerned in the supply are the Newcastle-upon-Tyne Electric Supply Co., the Durham Electrical Power Distribution Co. and the Cleveland & Durham Electric Power Co. The unity of policy and uniformity of system on the part of these three companies have been secured by working agreements. The following tables give particulars of the various generating stations and transmission systems. The plant installed represents about one-ninth of the total in the public supply stations of the United Kingdom. The development has been delayed by the alterations necessary at each amalgamation, due to different frequencies, &c., but

* Abstract of a Paper read, on Wednesday, at the meeting of the Iron and Steel Institute at Middlesbrough.

it was felt to be better to sacrifice something for the sake of uniformity. The work of unification has now been completed and nine small uneconomical generating stations, not mentioned in the table, have been shut down.

Particulars of Generating Stations.

Power station.	Type.	H.P. of plant installed.	Voltage.*
Carville	Coal-fired	56,000	6,000
Philadelphia	Coal-fired	13,000	6,000
†Neptune Bank	Coal-fired	6,800	6,000
Grangetown	Coal-fired	8,000	12,000
†Hebburn	Coal-fired	4,500	6,000
Weardale	Waste-heat	6,650	3,000
Newport	Waste-heat	4,000	3,000
Blaydon	Waste-heat	3,000	6,000
Capacity of plant installed		101,950	
‡Dunston	Coal-fired	30,000	6,000
‡Bankfoot	Waste-heat	3,300	3,000
‡Tees bridge	Waste-heat	1,300	3,000
Capacity of plant under construction		34,600	
Total		135,550	

Main Transmission and Distribution Networks.

Main trunk system	3 phase 40 cycles	20,000 volts	Underground and overhead
Main high-tension power distribution system—			
Tyne & North Durham area	3 phase 40 cycles	6,000 volts	Underground and overhead
Tees area	3 phase 40 cycles	12,000 volts	Underground and overhead
Power supply	3 phase 40 cycles	3,000 and 440 volts	Underground and overhead
Railway supply	Continuous current	600 volts	Third rail
Lighting supply (and small motors)	Continuous current	480 and 240 volts	Three wire
	and 3 phase 40 cycles	440 and 250 volts	Four wire

A factor invariably of vital importance in the production of cheap current, whether by a public company or by a private manufacturer, is the capital expenditure per useful horse power of plant. This decreases as the size of plant grows, while the running efficiency at the same time increases. The local conditions governing power supply in this district are: (1) The low price of coal, enabling manufacturers to produce power themselves at relatively low rates. (2) The fact that the manufacturers' works are mostly of considerable size—*i.e.*, their individual electrical requirements are large. (3) The existence of large quantities of potential energy in the form of waste heat and combustible gas. The first and second conditions have been met by the power companies in erecting their main generating stations, (*a*) taking full advantage of the best coal and water facilities available, (*b*) installing plant of capacity much in excess of that which any individual manufacturer, however large, could adopt, (*c*) by catering for all classes of consumers, thereby securing a diversity of load with a resulting constancy of output, and so utilising the plant installed to the best possible advantage. These factors, combined with the employment of a highly skilled technical staff and attention to numberless relatively minor details, have resulted in securing an efficiency of production much greater than that practicable to any manufacturer producing power merely as an auxiliary to his main business. This is, after all, an age of specialisation, and the production of electricity from coal at a minimum of cost presents opportunities for the highest technical skill and for unremitting vigilance.

Extent of Power Supply.—Power supply in this district began on the north bank of the Tyne. It has naturally, therefore, reached its highest development there, and although even in this section of the area it is only seven years old, there is at the present moment not a single firm of shipbuilders or engineers on the north bank of the Tyne inside the power company's area of supply which does not take 95 per cent. of its power from the company, the remaining 5 per cent. being produced from small gas engines or from boilers fired with scrap wood. On the south bank of the Tyne progress has, since power supply started, been equally rapid, while in the Tees area, although the power company only began operations in January of last year, they have already connected over 20,000 H.P. of motors.

The credit of electrifying the Newcastle suburban railways is, of course, due to the enterprise of the North Eastern Railway Co., but the fact that they were the first important English railway to electrify a portion of their system, and that they purchased the necessary electricity from the power company, shows that the availability of cheap power is an advantage not only to manufacturers but to the public generally in facilitating the introduction of electric traction. Since the electrification of the Newcastle system the train service has been more than doubled and the schedule speed improved by 20 per cent. A comparison with other cities at home and abroad shows that no other town of similar population, or indeed having twice the population, has so extensive an electrified railway system and so frequent a suburban service, and this has, of course, resulted in a large increase of travel.

There are now four new electrically driven rolling mills being installed in this area—two by Dorman, Long & Co., one by the Bowesfield Steel Co., and one by a new company now being formed. The electricity for these will be purchased from the power company, so that in this direction also power supply has facilitated new developments.

The supply of electricity to coal mines, beginning as it did not more than four years ago, has not reached the same stage of development as in the case of other industries, though collieries having an output of some 8,000,000 tons per annum are taking, or are arranging to take, practically their whole supply from the power companies. This supply will include, among other

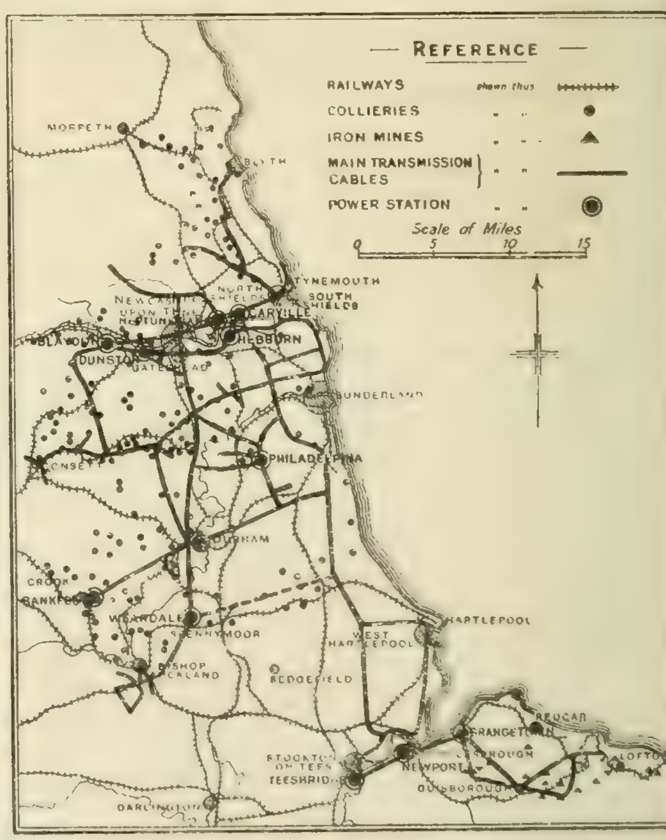


FIG. 1.—MAP SHOWING POWER SUPPLY NETWORKS ON N.E. COAST.

apparatus, winders of 1,600 H.P. each; and it would appear that the supply of electricity to coal mines is likely to be of even greater magnitude than the supply to shipbuilding and heavy engineering works. An estimate shows that the collieries of Northumberland and Durham burn for their own power requirements about 2,500,000 tons of coal per annum; the same power could be provided electrically in a large central power station at one quarter the above consumption.

Summarising present results, the three power companies are now responsible for the supply of current to 80 miles (single track) of electrified railway, four tramway systems, the lighting in towns having populations aggregating over 700,000, motive power to the extent of 85,000 H.P., and electro-chemical works of over 12,000 H.P. The last named are new industries attracted to the Tyne solely by cheap power supply, and there is every indication that their number will in future be largely increased.

Surplus or "Waste" Energy from Coke Ovens and Blast Furnaces.—This is perhaps the most interesting section of the problem, and one which it is not too much to say is also of considerable national importance. The counties of Northumberland and Durham and the North Riding of Yorkshire last year produced together [illegible],800,000 tons of coke. The bulk of this was made in the older fashioned beehive oven, but the retort type of oven, by virtue of the increased

* The current generated in all cases three phase at a frequency of 40 [illegible]. † Stand-by [illegible]. ‡ Under construction.

coke yield and of the recovery of the by-products, is making rapid progress, and it can be proved that were the whole of the above coke output produced in retort ovens there would be available waste gas and waste heat capable of developing over 150,000 H.P. continuously, if used under boilers, or probably rather less than twice this amount—or, say, 250,000 H.P.—if the gas were used in gas engines. The blast furnaces form a second but less important potential source of power. In evidence given before the Royal Commission on Coal Supplies it was estimated that if gas engines were used exclusively for power purposes, then, after the requirements of the stoves and blowing engines had been met, there would still be available from the Cleveland furnaces a supply of surplus gas equivalent to 61,000 H.P. continuously. Financial and other practical considerations definitely limit the pace at which progress can be made in the utilisation of this "waste heat," and, especially in the case of blast furnaces, greatly reduce the amount of power immediately available; whilst the many estimates made are misleading.

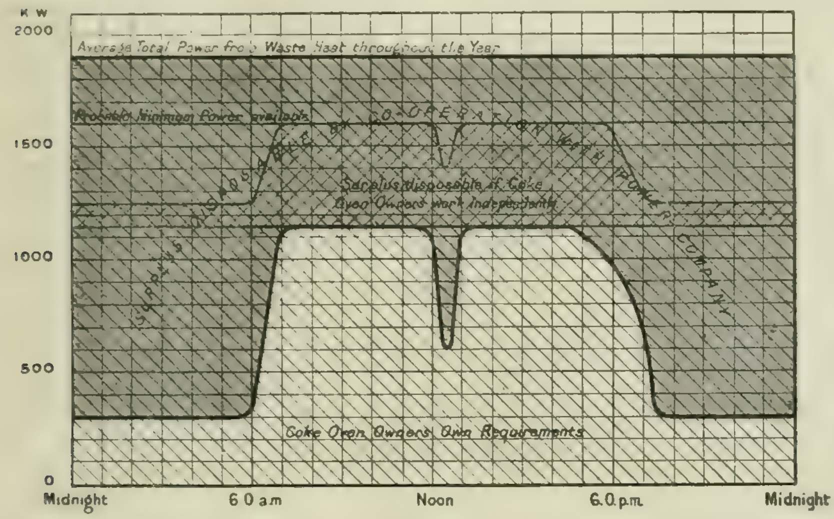


FIG. 2. -ESTIMATED DAILY OUTPUT AND LOAD CURVE OF WASTE HEAT STATION AT CROOK.

Dealing first with the waste energy from coke ovens, these are widely scattered throughout the county of Durham, and are for the most part at relatively long distances from the populous centres. The gas might be piped to some central point, as is the practice followed in America with natural gas, but there would have to be installed an expensive compressing plant. Further, there is, in addition to the gas given off from the coke ovens, a certain quantity of waste heat which can only be utilised locally under boilers; and in no calculations which the author has made has he been able to establish a case for the transmission of gas for power purposes as against the alternative of converting the gas into electricity and transmitting the power in this form.

Pease & Partners' installation at Crook, shows the advantage of co-operation very strikingly. It will be seen that the area of the rectangle enclosed between the top line and the base (shown batched) represents the total amount of power available, that "hatched" (but not shaded) the requirements of the colliery owner, and that "cross-hatched" the amount disposable had the colliery owner put in his own plant independently and been able to find a purchaser; it also assumes that the outside purchaser had approximately the same load curve as the colliery owner himself, which is a reasonable assumption, unless the power be transmitted long distances, as the only users of power in the vicinity of coke ovens are other colliery owners. The area shaded grey represents the surplus power actually used under the co-operative arrangement.

It is more difficult to get out so typical a curve in the case of blast furnaces, as the conditions vary so widely. Capital charges are invariably the controlling factor in the total cost of electricity, and the question raised above—namely, whether it is commercially sound for a blast-furnace owner to co-operate with a power company or not—can only be decided in each individual case after full consideration of the capital outlay involved, the amount of spare plant that has to be provided and the degree of coincidence between supply and demand.

The power companies in this district having their transmission cables interlacing the entire industrial area, and being in a position, with their large load already developed, to utilise any amount of electricity whenever and wherever produced, are arranging for waste-heat stations at different points, turning all the electricity so produced into a common network from which the colliery company, the coke-oven owner or the blast-furnace owner can purchase any amount he may require, all spare plant and all plant to deal with exceptional peak loads being kept at the main central coal-fired station. Such a policy applied to other commodities is as old as the hills; it began in the most primitive market when a producer gave his raw material and received in exchange manufactured articles, but, so far as the author is aware, this is the first time it has been extensively applied to electricity, although the principle so applied is equally sound, and it appears that only in this way is it possible to conserve the full national value of the energy now being wasted.

Brief Outline of Work already Done.—To summarise briefly the work which has already been done in the utilisation of surplus power, the first co operative arrangement made by any of the power companies was brought about by the initiative of the owners of the Priestman Collieries, and resulted in the erection of the power station at Blaydon in 1905. At the present moment the three power companies have at work or in hand five waste heat stations, three in connection with coke ovens and two in connection with blast furnaces. Additional stations are under consideration.

It will be remembered that as regards the Cleveland blast furnaces the calculations quoted dealt with the surplus available on the basis of the gas being utilised in gas engines, but the adoption

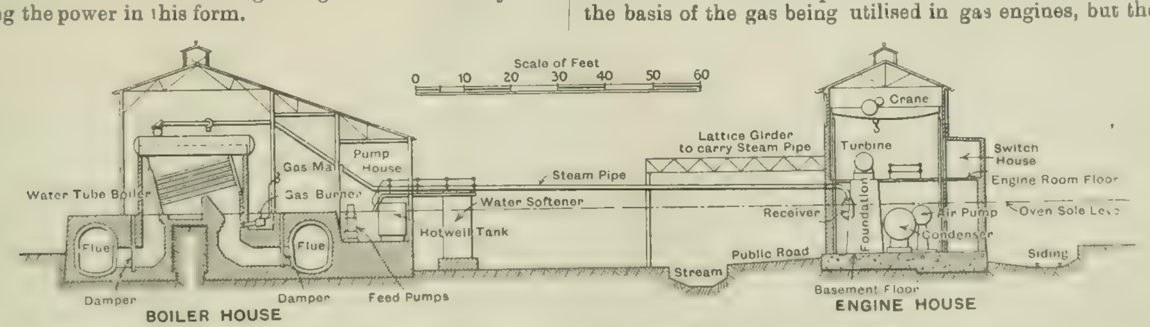


FIG. 3.—SECTIONAL ELEVATION OF BANKFOOT WASTE HEAT STATION.

Owing to the configuration of the site the engine-house is arranged at an angle of about 75° to the boiler house.

In all cases investigated by the author it has been found that a greater profit will accrue to the coke-oven owner by co operating with a power company than by proceeding on independent lines. There are three reasons for this: (1) When a private owner erects a generating plant independently he must instal some reserve or spare plant, with a consequent heavier outlay of capital than is necessary to a power company, which, possessing a coal-fired station, need instal no spare plant in any of their waste-heat stations. (2) This necessity of putting down spare plant results in smaller, and therefore more expensive and less efficient plant. (3) The power company, having a market for current many times greater than the output of any individual waste-heat station, can run such a station continuously at maximum output, so utilising completely all the current that can be produced. Fig. 2, which refers to Messrs.

of gas engines to the exclusion of all other types of prime mover still lies some distance in the future, and in the majority of cases in Cleveland it is found that steam blowing engines are used, and that after the requirements of the stoves have been met the gas is practically all expended in raising steam to supply these blowing engines. To free any substantial quantity of gas for outside power users would involve therefore the substitution of gas engines for the existing steam-blowers. Considerations of capital expenditure usually forbid this course, and had it not been for the genius of Mr. Parsons, whose exhaust steam-turbine provides another effective though less ambitious way of dealing with the situation, the Cleveland furnaces could not be regarded by a power company as an immediately available source of energy.

In this connection, as capital outlay controls so completely the cost

of electricity, and as exhaust steam-turbines are so dependent on a high degree of vacuum for efficiency (at 26 in. they consume 50 per cent. more steam than at 29) it is perhaps not always easy to justify the policy of installing small exhaust steam-turbines inland in conjunction with an intermittent supply of steam such as that from a colliery winding-engine, as this involves a cooling-tower and a regenerator with a consequent poor vacuum and high capital outlay.

The author gives diagrams of typical waste heat stations. The Newport station, at Messrs. Samuelson's and the Teesbridge station are exhaust steam stations, the Weardale station at Spennymoor is driven by coke-oven gas, while the Bankfoot station at Crook (*see* Fig. 3) will derive its energy chiefly from waste heat from coke-ovens. The Blaydon station also utilises waste heat and gas from coke-ovens.

It has lately become the fashion to argue that the resources of Great Britain have been developed on less scientific lines than those either of Germany or of America. The author thinks, however, that the persons urging these views are in the majority of cases omitting to give full weight to local conditions. The fact that the connections to the local power companies' systems have recently been increasing at the rate of 20,000 H.P. per annum appears to him to prove fairly conclusively that manufacturers on the North-East Coast are quick to avail themselves of new developments or of additional facilities.

THE PROPOSED ELECTRIFICATION OF THE MELBOURNE SUBURBAN RAILWAYS.

(*Concluded from page 920.*)

Fig. 1, herewith, is a map showing the suburban system of the Victorian railways.

System of Electric Traction Recommended.—To decide upon the system of electrical traction most suitable for the operation of the Melbourne

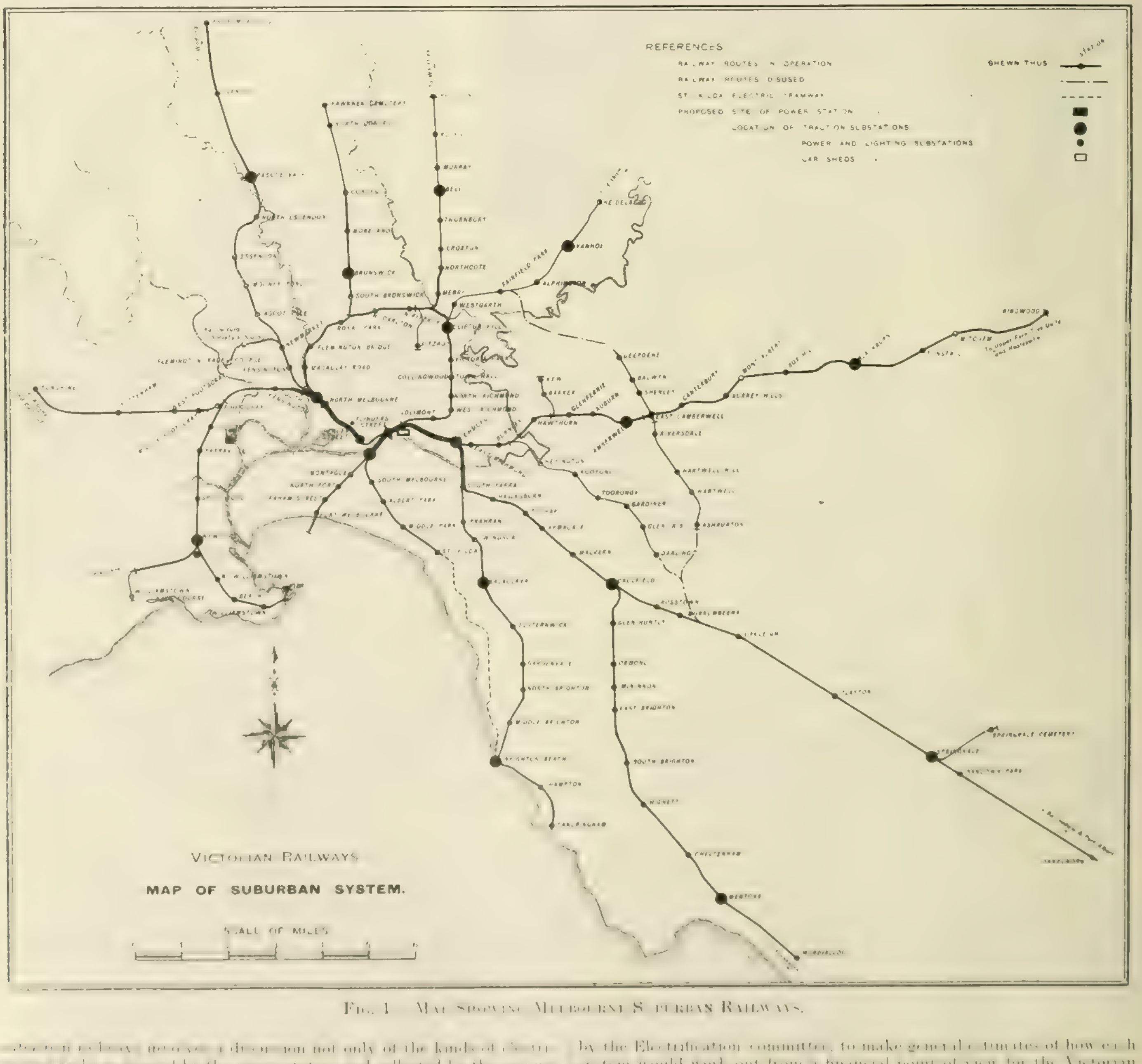


Fig. 1.—Map Showing Melbourne Suburban Railways.

suburban railways necessitates a decision not only of the kinds of electric [illegible] to be generated by the power station and collected by the moving [illegible] of the method to be adopted for conveying the current to [illegible]. The system chosen must, in any case, be suitable for [illegible] with [illegible] of the suburban railways. It may be noted [illegible] to the different systems which might be considered [illegible]. These may be conveniently grouped as "Conductor Rail Systems" and "Overhead Wire Systems." The former comprise: (1) Unprotected third rail with continuous current at low or medium pressure. (2) Protected third rail with continuous current at low or medium pressure. (3) Protected third rail with continuous current at high pressure (1,200 volts or over). And the latter systems: (1) Overhead wire with continuous current at high pressure (1,200 volts or over). (2) Three-phase alternating current at high pressure (3,000 volts or over), using two overhead wires for each track. (3) Overhead wire with single-phase current at extra high pressure (6,000 to 10,000 volts).

Before Mr. Merz visited Melbourne he was able, with the data furnished by the Electrification committee, to make general estimates of how each system would work out from a financial point of view for the Victorian railways, both as regards capital cost and operating expenses. Since his visit he has been able to make a more detailed and exact investigation in the light of his knowledge of the local conditions. As the investigation proceeded, and the conditions to be met with on the system were fully realised, it was considered that all the systems might be put on one side

with the exception of the unprotected third-rail system, the protected conductor rail system and the single-phase overhead wire system.

Mr. Merz is not prepared to recommend the high tension continuous current system on account of the extra complication and cost of the equipment of the trains themselves compared with the continuous current system at lower voltage. Pressures of 1,000 volts and over are not suitable for use with a conductor rail, and if used with overhead wires the system does not compare favourably with the single-phase system for railways, such as those at Melbourne. The three-phase system is specially suited to long runs and for heavy gradients, but is not the best for a suburban service. Choice, therefore, becomes restricted to (1) the unprotected third-rail system at 600 volts, (2) the protected conductor rail system at 800 volts, and (3) the single-phase high-tension system at 10,000 volts.

The calculations show that a protected conductor rail system with a voltage of 800 has many advantages over the unprotected third-rail system at a lower voltage, from both financial and operation points of view. Although the unprotected third-rail system has been operated with great success both in England and abroad, and although the accidents from shock have been remarkably few even in a country like England, where for a large part of the year the ground is more or less saturated with moisture, there is no doubt as to the superiority of the protected conductor rail system even in a climate like that in Melbourne. When, in addition, it is found, as is here the case, that an 800 volt protected conductor rail system can be installed for considerably less money and will operate at a higher efficiency on account of the lower losses in the conductor rails and track, Mr. Merz has no hesitation in recommending it in preference to any unprotected third-rail system, even under the particularly favourable conditions of track and climate existing in Melbourne. For the Melbourne suburban railways, therefore, it comes down to a choice between the 800 volt continuous current protected conductor rail system and the single-phase overhead wire system.

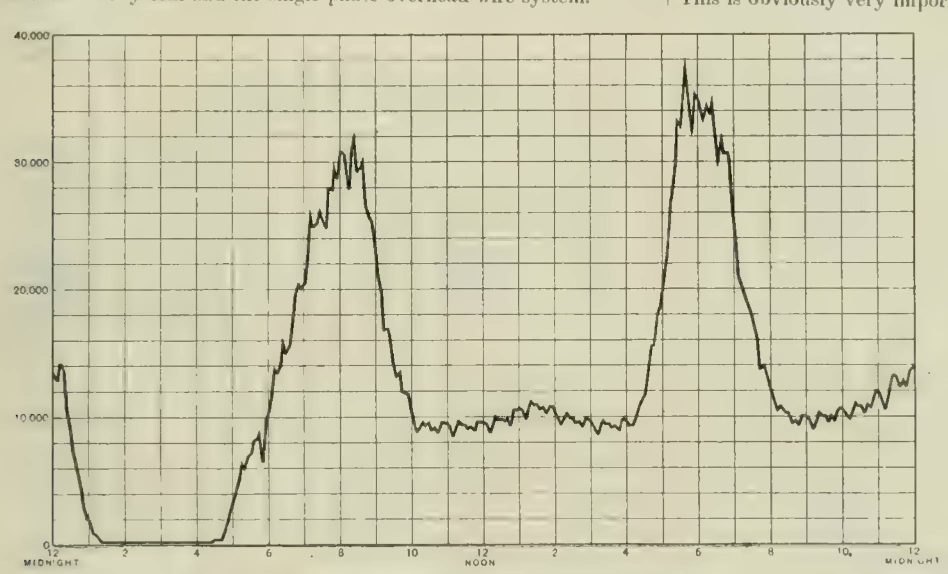


FIG. 2.—ESTIMATED LOAD CURVE OF POWER STATION.

The single-phase system shows advantages over continuous current for long lines with a comparatively infrequent service. At Melbourne, however, the traffic on the main lines is so extremely small that their electrification cannot be contemplated, and therefore there is no object in sacrificing the efficiency of the suburban service by considering the possibilities of another system suitable for main line working as well.

It has been claimed that even for such suburban railways on which there is a frequent service the single-phase system shows very considerable advantage in first cost compared with the continuous-current system. This, however, has not proved to be the case after having worked out in detail the cost of dealing with the Melbourne suburban traffic, for not only would the overhead lines be very much more costly than has frequently been stated to be the case, but the additional cost of the large number of train equipments required would practically balance the extra expenditure on the sub-stations required in the case of the continuous current system; in fact, the very complete investigation which was made into the first cost of providing the electrical equipment for the Melbourne suburban railways has confirmed the opinion as to the relative first cost of the two systems which Mr. Merz had formed in investigating similar problems for the other suburban railways. In the case of Melbourne, it is only when including very long and sparsely populated lines, such as the Frankston branch, to which in any case Mr. Merz does not consider the extension of electrical operation justifiable, that the single-phase system shows any appreciable saving in first cost over the continuous-current system. However, when coming to consider the total annual cost (which is the important figure), including operating expenses and interest charges, it is found that under Melbourne conditions the continuous current system shows a saving compared with the single-phase system. It is, therefore, not possible to recommend the adoption of the single-phase system on financial grounds.

When it comes to a question of considering, apart from financial reasons, which is the more suitable system for dealing with the large suburban traffic which our suburban railways have to cope with, a comparatively new system, such as the single-phase system, must obviously show some very decided advantages in operating facilities before it should be adopted in preference to the well-tried continuous current system, especially when it shows no advantage from a financial point of view. It must not be forgotten that the only line at all comparable with the Melbourne suburban system which is operating to-day on the single-phase system is the Hamburg–Altona line, and that this line has only been in regular operation since January of this year, and even yet can hardly be considered complete. There are also many cases in America where long-distance inter-urban lines are operated on the single-phase system, but these are not comparable with the Melbourne system for complexity, as they mostly operate single coaches, not trains. The New Haven line outside New York also operates on this system, but at present only locomotives are in use.

As, therefore, Mr. Merz cannot recommend the Commissioners to consider the single-phase system for financial reasons, and as he considers that the continuous-current system is superior to it in a case such as that of the Melbourne suburban railways from an operating standpoint, he has decided, after having studied the whole problem in great detail and from all points of view, that the continuous current 800 volt protected conductor rail system is the right one to adopt for Melbourne. As a mechanical structure a protected conductor rail, compared with overhead wires, is superior in both simplicity and reliability; it not only needs less repair, but less inspection. Most important of all, the inspection and repair work can be done by the ordinary permanent way staff in daylight, and when the service is in full operation, whereas the inspection and repair of overhead wires requires a special staff, not only because it has to be done at night, but also on account of the class of labour required. This is obviously very important in a country where electrical operation has not hitherto been adopted and where labour is dear. When it is also considered that the wear on the conductor rail is practically negligible, whereas the wear on the overhead wire is not inconsiderable, this point becomes still more important. While overhead wires may be in every way suited to long lines on which the service is not so frequent and where there is consequently less wear and tear and where, also, there may be time between trains to inspect and to do repair work, the protected conductor rail which needs less inspection and can be, and is, inspected at any time by the ordinary permanent way men, offers a more reliable service on a busy suburban system.

On a system where as many as 500 motors are required, reliability of the train equipment is of great importance. A single-phase equipment, such as would be required for Melbourne is not only some 50 per cent. heavier than a continuous current equipment but is also much more expensive on account of the greater complexity and weight. This necessarily means more costly repairs, apart from the fact of less satisfactory commutation of the single-phase motor. Obviously also, the lighter the equipment the better.

The question of interference with the important telephone system of Melbourne, although not a matter which concerns the State so much as it does the Commonwealth Government, might have justified, Mr. Merz considers, taking into consideration—though this has not been done—the large extra expense which the installation of high-tension overhead wires closely adjacent to the telephone wires would probably mean, not to mention the great public inconvenience of having the telephone service seriously interfered with even temporarily.

Mr. Merz recommends three-phase generation and high-tension transmission with conversion by rotary converters. The energy consumption is estimated to be 83·7 watt hours per ton mile, including coach lighting, heating, control circuit, motor-driven compressor for supplying power for brakes, and irregularities in operation. The total units required for the complete scheme are estimated at 68 millionsper annum, and the E.H.P. required at the power station during the heaviest half-hour is 32,100. The load-factor on the station is estimated at 33 per cent.

Power Production. A reference to the general estimates given in the report shows that, according to Mr. Merz's recommendations, the total cost of power, including interest charges, for working all the suburban lines electrically will amount to over £100,000 per annum. The question, therefore, of the way in which this power should be obtained is a very important one. It has also an important bearing upon the question of the size of scheme that can be economically proceeded with in the first instance. As it is frequently found to pay better to buy power than to erect a special power station for railway purposes, Mr. Merz first disposes of this alternative. There are only two power stations of any size in the neighbourhood of Melbourne; the Corporation station, situated in Spencer-street, and the station of the Electric Light & Traction Co. of

Australia, situated at Richmond. Neither of these (nor any other station) is suitable for the production of power in sufficient quantities or at a low enough price for the working of the railways.

Mr. Merz then considers the sites available for the erection of a power station, and gives his reasons for choosing that at Yarraville. The power station proposed at Yarraville will contain steam turbines and water-tube boilers. When the whole of the work is complete there would be eight generating sets installed, each of 5,000 E.H.P. but capable of giving more for a short time. Superheated steam would be used, and the electricity generated at a pressure of 12,000 volts. A special feature of the design will be that the switchgear from which the operation of the machinery and the circuits will be controlled will be situated in a separate building where the operators are undisturbed by the noise of machinery or accidents. An elaborate telephone system connects this control room with each engine and also connects it with the various sub-stations throughout the system to which the high-pressure current is conveyed and where it is transformed into low-pressure current suitable for use on the trains. A typical load curve such as may be expected on the power station is given in Fig. 2.

The collection of current from the conductor rail is by means of a contact shoe attached to the bogie truck, and this may be of either the under, over or side contact type. The decision as to which of these alternatives should be adopted depends upon the exact design of protection. Whilst Mr. Merz was in Melbourne some samples of typical forms of protection were made and erected on the track and it was decided to leave these exposed to the atmosphere for a considerable time before coming to a final decision as to the best form of protection and kind of wood to adopt. He also had samples of various woods which it would be possible to use for this protection sent to England and tested in his laboratory, and, although it seems certain that "Messmate" gives the best result electrically, he withholds his decision as to the exact design of protection for the time being, until it is seen how the samples erected in Melbourne stand the effect of sun and weather, and also until some further laboratory tests now being made are completed. The estimates, however, allow for the adoption of any of the chosen types, and the specifications provide for the supply of rails, insulators and bonds of such design that the conductor rail may be completely protected throughout its length. On double-track roads the conductor rails for both tracks will be laid in the 6 ft. way, thus leaving the tracks themselves and the outside of the tracks free from obstruction. Where there are level road crossings or special track work, such as cross-over roads or junctions, the conductor rail will be discontinued and the gap bridged by lengths of low-tension cable laid underground. Fig. 3 shows the available forms of protected conductor rails.

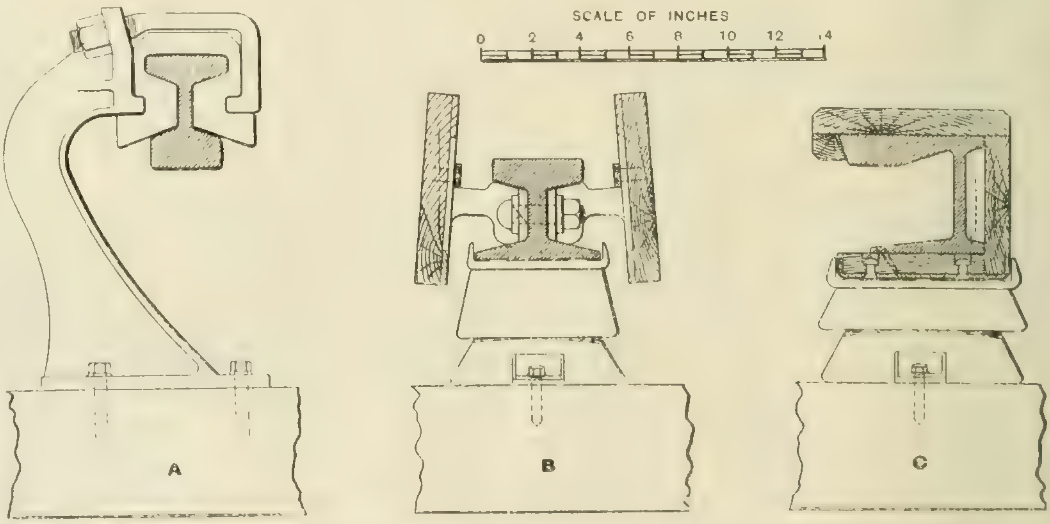


FIG. 3.—FORMS OF PROTECTED THIRD RAIL.

Cables.—It is recommended that the current be conveyed from the power station by underground cables as far as Richmond and around the inner circle, and by overhead lines elsewhere, although were it not for the expense it would be better to put all the cables underground.

Rolling Stock.—In considering the question of the most suitable type of rolling stock for a large, important and rapid suburban service, Mr. Merz says the two chief considerations are: Firstly, to secure the maximum passenger accommodation for a given weight of coach; and secondly, to adopt a design which will enable the passengers to enter and leave the trains at the different stations as rapidly as possible. As would be expected, the first of these considerations is best met by making each coach as large as possible, that is, as long and as wide as possible. The second consideration is almost entirely one of arrangement of seats and doors. The types of stock generally in use may be classified under two general heads: corridor stock with doors at each end, and cross-compartment stock with side doors. Whereas end-door stock is usual in America to the almost entire exclusion of side-door stock, the reverse holds good on the Continent of Europe. For main line and high speed working, it is considered that corridor stock has great advantages. The design may be made rigid and strong and the side framing being without openings or breaks for doors, can be built in the form of a continuous girder. In America, and to a certain extent in England, the corridor type of coach has also been developed for suburban working. For tube, subway or underground railways dealing with very heavy traffic, it has undoubted advantages if train men are stationed at each end of every coach. On the other hand for ordinary suburban working, the expense of so many train attendants is prohibitive, and without them there is a delay in discharging and loading trains where all passengers have to leave by comparatively small end doors. If it were a question of building new stock, Mr. Merz considers the type of stock originally suggested by the Chairman of the Railway Commissioners and designed by the chief mechanical engineer would be the most advantageous. This design is really a combination of the two types, being a cross-compartment coach with communication way between compartments. Such a coach has been used on certain of the American and German lines and has been proposed for some of the English systems.

The duty of closing the carriage doors, at present devolving upon the station staff, will be rendered more difficult by the higher acceleration. It is recommended that if any electrification scheme be proceeded with, such of the existing stock as is suitable for the purpose be lengthened and altered for the electric service, and that, on routes where this is used, additional staff be provided at the busier stations during rush hours of traffic and that new stock be provided to make up the required number of coaches. The existing trucks, while they can conveniently be made suitable for use as trailer trucks, are not suitable for carrying the motors themselves. It is therefore recommended that new motor trucks be built.

Incidental Considerations.—The report then deals with various auxiliary works such as new block sections, systems of signalling and train despatch, alteration of existing lines, increase in the number of passenger stations, provision for holiday and race traffic and general power and lighting, but makes no definite recommendation except that it would be better to defer making any radical changes in signalling and train despatching until experience has been gained from electric working.

General Power and Lighting Scheme.—The electrification of the railways and the consequent erection of a large and economical power station capable of generating electrical energy at the lowest possible cost, enables a supply of power to be obtained for any further requirements of the railways at a very low price, and this use of current for other purposes, such as power, lighting, in connection with the railway system, should produce, not only a saving in cost compared with the present method of producing power and light, but also, by improving the load on the power station, a beneficial effect on the cost of producing energy for the railways themselves.

Mr. Merz recommends that all the stations in the central area be lighted by enclosed arc lamps, or else by groups of metallic filament lamps. Whilst for stations outside the central area the lighting should be done from the conductor rail by means of incandescent lamps arranged in series. In the more important stations, where, on account of the number of offices and buildings, it might not be convenient to adopt series incandescent lighting, he recommends the provision of a small motor generator supplied from the conductor rail, suitable for transforming down to 100 volts and running in parallel with a small emergency battery.

The average cost of wiring, fittings, &c., may be taken as ranging from £2. 10s. to £3 per point for platform and outdoor lighting generally, and £1 per lamp for interior work. These prices are inclusive of all material and labour up to and covering the switchboard, and vary with the facilities available for open wiring. Arc lighting, with enclosed arcs, for piers and yards may be taken as £17 per lamp inclusive. On the basis of these prices, Mr. Merz estimates that the whole of the stations could be wired and fitted, including extensions at Flinders-street and Spencer-street and 50 cycle transformers at North Melbourne and Richmond and four motor generator sets as described, for the sum of £13,816.

If any electrification scheme be proceeded with the railway department will have available a supply of electrical energy at a low price, and it would certainly pay to equip the Newport workshops and the North Melbourne workshops for electrical driving. Mr. Merz has prepared a complete scheme for this which is submitted together with the report. The whole installation involves some 980 B.H.P. in three-phase induction motors, and the estimated capital cost is £9,550.

General Estimate.—The last section of the report gives a summary of the estimates and makes a comparison between the cost of converting steam traction and installing electric traction.

Table III.—*Capital Expenditure and Increased Interest Charges Involved by Electric Traction (for the complete Scheme).*

Power station, high-tension feeders and sub-stations, including spares	£846,689
Track equipment, including low-tension cables and alterations to permanent way, and spares	568,139
New rolling stock (less credits), alterations to existing stock, and electrical equipments (including spares)	754,881
Inspection pits and Flinders-street car shed	57,341
Total cost of electrical scheme.........................	2,227,050
Less expenditure to deal with traffic by steam traction	425,590
Nett additional cost of electrical scheme..............	1,801,460
Interest charges at 4 per cent. per annum..............	72,058

Table IV.—*Operating Expenses with Electric Traction.*

Cost of power..	£70,591
Motormen's wages and stores..............................	29,079
Inspection and maintenance of rolling stock and equipment	76,911
Additional staff at stations..............................	6,840
Guards' wages and stores..................................	23,479
Maintenance of electrical track equipment...........	12,800
Electric Traction :—	
Operating costs—total	219,700
Operating costs—total per train-mile	11·03d.
Steam Traction :—	
Operating costs—total......................................	246,967
Operating costs—total per train-mile	18·93d.
Difference in Favour of Electric Traction :—	
Total	27,267
Per train-mile	7·90d.

Table V.—*Comparison of Increased Cost of Electric Service with Increased Revenue due to Improved Facilities.*

Interest charges at 4 per cent. on capital cost of electrification scheme	£72,058
Saving in operating expenses with electric traction...	27,267
Extra cost of electric traction (including interest charges)	44,791
Additional increase in revenue on basis of 5 per cent. greater traffic, with electric traction	28,632
Additional increase in revenue on basis of 10 per cent., greater traffic	57,265
Additional increase in revenue on basis of 15 per cent., greater traffic	85,897
Actual percentage increase of revenue above the assumed normal growth of 20 per cent., necessary to balance the additional capital charges less the saving in operating expenses	7·8

Table VI.—*Profit from Suburban Business in* 1906 (*Steam*), *and* 1912 (*Electric*).

Operating expenses in 1912 (electrical)..................	£219,700
Operating expenses in 1906 (steam).......................	205,871
Increase in operating expenses............................	13,829
Increase in revenue	143,162
Increase in gross profit....................................	129,333

Conclusions.—The conclusion is that the application of electric traction to the Melbourne suburban system is justified from a financial point of view and that it will result in greatly improved service to the public, and that the first section to be converted should be that referred to in Stage I. A summary of conclusions, numerous plates and specifications are given at the end of the report. We are able to give these interesting particulars through the courtesy of the Victorian Railways Commissioners.

THE INTERNATIONAL CONGRESS AT MARSEILLES.

(FROM OUR OWN CORRESPONDENT.)

There was quite a crowd at this Congress, the enrolled members numbering over 1,400; but among these only one or two Englishmen. For the purpose of voting, decisions and recommendations, the Congress lost much of the authority it might otherwise have assumed, by the non-representation at its meetings of the English Government and of the English Institution of Electrical Engineers. This abstention is to be regretted, as there was here a good opportunity for the interchange of what might then have been fairly termed universal views. Under the circumstances it was prudent to confine the formal votes taken almost entirely to matters of solely French interest. France, Italy and Switzerland were all numerously represented at this gathering. Belgium, Germany, Austria and Russia were well in evidence. Most of these countries had sent official Government delegations, as had also Sweden, Canada and the United States of America. The last-named delegation was headed by Mr. Mailloux, who was very active in speaking in several of the sections, giving information as to results attained in America and urging the adoption of practice similar to that followed in America. Mr. Higman, of the Canadian Government delegation, also spoke, but did not take much active part in the proceedings. M. Berthou, Minister of Public Works, who was expected to open the Congress personally, did not turn up, and Prof. Mauria Lévy, was voted President for this year. In his opening speech, at the Theatre of the Electrical Exhibition on Monday, September 13th, he gave a brief sketch of the history of electrical industry. On the same day Prof. Ch. Fabry gave a lecture on points of interest at the Exhibition, and the rest of that day was spent in a round of the three main Exhibition halls.

On the previous Sunday, an expedition to Brillanc-Villeneuve, 75 kilometres from Marseilles, had been made by those who arrived in time for it. This is the chief hydro-electric generating station supplying the south-east of France. The water is taken from the River Durane. 12,000 H.P. is at present installed. The transmission voltage is 50,000 and the frequency 25, three-phase current. At Allauch and at Arles there are two large transforming stations, where the voltage is reduced again to 13,500. These two stations were visited by the Congress in subsequent excursions. The latter of the two transmits a supply to Marseilles. Visits were also made to three steam generating stations situate in the suburbs of Marseilles. One of these, at St. Giniez, feeds the tramways, which are crowded with traffic, in a fashion seldom, if ever, seen in any other city in the world. At this station cross-compound Corliss engines are employed. At the other two at Cap Puiedo and at the Gas Works at the new Port, Brown-Boveri-Parsons and Curtis turbines are used. At the last-named works, an American Curtis machine of 5,000 H.P. is now being completed, and will be running in a month or two.

Other afternoon employment for the Congress consisted in a very interesting and ably delivered lecture by Prof. Abraham, of Paris, on the rheograph, which is an improved oscillograph. It gives accurate diagrams on a large scale, so that they can be exhibited directly to classes of students; and it provides means for the complete graphic analysis of electric vibrations, as also for the synthesis of the components in adjustable proportions and with difference of phase under control. Another afternoon lecture was on Wireless Telephony, by Prof. de Lesignier. It was popular in character, but was well illustrated by diagrams.

The reading of Papers and the discussions thereon were begun on Tuesday morning after presidents had been elected to each of the nine sections. The subjects were allotted to the sections thus:—(1) Laws and Regulations; (2) Design and Precautions against accident; (3) Technical and Commercial Management; (4) Lighting and Household Apparatus; (5) Mines, Traction and Agriculture; (6) Electrochemistry and Electro-metallurgy; (7) Telegraphy and Telephony; (8) Education and Measurements; (9) Hygiene and Medicine. The sections were supposed to meet from 9 to 12 each morning, but several of them found little to do and contented themselves with three or four sittings of half an hour to an hour's length. The sections which found themselves fully occupied were (2), (3), (4), (5) and (8). In section (2) interesting Papers were read by Mr. Grosselin on extra high tensions produced in networks by resonance and reflexion of waves; a report by De Marchena upon underground cables; by Mr. le Roy on poles of wood, metal and armoured cement; and by G. Semenza upon tests of modern high-tension insulators, in which most interesting results from the author's own researches were explained. In section (3) the best Papers were by Mr. Boissonas on the comparison of different methods of electric energy transmission; by Emile Doncerain on the various risks in electric work, and the various modes of covering them by insurance, on which a long and lively discussion arose; by E. Brylinski on earth-returns, in which the author anticipated the speedy overcoming of all objections to the use of the earth as the return, made light of electrolytic difficulties, and showed that the really expensive troubles came from various induction phenomena; on the

use of accumulators in electric distribution by A. Nisson; a report by M. George on various methods of charging for electricity, on which the usual differences of opinion were expressed at considerable length and with some warmth; on the economic organisation of distribution companies by M. Loucheur, which also occasioned long debate showing much diversity of belief. In the fourth section the most important Paper was a thoroughly practical one on Domestic Heating by G. Goisot. The programme of the fifth section was a heavy one. It included Papers by Ed. Tissot on the comparison of the various systems of electric traction; by Jean de Tratz on electric motors in workshops and factories; on railway traction by M. Janin; by J. L. Routin on electric governors and servo-motors (relays); on railway signals by Cumont; on canal traction by M. Legouez; by Brunswick on mine equipment; by M. Korda upon the Heyland-Korda unipolar transformer; by Herr Gratzmuller upon monophase traction motors, upon which Prof. Latour spoke at length; and by Prof. Swyngedauw on economic sections and voltages. Only a few of these Papers received any attention at all, although all were excellent and several of great length and thoroughness; and the debates upon those which were read, were very much restricted from want of time. It seemed strange mismanagement to load up one section with two or three times the amount of work it could by any possibility deal with. The same want of good arrangement had perforce the same result in section eight. Here Prof. Ch. Fabry read a Paper on energy meters; and Prof. A. Blondel upon modern incandescent lighting. This latter author had also an excellent Paper upon the training and the essential qualities and accomplishments of the electrical engineer. P. Janet and M. Chaumat presented a very long and elaborate report upon electrotechnical schools, but this was not read; and the only debate upon education and training arose upon Prof. Blondel's Paper. Only half of the last forenoon was spent in considering education, but the debate, although short, was very much in earnest, and while much difference of opinion on details was revealed, there seemed to be a generally felt dissatisfaction with the present condition of affairs.

Although a great deal that was of extreme interest and utility appeared in the Papers and the speeches at this Congress, it must be confessed that the opportunity for a much higher standard of usefulness was lost through the apparently total want of common-sense in the office arrangements, whereby many sections had nothing to do while others were impossibly overloaded with matter, and Papers on the same subject were actually put down for different sections.

It may also be mentioned that a couple of dinners enlivened two of the evenings.

THE UTILISATION OF PEAT FOR MAKING GAS OR CHARCOAL WITH RECOVERY OF BY-PRODUCTS.*

BY CAPT. H. RIALL SANKEY.

Summary.—The author first gives a general outline of an electric power undertaking with gas producers using peat as fuel and describes methods for getting and drying the peat. The different types of gas producers are then referred to, and also the by-products which can be obtained, whilst particulars of the expected cost of operation are given. Reference is made to some German installations, in which several of the processes involved are in actual operation.

The much discussed subject of the utilisation of peat has during the last few years been revived owing to developments in gas producers and in gas engines, and at the moment it is of considerable interest in Ireland in connection with the Bill which has been promoted in Parliament to obtain powers to produce gas from peat, to use this gas for making electricity by means of gas engines and dynamos, and to distribute electric power to works which will probably be established in the immediate neighbourhood of the power station and throughout a certain prescribed district. It is proposed to put the power station alongside the Grand Canal, not far from Robertstown, about 25 miles from Dublin. Previous attempts to utilise peat for power failed because they were based on drying the peat so as to retain no more than 25 per cent. of water, and in some cases the expense of "briquetting" was incurred; the peat was then transported to the place where power was required and burnt in steam boilers fitted with specially designed furnaces. Such peat could not compete with coal; moreover, the valuable by-products were not recovered.

In the proposed scheme the peat will only be partially dried—that is, will still contain 60 per cent. of water; it will be used on the spot to make gas, so as to get the benefit of the great thermal efficiency of gas engines and to save the cost of carriage. The by-products will be recovered, the profit on which will at least cover the cost of getting and drying the peat. It will be possible to supply power to works in the immediate neighbourhood of the power station as cheaply as can be done from water power. Many of those industries which are dependent upon cheap power will undoubtedly be attracted.

To fix ideas, the power station will be considered to have a capacity of about 5,000 kw., and a sufficient number of producers to make gas for this amount of power will be erected, together with the recovery plant for making sulphate of ammonia, &c., quite close to the bog. Peat, containing 60 per cent. of water, will be brought on to the producer platforms from the bog by means of either a narrow gauge railway or an aerial tramway, as may be found most convenient. The producers will be worked continuously at full load, so as to get the full output of sulphate of ammonia and of the other by-products the plant is capable of producing, and the engines will take all the gas they want, but during the hours of small demand for electricity the remainder of the gas will be used for heating purposes, or burnt to waste; in this way there will be an almost immediate return on the capital. A scheme for the utilisation of peat similar to the above was outlined by Mr. T. Rigby (of Messrs. Crossley Bros.) in a Paper he read before the Engineering and Scientific Association of Ireland on March 26, 1906. A very suitable size of gas engine plant is in units of 500 kw. to 1,000 kw. each, and a beginning will be made with, say, two or three sets.

Although there are many small installations, principally in Sweden, using peat and producing electricity, there is at the present moment no electric power undertaking of any magnitude in existence devised on the lines indicated above, but each and all of the separate links in the chain of operations are now successfully at work and none are missing; it only remains to put the links together into a chain. As an engineer, the author has no doubt as to the result, and for many reasons it is greatly to be hoped and desired that the credit of doing so may rest with Ireland.

The author has, however, seen an electric power installation scheme at work in Germany, near Aurich, in which peat is the fuel, and which shortly will have a capacity of 5,000 kw., but the peat is burnt under steam boilers and steam engines are used. By means of a special adjunct to the boilers the peat, or at any rate, the greater portion of it, is used direct as it comes from the bog—that is to say, containing from 90 to 95 per cent. of water—is dried and briquetted, and is then automatically discharged into the furnace. It would appear that a small proportion of air-dried peat must also be used, which can be obtained in summer for use during the remainder of the year, and thus only quite a small store of air-dried peat is required. Unfortunately, he is unable to give further details, as the matter is at present confidential, but from calculation it appears that the cost of peat fuel thus used is equivalent to using coal at 5s. to 6s. per ton, which, as will be seen later, is not nearly so advantageous as the proposed gas producer scheme. This scheme can be compared with those power stations in England using coal practically at the pit's mouth, and it is not so satisfactory as the proposed scheme which, in this respect, is comparable with water power electric supplies.

The general outline of an electric power distributing undertaking using peat as a fuel through the intermediary of gas producers and gas engines having been thus indicated, the arrangements to adopt for its various component parts are considered under the following heads: Getting and drying the peat, gas producers, by-products, gas engines, together with the cost of producing electricity at the dynamo terminals.

Getting and Drying the Peat.—The peat can be got and dried in four different ways—namely: (1) Entirely by hand labour—that is, by cutting and stacking, as is now practised in Ireland. For the purpose in view the cost of this method is too great; the cost reckoned on *theoretically* dry peat appears to be about 6s. per ton delivered to the producer. (2) The peat may be cut by hand and then shovelled into an elevator which transports it to a press—the "Dornberg" or the "Anrep" press, for example—which consists of a hopper discharging into a horizontal rectangular chamber in which two worms are rotating in opposite directions. They break up the peat and force it through a mouthpiece of suitable shape on to a moving band, where it is cut into slabs, much as in brick making. These slabs are laid out to dry, and it appears that the effect of this press is to facilitate the drying. It is estimated that with this method the cost would

* Abstract of a Paper read before Section G of the British Association, at Dublin.

be reduced to about 4s. per ton. (3) The digging and spreading for drying can also be performed by a machine devised by Herr Strenge, of Elizabethfehn, near Oldenburg. The digging is performed on a vertical face by a continuous chain of buckets, which are given in addition a gradual horizontal feed motion of 10 ft. backwards and forwards; the depth dug is from 8 ft. to 10 ft., and the progress is 150 yards in 12 hours. The peat is discharged from the buckets on to a conveyor, which carries it to a "Dornberg" press. The capacity of one machine is about 1,000 tons of 90 per cent. peat per day of 12 hours. (4) The peat can be dug by means of an ordinary grab (such as a "Hone" grab) which can be worked by a derrick placed on a truck on rails or else mounted on a barge or pontoon, as at Schelecken in East Prussia. Half a ton of wet peat is dug at each fall of the grab, and is discharged into tip waggons running on an 18 in. gauge railway. A train of these tip-waggons is taken by an electric locomotive worked from an overhead wire to a Dornberg press about a mile away, where the peat is tipped on to a conveyor carrying it to the press.

Taking everything into consideration, it would appear that the grab process is the best method for the purpose of the proposed power scheme, as it can be worked in practically all weathers, except hard frost, and the peat can be dug under water. The peat when cut as described and stacked will dry to 60 per cent. of water in a few days in the summer, but in the spring and autumn a longer time will be required, and in the winter it may not dry at all. When passed through a Dornberg press the drying is more rapid, as it brings the water to the surface. The effect of the press is to put a skin on the sods, which prevents them from absorbing moisture if exposed to rain. To meet the difficulty of not drying in the winter, a reserve of peat can be cut in the summer and air dried, to, say, 25 per cent. This dried peat can be mixed with the 90 per cent. peat coming direct out of the bog in such a proportion as to give a 60 per cent. mixture.

An interesting method of drying peat has been devised by Mr. A. B. Lennox, and is at work on a moor near Dumfries. The peat, as cut from the bog, is placed on wooden trays having short legs, so that they can be packed one on top of the other; and thus the peat not only drains readily, but as the air can get round each piece of peat, it dries more quickly. Six trays are placed one on top of the other, and, by means of a special tramway and truck, are easily conveyed to and placed on short wooden gantries.

Another process of drying peat has recently been brought to notice by Dr. Ekenberg, and is intended primarily for the making of briquettes. He states that when peat containing 90 per cent. of water is exposed to a temperature of over 150°C. (300°F.), that the slimy hydro-cellulose which prevents the water in the peat from being extracted even by hydraulic pressure, are decomposed, and the peat is also partially carbonised. In this condition the peat readily parts with its water, and it can be easily squeezed out to 35 per cent. Dr. Ekenberg calls it the "wet carbonising process," and states that he can, in less than an hour, from the peat as it comes from the bog, produce peat having 60 per cent. of water, and containing all the by-products, for a cost of under 3s. per ton of theoretically dry substance. Incidentally, it may be pointed out that Dr. Ekenberg's process requires heat, and that, as normally arranged, he has to burn about one-third of the peat to effect his object, but in the proposed electric power scheme there will be a considerable amount of gas burnt to waste during certain hours of the day, and there appears to be no reason why this gas should not be used to supply the Ekenberg process with the heat it requires, and, on the other hand, the Ekenberg process could, during the winter months, supply the producers with the 60 per cent. peat they require.

Gas Producers.—There are many producers on the market for making gas from peat. Many of them are intended for small, or for comparatively small, isolated plants in which it would not pay to recover the by-products; these producers are designed for working with air dried peat (25 to 30 per cent. of water) in the form of sods or briquettes. These producers are like those intended for bituminous coal, but vary in certain matters of detail, and principally in the dimensions, which have to be greater in the case of peat to produce the same power. In Germany a large number of gas producers are working with lignite briquettes, and the author saw several of these at work. At Messrs. Pintzsch's works, near Berlin, he saw many in various stages of construction. The largest size is capable of producing gas for 800 H.P. The identical producer is used for peat, but then it is only suitable to give from 600 to 700 H.P. The producers the author saw at these works were a splendid engineering job; the steel plates were riveted as if it were for boiler work, and, no doubt, therefore, such producers would be somewhat costly. Messrs. Pintzsch also propose to use the same producers with 60 per cent. peat by pre-drying by means of the exhaust of the gas engine.

The author saw some smaller producers suitable for working with peat, without by-product recovery, at the works of Messrs. Scheben & Krudwig, of Henef, near Cologne. Messrs. Körting also make a producer for peat, which is in considerable use in Sweden; it is not designed for the recovery of by-products. The author illustrates a producer by Messrs. Crossley Bros. for use with peat, and intended for the recovery of by-products, erected at Openshaw; and also one designed for the same purpose by Messrs. Ziegler, Reddig & Fleusse, and erected at Schelecken.

The gas produced when the by-products are recovered is of excellent quality. An average analysis of the dry gas, as given by Mr. Rigby, is: CO 12, CH_4 2·8, H 24, CO_2 18, N 43·2, total 100 per cent. Lower calorific value 135·7 B.Th.U. per cubic ft. The recovery of the ammonia as a sulphate requires a very intimate contact with dilute sulphuric acid, and this obviously ensures a very perfect washing of the gas, and therefore the principal trouble with large gas engines, which is due to the presence of tar and dust, cannot occur. This is a matter of very great importance, ensuring the satisfactory running of the plant.

By-Products. The by-products which can be obtained from peat are somewhat numerous, but at the moment, when gas is made, sulphate of ammonia is the only one which has been treated on commercial lines, and it is estimated that, when combined with an electrical power undertaking, the net profit on this sulphate of ammonia is about 4s. per ton, which, it will be observed, more than covers the cost of peat—namely, 3s. per ton. The profit on the other by-products cannot yet be credited, because up to the present these by-products have only been obtained commercially when making peat charcoal (Ziegler process), and it is possible that, when making gas, some initial difficulties may be met with in obtaining them on a commercial scale. There is no reason to doubt, however, that eventually they will be satisfactorily worked. In particular there appears to be no reason why the wagon grease referred to later in describing the Beuerberg works should not be readily obtained when making gas, and the annual output would be about 3,000 tons, with the proposed producer capacity of 65,000 tons of theoretically dry peat per annum.

The amount of sulphate of ammonia obtainable depends on the amount of nitrogen in the peat. According to the trials made at Openshaw by Messrs. Crossley Bros., the actual yield, with peat containing 2·2 per cent. of nitrogen, was 140 lb. per ton of dry peat, and the proportionate yield for 1·6 per cent. of nitrogen is 102 lb., which is 60 per cent. of the theoretical yield. The capacity of the producers for the power scheme under consideration being 65,000 tons of dry peat per annum, the yield of sulphate of ammonia would, in round figures, be 3,000 tons per annum. Great care must, however, be taken in selecting the bog, since some analyses show as little as 1 per cent. of nitrogen.

Gas Engines.—For the 5,000 kw. power station under consideration large gas engines would not be required, and units of moderate size, 500 to 1,000 kw. would be suitable. Horizontal engines with two sets of tandem cylinders, placed on each side of a flywheel dynamo, will give satisfactory results, and an even turning moment, so that there will be no difficulty in paralleling the alternators. In reality there is very little saving in capital cost and none in annual cost in using very large gas engines.

To determine the cost of fuel per kilowatt-hour it must first be stated that the calorific value of theoretically dry peat is about 8,600 B.Th.U., and that the thermal efficiency of a producer may be safely taken at 75 per cent., and that a good gas engine, reckoned on the brake horse power, as 30 per cent., therefore, the thermal efficiency of the complete plant is 22·5 per cent., and hence from each 1 lb. of dry peat 1,935 B.Th.U. will be converted into work so that 1 B.H.P. will require 1·32 lb. of dry peat per hour. Assuming that the efficiency of the dynamo is 90 per cent., it works out that the consumption of dry peat per unit is 1·95 lb. Taking the cost of peat at 3s. per ton, it will be found that the cost of fuel works out at 0·031d. per unit. Assuming that the average engine load is 70 per cent. of the full load, the fuel consumption will be increased to 2·15 lb. per unit, and the cost to 0·034d. per unit. Compare this cost with 0·11d. when using producer gas, made from bituminous coal at 14s. per ton (an average Dublin price). Or in the case of steam engines 0·23d.

When the by-products are recovered the weight of peat required per unit of electricity is increased, and a very safe figure to take, supposing, as before, that the average load on the engines is 70 per cent. of their full load, is that 1 ton of peat will produce 1,000 B.H.P. hours. This figure has been experimentally proved by Messrs. Crossley Bros., and gives a fuel cost of 0·05d. per unit, without crediting the profit on the by-products.

It has been pointed out that cheap power can only be obtained from peat when the power station is established in the close proximity of the peat bog, and therefore an undertaking of this kind would not be a sound commercial proposition unless there were a practical certainty that a market for the electricity produced would be established. It is to be observed that, owing to electro-chemical

science, a great many industries have been established in recent years which require a large amount of power, and which depend on the cheapness of this power to enable them to make their products at a remunerative rate. History will undoubtedly repeat itself, and the erection of works, as occurred in the case of the electric water power at Niagara, in many places in Sweden and Norway, and in Italy, will also take place in the neighbourhood of electric power undertakings using peat fuel and recovering the by-products, for it is fairly obvious that it will be possible under the conditions described above to supply power in bulk at the same price it is now supplied by water power. A peat-driven station near Robertstown would be able to supply cheap power, and limestone of a very suitable quality is obtainable locally; moreover, specially good anthracite can be had from the Kilkenny mines. Incidentally there is the advantage of cheap water carriage for this anthracite by the Grand Canal and when the carbide of calcium has been made it can be taken by the Grand Canal to Dublin. It is difficult to conceive better conditions for the remunerative manufacture of carbide of calcium. Recently a new fertiliser, called "cyanamide," has been put on the market, and its manufacture should also be carried out remuneratively at Robertstown.

Peat Charcoal.—The author had the opportunity of seeing over the peat works at Beuerberg, near Munich, which are designed under Dr. Ziegler's patents for the production of fuel in the form of peat-coke or charcoal, also of what is called "semi-peat-coke," in which the carbonisation is not complete, together with pitch, tar, acetic acid, methyl alcohol, sulphate of ammonia, gas oil, paraffin, and wagon grease. In general terms the process has been worked out on the principle that the heat required for the distillation of the peat and for evaporation, &c., shall be obtained from the peat itself, and that all power shall be electrical; the fuel for this purpose being obtained from the rough peat unsuitable for distillation purposes.

The following is the analysis of the gas obtained from the distillation of the peat, as given to the author by Dr. Kaiser, the managing director: CO_2 15·5, O 1·1, CO 20·4, CH_4 12·4, H 28·6, N 21·9 per cent. The present plant at Beuerberg is capable of treating 35,000 tons of theoretically dry peat per annum, and from this amount the following weights of products are obtained: peat coke 13,800, paraffin 230, oils (heavy and light) 1,380, sulphate of ammonia 184, methyl alcohol 92, acetate of lime 270 tons. It will be noticed that there is only a small proportion of sulphate of ammonia; considerably less than the amount obtainable when gas is made from peat.

MAGNETIC RELUCTANCE OF JOINTS IN TRANSFORMER IRON.*

BY DR. H. BOHLE.

For the determination of the no-load currents of transformers a knowledge of the magnetic reluctance of the joints in the iron core is necessary. The usual practice consists in assuming that each joint is equivalent to a film of air 0·005 cm. long, this being the mean of a number of values given by Prof. Ewing in his well-known treatise, "Magnetic Induction in Iron and Other Metals." Unfortunately, these figures were obtained from tests on solid rods, whereas for transformers laminated cores can only be employed. Moreover, the tests were made with butt joints alone, and data for overlapping joints are not available, at least as far as the author is aware. In transformer design, some assume that cores with overlapping joints are equivalent to jointless frames, while others consider overlapping joints no better than butt joints.

Two magnetic squares were built up, one jointless, the other consisting of stampings capable of being placed together so as to form abutting or overlapping joints, without altering the mean length of the magnetic path. The number of joints in each case was four. To make the flux distribution as uniform as possible over the whole cross section, the width of a stamping was made less than one tenth of a side of the square. The exciting winding of 160 turns was placed uniformly along the whole circumference, in order to reduce magnetic leakage to a minimum. The quantity of iron employed was 10 kg. per magnetic square. For testing, direct current was employed, which is permissible, since the magnetisations due to direct and alternate currents differ little, according to the investigations by Gumlich and Rose. Although the stampings of both frames were supposed to be obtained from the same bulk of material, a direct comparison was impossible, because permeabilities differ often even within a single sheet. In fact, it was found that the material for the jointed core was a great deal superior to that for the jointless core. The difficulty was overcome by testing—after demagnetisation—the first frame with the core in one piece, and again after it had been provided with a butt joint.

The second frame was then used, built up with four butt joints, carefully made but neither compressed beyond what was due to the weights of the cores, nor machined. Previous to each test the iron was demagnetised as far as possible. The test was then repeated by placing the joints under compression by means of suitable clamps. The actual compressive stress was not measured, but was of a nature corresponding as far as possible to actual transformer practice. This frame was then taken to pieces, and this time built up with overlapping joints, demagnetised and tested as before. The four cores of the same frame were then once more arranged with butt joints, which were this time carefully machined and tested, (1) non-compressed, (2) compressed.

Some of the results of the tests are shown in the table herewith:—

Flux density.	Equivalent length of single air-gap in cms.				
Lines per sq. cm.	Butt joint, rough, non-compressed.	Butt joint, rough, compressed.	Overlapping joint.	Butt joint, machined, non-compressed.	Butt joint machined, compressed.
4,000	0·00470	0·00370	0·00165	0·00470	0·00290
6,000	0·00520	0·00430	0·00240	0·00520	0·00335
8,000	0·00545	0·00475	0·00300	0·00540	0·00370
10,000	0·00560	0·00505	0·00330	0·00550	0·00395
12,000	0·00575	0·00520	0·00350	0·00560	0·00425
13,000	0·00580	0·00530	0·00360	0·00565	0·00430

It is seen that a machined butt joint when not compressed is no better than a rough one. In both cases is the length of the gap reduced considerably when compression is applied, especially in machined joints, which are almost as good as overlapping joints. The reluctance of the latter, although lower than that of the ordinary butt joint, is by no means a negligible quantity, especially for high flux densities. The reluctance of these joints is due to the fact that the flux bends out from one sheet to another, whereby the flux is somewhat contracted, this being equivalent to an increase in the length of the gap between the sheets. Also the insulation of the sheets (those used in the test were coated with varnish) augments somewhat the length of the gap.

It would appear from these tests that a mean value of 0·005 cm. per single gap would meet the case for all butt joints. Experience has, however, shown that this is hardly correct. In the above tests the sheets were assembled with the greatest care, so that the abutting ends were perfectly even; but such accuracy cannot be bestowed on work done in the factory. In all cases it will be safer to use values 50 or even 100 per cent. higher than those given in the table, according to workmanship.

As regards overlapping joints, a gap length of 0·004 cm. will in most cases give results on the safe side, this being somewhat larger than the mean value in the table, taking into account uneven insulation of the stampings. When cores are so placed together that the stampings cross one another, it is essential that a thin sheet of insulating material is inserted to prevent the production of eddy currents near the joint. The thickness of the insulation should then be added to the figures given in the table.

As regards the setting up of eddy currents, overlapping joints are little better than butt joints, and the type of joint applied will, therefore, depend chiefly upon the class of work the transformer is intended to do. For lighting transformers a small no-load current is of great advantage to reduce the wattless currents. For power transformers which are usually disconnected when the power is no longer required, and which are more fully loaded, the wattless currents are of no importance, and butt joints are no disadvantage. As regards the manufacturing cost, there is little to choose between the joints except in the case of large transformers, where butt joints are somewhat cheaper.

* Abstract of an original communication to the *Journal* of the Institution of Electrical Engineers.

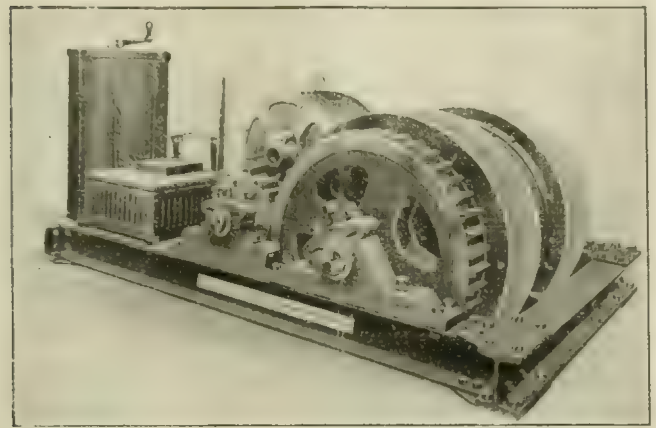
E.C.C. ELECTRIC HAULAGE GEARS.

The Electric Construction Co., Dashwood House, London, E.C., and Wolverhampton, are specialising in machinery and apparatus for mining work, and have recently placed upon the market some very compact and efficient haulage gears for underground operations.

A very neat pamphlet describing and illustrating several examples of these machines driven by either continuous or alternating current motors has just been issued. It is pointed out that a fruitful cause of breakdown in electrical machinery used in mines is the manufacturer's failure to appreciate the fact that such machinery needs to be specially designed for its special duties. Electrical and other gear

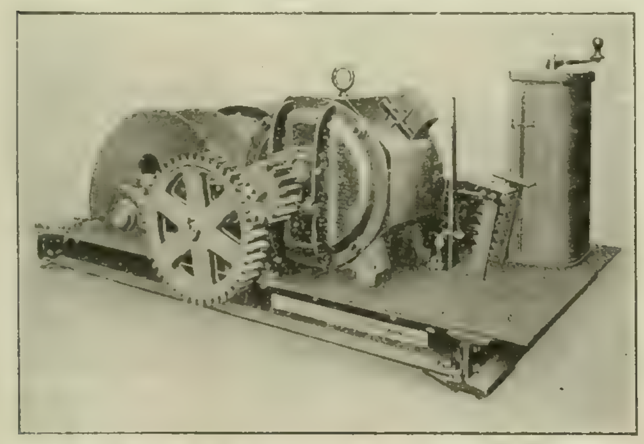
designed for ordinary industrial purposes frequently give bad results when installed below ground, and the object of the company in manufacturing a standard range of electrical haulage gears for underground work is based upon the necessity for specialising in this department.

It will be seen from the accompanying illustrations that a very compact and efficient piece of machinery results from the company's development of this branch of its large manufacturing business.



E.C.C. Main and Tail Haulage Gear with A.C. Motor.

The types included in the standard range are endless rope, main and tail, and single drum, in sizes 25, 50, 75 and 100 B.H.P. Motors can be provided of the open type, enclosed ventilated, or totally enclosed, and to suit any supply for direct or alternating current. The fact that the Electric Construction Co. has decided to devote a special department to the design and manufacture of a class of machinery



E.C.C. Main and Tail Haulage Gear with D. C. Motor.

whose requirements are so peculiarly exacting, as is the case with underground operating machines, is a step upon which the company and the industry are to be congratulated. A feature of the machine which we illustrate is, we think, the regard which has been obviously paid to the importance of economy in space occupied. Interested parties should apply to the company for leaflet A/306.

MANCHESTER EXHIBITION RAILWAY ARRANGEMENTS.

In our last issue (p. 925) we gave a fairly exhaustive summary of the railway arrangements in connection with the great Electrical Exhibition at Manchester, October 3 to 31. Some additional particulars are appended:—

Midland Railway.—We are able to amplify the particulars given in our last issue relating to the Midland Company's route from St Pancras to Manchester. The company inform us that there are 13 express trains in this service in each direction, and at Nottingham, Leicester, Derby and other points these trains form connections with other services with all parts of the Midland Railway system, including Northampton, Bedford, Wellingboro', Leicester, Loughboro', Derby, Nottingham, Sheffield, Mansfield, Burton, Birmingham, Gloucester, Cheltenham, Bristol, &c. Luncheon and dining cars are run on many of the trains, and all the trains travel through the Peak of Derbyshire district famous for some of the finest scenery in England.

Great Northern Railway.—In our note last week regarding the arrangements of the Great Northern Co. for Manchester a slight error occurred. The restaurant car which we mentioned as leaving King's Cross at 7:15 a.m. should read 8:15 a.m.

London & North Western Railway.—This company issue a handy pocket list of trains, showing the service between London and Manchester, and also a very complete list of excursion and week-end arrangements over the North-Western system. From the published particulars we find that excursion and week-end tickets are issued between London and Manchester for 1, 3, 5 and 8 days, the trains leaving on Fridays at midnight and on Saturdays at 10:30 a.m. and 4:5 p.m., returning on Mondays, Wednesdays and Saturdays from London Road, Manchester, at 5:30 p.m. Fare for one day 11s., 3 days 12s. 6d., 5 days 16s., and 8 days 19s. for the return journey.

Lancashire & Yorkshire Railway.—There is a fast service of trains over this line between Liverpool and Manchester; between Barrow, Windermere and Scotland (via Preston) to Manchester; between Hellifield and Scotland and Manchester; between Southport and Manchester; and between Bolton, Blackpool, Fleetwood and Manchester. There is also a steamer service which leaves Belfast for Fleetwood. Express boat trains are run to and from Manchester in connection with this service. The Lancashire and Yorkshire system taps most of the principal towns in Lancashire and Yorkshire, and a number of fast through trains are included in the regular service to Manchester from these towns.

Electrical Enterprise.—Our contemporary "Electrical Industries" has arranged a special train from London to Manchester and back to take visitors to the Manchester Exhibition for 12s. 6d., which includes admission to the Exhibition. There will be a two-day excursion by this special train leaving Euston about 10 a.m. on Friday, Oct. 16, and returning Saturday evening, Oct. 17.

MUNICIPAL, FOREIGN & GENERAL NOTES.

APPOINTMENTS VACANT AND FILLED.

The Metropolitan Railway Co. require a traffic manager. Applications to the Secretary, 32, Westbourne-terrace, London, W., by Oct. 17.

Portsmouth Corporation require a switchboard attendant. Applications to the engineer, Electricity Works, Gunwharf-road, Portsmouth, by Oct. 8.

A professor of mathematics and physics is required for the Transvaal University College, Pretoria. Salary £800. Applications by Nov. 1 to Mr. A. R. Goldring, 202-6, Salisbury House, London, E.C.

The directors of the Liverpool Overhead Railway Co. have appointed Mr. E. J. Neachell, M.I.E.E., A.M.I.Mech.E., as engineer and general manager in succession to Mr. S. B. Cottrell, who has resigned.

Mr. M. H. Rooney has resigned his position with the Cork Electric Tramways & Lighting Co. to take up an appointment in the Straits Settlements.

Mr. G. F. Cowley has been appointed lecturer in engineering at the Rotherham Technical Institute at £160 per annum.

EDUCATIONAL NOTICES.

Battersea Polytechnic (London, S.W.).—At this polytechnic there are day and evening courses of instruction. The day courses include preparation for the B.Sc. in engineering of the University of London and the polytechnic diploma in (*a*) mechanical, (*b*) electrical and (*c*) civil engineering. The evening classes include preparation for the B.Sc. in engineering, associateship examination of the I.C.E., &c. Prospectus on application to the Secretary.

South-Western Polytechnic (Chelsea, London, S.W.)—A complete three years' course in electrical engineering is held during the day and a four years' course in the evening. There are courses of lectures and practical work in elementary, intermediate and advanced electrical engineering, electrical design, instruments and lamps, alternating and polyphase currents, electric wiring and fitting, calculus for engineers, &c.

Merchant Venturers' Technical College, Bristol.—Courses of instruction in civil, mechanical, electrical and mining engineering, chemistry, &c., are provided at this college. The courses prepare for the matriculation and B.Sc. and D.Sc. degrees (including engineering) of the University of London. There are well-equipped laboratories and workshops for practical work, &c. Calendars (6d.) or short prospectuses (free) can be obtained from the Registrar.

Borough Polytechnic Institute (London).—At this institute a three years' course in electrical engineering is given, and there are also special courses in electric wiring instruction and design of electrical appliances and workshop fittings, advanced electricity and magnetism, &c. Prospectuses, which contain further particulars and a detailed syllabus of each course, from the Principal, Mr. C. T. Millis, 103, Borough-road, London, S.E.

University of London (University College). — The arrangements for the opening of the faculty of engineering at University College are now complete. The provost (Dr. T. Gregory Foster) and the dean (Prof. J. D. Cormack) will attend on Oct. 5 and 6 (from 10 a.m. to 1 p.m.) to give information to students entering the college. In addition to the regular undergraduate and postgraduate courses, special additional courses have been arranged and include a course in electrical design by Mr. H. M. Hobart, a course in railway engineering by Mr. H. Deans, and a course in municipal engineering by Mr. Reg. E. Middleton. A public lecture introductory to the special course on "The Scientific Principles of Radiotelegraphy and Radiotelephony" will be given by Prof. J. A. Fleming on Oct. 11 at 5 p.m., when the chair will be taken by Major O'Meara, R.E., C.M.G.

Armstrong College (Newcastle-on-Tyne).—The session 1908-9 commenced on Sept. 28. There are complete courses of instruction in mechanical, civil, electrical and marine engineering, naval architecture, mining, metallurgy, &c. Particulars from the secretary (Mr. F. H. Pruen).

City and Guilds Technical College.—The next session for evening classes begins on Monday, Oct. 5 at 6 p.m. There are lectures and laboratory work in mechanical and electrical engineering, industrial and technical chemistry, &c. Programmes from the College, Leonard-street, Finsbury, or the Head Offices, City & Guilds of London Institute, Gresham College, London, E.C.

Argentina—The "Review of the River Plate" states that a concession has been granted to Messrs. Gandulfo & Diaz Velez for the construction of an electric tramway in the Port lands from Calle Brasil and Avenida Oeste to Calle Maipu and Avenida Rosales.

Cordoba Municipality have decided to extend the time allowed by the concession authorising the tramway company to construct electric tramways in the city, on receipt of an additional deposit of $75, 000.

Australasia.—The "Australian Mining Standard" (Aug. 26) states that a poll of *Prahran and Malvern* (Victoria) ratepayers is to be held to decide the question whether £85,000 shall be borrowed for the construction of the projected electric tramway for the district.

The *Bulla* (Victoria) Shire Council are also taking the opinion of the ratepayers on the proposal to borrow £5,000 for electricity works for Sunbury.

Rutherglen (Victoria) ratepayers are to vote on the question of accepting the offer of the local electric lighting company for lighting the town electrically.

Dungog (N.S.W.) Council have decided by a majority of one not to accept the offer of the Williams River Co-operative Mfg. & Battery Co. to light the town electrically without any expense to the Council.

Asylum Lighting.—The Joint Committee of Richmond (co. Dublin) District Asylum recently received a report from Mr. H. T. Harris (consulting electrical engineer) on the subject of adopting electric lighting in the asylum.

The report stated that, taking the last three years' average of gas consumed, the average c.p. hours per day were 54,720, which cost (at 3s. per 1,000 ft.) £3. 5s. 5d. per day. The same c.p. hours of electric lighting would cost (at 3d. per unit) £2. 0s. 6d. per day, saving £454 per annum. Lighting by incandescent gas burners would cost £114 a year more than electric lighting by metallic filament lamps. If the gas lighting (on the present system) were extended so as to efficiently light the whole of the buildings 9,000 burner hours (burners consuming 5 ft. of gas each) would be required = 16,425,000 ft. per annum at 3s. = £2,464, whereas the electrical energy required would be 108,000 c.p. hours at 1·5 watts by 365 days = 59,130 kw. at 3d. or £739 per annum, showing a saving of £1,725. The capital cost of a suitable installation is put at £2,805. The committee have now asked Mr. Harris to supply detailed specifications and conditions of contract, an estimate of annual cost of renewals and maintenance, wages of electrician to take charge of plant, an estimate of the increased capital cost and cost of renewals of Osram or other efficient metallic filament lamps and of the saving of current by their use compared with carbon filament lamps.

Barking.—Osram lamps are to be substituted for the existing street lamps in London Bridge-road.

Board of Trade Court of Arbitration.—With a view to consolidating, expanding and popularising the working of the Conciliation Act of 1896, the President of the Board of Trade recently announced that he proposed to set up a standing Court of Arbitration.

The Court, which would sit wherever required, would be composed of three (or five) members, according to the wishes of the parties, with fees and expenses to members of the Court, and to the chairmen during sittings. The Court would be nominated by the Board of Trade from three panels. The first panel (of chairmen) would comprise persons of eminence and impartiality. The second would be formed of persons who, while preserving an impartial mind in regard to the particular dispute, would be, nevertheless, drawn from the employer class. The third panel would be formed of persons similarly drawn from the class of workmen and trade unionists. It is believed that by the appointment of two arbitrators selected from the employers' panel and two from the workmen's panel in difficult cases, thus constituting a Court of five instead of three persons, the decisions of the Court would be rendered more authoritative, especially to the workmen, who, according to the information of the Board of Trade, are more ready to submit to the judgment of two of their representatives than of one. As the personnel of the Court would be constantly varied, there would be no danger of the Court itself becoming unpopular with either class in consequence of any particular decision; there would be no difficulty in choosing members quite unconnected with the case in dispute, and no inconvenient labour would be imposed upon anyone who consented to serve on the panels. Lastly, in order that the peculiar conditions of any trade may be fully explained to the Court, technical assessors may be appointed by the Board of Trade at the request of the Court or of the parties to assist in the deliberations, but without any right to vote. The Court will only be called into being if, and in proportion as, it is actually wanted. No fresh legislation is necessary.

Castleblayney (co. Antrim).—Messrs. Wilkins & Burden have asked the Council to consider a proposal to establish electricity works for public and private lighting in this district. The firm would undertake the public lighting at less than the present cost.

Charing Cross-Highgate Tube Railway.—It is announced that the Charing Cross, Euston & Hampstead Railway Co. have in contemplation a scheme for the extension of the Highgate section of their line to the Alexandra Palace.

Croydon.—The Board of Trade have sanctioned the borrowing of £900 for doubling a portion of tramway track in Cherry Orchard-road.

East Ham.—The Electric Lighting and Tramways committee have decided to extend their scheme for the supply of electric lamps, &c., to consumers.

Electrical Contractors' Association.—With reference to the meetings of this Association on Oct. 16 and 17 at the Manchester Electrical Exhibition, we are asked to announce that any electrical contractor not in the Association can obtain a ticket admitting him to the Exhibition to attend the propagandist meeting on Oct. 17 from Mr. Shaw, 10 and 16, Warren-street, Stockport (hon. sec. of the Manchester Branch), or Mr. R. Robson, Haymarket-lane, Percy-street, Newcastle-on-Tyne (hon. sec. of the Northern Section).

Electricity in Mines.—The accounts of Harrison, Ainslie & Co. (owners of Lancashire mines) for the past year include expenditure of £50,000 for electric pumping plant, which has been installed, besides about £14,000 for incidental works, such as the construction of water troughs, a tramway to the power house, &c.

Exhibitions.—The Seventh International Motor Exhibition, promoted by the Society of Motor Manufacturers and Traders, will take place at Olympia, London, from Nov. 13 to 21 next. Entries have been received from over 300 firms, and it is stated that the show will occupy the whole of the space in Olympia and its annexe (although it is confined to racing, touring and pleasure cars), and that new departures in engine design of a startling character will be shown. Particulars from Mr. H. A. Blackie, Maxwell House, Arundel-street, London, W.C.

A separate exhibition for commercial vehicles and motor boats will be held next spring.

An international exhibition of hygiene will be held at Rio de Janeiro, Brazil, from Aug. 1 to Sept. 30, 1909, in connection with the fourth Latin-American Medical Congress.

First-Class Tramcars.—An experimental service of first-class tramcars, at increased fares, was started yesterday (Thursday) on the Liverpool Corporation's Garston, Dingle and Pierhead route.

Heckmondwike.—The accounts of the electricity department for the year ended March last show total capital expenditure £40,014.

Revenue was £5,305, including private lighting £1,544, power £1,277, traction £1,914, and street lighting £425. Works costs were £1,967, total costs £2,805, and net profit (after meeting capital charges, &c.) £1,027.

Heston and Isleworth.—A committee of the whole Council is to consider the financial position of the electricity undertaking and the best means of meeting capital expenditure on extensions, &c.

Hull.—The Electric Lighting committee have been asked to state their terms for a supply of electric current for lighting and power at the new post office in Lowgate. Current will be required for 131 8 c.p. and 631 16 c.p. incandescents, 16 arc lamps and nine motors of an aggregate of 222 H.P.

The Council are equipping showrooms in Water-works-street for the display of electric fittings, lamps, motors, &c.

Ilford.—It was reported at the meeting of the Council last week that the demand for electric current was "increasing by leaps and bounds." During July and August there were 68 new consumers connected.

Jamaica.—Mr. H. E. Wilson, superintendent of Jamaica telegraphs has recently visited the United States with a view to acquainting himself with the latest electrical developments in that city.

Kingsbury (Middlesex).—The Council have called upon the North Metropolitan Electric Power Supply Co. to lay mains in this district in accordance with the terms of their provisional order.

L.C.C. Tramways.—Chelsea Council are recommended by their Highways committee not to consent to the proposal of the L.C.C. to construct tramways in the borough. The County Council desire to run trams from Battersea over Battersea Bridge to Chelsea and Shepherd's Bush.

Marriage.—On Sept. 26, at Trinity Church, Scarborough, Mr. Lewis Wm. Dixon, youngest son of Mr. John Dixon, J.P., of Southampton, was married to Miss Mary Roberts. Mr. Dixon is engineer and manager of the Merthyr Electric Traction & Lighting Co.

Municipal Telephony.—To Hull Telephone committee last week Ald. J. Brown announced that the work of adapting the National and the Corporation systems for more effective intercommunication had now been completed. The cost to the Corporation alone was about £700. The increase in the number of connections to the Corporation system during the past 12 months was over 300.

Obituary—The death is announced of Mr. Wm. Trotter, J.P., director of the United Electric Tramways of Monte Video and other companies.

Penny Post to America—Yesterday (Thursday) saw the inauguration of penny postage between the United Kingdom and the United States of America. This important event was signalised by a great increase in the amount of the letter post mail.

Proposed New Shetland Cable—At a meeting of the Aberdeen Chamber of Commerce on Tuesday a letter was read from the Postmaster-General notifying that the question of laying a new telegraph cable, or establishing a wireless service to the Shetland Islands, is under consideration.

Personal.—Mr. S. B. Cottrell, M.Inst.C.E., has decided to resign his position as general manager and chief engineer of the Liverpool Overhead Railway Co. Indifferent health has caused Mr. Cottrell to take this step, but he hopes soon to engage in consulting work.

South Africa.—Cape Town Council have approved the agreement for the supply of electrical energy to the Cape Government on the basis of 1½d. per unit, with coal at 26s. 9d. per ton.

A clause has been inserted to the effect that if the Government exercise its right of terminating the contract when their demand exceeds 5,000,000 units per annum, the Council is to be compensated for all its outlay. The supply is to be confined to "Government requirements."

The Mayor pointed out that if the Council had not taken the contract the Harbour Board and the C. G. Railways Dept. would have combined their power stations to supply the demand.

The Council's contribution to the expenses of Mr. W. F. Long (city electrical engineer), in connection with the contract, on the occasion of his recent visit to England, is not to exceed £100.

Southampton.—Last week the Council decided to apply for a provisional order to give a supply of electricity in North and South Stoneham.

Telegraph Signallers' Pay in India.—An increase in the pay of telegraph signallers in India has been approved by the Indian Telegraph department.

Telephone Rates Question.—On Tuesday the Council of the Liverpool Chamber of Commerce unanimously decided to re-nominate Mr. Charles Lancaster to represent the Chamber on the Telephone committee of the Associated Chambers of the Kingdom, expressing full confidence in him, notwithstanding the fact that he is a shareholder in the National Telephone Co. It will be remembered that this fact led to the exclusion of Mr. Lancaster and of Mr. Faithful Begg (London) from the meetings of the Telephone committee at its earlier sittings a few days ago.

Tug of War.—Some of our readers may be interested to learn that a tug of war team selected from the West Ham Corporation electricity staff at the generating station, Canning Town, is to compete in the great series of tug-of-war contests that will be "tugged" in the stadium of the Franco-British Exhibition on October 10. We wish them luck in their venture and trust that another laurel will be added to the wreath which West Ham wears in the sports world. The team is Messrs. Mackenzie, Crane, Sheehan, Bowles, Saunders, Harris, Brown and Horn. Mr. G. Lloyd Jones, resident engineer at the Canning Town generating station, has acted as coach.

Warning.—Messrs. Stegmann & Co. write to warn the trade against the practices of a man who poses as a farmer at Leatherhead.

Some little time back this man, giving the name of Lawrence, of Leatherhead, called with regard to an estimate for telephones in connection with his farm buildings, and wished us to make an appointment with regard to our calling down there. Fortunately we could not make an immediate appointment, and on writing to the address given the letter was returned "Not known." We understand he has befooled several electricians to go to Leatherhead on a Saturday afternoon, but the journey proved a hoax.

Westminster.—The City Council have authorised the General Purposes committee to make an experiment with metallic filament lamps in the City Hall.

ELECTRICITY SUPPLY AND TRAMWAY ACCOUNTS

Hampstead (London).—The income of the electricity department for the midsummer quarter was £7,459, compared with £7,294 for the corresponding quarter of 1907.

Leicester.—The Town Council on Tuesday adopted the report of the Electric Lighting committee for the past half-year.

The half-year's receipts were £15,847, and expenses £6,698, leaving gross profit £9,149. Interest required £3,853, and sinking fund £3,343, the net profit being £1,931. The disposable balance (with amount brought forward) was £2,739 (decrease £673). There were 77 additional customers, but it was stated that consumption was decreasing owing to the use of metallic filament lamps.

TRADE NOTES AND NOTICES.

TENDERS INVITED.

The Directors of the *Gt. Western Railway Co.* are prepared to receive tenders for the supply of stores, including incandescent electric lamps, electric wires and cables, electric light carbons, telegraph instruments and apparatus, telegraph ironwork and tools, wire, oils, indiarubber goods, ironmongery, steel tools, brasswork, &c., &c. Samples and patterns may be seen at the General Stores, Swindon. Specifications, with forms of tender, may be obtained at the offices of the Stores Superintendent, Swindon, and tenders addressed to the secretary (Mr. G. K. Mills), Paddington Station, London, W., must be in by Oct. 20 for group I., and Nov. 10 for group II. Further particulars are given in an advertisement.

Leeds Tramways committee invite tenders for the supply of material necessary for constructing the Horseforth–Guiseley tramway, including 1,350 tons rails, three pairs 150 ft rad. cross-over, points and one 1 in 5 8 ft, crossing, 40 tons tie bars, 9,000 tons granite setts, 950 tons cement, 130 street poles and fittings, 70 cast-iron pole bases, 8 miles 0·4 sq. in. paper-insulated lead-covered 600-volt low-tension cable, 12 miles S.W.G. 14 hard-drawn bare telephone wire and 5 miles 4/0 S.W.G. grooved trolley wire. Specifications and forms of tender may be obtained at the Tramways Office, Leeds, after Oct. 7. Tenders must be received by 10 a.m., Tuesday, Oct. 13. Further particulars are given in an advertisement.

Salford Electricity committee invite tenders for the supply and delivery of vertical steam feed pumps at the Corporation electricity generating station, Frederick-road, Salford. Specification and form of tender from the borough electrical engineer (Mr. Victor A. H. M'Cowen, M.I.E.E.), to whom tenders are to be sent by noon of Monday, Oct. 12. See also advertisement.

SPECIAL NOTICE.

NOW READY.—Vol. LX. of "The Electrician" (1,016 pages), bound in strong cloth. Price 17s. 6d.; post free, 18s. 6d. Also ready Cases for Binding. Price 2s.; post free, 2s. 3d.

A complete set of "The Electrician" (1860-1865—1878-1908) can be supplied. A number of odd volumes and some odd old back numbers, to help in making up complete sets, are also now available.

Tenders are invited by *Melbourne* City Council for the supply of 60 direct current flame arc lamps. Copies of specification, conditions of contract, and forms of tender may be obtained from the agents for the Council (Messrs. McIlwraith, McEacharn & Co., Proprietary, Ltd.), Billiter-square Buildings, London, E.C., to whom tenders by noon of Tuesday, Oct. 20. See also an advertisement.

Melbourne (Victoria) Council also invite tenders for supply of 770 electricity recording meters and 157 maximum demand indicators. Copies of specification, conditions of contract and forms of tender from the agents for the Council (Messrs. McIlwraith, McEacharn & Co. Proprietary, Ltd.), Billiter-square Buildings, London, E.C., to whom tenders by noon Oct. 13.

Tenders will be received at the office of the *Commonwealth of Australia* representative, 72, Victoria-street, Westminster, London, S.W., until noon, Oct. 19, for supply and delivery at that office of four complete sets of instruments (signalling and protecting), necessary for direct duplex cable working, for the Postmaster-General, Melbourne. Forms of tender, &c., can be obtained at the General Post Offices, Sydney, Melbourne, Adelaide, Perth, and Hobart, and at the Commonwealth office as above. Tenders (on forms supplied) to Capt. Collins, Commonwealth representative, 72, Victoria-street, Westminster, S.W. Further particulars are set out in an advertisement.

Tenders are invited for supply and delivery to the Postmaster-General's Department in *Western Australia* of telegraph and telephone material. Tender forms and specifications may be obtained at the Commonwealth offices, 72, Victoria-street, London, S.W. See also an advertisement.

Tenders are invited for the supply and erection of installations for wireless telegraphy at *Launceston*, *Melbourne*, *King Island* (Bass Straits) and *Flinders Island* (Furneaux Group). Tender forms and specifications may be obtained at the Commonwealth Office, 72, Victoria-street, London, S.W. See also an advertisement.

The directors of the *Metropolitan Railway Co.*, invite tenders for the supply of general stores, including electric wires and cables, electric lamps, carbons, fuses, ebonite, battery jars, zincs, &c., during twelve months ending Oct. 31, 1909. Manufacturers and others desirous of tendering should apply to the Secretary, Mr. R. H. Selbie, for forms of tender. Tenders to the Secretary, 32, Westbourne-terrace, London, W., 10 a.m., Oct. 5.

Mountain Ash Council want tenders by Oct. 5 for erection of an electrical sub-station, supply and erection of switchgear and transforming apparatus and overhead mains for the electric lighting of Ynysybwl. Specifications from the Surveyor or the consulting engineer (Mr. B. J. Day), 3, Park-place, Cardiff.

Tenders are invited by *Salford* Education committee for electric wiring of Halton Bank Council School, Pendleton. Specifications from the borough electrical engineer (Mr. V. A. H. M'Cowen), electricity works, Frederick-road, Pendleton. Tenders to the town clerk (Mr. L. C. Evans) by noon Oct. 5.

Twickenham Council require tenders by noon Oct. 14 for a generating plant, cable, battery, transformer, &c., for the electric lighting of the Whitton Isolation Hospital. Specifications from Mr. Fairley, 69, Victoria-street, London, S.W., or at the Town Hall, Twickenham.

London County Council want tenders by 11 a.m., Oct. 13, for supply and erection of six 320 tube fuel economisers, three electrically driven feed pumps, and two 5,000 kw. steam turbo generators. Forms from the Clerk, Spring Gardens, S.W.

Manchester Tramways committee require tenders by Oct. 6 for supply of tramway rail bonds. Specifications from Mr. J. M. M'Elroy, [illegible], Piccadilly, Manchester.

Beckenham Council want tenders by 4 p.m., Oct. 5, for supply of Welsh and Midland small coal for the electricity works. Forms from County Offices.

Southend Corporation want tenders by Sept. 30 for supply of three [illegible] tramcars. Forms from the Borough Electrical Engineer.

Leith Council want tenders by noon Oct. 7 for granite setts for extension of tramways. Specification from burgh surveyor.

TENDERS RECEIVED AND ACCEPTED.

For their new electricity generating station Bury Corporation have accepted the tender of John Musgrave & Son for two 2,000 kw. turbo-generators (Musgrave-Zoelly steam turbines and Siemens alternators), and for Contraflo condensers with steam, air and circulating pumps.

London County Council have received the following tenders for the tramways department:—

Seven Motor-Generators for Tramway Sub-stations.

	£	s.	d.		£	s.	d.
Brit. Westinghouse Co. *(accepted)* ...	**£11,632**	**0**	**0**	Union Electric Co....	£12,541	7	6
Elec. Construc. Co..	16,473	0	0	General Electric Co.	12,282	0	0
Siemens Bros. Dynamo Works	13,808	15	0	Dick, Kerr & Co. ...	12,234	14	0
				Phœnix Dynamo Mfg. Co.	12,077	10	0

L. T. Cables, Cable boxes, Wiring Material, &c.

	£	s.	d.		£	s.	d.
Edison & Swan Co. *(accepted)*	**£2,259**	**18**	**6**	British Insulated & Helsby Cables ...	2,469	0	4
Callender's Co.	2,668	4	1	General Electric Co.	2,423	10	8
Nettlefold & Son ...	2,633	16	0	W. T. Henley's Co...	2,384	16	5
W. T. Glover & Co.	2,606	12	4	G. E. Taylor & Co...	2,357	7	11
Siemens Bros. & Co.	2,534	9	7	Baxter & Caunter ...	2,356	3	4
Western Electric Co.	£2,477	12	1	Johnson & Phillips..	2,307	2	6
				Pinching & Walton	2,286	15	11

Charles Macintosh & Co., Simplex Conduits (Ltd.), W. Rickard and James Littauer submitted incomplete tenders.

Supply and Erection of h.t. and l.t. Switchgear for Tramway Sub-stations.

	£	s.	d.		£	s.	d.
Johnson & Phillips *(accepted)*	**£3,807**	**9**	**2**	British Westinghouse Co....	£4,301	15	0
Union Electric Co...	5,605	8	6	Switchgear Co.	4,279	5	6
General Electric Co.	5,105	15	0	Whipp & Bourne ...	4,119	8	9
Ferranti Limited ...	4,553	19	6	Spagnoletti Limited	4,019	13	0

Stoneware Ducts for Tramways.

	£	s.	d.		£	s.	d.
*Stanley Bros. *(acc.)*	**£2,250**	**0**	**0**	H. R. Mansfield ...	£2,266	13	4
Sutton & Co.	2,910	0	0	Robinson & Dowler..	2,250	0	0
N. Bitchburn Coal Co.	2,800	0	0	Doulton & Co.	2,250	0	0
Ensor & Co.	2,500	0	0	J. Stiff & Sons (for 100,000 ducts)......	1,170	0	0
Donington Sanitary Pipe, &c., Co.......	2,500	0	0	G. Skey & Co. (for 75,000 ducts)	923	2	6
Gibbs & Canning ...	2,450	0	0	Oates & Green (for 10,000 ducts)	250	0	0
T. Wragg & Sons ...	2,400	0	0				
Hosea, Tugby & Co.	2,266	13	4				

* Less $2\frac{1}{2}$ per cent. discount for monthly cash payments.

Supply and Erection of Overhead Travelling Hand Crane.

	£		£
John Smith *(acc.)*	**£190**	Marshall, Fleming & Co.......	£219
Willcocks & Son	295	J. Carrick & Sons	208
Rowland Priest..................	275	Alex. Jack & Co.	199
J. Williams & Sons	270	J. Spencer & Co.	190
Applebys Limited	264		

Laying Stoneware Cable Ducts, Repairing, &c.

	£	s.	d.		£	s.	d.
John Mowlem & Co. (*accepted*)	**£17,476**	**0**	**0**	Wm. Muirhead & Co.	£18,211	12	3
J. A. Ewart	18,539	16	10	Dick, Kerr & Co. ...	17,904	16	6
				Reid Bros.	17,490	12	11

Wiring and Fitting Central Car Repair Depôt.

	£	s.	d.		£	s.	d.
G. E. Taylor & Co. (*accepted*)	**£1,273**	**8**	**11**	Lund Brothers & Co.	£1,628	1	7
W. E. King	1,954	0	8	W. Mackie & Co. ...	1,500	15	7
Charles Pullan	1,684	8	0	Pinching & Walton	1,325	4	0
				Tredegar & Co.	1,319	2	11

The Postmaster-General's Department, Adelaide, S. Australia, have accepted the tenders of British Insulated & Helsby Cables for two 50 and two 25 metallic circuit switchboards, and two 25 metallic circuit lightning arresters; Western Electric Co. for three 100 metallic circuit switchboards, switches and coin attachments, International Electric Co. for lightning arresters and vibrating indicators; India Rubber Co. for Meidinger line corks, tubes, leads and zincs and sal ammoniac; Geo. Wills & Co. for sulphate of magnesia, and J. Bartram & Son for trunk line timers.

The Imperial Electric & Engineering Co. have a contract for a 4 H.P. electric motor for the Western Australia Government Tender Board.

Hull Municipal telephone department have accepted the tenders of McMillan & Co. for 200 instruments at £368 and Bullers Limited for ironwork at £60. 2s. 6d.

Portsmouth Electric Lighting committee have placed an order with the Edison & Swan United Electric Light Co. for a year's supply of carbon filament incandescent lamps for street lighting.

Croydon Corporation have accepted the tender of Casperd & Co for wiring the new swimming bath at £151.

Hebden Bridge Council have accepted the tender of Gatley & Co for wiring the secondary schools.

The tender of S. Anderson & Son has been accepted for wiring the Creekmouth school, Barking.

The Postmaster-General's Department, Sydney, N.S.W., has placed an order for 4,000 insulators with Zwicker, Tod & Co.

Blackfriars Power Station. The Postmaster-General has just given his decision in regard to the equipment of the new Blackfriars power station, and as a result the steam turbines, surface condensers.

IMPORTANT NOTICE.

Extra Copies of "The Electrician" Special Mining Issue (July 10th, 1908), are obtainable, price 1/- nett (post free U K., 1/4 ; abroad 1/6).

&c., are to be supplied by Willans & Robinson, and the alternators, water strainer, &c., by Dick, Kerr & Co. Willans & Robinson are the main contractors for this plant, and the contract price is £24,191.

BUSINESS NOTICES.

Messrs. Geo. Piggott & Co., Electrical and Mechanical Engineers, &c., have removed to 24, New Bridge-street, E.C. Mr. T. Murley Oldham has been taken into partnership and in future the firm will be styled the Piggott Electrical Co. The telephone No. will be "2208 Holborn." The change of address also applies to the firm's agencies (for Messrs. Turner, Atherton & Co., and I. Griffiths & Sons), and to their monthly periodical.

Mr. W. Pollard Digby, electrical engineer, has removed from 82 to 28, Victoria-street, Westminster, S.W. Telephone, 666, Victoria.

Mr. T. L. Reed Cooper, M.I.Mech.E., M.I.E. & S., has acquired the works of the Johnson-Lundell Electric Traction Co., at Southall, Middlesex, and is the vendor to the J. L. Mfg., Co. (Ltd.), who have acquired from him the manufacturing business of the Johnson-Lundell Co., and the freehold factory at Southall. The J. L. Mfg. Co., will continue to manufacture under license the Johnson-Lundell laminated field motors and dynamos, and will carry on a general electrical engineering business. The new company invite the support of past customers of the Johnson-Lundell works, as they are now in a position to execute orders at short notice.

Sale by Auction.—Messrs. Edward Rushton, Son & Kenyon are instructed by Mr. E. Musgrave, trustee in the failure of W. T. Garnett's Cable Co., to sell by auction (at Barkerend Mills, Bradford) in one lot as a going concern, on Thursday, Oct. 15 (*not Oct. 8*, as announced in our last issue), at 3:30 p.m., valuable electric cable-making plant and machinery, the stock-in-trade and effects, &c. Printed particulars and other information may be had from the auctioneers, 13, Norfolk-street, Manchester, or from the trustee, Mr. E. Musgrave, C.A., 1, Bank-street, Bradford. See also an advertisement.

Plant for Sale.—Messrs. G. Elliott & Co., Machinery Depot, Long-lane, Bermondsey, London, S.E., have for sale two 150 I.H.P. Marshall compound vertical engines, coupled to Crompton dynamos, and also one Johnson-Lundell, one General Electric and one Holmes dynamos and a Johnson & Phillips combined dynamo and 5 H.P. steam engine. See also advertisements.

Factory Site for Sale.—Messrs. Green & Son, auctioneers, have an extensive site (about 3¾ acres) close to a railway station, and suitable for the erection of engineering works, to be let on building lease. The site is outside the L.C.C. area. Further particulars from Messrs. Green & Son, 72, King-street, Hammersmith, London, W. See an advertisement.

Patent Development.—The proprietor of Patent No. 27,449, 1904, relating to a "Method and Apparatus for Electrostatic Separation," is desirous of entering into arrangements by way of licence or otherwise for exploiting same. Applications to Messrs. Cruikshank & Fairweather, 65–66, Chancery-lane, London, W.C.

Cable Box Ventilators.—An interesting exhibit at the forthcoming Electrical Exhibition at Manchester will be a new type of ventilator for cable boxes which Messrs. Bullers Limited, 6, Laurence Pountney-hill, London, E.C., and Tipton and Hanley, are putting on the market. As the ventilator is easily adapted to existing covers of cable boxes or manholes and is also cheap it is sure to appeal to engineers and managers of electricity works who are troubled with explosions on their networks.

CATALOGUES, &c.

Tubes and Piping.—We have received from John Spencer, Ltd., a copy of their trade price list of wrought-iron tubes and fittings for gas, water and steam, iron and steel lap-welded boiler tubes and accessories, &c. The list, which cancels all other lists, gives particulars of the firm's telegraph and tramway poles, arc lamp posts, &c.

Electrical Fixtures.—An artistically produced catalogue of fittings is to hand from Messrs. Falk, Stadelmann & Co. It is impossible to do justice to this catalogue briefly, and we are therefore compelled to advise interested readers to apply at once for a copy.

Steam Turbines.—Messrs. John Musgrave & Sons send us an advanced copy of their latest catalogue dealing with the Zoelly turbine which they are manufacturing at Globe Iron Works, Bolton. The list contains a number of useful tables which should ensure its being kept for reference by engineers. One of the most useful of these tables is that relating to the properties of saturated steam at all pressures, from 1 to 300 lb. The list is completed by an entropy table for steam which will doubtless prove of value to engineers. We also refer readers to another part of the issue where a complete description of the Musgrave-Zoelly steam turbine will be found.

Controller Resistances.—The A.E.G. Electrical Co., of South Africa send us a list of resistances for controllers intended for intermittent service. Full particulars can be obtained of the company, Caxton House, Westminster, London, S.W.

Flame Arc Lamps.—Messrs. Johnson & Phillips, Charlton, Kent, have just issued leaflet K, which contains illustrated particulars and prices of their open, enclosed and flame arc lamps and accessories. The firm will be pleased to send copies on request.

Auto-Transformers.—List 1406 issued by the Union Electric Co. describes their small transformers for single and multiple circuit secondaries. The transformers are supplied for a number of voltages and are intended for use with metal filament lamps.

Tantalum Lamps.—We understand that Messrs. Siemens Bros. Dynamo Works have completed arrangements for a poster advertising campaign in the provinces and on the underground railways and tube carriages in London. This is the first direct reply to the vigorous policy of the gas companies and gas mantle makers which has yet been made by the electrical industry. We give a reproduction of one poster depicting the evident pleasure of a consumer on finding that his electric light bill is halved owing to the use of tantalum lamps. A reproduction of the poster in neat show card form will be sent on application to the City address of the company, 6, Bath-street, London, E.C.

Tantalum Lamp Poster.

Excello Carbons.—The Union Electric Co. send us copies of their latest list dealing with Excello carbons. The list will be useful for reference, seeing that the winter lighting season is approaching.

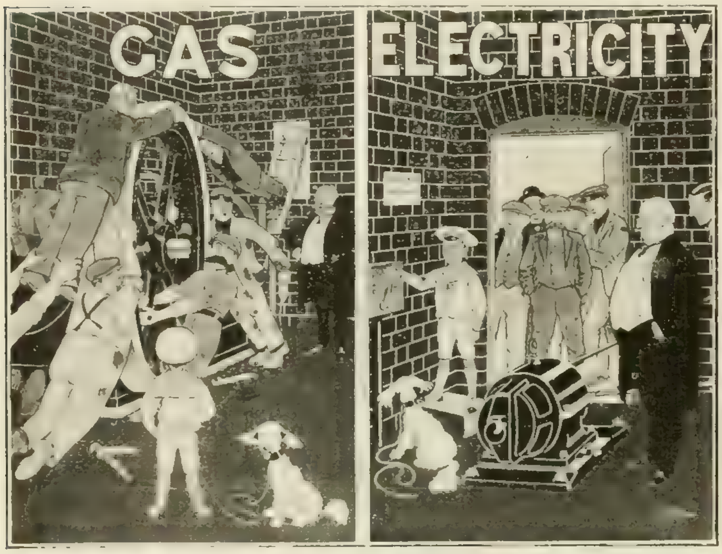
Heating and Cooking Apparatus.—The General Electric Co. have issued section H of their catalogue which is devoted to electric heating and cooking apparatus. Illustrated particulars and prices are given of a great variety of electric glow radiators, elevectors and radiators (made under the "Archer" system), kettles, urns, coffee machines, hot-water jugs, hot plates, ovens, water heaters, cigar lighters, laundry irons, glue pots, soldering irons, and many other domestic and culinary and industrial utensils. This section of the catalogue is bound and holed for filing.

Circular Slide Rule.—The publishers of "Knowledge" send us a specimen of an interesting slide rule which has been designed by Major Baden Powell. It comprises a circular card, in the centre of which is a fixed circular dial and a rotatable dial. The scales of both of these are similar and are graduated in logarithmic sequence. Multiplication, decimal equivalents of fractions, proportion, squares and cubes and square roots can be worked out on the dial. Full particulars from "Knowledge" Offices, 27, Chancery-lane, London, E.C.

G.E.C. Leaflets.—The General Electric Co. have issued the following leaflets: No. F1,207 on the "New Era" fittings block, F1,217 dealing with adaptors and galleries for "Osram" lamps, F1,229 relating to "Striplite," and S1,270 on electric flashers for signs and advertising devices, while S1,266 is on "Robertson" lamps.

Electricity Supply Posters.—In our last issue we gave an illustration of a poster due to the Associated Municipal Engineers of London which we hope will take a place with "Bubbles" or "Alas! my poor brother" as masterpieces of the poster artist's craft. It indicated, perhaps with rather a heavy hand, the insidious effects of coal gas on the "domestic hearth" and the correspondingly beneficial results of the employment of electricity. This heavy

artillery has been speedily followed by others which should prove equally effective. These we illustrate herewith. They teach the same practical lesson, but in the present case the lesson is applied to the power problem. The posters are representative of Mr. McBean's skill in this department of artistic work and are excellent in every way. There is one point, however, which we think needs explanation. The energetic representatives of the British workman seem to be aiding and abetting the engine to "stick" rather than helping it forward. They appear to be pulling in opposite directions, an altogether unlikely thing to happen. But perhaps they know it will not start any way. In the other picture all is peace, perfect peace. Posters of this description must serve to call the attention of the man in the street



Further Expressive Posters of the A.M.E.

to the fact that electric power has vast advantages over other methods of driving machinery. The series of McBean posters promises to become exciting.

BANKRUPTCIES, LIQUIDATIONS, &c.

The Gould Storage Battery Co. (Ltd.), 25, Regent-street, London, S.W., is being wound up voluntarily and claims are to be sent to the liquidator (Mr. E. A. Locock), 164, Coleherne Court, S.W., by Oct. 31. A meeting of creditors will be held at 25, Regent-street, S.W., on Oct. 17.

The trustee (Mr. G. David, 117, St. Mary-street, Cardiff) in the bankruptcy of Wm. Aneurin Roderick, electrical engineer, 12, Penmaen-street, Swansea, has been released.

PATENT RECORD.

APPLICATIONS FOR PATENTS.

Note.—*The undermentioned Applications (except those marked †) are not open to public inspection until after acceptance of Complete Specifications. Those marked † are open for inspection 12 months after the date attached to them, if they have not been published previously in the ordinary course. Names within parentheses are those of communicators of inventions.* ***When Complete Specification accompanies application, an asterisk is affixed.***

June 9, 1908.

12,364 Roberts & Roberts. Electric pumps.
12,389 Siemens Bros. Dynamo Works & Kloss. Oil switches for alternating currents.*
12,390 Siemens Bros. Dynamo Works & Kloss. Obtaining a smooth electromotive force curve in alternate current dynamos.
12,398 Dieeman. Installations of electric lamps having metal filaments.
12,420 Pattis & Fortune. Telemotor apparatus for ships' steering gear, telegraphs, indicators, &c.*
12,447 Massoni. Electric motors for vehicles.*

June 10, 1908.

12,468 Sahulka. Wireless telegraphy.*
12,470 Wright. Adaptor for incandescent lamps.
12,498 Mavor & Mavor & Coulson. Control of electric motors.
12,507 Ellison & Jacobs. Telephone or like calling apparatus. (Addition to 18,308/07.)
12,508 Barlow. Motor controlled switches.

June 11, 1908.

12,527 Ernest Brown. Variable motion gear for electric ignition.
12,528 Benton. Emergency brakes or slippers.
12,531 Knight & Keppie. Electrically driven percussive tools.
12,532 Knight & Keppie. Electric pumps.
12,556 Siemens Bros. Dynamo Works. Carbons for arc lamps. (Siemens Schuckert-Werke G.m.b.H., Germany.)*
12,563 Hall. Electric ignition systems.
12,580 B.T.-H. Co. (G.E. Co., U.S.). Alternating current motors of the commutator type.*

June 12, 1908.

12,592 Ide. Push switch lamp holder.
12,614 Hacking & Hill. Electrically operating tramway points, switches, &c.
12,630 Bourgeois & Bourgeois. Pocket electric lamp.*
12,634 Keller. Electrical conductors.*
12,646 Dudman. Burglar alarm.*
12,650 Johnson & Phillips & Paterson. Electric motors.
12,651 Johnson & Phillips & Paterson. Electric arc lamps.
12,654 London Import Co. & Pordes. Electric lamps.
12,656 Timar & von Dreger. Arc lamps. (Date applied for, 8/7/07.)*†
12,678 Gaglio & Villani. Electric cut-out.*
12,682 Allgemeine Electricitats Ges. Arc lamps. (Date applied for, 15/7/07.)*†
12,684 B.T.-H. Co. (G.E. Co., U.S.) Electromagnetic relays for the control of electric motors. (Addition to 16,195/06.)

June 13, 1908.

12,689 Charles. Tumbler switch.
12,690 Smith. Electric cables.
12,704 Stansfield & Hatt. Controlling the voltage of dynamo-electric machinery.
12,720 Societe Francaise d'Incandescence par le Gaz (Systeme Auer). Incandescent lamp filaments and apparatus therefor. (Date applied for, 13/7/07.)*†
12,736 Heldbek. Adjustably suspending incandescent lamps.

SPECIFICATIONS PUBLISHED.

1907 Specifications.

12,937 Felten & Guilleaume Lahmeyerwerke A.-G. Compensated alternate current series motors. (Date applied for, 12/7/06.)
13,129 Grob. Voltage regulated system for electric lighting and heating of vehicles. (Date applied for, 9/6/06.)
13,190 Harrison & Hirst. Electrodes for arc lamps.
13,432 Schattner. Fusible cutouts.
13,712 Parsons & Law. Regulation of dynamo-electric machinery.
13,821 Jentzsch. Coin-controlled telephones.
14,567 Eckstein, Heap & Mellis. Electrically-operated switches.
15,367 B.T.-H. Co. (G E. Co., U.S.) Metallic filaments.
17,300 Buckton. Combined electric connection plug and socket and switch. (Post-dated, 24/1/08.)
18,044 Felten & Guilleaume Lahmeyerwerke A.-G. Monophase shunt electric machines. (Date applied for, 11/8/06.)
18,187 Bailey. Signalling approach of tramcars at cross roads where overhead wires are employed.
20,824 Irwin. Electric oscillographs.
22,082 Watson & Smith. Electric ignition systems.
26,084 Meyerling. Electricity meter for continuous current. (Date applied for, 23/11/06.)
26,973 Anderson. Spark plugs for explosion engines. (Post-dated, 11/12/07.)

1908 Specifications.

325 Sanders & Greenberg. Induction ignition coils.
2,083 Allgemeine Elektricitats Ges. Pumps and the like. (Date applied for, 30/1/07.)
2,308 Siemens & Halske A.-G. Electrically selecting one of several receivers connected with a common conductor. (Date applied for, 11/2/07.)
2,481 Siemens Bros. Dynamo Works & Wheat. Holders for incandescent lamps.
2,569 Rawlings & Smith. Adjustably supporting incandescent lamps, and shades or reflectors. (Application for Patent of Addition to No. 8,151/07.)
2,956 Soc. Industrielle des Telephones (Constructions Electriques, Caoutchouc, Cables). Wheels for road vehicles. (Date applied for, 22/2/07.)
3,505 Mertens. Current collector for electric vehicles. (Date applied for, 16/2/07.)
3,526 Carl Zeiss. Stereoscopic telemeters. (Date applied for, 23/2/07.)
3,556 Gell. Automatic telegraphic transmission instruments. (Date applied for, 12/8/07.)
3,700 Schmidt. Arc illuminating apparatus, particularly for photography. (Application for Patent of Addition to No. 9574/07.)
3,770 Buttmell, Buttmell, Buttmell & Shiel. Electrically controlled pneumatic dispatch tubes, cash railways, &c.
3,701 Polyphos Elektrizitäts Ges. Transmitting graphic signs, photographs, and the like by electric current. (Date applied for, 25/2/07.)
4,112 Siemens Bros. Dynamo Works (Siemens Schuckertwerke Ges.). Section insulating arrangement for conductors used in overhead construction of electric railways or tramways.
4,433 Siemens Schuckert Werke Ges. Starting and working three-phase motors from single phase supply. (Date applied for, 28/6/07. Addition to 1,243/07.)

4,139 BLOXAM. (Markische Maschinenbauanstalt Ludwig Stuckenholz A.-G.). Lifting magnets for cranes.
4,166 EVANS. Multiple rate electricity meters.
4,432 MASCHINENFABRIK OERLIKON. Single-phase commutator motors. (Date applied for, 9/3/07. Addition to 28,968/04.)
4,444 DOWSING. Electrical radiators.
4,464 SIEMENS BROS. & CO. (Siemens & Halske A.-G.). Coils of large section for electromagnetic apparatus.
4,621 FRIEDHEIM. Manufacture of heat interchangers by an electrolytic process. (Date applied for, 4/3/07.)
5,225 ALLGEMEINE ELEKTRICITATS GES. Electrodes for arc lamps. (Date applied for, 5/7/07.)
5,610 ALLGEMEINE ELEKTRICITATS GES. Incandescent electric lamps. (Date applied for, 14/3/07.)
6,050 SIEMENS & HALSKE (A.-G.). Process for hardening tantalum. (Date applied for, 26/3/07.)
7,219 ADAMIAN. Electrically-controlled apparatus for seeing at a distance.
7,910 SIEMENS BROS. & CO. (Siemens & Halske A.-G.). Pyrometers and thermometers of the thermo-electric or electrical resistance type.
8,746 AUGER. Incandescent filaments.
9,023 DENIEPORT. Electric condensers. (Date applied for, 30/9/07.)
9,552 BROWN. Electrical block signalling apparatus. (Date applied for, 8/5/07.)
9,977 ALLGEMEINE ELEKTRICITATS GES. Electrical power transmission systems. (Date applied for, 8/6/07.)

COMPANIES' MEETINGS AND REPORTS.

Dick, Kerr & Co. (Ltd.)

The ordinary general meeting of this company was held on Tuesday, Mr. JOHN KERR presiding.

The SECRETARY (Mr. Frank Mott) having read the notice convening the meeting and the report of the auditors,

The CHAIRMAN said the board regretted having to announce a decrease in the profits. The reduction had not arisen from any slackness on the part of the board or restriction in the efforts of a very energetic and capable staff, but was entirely owing to the very severe competition met with in every department. In addition, the financial crisis in America had had its effect all over the world and they, among others, had suffered very considerably, inasmuch as investors hesitated to enter into new enterprises. Again, owing to the financial crisis as well as the high Bank rate in the earlier part of the year, municipal borrowing was considerably restricted, and this had a serious effect upon their turnover. The electrical industry had been engaged in a very severe struggle for some years past and at the moment he could not see much likelihood of competition becoming less keen in this country. They were, therefore, devoting most of their energies to developing colonial and foreign business and a large proportion of the machinery now manufactured in their Preston works was for abroad. They had taken a rather important contract for tramway car equipments for the City of Moscow, and this in the face of very keen competition from Continental makers. In South America and Japan particularly their business connection had been increasing rapidly. The extraordinary demand which existed a few years ago for electric tramway equipments had been steadily falling off owing to most of the lines at home and abroad being now electrified. They had, therefore, deemed it necessary to devote some attention to another and important branch of business which hitherto they had not developed. He referred more particularly to important power schemes, hydraulic and steam. This class of business had been very largely exploited in Switzerland, Norway, America and Canada, and, their plant at Preston being designed specially to deal with heavy machinery they were utilising it in this direction. The directors had never been guilty of holding too sanguine views; however, if they had found it possible to complete the year under review with £59,558. 4s. 5d. of profit, it was not too much to expect that within a reasonable period a prosperous time would return. In the past the policy of building up strong reserves, and the present carrying forward of £81,566. 17s. 2d., of undivided profits must meet the approval of the shareholders, in view of the fact that the works had been maintained in the highest state of efficiency, and the plant and machinery amply depreciated.

One constantly heard the cry of "support home industries," and, bearing on this, he would ask their financial friends to use their good influence on behalf of English manufacturers. It seemed hard to know of money leaving London by millions, which eventually had the effect of securing employment for factories in Germany and America. Financial houses knew their own business best, but a little patriotic feeling and support might do much in helping the cause of the unemployed and of industrial capital in their own country. The figures in the accounts practically reflected the trading position for the year. He would like to express, on behalf of the board, their high appreciation of the management and staff throughout a trying year's business.

The adoption of the report and accounts was seconded by Mr. CLAUD T. CAYLEY (deputy chairman).

Mr. J. B. CONCANON said he knew what a terrible amount of competition there was in their trade. It was notorious to every man interested in investments that kindred companies, working on as good, if not better, terms as regarded the support they got from their backers, had had disastrous results. He might say that theirs was the only company of its class which had maintained its dividend in the past year. He congratulated the board and the staff, and he looked forward, as they did, to even better days.

The resolution was then put and carried unanimously.

The retiring directors (Mr. R. H. Prestwick and Mr. Thos. D. Lingard) and the retiring auditors were then re-elected, and a hearty vote of thanks to the directors and staff terminated the proceedings.

CLEVELAND AND DURHAM COUNTY ELECTRIC POWER CO.—The directors' report to June 30 states that depression in the trade on the North East coast, with labour disputes, affected the demand for electric power, and, at the same time, demands for the extension of the company's system necessitated large capital expenditure. Agreements have been made with the Waste Heat & Gas Electrical Generating Stations Co. for the operation by the Cleveland & Durham Company of power stations erected by that company at the works of the Weardale Steel, Coal & Coke Co., Tudhoe, Spennymoor), and Sir Bernard Samuelson & Co. (Newport, Middlesbrough). Arrangements for a bulk supply and the extension of the mains to Hartlepool have been completed, and it has lately been decided to link up the company's cable system with those of the companies further North. An important extension of mains is now proceeding from the north bank of the River Tees to the North-East Durham coalfield. A bulk supply to Middlesbrough Corporation was commenced in March, and important contracts have been closed for supplying four new rolling mills in the Cleveland district. The connections now aggregate 20,105 H.P. compared with 9,172 H.P. last year. Arrangements have also been made for connecting up a further 8,850 H.P. The net revenue for the year, after writing down preliminary expenses by £10,000, amounts to £5,142. In April last an interim dividend of 5 per cent. on the preference shares was paid, which absorbed £7,120, and it is now proposed to carry forward to next account £1,252.

DEVONPORT AND DISTRICT TRAMWAYS CO. (LTD.)—The directors' report states that £65 had been expended on capital account, bringing the total to £162,184. Revenue for the six months was £11,812. Receipts showed an increase of £85 and expenses a decrease of £50. After deducting expenses (including interest) there is a surplus of £579 (which, with £150 forward) is carried forward. During the next few years considerable expenditure will have to be incurred in relaying portions of track, and the directors have decided to transfer £6,749 from depreciation and reserve fund to permanent way renewals fund. As the company has been unable to pay any dividend for the past three years the directors approached the Corporation with a view to obtaining some concessions, or, in the alternative, selling the undertaking to the Corporation. The latter declined to grant any concessions, but they have not yet given a definite answer as to whether they will purchase.

SWANSEA IMPROVEMENTS AND TRAMWAY CO.—The report for the half-year ended June 30, states that the gross receipts on the tramway undertaking were £24,267, an increase of £1,950 upon the corresponding period of 1907, and the expenses £19,690, an increase of £1,115. The profit is £4,576, which, added to £1,532 brought forward, makes £6,108. The directors propose to place to reserve and depreciation fund £1,000, to pay a dividend on 984 preference shares at rate of 6 per cent. per annum, and on 4,016 preference shares at rate of 5 per cent. per annum, leaving to be carried forward £3,809.

WILLANS & ROBINSON (LTD.)—The 29th half-yearly report of the directors of this company discusses the accounts for the half-year to June 30. As regards Rugby, after writing off £6,510. 17s. 8d. as depreciation, there is a profit of £18,472. 18s. 4d. on the half-year's work. On Queen's Ferry there is a net loss on the half-year (after contributing to debenture interest and to directors' salaries) of £2,786. 4s. 6d. The net profit is therefore £15,685. 13s. 10d., and the total amount available for distribution or otherwise, including £7,443. 1s. 2d. brought forward is £23,129. 15s. The directors propose to pay the dividend on the 6 per cent. preference shares, absorbing £9,999. 18s.; to apply £1,750 partly in paying interest upon, and partly in redeeming funding certificates, in accordance with the approved scheme; and to pay a dividend at the rate of 10 per cent. per annum upon the ordinary shares, amounting to £3,333. 6s. £8,046 11s. is carried forward. The profit for the half-year, though inferior to that for the half-year preceding, is approximately the same as for the corresponding period of 1907. In view of the present exceedingly unfavourable trade outlook, the directors think it right to point out that, unless there should be a definite revival of business, it will not be safe to assume that the recent satisfactory progress of the company will be sufficiently maintained to assure the continuance of the present dividend upon the ordinary shares.

The Queen's Ferry works were offered by auction on Sept. 16, but were not sold. No exertion will be spared to effect a sale by private treaty, and in any case it is intended to dispose of that portion of the plant which it is not specially desired to retain with the buildings. Work at Queen's Ferry has practically ceased.

YORKSHIRE ELECTRIC POWER CO.—At the meeting on Wednesday Mr. A. G. Lupton, in moving the adoption of the directors' report, said that after paying interest, there was for the first time a profit on net revenue account amounting to £363. 6s. 10d., compared with a loss of £1,211. 3s. 9d. for the corresponding period of 1907. Since the report was issued there had been further applications for the new capital, of which £32,805 had now been taken up out of the total of £45,000. At present the company was suffering from the general wave of bad trade and short time, and although, of course, not directly affected by the deplorable strike in the cotton mills, must necessarily suffer when so large a number of the consumers of textiles were out of work. The group of textile industries to

which the company supplied power was more important than any other single group of customers and provided some 40 per cent. of the total receipt of the company.

The company's plant was all British made, and wherever its mains were laid they represented large sums paid in wages and employment found for labour. During the next few months several thousands of pounds would be spent in the district in extra labour alone on mains and works. That was not without importance at the present time, especially when it was remembered that wherever the mains were constructed new trades were stimulated, and extra ratable value created.

NEW COMPANIES, STATUTORY RETURNS, MORTGAGES AND CHARGES.

NEW COMPANIES.

CORDOBA LIGHT, POWER & TRACTION CO. (LTD.) (99,640.)—Reg. Sept. 24, capital £500,000 in £1 shares, to acquire benefit of concessions, grants, rights and powers granted by any authority in Cordoba or elsewhere in the Argentine Republic, and to carry on the business of electric power station, tramway, railway and omnibus proprietors, carriers, suppliers of electric light, &c. First directors, Sir Irving Courtenay (chairman), G. Kitchin, T. F. Thomson and H. A. Trotter. Reg. office, 15, Copthall-avenue, London, E.C.

EGHAM & DISTRICT ELECTRIC LIGHT CO. (LTD.) (99,625.)—Reg. Sept. 23, capital £25,000 in £5 shares, to acquire and carry on the business of the Egham Electric Lighting Synd. and to take a transfer of a certain provisional order. First directors, F. S. Powell and F. J. Powell.

FIXARC LAMP CO. (LTD.) (6,901.)—Reg. in Edinburgh on Sept. 22, capital £1,500 in £1 shares, to acquire from Pierre M. Capitaine and from the Fixarc Lamp Co. the exclusive license to exploit, manufacture and sell in any part of the world a patent for arc lamps, and to carry on in France and elsewhere the business of dealers in electric lamps, carbons and accessories, &c. First directors, W. D. Hendry, J. Robertson and W. F. Fellows. Reg. office, 49, Virginia-street, Glasgow.

I. T. C. (LTD.) (99,612.)—Reg. Sept. 22, capital £10,000 in £1 shares, to make, sell, maintain and work telephones, telegraphs, electrical apparatus, &c. Private company. First directors, H. Mayer (permanent managing director and chairman) and E. Mayer. Reg. office, 64, Leadenhall-street, London, E.C.

J. L. MFG. CO. (LTD.) (99.613.)—Reg. Sept. 22, capital £20,000 in £1 shares, to acquire the manufacturing business carried on by the Johnson-Lundell Electric Traction Co. (Ltd.), to adopt an agreement with T. L. R. Cooper and to carry on the business of manufacturers of and dealers in electric motors and dynamos and their accessories, electricians, electrical and mechanical engineers, &c. Private company. First directors, T. L. R. Cooper and H. Rottenburg. Reg. office, Johnson-street, Southall, Middlesex.

TUNGSTEN METAL CO. (LTD.) (99,618.)—Reg. Sept. 22, capital £40,000 in £1 shares, to acquire from the Cornish Development Co. a leasehold factory for the production of tungsten metal (now in course of erection at Widnes), with the benefit of certain contracts for the supply of wolfram ore, &c. Reg. office, 56, Cannon-street, London, E.C.

STATUTORY RETURNS.

BRAY, MARKHAM & REISS (LTD.)—According to return to Sept. 2 capital is £20,000 in £1 shares, of which 8,000 have been taken up and paid for in full. Mortgages and charges, nil.

BRUSH ELECTRICAL ENGINEERING CO. (LTD.)—The capital in return to June 30 is £489,512 in 74,268 ordinary shares of £2 each, 105,732 ordinary shares of £1. 6s. 8d. each and 150,000 preference shares of £1. 6s. 8d. each, of which 105,732 ordinary and 150,000 preference have been taken up. £1. 6s. 8d. per share has been called up on 35,818 ordinary and 78,463 preference and £152,734. 13s. 4d. has been received. £188,601. 6s. 8d. is considered as paid on 69,914 ordinary and 71,537 preference. Mortgages and charges, £250,000.

CHILI TELEPHONE CO. (LTD.)—In return to July 30 capital is £250,000 in £5 shares, of which 44,000 have been taken up. £220,000 has been received. Mortgages and charges, nil.

ELECTRICAL POWER STORAGE CO. (LTD.)—The capital in return to July 30 is £100,500 in 20,000 ordinary and 100 founders' shares of £5 each, of which 66 founders and 18,592 ordinary have been taken up. £5 per share has been called up on 66 founders' and £4 per share on 3,132 ordinary and £13,332. 5s. 1d. has been received, including £471. 5s. 1d. paid in advance of calls. Mortgages and charges, £10,000.

GENERAL ELECTRIC TRAMWAYS CO. (LTD.)—Return to June 2 gives capital as £50,000 in £1 shares, of which 18,500 have been taken up. £18,560 has been received. Mortgages and charges, £18,000.

SUNBEAM LAMP CO (LTD.) Return to July 14 gives capital as £75,000 in £10 shares, of which £17,650 has been taken up. £10 per share has been called up on 908 and £9,080 has been received. £8,570 is considered as paid on 857 shares. Mortgages and charges, £3,300.

MORTGAGES AND CHARGES.

ADDINELL & CO. (LTD.) Particulars of two series of debentures (1st) for £200 and 2nd for £300, created by resolutions of March 12 and Aug. 8, 1908, have been filed pursuant to sec. 10 (3) of Companies Act, 1907, the amount of the present issues being £50 and £240 respectively. Property charged, company's undertaking and property, present and future, including uncalled capital. No trustees.

AMALGAMATED RADIO-TELEGRAPH CO. (LTD.)—A debenture dated Sept. 11, 1908, to secure £350, and further advances, charged on company's undertaking and property, present and future, including uncalled capital has been registered. Holders, H. Malpas and Mrs. M. M. Malpas.

BRADFORD ELECTRICAL ENGINEERING CO. (LTD.)—A debenture dated Sept. 17, 1908, to secure £100, charged on the company's undertaking and property, present and future, including uncalled capital, has been registered. Holder, J. Garnett.

GUILDFORD ELECTRICITY SUPPLY CO. (LTD.)—Reissue on Sept. 22 of a £100 debenture, part of a series of which particulars have already been filed.

S. H. HEYWOOD & CO. (LTD.)—A statement of the total amount outstanding on July 1 in respect of mortgages and charges created prior to that date and not required to be registered under sec. 14 of the Companies Act, 1900, has been filed pursuant to sec. 12 of the Companies Act, 1907. Particulars, mortgage dated 1901, securing £800.

HOLLOWAY ELECTRIC SUPPLY CO. (LTD.)—A statement of the total amount outstanding on July 1 in respect of mortgages and charges created prior to that date and not required to be registered under sec. 14 of the Companies Act, 1900, has been filed pursuant to sec. 12 of the Companies Act, 1907. Particulars, debentures dated 1900, securing £15,000, and charge dated 1907, securing indefinite amount (£2,300 outstanding on July 1).

MORRIS-HAWKINS LIMITED.—Deposit of deeds dated Sept. 3, 1908, to secure all moneys due or to become due to the London Joint Stock Bank has been registered. Property charged, certain freehold land and premises at Dagenham.

CITY NOTES.

MEMORANDA (Oct. 1).—Bank rate $2\frac{1}{2}$ per cent. (since May 28, 1908) Price of silver, $23\frac{7}{8}$d. per oz. Consols $85\frac{11}{16}$—$85\frac{13}{16}$ for money and $85\frac{13}{16}$–$85\frac{15}{16}$ for account. Consols Pay Day, Nov. 5; Stock and Shares Continuation Days, Oct. 13 and 27; Ticket Days, Oct. 14 and 28; Pay Days, Oct. 15 and 29.

PRICES OF METALS (London). — *Copper*, cash, $59\frac{5}{8}$; three months, $60\frac{1}{16}$. *Lead*, English, $13\frac{1}{2}$—$13\frac{5}{8}$; foreign, $13\frac{1}{16}$—$13\frac{7}{16}$. *Spelter*, foreign, $19\frac{3}{4}$—$20\frac{1}{4}$. *Tin*, English, 133—135; Fine Foreign cash, $134\frac{1}{8}$, three months, $135\frac{1}{2}$. *Iron*, Cleveland, cash, 51/$4\frac{1}{2}$, three months, 51/$2\frac{1}{2}$.

AMERICAN TELEPHONE & TELEGRAPH CO.—A dividend of $2 per share has been announced.

BERGMANN ELEKTRICITATS WERKE A.G., BERLIN.—The shareholders are to be asked to sanction the increase of the capital from 14,000,000 marks (£700,000) to 21,000,000 marks (£1,050,000) by the issue of 7,000,000 marks of new shares, which will be offered to present holders at 165 per cent.

BRISBANE ELECTRIC TRAMWAYS INVESTMENT CO. (LTD.)—The directors have decided on payment of the following interim dividends on Nov. 2 in respect of profits for the half-year to June 30: Usual half-yearly preferred dividend of 2s. 6d. per share and a dividend of 2s. 6d. per share (tax free) on the ordinary shares.

CALCUTTA ELECTRIC SUPPLY CORPN. (LTD.)—The number of units delivered to consumers during the four weeks ended Aug. 28 were 615,469, compared with 564,913 units in the corresponding four weeks of 1907.

EASTERN TELEGRAPH CO. (LTD.)—This company announce the payment on 15th inst. of a dividend at the rate of $3\frac{1}{2}$ per cent. per annum (less tax) on the preference stock for the quarter ended Sept. 30 and the second quarterly interim dividend of $1\frac{1}{4}$ per cent. on the ordinary stock (tax free) in respect of profits for the year ending Dec. 31, 1908. The transfer books of the ordinary stock will be closed from Oct. 7 to 14 inclusive.

EASTERN EXTENSION AUSTRALASIA & CHINA TELEGRAPH CO. (LTD.)—The directors have declared an interim dividend for the quarter ended June 30 of 2s. 6d. per share (tax free) payable Oct. 15. The share register will be closed from 7th to 14th inst. inclusive.

ELECTRIFICATION OF PRUSSIAN RAILWAYS.—It is announced that the Allgemeine Electricitäts Gesellschaft and the Siemens-Schuckert Elektricitäts Gesellschaft are considering a project for forming a new company to deal with the electrification of the Prussian railways.

HOVE ELECTRIC LIGHTING CO.—An interim dividend at the rate of 8 per cent. per annum has been declared on the ordinary shares for the six months ended June 30.

REUTER'S TELEGRAM CO. (LTD.)—The board have declared an interim dividend of 4s. per share (at the rate of 5 per cent., tax free) for the half year ended June 30.

SHAWINIGAN WATER & POWER CO.—A dividend of 1 per cent. for the past quarter has been declared.

STOCK EXCHANGE NOTICES.—The Stock Exchange committee have ordered $1,115,000 additional $1,000 consolidated mortgage 5 per cent. 50 year coupon bonds of the *Havana Electric Railway Co.* to be quoted in the Official List. Application has been made for quotation for £1,000,000 5 per cent. prior lien bonds, £2,800,000 $4\frac{1}{2}$ per cent. (1933) bonds, and £4,900,000 6 per cent. income bonds of the *Underground Electric Railways Co. of London (Ltd.)*.

ELECTRIC TRAMWAY AND RAILWAY TRAFFIC RECEIPTS.

Line	Week ended.	Amount.	Inc. or Dec. (a)	Aggregate: No. of weeks.	Aggregate: Amount.	Aggregate: Inc. or Dec. (a)
		£	£		£	£
Aberdeen Corporation	Sept 23	1,373	− 203	17	26,114	− 479
Airdrie	„ 18	226	− 10	37	8,276	+ 21
Anglo-Argentine	„ 23	25,196	+ 9,082	38	766,633	+ 141,184
Ayr Corporation	„ 26	270	− 41	19	7,871	− 271
Baker St. & Waterloo Ry.	„ 26	3,315	+ 1,005	13	37,935	+ 8,490
Barnsley	„ 18	177	+ 7	37	6,628	+ 376
Barrow	„ 18	200	− 29	37	9,345	− 111
Bath Electric Trams, Ltd.	„ 23	830	− 104	38	28,489	− 2,222
Birkenhead Corporation	„ 27	1,100	− 53	...	...	
Birmingham Corporation	„ 26	6,570	− 105	26	163,655	+ 5,482
Birmingham & Mid.	„ 11	862	− 1	36	[illegible],270	+ 789
Blackburn Corporation	„ 23	1,075	− 137	26	30,401	+ 166
Blackpool Corporation	...	...		...		...
Blackpool and Fleetwood	„ 26	761	− 266	...	...	...
Bolton Corporation	„ 27	2,274	− 51	26	61,755	+ 959
Bombay	„ 3	R36,608	+ R3,640	35	R1,211,309	+ R233,951
Bournemouth Corporation	„ 23	1,883	− 37	25	46,026	− 3,025
Bradford Corporation	„ 26	1,545	− 409	25	123,825	− 130
Brighton Corporation	„ 27	940	− 90	23	16,345	+ 345
Bristol Trams & Carriage	„ 25	5,081	− 199	44	194,108	− 968
Burnley Corporation	„ 26	1,030	− 203	26	32,061	− 203
Burton Corporation	„ 27	268	− 13	26	7,217	− 568
Bury Corporation	„ 27	1,163	− 60	†26	31,437	+ 1,038
Calcutta Tramways Co.	„ 26	R50,626	+ R2,436	13	R613,520	− R5,920
Camborne-Redruth	„ 26	126	− 7	39	4,365	+ 177
Cardiff Corporation	„ 26	2,163	+ 44	26	57,891	− 365
Cavehill	„ 18	93	− 6	37	3,463	+ 188
Central London Railway	„ 26	8,765	+ 3,575	13	94,108	+ 32,339
Charing C., Euston & H'stead	„ 26	3,510	+ 969	13	42,340	+ 9,785
Chatham & Dist. Lt. Rys.	„ 24	932	+ 133	38	28,719	+ 304
City & South London Rly.	„ 27	3,263	+ 189	13	38,670	− 755
City of Birmingham	„ 18	2,729	− 170	37	103,036	− 869
Colchester Corporation	„ 25	232	− 4		...	...
Cork Electric Trams Co.	„ 24	528	− 21	38	17,714	− 665
Croydon Corporation	„ 25	1,457	− 68	26	37,692	− 690
Devonport & Dist. Trams	„ 18	519	+ 3	37	17,310	+ 22
Dover Corporation	„ 26	228	− 40	26	6,364	− 253
Dublin & Lucan Railway	„ 25	144	− 10	12	1,958	− 88
Dublin United	„ 25	5,199	− 1,671	12	72,223	− 22,291
Dudley-Stourbridge	„ 18	867	− 68	37	31,405	− 1,546
Dundee Corporation	„ 23	1,193	+ 41	‡19	23,171	+ 1,531
East Ham Council	„ 26	916	− 60	26	22,780	− 1,344
Exeter Corporation	„ 25	331	− 5	26	8,037	− 223
Falkirk and District	...	...	...	...	...	...
Gateshead & Dist. Trams	„ 18	1,014	− 21	37	37,528	+ 100
Glasgow Corporation	„ 26	17,342	− 967	17	290,201	− 4,635
Gravesend—Northfleet	„ 18	224	− 51	37	8,001	− 1,271
Great Northern & City Rly.	„ 26	1,325	− 288	13	16,749	− 3,845
Gt. Northern, Piccadilly, &c.	„ 26	5,445	+ 1,365	13	63,930	+ 13,525
Greenock & Port Glasgow	„ 18	515	− 122	37	19,975	− 4,899
Hartlepool Tramways	„ 18	236	− 92	37	9,082	− 1,911
Hastings Elec. Trams Co.	„ 24	1,269	− 96	13	18,255	− 1,692
Hong Kong	„ 26	$7,698	− $565	39	$307,312	− $14,391
Huddersfield Corpn.	„ 26	1,833	− 220	26	42,593	− 252
Hull Corporation	„ 26	2,528	+ 106	26	62,830	+ 276
Ilford District Council	„ 19	461	− 25	25	11,539	− 657
Ilkeston District Council	...	...	...	...		...
Ipswich Corporation	„ 26	434	− 16	26	11,075	− 328
Isle of Thanet Co.	„ 26	693	− 81	37	30,967	− 736
Jarrow	„ 18	106	− 16	37	4,037	− 564
Keighley Corporation	„ 21	161	− 26	12	2,068	− 96
Kidderminster & District	„ 18	109	− 16	37	4,340	− 295
Kilmarnock Corporation	„ 26	115	− 13	19	3,017	− 196
Lanarkshire Trams Co.	„ 21	1,302	− 18	38	49,267	+ 3,285
Lancashire United	„ 23	1,342	+ 4	38	51,383	+ 2,101
Leamington	„ 18	223	− 18	37	6,420	+ 341
Leeds Corporation	„ 19	6,624	− 11	21	168,000	+ 3,928
Leicester Corporation	„ 26	2,181	− 31	13	29,569	− 61
Leith Corporation	„ 26	485	− 19	19	10,704	− 50
Lincoln Corporation	...	...	...	...	...	...
Liverpool Corporation	„ 19	10,769	− 371	38	405,174	− 8,549
Liverpool Overhead Rly.	„ 27	1,395	− 113	13	18,803	− 2,048
•London County Council	„ 19	36,908	+ 4,593	†25	867,118	+ 93,452
London United	„ 26	7,359	− 58	38	263,339	+ 1,874
Lowestoft	„ 26	242	− 19	52	10,915	+ 81
Maidstone Corporation	„ 26	239	...	26	5,335	...
Manchester Corporation	„ 26	15,013	− 1,237	26	394,361	+ 9,092
Mersey Railway	„ 26	1,927	+ 56	13	24,030	+ 513
Merthyr	„ 18	213	− 6	37	7,847	+ 60
Metropolitan Dist. Railway	„ 26	9,802	+ 2,017	13	115,778	+ 20,154
Metropolitan Elec. Trams	„ 18	6,258	+ 684	27	2[illegible]3,523	+ 39,489
Middleton	„ 18	321	− 52	37	13,679	+ 272
Nelson Corporation	„ 26	112	− 36	§25	3,657	− 298
Newcastle-on-Tyne Corp.	„ 26	4,007	− 9	26	101,187	− 6,186
Newport (Mon.)	„ 26	612	− 38	26	17,678	− 1,113
Northampton Corporation	„ 25	174	+ 17	§25	12,411	+ 176
Oldham, Ashton & Hyde	„ 18	527	− 80	37	22,279	− 359
Oldham Corporation	„ 27	1,931	− 122	26	53,490	+ 263
Perth (N.B.) Corporation	„ 23	170	+ 2	19	3,124	− 169
Perth (W.A.) Elec. Trams	„ 25	1,306	− 62	39	53,205	− 1,085
Peterborough	„ 18	134	− 9	37	4,797	+ 7
Portsmouth Corporation	„ 25	2,023	− 141	26	56,779	− 202
Potteries	„ 18	1,922	− 61	37	67,441	− 1,252
Preston Corporation	„ 23	746	+ 4	12	9,137	− 462
Rotherham Corporation	„ 24	405	− 9	25	15,723	+ 41
Rothesay	„ 18	194	− 7	37	8,921	− 317
Salford Corporation	„ 25	1,652	− 205	26	123,794	− 494
Sheerness	„ 16	61	− 9	37	2,180	− 70
Sheffield Corporation	„ 27	6,6[illegible]7	− 121	†27	149,514	− 1,335
Singapore Trams	„ 26	$4,589	− $819	...	...	...
South Metropolitan	„ 18	172	− 130	37	30,409	+ 100
South Staffs	„ 18	101	...	37	32,874	− 653
Southend Corporation	„ 23	515	+ 41	26	13,755	+ 919
Southport Tramways	„ 18	296	− 16	37	10,891	− 808
Stalybridge, Hyde, &c., Jt. Bd.	„ 25	680	− 235	†26	20,648	− 920
Sunderland Corporation	„ 27	1,170	− 17	26	31,617	− 6,367
Sunderland District	„ 23	479	+ 17	47	22,007	− 1,590
Swansea Trams	„ 18	956	− 86	37	35,359	+ 995
Taunton	„ 18	44	− 3	37	1,558	− 94
Tynemouth and District	„ 18	240	− 93	37	8,980	− 745
Tyneside Trams Co.	„ 24	424	− 38	12	5,256	− 128
Wallasey District Council	„ 26	865	− 17	§25	21,168	+ 949
Walsall Corpn.	„ 26	531	− 19	39	20,731	− 1,121
Warrington Corpn.	„ 17	385	+ 5	24	9,176	− 113
West Ham Corporation	„ 21	2,225	− 136	26	58,257	− 3,013
Weston-super-Mare	„ 16	211	− 105	37	6,910	− 208
Wolverhampton Co.	„ 18	473	− 76	37	17,012	− 846
Wolverhampton Corpn.	„ 23	801	− 20	16	11,100	+ 97
•Worcester	„ 18	307	− 51	37	10,061	19
Wrexham	„ 18	103	− 10	37	3,833	− 34
Yorkshire W.R. Trams	„ 27	1,276	− 71	39	47,812	...
Yorkshire Woollen District	„ 18	993	+ 55	37	34,269	− 1,659

(a) These comparisons are with the corresponding period last year. § Plus 3 days. Plus 2 days. * Partly electrical. † Minus 3 days. ‡ Minus 2 days.

ELECTRICAL COMPANIES' SHARE LIST

Share	Last Dividend	Name.	Price Wed., Sept. 30.	Rate % Yielded. £ s. d.	Dividend Due.	Business Week to Sept 30. Highest.	Lowest.
		ELECTRICITY SUPPLY.					
10	5 0	Bournemouth & Poole Elec. Sup. Ord.	10 −10½	6 13 6	Mar, Sept,	..	..
10	4 6	Do. 4½ per Cent. Cum. Pref.	9½ − 10	4 10 0	Feb, Aug	.	—
10	6 0	Do. 6 per Cent. Cum. Second Pref.	10½ − 10⅞	5 6 6	Feb, Aug	10½	..
St.	4½%	Do. 4½ per Cent. Deb. Stock (red.)	101 −105	4 5 6	Jan, July	..	..
5	2 0	†Bromley (Kent) El. Lt. & Power Shares	4⅜ − 4⅞	5 12 8	April, Oct	..	..
St.	4½	Do. Do. 1st Debs.	99 − 100	4 10 0	May, Nov	..	..
5	4 6	Brompton & Kensington Elec. Sup. Ord.	7 −8	6 5 0	March....	..	..
5	3 6	Do. 7 per Cent. Pref.	7 −8	4 7 6	Mar, Sept	7	7½
St.	4%	Central Elec. Sup. Co. 4% Guar. Db. Stock	99 −102	3 18 6	June, Dec	..	..
5	2 6	Charing Cross (W. End & City) El. Sup. Co.	3¾ − 4	6 5 0	Feb, Aug	3¾	3¾
5	2 3	Do. 4½ per Cent. Pref.	4 −4½	5 0 0	Feb, Aug		..
St.	4%	Do. 4 per Cent. Deb. Stock (red.)	98 −99	4 1 0	Jan, July	..	..
5	2 3	Do. City Undertaking 4½% Cm. Pref.	3½ −4	5 12 0	Jan, July	..	..
5	2/0	Chelsea Electric Supply Ord.	2¾ −3¼	6 18 0	March ..	..	..
St.	4½%	* Do. 4½ per Cent. Deb. Stock (red.)	100 −103	4 7 6	June, Dec	..	..
10	5 0	City of London Electric Lighting Ord.	9½ 10½	5 17 0	Feb, Aug	9⅞	..
10	6/0	Do. 6 per Cent. Cum. Pref.	12 −13	4 12 0	Jan, July	12½	—
St.	5%	Do. 5 per Cent. Deb. Stock (red.)	122 −125	4 0 0	June, Dec	..	..
St.	4½%	Do. 4½ per Cent. 2nd Deb. Stock (red.)	101 −104	4 6 6	Jan, July	..	—
5	2%	County of Durham Elec. P.D. Ord.	2¾ −3	8 9 7	April, Oct	..	..
5	5%	Do. 5 per Cent. non Cum. Pref.	3¾ − 4¼	6 5 0	April, Oct	..	..
10	4/0	County of London Elec. Supply Ord.	7½ −8½	5 17 6	Feb, Aug	..	..
10	6 0	Do. 6 per Cent. Cum. Pref.	10⅜ − 10⅞	5 9 6	Mar, Sept	10⅜	..
St.	4½%	Do. 4½% Deb. Stock (red.)	107 −110	4 2 0	Jan, July	..	..
St.	4½%	Do. Second Deb. Stock	99 −102	4 8 0	May, Nov	..	..
5	3 6	†Folkestone Electricity Supply Co. Ord.	4¾ −5¼	5 7 0	April, Oct	..	..
5	2/6	† Do. 5 per Cent. Cum. Pref.	5 −5½	4 11 0	Mar, Sept	—	..
St.	4½%	Do. 4½ 1st Deb. Stock (red)	97 −100	4 10 0	Feb, Aug	..	..
5	4 6	Hove Electric Lighting Ord.	6 −6½	6 11 0	April, Oct	..	..
5	4 0	Kensington & Knightsbridge Ord.	7¾ −8¼	5 14 0	Feb, Aug	..	—
5	6%	Do. 6 per Cent. 1st Pref.	6 −6½	4 12 0	Jan, July	..	..
St.	4%	Do. 4 per Cent. Deb. Stock (red.)	94 −97	4 2 6	..	..	..
St.	4%	†Kensingtn. & Kngtbg. Co. & Notting Hill Co. (Joint Station) 4% Deb. Stock (red.)	96 −100	4 0 0	April, Oct	—	..
St.	4½%	Kent Elec. Power Co.	86 −90	5 0 0	Jan, July	..	..
3	1 6	London Electric Supply Ord.	⅞ −1⅛	5 8 0	Mar, Sept	..	..
5	3 0	Do. 6 per Cent. Pref.	4½ −4¾	6 9 6	Mar, Sept	..	..
St.	4%	Do. 4 per Cent. 1st Mort. Deb.	89 −92	4 7 0	Jan, July	..	..
5	2 6	Metropolitan Electric Sup. Ord.	4½ −4¾	6 16 6	April, Oct	..	..
5	2 3	Do. 4½ per Cent. Cum. Pref.	4½ −5	4 10 0	Jan, July	..	..
St.	4½%	Do. 4½ per Cent. Deb. Stock 1st Mort.	105 −109	4 1 6	June, Dec	..	..
St.	3½%	Do. 3½ per Cent. Mrt. Deb. Stock (red.)	84 −89	3 19 0	Jan, July	..	..
100	4½%	Midland Elec. Corp. for P.D. 1st Mort. Db.	94 −97	4 12 6	June, Dec	96½	..
10	4%	Newcastle & Dist. Elec. Ltg. Ord.	6¾ −7¼	5 14 4	Feb, Aug	—	—
100	4½%	Do. 4½ per Cent. Deb.	94 − 96	4 14 9	Jan, July	—	..
5	8%	Newcastle Elec. Supply Ord.	5⅜ −5½	7 7 6	Feb, Aug	..	..
5	5%	Do. 5 per Cent. non Cum. Pref.	5⅜ −5⅝	4 10 0	Feb, Aug	—	..
100	4%	Do. 4 per Cent. Mort. Deb. red. 1907.	95 −97	4 3 4	Jan, July	..	—
1	3%	Northern Counties Elec. Sup.	—	..	Mar, Aug	—	..
100	4½%	Do. 4½ per Cent. Deb.	93 −95	4 15 9	Jan, July	..	..
10	6 0	Notting Hill Electric Ord.	11¾ −12¼	5 10 6	March ..	..	..
5	2/6	Oxford Electric Ord.	6⅛ −6⅜	5 14 0	March ..	..	..
St.	4%	Do. 4 per Cent. Deb. Stock	95 −98	4 2 0	Jan, July	..	..
5	5/0	St. James' & Pall Mall Elec. Ord.	7 −8	6 1 6	Feb, Aug	7⅝	7½
5	3 6	Do. 7 per Cent. Pref.	6½ −7½	4 16 6	Feb, Aug	..	—
St.	3½%	Do. 3½ per Cent. Deb. Stock (red.)	88 −90	3 18 0	Jan, July	..	..
5	..	Smithfield Markets Electric Sup. Ord.	¼ −¾	..	Feb	..	..
St.	4%	Do. 4 per Cent. Deb. Stock	68 −72	5 11 0	Feb, Aug	..	..
5	4 0	South London Electric Supply Ord.	2¼ −2¾	7 5 6	April	..	..
1	0/6	South Metrop'n Elec. Lt. & Power Ord.	⅝ −⅞	4 0 0	..	..	—
1	0 8⅖	Do. 7 per Cent. Cum. Pref.	1 −1⅛	6 4 0	Feb, Aug	1	..
St.	4½%	† Do. 4½ 1st Db. Stk. Red.	98 −101	4 9 0	April, Oct	..	—
5	2/6	†Urban Electric Supply Ord.	½ −1	—	April, Oct	—	..
5	2/6	† Do. 5 per Cent. Cum. Pref.	1¾ −2¼	10 12 0	April, Oct	2¼	2¼
St.	4½%	† Do. 4½ per Cent. 1st Mort. Deb.	80 −83	5 8 3	April, Oct	..	..
5	5 0	Westminster Elec. Sup. Ord.	7¾ −8¾	5 14 0	Mar, Sept	8½	8
5	2/3	Do. 4½ per Cent. Cum. Pref.	5 −5½	4 2 0	Jan, July	..	—
		ELECTRIC RAILWAYS & TRAMWAYS.					
St.	4%	Baker St. & Waterloo 4% Perp. Db. St.	91 −96	4 3 3	Jan, July	95½	94½
1	..	Bath Elec. Trams Pref. Ord.	⅛ −⅜	10 13 0	April	..	—
1	0/6	Do. 5 per Cent. Cum. Pref.	½ −¾	6 13 4	Jan, July	..	—
St.	4½%	† Do. 4½ 1st Mort. Deb. Stock (red.)	83 −88	5 2 0	April, Oct	..	..
St.	4½%	B'ham & Midland Trams 4½ 1st Db. Stk.	93 − 96	4 13 9	Jan, July	..	..
10	9%	Bristol Tramways & Carriage Ord.	10½ −11	8 3 6	Feb, Aug	..	..
10	4%	Do. Cum. Pref. (fully paid)	8¾ −9	4 9 0	..	..	..
St.	4%	Do. 4 per Cent. Debs.	96 −98	4 2 0	Feb, Aug	..	..
10	..	British Electric Traction Ord.	¾ −1¼	..	June, Dec	1⅛	⅞
10	3/0	Do. 6 per Cent. Cum. Pref.	3¾ −4⅛	..	Feb, Aug	3⅜	3
St.	5%	† Do. 5 per Cent. Perpetual Debs.	94 −97	5 2 6	April, Oct	..	—
St.	4½%	Do. 4½ per Cent. 2nd Deb. Stock	76 −78	5 15 0	May, Nov	..	..
St.	3%	Central London Ordinary Stock	70 −72	4 3 6	Feb, Aug	70	68½
St.	4%	Do. 4 per Cent. Pref. Stock	86 −88	4 11 0	Feb, Aug	87½	..
St.	2%	Do. Deferred Stock	51 −54	3 14 0	Feb	53½	51½
100	4%	Do. 4 per Cent. Debs.	101 −104	3 17 0	Jan, July	..	..
St.	4%	Charing X, Euston & Hmpstd Per. Db. Stk.	85 −87	4 12 0	Jan, July	87	85
5	2/6	City of Birmingham Trams. 5% Cm. Pref.	4½ −4¾	5 5 0	April, Oct	..	..
100	4%	Do. 4 per Cent. 1st Mort. Debs.	97 −100	4 0 0	April, Oct	..	..
St.	1½%	City & South London Rly. Con. Ord.	33½ −34½	4 19 6	Feb, Aug	33½	32
St.	5%	Do. 5 per Cent. Perp. Pref. (1891)	111 −114	4 7 6	Feb, Aug	..	..
St.	5%	Do. (1896)	109 −112	4 9 3	Feb, Aug	—	..
St.	5%	Do. (1901)	107 −110	4 11 0	Feb, Aug	..	..
St.	5	Do. (1903)	102 −105	4 15 3	Feb, Aug	..	..
St.	4%	Do. 4 per Cent. Perpetual Debs.	100 −103	3 17 6	May, Nov	..	..
10	6/0	Dublin United Trams. Ord	11½ −12½	5 4 0	Feb, Aug	..	..
10	6/0	Do. 6 per Cent. Pref.	12½ −13½	4 10 6	Feb, Aug	..	..
10	..	Gt. Northern & City Rly. Pref. Ord. (4%)	½ −1	..	Feb, Aug	.	
10	0/9	G. Northern, Piccadilly & Brompton Ord.	7½ −8½	..	Feb, Aug		..
St.	4%	Do. 4 per Cent. Deb. Stock	93 −94	4 5 0	Jan, July	9[illegible]	91½
5	4/0	Hastings & Dist. Elec. Trams. 6% Cm. Pf.	3 −4	..	Mar, Sept	..	..
St.	4½%	† Do. 4½ Db. St.	90 −91	4 15 9	April, Oct	..	..
10	9%	‡Imperial Tramways Ord.	10 −11	7 7 3	Mar, Sept	..	..
10	6%	‡Do. 6 per Cent. Pref.	9½ −10½	5 11 0	Mar, Sept	..	..
St.	4½%	‡Do. 4½ per Cent. Debs.	90 −92	4 18 0	Jan, July	..	..
5	..	I. of Thanet E. T. & Lt. 5 per Cent. Pref.	⅞ −1⅛	..	Mar, Sept	..	—
St.	4%	Do. 4 per Cent. Deb. Stock	59 −61	6 11 0	Jan, July	57½	—
10	6/0	Lanarkshire Tramways	9⅛ −9⅝	6 3 0	Feb, Aug	9⅝	..
St.	5%	Lancs. Utd. Trams 5% Prior Lien Db. St.	92 −94	5 6 6	Jan, July	.	..
10	..	Liverpool Overhead Railway Ord.	1½ −1½	..	Feb, Aug	..	—
10	5%	Do. 5 per Cent. Pref.	5 −5½	9 2 0	Feb, Aug	..	..
St.	4%	Do. 4 per Cent. Deb.	84 −85	4 13 0	Jan, July	..	..
10	5/0	London United Trams. 5% Cum. Pref.	5¾ −6¼	8 0 0	Jan, July	5⅝	5½
St.	4%	Do. 4 per Cent. 1st Mort. Deb. Stock	75 −80	5 0 0	Jan, July	75	..
St.	..	Mersey Con. Ord. Stock	1 −3	—	Feb, Aug.	..	—
St.	..	Do. 3 per Cent. Perp. Pref.	3 −6	—	..	..	..
1	..	Metropolitan Elec. TramwaysOrd.	⅝ −⅞	—		..	.
1	..	Do. Def.	⅛ −⅜	..	April.. .	..	..
1	0/6	Do. 5 per Cent. Cum. Pref.	¾ −1	6 3 6	Feb, Aug	..	..
St.	4½%	Do. 4½ per Cent. Deb. Stock	92 −95	4 14 9	Jan, July	94½	..
St.	½	Metropolitan Railway Consolidated	41 −42	1 4 0	Feb, Aug	41	37½
St.	2½%	Do. Surplus Lands Stocks	63 −68	4 1 6	Feb, Aug	67½	65
St.	3½	Do. 3½ per Cent. Preference	84 −87	4 0 6	Feb, Aug	..	.
St.	3½	Do. 3½ per Cent. "A" Preference	74 −77	4 11 0	Feb, Aug	73	73
St.	3½%	Do. 3½ per Cent. Convertible Pref.	75 −78	4 9 9	Feb, Aug	76¾	72½
St.	3½%	Do. 3½ per Cent. Debenture Stock	91 −93	3 15 3	Jan, July	92¾	92
St.	3½%	Do. 3½ per Cent. "A" Ditto	88 −91	3 17 0	Jan, July	89¾	88½

* In calculating the yield allowance has been made for accrued interest but not for redemption Ex Dividend. ‡ The London Stock Exchange Committee have declined to quote these.

ELECTRICAL COMPANIES' SHARE LIST.—*Continued.*

Share.	Last Dividend	Name.	Price Wed., Sept. 30	Rate % Yielded. £ s. d.	Dividend Due.	Business Week to Sept. 30. Highest.	Lowest.
		ELECTRIC RAILWAYS & TRAMWAYS—*Continued.*					
St.	..	Metropolitan District Railway Ord.	14 —15	..	Feb, Aug	14⅞	13⅞
St	..	Do. Extension Pref. (5 per Cent.)	20 —24	..	Feb, Aug	..	..
St.	3½%	Do. Assented Ext. Pref. (Int. Guar. by Und. Elec. Rlys. Co. of London, Ltd.)	50 —55	6 7 0	Feb, Aug	..	..
St.	3%	Do. 3 per Cent. Consoltd. Rent-charge	74 —77	3 18 0	Jan, July	..	..
St.	4%	Do. 4 per Cent. Midland Rent-charge	99 —103	3 17 6	Jan, July	102½	100½
St.	1%	Do. Guar. Stock 4 per Cent.	6) —65	3 1 6	Mar, Sept	63	54
St.	6	Do. 6 per Cent. Perp. Deb. Stock	122 —125	4 16 0	Jan, July	..	..
St.	4	Do. 4 per Cent. Ditto	8) —84	4 16 0	Jan, July	74½	73
5	..	New Gen. Tract. 6 per Cent. Cum. Pref.	½—¾	..	May	..	—
1	0/9¾	Potteries Electric Traction Ord.	¼—½	8 0 0	April, Oct	..	—
1	0/6	Do. 5 per Cent. Cum. Pref.	13/32—15/32	6 19 0	Feb, Aug	..	..
St.	4½%	Do. 4½ per Cent. Deb Stock	92 —95	4 14 9	May, Nov	..	..
1	0 7½	S. Met. Elec. Trams. & Ltg. 6% Cm. Pref.	¾—1	6 0 0	Feb, Aug	..	..
St.	4%	Do. 4 per Cent. Deb. Stock	76 —80	5 0 0	Jan, July	—	..
100	5%	Sunderland Dist. Elec.Trms.5%1stMt.Db.	78 —82	6 2 0	Jan, July	..	..
..	21/0	Underground Elec. Rys. Co. of London...	43 —47	..	June, Dec	..	..
5	..	Yorkshire (W.R.) Elec. Trams. Ord.	⅞—1⅛	—	March ..	..	..
5	..	Do. 6 per Cent. Cum. Pref.	3 —3½	—	..	..	..
St.	4½	Do. 4½ per Cent. 1st Debs.	84 —87	5 3 0	Jan, July	..	..
		ELECTRIC MANUFACTURING, &c.					
1	..	Aron Electricity Meter Ord.	7/32—11/32	..	..	..	..
1	1/4⅘	Do. 6% Cum. Pf. (ex on a/c arrears)...	11/16—13/16	7 12 0	April, Oct	¾	..
1	1/7⅕	†Babcock & Wilcox Ord.	3¾—4	5 0 0	April, Oct	..	..
1	0/7⅕	† Do. Pref.	1½—1⅝	3 13 9	..	..	..
5	4/0	British Insulated & Helsby Cables Ord.	6¼—6¾	7 8 3	July, Feb	..	—
5	3/0	Do. 6 per Cent. Pref.	6 —6½	4 12 0	Jan, July	..	..
St.	4½%	Do. 4½ per Cent. 1st Mort. Deb. (red.)	103 —106	4 5 0	Jan, July	..	..
St.	4½%	British Thoms'n-Houst'n 4½% 1st Mt.Db.	91 —96	4 14 0	Mar, Sept	..	..
5	..	British Westinghouse 6 per Cent. Pref...	⅜—⅝	..	Feb, Aug	..	..
St.	4%	Do. 4 per Cent. Mort. Deb. Stock	40 —45	8 17 6	Jan, July	43½	43
2	..	Brush Electrical Engineering	½	—	March ..	..	..
2	..	Do. 6 per Cent. Pref. non-Cum.	⅛—⅜	..	Mar, Sept	..	..
St.	4½%	Do. 4½ per Cent. Perp. 1st Deb. Stock	68 —73	6 3 0	Mar, Sept	..	..
St.	4½%	Do. Perpetual 2nd Deb. Stock	50 —54	8 6 6	Jan, July	..	..
5	10 0	Callender's Cable Con. Ord.	9⅞—10⅜	6 17 6	Jan, July	9⅞	—
5	2/6	Do. 5 per Cent. Cum. Pref.	5¼—5¾	4 7 0	Jan, July	..	..
St.	4½%	Do. 4½ per Cent. 1st Mort Debs. (red.)	107½—109½	4 2 0	Nov, May	..	..
1	1/0	Castner-Kellner Alkali Co.	1 1/16—1 3/16	8 0 0	May, Nov	1⅛	..
St.	4½%	Do. 4½ per Cent. 1st Mort. Deb. (red.).	103 —107	4 4 0	Feb. Aug	..	—
1	0 9⅜	Chadburn's (Ship) Telegraph Ord.	15/16—1 1/16	7 11 6	March ..	..	..
1	0/7½	† Do. 6 per Cent. Cum. Pref.	15/16—1 1/16	5 13 0	April, Oct	..	..
1	0/8⅘	Consolidated Electrical Co.	⅜—½	7 0 0	August ...	..	..
1	1/0	Consolidated Signal Co.	1¼—1 7/16	10 8 6	April, Oct	..	..
1	0/7½	Do. 6 per Cent. Cum. Pref.	⅞—1	6 0 0	April, Oct	15/16	..
3	3/0	*Crompton & Co. (Nos. 1 to 86,000)	1 7/16—1 9/16	9 5 0	Jan, July	..	..
100	5%	Do. 5 per Cent. 1st Mort. Debs. (red.).	98 —101	4 19 0	Jan, July	99¼	—
1	0/7½	Davis & Timmins	⅞—1⅛	..	Mar, Sept	..	..
5	2/0	†Dick, Kerr & Co. Ord.	1 1/16—1 5/16	7 12 0	Sept	1 3/16	1¼
5	0/7½	† Do. 6 per Cent. Cum. Pref.	1 —1¼	4 16 0	Sept	1 3/32	1⅛
St.	4½%	Do. 4½ per Cent. Deb. Stock	101 —104	4 6 6	Jan, July	..	—
5	2/6	Edison & Swan United ("A" Sh.) (£3 pd.)	½—¾	..	Feb, Aug	..	..
5	4/2	Do. (£5 paid)	1½—2½	5 0 0	Feb, Aug	..	—
St.	4%	Do. 4 per Cent. Mort. Deb. Stock (rd.)	76 - 79	5 1 6	June, Dec	..	..
St.	5%	† Do. 5 per Cent. 2nd Deb. Stock	83 —86	5 16 0	Mar, Sept	—	..
5	..	Edmundson's Elec. Corp. Ord.	⅛—⅜	..	Jan, July	—	..
5	..	Do. 6 per Cent. Cum. Pref.	⅞—1	..	May, Nov	25/32	..
St.	4½%	Do. 4½ per cent. 1st Mort. Deb. (red.)	59 —66	6 16 0	Jan, July	..	..
2	..	Electric Construction Co.	½—¾	..	Jan, July	—	..
2	2/9½	Do. 7 per Cent. Cum. Pref.	1⅜—1⅞	8 0 0	July	—	..
St.	4%	Do. 4 per Cent. Perp. 1st Mort. Debs.	65 —70	5 14 0	Jan, July	..	..
10	5/0	General Electric (1900) 5% Cum. Pref...	7½—8	6 5 0	June, Dec	—	..
St.	4%	† Do. 4 per Cent. 1st Mort. Debs.	84 —88	4 11 0	Mar, Sept	—	—
5	6/0	Henley's Telegraph Works Ord.	10½—11½	6 11 0	Feb, Aug	..	..
5	2/3	Do 4½ per Cent. Pref.	5 —5½	4 2 0	Feb, Aug	..	..
St.	4½%	Do. 4½ per Cent. 1st Mort. Deb. Stock	107 —109	4 2 6	Mar, Sept	..	..
10	5/0	India Rubber, Gutta Percha, &c., Wrks.	16 —17	5 17 9	Feb, Aug	16½	16½
100	4%	Do. 4 per Cent. Debs. (red.)	97 —99	4 1 0	April, Oct	..	—
1	..	National Elec. Construction Co.	⅛—⅜	..	April	..	..
1	0/9⅜	Richardsons, Westgarth & Co., Ltd. Ord.	7/16—9/16	7 2 0	Nov	..	..
1	0/7½	Do. 6 per Cent. Cum. Pref.	¾—⅞	6 17 0	May, Nov	[illegible]	..
St.	4½%	Do. 4½ per Cent. Perp. Deb. Stock	85 —88	5 2 0	Jan, July	86	..
1	..	Simplex Conduits Ord.	1½	..	..	—	—
5	..	Do. 6 per Cent. Cum. Pref.	5½	..	..	..	..
12	12/0	Telegraph Construction & Maintenance	32 —34	6 5 0	Mar, July	33	32
100	4%	Do. 4 per Cent Deb. Bonds (1909)	101 —103	3 17 0	Jan, July	..	..
1	1/0	Vickers, Sons & Maxim, Ltd., Ord.	1 1/16—1 3/16	9 1 0	..	1 3/32	1⅛
1	0/6	Do. 5 per Cent. non-Cum. Preference	1 —1⅛	4 9 0	..	1 1/32	1 1/16
St.	5%	Do. 5 per Cent. non-Cum. Preferred	101 —104	4 16 0	..	103	..
St.	4%	Do. 4 per Cent. 1st Mort. Db. Sk. (red)	104 —106	3 15 0	June, Dec	..	..
100	4½%	Do. 4½ per Cent. 2nd Mort. Deb. (red.)	104 —106	4 5 0	June, Dec	105	..
100	15/6	Do. 5 per Cent. 3rd Mort. Debs. Scrip.	103 —105	4 15 0	..	104⅜	103½
10	10/0	J. G. White & Co. 6% Cm. Pref.	8½—9⅛	8 17 9	..	..	..
5	1/0	Willans & Robinson Ord.	¾—1¼	4 0 0	Apr, Oct	1⅞	..
5	3/0	Do. 6 per Cent. Cum. Pref.	2¾—3¼	9 4 0	Apr, Oct	3 1/16	2⅞
100	4%	Do 4 per Cent. 1st Mort. Debs.	72 —76	5 5 6	May, Nov	..	..
		TELEGRAPHS.					
10	..	Amazon Telegraph	2 —3	—	June, Dec	..	—
100	5%	Do. 5 per Cent. Debs. (red.)	90 —93	5 7 6	June, Dec	..	..
St.	15/0	Anglo-American	58 —61	5 16 0	F,My,Ag,N	59¼	..
St.	30 0	Do. Preferred	103½—104½	5 16 6	F,My,Ag,N	104½	103½
St.	1%	Do. Deferred	17½—18	5 10 0	F,My,Ag,N	18 1/16	17
St.	4%	†Commercial Cable 4 per Cent. Deb. Stk.	88 —90	4 9 0	Jn,Ap,Jy,O	90½	89⅞
10	6 0	Cuba Submarine Ord.	7½—8½	7 0 0	Feb, Aug	8	..
10	10/0	Do. Preference 10 per Cent.	16 —17	5 17 9	Feb, Aug	..	..
5	2/0	†Direct Spanish Ord.	3 —3½	6 4 0	April, Oct	..	..
5	5/0	† Do. 10 per Cent. Cum. Pref.	8 —9	5 11 0	April, Oct	..	..
50	4½%	Do. 4½ per Cent. Deb.	100 —103	4 7 6	Jan, July	..	..
20	[illegible]	Direct United States Cable	13½—13⅞	6 2 6	Ja,Ap,Jy,O	13½	13⅜
100	4½%	Direct West India Cable 4½% Rg. Db. (rd.)	100 —102	4 8 0	June, Dec	..	..
St.	26/0	Eastern Ordinary	136 —139	5 0 9	Ja,Ap,Jy,O	137	135½
St.	17 6	Do. 3½ per Cent. Pref. Stock	85 —87	4 0 6	Ja,Ap,Jy,O	86⅞	84⅞
St.	4%	Do. 4 per Cent. Mort. Deb. Stk. (red.)	103 —105	3 16 0	May, Nov	104½	103
10	2/6	Eastern Extension	12¾—13¼	5 5 6	Ja,Ap,Jy,O	13	12¾
St.	4%	Do. 4 per Cent. Deb. Stock	101 —103	3 17 9	Feb, Aug	101½	..
100	4%	Eastern & S. African 4% Mort. Deb 1900	99½—101½	3 18 6	Feb, Aug	..	..
25	4%	Do. 4% Mauritius Sub. Debs. (red.)	101½—103½	3 16 6	May, Nov	102½	..
10	[illegible]	G.N. (of Copenhagen), with Coupon 74...	80 —82	6 5 0	Jan, July	[illegible]	..
100	4½	Halifax & Bermuda 4½% 1st Mt. Db. (red.)	100 —102	4 8 0	June, Dec	..	..
	[illegible]	Do. European	66 —69	6 12 0	May, Nov	67	66½
100	$1	Mackay Companies Common	68 —72	5 11 0	Ja,Ap,Jy,O	..	..
100	$1	Do. Preference	68 —72	5 11 0	Ja,Ap,Jy,O	..	..
1		Marconi's Wireless Teleg. Co.	¾—1	..	April	[illegible]	..
100	4%	Pacific & European Tel. 4% Guar. Dbs. (red.)	99 —102	3 18 0	June, Dec	..	—
[illegible]	[illegible]	West Coast of America	1½ —1¾	4 3 0	May	..	—
100	4	Do. 4 per Cent. Debs.	99 —102	3 18 0	Jan, July	..	..
10		West India & Panama	½—¾	..	May, Nov	..	..
10	[illegible]	Do. 6 per Cent. 1st Pref.	8 —8½	7 1 0	May, Nov	..	..
10	[illegible]	Do. 6 per Cent. 2nd Pref.	8½ —9½	..	May, Nov	..	..
100		Do. 5 per Cent. Debs.	101 —103	4 17 0	Jan, July	..	..
10	..	Western Telegraph	13⅝—14⅛	4 18 6	Mr,Jn,O,D	13¾	13⅝
St.	4	Do. 4 per Cent. Deb. Stock (red.)	101½—103½	3 16 6	June, Dec	..	..
..	4	Western Union Teleph. $1,000 4% Bonds	84 —88	4 11 0	..	..	..

Share.	Last Dividend	Name.	Price Wed., Sept. 30.	Rate % Yielded. £ s. d.	Dividend Due.	Business Week to Sept. 30. Highest.	Lowest.
		TELEPHONES.					
100	2s	†Amer. Teleph. & Telegh. Cap. St.	129 —133	6 0 0	..	..	..
..	4%	Do. Coll. Trust $1,000 4 per Cent. Bds	93 —95	4 4 0	Jan, July	93⅞	93½
St.	5%	Anglo-Portug'se Tel. 5% 1st Mt. Db. Stk.	99 —102	4 18 0	Mar, Sept	..	..
5	5 0	Chili Telephone	8 —8½	4 14 0	August ..	8½	—
1	0/7½	Monte Video Telephone Ord.	1 —1⅛	6 4 0	Nov	1 1/16	..
1	0/6	Do. 5 per Cent. Pref.	⅞—1	5 0 0	May, Nov	1⅛	..
St.	6%	National Co. Pref. Stock	109 —111	5 8 0	Feb, Aug	110⅛	109
St.	6%	Do. Def. Stock	118 —120	5 0 0	Feb, Aug	118⅝	118
10	6/0	Do. 6 per Cent. Cum. 1st Pref.	10½—11½	5 6 6	Feb, Aug	10⅞	..
10	6/0	Do. 6 per Cent. Cum. 2nd Pref.	10½—11½	5 6 6	Feb, Aug	..	..
5	2/6	Do. 5 per Cent. non-Cum. 3rd Pref.	5 5/16—5 13/16	4 8 0	Feb, Aug	5⅝	5⅝
St.	3½%	* Do. Deb. Stock 3½ per Cent. (red.)	98½—100½	3 9 6	June, Dec	..	..
St.	4%	Do 4 per Cent. Deb. Stock (red.)	102 —104	3 17 0	Jan, July	102	..
1	1/0	Oriental	1¼—1⅜	5 16 3	April, Oct	1 5/16	..
1	0 7½	Do. 6 per Cent. Cum. Pref.	1 1/16—1 3/16	4 11 6	April, Oct	..	..
St.	4%	Do. 4 per Cent. Red. Deb. Stock	89 —92	4 7 0	Jan, July	—	..
St.	4½%	Telephone Co. of Egypt 4½%Db.Stk.(red.)	99 —102	4 12 0	Jan, July	—	—
5	5/0	United River Plate	6¾—7¼	5 10 0	July	6⅞	..
5	2/6	Do. 5 per Cent. Cum. Pref.	5 —5½	4 11 0	June, Dec	5 1/16	5⅛
St.	4½%	Do. 4½ Deb. St. Red.	103½—105½	4 5 0	Jan, July	..	..
		FINANCIAL, INVESTMENT, &c.					
5	3/0	Elec. & Gen. Investment 6% Cum. Pref.	3½—4	7 10 0	Jan, July	3 15/16	3⅞
10	2 0	†Globe Telegraph & Trust	10¾—11¼	5 8 0	Sp De Mr Ju	11	10¾
10	3/0	† Do. 6 per Cent. Pref.	13⅝—14⅛	4 5 0	Sp De Mr Ju	13⅞	13⅞
10	6%	Submarine Cables Trust (Cert.)	130 —133	4 10 3	April, Oct	130	..
		COLONIAL AND FOREIGN ELECTRIC RAILWAYS, TRAMWAYS, &c.					
5	3/0	Anglo-Argentine 6% Cum. 1st Pref.	6¼—6¾	4 12 6	April, Oct	6 9/16	..
5	5/0	† Do. 10% Non-cum. 2nd Pref.	8⅜—8⅞	5 16 0	Jan, July	8⅝	8½
St.	5%	Do. Permanent 6% Deb. Stock	143 —148	4 1 0	June, Dec	..	..
St.	5%	Auckland Elec. Trams. 5% Deb. (red.)	103 —106	4 14 3	Jan, July	104½	..
5	4/0	Brisbane Electric Trams. Invest. Ord.	4 5/16—4 11/16	4 2 0	May	4⅝	..
5	2/6	Do. 5 per Cent. Cum. Pref.	4⅞—5⅜	4 17 6	May, Nov	..	..
St.	4½%	Do. 4½ per Cent. Db. Prov. Certs.	100 —104	4 6 6	Jan, July	102⅜	..
St.	8%	British Columbia El.Ry.Df. Ord.	136 —140	5 14 0	Mar, Sept	136½	..
St.	30 0	Do. Pref. Ord. Stock	117 —121	4 19 0	May, Nov	120	118
St.	5%	Do. 5% Cum. Perp. Pref. Stock	105 —109	4 11 6	Jan, July	107½	..
40	4½%	Do. 4½ per Cent. 1st Mort. Debs.	101 —104	4 6 6	April, Oct	..	..
100	4½%	Do. Vancouver Power Debs.	101—104	4 6 6	Jan, July	..	—
St.	4½%	† Do. 4½% Perp Con. Deb. St.	101 - 105	4 0 6	—	105½	101⅞
St.	5%	Buenos Ayres Elec. Trams (1901) Ltd. Deb. St.	97 —102	4 18 6	Ja, Jul ..	..	..
5	..	Buenos Ayres Grand National Ord.	2½—3	..	..	..	..
5	2/6	Do. 5 per Cent. Cum. Pref.	4 —4½	5 11 0	Feb. Aug	—	..
100	5½%	Do. 5½ per Cent. Pref. Debs.	100 —105	5 4 6	Jan, July	..	..
100	6%	Do. 6 per Cent. 1st Deb. Bonds.	102 —107	5 12 0	April, Oct	..	..
St.	5%	Buenos Ayres Lacroze Trams 1st Mt. Db.	95½ —97½	5 2 6	Mar, Sept	96½	96
St.	6%	Buenos Ayres Port & City Tram. 1st Mt. Deb. Stock £75 Paid	61 —65	6 12 0	Feb, Aug	..	..
5	2/6	Calcutta Tramways (1 to 137,610)	5½—6	5 0 0	Mar, Sept	5¾	5
100	2/6	Do. 5 per Cent. Cum. Pref.	4⅝—5¼	4 13 0	Jan, July	4⅝	..
1	4½%	Do. 4½% 1st Deb. Stock (red.)	103 —106	4 5 0	Jan, July	104½	103½
St.	..	Cape Electric Tram Shares	⅛ - ⅜	..	..	..	—
5	1/3	City of Buenos Ayres Trams Co. (1904)Sh.	5⅝ —5⅞	4 5 3	F,My,A,N	5 11/16	..
St.	4%	Do. 4 per Cent. Deb. Stock	99 —103	3 17 [illegible]	June, Dec	..	..
	5%	Colombo Tr. & Ltg. 5% 1st Mt. Db.	90 —93	5 6 6	May, Nov	..	—
100	5%	Electric Traction Co. of Hong Kong 5 per Cent. 1st Mort. Debs.	85 —90	5 10 0	June, Dec	..	..
1	5%	Havana Elec. Ry. Con. Mt. 5% $1,000 50 year Coup. Bds.	85 —90	5 11 0	Feb, Aug	..	..
1	..	Kalgoorlie Elec. Trams Sh.	1/32—3/32	..	..	..	..
100	5%	Do. 5 per Cent. "A" Deb. Stock	85 —89	5 12 0	Jan, July	..	—
5	6%	Do. 6 per Cent. "B" Ditto	64 —69	8 14 0	Jan, July	65	64
5	1/0	Lisbon Elec. Trams. Ord.	1 —1¼	4 0 0	July	..	..
100	0/7½	Do. 6 per Cent. Cum. Pref.	1 —1¼	4 16 0	Jan, July	..	..
St.	5%	Do. 5 per Cent. Reg. Mort. Debs	92 -97	5 3 0	Jan, July	..	..
St.	5%	Madras Elec. Trams. 5% Deb. Stk.	93 —96	5 4 0	Jan, July	..	..
..	5%	Manila Elec. Ry. $1,000 Gold Bonds	84 —88	5 14 0	Feb, Aug	..	..
100	4/[illegible]	Mexico Trams Co. Com. St.	130 —132	3 15 6	..	131	1[illegible]
500	5%	Do. Gen. Con. 1st Mort. 5% Gold Bds.	92 —93½	5 7 6	..	92⅛	92
St.	4½%	Montreal St. Ry. Sterling 4½ per Cent. Debs. (1922) (Nos. 601 to 2,100)	101 —103	4 7 6	Feb, Aug	..	..
1	1/0	Perth Elec. Trams Ord	[illegible]	6 13 6	May	..	..
St.	5%	Do. 1st Mt. Db. Stock	101 —104	4 16 0	Jan, July	..	..
5	3/0	Rangoon Elec. Trams & Supply Co. 6% Cum. Pf.	5⅛—5⅝	5 6 6	..	..	—
St.	4½	Do. 4½% 1st Mort. Deb. Stk.	95 —100	4 10 0	..	..	..
..	$2½	†Sao Paulo Tramway, Light & Power Co. $100 Stock	153 —157	5 11 6	..	157½	153
	5%	Do. 5 per Cent. 1st Mt. $500 Db.	99½—100½	4 19 9	June, Dec	100	99½
100	4½%	Toronto Ry. Co. 1st Mt. 4½% Ster. Bonds	97 —99	5 1 0	Feb, Aug	97½	..
		COLONIAL AND FOREIGN ELECTRICITY SUPPLY &c.					
5	8 0	Adelaide Elec. S'ply Co. 6% Cu. Pr.	4¾—5¼	5 14 0	Mar, Sept	..	..
10	6/0	Bombay E.S. & T. 6% Cm. Pf.	9⅝—10⅛	5 16 3	..	..	..
St.	4½%	Do. 4½ per Cent. Deb. Stk. (red.)	94 —96	4 13 9	Jan, July	94½	..
5	$1½	†Calcutta Elec. Supply Ord.	6 —7	5 14 0	April, Oct	[illegible]	[illegible]
100	7/2	Canadian Gen. Elec. Co. Com. St.	102 —106	6 14 6	..	104½	..
100	5%	Castner Electrolytic Alkali Co. (of U.S.A.) 1st Mort. Stl. Debs.	92 —97	5 2 6	Jan, July	..	..
500	5%	Elect. Development Co of Ontario	84½ —87½	5 11 0	..	86½	[illegible]
5	..	Elec. Ltg. & Trac. Co. of Aust. 6 per Cent. Cum. Pref.	2 —2½	..	Feb, Aug	..	..
St.	5%	Do. 5 per Cent. Deb Stock	83 —88	5 13 9	Jan, July	..	..
St.	5%	Elec. Supply Co. of Victoria 5 per Cent. 1st Mort Deb. St.	90 —93	5 7 6	Jan, July	..	..
St.	6%	Indian Elec. Sup. & Trac. Co. Constn Deb. St. Rd.	30 —40	15 0 0	Jan, July	—	..
10s	0/3	Kalgoorlie Elec. Power & Ltg. Ord.	⅛—¼	..	..	—	
1	0/7½	Do. 6 per Cent. Cum. Pref.	⅝—⅞	8 0 0	April, Oct	..	..
St.	5%	Madras E. S. Corp. 5 per Cent. Constn Deb. St.	85 —90	5 11 0	April, Oct	..	..
500	5%	Mexican Elec. Light Co. 5% 1st Mort. Gold Bonds	88½—90½	5 10 6	..	92½	[illegible]
St.	$1	Mexican Lt. & Power Co. Com. St.	79½—81½	..	—	81¼	[illegible]
500	5%	Do. 5% 1st Mort. Gold Bnds.	91 —93	5 9 0	..	[illegible]	[illegible]
100	6/2	Montreal Lt. Ht. & Power Co. Cap. St	106 —108	5 14 0	F,My,A,N	107	105
1	1/7½	River Plate Electricity Co. Ord.	1 —1	4 18 0	April	..	..
1	1 2½	Do. 6 per Cent. non-Cum. Pref.	[illegible]	6 13 0	May	..	..
St.	5%	Do. 5 per Cent. Deb. Stock	99 —102	4 18 0	Jan, July	..	..
5	3/0	†Rosario Elec. Co. 6% Pref. (1-20,000)	4¾—5¼	5 14 0	April, Oct	[illegible]	[illegible]
100	$1	Shawinigan Water & Power Co. Cap. St.	80 —82	4 17 6	..	[illegible]	80
..	5%	Do. 5 per Cent. Bds.	103 —105½	4 15 6	Jan, July	104½	103
..	6%	Victoria Falls Power Co. Pref.	⅛—⅜	—	Jan, July	..	..

* In calculating the yields allowance has been made for accrued interest but not for redemption. † Ex dividend. ‡ The London Stock Exchange Committee have declined to quote these.

THE ELECTRICIAN:

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CONTENTS OF THE CURRENT NUMBER.

NOTES.

The Manchester Exhibition.

THE opening day of an important industrial exhibition is one fraught with anxiety, alike to the management and to the exhibitors, and it is no mall credit that is due to both when, on the eventful morn, it can be said that the exhibitors have supported the management in carrying out their share of the programme and have made it possible for the exhibition to be trim and ready for the opening ceremony. When, too, this can be truthfully said of an exhibition which represents over 250 manufacturing firms whose works are scattered all over the country, and whose exhibits, in many cases, require to be erected, a meed of praise is due, first to the management and secondly to the exhibitors. All this, and even more, can be claimed for the Electrical Exhibition which opened at Platt's Fields, Rusholme, Manchester, on Saturday. With the exception of one or two stands, the entire Exhibition was in a state of actual readiness at the appointed hour. To Mr. C. S. NORTHCOTE, the energetic general manager, and his colleagues in the management, and to the General Committee, the thanks of the exhibitors and, indeed, of the entire industry are due, and their example may be commended to future organisers of such displays.

FROM the exhibitors' point of view, and from that of the general public, the Exhibition certainly promises well. It is of much greater extent and a much more comprehensive show, we believe, than was generally regarded as likely. The Exhibition will bear favourable comparison with any of its predecessors, and on the score of size and general interest it is far and away superior to anything of an electrical character hitherto held, at any rate so far as this country is concerned. The weather has proved eminently favourable, which is an immense factor. As we have previously mentioned in these columns, there are certain aspects of the show to which slight exception may be taken; but, on the whole, the work of aggregation has been well done, and if the crowds which have so far patronised the Exhibition may be taken as a criterion of what is to follow, the Electrical Exhibition at Manchester will have fully justified its existence. We learn that about 2,000 persons actually paid for admission on Saturday after two o'clock, and that the number of admission tickets which have been sold is sufficient to ensure a large attendance throughout the month. The character of the exhibits, the standing of the exhibitors in the industry, and the businesslike appearance of the various stands is a guarantee that visitors on business bent will find much to interest them, and that the general public will get an insight into the possibilities of electrical applications which only such a display could afford. Exhibitions are usually only justified by results, and from this aspect the great Electrical Exhibition, 1908, now being held at Rusholme, Manchester, seems destined to justify fully the sanguine anticipations of its organisers. We gave a general survey of the exhibits in our last issue, and this week we publish the first instalment of our detailed description of the chief exhibits.

Tramway Practice.

IT is refreshing to peruse a Paper such as that read by Messrs. R. G. and J. G. CUNLIFFE before the recent meeting of the Municipal Tramways Association. There is always a danger in standard practice becoming so far standard as to make engineers think it is not worth while to inquire into the merits or demerits of the particular standard practice that is adopted. Tramway methods are a case in point. Electric tramways have now been running for so many years that every part of the equipment has become fairly standardised, and yet there are evidently many lines along which inquiry is most desirable. We are glad to find that Manchester is so up-to-date and so

progressive as to see the desirability of inquiring into these points for themselves, and to realise the advantage of spending money on technical assistance for such work. The outcome is the Paper by Messrs. CUNLIFFE, which will be found elsewhere in this issue almost in full. Among the many interesting points it may be noticed that, whereas Mr. TWEEDY has, for mechanical reasons, advocated the use of a particularly small trolley wire—namely, No. 2/0 S.W.G.—Messrs. CUNLIFFE come to the conclusion that Nos. 4/0 and 5/0 are desirable for Manchester generally, when the usual Kelvin law is taken into account, and that it is desirable to go even so far as No. 7/0. Even then the most economical life is only four years, and, generally speaking, from three to five years is the best life to allow a trolley wire. In many ways this early replacement is open to question, and is akin to removing distributors after a few years because the house main switches have become worn out. There is certainly something to be said in favour of the authors' suggestion that a heavy wire should be run for giving the supply and used for that purpose alone, small trolley wires being run in parallel with this from which the current would be taken: the latter would be only large enough to satisfy mechanical conditions and be subject to the mechanical wear.

ANOTHER interesting point is the attempt to diminish the maximum demand per car on the station, by accelerating cars more rapidly when the motors are in series than when they are in parallel. For the same acceleration, the current in the former case is less than in the latter, and thus, in order to effect this object, the authors have diminished the resistance on the second notch and have entirely removed it on the third notch of the controller on one of the equipments, thereby diminishing the maximum demand by 12 per cent. Such a simple expedient is certainly worth attention. The fact that good gearing costs Manchester £7,000 per annum, and that if allowed to get into bad condition it costs perhaps £35,000 per annum, will appeal to all tramway managers. Likewise the fact that bent axles cost £5,000 per annum, and if slightly neglected this may become £10,000 per annum, is equally interesting. The authors make a number of suggestions, and although these may be somewhat debatable, they are certainly worthy of most careful consideration.

Mishap on the "Underground."

THERE are probably but few engineers who would have thought it possible for the supply of electrical energy from the Lots Road generating station, which supplies the District Railway and three of the tube railways, to be entirely interrupted, and thus for the whole service to be suspended. The improbable, however, has taken place, and elsewhere in the present issue will be found a very interesting account of the cause of all the trouble. The provision of a brick chamber for a series transformer, with 2 ft. of free air space, and a concrete floor between this and the main oil switch would be expected to ensure ample safety. It has turned out, however, that this is not the case, and the failure of this comparatively insignificant piece of apparatus resulted in the complete shutting down of the generating station. As pointed out by a correspondent to *The Times*, to have the supply of electrical energy to London dependent on a single generating station, which is the aim of recent efforts in Parliament, involves a certain element of risk in view of this occurrence, not to mention the eventualities of war.

Electrolytic Iron.

THE Paper which Mr. S. COWPER-COLES read before the recent meeting of the Iron and Steel Institute, upon the Production of Finished Iron Sheets by Electrolysis, and which we give in abstract elsewhere, is of more than usual interest from both the scientific and technical points of view. It had been previously observed, and this is now confirmed by Mr. COWPER-COLES, that the amount of carbon in electrolytic steel may be varied to a considerable extent, so that not merely can electrolytic iron be produced, but also steel as distinct from iron. A necessary condition is that the deposition should take place from iron containing combined carbon. Considering that carbon as an ion is not at present known, it is curious that this result should be obtained, and it will doubtless be concluded that some of the ions taking part in the process are complex ions, consisting of iron combined with more or less carbon. The physical properties of the deposited metal, as is well known, vary with subsequent treatment. As obtained from the vat it contains large volumes of hydrogen, and is characterised by inertness and freedom from corrosion, notwithstanding statements that have been sometimes made to the contrary. Possibly this property is akin to the well-known passive state of iron.

FROM the electrical point of view electrolytic iron is of interest as being more highly magnetic than ordinary iron, though there does not seem to be any particular reason why it should be so, and, what is more important, it is characterised by a very low hysteresis loss. A figure of 0·3 watt per pound is mentioned, but the conditions under which this was obtained are not given. This last property should certainly commend this form of iron to the electrical manufacturer, provided, of course, that it can be obtained at a sufficiently low price. Upon this important point the Paper does not throw much light. The cost per ton is put at £5. 5s. 3d., with electrical energy at ¼d. per unit, but nothing is said as to any trouble from impurities introduced into the electrolyte when using pig iron or iron ore, and as such difficulties have been serious in the past in the case of copper processes, we must await further details before expressing an opinion as to whether the process is as revolutionary as the cheap electrolytic production, or even refining, of iron might well become.

German Organisation.

MUCH is heard at the present time of the superiority of German organisation as compared with British methods in the electrical industry, though not very much is known as to the actual system employed. Elsewhere in the present issue we publish a short article in which the German Kartell is discussed from the German point of view, more particularly from that of the firms making use of the system. Whatever may be the opinion as to the practicability or otherwise of such a system in this

country, the information given in this article will be read with interest, and tends to show that the system is in the main beneficial to the producer without being harmful to the buyer.

Junior Institution of Engineers.—The visit which this Institution was to have paid to the works of Messrs. Siebe & Gorman at 157, Westminster Bridge-road, on Wednesday next has been postponed.

Royal Engineers (Territorial Force).—W. Wood has been gazetted captain and V. W. Goss lieutenant in the North Midland Divisional Telegraph Company, North Midland Divisional Engineers.

The following officers from the Hampshire Royal Engineers (Volunteers) are appointed to the Hampshire Fortress Division, with rank as in the Volunteer Force: Major E. North, Lieut. R. H. P. Bevis and 2nd Lieut. G. E. Couzens to No. 4 Electric Light Company; Capt. H. D. Gilbert and 2nd Lieut. W. B. Brown to No. 5 Electric Light Company; Capt. A. V. White and 2nd Lieut. P. G. King to No. 6 Electric Light Company, and Supernumerary Capt. (hon. lieutenant in the Army) A. P. Lambert (to remain seconded), Lieut. H. A. B. Storry and 2nd Lieut. S. Flower to No. 7 Electric Light Company.

O. N. Wightman has been appointed lieutenant in Electric Light Company, East Riding (Fortress).

International Electrotechnical Commission.—The first meeting of the Council of the Commission, to which we have several times referred, is to be held on Monday, the 19th inst., at the new home of the Institution of Electrical Engineers, the Medical Examination Hall, Victoria Embankment. Delegates are coming from several different countries, and they are to be welcomed by the Right Hon. A. J. Balfour, M.P. There are at present committees in nine of the principal countries, which are officially constituted and in proper working order, and committees will shortly be formed in several other countries. One of the chief matters to be discussed is the election of the new president to take the place of the late Lord Kelvin. The late M. Mascart, the eminent French scientist, was to have been elected President. There is very little doubt that Prof. Elihu Thomson, of America, will be unanimously elected president of the Commission. Several matters, including the system upon which the glossary of terms is to be drawn up, a provisional standard of light, and the question of the metric system as affecting the work of the Commission, are to be carefully considered. A short account of the deliberations of the Council will be published later.

Census of Production Act.—To meet the requirements of this Act a schedule has been issued dealing with the generation of electricity. This schedule is being sent round to the various supply companies and local authorities in order that the necessary details may be filled in. These details will, as heretofore, be treated as confidential, and will simply be incorporated in the census without the name or the address of the firm being disclosed. This schedule requires many details of the cost of the total electricity supplied and of the work carried out by the supplier, whether charged to capital or revenue account. The cost of the materials purchased during the year has also to be stated in order that the *net* production of the United Kingdom in the year of return may be ascertained. The number of persons employed and the details of the plant installed are also to be given. The above forms the compulsory information, but information on the following points may also be given voluntarily: Details of quantity of electricity supplied, fuel consumed and iron and steel used. The data obtained from this return should be of great interest and should contain valuable information on a subject in which our readers are much interested, but they may tax the patience of those from whom it is required.

Cable Interruptions.	Date of Interruption.
Paramaribo—Cayenne	Sep. 3, 1908
Pontianak—Saigon	Sep. 16, 1908
Sitia—Rhodes	Sep. 17, 1908

Birmingham and District Electric Club.—The opening meeting of this club's session will take place to-morrow (Saturday), at the Colonnade Hotel, New-street. A smoking concert will be held, with Mr. E. C. R. Marks, president, in the chair.

Obituary.—We regret to record the death of Sir George Livesey, chairman of the South Metropolitan Gas Co., which occurred at Reigate on Sunday last. The deceased was 74 years of age. Sir George, who from the early age of 14 was connected with the affairs of the South Metropolitan Gas Co., will be most familiar in electrical circles from the whole-hearted way in which he looked after gas interests. Not only was he perfectly familiar with all the details of gas manufacture, but he also, when occasion demanded, showed his capabilities as a captain of industry. His part in the strike troubles of the late eighties will be recalled, and it was the experience gained then which led him to introduce the system of profit-sharing by which his name will long be remembered. Although his work was rather antagonistic to electrical interests, his endeavours were for the good of the engineering profession as a whole, and there is no doubt he will be greatly missed.

We also regret to record the death of Mr. Bennett H. Brough, secretary of the Iron and Steel Institute, which occurred on Saturday last at Newcastle. The deceased was taken ill during the course of the meeting of the Institute at Middlesbrough, and although an operation was performed it was unsuccessful. Mr. Brough was well known in connection with metallurgical and mining work. He was connected with many learned societies and was the author of several books. The funeral will take place to-day at Surbiton.

Wireless Telephone Notes.—The public journals have been well supplied with "particulars" of certain experiments which have been in progress during the past few days in connection with the establishment of a system of wireless telephony by the Admiralty authorities, the object being to effect telephonic communication between the Admiralty offices at Whitehall, London, and H.M. ships in home waters. The reported success of certain experiments conducted off the coast of the United States has led to the Admiralty authorities making the experiments above referred to with the De Forest system. The published particulars, however, although highly flavoured, do not carry us very far, and the parties mainly concerned are naturally reticent. The "Vernon," the vessel on which the torpedo and wireless telegraphy school at Portsmouth is located, has been the receiving vessel for the messages, transmission being effected by apparatus fitted on the cruiser "Furious" and the destroyer "Velox." It is stated that conversation was carried on successfully at sea for distances up to 30 miles and with only a few errors for distances up to 50 miles, but that the land transmission to London was not accomplished satisfactorily. One account states that considerable interference was caused to wireless telegraph signals in the neighbourhood of the telephonic experiments.

ARRANGEMENTS FOR THE WEEK.

WEDNESDAY, October 14th.

Association of Engineers-in-Charge.

8 p.m. Meeting at St. Bride's Institute, Bride-lane, Fleet-street, E.C. Presidential Address by Mr. James Swinburne, F.R.S.

THURSDAY, October 15th.

Rugby Engineering Society.

8 p.m. Meeting at Benn Buildings, Rugby. Presidential Address by Mr. A. F. Bennett.

FRIDAY, October 16th.

Institution of Mechanical Engineers.

8 p.m. Meeting at Storey's Gate. Paper on "Repairs, Renewals, Deterioration and Depreciation of Workshop Plant and Machinery," by Mr. J. E. Darbishire.

The Electrical Engineers (London Division).

The following orders have been issued for the current week:—

Monday, 12th, "A" Company	Technical drills from 7 p.m. to 10 p.m.
Tuesday, 13th, "B" Company	
Thursday, 15th, "C" Company	
Friday, 16th, "D" Company	

Tuesday, 13th, and every Tuesday until further orders, medical inspection for recruits, 6 p.m. to 7:30 p.m. Members of the corps are requested to sign the new Special Service Section Forms.

THE MANCHESTER ELECTRICAL EXHIBITION.—II

Since its unofficial opening on Saturday last the Manchester Electrical Exhibition has attracted large crowds. After gigantic efforts on the part of the management and the exhibitors, most of the stands were ready by the time appointed for the Press inspection on Saturday, October 3rd. We think the organising manager, Mr. C. S. Northcote, can claim a record in the matter of completed stands on the day of the Exhibition opening. Both Mr. Northcote and the secretary, Mr. W. Davenport, have borne the heat and burden of the day in an arduous undertaking, and those of our readers who show regularly at trade exhibitions will realise that the position of the management is not one to be envied.

A luncheon was given to the Press on Saturday, which practically inaugurated the exhibition, and a large number of guests sat down. The chair was taken by Councillor Kay, chairman of the Exhibition committee.

On Monday the Lord Mayor of Manchester attended and officially inspected the stands, commenting upon those objects of general interest. Subsequently luncheon was served, at which a number of congratulatory speeches were made. In reply to the toast of his health, the Lord Mayor recalled the many improvements made possible by electrical science, and expressed the opinion that the exhibition was likely to do much towards furthering the interests of the industry.

Councillor W. Kay lauded the enterprise of the Corporation in allowing the Exhibition to be held within the borders of Manchester. Manchester and Salford together were the largest producers of electricity among municipal authorities, and it was therefore fitting that the Exhibition should be held within their borders.

The electrical visitor to the Exhibition will be impressed with the fine display of arc lighting, especially by means of flame lamps. These are encountered in the more prominent positions at the main gates (Gilbert), on the building (Westinghouse) and down the aisles (Oliver), while there are many independent exhibits of these lamps. Metal filament lamps are well to the fore in stand illumination, signs and general lighting display.

Motors and motor driving present an impressive display, and almost every kind of motor-driven tool is to be seen. Textile machinery is also much in evidence, and there are several new machines introduced at this exhibition for the first time.

Among such machines is an electrical gassing frame at the stand of SIEMENS BROS. DYNAMO WORKS (86-97), this being shown in operation. The feature of the machine is a platinum-iridium ∩ piece about 3 in. long which is held vertically by two clamps mounted on an insulating base. This is maintained at a white heat by a current of 30 amperes at 4 volts pressure. The thread to be "gassed" is passed rapidly through this ∩ piece and the projecting fibres are burned off, leaving a finish on the yarn which depends on the rate at which the thread travels. This rate can be adjusted in the machine. A lever device is fitted to withdraw the thread from the heating piece before it is stopped in its travel. We shall return to this machine in our next issue.

Messrs. BROWN, BOVERI & CO. (Stands 4 and 59) exhibit a special motor for ringspinning which is attracting much attention. This is necessarily a very delicate operation, and the results obtained are found to be better and more uniform when the tension on the yarn as it leaves the nip of the rollers is kept constant. To obtain this result has been the object of a series of experiments carried out by Messrs. Brown, Boveri & Co., and on their stand they show a motor equipment which, it is claimed, makes the above possible. To keep the tension on the yarn as it leaves the nip constant a certain variation in speed is necessary. This is obtained by driving the tin roller shaft of each frame by a specially designed single-phase motor (Fig. 1), the speed of which is automatically controlled by a simple mechanism driven by the heart shaft. As those interested in textile work will recognise, this is a distinct departure from the usual practice of employing a three-phase motor running at one fixed speed throughout. The motor illustrated can be run off a three-phase supply. It is of the commutator type, and the speed variation is effected by simply moving the brushes. This motor embodies all the advantages possessed by Brown, Boveri & Co.'s standard designs, and as it can be adapted to all types of spinning frames it should receive a wide application in textile work.

In our last issue we gave a brief *résumé* of the most interesting and important exhibits at the Manchester Electrical Exhibition, hoping by this means to help our readers on their first visit to obtain a general idea of the machinery and apparatus installed. The first inspection of a series of exhibits such as are set out at Manchester can at best be only cursory, and a thorough delving into the details and novelties of the various equipments must be left to further visits.

Assuming that our readers have now taken a preliminary walk round the Exhibition, we shall proceed to describe the various exhibits in more detail, and thus, we hope, prove of assistance when subsequent visits are made.

THE SUB-STATION.

For the purposes of general illumination and for supplying the various power and lighting requirements of the exhibitors it has been necessary to erect a sub-station, which is located practically in the centre of the Exhibition building, and will form an exhibit of considerable interest. Two of the existing 0·15 sq. in. extra-high-tension 6,500 volt three-phase feeders from Stuart-street are diverted and brought into the sub-station, and the following converting and transforming plant is provided for the direct current requirements: One 700 kw. rotary converter, complete with starting induction motor and alternating current booster on the one shaft, by the British Westinghouse Company; one 800 kw. three-phase static transformer for the above; one 600 kw. three-bearing type motor converter, by Bruce, Peebles & Co.; one 500 kw. two-bearing type induction motor generator, by the General Electric Co. Each of the above sets is arranged for three-wire balancing, and, together with the switch gear, they are respectively representative of the most modern practice obtaining to-day. For the alternating current requirements static transforming plant, consisting of three 250 k.v.a. units with a ratio of 6,500/400, is provided by the British Westinghouse Co. They are mesh-connected on the primary side, and, in order to provide a neutral, they are supplied on the secondary side with three inter-connected star balancing coils for the lighting supplies at 230 volts.

The extra-high-tension and low-tension switchgear for controlling the sub-station equipment as well as the whole of the various direct current and alternating current distributing feeder circuits, arc lighting and domestic circuits for the Exhibition, has been supplied by Messrs. Ferranti Limited, of Hollinwood. The extra high-tension gear is completely enclosed in concrete cells; it comprises nine complete panels and possesses many points of interest. The low-tension panels call for no special comment.

It should be mentioned that the whole of the sub-station equipment was built to comply with the Manchester Corporation's requirements and to their standard specifications.

Single-core cables for wiring up the machines to the switchboards are run on insulators provided beneath the flooring of the sub-station. On account of the somewhat limited space available and the particular construction of the Exhibition building, the general lay-out of the sub-station has been a matter of some little difficulty. The result, however, is such that a minimum of space is occupied without unduly cramping the plant, and on three sides the sub-station is open to full inspection by the general public. From the sub-station, 12 three-wire direct-current feeder circuits, each of 0·25 sq. in., 0·125 sq. in., 0·25 sq. in. section, are run underground before rising up to the distributing fuse boards. These latter are of the ironclad and totally enclosed type, and are mounted high up on the uprights of the building supporting the roof principals. Two double pole boards are provided at each feeding point, the middle wire being split between the two, so that 24 double pole boards have been required in all. Twelve ways are provided on each board, and each is capable of carrying 30 to 40 amperes.

In a somewhat similar manner the alternating current feeder circuits of 0·075 sq. in. section comprising four single conductors are run to four points in the building where the three-phase distribution fuse boards are fixed. The latter are of similar type to the direct current boards and all have been provided by Messrs. Reyrolle & Co., of Hebburn-on-Tyne.

In addition, there are some eight circuits ranging in capacity from 25 to 150 amperes in connection with the glow lamp illumination of the front and the domestic lighting of the main building.

The service mains to the stands are all run overhead from the several distribution boards as required, the mains being brought down the building columns to the exhibitors' switchboard, on which the main switches and fuses and meters are mounted by the management. The whole of the switchgear for controlling the supplies to the stands is of the foolproof type supplied by Messrs. Berry, Skinner & Co. In

the case of some dozen exhibitors demanding a large supply, underground mains are laid direct to their respective stands, and are controlled directly from the sub-station distribution panels.

It is anticipated from the applications that the demand on the sub-station for power and lighting purposes, alternating current and direct current, will amount to some 1,300 kw. The whole of the wiring of the building as thus far described has been almost entirely carried out by the electricity department of the Corporation.

Some 16 circuits control the general illumination of the building. For the interior 44 flame arcs and 10 enclosed arcs have been supplied by the Oliver Arc Lamp Co., the General Electric Co. and the Gilbert Arc Lamp Co. For the front exterior of the building, as well as the approach road lighting, 24 flame arcs have been supplied by the Gilbert Lamp Co. and the British Westinghouse Company. The wiring contract in connection with the arc circuit, as well as the general domestic lighting, of the dining room, tea room, Welcome Club, &c., has been carried out by Mr. J. Lomax Kendall, of Manchester. In addition to the arc lighting of the front of the building, many hundreds of coloured lamps will be used for the decoration and illumination of the front and the trees, which form an effective foreground to the site. This portion of the work has been entrusted to Messrs. Pearson & Co., of Manchester.

The interior arc lighting of the building is arranged on 16 circuits, eight of which may be termed the "emergency" circuits. An alternative supply to these latter has been provided from Messrs. Crossley's gas engine exhibit in the event of any failure at the sub-station.

In conclusion, we may mention that the whole of the work incidental to the lighting and power supplies and general illumination of

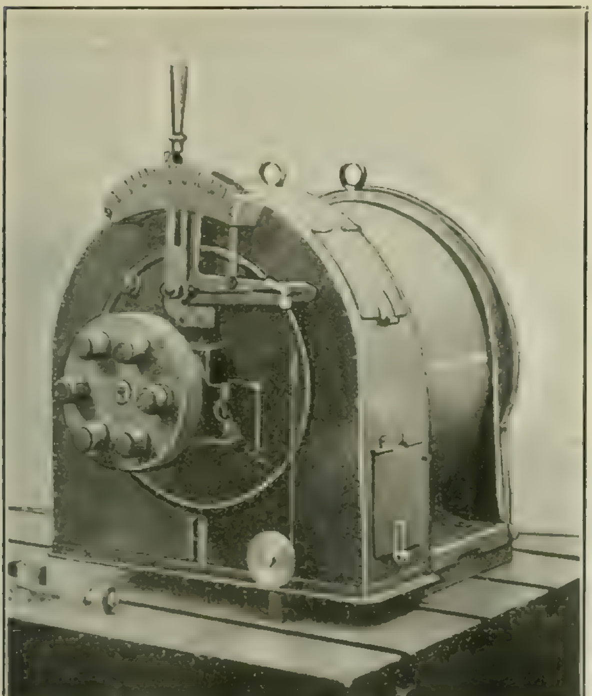

Fig. 1.—8 h.p. Brown-Boveri Single-phase Motor for Direct Coupling to a Ring Frame, showing Attachment for Automatic Speed Regulation.

the building has been planned by and carried out under the supervision of Mr. S. L. Pearce, the Manchester city electrical engineer, with whom has been associated as joint consulting engineer to the Exhibition management Mr. V. A. H. M'Cowen, borough electrical engineer of Salford.

DETAILS OF THE EXHIBITS.

ACCUMULATORS.

Electrical Power Storage Co.

Unfortunately the storage battery, in spite of its many good qualities, does not lend itself very easily to exhibition purposes. To the uninitiated it appears to be simply a glass or lead case containing some rather peculiar plates, and is quickly deserted for some more showy piece of apparatus. Several well-known battery makers have, however, taken the risk of being thus neglected and are exhibiting at Manchester. Among these we noticed the Electrical Power Storage Co. whose stand (No. 128) contains examples of their well-known accumulators. These vary from the O. L. type, in which each positive plate weighs 48 lb. and which is capable of giving out a current of 165 amperes per positive plate, for half an hour, to the "Epsco" cell which is intended for ignition purposes in motor car work. A special feature of the stand is the excellent lighting. This is obtained from 300 25 c.p. Osram lamps fed from 14 D.H. 17 E.P.S. cells. This battery has a capacity of 840 ampere-hours at the 10 hours' discharge rate and is charged from a small motor-generator placed on the stand.

The exhibit also includes such necessary accessories as hydrometers and cell testers. Another interesting detail are a number of E.C.C. dry cells which has always been manufactured by the Electrical Power Storage Co. and are now being supplied by them alone.

Hart Accumulator Co.

The exhibits of the Hart Accumlator Co. on stands Nos. 190 and 213 give a good idea of the various types of this firm's products. Among the exhibits is a complete lighting battery made up of 30 "1908" lighting type 11 plate cells, having a capacity of 300 ampere-hours on the eleven-hour discharge rate and 120 ampere-hours at the one-hour discharge rate. This battery is shown complete with all accessories, and is fitted with patent non-corrosive terminals. Connection between the cells is made by copper rods, while for the prevention of internal short circuits and buckling sheet separators are used. Besides these the ordinary glass separators are employed, giving a clearance between the plates of $\frac{3}{16}$ in. The clearance between the plates and bottom of the cell is 3¼ in. Among the other exhibits are cells of heavier types including some suitable for central station work having a capacity of 1045 ampere-hours. The productions of the Hart Accumulator Co. are already so well known that a detailed description is unnecessary. All their usual types will be found at Manchester, including those suitable for motor car work and for portable purposes. In the latter case special care has been taken to avoid spilling.

Pritchetts & Gold.

Messrs. Pritchetts & Gold are showing a battery of their well-known accumulators on the stand of the Heatly-Gresham Engineering Co. (No. 295). These embody all the features of this firm's standard design, including the Planté formed positives and the latest type of box-grid negatives.

GENERAL EXHIBITS.

Siemens Bros. Dynamo Works.

We often wonder what would have been the effect on the electrical industry had there been no firm of Siemens. Surely the blank could not have been filled in any adequate manner. Far from there being a blank at present, things are very much alive in this quarter, and the exhibit of

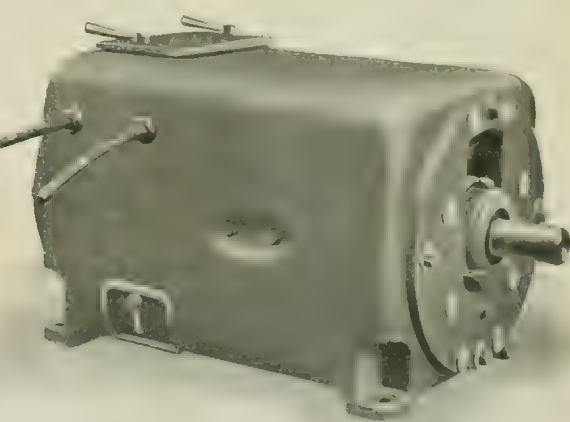

Fig. 2.—A Siemens Totally-Enclosed Motor.

Messrs. Siemens Bros. Dynamo Works (stands Nos. 86 and 87) is one of the most interesting at Manchester. Advantage is taken of textile associations to show a small 0·5 h.p. loom motor driving a Robert Hall loom. This is fitted with a spring belt tightening arrangement and the usual switchgear. There are also a number of small motors of various types suitable for use on either direct or alternate current circuits. One of these is driving a 12½ in. fan, and is complete with a controller of the drum type. On this set speed regulation is obtained over wide limits by altering the grouping of the motor field coils. The controller is provided with overload and no voltage releases, which act independently of one another. A magnetic blow out is fitted to reduce sparking. A Siemens' continuous current totally enclosed motor is shown in Fig. 2. A number of small shunt motors are also dotted about, one of which recalls painful memories, as it is intended for use in unpleasing dental operations. The switchgear exhibit of Messrs. Siemens is specially interesting, and includes a 80 h.p. protected starter for use on 500 volt circuits, and a 100 h.p. fool-proof starter for the same voltage. There are also a number of switches for heavy current work fitted with maximum and reverse current gear. The meter exhibit is of great interest. It contains a continuous and alternating current meter for house services up to 200 amperes and 650 volts and a similar meter for power and heavy current work up to 4,000 amperes and 1,500 volts. Both of these types are used by the Manchester Corporation. There are a number of other meters for both continuous and

alternating current work, among the latter being one of the polyphase type for unbalanced inductive loads for two-phase four wire and three-phase three wire circuits. As might be expected, a special feature is made of the famous tantalum lamps, which besides being used for lighting the stand, are largely employed for the same purpose throughout the Exhibition. In this exhibit are included show cases containing samples of standard tantalum lamps and parts of the lamps illustrating the process of manufacture. The holophane "arc" lamp, consisting of tantalum lamps, which we illustrate in Fig. 3, is a very prominent feature, and this exhibit also includes examples

FIG. 3.—SIEMENS HOLOPHANE "ARC."

of the "Economy" and "Lilliput" arc lamps, the latter being fitted with various reflectors, one of which is specially adapted for shop window lighting. We have also referred to this exhibit in our introductory remarks and we hope to return to it in our next issue.

British Thomson-Houston Co.

One of the most interesting of the many interesting exhibits in the Exhibition is to be found on the stand (No. 48) of the BRITISH THOMSON-HOUSTON Co. It consists of a 1,000 kw. horizontal Curtis turbine direct-coupled to an alternator and exciter set. The Curtis

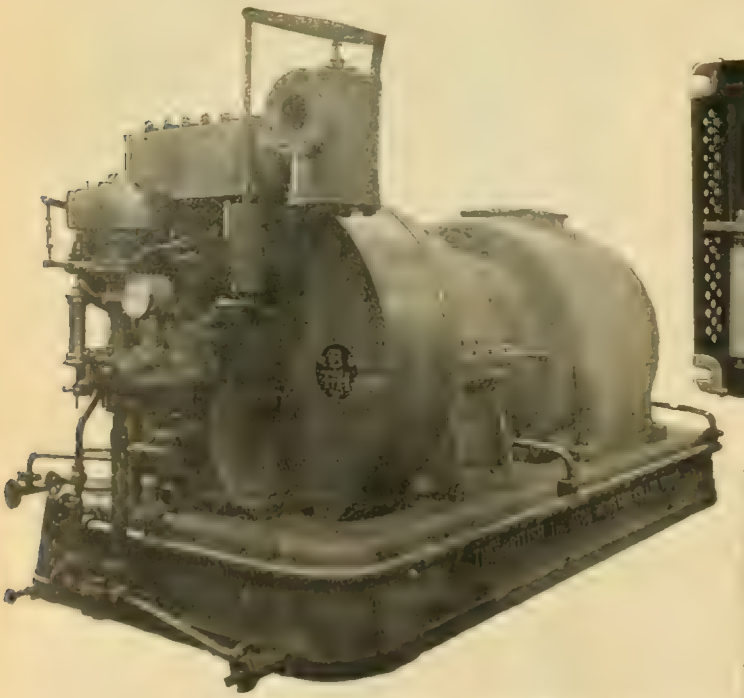

FIG. 4. 1,000 KW. HORIZONTAL CURTIS TURBO SET.

turbine has so far been identified, unlike its competitors, with the vertical form of construction, so that the present type indicates an interesting change in engineering policy. The voltage of the alternator is 2,000 volts and the frequency 50 when running at 3,000 revs. per min. This set, of which we are able to give an illustration in Fig. 4, is of the well known Curtis type designed for high-pressure working. The standard steam pressure is 150 lb. and any degree of superheat can be employed, the large bucket clearances possible with turbine of this kind being very favourable from this point of view. A great saving in steam consumption is, therefore, possible. The short stiff shaft which can be used with this turbine eliminates all tendency to "whip," and thus avoids what has often been a very great source of trouble in this class of work. Lubrication is effected under pressure by a small rotary pump driven through worm gearing from the main shaft. Oil rings are also fitted to lubricate the bearings in starting up and at the same time to assist the normal distribution of oil in the bearings. A centrifugal governor allows speed regulation to be obtained within 2 per cent. from no load to full load, while in addition an emergency governor with positive action is designed to shut off the steam supply should the speed of the set increase more than 15 per cent. above normal. The alternator consists of a cylindrical rotor which is amply ventilated and of specially rigid construction to withstand the high stresses due to centrifugal action. To obtain this desirable end no detachable parts have been used, so that mechanically the structure is exceedingly good. Another point of interest is that the exciter winding allows a standard voltage to be used for this purpose, thus avoiding the large exciting currents met with in some turbo-alternators. The alternator is rated at 1,250 k.v.a. with an overload capacity of 25 per cent. for a period of two hours. This extra load can be sustained without undue temperature rise.

British Westinghouse Co.

The interesting exhibit of the BRITISH WESTINGHOUSE Co., which is set out on four stands, viz., Nos. 79, 87, 101 and 103, is representative of the wide range of electrical manufactures supplied by this firm, and the visitor will be able to see some of its activities in practically every department. The lamp department shows flame and enclosed arc lamps, Cooper-Hewitt mercury-vapour lamps (four of which illuminate the outside of the Exhibition), tungsten lamps and carbon-filament lamps. The latter are shown fitted to some handsome electroliers, and also as applied to street lighting. Examples of shop window lighting are also shown. A number of Bremer arcs are exhibited whose advantages are already well known to our readers. They are suitable for use on both direct and alternating current, and are made in three types—viz., single, double-carbons and magazine. The enclosed arc lamps are supplied for either continuous or alternating current circuits, and for either indoor or outdoor use. In this lamp sparking troubles are obviated by making contact with the carbons through their holders, instead of through the clutch. The working parts have been reduced to a minimum and are all readily accessible.

The British Westinghouse Co. is also showing an extensive display of switchboard work, including alternating current and direct current switchboards equipped with representative Westinghouse instruments. Colliery engineers will be interested in some switchgear that has been designed specially for use

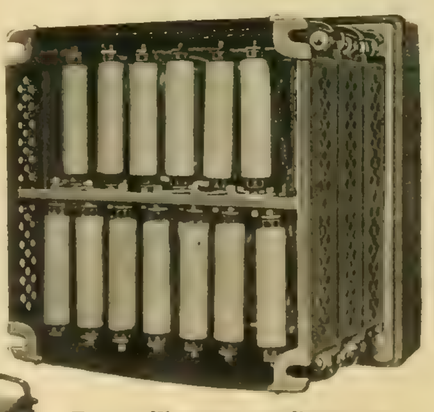

FIG. 5.—WESTINGHOUSE RESISTANCE.

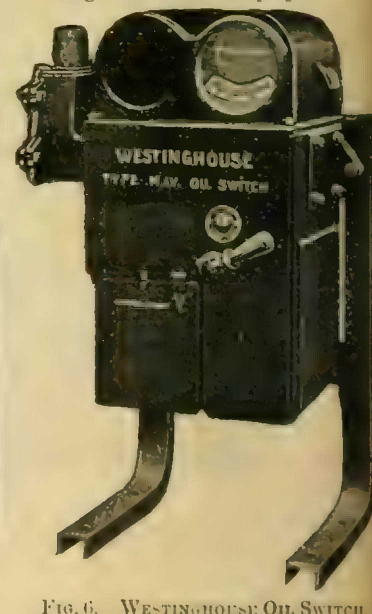

FIG. 6. WESTINGHOUSE OIL SWITCH.

in mines and exposed situations. The new Westinghouse totally-enclosed oil switch (Fig. 6), which is weather-proof, gas-proof and dust proof, and which has the special feature that the oil tank is detachable without dismantling the switch, is also of interest.

A number of Westinghouse direct current motors are shown. These can be supplied in all the usual types and sizes. Closely connected with this exhibit are some examples of the company's well known controllers and starters for various services. They are easily operated, compact in design, well finished and practically fool-proof. The new Westinghouse starters, fitted with embedded unit-type resistances (Fig. 7) are well worthy of notice. These resistance units are so mounted that in the event of one burning out or breaking it may be removed by simply loosening the nuts and a spare unit inserted. The Westinghouse automatic transformer cut out device should prove of interest to station engineers. This device is used in conjunction with transformers for reducing the losses on light loads. This result is accomplished by automatically switching out a large transformer on light loads and replacing it by a smaller one capable of taking the duty.

Another interesting set of exhibits on this stand are the meters, which include both those of the direct current and alternating current type, the latter having an accuracy of within 2 per cent. from one twentieth of full load to 25 per cent. overload and is guaranteed for one year.

The stand also contains several handsome electroliers and fittings, as well as bells, telephones, fans, &c. The Westinghouse Co. has

two machines in the Exhibition sub-station. These are described at the beginning of this article. The Westinghouse Co. are also exhibiting a vertical tandem gas engine of the enclosed type, having two pairs of cylinders placed over two cranks and rated normally at 150 B.H.P. (Fig. 7). Forced lubrication is adopted throughout and operated by valveless pumps, which are fitted in duplicate. The oil before passing to the engine parts is drawn through filters, the sieves of which are arranged so that they can be withdrawn for cleaning whilst the engine is in operation. The engine has been designed with a special consideration for simplicity and accessibility of the parts, and by removing the top cover and dropping the bottom half of the connecting-rod bearing, the connecting rod, together with the pistons and the internal cover, can all be removed by an overhead crane in a very short space of time. A special feature in this type of engine is that no water-cooling is used in any of the moving parts. All the valves are actuated by cams and straight push rods working directly on short bell crank levers fitted on the covers. Any trip gear and unnecessary wearing parts are avoided. The engine is controlled by a governor fitted on the end of the shaft, which operates directly on the throttle valve.

On this stand is also included a Leblanc rotary valveless dry air pump. The pump shown is suitable for dealing with the exhaust steam from a 1,000 kw. set, when coupled either to service or jet condenser. This pump runs at 960 revs. per min. and requires a 10 B.H.P. motor to drive it. It may be mentioned that a Leblanc jet condensing

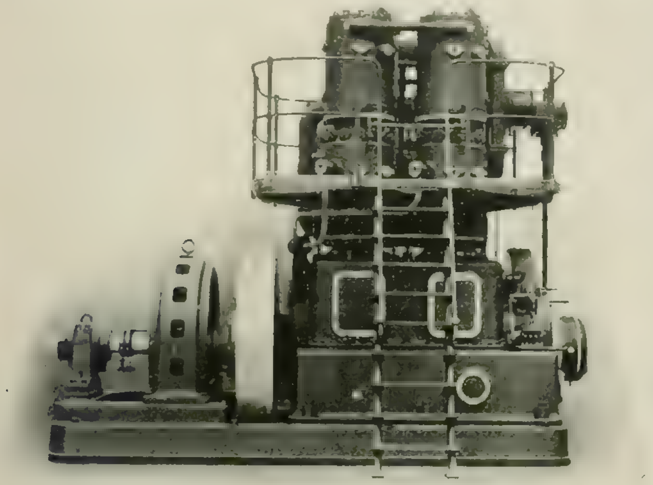

FIG. 7.—WESTINGHOUSE GAS ENGINE.

plant fitted with this type of air pump has been erected on the test-plate of the British Westinghouse Co.'s works, Trafford Park, and will remain there during the course of the Exhibition. Those interested may inspect this plant being tested under as near ordinary working conditions as possible.

Union Electric Co.

The necessity for knowing the exact speed of certain machinery is becoming more and more marked at the present time. It is further often an advantage to have the speed indicated at some point more or less distant from the moving parts. Electrical equipment is very well adapted for this purpose, and on the stands (Nos. 175 and 231) of the UNION ELECTRIC CO. is a comprehensive exhibit dealing with this subject. In the base of the stand is a variable speed motor driving a shaft which represents any rotating body, such as the crank shaft of an engine or other similar moving part. The whole exhibit forms a practical demonstration of the researches of Dr. Robert Hartmann-Kempf, and their practical outcome in the form of reliable measuring apparatus for use either in the neighbourhood or at a distance from the revolving machinery. The main shaft is driven by a small variable speed motor, and the results obtained are indicated either by means of pointers working on the volt-meter principle, or by resonance frequency indicators. From this main shaft are also driven various magneto-inductors (Fig. 8.) The different applications demonstrated include a large range speed indicator for use at a distance. This is made up of an inductor with four rows of tongues, thus giving four impulses per revolution. The frequency indicator has four sets of reeds, showing from 30 to 180 alternations per second, and the scale is graduated both in alternations and revolutions per minute. By means of this apparatus the speed can be read with an accuracy of 1 in 1,000 at any desired distance. Two instruments on the same arm are also connected to this inductor, and are capable of being turned round a vertical axis. All the above are calibrated in revolutions per minute and, therefore, act as tachometers. A small resonance tachometer is also shown as well as a speed indicator and voltmeter, suitable for a scale range from 0 to 1,200 revs. per min. In this case the current for demonstration purposes is obtained from a six-pole magneto-inductor. To demonstrate the application of this arrangement to locomotive work a flanged wheel is shown apparently running on a rail. On the outer side of this wheel is a steel case containing a 24 pole inductor, the coils of which remain stationary, while the current is conveyed from the inductor through the steel tube by insulated wires. It has been found that below a vibration rate of 50 per second the use of reeds is not advisable, especially where there is a liability to shocks. In the apparatus for indicating the speed on locomotives a voltmeter is, therefore, used for the lower speed range with a separate dial, while the higher speed ranges are indicated by means of vibrating reeds. The apparatus is constructed for an accuracy of about a half of 1 per cent., thus giving to the driver a reliable indication of the speed at which his train is running. A great advantage is the absence of moving connections between the wheels and the indicating instruments and there is, therefore, no liability to damage from dust. This system is also shown applied to recording tele-tachometers, and this apparatus is claimed to be the first of its kind put on the market for practical purposes. There should be a great demand for this class of instrument for by its means the speed of distant machinery can be recorded in the engineer's office. This recorder is connected to a large 24-pole magneto-inductor, and the recording drum can be run at two different rates, one giving one complete revolution in one hour, and the other one a complete revolution in 12 hours. The supply of record strip enables a week's record to be taken without renewal. The Union Electric Co. claim that in practical working the resonance type of instrument is the most accurate means of indicating speeds because the reeds are not liable to damage, and remain perfectly constant in their readings. The inductors used are of a special form, in which the rotating part is the magnet whilst the fixed part consists of coils in which the periodic currents are induced. The cases of the inductors are made dust-proof, and are arranged on the outside to act as step-down belt pulleys of three different diameters, or they may be direct coupled. They are fitted with ball bearings, and it is claimed that they can be run continuously under heavy load without any alterations to the electrical connections.

The numerous other exhibits of the Union Electric Co. include an excellent display of the well-known "Excello" arcs. This lamp was among the earliest of the flame type to be put on the market, and, in spite of its many competitors, it is still going strong. Its special feature is the way in which the whole globe is illuminated so that shadows are eliminated, and its suitability for interior lighting thereby increased. These lamps are most satisfactory when burnt two in series on 110-125 volts, either direct or alternating, or four in series on 220-240 volts; they can, however, be burnt in other ways, though this is not recommended. The details of this lamp are claimed to be unique, and the care that has been expended on its design has doubtless much to do with its efficiency. Numerous accessories are, of course, available for use with this lamp, and its upkeep is easy and quite cheap.

The above by no means exhausts the exhibits of this firm which, in fact, cover fully the whole field of electrical engineering.

We shall hope to deal further with this stand in our next issue.

Electromotors Ltd.

The exhibit of ELECTROMOTORS LTD. (stands Nos. 133 & 161), demonstrates the facility with which electricity can be applied to driving every possible class of machinery. In addition to examples of the firm's standard motors, spur reduction gear motors, worm gear motors, &c.,

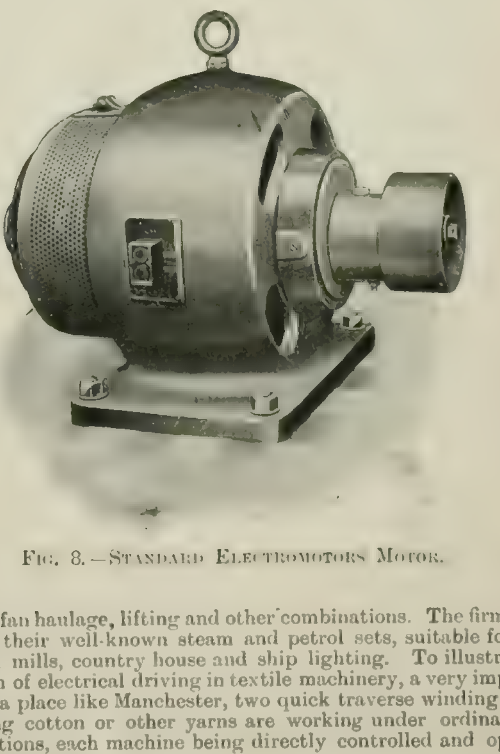

FIG. 8.—STANDARD ELECTROMOTORS MOTOR.

are pump, fan haulage, lifting and other combinations. The firm is also exhibiting their well-known steam and petrol sets, suitable for pilot lighting in mills, country house and ship lighting. To illustrate the application of electrical driving in textile machinery, a very important subject at a place like Manchester, two quick traverse winding frames for winding cotton or other yarns are working under ordinary normal conditions, each machine being directly controlled and operated by an electric motor.

A large selection of motors is shown, among which may be mentioned a 3½ kw. motor generator, suitable for boosting or transforming; a 3 H.P. motor with enclosed worm gear reducing from 1,100 revs per min. to 50 revs. per min., specially adapted for driving economisers, organ blowers, &c.; a 4½ H.P. lift gear combination, comprising an interpole motor worm-reducing gear and a special automatic brake situated between the motor and the worm-gear designed to bring the lift to rest immediately the current is cut off. This is the firm's standard lift equipment for passenger, goods or service lifts, and can be supplied with hand-rope, ordinary push button control with attendant, or push button control without attendant.

The exhibit also includes a petrol dynamo set (which we illustrated in our last issue) for private house lighting, with a battery and low voltage metallic filament lamps; and a 3 kw. steam dynamo, with an open vertical high-speed double-acting engine, direct-coupled to a compound-wound dynamo of the type standardised by this firm for ship and private house lighting. We may also mention a 5 cwt. friction hoist designed to work at 100 ft. per minute and driven through a combined spur and friction gear by means of a compound-wound motor, such hoists being in popular demand for warehouses, provision stores, bale hoists, engineering and factories generally; and a main drum haulage set capable of hauling at 4 miles an hour, direct driven through gearing by a 5 H.P. motor 850 revs. per min. These haulage gears can be supplied in varying sizes and are designed for hauling up inclines in which the gradient exceeds 2 in. to the yard. Main-and-tail haulages and endless-rope gears are also standardised. A 1 ton electric pulley block, worked by self-contained motor, illustrates another of the firm's specialities. They can be supplied of the suspension type with hand-travelling gear or motor-travelling gear for running on the flanges of a single H-girder, making an ideal runway for workshops, warehouses, chemical works and the like. A specially designed switchboard controls a greater portion of the exhibits, automatically starting and stopping the motors at will. A standard motor is shown in Fig. 8.

Lancashire Dynamo & Motor Co.

The stand (No. 47) of the LANCASHIRE DYNAMO & MOTOR Co. is an exceedingly good avertisement of the benefits of the electric drive. It contains a number of examples of this firm's well-known productions in conjunction with such useful equipment as winches and fans. One of the exhibits, a short-circuited rotor-type of induction motor, is interesting from the fact that copper discs with radial arms are connected to the rotor rods. By this means, it is claimed, a large cooling surface is obtained, as these radial arms act as fan blades. Another special point is the method of attaching the core plates to the spider to ensure tightness of the case, so that it may stand shock and vibration most satisfactorily. Another detail we noticed was the belt tightening gear, which is embodied in the bed plate. This part of the equipment seems to have been receiving more attention lately, with the result that old-fashioned methods of belt tightening are gradually being discarded. This particular motor has an output of 25 H.P., and is designed for working on a three phase circuit with a voltage of 400 volts and a frequency of 50. A motor driven winch on this stand is very compact. Its capacity is 1½ tons, and the motor, which is wound for direct current, develops 38 H.P. on the half-hour rating. The winch frame is built up of steel sections so disposed as to carry conveniently all the gearing, motor-controller, brake, &c. A solenoid brake is fitted, and in addition the winch barrel is equipped with a foot brake. It is impossible here to describe in full detail all the motors shown on this stand, but one other is specially worthy of mention. It is a shunt-wound motor totally enclosed, whose speed can be varied in the ratio of 3:1 by shunt regulation alone. It is also fitted with commutating poles and with pipe ventilation. Such machines are specially useful in hot or dusty situations, and are meeting a long felt want. Quite a new departure is Kelsall and Warburton's patent flywheel equaliser set which is shown on this stand. This embodies so many points of interest that we shall devote considerable space to it in our next issue. It is designed to equalise the load on the main generators by taking up the peaks. This is obtained by means of a flywheel which acts as a storer of energy. It is claimed that the action is instantaneous, so that the generator current is practically constant.

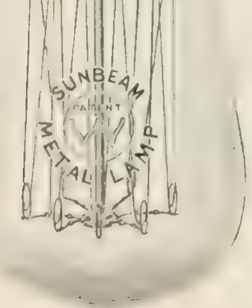

FIG. 9.—"SUNBEAM" METALLIC FILAMENT LAMP FOR 220 VOLTS.

Sunbeam Lamp Co.

The exhibit of the SUNBEAM LAMP Co. (stand No. 200) is interesting from the fact that it contains numerous examples of their new metallic filament lamp. This is of the tungsten type, and will doubtless be a partaker in the success which has always attended "Sunbeam" productions. Lamps of this type (Fig. 9) are shown suitable for use on voltages from 25 to 250 volts, and for candle-power from 8 c.p. to 100 c.p. The efficiency is 1¼ watts per candle-power for both single and series running. The lamp is slightly over 6½ in. long with a diameter of about 3½ in. The 25-volt lamp has a comparatively small pear shaped bulb, but is well adapted for artistic effects. The company claim that there is little or no risk of breakage in transit, and a special feature of the lamp is the shortness of the bulb. Other exhibits include examples of the well-known "Sunbeam" carbon lamp, including a new device for reducing the light in a lamp to a very small amount. This enables the lamp to be used as a night light, or in places where a very dim light is required. The contents of the stand also include a number of "Sunbeam" heating lamps shown in radiators. These should appeal to visitors, for winter is coming on, and they offer an effective means of avoiding dust and dirt. The "Sunbeam" fancy lamps make a pleasing sight, while attention is called to the more work-a-day side of the company's products by a series of accessories, switches, &c., including an exhibit of Messrs. Lundberg's well-known specialities for which the Sunbeam Company are the agents in the Lancashire district. The benefits accruing from the use of electrical signs has been recognised by the Sunbeam Company, who are now turning out a number of novelties in this line. One of their flashing signs is displayed on the stand, and makes a very effective advertisement.

Berry, Skinner & Co.

Messrs. BERRY, SKINNER & Co. (stands Nos. 188A & 216A) are showing latest developments of Berry's patent "fool-proof" switchgear and methods of "fool-proof" distribution, as supplied by them to collieries and workshops in accordance with the revised regulations of the Home Office. And, as showing the reliance placed on this apparatus, it may be stated that the whole of the lighting and power in the Manchester Exhibition is controlled by it. We also noticed Berry's patent "fool-proof" combined switchfuse and plug for portable machinery for use in mines, dockyards, workshops, in accordance with the revised regulations of the Home Office, and a patent repeater fuse, the interior of which is shown in Fig. 10, by which a fuse is replaced by simply turning a handle. The fuse wire is always visible. This is specially suitable for use with cranes, lifts, mining machinery, capstans, &c., and in all cases avoids searching about for fresh fuses and the consequent delay. The exhibit also includes an improved form of triple concentric Tee joint box, ice making and refrigerating plant, and the new form of primary battery (Fig. 11) miners' lamp which we described recently in these columns (*The Electrician*, Vol. LXI., p. 535).

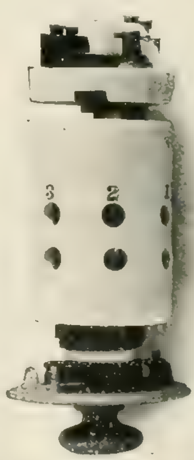

FIG. 10.—INTERIOR OF DENNY "REPEATER" FUSE (BERRY, SKINNER).

FIG. 11.—BERRY, SKINNER PRIMARY BATTERY MINERS' LAMP.

Consolidated Pneumatic Tool Co.

The exhibit of the CONSOLIDATED PNEUMATIC TOOL Co. (stand No. 225) comprises portable electrically-driven tools suitable for drilling, reaming, tapping, tube expanding, grinding and similar operations. The drilling machines, which range from small breast drills, capable of drilling holes ⅝ in. diameter in steel, to large machines capable of drilling 2½ in. to 3 in. in steel, and a number of intermediate sizes practically cover the entire range of tools required by engineers and shipbuilders. The outstanding feature of the Consolidated Pneumatic Tool Co.'s machines is strong mechanical design, which, as is well known, is of great importance where tools are exposed to rough treatment. It is claimed, with justice, that electric tools give all the advantages of pneumatic tools, so far as economy of labour is concerned, with the additional advantage that considerable economy in power is possible. It has been found by several investigators that the distribution of power by compressed air for portable tools involves from four to five times as much power at the air compressor as is required with electric tools to do the same amount of work. Improvements in design which the Consolidated Pneumatic Tool Co. have introduced have, it is claimed, reduced the maintenance charges of electric tools to a figure quite comparable with pneumatic

tools and possessing the additional advantage that economy in the cost of power is secured. We learn that one of the leading shipbuilding firms in the country use no less than 30 of these electric machines, and their use is rapidly extending all over the country. Fig. 12 shows one of the company's electrically-driven wire-rope hoists, and they are also exhibiting magnetic drill posts which can be fixed to any iron or steel surface by merely turning a switch, and in this respect save the cost of bolting the pillar to the work as was formerly done.

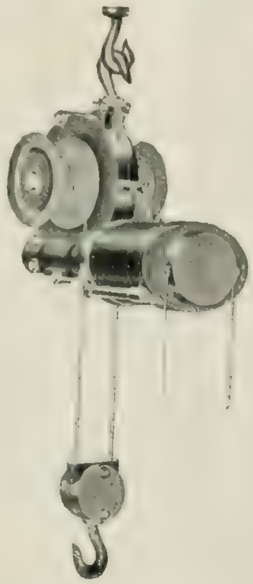

Fig. 12.—Consolidated Pneumatic Tool Co.'s Wire-rope Hoist.

National Telephone Co.

The National Telephone Co.'s exhibit at stand No. 65 includes a private branch exchange providing telephone service to the principal exhibitors and call offices adjoining the main entrance for the use of visitors. The exhibit represents a standard private branch exchange as supplied for large offices, warehouses works, &c., enabling both inward and outward calls to be handled more directly and more expeditiously than by any arrangement of direct lines not worked by a switchboard on the subscriber's premises, and with the additional advantage that the caller can be directly connected with the person with whom he wishes to speak either in his own office or department.

The switchboard installed is of the standard common battery type, equipped for two operators' positions, 100 extension lines and 40 junctions to the main exchange. There are 15 connecting-cord circuits per position, each provided with two supervisory signals. The extension lines call automatically on magnetic visual signals at the switchboard when a telephone is removed from its rest, and the junction circuits are so arranged that they may be worked either for incoming or outgoing calls. The current required for speaking and signalling purposes is supplied by a battery of 11 accumulators charged over special power leads from the main exchange. A standard pattern test board fitted with lightning arresters and heat coils is installed for testing the subscriber's lines and for the purpose of protecting the equipment from lighting and stray high-voltage currents.

British Insulated & Helsby Cables.

One of the exhibits on stands Nos. 28 and 41 of the British Insulated & Helsby Cables has created quite a *furore* among visitors to Manchester. This is the Prescot non-fouling trolley wire, which is seen in the accompanying illustration. This shows the Prescot non-

Fig. 13.—View of the "Prescot" N.F. Trolley Wire of the British Insulated & Helsby Cables.

fouling trolley wire fitted with a straight line mechanical ear, and is practically self explanatory. Numerous advantages are claimed for the use of this device including the following: Non-fouling fittings, no bumping or arcing, no crystallisation of the trolley wire, reduced pressure on the trolley boom, considerable saving in trolley wheels and wire, low cost of maintenance and perfection in running. We shall return to the other exhibits of this firm in a subsequent issue.

EXHIBITION ITEMS.

Eighteen motors are started and stopped automatically on the stand of Electromotors Ltd. As each machine runs up to speed a sign lights up clearly showing the size and speed of the motor.

There is a 200 volt Tantalum lamp on Drake & Gorham's stand.

The Mirrlees Diesel engine on the stand of Mirrlees, Bickerton & Day is driving a dynamo coupled to a water cooled artificial load.

The Denny renewable fuse, in cast-iron box, may be inspected at Berry, Skinner's stand.

The electrical gassing frame shown by Siemens Bros. Dynamo Works is one of the novelties of the exhibition.

The phantom sign of Osram Lamps is to be seen around the exhibition. It mystifies most people at first glance.

A slow-moving foolproof motor starter is a feature of the exhibit of Marples, Leach & Co.

The steam turbine models of C. A. Parsons & Co. are beautiful specimens of the model maker's art. They show the details of both turbine and generator to perfection.

Westinghouse gas engine and Leblanc condenser are combined in a single exhibit.

Engineers interested in "Sticktion" should try their strength at the stand of the Hoffmann Mfg. Co., where ball bearings are shown off to advantage.

A novel textile exhibit is that of Brown Boveri, in which a ring spinning frame is driven by a variable speed motor. The speed is varied to give an even tension on the yarn whether winding on the nose or the body of the cop, as described elsewhere.

The circuit-breakers and oil switches of Eckstein, Heap & Co., make an imposing display. Engineers will find several novelties here.

Telegraphy and telephony over the same wire is practically demonstrated at the exhibit of British Insulated & Helsby Cables (Ltd.). The speaking is excellent even while Morse signals are passing.

The Lea recorder is shown under actual working conditions, and station engineers and steam users should make a point of calling at this stand.

The E.P.S. accumulator display is one of the largest of the exhibits. It makes the finest show of batteries. (See elsewhere.)

The Gilbert Arc Lamp Co.'s display in front of the sub-station is one of the things which cannot be missed.

The Dowsing Radiant Heat stall has a nurse in attendance who explains the details of the radiant heat bed exhibited.

Mr. D. C. Bate has a good lift controller to show amongst his other specialities in the way of motors, starters, &c.

Drake & Gorham show a universal conduit clip and earthing terminal which "licks creation."

At the prettily lighted stall of Pearson & Co. is the only electric cooker at work in the show. Mrs. Pearson makes excellent cakes in the electric oven.

Sarco steam specialities are on view at the stand of F. V. Brown & Co.

The insulator cases of Taylor, Tunnicliff should be examined in detail. They typify good British porcelain practice.

The "Medhurst" portable telephone is on view at the stand of the International Electric Co., where meters and lamps (the Orieco) are also on view.

Venturi water meters are working on the stand of George Kent (Ltd.).

The high-tension switches with contacts below the oil level should be examined on the stand of the Union Electric Co.

A novelty in electric signs which is both cheap and effective is shown by Mr. Venner, of Venner & Co. The sign is unmistakably clear in the light of four flame arcs.

A Reyrolle starter placed across the direct current mains with ammeter in circuit is worth inspection. With the starter on the first stop and the switch closing the circuit, the current steadily rises on the ammeter.

The only electric coal cutter in the show is exhibited by A. Hirst & Co., who also show an electric rock drill.

Motor-driven machine tools are a feature of the Exhibition. They will be seen everywhere.

The Hope "spring on" switch fuse should not be missed. It is on the stand of Parmiter, Hope & Sugden facing the sub-station.

The testing of insulators at 75,000 volts is to be seen at the stand of Bullers Limited.

The auto switchgear of the flywheel equaliser set of the Lancashire Dynamo & Motor Co. should be closely inspected. It is a novelty in switching apparatus and is the product of Bertram Thomas (Ltd.).

An interesting piece of apparatus is to be seen on the stand of Messrs. Ferranti. It is a new prepayment meter and we give a special description of it on another page of this issue.

We shall be glad to welcome all our readers **at Stand 66**, next the National Telephone Exchange exhibit.

THE WORKS OF MESSRS. A. REYROLLE & CO. (LTD.) OF HEBBURN-ON-TYNE.

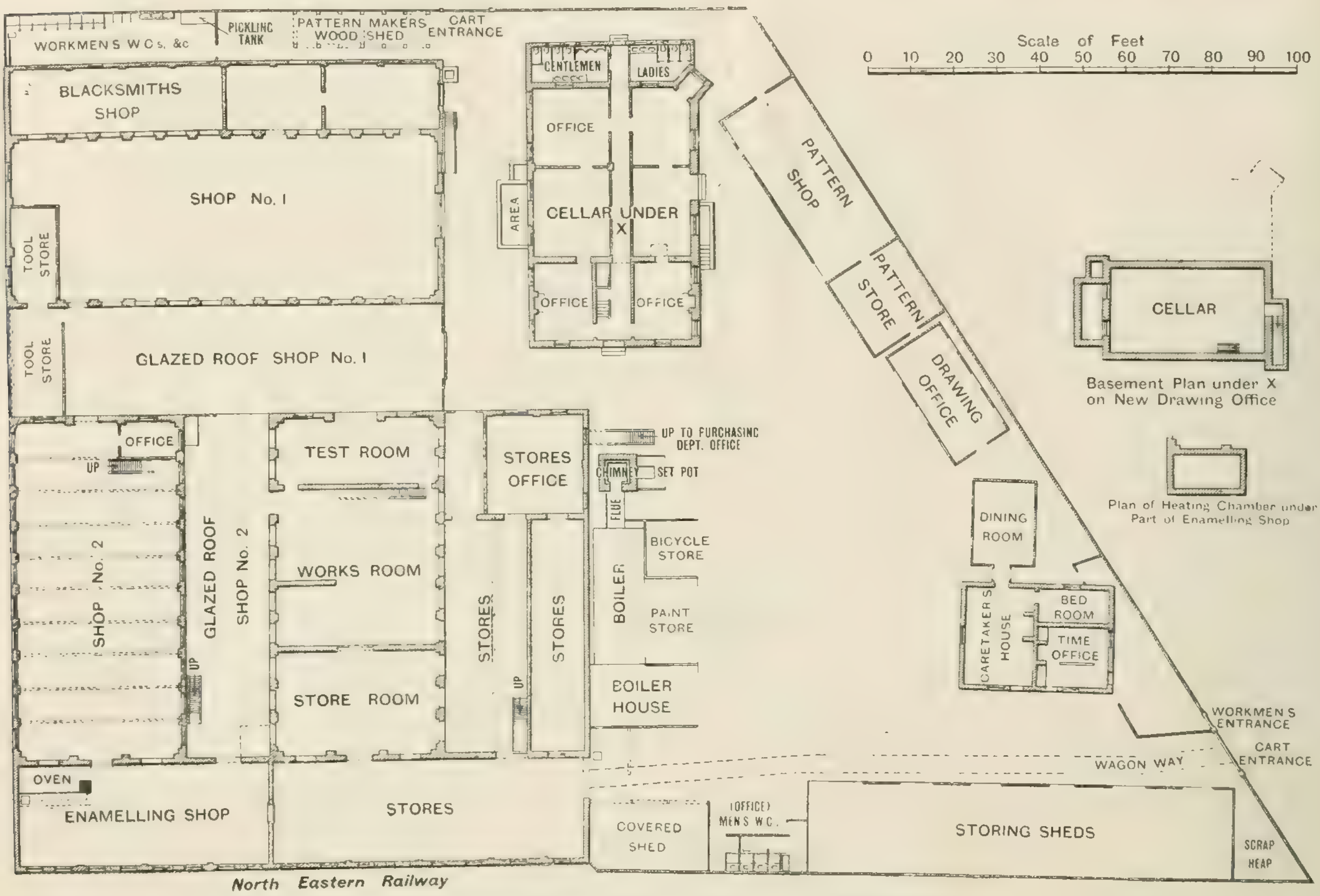

Fig. 1.—Ground Plan of Messrs. Reyrolle & Co.'s Works.

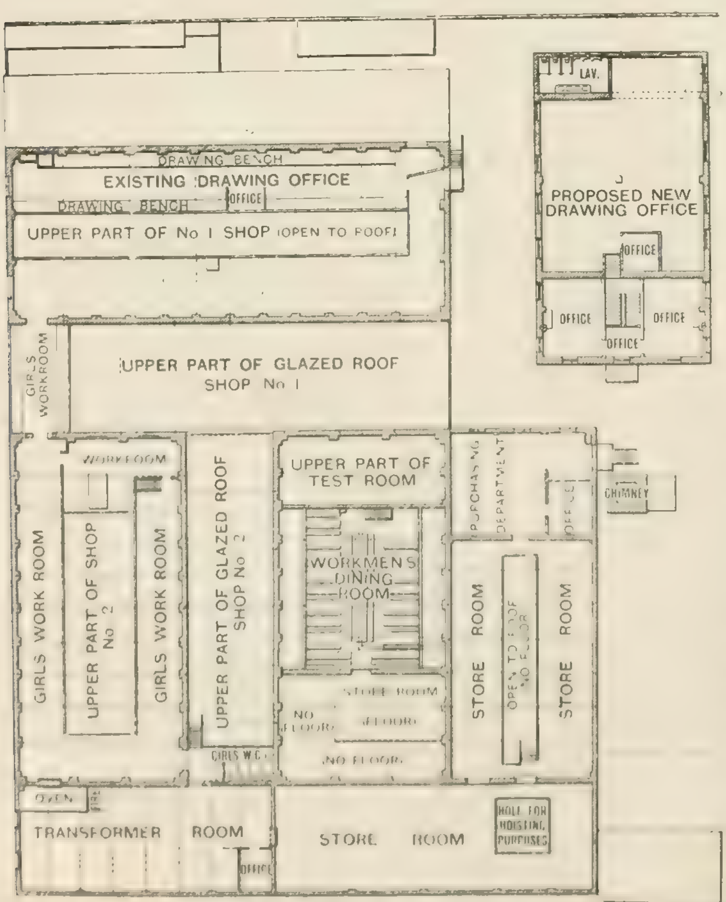

Fig. 2.—First Floor Plan.

It takes some little time for a new movement of any description to become acknowledged, but it is gradually being borne in on the minds of observers that the *rôle* of electrical undertakings established in the vicinity of Newcastle-upon-Tyne is becoming so lengthy as to render this area an extremely probable "centre of gravity" of the electrical industry in the near future. One of the examples of this tendency is to be be found in the rapid expansion of the works of Messrs. A. Reyrolle & Co. (Ltd.), at Hebburn, whose manufactures in the direction of switchgear and accessories have made for themselves a reputation for excellent workmanship and design

The firm was originally established in London by Mr. Reyrolle in the year 1886, and some few years ago migrated to Tyneside, where its rapid expansion necessitated its conversion into a limited liability company, whose success may be gauged by the fact that last year it paid a dividend of 7 per cent., besides adding a substantial amount to reserve. In 1886 the staff numbered six men; at the present day the pay list totals some 300 or 400 names. Mr. Reyrolle gives his personal attention to every new design and method of production, and one of his very strong characteristics is an inherent dislike for anything appertaining to shoddy workmanship.

It is, of course, impossible to conduct a highly specialised business of this nature on the scale indicated above without a very complete organisation. In the office building the market of the firm is represented by a card filing system which is very complete. The department for keeping in touch with the outside agents in this way also looks after the blocks, price lists and circular letters forming the basis of advertisement; its duties may be summarised as systematic business-getting, The next link in the chain is provided by the estimating department, composed of technical men who, on receipt of inquiries, can determine working costs, make suggestions in the interests of customers and watch the execution of orders they have estimated for, and also issue job sheets which vir-

tually consist of systematic orders for works. These then pass to the order section, which is really a species of library or central bureau for job sheets. From this section the sheets first pass to the drawing office, which makes the necessary drawings and detailed material sheets for the order, and returns the complete dossier to the order section. It then passes to the purchasing department, which ascertains what material is in stock, and orders such goods as are not in stock. To facilitate this the superintendent of this department is also in charge of the stores department. So close is the check kept in this manner that if a works foreman wants even a piece of yarn from the stores that is not put down on the job sheet he has to give due reason. On return of the sheet from the Purchasing department to the order department it passes out to the shops, where it is allocated to a suitable foreman. The works manager's office keeps a separate card record stating the order number, the date received, the date on which the completed work is promised, and other data. When the work is done the job sheet is sent back, together with the work, to the stores, where it is checked against the job sheet. The system has been found of the utmost benefit in reducing the amount of scrap and material unaccounted for. From this point the accountant's department takes the matter up, and, by a further series of cards, keeps in touch until payment is secured. It must not, however, be assumed that the above system entails cast-iron routine. One of the great essentials in switchgear manufacturing is strictest attention to small details. Even in small articles like motor starters it would be no exaggeration to say that there are some thousands of details which from time to time must have the careful attention of the heads of the departments.

FIG. 3.—SWITCHBOARD ASSEMBLING DEPARTMENT.

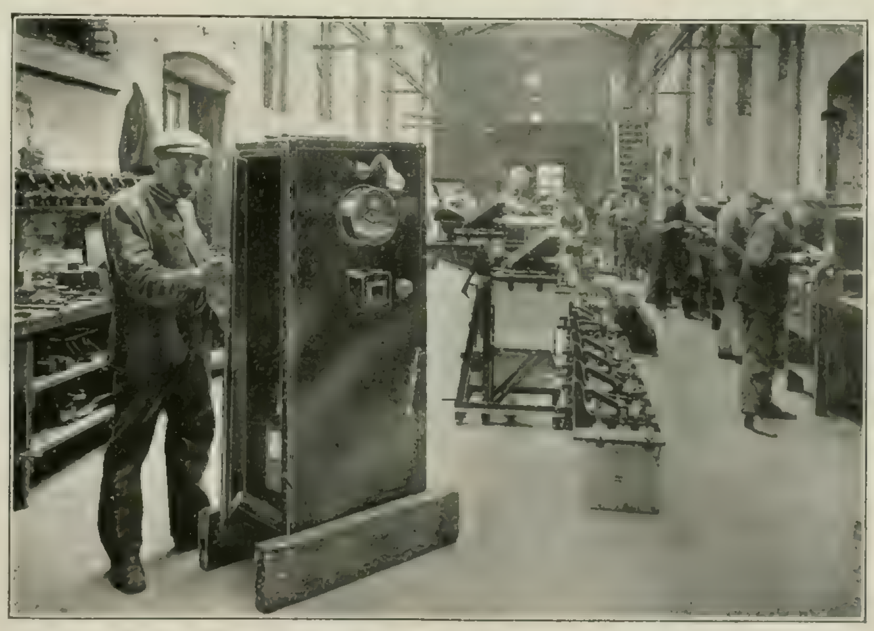

FIG. 4.—IRONCLAD AND COLLIERY SWITCHGEAR, ERECTING SHOP.

The plans produced herewith (Figs. 1 and 2) give an idea of the general arrangement of the works, these being arranged, generally speaking, on the two-storey principle. The drawing office is situated on the upper floor of the main block, in one of the galleries, and secures a good natural top light. It consists of two wings, accommodating 15 draughtsmen, with an office at the centre for the head of the department, and the necessary typists for keeping up the departmental card system for records of drawings and article numbers, and the making out of material

sheets. At one end is situated a Halden & Co. blue-printing apparatus rendering quick reproduction entirely independent of weather conditions. Following the path of the "job sheets" the next department to be visited is the purchasing department, situated on the upper floor of an adjacent block and next door to the raw and finished material stores. The staff of this section looks after the ordering of material, its receipt and the checking of invoices. It also looks after the dispatch of finished goods and is responsible for maintaining the stores with a plentiful supply of stock manufactures. A card system in this office keys in with the job sheets.

Fig. 5.—Enamelling Shop.

The shops themselves are organised with regard for smooth progression of work. The key of the system is in the jig and tool department where all gauges, templates and jigs for use in the shops are made and, when not in use, stored under system numbers. As a type of the apparatus handled here we saw on our visit to the works a very interesting jig for holding the contacts of porcelain fuses in position while being cemented in, ensuring absolute interchangeability, while a box gauge for securing the contacts of oil break switches to the insulators on the top covers also happened to be in evidence. All the milling tools, drills, &c., used in the shops are also fettled here, and the equipment includes an interesting Wagner grinder with an attachment for the automatic sharpening of milling saws. Dies necessary for stamped work are also made and kept here and in connection with repetition work of this description an interesting system may be mentioned. Instead of relying on dimensioned shop drawings, each workman is given a board having mounted on it an actual sample to size of the part to be turned out, in its various stages of manufacture, so that he may refer at once to an example without mental calculation.

Adjacent to the jig and tool department is the machine shop, occupying a large bay on the ground floor, with smithy in close proximity. In the former we noted a section devoted to fly presses, which are kept continually in use; a long and interesting series of dies and punches for the production of standard articles were inspected. Capstan lathes were also much in evidence, being rendered necessary by the large amount of repetition work required, while an American vertical capstan drilling machine, capable of drilling different sizes of holes in a piece of work by the rotation of the capstan head, is an interesting innovation. For cutting the pole faces of electromagnets on motor starters and similar work a heavy circular saw has been specially installed, while the large amount of copper requires a series of machines specially intended for this class of work, ranging from a high-speed band saw for cutting copper to disc grinders. Incidentally it may be mentioned that the smithy is especially equipped for copper forging, an example of a switch contact head 3 in. by 2 in. and shank 1 in. in diameter by 6 in. long being shown as standard practice in drawing down from the solid bar. This is preferred by the firm to making screwed joints or using castings, on account of the better conductivity obtained. Parallel to the main machine shop is the switchboard assembling department, added last year and shown in Fig. 3. Here the finished parts of continuous and alternating current low-tension boards are assembled and connections made. Among the work passing through this department at the time of our visit may be mentioned a large feeder and motor generator board for Rio de Janeiro, for a low-tension three-wire supply, and a distribution switchboard of the firm's new Iron-Clad type for the Aston Manor Corporation. The demand for this type of board, which has recently attracted considerable attention, has, since its introduction, grown to such dimensions that an "iron clad" erecting shop has been opened (Fig 4). During the last two years this section of the works has been very fully occupied in producing iron-clad switchgear apparatus for the supply companies in Northumberland and Durham, which embodies so many advantageous features that a revolution in high-tension switchgear construction may be said to have been effected. The compactness of this gear is demonstrated by the small space occupied by erection. A strip in the middle of the shop about 4 ft. wide is sufficient for the erection of about 24 2,000 kw. panels. A unique piece of colliery equipment for the Fife Coal Company can also be mentioned, this being a plug distributing board for colliery work, controlled by a main oil-break switch. This is enclosed in an iron-clad structure something like a night watchman's hut, closed at the front by an iron door which is so interlocked with the main switch that it cannot be opened unless the switch is out. Moreover,

Fig. 6.—Transformer Winding Shop.

when the door is open no pressure against the switch handle will close the switch.

The enamelling section (Fig. 5) is also worthy of mention, in as much as every slate receives three coats of enamel before being considered of good enough finish. A stove 8 ft. square and liberally furnished with racks is kept at a uniform temperature of 180° F. by means of hot-water pipes leading to coke stoves. The slates and castings are given 12 hours' stoving for each coat of enamel and a further 12 hours' drying, the final polishing in the case of the slates being by hand. In the transformer winding department (Fig. 6) a speciality is made of transformers of various patterns for use on switchboards, one type being the "straight through" arrangement, adopted in connection with the ironclad gear for the Merz-Price system of feeder protection. Several bench lathes are installed for winding small coils, and as an instance of the up-to-date equipment of the works may be mentioned an apparatus for heating insulating compound electrically. A heating coil warms up a chamber containing oil, which, in its turn, circulates through pipes in the compound tank. To ensure the delicate handling of such work as relay coils, girls are employed under the superintendence of capable men.

Fig. 7.—Interior View of Stores

Three other closely grouped but important departments are the lacquering room, where a special process for tinning phosphor-bronze springs was in operation during our visit; the section devoted to resistances for Reyrolle starters, in which specially trained girls fill the sections of the resistance with graphitic compound, adjusting the quantity with a skill born of experience; and the fuse and switch gallery where fuse handles were being fitted with contacts by means of jigs, water-tight wall plugs for ships and dockyards were being manufactured, and a rather nautical-looking section of girls were busy on light drilling operations to template. The said nautical appearance was caused by the sailor hats worn to preserve the pristine glories of the ladies' hair.

A most important department is the testing shop, chiefly devoted to load testing motor starters and pressure testing high-tension apparatus. For the former purpose two 20 H.P. 500 volt motors and two 25 H.P. 120 volt motors capable of parallel or series operation are installed and fitted with brakes. All starters made by the firm are required to start at full load up to their normal capacity, and where the large starters exceed the capacity of the testing sets, each resistance is tested separately across the mains, passing heavy currents before assembling. An auxiliary set for motor starters under 2 H.P. capacity is also installed. In addition to the standard insulation test, a pressure test from resistance to case is also accomplished by a 2,000 volt alternating current, and the starter before being sent out is examined as to uniform pressure on brushes, performance as to holding up with or without current on, the contact fingers are examined, the ohmic value on switching the current on and the time taken for current to grow (in accordance with the peculiar current increasing properties of the Reyrolle starter) determined, the series magnet adjusted to the proper values, and the mechanical construction examined to guard against loose connections and other contingencies. The pressure testing of the high-tension gear is carried out by a step-up transformer capable of giving up to 30,000 volts, and for 20,000 volt switchgear, &c., a transformer giving up to 100,000 volts is installed. Both these, with their gear, are enclosed in a chamber with interlock so arranged so so that when the door is opened all pressure is cut off the transformers, and the high tension apparatus must be locked off before it can be made alive; thus ensuring against accidents. A heavy current low potential transformer is also installed of a capacity up to 6,000 amperes for testing current transformers. Standard shunts are used for routine testing, these being periodically tested against a standard Kelvin balance.

The output of the firm can be gauged by the appearance of a portion of the stores (Fig. 7). In this photograph a load of motor starters is being lowered to the ground floor; where the railway trucks from the siding connected with the Hebburn Goods Station are brought directly under the hoist shown in the foreground. We were quite able to believe the statement that in the motor-starter section alone the parts and finished starters carried in stock amounted to about 2,000 starters of different sizes, and in addition to these were switches, fuses, plugs, cable dividing boxes, switchgear, accessories for mine equipments, parts of switchboards and the component parts of the ironclad switchgear. The works are electrically lighted and driven from the mains of the Northern Counties Electricity Supply Co., and from the appearance of the shops we imagine they represent a good load.

In concluding this description of a specialised industry, we have to thank the firm for their courtesy in enabling us to make a thorough inspection of their works, and in particular we are indebted to Mr. H. W. Clothier for indicating the way in which the special requirements involved in the mechanical design of switchgear have been met by the works and office organisation.

A GERMAN MANUFACTURERS' PROTECTIVE ORGANISATION.

A revelation have been recently made in the German Press with regard to what has been known in the Fatherland for some years past as the "Geheim-Kartell," or secret trade organisation, of the electrical manufacturing industry. Secrets of the kind are bound to leak out sooner or later, but on the whole the doings of the three great firms which form the kartell—the Allgemeine Elektrizitäts Gesellschaft, the Siemens-Shuckert and the Felten und Guilleaume-Lahmeyer—have been enveloped with considerable mystery, so far as the general public is concerned, since the year 1903, when they first entered into their trade understanding, until the present day. A little over a month ago, however, a comparatively small manufacturing firm, the Ernst Heinrich Geist Elektrizitäts A.G., of Cologne, directed a public complaint to the Chamber of Commerce in that city with reference to the "Geheim-Kartell," alleging that when the three great firms concerned made sure of a certain contract falling into their hands they would bid high in tendering for it, whereas when they feared the competition of outside firms they would purposely bid low, in order to exclude them from the business.

Whether, or to what extent, this accusation was justified (and how far it is legally wrong even if justified) has not, however, yet been decided by any competent judge. What interests English manufacturers, who may be presumed to be looking out for a suitable trade organisation of their own, which, without any injustice to any particular firm, will keep up prices to a profitable level, is the fact that the occasion has been used by the leading commercial organ in Germany, the *Frankfurter Zeitung*, to open its columns to an expert on the subject, who has written an article descriptive of the whole trade organisation as it exists at the present time. This article was so accurate that, about a fortnight later, a communication was made semi-officially by the three great firms in the combine supplementing the information contained in the article, and defending their policy against the imputation of unfairness to smaller firms outside their own circle. We have thus a complete description of the organisation at present existing in the German electrical manufacturing trade from very reliable sources, and have the advantage of knowing what has already been done in this direction in spite of the special difficulties confronting trade arrangements and understandings in so complicated and highly diversified an industry. How much of the organisation would be suitable, and how much unsuitable, to the requirements of this country is a matter for the consideration of British manufacturers themselves.

The gist of the article which first let in daylight upon the subject is pretty much as follows: It is necessary to go back some years in order to be able to judge of the importance of the position held by this great defensive alliance in the entire movement towards concentration, which is gradually, but undoubtedly, taking place in the German electrical industry. The end of the year 1900 was a very critical time for electrical manufacturers; two big concerns went under entirely, the Kummer Gesellschaft and the Helios of Cologne, while the Union Elektrizitäts-Ges. was absorbed by the Allgemeine. Crashes of this sort made manufacturers realise what may be termed the inherently speculative character of some electrical undertakings. There is no other industry which involves such long series of costly experiments in order to ensure the production of apparatus which may be expected to maintain its foothold in the market for a number of years, while tendering for an electrical contract, under some circumstances, is a most formidable affair, necessitating great outlay and the employment of a small army of skilled engineers, operatives and clerks. Large sums of money are expended merely on the chance of securing a contract, and with the progress of electrical invention this element of speculation will always be found in the most solidly conducted electrical manufacturing businesses. This is what makes price-cutting so peculiarly intolerable, and what, in the year 1900, made the firms of Siemens-Schuckert, Felten und Guilleaume-Lahmeyerwerke and the Allgemeine company form what they called a "protective agreement" for all heavy business. What the agreement consisted in, customers could only get to know, or guess, by indirect means, but it has transpired in the course of time that the mutual protection resorted to by the three concerns involved, firstly, protection as to individual interests, and, secondly, a protection as to prices. In virtue of the first protective measure, each firm agreed not to interfere with business which fell naturally to any one of the others, and this fact was gauged by the former business done by the firm in question, its banking connections, its personal and business relations, the wishes of customers and the amount of goods the firm had hitherto shown itself capable of turning out. This measure was known as "normal" protection. As to the protection of prices, each firm pledged itself to maintain them at a remunerative level by arranging a common price basis when tendering for a contract which the other firms had equal chances of obtaining. It was agreed that the respective tenders should not show more than 2 or 3 per cent. difference in the total price, and which firm should make the lowest bid and which the higher bids was always decided either by amicable arrangement or by the casting of lots. The statistics collected since the trade convention was first entered into show that about 20 per cent. of the contracts obtained by the three firms were thus arranged for, either on the normal protection or the price protection basis. Moreover, the marked tendency has been for the former protection gradually to be eliminated in favour of the latter, which is, perhaps, a good thing in the general propaganda of the electrical industry, as when a firm was left absolutely alone to fix whatever price it could with its customer the chances were that prices would be put up too high, and that thus, though a profit would be very good on one transaction, the customer would be frightened from adopting electrical installations in future emergencies. It may be urged that the same danger is to be feared in the case of price protection as well as in that of normal protection, but the answer on the part of the "Secret Kartell" is that the great selling firms of electrical apparatus and installations are, from long experience, well acquainted with the costs of production, and can form a very good judgment as to the equitable nature of the manufacturing firm's demands.

The long experience of the manufacturers' customers has, however, also brought another phase of the trade conditions into prominence: the customers have got to know, or pretty well guess, the kind of arrangements subsisting between the combined firms, and have on occasion resorted to a reduction of their consumption in protection of their own interests—a fact which, of course, tends to prejudice the general progress of the industry. This has been met again by manufacturing firms outside the combine forming temporary agreements with the three great firms to handle a particular business on their basis, and thus the field of the combine's operations has latterly been very much extended. Moreover, its readiness to meet outside manufacturing firms in this particular forms its answer to the charge that its tendency is, on the model of the American "trust," to crush smaller competitors out of existence. It seems difficult, or impossible, to "trustify" the electrical manufacturing industry on the American model owing to its extemely changeable and progressive nature. A small firm may any day come into possession of a valuable invention which would make any monopolising aggressor glad to cry quits with it. Thus the present tendency in the trade is undoubtedly towards the spread of the kartell idea among all German manufacturing firms, and it is quite certain that a very large number of the leading manufacturing houses are at present seriously considering the formation of a comprehensive kartell, with a general pooling of orders to be distributed according to the proved capacity of each concern, more or less on the model of the Stahlwerksverband (Steel Works Union) and the Rhenish-Westphalian Coal & Coke Synd. How this will turn out it is unsafe to prognosticate at the present moment, but it is pretty certain that for the future all elements of secrecy will be eliminated from the organisation of the electrical manufacturing industry. Too many mistakes have been made in the past by disingenuous tendering and underhand manipulation of business, which, while succeeding for the moment, has in the long run been recognised by customers and resulted in a check to the flow of orders. German organisation will for the future aim at the maintenance of a reasonable competition within narrow limits rather than at a despotic monopolisation which would check the healthy growth of trade.

The correctness of the above delineation of ruling conditions has been since vouched for by the following "supplementary information" communicated to the *Frankfurter Zeitung* by "a personage connected with the three great firms and voicing their views." This communication runs as follows:—

"The motive for the combine has been made clear by the article which has already appeared. Price wars, reckless underbidding, or quotations based upon errors in calculation, in many cases reduction below the cost of production, and at the same time rapidly-increasing expenditure in respect to the compilation of estimates. It is characteristic of the industry that orders are only given in about one in a hundred cases, while all have to be worked out and estimated for at great expense. The kartell idea was consequently easily brought to the fore and the regular sittings of the Association of German electrical firms (Vereinigung Deutscher Elektrizitätsfirmen) afforded natural opportunities for its discussion. This association, which only takes in manufacturers of heavy engineering installations, is well known because of its temporary success in raising quotations, from its having brought about uniformity as to guarantees in heavy current business and a reduction in the policies required by fire insurance companies in the case of risks incurred through the employment of electrical installations. At its foundation in 1901 the following firms belonged to the Association: the Allgemeine, Bergmann, Brown Boveri, Esslinger Maschinenfabrik, Felten & Guilleaume

Lahmeyer, Garbe-Lahmeyer of Aachen, Ges. für Electrische Industrie of Karlsruhe, Helios, Poege, Pöschmann, Sachsenwerk, Siemens-Schuckert, Schorch-Reydt, Schwartzkopff of Berlin, and Geist of Cologne. A year or two after its establishment, the question of a kartell to take in all the firms and to secure better price conditions was amply discussed by the Association, both in general and in committee meetings, and constitutions for such a combine were regularly worked out, so that in many respects its labours need not be considered lost even in view of present-day requirements, although in consequence of the varying nature of products, constant changes in manufacturing methods, and the different degrees of development acquired by the manufacturing works themselves, the matter was an extraordinarily difficult one to handle.

"These efforts towards kartellisation were broken off definitely in 1903, and then the three firms of the A.E.G., Guilleaume-Lahmeyer and Siemens-Schuckert tried their hand at it on their own account by forming the so-called 'secret kartell,' *i.e.*, protective agreement. In order to judge later events correctly, it must be borne in mind that it was, and is, free to all members of the Association to participate in the agreement, provided they pledged themselves to take up a proportionate part in the general output of the concern, a proportion that in the case of new comers is determined at an amount not exceeding their own last year's output. Moreover, no business is included under the agreement that is not worth a minimum of 20,000 marks (£1,000). This accords with the business conditions of the big firms, though, as will be easily understood, the smaller firms tried to get the amount reduced. In this way the nature of the agreement was known to all the firms which remained outside it, and this fact, combined with the imperfections incident to the nature of the agreement itself, tended to weaken its effectiveness. The outside firms had grounds on which to base a complaint against the combined firms, and they kept up a sort of movement against them, it has even been stated that since the inception of the kartell the turnover of most of the smaller firms has advanced by a larger percentage than that of the three kartellised firms.

"Now, as to the tendency of the agreement. If the mere wording of several paragraphs be considered, its tendency is a fighting one, directed against the outsider; the much quoted sec. 7 begins by saying 'No order must fall into the hands of an outsider,' and a protected firm that 'under normal circumstances' lets an order slip through its hands is penalised on that account. But this very qualifying clause shows that it is rather against the negligence of a partner than against an outsider that the regulation is directed. No one could have ever have cherished the Utopian as well as unjust idea that all the orders which the kartellised firms tried for must necessarily fall to them. Further, this paragraph only has reference to the 'normal protection,' which does not include 1 per cent. of the whole amount of orders received, while the penalty consists in an addition of 20 per cent. of the order missed to the offender's credit account for orders with the kartell. That is to say, supposing a firm lets slip an order worth 50,000 marks, the amount of orders it can claim through the distributing bureau of the kartell is reduced by 10,000 marks. There is no monetary penalty imposed directly on the negligent firm or its representative.

"What the kartell had in view was a guarantee against mutually ruinous price cutting. Certain minimum prices were not to be underbidden by its partner firms, so as to counteract the policy adopted by customers—sometimes with perfect right, at other times not without fraud—of 'playing off' one manufacturing firm against another. For years the secret kartell has refrained from any aggressive measure against outsiders, except in the single instance of a Saxon firm in 1907, which provoked the attack by its unfair price cutting. In general the policy of the kartell has been to keep prices up, and not to indulge in a rate war, which forces prices down. But on the other hand, it has no intention of overcharging customers, or of giving ground for any accusation of exercising a monopoly. That is proved by the fact that no partner firm can be compelled, according to the agreement, to bid above the normal price list, which is as well known to the customer as to his competitors, in the case of any contract which falls to his lot. Every tender is considered and carefully worked out by the three firms in common, and the price each has calculated apart is discussed by way of common counsel and often rigidly criticised. Many affairs, such as large tenders for municipal orders, are altogether excluded from the agreement. Finally, the buyer is not compelled to accept the lowest tender; he is free to give the order to whichever of the three firms he pleases; each of the protected firms is expressly authorised by the agreement to take up any such order and put it through. And cases such as this occur in practice every day."

On the whole, it seems to us that the above forms a very suggestive picture of a successful organisation, which well merits consideration. It must be remembered, of course, that it is a one-sided picture, being drawn only on the side of the kartellised firms. But, at the worst, it can be taken to express an ideal or theory of organisation which is full of possibilities, and which has, at any rate, been successfully worked for five years without giving the firms concerned serious cause for dissatisfaction, or raising amongst its competitors anything like an organised agitation of complaint.

WIRELESS TELEPHONY.*

BY REGINALD A. FESSENDEN.

(*Concluded from page 869.*)

Summary.—The author first gives a brief history of the development of wireless signalling, proceeding to describe the method and apparatus used in wireless telephony. He also discusses its possibilities and how its development has been retarded.

G. Possibilities.

A. *Local Exchanges.*—There is no immediate prospect that wireless telephony will take the place of local exchanges. The difficulty in regard to the number of tunes can be overcome, but the fact remains that high-frequency oscillations cannot be transmitted over wires and hence each subscriber must have his own generating station. At the present time no method is known which would be practicable if placed in the hands of a subscriber. If such means should be found it would be very convenient to call up directly instead of through an exchange, but as I see it there are no immediate prospects of this.

B. *Long Distance Lines.*—I believe, however, that there is a field for wireless telephony for long distance lines. The present long distance lines are very expensive to construct and to maintain, and a storm extending over any considerable section of country inflicts considerable loss on the telephone companies. Moreover the distance of transmission is limited by the electrostatic capacity of the line, as I understand it. Wireless telephony would have the following advantages:—

a. The initial cost would be very much less than that of wire lines. *b.* Maintenance would be practically negligible in comparison. *c.* In case of breakdown, it would be right in the station and not at some unknown point outside on the line. *d.* Depreciation would be comparatively small. *e.* The number of employees required would be smaller. *f.* Transmission is better, and as there is no distortion of the speech, the working distance is, it is believed, considerably greater. *g.* Flexibility is greater. With wire lines a telephone company may not be able to give a Boston subscriber a line to New York, while having lines from Boston to Chicago and from Chicago to New York free. Operating wirelessly the wireless circuit normally used for operating between New York and Chicago and between Boston and Chicago could be used to operate from Boston to New York. *h.* No right of way need be purchased and franchises, it is believed, are not necessary.

It will be noted that I have carefully avoided mentioning any of the disadvantages of wireless telephony for long distance work. I presume this is because I am not a telephone engineer. I hope the defects will be supplied by the experts who are familiar with telephone operation and therefore better able to point out the defects. Before leaving this part of the subject I would say that I think the question of interference has been worked out to such an extent that no serious difficulty need be feared in that direction.

C. *Transmarine Transmission.*—Wireless telephony is peculiarly suited for this class of work. Pupin's ingenious and beautiful method has been successful at Lake Constance in Switzerland, I believe, but even assuming that deep-sea cables of this type could be laid and operated successfully, they would nevertheless be very much more expensive than wireless telephone stations. It is believed that wireless telephony will come into extended use for this purpose. Even without further development telephonic communication could be established between Norway or Denmark or Germany or Spain and Great Britain; between Sardinia and Corsica and France and Italy; between France and Algeria, between Australia and Tasmania and New Zealand; between the United States and Cuba and Porto Rico, &c., were it not that it is at present forbidden by law.

As regards telephonic communication between England and America, my measurements show that this should be possible with an expenditure of approximately 10 kw. and suitably large towers, say, 600 ft. high, or with some of the new forms of antenna. Whether such a transmission would be commercially valuable or not is another matter. Personally I do not see that it would, but when I remember that, at the time when the telephone was first being introduced, a number of eminent business men decided that the house-to-house-printing telegraph would be more of a success commercially than the telephone for the reason that no one would want to do business unless

* Abstract of a Paper presented at the 25th annual Convention of the American Institute of Electrical Engineers, June-July, 1908.

he were able to have a record of the transaction. I must admit that there is a possibility of my being mistaken in this.

D. *Wireless Telephony from Ship to Ship.*—Here, of course, wireless telephony occupies a unique position. Wireless telegraphy has the disadvantage that a telegraph operator must be carried. The additional expense is an objection in many cases. The proposition that the captain or mate should also be a telegraph operator has not met with favour. Anybody, however, can operate the wireless telephone and almost every vessel carries an engineer capable of repairing the electrical apparatus in case of accident. The final arrangement will, I believe (if we can prevent the Governments from carrying out their proposed laws, forbidding wireless telephony), be this: that passenger vessels will carry a telegraph operator and use the telephoning apparatus for ordinary work and for telegraphing where it is desired to communicate over long distances. Other vessels will use the telephone alone.

E. *Wireless Telephone from Ship to Local Exchange.* This also will, I think, have considerable value, as enabling the captain of a vessel to communicate, by relaying over the wire line, with the owner of the ship, or enabling a passenger on a vessel to communicate with friends on shore.

F. *Range of Wireless Telephony.* 1. *Atmospheric Absorption.*—The great obstacle to long distance wireless telegraphy and telephony is atmospheric absorption. For short distances up to 100 miles in the temperate zone there is little difference between the strength of the signals at one time of the day and another. As soon as the distance is increased much over 100 miles for the temperate zones and 40 or 50 miles for the tropics the signals at night are very irregular and there is great absorption during the day time. The daylight absorption may be so great that less than a tenth of 1 per cent. of the energy transmitted gets through. Some nights will be as bad as day-time while on other nights there will be apparently no absorption. Fig. 18 is a curve showing the strength of the messages transmitted between Brant Rock, Mass., and Machrihanish, Scotland, at night, during January, 1906. Nothing at all was received that month during day-time.

The change in the strength of the signals is very sudden. In working from Brant Rock to Porto Rico, a distance of 1,700 miles, the strength of the signals with short wave lengths would fall off to one one-thousandth of their former value during a period of less than fifteen minutes, while the sun was rising. Early experiments showed that the absorption was greater as the wave length was increased and the effect was at first attributed to absorption in the neighbourhood of the sending station, and was thought to increase continuously with the wave length.[1] This fluctuating absorption at one time appeared to place a fundamental obstacle to commercial wireless telegraphy, as telegraph engineers will easily appreciate the impossibility of operating telegraph systems with circuits where the strength of the received signals may fall to one thousandth of its value or rise to a thousand times its value in the course of a few minutes. It was therefore considered absolutely essential, in order to decide whether long distance wireless telegraphy was commercially possible or not, to investigate this phenomenon fully. As a preliminary the station at Brant Rock sent to four or five other stations at varying distances and comparative readings were taken. The following table shows the general character of the results obtained:—

Station.	Distance.	Strength of signals received on worst nights.[2]
Company's cottage	200 yards	1,000
Lynn	30 miles	1,000
Schenectady	170 miles	500
Philadelphia	270 miles	300
Washington	400 miles	150
Machrihanish	3,000 miles	1

These experiments proved conclusively that the absorption did not take place in the neighbourhood of the sending station, because the strength of the signals received at nearby stations was the same during the day as during the night, while there was great variation in the strength of signals received at stations further away. It was also found that the absorption at a given instant was a function of the direction as well as of the distance, since on a given night the signals received by stations in one direction would be greatly weakened, while there would be less weakening of the signals received by stations lying in another direction, while a few hours or a few minutes later the reverse would be the case.

[1] A mathematical explanation of this supposed fact is given by Dr. Fleming, "Principles of Electric Wave Telegraphy," p. 617-618, 1906, the following conclusion being reached: "Accordingly, the chief part of the weakening of the wave by sunlight is done in the neighbourhood of the sending antenna where the magnetic force H is greatest, and it is more noticeable for long and powerful waves than for short and feeble ones. This agrees with the observations of Mr. Marconi."

[2] Strength of unabsorbed signal being taken as 1,000.

This was thought to be connected with the coming weather conditions but before this fact is proved a much larger amount of data must be collected. Through the kindness of the U.S. Weather Bureau the author was enabled to obtain a chart of the magnetic variations, and on comparison of these with the absorption between the Massachusetts and Scotland stations there appeared to be a quite definite relation, *i.e.*, the greater the absorption the greater the magnetic variation. Here also, however, much more data is needed before arriving at a definite conclusion. The fact that the absorption did not take place in the neighbourhood of the sending station having thus been definitely settled, the next point to be investigated was whether or not there was any way of overcoming it.

The fact that variations in the absorption occurred with extreme rapidity, the absorption increasing sometimes a hundred fold in a single minute, and at night, when the effect could not be due to the sun directly, seemed to indicate that the body producing the absorption, whatever it was, was not in a state of continuity but was broken up into masses like clouds.[1] This also was in accordance with some experiments made in Brazil in 1905. From optical theories it is known that where the absorption is produced by conducting masses of a more or less definite size the absorption is to a certain extent selective. The next point in the investigation was, therefore, to determine whether there was any possibility of this being the fact in the case of the absorption of wireless signals. Comparative tests were, therefore, made of the absorption at night and during the day between Brant Rock and Washington, with wave lengths varying from a fraction of a mile up to four or five miles. It was found that the absorption did not increase continuously with the wave length but reached a maximum and then fell off with great suddenness. Fig. 19 shows the general character of the curve, the ordinates referring to the amount of the absorption and the abscissæ to the wave frequency.

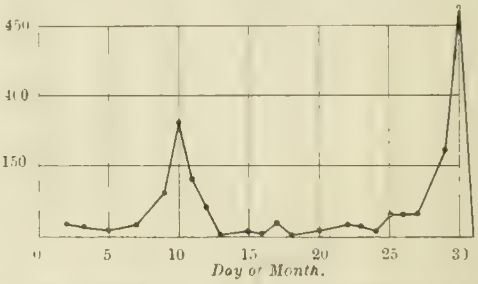

FIG. 18.—CURVE SHOWING VARIATION OF INTENSITY OF TRANSATLANTIC MESSAGES FOR THE MONTH OF JANUARY, 1906.

It may be noted that the absorption is a maximum at a frequency of about 200,000 per second, nine hundred and ninety nine thousandths (0·999) of the energy being absorbed at this frequency during daylight, while for a frequency of 50,000 the absorption does not appear to be appreciable. Longer experiments, of course, might show some absorption, but in any case it is of a different order from the absorption for the shorter wave lengths.

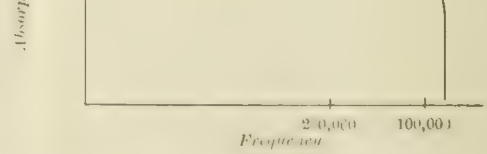

FIG. 19.

Experiments were then made between Brant Rock and the West Indies, a distance of 1,700 miles, during the spring and summer of 1907. It was found that the results were of the same character, *i.e.*, that while there was greater absorption for frequencies of 200,000 there was comparatively little absorption for frequencies in the neighbourhood of 80,000, and messages were successfully transmitted in daylight with this latter frequency. No messages were received in daylight with the higher frequency, though messages transmitted from the same station and with the same power and frequency were officially reported as having been received at Alexandria, Egypt, a distance of approximately 1,000 miles. The fact that these experiments were made during summer weather, and the recent

[1] *Electrical Review* (N.Y.), May 18, 1906.

ing station was in the tropics, and the fact that the distance, 1,700 miles, was practically the same as that between Ireland and Newfoundland, definitely settled the question as to whether long distance wireless telegraphy was a commercial possibility or not, and the results were therefore published.*

Since the publication of these results transmission has been accomplished by means of these long waves over still greater distances during daylight. Mr. Marconi, early in October, 1907, succeeded in operating between Glace Bay, Nova Scotia, and Clifden, Ireland, a distance of more than 2,000 miles, at a frequency of approximately 70,000. The same messages were received at Brant Rock, Mass., a distance of nearly 3,000 miles. Still more recently Capt. Hogg, of the "Glacier," has written that during the southward passage of the Pacific fleet he received messages from the station at Brant Rock, Mass., while off Cape Ste. Roque, Brazil. The frequency used for sending was approximately 80,060, and the messages were received with the very interesting and sensitive silicon receiver invented by Mr. Pickard. This distance of 3,000 miles is the greatest yet achieved by wireless transmission during daylight, and would indicate that with the use of suitably high towers much longer distances can be reached.

2. *Range of Wireless Telephony and Wireless Telegraphy Compared.*—For the same power it is possible to telegraph to a further distance than to telephone. Distinct speech depends upon the presence of harmonics of a frequency as high as 1,200 per second. The amplitude of these harmonics is, according to some rough experiments made by the author, only about 1 per cent. of the fundamental frequency. Consequently, with a perfectly modulated transmitter 100 times as much energy would be necessary to telephone a given distance as to telegraph. It, fortunately happens, however, that a carbon transmitter and also the circuits in which it is used, can be so constructed as not to modulate perfectly but can be arranged so as to accent the higher harmonics. With transmitters arranged for the purpose good transmission has been obtained with thirty times the energy required to produce audible telegraphic signals. By still further modification the power required has been reduced to approximately ten times that necessary for telegraphing, curiously enough without noticeably distorting the character of the speech. There is one fact, however, which prevents the ratio from being as large practically as the instruments show, *i.e.*, speech can be satisfactorily understood with a less increase of power above a minimum audibility than telegraphic signals.

The amount of power necessary for wireless telephony may, therefore, be taken as approximately five to fifteen times that necessary for wireless telegraphy; *i.e.*, under the same circumstances and for the same power the wireless telegraph will carry two to four times as far. The difference in range would be very much greater also but for the curious fact that there is much less falling off with sustained oscillations than with intermittent groups of waves, even though the frequencies are identical. This fact has been repeatedly determined by sending between Brant Rock and Brooklyn on the same frequency, using in the one case spark produced trains of waves and in the other the high-frequency dynamo. The difference in the falling off for the same frequency and energy is very great, but further work is necessary before anything very definite can be said about it or the reasons finally determined.

In Section H Prof. Fessenden deals with the subject, "How Wireless Telegraphy has been Throttled by Governmental Action," and on this point the author is emphatic that such action has been against the development of the new system. Many points are discussed to support this view, which will convince readers or otherwise according as they are regarded from many standpoints. In an Appendix Prof. Fessenden deals with the question of the manner in which the governments of the world act in regard to the inventors' rights in their patented apparatus and appliances. He complains particularly of the treatment which inventors experience from the Governments of the United States and Russia.

BOOKS RECEIVED.

(Copies of the undermentioned works can be had from *The Electrician* office, post free, on receipt of published price, adding 3d. for books published under 2s. Add 10 per cent. for abroad or for foreign books.)

"Deutscher Schiffbau, 1908." Edited by Prof. Oswald Flamm. (Berlin: Carl Marfels A.G.) M.3.

"Proceedings of the Royal Society." Vol. LXXX. No. B 542. Series B—Biological Sciences. (London: Harrison & Sons.) 3s.

"Experimental Elasticity." By G. F. C. Searle. (Cambridge: University Press.) 5s. net.

"The Slide Rule." By Charles N. Pickworth. 11th edition. (London: Whittaker & Co.) 2s.

* *The Electrician*, July 26, 1907.

SOME OPINIONS ON RAIL CORRUGATION.

To say that rail corrugation is one of the most pressing problems with which the tramway engineer has to contend at the present day is to be guilty of a platitude. Attempts at a solution of the problem, however, are not wanting, being, if anything, too numerous, for the question seems in imminent danger of being swamped by the superfluity of reasons brought forward to account for the phenomenon.

To realise the truth of the above statements a glance through the answers to the *questionnaire*, sent out by a committee * of the Union Internationale de Tramways et de Chemins de Fer d'Interêt local will be quite sufficient. It will also be rather disheartening. The answers, of course, depend on the conditions present on a particular system, and to co-ordinate the very varying factors seems an almost impossible task. It is not our province to comment at the present time on the answers sent in, for a report will shortly be issued by the committee giving their conclusions. We shall simply content ourselves with giving an abstract of the most interesting of the answers, though it should be borne in mind that each of these only refer to one particular system and can in no case be taken as a general criterion. All the answers sent in have not been dealt with, some because they offer no reasons for the formation of corrugation, some because their conclusions are given under other headings, while one company, the Société anonyme des Tramways Est-Ouest de Liége et Extensions, is in the happy position of having no corrugation.

The *questionnaire* begins by summarising the conclusions put forward to account for corrugation by a committee of the Verein Deutscher Strassenbahnen und Kleinbahnen Verwaltungen in their report † to the eleventh annual general meeting of this society and by Mr. A. L. C. Fell in his Paper‡ before the sixth annual conference of the Municipal Tramways Association. These have already been dealt with in *The Electrician* (*loc. cit.*), but for the sake of completeness we reproduce them here.

The German committee considered that corrugation might occur (1) when the tyre was harder than the rail; (2) when slipping occurred, caused by (*a*) applying the brakes hard or suddenly, (*b*) starting up too quickly, (*c*) travelling round curves, (*d*) the advance of the driving wheel and the springy following of the driven wheel, (*e*) various effects, such as unequal diameter of the wheels on one axle, unsuitable tyres and rail-head profile, unequal wear on the tyres, unequal elasticity of the rail head, &c.; (3) by a combination of any of the above, though one of them by itself might not cause corrugation. Moreover, it might arise through a combination of the above with (*a*) vibration, (*b*) increased speed, (*c*) increased wheel pressure and (*d*) diminished contact surface between wheel and rail on account of unsuitable profile.

Mr. Fell came to the conclusion that the following were the chief producers of the trouble: (1) Original roughness of the rail after rolling; (2) cold rolling of the rails by the car wheels; (3) soft rails and heavy cars; (4) sand and grit on the head of the rail; (5) defective and open joints; (6) tight or wide gauge of track or wheels; (7) loose or springy rails and points; (8) defective trucks—*i.e.*, out of square and buckling; (9) slip of wheels on curves; (10) wheels not being of the same diameter; (11) flats on the wheels; (12) rapid acceleration and retardation causing wheels to slip; (13) defective brake mechanism, or a too rapid application of the brakes, causing chattering and a series of short skids.

The *questionnaire* was as follows:

1.—A. Have you noticed any corrugation on your rails? B. (*a*). How long have you noticed it? (*b*) How long have the tracks in question been in use and what is the wear of the rails? 2.—A. Is the corrugation very pronounced? B. What distance are the corrugations apart, what is their depth and the direction of the hollows (*a*) at the beginning; (*b*) at the maximum of their formation? 3.—A. Are the whole or only a part of your lines corrugated? B. Is it produced especially at points where (*a*) the motors are working; (*b*) the brakes applied; (*c*) the cars running freely? 4.—For each part of your track where corrugation is noticed indicate: A. All particulars relating to the track construction and especially: (*a*) The nature of the sub-soil, of the foundation and of the road surface; (*b*) the gradient and sense of the camber; and (*c*) the gradient of the road. B. All particulars of the rolling stock and especially: (*a*) Diagrams giving the weight per wheel and their

* The following were the Reporting committee: Messrs. Boulvin (Brussels), Busse (Berlin), Culin (Hamburg), D'Hoop (Brussels), Dubs (Marseilles), Fischer (Duisburg-Ruhrort), Mariage (Paris) and Reitz (Munich), with M. t'Serstevens, secretary of the Union Internationale de Tramways et de Chemins de Fer d'Interet Local.

† *The Electrician*, Vol. LX., p. 167.

‡ *The Electrician*, Vol. LIX., p. 979.

arrangement on each car, indicating the driving and driven wheels; (b) the extent of the daily traffic; (c) the system of driving and method of transmitting the energy; and (d) the system of braking, &c. 5.—What are the characteristics of your tyres (breaking strength, extension, hardness, &c.)? 6.—What are the characteristics of your rails? 7.—To what causes do you attribute corrugation? 8.—On what observations do you base your opinion? 9.—Have you noticed whether the appearance of corrugation coincided with any modification in the construction of your track or rolling stock or with any new rules concerning the driving of the cars? 10.—Have you made any other researches which may contribute to a solution of the problem? 11.—Have you tried to remove the corrugation? If so, by what means and with what results? 12.—Have you noticed in certain cases the disappearance of corrugation after it has reached a maximum?

In what follows we summarise the answers sent in by the various members in answer to the above *questionnaire*.

Aix-la-Chapelle have only corrugation on certain parts of their system, but it occurs specially on those lines exposed to dust and mud. It appears less on the crowded parts than on the suburban lines, whilst it is more pronounced on curves of large than on those of small radius and on the outer than the inner rail. The greater part of such corrugated lines are worked under current. As corrugation is only noticed on curves, it appears to be due to the difference in the length of path traversed in the same time by the outer and inner wheels respectively, thus causing the former to make a series of jumps. On curves of small radius these jumps succeed one another so rapidly that uniform wear is the result. Corrugation has only been noticed on those rails whose resistance to compression exceeds 1,000 lb. per square inch.

Aberdeen noticed corrugation on one particular line where light rails were used. When these were replaced by others more adapted to electric traction it did not reappear.

Amsterdam find that corrugation is pretty general throughout their system, especially at places where the cars travel at high speeds. It is considered that at these places the rails so act on the car as to slightly alter its direction and that whether the car is travelling under current, being braked or running free is of little consequence. The sub-soil at Amsterdam is very bad, being of an exceedingly marshy nature, and various methods of track construction have been tried. The employment of a foundation of concrete above which is placed a sleeper of wood on which the rail rests seems to act as a preventative of corrugation, the rail being held tightly in place. In their opinion the kinetic energy of heavy cars moving at high speeds must be considered as the primary cause of corrugation. It is recommended that, while maintaining the present high speeds, the following points tending to prevention of corrugation should be considered: (a) The choice of as long a wheel base as possible and the employment of bogie vehicles and of tyres which are not too hard in relation to the rail; (b) the reduction to a minimum of the lateral play between the chassis or body of the car; (c) the maintenance of a great track rigidity to avoid any possibility of sinking; (d) in the course of construction to avoid the occurrence of "pockets" under the rails, and (e) to remedy any sinkings as they occur; (f) the removal of corrugations by grinding as soon as they appear; (g) to increase the number of ties in order to reduce the lateral play of the rails; (h) The choice of a rail having a great resistance to lateral vibrations; (i) to pay great attention to the removal of, and (k) to make the roadway between the rails very impermeable to surface water.

Anzin notice that corrugation only occurs on heavy rails, and consider that the great resistance of the rail in relation to the load per axle is a primary cause of this abnormal wear. No corrugation was noticed on certain parts of the system, where it is now present, when lighter rails were used, and it seems that corrugation may be determined by the vertical oscillations to which the car frames are submitted by the action of the springs.

Berlin Tramways have corrugation throughout their system, and consider it to be due to the causes put forward by the Verband Deutscher Strassenbahnen und Kleinbahnen Verwaltungen.

Berlin Underground Railway notice corrugation, particularly on some rails 7·2 in. high, resting on rigid foundations, and least on rails 4·6 in. high resting on elastic foundations. It is, further, specially noticeable at places where the brakes are applied and least at places where the trains start. It is very slight between the stations, especially at places where the train is running freely. The cause is thought to be the great stresses on the rail, so that the elastic limit is exceeded.

Bielefeld notice corrugation at all places where a high speed is attained. It is attributed to (a) vibrations to which the rails are submitted; (b) simultaneous braking and sanding; (c) excessive acceleration which occurs when the motors are put in parallel, and (d) the action of the brakes in checking the motion, and thus causing skidding.

Blackburn attribute corrugation to (a) the "uncentral" drive on the axle by the motor; (b) weak rails; (c) open joints; (d) the presence of hard places on the rail head; (e) to the car frames being out of square; (f) to skidding; (g) to differences in the wheel diameter; (h) to flats on the tyres; and (i) to insufficient play between wheel and rail.

Bordeaux. At certain points—*e.g.*, on gradients—where braking takes place and at spots where the rails cross transversely, corrugation is thought to be due to skidding, while at others—*e.g.*, down hill—it is considered that the want of elasticity in the rails and vibrations from the rolling stock always passing the same points at the same speed are factors.

Breslau only notice corrugation on parts of their system, and consider it to be due to the quality of the rail metal. They do not agree very cordially with the opinions put forward by the Deutscher Strassenbahnen und Kleinbahnen Verwaltungen.

Brussels find that corrugations occur especially on those lines worked on the conduit system and on those rails opposite to the Haarmann rails which form the slot through which the current is taken. They cannot attribute corrugation to one, but to numerous, causes, which may be divided into two classes—those which are actually a cause and those which favour its development. In the first of these are placed (a) a dissymmetry in the coefficient of adhesion of wheels on the same axle; (b) original inequalities on the rail heads; and (c) different diameters of the wheels. In the second category are placed (a) the increasing hardness of the tyres, which are generally harder than the rails; (b) an insufficient fixing of the rail on the subsoil, which leads to vibrations; (c) the bad quality of the subsoil and paving; and (d) the proportion of driving wheels to trailers, both as regards number and load. The drive being taken from one side, the driving effort on that side is greater than on the other, consequently leading to skidding and corrugation.

Cologne find that corrugation occurs principally in asphalted streets with a concrete foundation with or without a layer of asphalt under the rails, but it also occurs in other ordinary paved roads where the foundation is of concrete. In roads were the foundation is of gravel or flints it is very slight. Its appearance is fitful and most often on the right rail in the direction of motion, the other being free. It occurs more often on those parts worked under current than on those where the car is running freely. In general, the phenomenon is particularly noticeable on lines worked at high speeds, where the rail has parted from its place. On lines, however, where, owing to the traffic, but low speeds are attained it is very little observed. Corrugation is attributed to (a) unequal resistance at the rail head caused by vibration of the mill rollers; (b) high speed, which gives the rail vibrations succeeding each other at short intervals; (c) a too rigid foundation; and (d) too great a pressure on the higher rail.

Dresden have corrugation pretty generally over their system, and it seems that motors working at full power and high speeds favour its appearance. A part of the track which is laid on wooden sleepers, in spite of the fact that it is worked by a very heavy traffic, has no trace of corrugation, while the neighbouring track, built on a concrete foundation, showed it after a very short time. On large radius curves corrugation is explained by the successive jumps and slips of the outer wheel, while it occurs more rapidly and in greater quantity as the speed of the car is raised and the foundation made more rigid. Another cause is the differing degrees of hardness of the wheel and tyre, and, in general, corrugation occurs less on lighter than on heavier rails. It is proposed to carry out experiments on the last two points by alternating lengths of rails of various hardness on the same route and running hard tyres over them. If tyre hardness is really a cause of corrugation, the latter should appear more quickly on soft rails. If, on the other hand corrugation depends on rail vibration, the opposite should be the case.

Dusseldorf find that corrugation appeared with electric traction. It is attributed to the greater hardness of the rail and tyres, and it is considered to arise from the vibration of these parts.

Frankfort.a.M. have corrugation on all their routes, but it is specially noticeable along those roads paved with asphalt or wood and resting on a foundation of concrete. Corrugation, however, also occurs on those lines where stones or flints are used as foundation.

Hanover suffer from corrugation only on such lines as carry a heavy service, and especially on those parts which are run under current or where braking occurs. Corrugation is attributed to insufficient strength of, and lack of uniformity in, the rail metal, taking into account the great stresses caused by the employment of electric traction.

Kristiania consider that the principal cause of corrugation, which occurs on all parts of their system, is two wheels on the same axle not being independent. As the path described per revolution is not always equal to the circumference of the wheel, skidding results. Corrugation does not occur on curves less than 130 ft. radius; for this purpose rails not mathematically straight may be considered as curves of large radius. The conical shape of the tyres appears to favour the appearance of corrugation, as the car will always have a tendency to slip towards the lower rail and the rolling circumferences, not being of the same length, will cause skidding. In these two cases, however, corrugation can only occur when the path described along the rail

is greater than the circumference of the wheel—*i.e.*, on the outer rail of curves or on straight lengths on the rail against which the car does not press. If the car press against one of the rails there will be a tendency, on account of the greater rolling circumference, for it to follow a fictitious curve, in order that it may approach the other rail. The same phenomenon will then be produced in the opposite direction, so that a sinusoidal curve is obtained, which indicates in plan the path taken by the car. These considerations permit all cases of corrugation met with on the Kristiania tramways to be explained. On the straight lengths corrugation is only noticed on one rail at a time, and when it finishes on one rail it immediately begins on the other, the change-over occurring in a nearly periodic manner. It is considered that the following reasons, which are often put forward to explain corrugation, are not originating causes (*a*) Braking, starting too quickly, sanding or presence of dust on the rails: Should cause corrugation to appear more on one rail than the other, besides which the phenomenon is not noticed more particularly at places where braking, starting or sanding occurs. (*b*) Chassis out of straight, difference in tyre diameters, surface of rail not flat: If these had any effect there is no reason why corrugation should not occur everywhere. Further, these factors would tend to destroy one another. (*c*) Want of homogenity in rail surface: Very characteristic corrugations have been noticed on badly aligned rails, especially in winter, but when these had been adjusted they showed a perfectly plane surface. This is explained by considering the above phenomenon as the first trace of corrugation due to the lateral movement of the cars. The rail metal, however, shows in every case quite a uniform resistance. Differences in the gauge: If this were a cause corrugations should appear at points where the gauge is tight or wide and on both rails simultaneously. This has not been noticed at Kristiania. Loose joints: Where loose joints have been present three or four corrugations have appeared on both rails, but these cannot be considered as characteristic. These often appear at the middle of the rail. Bad foundations: Corrugation often appears at places, where the track has lost its rigidity, and this loss is considered to be due to the successive pounding of the passing cars. Corrugation has also been noticed at places where the foundation is quite rigid.

Leipzig have found corrugation on most of their lines, but have not noticed that the working of the motors or braking has any particular effect. They attribute corrugation to a variety of causes, but especially to a want of uniformity in the structure of the metal. The rails are forced from their places and submitted to oscillations in a vertical direction which appear to favour the production of corrugation. Its cause should be sought in the peculiarities of the rolling stock.

Linz-Unfahr consider that corrugation is produced on systems, where the tyres are harder than the wheels. It appears to occur where the rail head has not been rolled smooth. It is thought that corrugation may be due to the shape of the tyres, and that the wheels, only coming in contact with the rail at one point, set up large stresses in the interior of the metal.

London County Council agree with the conclusions put forward by Mr. Fell, and inquire whether corrugation may not be due to the conical profile of the wheel and rail head. No corrugation was noticed on a certain section of the system worked only by a special type of car at the end of 14 months, and it then appeared only in a very modified form. This, it is thought supports the theory that the car plays a great part in the phenomenon.

Lyons attribute corrugation to a want of elasticity in the track foundation and to a want of homogenity in the rail material caused by fortuitous cooling during rolling.

Lucerne, besides having corrugation on those parts of the system where the cars are under current or being braked, also find it on sections where the car is running free. They do not support any of the theories at present current to account for corrugation, but consider that a deep study of a large number of cases only can lead to a satisfactory result.

Mannheim consider that difference in the diameter of tyres on the same axle had to do with the formation of corrugations, together with the fact that the motors do not drive the axle centrally and that the foundation of the rails is often too elastic.

Montreux-Oberland attribute corrugation to a too sudden application of the brakes.

Nurenburg-Furth find that corrugation especially occurs on parts where the cars work at high speeds, and that where the roads have a large amount of camber it appears more on the upper than on the lower rail. They attribute it to hard tyres.

Compagnie Générale des Omnibus de Paris find that corrugation is not confined to one particular part of the system or where the traffic is conducted in a certain way. They think it is due to the fact that the rail is not sufficiently hard in relation to the tyres. The system of driving the wheels is not considered to have much effect on the formation of corrugation. It is thought that it occurs more on the less stable of the lines, and that the "conduit" rails which lack in homogenity may also be a cause.

Chemin de fer Métropolitan de Paris find that corrugation occurs on all curves and at places where the brake is applied. It does, however, occur at certain places where the train starts and runs free. They consider the primary cause of corrugations to be the rolling. Quite a new rail was planed and immediately showed traces of corrugation. Among the causes which accentuate the faults are skidding, braking, slipping at starting and differences in diameter of the driving wheels.

Riga consider that corrugation is favoured by weakness in the sub-soil causing an alteration in the position of the rails. The primary cause, they consider, may be attributed to phenomena arising from the rolling of the rail. Corrugation has been noticed on a new rail before being placed in service.

Sheffield consider that corrugation is due to defects in the track foundation.

Stettin have corrugation on large radius curves as well as on parts of the system which include slight gradients. On heavy gradients no corrugation has been noticed. They consider it to be due to the following causes: When the car enters a curve the wheel flange takes up an oblique position with regard to the groove of the rail and strikes the rail head on its side face. When the flange, still in an oblique position, obtains a little play in the groove, it will suddenly be checked by the rail, partly by the pressure of the wheel and partly by the coefficient of rolling friction between the surfaces of tyre and rail. Meanwhile, the car will have continued its course round the curve, and the same operations will be repeated. This skidding of tyre on the rail head and the simultaneous rotation of the wheel produces corrugation. The tyre acts on the rail like a machine tool, while owing to the vibrations the rail breaks away from its foundation and the pavement that imprisons it. As a result it follows that on two rails which are perfectly straight and at the same level corrugation cannot occur, but if a car passes from a part of the track, where the rails are perfectly horizontal to another where one is raised slightly above the other, the phenomena will be reproduced giving rise to corrugation. In this case the car heels over, and the flange having no play in the groove causes corrugation. For the same reason it is thought that corrugation cannot occur on large radius curves where there is a superelevation. It, therefore, appears that the phenomenon is not initially due to braking, sanding, to want of homogeneity in rail or tyre or to differences in hardness of rail or tyre. These factors may be considered as favourable to corrugation, but not as themselves causes.

Strassburg attribute corrugation to rail vibration caused by a combination of several phenomena. It is to be remarked that the vibrations which were considered as the original causes of the phenomena exist at the points affected by corrugation and only at those points. These vibrations are rhythmical and correspond to the corrugations formed. It is thought by some that these vibrations would still be rhythmical if caused by the corrugation, but this does not appear to be the case; for the rhythm of the vibrations is determined solely by the vibrating object, in this case the car. Vibrations attributable to other causes would naturally have a rhythm different to that of the car, and should damp the latter. It appears that the best method of preventing corrugations would be to change the vibrations of the car by modifying the distribution of pressure and the system of suspension.

Vienna have suffered from corrugation throughout their system, especially on the exterior rail of large radius curves. In their opinion too rigid or too elastic a foundation both favour the appearance of corrugation. The manner in which the conduit system rails behave is, from this point of view, very characteristic. One of the rail lengths is made up of a grooved rail resting on a concrete foundation. The other consists of a slotted rail through which the current is collected. These rails rest on frames of cast iron about 4 ft. 6 in. apart. About 10 miles of double track are arranged in this way, and the slotted rail in no case shows a trace of corrugation, while the other is frequently affected in this manner. The system of foundation used on the slotted rail, which is a mean between a too rigid and too elastic foundation, seems to prevent corrugation. The rails themselves are the same in every way, and are submitted to the same wear, the only difference being in the foundation. The grooved rail has to be repaired more often than the slotted rail, perhaps owing to the greater ease with which the latter is rolled. The skidding of the tyres on the rail head, thereby giving rise to stresses which exceed the elastic limit appears to be a factor favourable to the formation of corrugations. The results noticed by M. Busse on the rolling of rails have also been observed at Vienna. It has been noticed that Vignoles' rails, which have never been in service, and which served in the mills for sliding bars to the cooling off place, almost invariably showed corrugation. The reason of this is thought to be due to the fact that they carry rails that have been submitted to vibration. It is possible that a deeper study of this phenomenon, by reconstructing it under simpler conditions than those present on tramways, may lead to a determination in no uncertain fashion of the causes of corrugation.

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"THE ELECTRICIAN" INDUSTRIAL SUPPLEMENT.

With "THE ELECTRICIAN" for Sept. 14, 1906, was issued the first of a series of "Industrial Supplements," to be published from time to time with "THE ELECTRICIAN." The twenty-eighth issue of the Supplement will be issued (Gratis) with the number of "THE ELECTRICIAN" for Oct. 16.

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THE PROBLEM OF WASTE HEAT.

It seems only the other day that Lord KELVIN, in his speech at the inauguration of the Tyneside power scheme, spoke of that development, and especially of the three-phase motor, as being of interest to the whole civilised world. Had he been able to foresee that same district as it now is he would have probably been equally impressed, not only by the growth and extension of the undertaking which he inaugurated, but still more at the latest developments in the production of power.

Since the first establishment of central electrical generating stations about 25 years ago there have, of course, been many changes in the details of production. Belt driving was succeeded by direct coupling, slow-speed engines by high-speed engines, and reciprocating engines by turbines. But in this country, at least, the greater part of the power is still derived from combustion of coal under boilers. It is in this connection, the means of producing the motive power for the dynamo, that the most recent development has taken place.

This was described in a Paper read by Mr. CHARLES MERZ before the Iron and Steel Institute at the Middlesbrough meeting, and which was given in abstract on page 959 of our last issue. One of the chief characteristics of the industrial districts of the North-East Coast is the fact that the processes there carried on result in the production of large quantities of waste energy. Coke ovens, blast furnaces and blowing engines are the principal sources of this waste heat and gas. From time to time calculations have been made of the quantities of heat wasted annually in the district, but such calculations are of little value unless they deal also with the capital outlay necessary for its utilisation. It must also be remembered that a large portion of the heat is used already. In most blast furnaces

the waste heat is used to raise steam for driving blowing engines, or the waste gas is used to drive gas engines for blowing or for producing electricity. It is, again, used for rolling mills, pumping and other purposes, and in Germany a good deal has been done in this latter direction. But the best existing arrangement for utilising waste heat on the spot falls far short of the full efficiency attainable. This arises from the fact that it is practically impossible for the owner of the waste heat to utilise it, either in his own works or by selling it to neighbouring works, throughout the 24 hours. He is indeed fortunate if he can find a purchaser for his surplus with as good a load factor as his own. Again, as regards the capital outlay, the establishment of a private installation is costly, involving as it does the installation of about 50 per cent. of spare plant. And finally, although this spare plant can safeguard him against breakdowns of machinery, it cannot safeguard him against fluctuations in the demand for coke, coal or steel. Even if no coal at all is being raised from the collieries, a considerable amount of power for such operations as pumping, &c., is necessary. Thus, even if no coke is required and he desires to shut down the coke ovens, he cannot do so, because he requires the power for the pits; in other words, he is constantly liable to have too little or too much power, depending upon the fluctuations of the market. By entering into an arrangement for selling his waste power to a power company he avoids all these drawbacks. In the first place, the power company, possessing as it does a very much larger demand for power than the ironmaster, is in a position to take from him the whole of his waste power at whatever time in the 24 hours it may be produced. Secondly, it can continue to purchase this power independently of the fluctuations of trade; and, thirdly, as the power company possesses a comparatively large amount of spare plant at its main coal-fired generating stations, it is unnecessary for the waste heat owner to instal spare plant. Hence, it is not surprising that a good deal has already been done on the North-East Coast in this way.

Mr. Merz showed in his Paper that over 15,000 H.P. of machinery has already been installed in waste heat stations in that district, and during next year these stations will generate nearly half the total number of units produced by the three power companies by whom this waste energy is being used. This cannot but have a marked effect ultimately in lowering the cost of production over the whole system. The methods adopted for converting the waste heat into electrical energy differ in each case. In some instances the waste heat and gas is used directly under the boilers which generate steam for driving steam turbines; in others the exhaust steam from the existing blowing engines is used in exhaust turbines. In other countries the gas engine, driven from coke oven or blast furnace gas, has in some cases been adopted, and the time may come when it will also be adopted in the waste heat stations on the North-East Coast. The question, however, of the relative merits of gas and steam, to which attention was drawn at the recent discussion at Middlesbrough, are, of course, entirely independent of the relative merits of co-operation and isolation. If the waste heat can be utilised more efficiently in gas engines, over a period of years, taking everything into consideration—depreciation, repairs and renewals—there is nothing to prevent the waste heat stations making use of gas engines instead of turbines. At the present time, however, this state of affairs has not come about. But the ability to dispose of their surplus energy in this way promises an important means of economy to those engaged in the iron and coke business. As Sir Hugh Bell pointed out, all that the power user or the power producer in that district need seriously concern himself about now is that he should instal machinery of the same frequency and voltage as the power company. Then, if he has a surplus of power, he can sell it to the power company, and if he needs more power he can buy what he wants from them. Whether he buys from them or sells to them, only a minimum of transformation and waste is necessary. Where the power user is not also a power producer, the purchase of power is, of course, the only economical course in a district where a large power company is at work, which accounts for the gradual disappearance of all private installations in that district.

REAL CHEMISTRY FOR ENGINEERS.*

In 1905 Prof. Haber published his "Thermodynamik technischer Gasreaktionen," as an expanded form of a course of lectures delivered by him at the technical University of Carlsruhe. The present work is more than a translation of the German original of 1905, as Prof. Haber has thoroughly revised the German edition for this translation. Thus the English edition contains amongst many other new things an account of Nernst's recent thermodynamical theory.

It would be difficult to exaggerate the importance of Haber's book. During the last 25 years thermodynamics, as usually taught to physicists and engineers in this country, has remained a classical and practically stationary science. In the class rooms of our engineering laboratories the young engineer has received his usual dose of entropy-diagrams and theory of heat engines, whilst in the physical laboratories the stock thermodynamics of the Clausius period has been laboriously and painfully administered. The wild rush after the electron of the last 10 years has probably caused the youthful physicist to regard this classical thermodynamics as a somewhat dull and unromantic science.

Meanwhile, however, the science of physical chemistry has been advancing with enormous strides. Hand in hand with this growth has gone the development of thermodynamics, a development based on the work of Gibbs, Helmholtz, Van't Hoff and Nernst. The application of thermodynamics to chemical phenomena has thus become a vast and important science, forming one of the (at present) most important chapters of physical chemistry. In the physico-chemical institutes of France, Germany, Austria, America, and Switzerland, and in a few chemical laboratories of this country, the new science has been enthusiastically taught and carried on. The older generation of chemists, with a few brilliant exceptions, have, however, failed to follow these advances. Chemistry has become a precise science with such marvellous rapidity that we need scarcely wonder at this. Now, the young engineers of this country have usually been forced to content themselves with a first-year's course of chemistry (and often with no chemistry at all) of the usual stereotyped description. They have received a smattering of the chemistry of Lavoisier, Dalton, Berzelius, and Avogadro. When later on, they went out into the real world, they have doubtless experienced a feeling of great uneasiness. They have been brought face to face with the phenomena

* **Thermodynamics of Technical Gas Reactions.** By Dr. F. Haber. Translated by Dr Arthur B. Lamb. (London: Longmans, Green & Co.) Pp. xix. + 352. 10s. 6d. net.

connected with constructive materials such as (to quote a few examples) steel in all its protean forms, gunmetals, bronzes, brasses, anti-friction alloys, hydraulic cements; the phenomena of iron corrosion, sewage precipitation, feed water purification, smokeless combustion, gas producer plant, internal combustion engines, metal filament lamps, and a hundred other things, too numerous to mention. Face to face with these questions, the engineer has slowly begun to realise that his classical thermodynamics was at fault and his early Victorian chemistry of very little use. Uneasiness has also spread amongst the chemical engineers and manufacturers of this country. The delicate equilibria of the Solvay process long ago broke up the rough and tumble heroics of the Leblanc *régime*. Those who scoffed at reaction-kinetics and catalysis have lived to mourn the success of contact sulphuric acid. The upshot of it all is that the engineers and manufacturers of England have at last awakened to the fact that there *does* exist a *modern* chemistry, usually but improperly named "physical" chemistry, which they must hasten to learn, or inevitably go to the wall. Nine times out of ten the problem facing the engineer or manufacturer is the control and regulation of the conditions of equilibrium and velocity which make for efficiency, rather than the neck or nothing production of a given substance. And that is, briefly put, the difference between the old purely preparative chemistry as usually taught (especially to the unfortunate engineer) and modern or "physical" chemistry.

The importance of Prof. Haber's work lies in this, that it will undoubtedly help in awakening interest in physical chemistry amongst engineers and manufacturers. The book deals with the chemistry and thermodynamics of gaseous equilibria, especially in relation to the variation of equilibrium with temperature. Questions relating to velocity of reaction and catalysis also come in for discussion. One of the features of the book is that reactions which are actually or potentially of technical importance are chosen as illustrative examples. Amongst these may be mentioned the oxidation of nitrogen, the water-gas and producer-gas reactions, the dissociation of carbon dioxide, the oxidation of sulphur dioxide, the direct formation of ammonia from its elements and the Deacon chlorine process. Special chapters of the book are devoted to the specific heats of gases and the measurement of high temperatures. As will be seen, the programme is a well-chosen one, and it has been carried out with great skill and knowledge. The integral equation which expresses the equilibrium-constant of a gas reaction as a function of temperature contains certain coefficients and an "undetermined constant." Although this function was discussed by Le Chatelier many years ago, attention has been particularly drawn to it recently owing to the many applications of physical chemistry to technical problems involving gas reactions. Haber's book is pre-eminently concerned with the evaluation of the coefficients and undetermined constant of the function referred to. The coefficients depend on the temperature-variation of the specific heats of the reacting gases and hence a considerable portion of the book deals with the existing information on this subject. Owing to want of thoroughly reliable data the author is often obliged to enter upon a very critical and detailed discussion of existing results. Although this is doubtless very necessary, some readers may find this part of the book somewhat fatiguing. The hunt after the "undetermined" constant (*i.e.*, undetermined by the first and second laws of thermodynamics) may also perplex some readers, although at the time when Haber's book first appeared, his attempts to calculate the value of this constant may be well described as pioneering work of the first importance. Since that time, Nernst's theory has appeared, whereby a definite basis for calculation is presented. This theory is also discussed in the new edition of Haber's work.

Engineers will find in the present work a most admirable feature. The physico-chemical thermodynamics required is not assumed by the author, but developed *ab initio* as he proceeds. Let those who have never made the acquaintance of Van 't Hoff's celebrated "equilibrium box" here taste of its joys. They will not find it a Pandora box!

F. G. DONNAN.

ON COMPENSATION FOR SELF INDUCTANCE IN SHUNT RESISTANCES.

BY ALBERT CAMPBELL, B.A.

(From the National Physical Laboratory.)

In certain types of alternating current ammeters and wattmeters it is convenient, as in similar direct current instruments, to pass the main current through a shunt resistance, the instrument being connected to potential points on this resistance. If the shunt resistance possesses self inductance, this will usually cause error, for the impedance of the shunt will alter with the frequency, and the P.D. will be out of phase with the current, a condition which may have a considerable effect in a wattmeter working at low power factors. When the shunt resistance is low (as for large currents), a quite small amount of self inductance is sufficient to give trouble; for example, with a resistance of 0·001 ohm, an inductance of 1 or 2 microhenrys might be quite objectionable. In order to get over the difficulty, the shunts are sometimes designed to be as non-inductive as possible by folding the strips back on themselves and by other devices, but this is not always easy, particularly when large very currents have

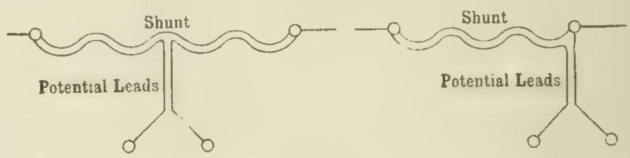


FIG. 1.

to be dealt with. I have found that the difficulty can be more easily avoided by using the following device, which gives almost perfect compensation for the self inductance. It consists simply in making the leads from the potential points of shape similar to that of the shunt and running one or both, so as to be almost coincident in position with the shunt itself; this is illustrated in Fig. 1.

Thus, for example, if the shunt is a broad strip, one or both potential leads should be in the form of strip of the same breadth and run as close as possible to the shunt. Of course, the leads may be much thinner than the shunt and of different material. With such an arrangement the P.D. obtained will be, in magnitude and phase, almost exactly what the shunt would give if it were non-inductive. The general explanation of this lies in the fact that the magnetic field due to the current in the shunt, while it causes the back E.M.F. of self inductance

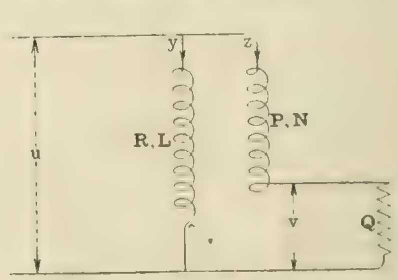


FIG. 2.

in the shunt, causes at the same time an equal and opposite E.M.F. of mutual inductance in the potential leads, and the result is the non inductive condition desired.

The thing may be proved more rigorously as follows:

In Fig. 2 let R, P and Q be the resistances of the shunt, leads and current coil of the instrument respectively, L and N being the self inductances, y and z the instantaneous values of the currents in the two branches, and M the mutual inductance between them. Let u and v be the instantaneous values of the voltage across the shunt and the instrument respectively. In general, v will be small compared with u. By the close collocation of the leads and shunt we have very nearly

$$L = M = N.$$

Accordingly

$$u = Ry + L\frac{dy}{dt} + M\frac{dz}{dt}.$$

Therefore $$u = Ry + M\frac{d}{dt}(y+z) \quad . \quad . \quad . \quad . \quad (1)$$

and $$v = u - Pz - M\frac{d}{dt}(y+z).$$

Therefore, by (1).

$$v = Ry - Pz \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (2)$$

Thus the voltage applied to the instrument is the same as with equal direct current, and the shunt behaves as a non-inductive resistance R. It is easy to prove that the effects of the electrostatic capacities of the shunt itself and those introduced by the leads are negligible in the case of low resistances.

As to the practical working of the device, Mr C. C. Paterson and Mr. E. H. Rayner have made numerous experiments with it, and they find the compensation practically perfect when used for water-tube resistances with an electrostatic wattmeter working down to power factors as low as 0·01. A fuller account of the matter will appear in a Paper which they hope to publish shortly.

TRAMWAY DEVELOPMENTS IN CARACAS, VENEZUELA.

The town of Caracas, which is the capital of Venezuela, has other and better claims to notoriety than those arising from political earthquakes. Even its age entitles it to some claim, for it was founded in 1564 and its history is the general history of the Spanish main. Needless to say this rather led to neglect of industrial development, and until 1872 the country was, in general, in an exceedingly unsettled state. From that time onward, however, thanks to the influence of Guzman Blanco, things have improved somewhat. Capital has been encouraged and public works begun. At the present time the population of the town is about 80,000, but it is expected to increase rapidly within the next few years. Like many other South American towns there are numerous foreigners working there, the German element preponderating from a commercial point of view.

Previous to the year 1905 there were two small horse companies in operation, the Bolivar, running east and west from the station of the Central Railway to that of the La Guaira and German lines. The other, was the Caracas Tramway Co. which, starting from the Plaza Bolivar, radiated out to the different quarters of the city. In 1905 the two companies were combined under the presidency of Dr. Zuloaga, a leading member of Caraquenian society, and the directorship of Messrs. Edgar A. Wallis and Albert Cherry, two of the most prominent members of the British community. A concession was obtained from the municipal authority with a view to the electrification of the whole system, and Mr. E. H. Ludford, formerly manager of the Bolivar Company was appointed general manager of the whole.

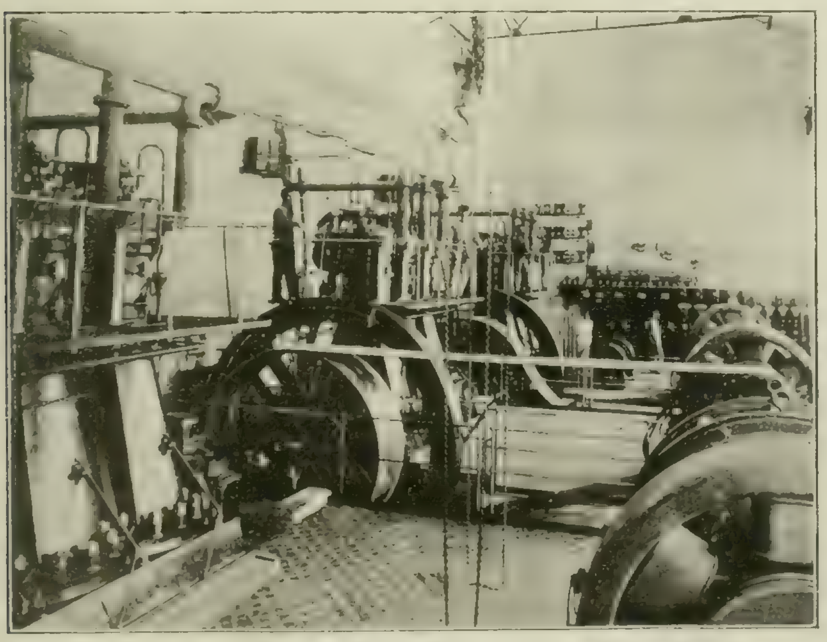


Fig. 2.—Interior View of Engine Room showing Diesel Engines.

Mr. Wallis then came to London where he speedily interested English capitalists in the scheme on which Messrs. J. G. White & Co. drew up a full report. Their recommendations were accepted, and a contract was drawn up, whereby Messrs. J. G. White & Co. undertook to supply a complete equipment, including track, office buildings, carshed, power house and plant and cables. Work was started in the spring of 1907 and completed by February, 1908.

Fig. 1.—Junction completed at Cathedral Corner of Plaza Bolivar: Central Square of the City.

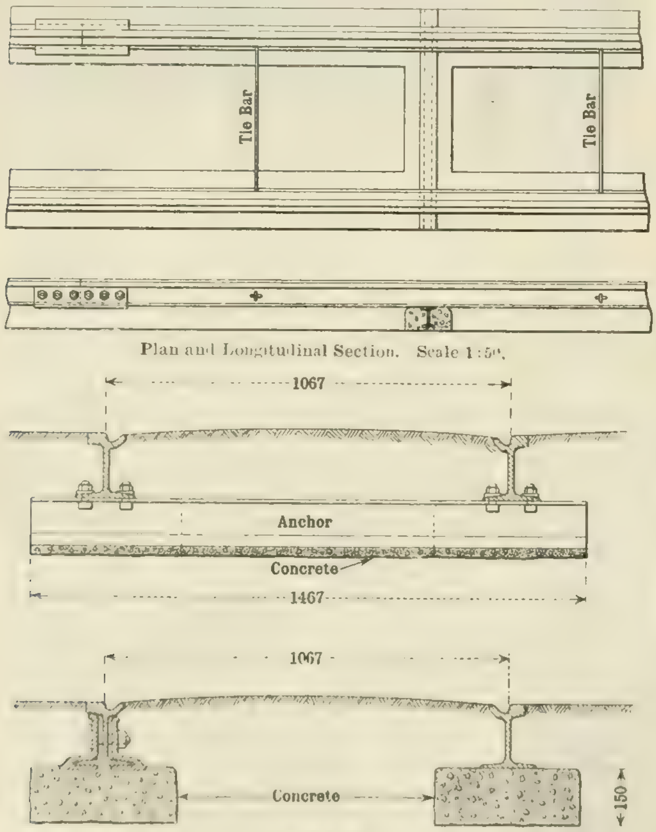
Routes.—The routes selected, with a total length of 10 miles, were practically those of the old companies. These naturally converged into the Plaza Bolivar (Fig. 1), the centre, political and social, of the city, in which and around which all the ministerial and Government buildings are situated. The principal line is that from east to west, uniting the Central Railway with the La Guaira stations. On the north side are three routes: Of these the Pastora runs to the north-west through a fashionable district; the Avenida Norte to the Hospital Vargas past the Panteon where are the ashes of the heroes of the independence, Bolivar and Sucre, and a monument to Miranda; while the third, the San José, parallel to this but further to the east, runs through a working-class district to the northern boundary. On the southern side are three routes, one to the south-east to the Ponte de Hierro, where the track crosses the Guaira River and connects with a light tramway to a suburb, 3 miles out; a second to the south; and a third to the south-west. The last divides into two, of which one crosses the La Guaira, and the other, the Palo Grande, connecting with the German line at a station of that line. Besides tapping a large and populous quarter of Caracas, the Palo Grande line forms the connecting link of a chain of railways of uniform gauge stretching some 180 miles from Pto. Cabello, an important growing port to the west of La Guaira, passing through Valencia, the city second in size and importance in the north of Venezuela and, traversing Caracas, travels towards the south by the Central Railway. By this route also the Caracas meat supply is introduced into the city, the abattoir being situated a short distance from the Palo Grande Station. The maximum gradient is 4 per cent.

Track.—The rails are in 30 ft. lengths and weigh 87 lb. to the yard, and were supplied by the United States Steel Products Export Co. Sections of the permanent way are shown in Fig. 3. They are of a pattern made especially to suit South American requirements. The tie-bars are of the Bayliss, Jones & Bayliss type. The joints are of the continuous rail joint type. The rails are laid on a concrete stringer, 16 cm. deep by 47 cm. broad, and

are anchored every 15 ft. The paving is of four kinds—cobbles, setts, macadam and concrete. The special work was manufactured by the Hadfield's Steel Foundry Co. (Ltd.), of Sheffield. All points are automatic and of the best toughened cast steel with manganese tongues. They are 10 ft. 6 in. in length, and have a centre radius of 100 ft. The mates are of solid Era manganese steel, and the rails are bonded with 4/0 B. & S. concealed bonds, supplied by the United States Steel Products Export Co. The fact that no general drainage system is in use in Caracas, and that the drains in existence are principally private property and close to the surface, caused considerable hindrance to the otherwise rapid progress of the work.

Overhead Equipment.—The bulk of the overhead construction consists of side poles with cross bracket arms. The junctions are formed of 7/12 galvanised steel span wire with a breaking stress of 4,000 lb. per square inch, supplied by Messrs. W. F. Dennis & Co. Only tubular poles are employed, of which 450 are of the Grand National type, their dimensions being $7\frac{5}{8}$ in. diameter, bottom section, $6\frac{5}{8}$ in. in centre and $5\frac{9}{16}$ in. top section, and 30 ft. in length. The rest of the poles are 31 ft. in length and are of British standard pattern. All were supplied by Messrs. Stewarts & Lloyds. The bracket arm tubes are $2\frac{3}{8}$ in. diameter. The feeder boxes, supplied by Estler Brothers, are three in number, being fitted with 250 ampere quick break switches; the section boxes 14 with 100 ampere quick break switches. The trolley wire is of the 2/0 B. & S. grooved type.

Cables.—The feeder cables, some 4 miles in length, are all aerial, and are suspended from cross-arms on the poles above the brackets.



Plan and Longitudinal Section. Scale 1:50.

Scale 1:20.

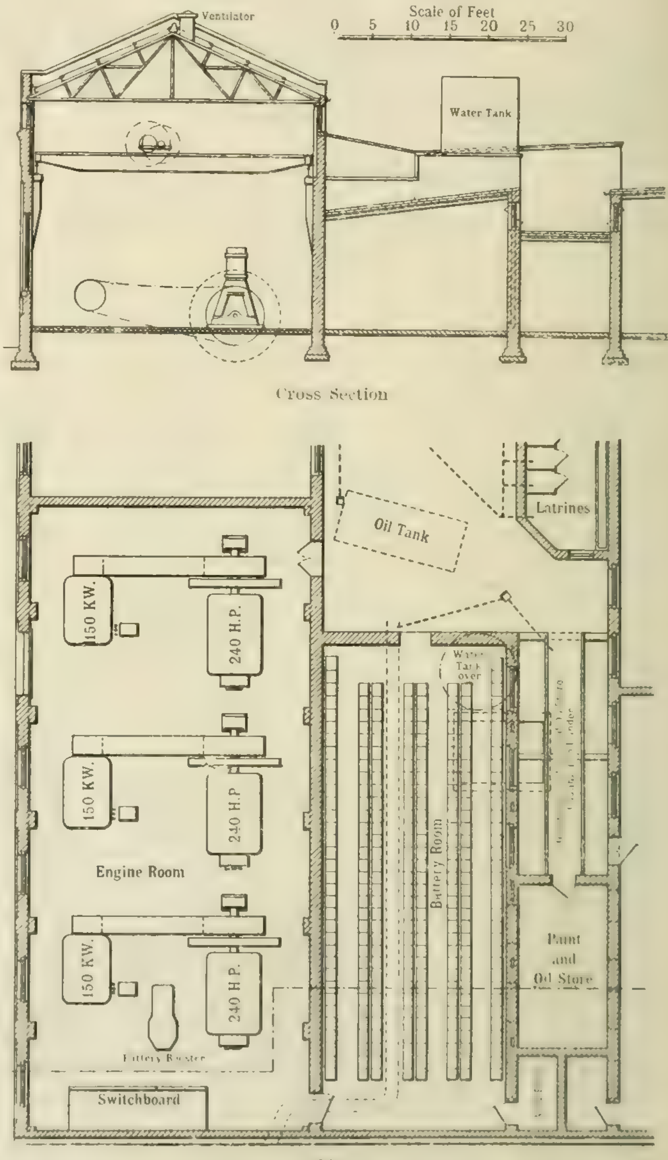
Fig. 3.—Sections of Permanent Way.

They are all of pure aluminium with a size of 0·33 and 0·25 sq. in., and have a conductivity 60 per cent. of that of copper wire with a conductivity of 99 per cent. of Mathiessen's standard of pure copper. They were supplied by the British Aluminium Co. and covered by the Silvertown India Rubber & Gutta Percha Co. with triple braided weather proof insulation and compounding overall.

Building.—The power house, office buildings and carshed are all built on one site on the north of the Avenida Este. The plot is rectangular and with a frontage of 53·870 metres, and a depth of 13·520 metres. They are all of brick with steel girders and roof work obtained from Messrs. Brown, Duncan & Co., of Bootle. The roof coverings of the power house and carshed are of galvanised iron, but the office buildings and manager's dwelling are tiled. The doors and window frames are of cedar. The general arrangement of the power house is shown in Fig. 4.

The carshed is situated at the back. Its dimensions are 35 by [illegible] metres, and its walls are 6 metres in height. It contains five tracks, two of which have a pit and are supported on iron columns. The floor and pit are concreted. The rails in the entrance and carshed are the A.S.C.E. 70 lb. tee rail, and the paving at the carshed entrance is cobble.

The frontage is taken up with the office buildings, and the power house, over which is the manager's dwelling. The office buildings are all on the ground floor and cover an area of 13 by 11 metres. It is subdivided into manager's, clerks' and accountants' rooms, and men's waiting room, and is provided with lavatory fittings by Messrs. Doulton & Co. The first story has been arranged to serve as a residence for the manager of the company, who can thus exercise the unusual close supervision requisite in training an inexperienced staff. The roof over the shops was also adapted to serve as a roof garden, providing a cool and pleasant place of retreat in the tropical evenings.



Cross Section

Plan.

Fig. 4.—General Arrangement of Power Station.

The rest of the road frontage is taken up with the engine room, with a length of 44 and a depth of 11 and a height of 10 metres, while behind the engine room is a battery room with a floor area of 19 by 7 metres and the machine, carpenters' and other needful shops, the whole making one compact and self contained system.

Power.—There are two aspects from which the power house may be regarded, either as a sub-station for a high-tension current or again as an independent producer. As a sub-station it is employed to transform from 1,500 to 500 volts. The high tension alternating current is obtained from the Electrical Co. of Caracas. This company has two stations at Encantado and Los Naranjos, about 16 km. from the capital. There are four generators at each station and more machinery is now being introduced. The motive force is the water of the Guaira River, which has a fall of 38½ metres and 154 metres at Encantado and Los Naranjos respectively. During the day the power is supplied by the Electrical Company.

In the evenings, however, when the town is lighted electrically, and also during stoppages which may occur occasionally, the power

is produced in the power house itself. This is effected by three Diesel engines of 240 B.H.P. each running at 180 revs. per min. The Diesel engines were selected on account of the high price of coal. They have, moreover, an additional advantage in that no delay need occur in starting them, an advantage which is obvious in the case of a sudden interruption of the high-tension transmission. The engines are belted to three motor-generators. On the induction motor side these are designed for 5,000 volts, three-phase, with 50 cycles, while on the direct current side they yield an output of 150 kw. at 550 volts at a speed of 500 revs. per min. The station is also furnished with a battery of 260 "Tudor" cells, with a capacity of 520 amperes for one hour and 252 amperes for three hours, the maximum charging current being 252 amperes. The Lancashire Dynamo & Motor Co. have supplied one of their automatic reversible boosters. The regulation of the battery and booster is such as to keep the load on one or two generators operating in parallel *i.e.*, 150 kw. or 300 kw. at 550 volts constant within 8 per cent. over or under the normal load of 272 or 544 amperes, provided the maximum load does not exceed 100 per cent. of the normal load of the set or sets running. In the case of 150 per cent. overload, the variation does not exceed 10 per cent. and in the case of 200 per cent. overload the variation does not exceed 12 per cent. A general view of the engine room is given in Fig. 4.

The switchboard consists of 10 panels, viz., one high-tension incoming feeder panel three-phase, 5,000 volts between wires; three induction motor panels, one battery and booster panel, three d.c. generator panels, and two feeder panels, all fitted with the necessary instruments. The board and motor-generators were supplied by the General Electric Co., of New York.

Cars.—The cars, 30 in number, each with a seating capacity of 32, are of the open single-deck type. The car bodies, supplied by Messrs. Milnes, Voss & Co., of Birkenhead, have the following dimensions:—

Length of car body over cross pieces	7·315 m.
Width of car body over sills	1·460 m.
Width of body over posts at seat ends	1·725 m.
Width over steps	1·858 m.
Length of platform at centre from outside of end posts	1·350 m.
Height of car from rail over trolley board	3·430 m.

The body framing and flooring are of teak and the roof of aluminium. The seats are of the garden seat pattern, four being reversible and four stationary. They extend transversely the whole width of the car. Storm curtains are provided at the open sides. There are destination indicators and also life-guards of the Hudson & Bowring type at each end of the car. The trucks are all of the Brill pattern, and were manufactured by the United Electric Car Co.

The electrical equipment of each car is composed of double motor G.E. 58, four-turn, 37 H.P. for 500 volts. It includes also two B18 controllers with one set of handles, magnetic blow-out circuit breaker, &c. With a view also to the sharp street corners and heavy gradients, each car has, in addition to the mechanical brake, one Westinghouse magnetic track brake.

From the commencement of the work by Messrs. J. G. White & Co., under the supervision of Mr. J. G. Rose, in March, 1907, to its completion in February, 1908, the ordinary horse-drawn tramway traffic was in full operation. The traffic and construction were so arranged that during the whole period of conversion little, if any, diminution took place in the receipts of the tramway company.

We are indebted to Messrs. J. G. White & Co. for the particulars here given.

THE APPLICATION OF TECHNICAL SCIENCE TO THE CONSTRUCTION, MAINTENANCE AND OPERATION OF TRAMWAYS.*

BY R. G. CUNLIFFE, M.SC. TECH., AND J. G. CUNLIFFE, M.SC. TECH.

Summary.—The authors show the utility of technical methods in examining the working of electric tramways. They discuss the arrangements of the feeders, the size, life and insulation of the overhead line, the return circuit, the equipment of the cars, and the current consumption per mile. A valuable feature of the Paper is the list of suggestions for profitable research in this department of engineering. A number of diagrams giving valuable information concerning the subjects treated of in the Paper are attached.

Technical science may be defined as the application of scientific knowledge and methods to the purposes of industry. The teachings of science when combined with business methods produce results which may be summed up in the phrase "maximum economy." The principle of this forms the basis of all applications of technical science, and may be briefly stated as follows:—In all industrial operations there is a "critical point" at which the gain effected by an increase of efficiency is balanced financially by the cost of obtaining such increase. This is the point of "maximum economy."

In constructing a tramway the following principles should be kept constantly to the front, as the original design determines very largely the subsequent cost of maintenance and working:—

Feeding System.—The most economical position for a generating or sub-station, or a line feed point, is at the centre of gravity of the electrical loads, and the nearest suitable position should be chosen. Thus for uniform traffic conditions and level lines the best position for the feed points is at the centre of the sections as is shown in Fig. 1. In this connection it should be observed that feeding from both ends of the sections is exactly the same as feeding from the centres of all sections and at the same time running the feeders in parallel. As it is preferable to work the feeders independently, the most economical way is to feed from the centres of the sections.

Overhead Equipment.—For mechanical requirements a small trolley wire only, say, 2/0 S.W.G., is required. This is quite strong enough, and has better wearing properties than a larger wire, if of hard drawn copper, as the hardness lies in the skin, which is of approximately the same thickness for all sizes of wire, so that a small wire has a greater percentage of skin than has a large one. In Manchester, however, a 4/0 S.W.G. conductor was employed until recently, and now a 5/0 wire is generally installed. This has been strongly criti-

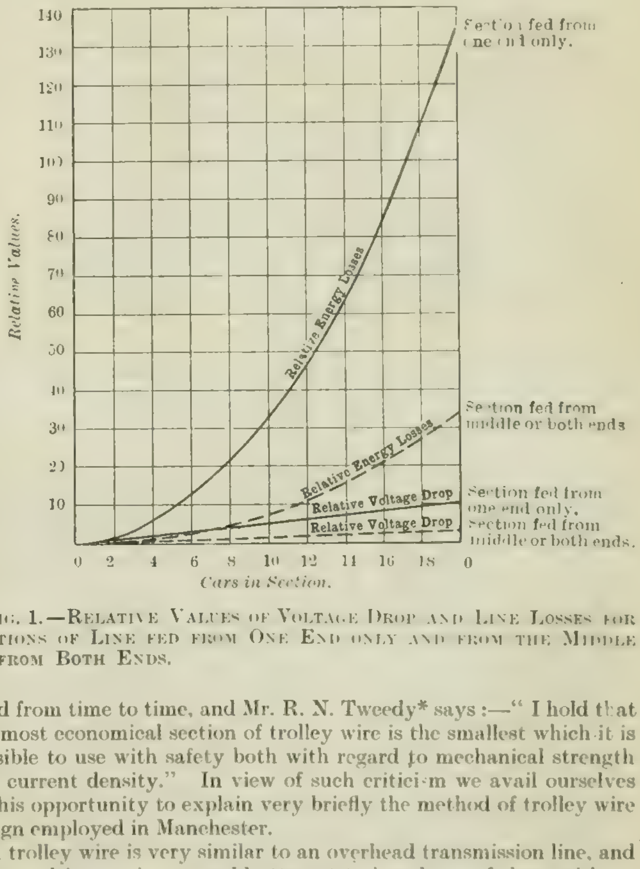


FIG. 1.—RELATIVE VALUES OF VOLTAGE DROP AND LINE LOSSES FOR SECTIONS OF LINE FED FROM ONE END ONLY AND FROM THE MIDDLE OR FROM BOTH ENDS.

cised from time to time, and Mr. R. N. Tweedy* says:—"I hold that the most economical section of trolley wire is the smallest which it is possible to use with safety both with regard to mechanical strength and current density." In view of such criticism we avail ourselves of this opportunity to explain very briefly the method of trolley wire design employed in Manchester.

A trolley wire is very similar to an overhead transmission line, and no consulting engineer would attempt to instal one of these without first calculating the most economical size of wire to employ. The problem is evidently not very difficult in the case of a transmission line, but for tramway work the wire is constantly wearing, and the difficulty is to determine the depreciation. In addition, maintenance and renewal charges now appear.

Evidently, before finding the most economical size of wire, it is necessary to determine the most economical life, *i.e.*, the most economical rate of depreciation. Thus from a knowledge of the capital costs of material and labour in erection and removal, the interest, depreciation and scrap values, the most economical life and then the most economical size of wire are determined. We have arranged to present the method, fully worked out, to the Institution of Electrical Engineers, and it will probably appear in their journal early next year.

Mr. Tweedy further objects to the short life of about seven years usually allowed. We, in Manchester, find it most economical to allow three to five years, according to traffic density. These figures

* Abstract of a Paper read at the recent Conference of the Municipal Tramways Association.

* *The Electrician*, Vol. LXI., p. 160.

may appear surprising, but this is only because the value of the electrical losses is seldom realised. The method of calculation is given in an appendix where particulars of tests show that the rates of wear for hard drawn 4/0 copper wire, with a resistance of 0·337 ohms per mile, are approximately 3 to 7 per cent. per annum for suburban traffic, and 7 to 10 per cent. for city traffic. The increases in resistance corresponding to the above are 3·1 to 7·6 per cent. and 7·6 to 11·1 per cent. per annum respectively.

Fig. 2 shows a typical example for Manchester conditions. This refers to a 7/0 S.W.G. conductor, the heaviest employed anywhere for tramway work to-day, and yet it will be observed that the heaviest individual loss is the electrical loss, and that the most economical life is only four years. The calculations have been carried out for city, urban and suburban lines, with the result that the wire should vary

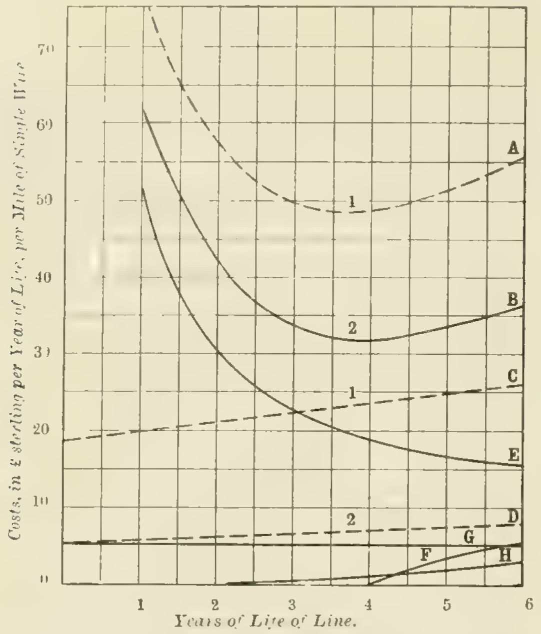


Fig. 2.—7/0 S.W.G. Wire. Costs per Year of Life, &c.

A. Total costs, 1. B. Total costs, 2. C. Electrical losses, 1. D. Electrical losses, 2. E. Depreciation. F. Anchoring. G. Interest on capital cost. H. Renewing cars. 1. Refers to line fed from one end only. 2. Refers to line fed from middle or from both ends.

in size from 6/0 to 5/0 to 4/0 respectively, but, as in the city the feeding points are, as a rule, very close together, the difference between the 5/0 and 6/0 wires is only apparent on about two short sections; and so for the suburban lines 4/0 wire is employed, and everywhere else a 5/0 wire is installed. It is found that the same line fittings can be employed for both 4/0 and 5/0 S.W.G. wire, but not for 6/0 wire. The saving varies according to the length of the section and the traffic density, from £1 to £10 per mile of wire per annum, and as Manchester has over 200 miles of overhead line the matter becomes of importance. In addition, maintenance and emergency costs are diminished because the wire is never allowed to wear thin.

under the influence of capillary attraction and of electrical endosmose more especially of the latter, water saturated with atmospheric impurities, which in Manchester is a powerful electrolyte, is drawn between the metal bolt and the insulating material, and is forced across from the positive metal of the bolt to the negative metal of the hanger. Electrolysis takes place; the metal of the bolt is corroded; a rust film is formed beneath the insulation which is split asunder. Fig. 3 shows the results of insulation tests carried out from day to day on two exactly similar bolts fixed in a vertical position in a tank containing a dilute solution of salt, the level of the liquid being kept just above the bottom of the insulation, the part in practice exposed to the weather. Wire gauze was wrapped tightly round the heads of the bolts, and between the water and the gauze of one bolt a potential of 500 volts was maintained night and day throughout the duration of the test, the water being positive with respect to the gauze. It was our intention to continue this until breakdown occurred, but Fig. 3 represents the state of the test at the time of writing, and fully

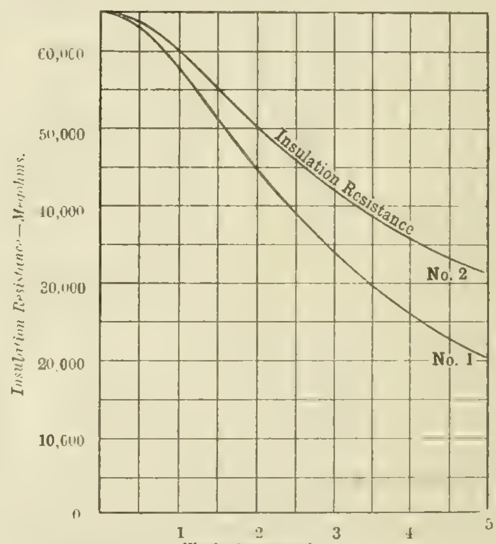


Fig. 3.—Insulated Bolts. Effect of Endosmose. Bolts Immersed in Dilute Salt Solution.

Bolt No. 1.—Kept alive at 500 volts throughout test.
Bolt No. 2.—Dead. Test still continuing.

bears out the above theory of the cause of failure, the conditions being purposely exaggerated in order to shorten the life.

In practice there is a considerable benefit to be derived even on level, equally-loaded lines, from having the trolley wires working in parallel, but it is of very little use to have them paralleled at two or three points only by means of "jumpers." They should be paralleled at every span by removing the insulator bolts and building the line as shown in Fig. 4, either with or without the central conductor. It will be said that this would cause shut-down of both lines in case of failure of either, but this we contend is an advantage, as it prevents bunching of the cars at the terminus, and with an emergency system

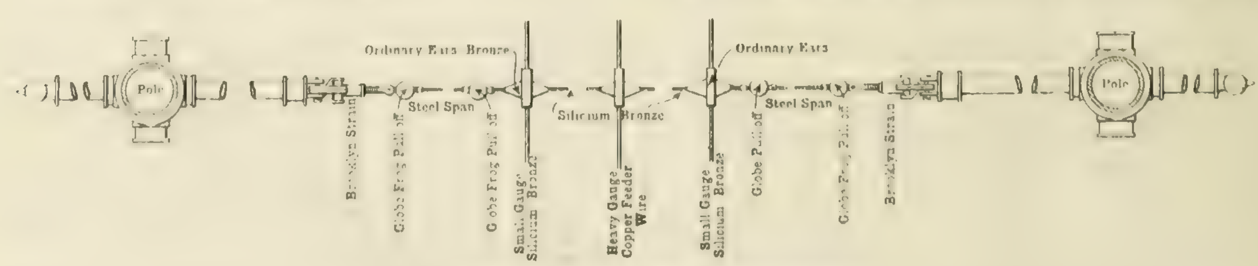


Fig. 4.—Suggested Overhead Construction.

An interesting side issue is that the anchoring of worn wire is a waste of money, as when a line is ready for anchoring it is ready for renewing.

Insulation.—In Manchester this is triple, the component parts being as follows:—Primary, insulator bolts in hangers; secondary, globe strain insulators; tertiary, Brooklyn strains. Of these the primary is the most interesting, as it is the weakest and least necessary.

Messrs. Tweedy and Dudgeon have shown before the Institution of Electrical Engineers that the failure of the primary insulation is due to electrolysis, but they have not explained how this is caused. Experiments carried out in the test room at Manchester show that,

like that at Manchester, no line fault can keep the service shut down for more than a very few minutes, and, in addition, such faults are almost unknown with efficient maintenance and inspection. The saving effected would be considerable under practical conditions.

Return Circuit.—Here, owing to the great current carrying capacity of the rails, there is no financial need to consider electrical losses; in fact, the rails are made far heavier for mechanical reasons than is necessary for electrical purposes. Unfortunately, however, there is another condition which requires the conductivity of the return circuit to be far greater than the economic limit, viz.:—electrolysis. As we shall show in a Paper to be read before the Institution of Electrical Engineers, November 27, 1908, there is no danger of electro

lysis under normal conditions, but in case of damp ground between pipes and rails in two or more places some distance apart, damage may be caused. Still, tramway authorities ought not to be put to any great expense in order to keep the rail drop exceptionally low, and a rail drop of 5 volts is not too high.

It has been the practice in Manchester, and is still the practice on most other tramways, to use a combination of 34 in. and 8½ in. bonds, mostly 4/0 S.W.G. In Manchester, two of the former and one of the latter have been used at every joint. As a general principle it is

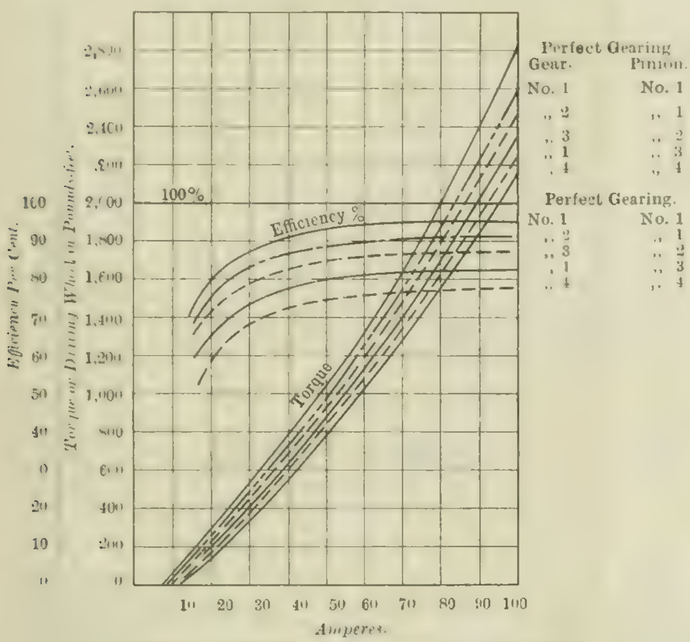


FIG. 5. -TORQUE AND EFFICIENCY LOAD CURVES.

Involute gearing, new and old. Cut steel gear wheels, 67 teeth (*see* Fig. 6). Cut steel pinions, 14 teeth. Driven by G.E. 52 motor.

uneconomical to run copper conductors in parallel with heavy steel rails, as the rails themselves have a better conductivity than any copper of an economical section. Thus, in the case of junctions, cross-over roads, &c., it is far better to efficiently bond the component parts together by means of short bonds than to run long copper strips haphazard round the special work.

A factor which is far more important than rail drop is length of section, as the leakage currents are proportional roughly to the cube of this length. Thus return feeders should be installed at short

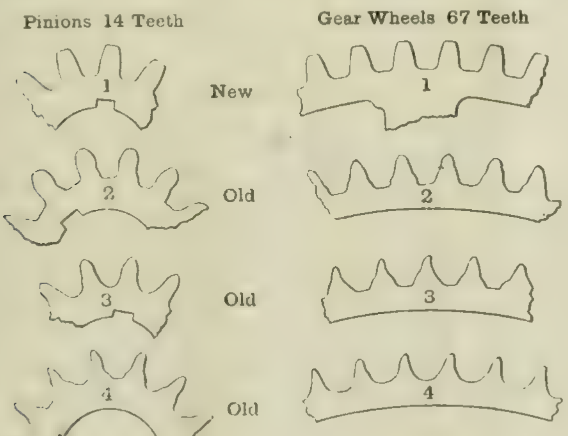


FIG. 6.

intervals, and it is better for each positive feeder to have its negative, as in Manchester. Negative feeders are useless unless they draw the current from the rails in both directions, so that the directions of flow of current in the rail on the two sides of the negative feed point are mutually opposite. If a feeder alone will not cause this reversal, then a negative booster should be employed.

Car Equipments.—The series parallel control has been universally adopted for electric cars. The maximum demand of the car occurs during parallel running, as, the tractive effort remaining about constant, the rate of supply of energy to the car must increase with the speed. It is important that this maximum demand should be kept low, and this can only be done by diminishing the tractive effort required, *i.e.*, the acceleration, during parallel working, and since a definite average value of the acceleration is required throughout the starting, the acceleration, hence the tractive effort, hence the current, must be increased in the series control, and that without diminishing in the least the time occupied in passing through the series notches, since this time is just as valuable as the acceleration itself in producing speed. The only way in which the result can be obtained is by diminishing the resistance on the various series notches, and in Manchester we have so treated a G.E. 52 equipment, reducing the resistance on the second series notch, and cutting it out altogether on the third, so that during the whole time allowed for the third and fourth notches the motors are running on the line.

Records were taken of the starting current by means of a specially designed recording ammeter, working at the rate of 12 in. per minute, and care was taken never to increase the current beyond the normal full load of the motors. An appreciable increase in series accelera-

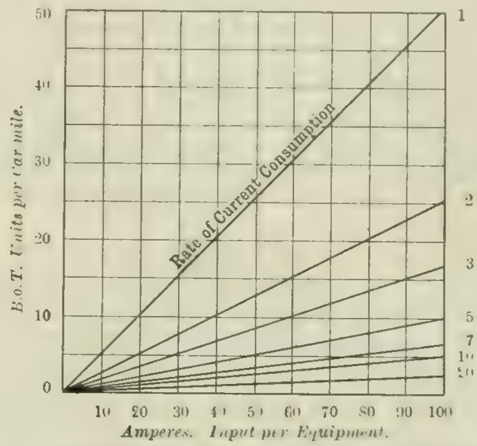


FIG. 7.—EFFECT OF SPEED ON RATE OF CURRENT CONSUMPTION.

Line voltage, 500.

tion was obtained, and the maximum demand was reduced by 12 per cent. The increased acceleration was not productive of jerking, or any other uncomfortable sensations to passengers. In order to keep down the size of the motors they are designed for a high speed, and a single reduction gear is employed to transmit the energy to the driving axles. It is of great importance that this gearing should be kept in good condition, as is shown by the curves of Fig. 5, the profiles of the various wheels and pinions being shown in Fig. 6. In

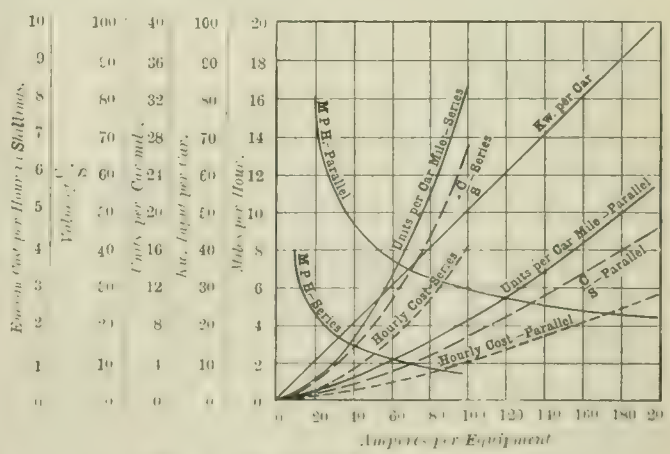


FIG. 8. CONSUMPTION CHARACTERISTICS.

Car equipped with two G.E. 52 motors. Line voltage, 500.

addition, the driving axles must be kept perfectly straight, as we found that a bend of from $\frac{1}{16}$ in. to $\frac{1}{8}$ in. in the centre would cause a loss of efficiency of from 8 to 16 per cent. The arrangement for these tests is described by the authors, a specially designed water-cooled band brake being employed, in conjunction with a compound steelyard balance mounted on a tripod, to measure the mechanical output, torque, &c., whilst an analysis of the acceleration, torque and horse-power requirements are treated in an appendix to the Paper.

Current Consumption.—There are two ratios employed for the expression of the rate of current consumption, viz.:—(*a*) the B.T.U

per car-mile; and (*b*) the B.T.U. per ton-mile. Neither ratio can be employed with fairness for purposes of comparison between different tramway systems, but variations in both should be carefully watched and accounted for in each individual system.

It is of advantage to obtain as high an average speed as possible for the system, as thereby not only is the number of cars necessary for a given service diminished, but although the working current is slightly increased, yet the units per car-mile are lower, as the increase in current is not in proportion to the increase in speed, as is shown by Fig. 7. The relation is given by the following equation:—$U=2S/C$, where $U=$ B.T.U. per car mile, $C=$ current taken by car in amperes (average), $S=$ speed of car in miles per hour, the line pressure being 500 volts. The running costs are shown in Fig. 8, both for series and parallel working.

During the past working year the account for energy supplied to the Manchester tramways amounted roughly to £143,000, so that every 1 per cent. saved represents over £1,400. By adopting the larger trolley wire Manchester saved several thousands of pounds per annum, in addition to paying the difference in capital costs, &c., and such saving will continue indefinitely. If the gearing is kept in the best possible condition the loss will be £7,000 per annum, but if neglected it can rise to £35,000 per annum. Bent axles may safely be said to account for another £5,000 per annum, and with the slightest neglect this can become £10,000. The efficient maintenance of these parts of the equipment is a costly process, but the care and expenditure are repaid by a saving of many thousands per annum, and the economies effected must, on the whole, make themselves felt even in Manchester's annual expenditure of £500,000 in working costs.

Suggestions for Profitable Research.

Overhead Equipment.—On consideration, it seems strange that a comparatively soft and expensive metal like copper should be employed for trolley wire simply because it possesses good current-carrying properties, and this has led to the adoption of silicium bronze wire, which possesses far better wearing properties than a large copper wire, as it is harder, and in addition its hardness extends throughout, as the metal is homogeneous, whereas, as already stated, hard-drawn copper wire consists of soft copper surrounded by a hard envelope. As the conductivity of silicium bronze is only 60 per cent. of that of copper, however, it becomes in the end an extremely costly metal to employ, and the 2/0 S.W.G. silicium bronze trolley wire at present being installed by certain English tramway authorities must be very uneconomical indeed.

In order to combine the mechanical properties of silicium bronze with the electrical properties of copper, we suggest the equipment shown in Fig. 4, consisting of two trolley wires of small gauge silicium bronze to take the wear and a central conductor of copper to carry the current. The three would be connected together at every span, The centres of the spans being made of silicium bronze stranded wire in order to carry the current. The present primary insulation would be abolished together with the costly hangers, a simple gun-metal attachment being required.

The tensile strength of silicium bronze is 45 per cent. greater than that of copper, and its resistance is also about 45 per cent. greater for wires of the necessary size, the torsional strength being 20 per cent. greater. Trolley wire fails by cracking about ½ in. inside the car, owing to continual vibration equivalent to a bending at the ears, and this would be reduced to a minimum by the adoption of the small gauge silicium bronze, whilst the copper conductor could be stranded, thereby gaining both in flexibility and strength. The first cost would be heavy, but the life of the line would be much greater, and when the time for renewal arrived, only the small silicium bronze wires would require replacing.

Return Circuit.—Experiments show that the fishplates provide an important part of the conductivity of the rail joints, being on the average better than a 4/0 S.W.G. 34 in. Chicago bond. As the mass of metal is nearly equivalent to 1 sq. in. of copper, we suggest fish plates with a thin layer of soft copper electrolytically deposited on their edges, tightly screwed to rails having their flanges cleaned and painted with copper sulphate solution. A copper to copper contact would be obtained, and it might be found possible on experiment to dispense with bonding altogether, as with double track efficiently cross bonded, even the entire failure of a joint would not be noticed.

Car Equipments.—As both maximum demand and current consumption are proportional to weight of car, this should be kept as low as possible, and any additional expenditure in providing cars of pressed steel with girder sides entirely self-supporting would be repaid by the saving effected. The most important factor in the current consumption is the driving, and by taking from the driver the control of rate of acceleration whilst leaving him full control of the starting and stopping the car, much could be saved without risk of damage. Thus it might pay to develop a system of control employing one or other of the several compounds at present on the market, possessing the property of automatically lowering their electrical resistance with increasing temperature. Thus, as all the properties are known, it would be possible to design an equipment to start the car at any given rate on the driver putting in the main switch. The only difficulty would be that the temperature of the resistances would not fall quickly enough, but this could easily be overcome.

Motors should be designed for the highest possible torque per ampere, and the starting qualities should be watched just as zealously as the load efficiency at 500 volts. On systems where maximum demand is of unusual importance, special combinations of the four-motor equipment are worthy of consideration. By the insertion of thin sheets of hard steel between the poles and the yokes, a sufficiently high permanent magnetic field to permit of reliable rheostatic breaking might be obtained without appreciable loss of efficiency, and the bonding together of the two motor frames makes this independent of the track.

The gear ratio should be as high as is obtainable with single reduction gearing, and the Renolds silent chain might here be worthy of consideration. The pinions would probably be better made like a truncated cone with the smaller diameter towards the motor, as pinions worn to this shape give a higher efficiency than when parallel, since with parallel pinions the inner ends of the teeth dig into the metal of the gear wheels, owing to whipping of the armature shaft.

CORRESPONDENCE.

OSCILLATION VALVE OR AUDION.

TO THE EDITOR OF THE ELECTRICIAN.

Sir: My attention has been called to Prof. Fleming's last letter in your issue of Sept. 11th. It should not be difficult for an unbiased reader of my American Institute Paper to perceive the fundamental differences between the audion and an "oscillation valve."

It is needless to reiterate these facts. It may however be pertinent to point out that Prof. Fleming's changing phraseology indicates that, whereas he formerly declaimed that the audion was his oscillation valve, he now would intimate that his valve is the audion!

Originally the "oscillation valve" was not a detector, but simply what its well-chosen name indicated, a rectifier permitting the detection of high-frequency currents by a galvano meter. This valvular action of an exhausted vessel containing one hot and one cold member was described by Elster and Geitel, *et al.* I doubt if Prof. Fleming will deny this. If to apply this rectifier to high instead of to low-frequency currents constitutes a basic invention, Prof. Fleming may have all the credit he can accumulate.

But a broad claim on such application of an old device is not liable to receive the support of the courts, as the disclaimer filed by the Marconi Co. in the United States as the result of their early patent suit bears pertinent witness.

I obtained an entirely different phenomenon from the valve action when I inserted an additional battery, of a potential much higher than that of the lighting current and a telephone receiver in the branch circuit. The difference between the "trigger" and the valve action is still more obvious and more marked when I insert two cold members in the chamber, enormously increasing the efficiency. All this is fully described in my U.S. patent No. 879,532; but Prof. Fleming now claims that this also is his valve. Truly a valve acts only in one direction! In view of the fact that my first patent application, claiming broadly the use of a heated gas as an element in a detector (the "flame audion") was filed in 1902, Prof. Fleming's avowal of priority of broad claim is amusing.

Also, in view of this fact, the statement of Prof. Fleming that the "valve" has operated across the Atlantic may prove a very interesting bit of evidence a little later on, although my experience convinces me that the "valve," *as disclosed* by Prof. Fleming, is absolutely incapable of any such performance.

The audion can so operate.

So far as I am concerned, the journalistic phase of this question is here ended.—I am, &c.,

Portsmouth, Sept. 27 — Lee de Forest.

INTERNATIONAL CONFERENCE ON ELECTRICAL UNITS AND STANDARDS.

By invitation of the British Government the International Conference on Electrical Units and Standards, as already announced, will be held in London during the present month, the place of meeting being the rooms of the Royal Society. The first meeting of the Conference will be held on Monday next at 11:30, when the delegates will be received by the President of the Board of Trade, and in the evening of that day there will be a reception by the Royal Society. The meetings of the Conference are expected to last until the 22nd inst., but the date is not fixed, as it will depend entirely on the progress made with the work.

The main object of the Conference is to obtain international agreement on the three electrical units, the Ohm, the Ampere, and the Volt, so that the realisation of these units in all the countries of the world shall be as nearly as possible identical. The best method of setting up the Mercury Ohm, the Silver Voltameter and the Cadmium Cell will be considered, and it is hoped that detailed specifications may be issued with the authority of the Conference.

The social programme that has been arranged is quite extensive, and, combined with the above objects, will not leave much leisure. The delegates will be entertained at an official banquet, and will lunch with the Lord Mayor; they will also make an excursion to Cambridge on the invitation of Trinity College and pay a visit to the Cavendish Laboratory. The Board of Trade Government Standards Laboratory will be open to inspection by the delegates, and the National Physical Laboratory at Teddington will be visited. The delegates will also dine at the Franco-British Exhibition with the "Dynamicables," and are invited to the annual dinner of the Institution of Electrical Engineers.

The 18 countries that are sending delegates are represented as follows:—

America – United States.—Dr. Henry S. Carhart, Professor of Physics at the University of Michigan; Dr. S. W. Stratton, Director, Bureau of Standards, Washington; Dr. E. B. Rosa, Physicist, Bureau of Standards, Washington.

Belgium.—M. Gerard, Director of the Montefiore Electrotechnical Institution and President of the Consultative Commission on Electricity; M. Clément, Secretary of the Consultative Commission on Electricity.

Denmark and Sweden.—Prof. S. A. Arrhenius, Nobel Institute, Stockholm.

Ecuador.—Senor Don Celso Nevares, Consul-General.

France.—M. Lippmann, Member of the Institute and Professor at the Sorbonne.

Germany.—Dr. Warburg, President of the Imperial Physico-Technical Institute; Dr. Jaeger, member of the Imperial Physico-Technical Institute; Dr. Lindeck, member of the Imperial Physico-Technical Institute.

Great Britain.—The Right. Hon. Lord Rayleigh, President of the Royal Society; Prof. J. J. Thomson, Cambridge; Sir John Gavey, C.B.; Dr. R. T. Glazebrook, Director of the National Physical Laboratory; Major W. A. J. O'Meara, C.M.G., Engineer-in-Chief, General Post Office; Mr. A. P. Trotter, Electrical Adviser to the Board of Trade.

Guatemala.—Dr. Francisco de Arce, Diplomatic Representative London and Paris.

Italy.—Prof. Antonio Roiti of Florence.

Japan.—Mr. Osuke Asano, Doctor of Engineering, Official Expert of the Department of Communication, Tokyo; Mr. Shigeru Kondo, Official Expert of the Department of Communication, Tokyo.

Mexico.—Don Alfonso Castello; Don Jose Maria Perez.

Netherlands.—Dr. H. Haga, Professor at the University of Gronigen.

Paraguay.—M. Maximo Croskey.

Spain.—Don Jose Maria Madariaga, Professor of Electricity and Physics at the School of Mines, Madrid.

Switzerland.—Dr. F. Weber, Professor of the Swiss Polytechnic School at Zurich; Dr. Pierre Chappius of Bale; Dr. J. Laudry, Professor of Electricity in the School of Engineers, Lausanne.

BRITISH COLONIES. *Australia.*—Mr. Cecil Darley; Prof. Threlfall.

Canada.—Mr. Ormond Higman, Chief Electrical Engineer, Inland Revenue, Ottawa.

Crown Colonies.—Major P. Cardew, Electrical Adviser.

India.—Mr. M. G. Simpson, Electrician of the Indian Telegraph Dept.

Proposed New Electric Railways.—An attempt is being made to induce the L. & S.W. Railway Co. to obtain parliamentary powers to construct an electric railway from Wimbledon to Sutton. At a meeting of interested persons at the Westminster Palace Hotel on Wednesday a committee was appointed to prepare a project. Should the line be sanctioned the Metropolitan District Railway Co. will probably secure running powers over the new line to Sutton.

It is also reported that the scheme for the proposed new tube from Victoria to the Crystal Palace is making progress.

THE PRODUCTION OF FINISHED IRON SHEETS AND TUBES IN ONE OPERATION.*

BY SHERARD COWPER-COLES.

Summary.—The author describes an electrolytic process for making tubes, cylindrical vessels, sheets and wire in one or two operations from crude or scrap iron, or direct from the ore, without the processes of smelting, rolling or drawing, and at a much lower cost than usual.

One of the first, if not the first, to mention iron produced electrolytically was Bockbushmann in 1846. He deposited on a copper matrix a plate of iron 150 mm. square (5·9 in.) and 2 mm. thick (0·079 in.). In 1857 Feuquieres exhibited specimens of electrolytic iron at the Paris Exhibition. Up to the present time the process of electro-deposition has been confined to the facing of engraved copper plates for fine printing, such as bank notes, as iron has the advantage of being easily removed with acid when worn through, thus enabling the iron facing to be removed without damage to the copper plate. Klein introduced a process in Russia for the production of iron electrotypes for bank note printing—that is, the plates were made of solid electrolytic iron instead of being copper faced with iron. The electrolyte used was composed of ferrous and magnesium sulphates, a current density as low as 0·30 ampere per sq. dm. being necessary, one and a half months being required to give a thickness of 2 mm. (0·079 in.). A list of the electrolytes most commonly employed for the deposition of iron are given in the Paper, and also tables showing the voltage required for different electrolytes at varying temperatures and current densities, the distance between the electrodes being 2 in. and the cathode being moved.

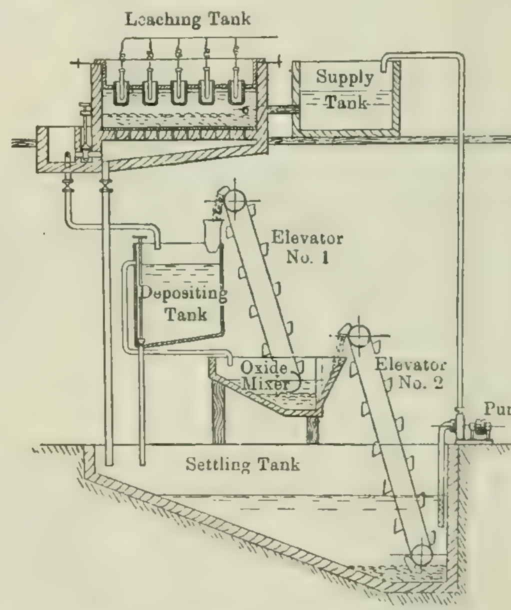


FIG. 1.—GENERAL ARRANGEMENT OF PLANT.

The author in the year 1898 made a number of experiments on the production of electrolytic iron plates, and produced plates of considerable thickness, but in such a rough condition that they required smelting and rolling; the rate of deposition, moreover, was so slow as to render the process impracticable, and it was not until the year 1900 that he succeeded in obtaining some small tubes. Some of the chief difficulties encountered were gas lines and pits and exfoliated deposits. The results obtained were a great advance on what had hitherto been effected, but were not far enough advanced to be turned to practical account; and it was not until the present year that sheets and tubes were obtained of a quality equal to steel, and with a surface that required no after treatment, such as rolling or drawing.

An electrolytic iron production process, to be of commercial value, must fulfil the following conditions, namely: The voltage between the terminals of the depositing cell must be low, the current density per square foot of cathode surface must be high, and the iron or steel deposited must be in such a form that it can be used for industrial purposes without smelting. An electrolytic process that fulfils these conditions must revolutionise many branches of the iron trade, as it will enable thin iron tubes and sheets in particular to be produced at a very low rate of cost and without the necessity of burning coal or carbon. The process briefly consists in placing crude iron (which

* Abstract of a Paper read at Middlesborough before the Iron and Steel Institute.

may contain those elements which are at present so detrimental to the production of high class iron or steel), or finely divided iron ore, in suitable containing vessels in which an acid solution is circulated, using an insoluble anode material; or, further, the process may combine the use of soluble and insoluble anodes. The crude iron or iron ore being in each case connected to the positive pole of a dynamo, the iron goes into solution, and is deposited on cylinders or plates which may be either rotated or stationary, depending upon the class of finished product required. Fig. 1 represents the general arrangement of the apparatus employed when depositing from crude iron or the ore. In the former case the iron is arranged around the cathode, and in the latter insoluble anodes, of graphite, for example, a small electric current being employed to assist the leaching process. It is conceivable that in some cases iron might be recovered without mining, acid liquor being circulated over the ore deposits. The process lends itself to the recovery of iron more especially from carbonated ores, "blue billy," Lake, and bog ores. An electric process will no doubt also prove to be a valuable adjunct where pig iron is used for precipitating copper, enabling the iron to be recovered instead of running to waste. Good results have been obtained from an ore of the following percentage composition: Ferric oxide 50·7, lime 3·8, phosphoric acid 1·51, alumina 10, silica 16. When it is desired to produce a highly finished sheet, a metal sheet of the desired surface is wrapped round the cathode, and held in position by means of grooves and wedges, as shown in Fig. 2. In this way sheets of

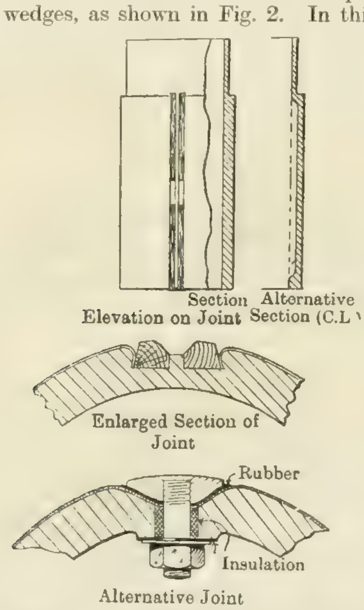


Fig. 2.—Construction of Cathode.

large dimensions can be made; by employing a mandrel, say, 8 ft. diameter, a sheet 24 ft. by 5 ft. or 7 ft. can be produced. When it is desired to produce tubes, iron mandrels somewhat smaller than the internal diameter of the finished tube are coated with lead by electrodeposition, or by having lead drawn over them. Thus prepared, the mandrels are rotated in such an apparatus as is shown in Fig. 3. When the desired thickness of iron has been deposited the mandrel is heated to a temperature sufficient to melt out the lead, and thus admit of its easy withdrawal.

The electrolyte employed consists of a 20 per cent. solution of sulpho-cresylic acid saturated with iron. Sulpho-cresylic acid is a cresol-sulphonic acid containing approximately 108 parts of cresol and 98 parts of sulphuric acid. The cresol contains ortho, 35 per cent.; meta, 40 per cent.; and para, 25 per cent. This cresol is heated with sulphuric acid, yielding isomeric cresol-sulphonic acids. In some cases it is advantageous to add small quantities of carbon-disulphide, the temperature of the solution being about 70°C., the current density about 100 amperes per sq. ft. The solution is kept charged with iron oxide, which is kept in suspension in the electrolyte by means of stirrers, by moving one or both of the electrodes, or by circulating by means of a bucket pump, as shown in Fig. 1. The specific gravity of the electrolyte having the iron oxide in suspension is about 1·32. Excellent results have also been obtained by depositing the iron in a closed cell with a vacuum of a few inches, and also with a chloride solution and porous cells, bleaching powder being produced as a by-product; or the chlorine utilised to form fresh iron chloride.

The following are two typical analyses of electrolytic iron produced under the conditions described: (1) Carbon (by combustion) 0·030, silicon 0·011, sulphur 0·016, phosphorus 0·041 per cent., manganese, trace, arsenic 0·004 per cent.; (2) combined carbon under 0·05, silicon 0·048, sulphur 0·045, phosphorus 0·04, arsenic 0·01 per cent., manganese, traces.

A peculiar feature of electro-deposited iron is that it creeps to an extraordinary degree with a rounded, smooth edge over any material; in fact, it is difficult to stop its spreading. Under certain conditions, when employing a rotating cathode, long tentacles form, 6 in. or more in length, in the direction of rotation with approximately the same curvature as the mandrel.

Amongst other applications the process can be applied to the production of bimetallic tubing and plates—that is to say, to tubes or sheets coated on the one side with copper or other metals or alloys. The process can also be applied to the direct production of large sheets or strips representing the cutting surface of a file, and cut up into portions of the desired shapes, and secured to suitable backing, to form separate files. Electrolytic steel, with considerable variation in the percentage of carbon, can also be produced. Houllevigue observed that when iron is deposited from iron containing uncombined carbon, the product at the cathode was free from carbon; but when deposited from iron containing combined carbon, the cathode product also contained carbon. The author's observations confirm this statement. The amount of silicon in the iron can also be considerably varied. An important feature of the electrolytic process will no doubt be the introduction of some new ferrous alloys, which cannot be made by fusion. Alloys of iron and nickel have already been produced electrolytically. Electrolytic iron sheets can be obtained with a highly finished surface, can be readily welded, coated with tin and zinc by dipping in a molten bath of these metals, coated with zinc by the Sherardising process, or electro-galvanised. The structure of electrolytic iron varies considerably, and in some cases it is found to be amorphous; whilst in other instances it possesses a structure somewhat similar to that of wrought iron. The structure is very minute as compared with wrought iron, the crystal grains being elongated at right angles to the surface of the steel, and there is not the same tendency to form a definite crystalline structure as in the case of electrolytic copper, which always crystallines at right

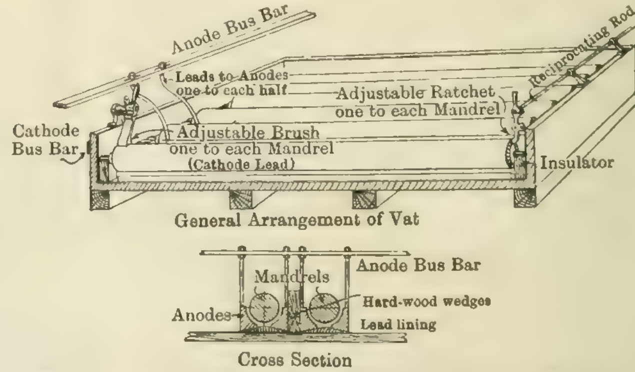


Fig. 3.—Apparatus for the Direct Production of Tubes.

angles to the cathode surface. Also a weak line of cleavage cannot be formed with the same precision as with copper.

The properties of electrolytic iron appear to depend largely on the amount of hydrogen present, and therefore on the annealing, which reduces or eliminates the occluded hydrogen. Samples tested have given a hysteresis loss of under 0·3 watt per lb. The iron when charged with hydrogen is magnetic; and when magnetised, becomes a very powerful magnet as compared with ordinary steel. Electrolytic iron always contains hydrogen in varying quantities, according to the conditions under which it is deposited, and the more hydrogen it contains the greater is its hardness. Longheber has found electrolytic iron to contain 0·2 to 0·001 per cent. of hydrogen. Although these figures appear small when expressed as weight percentage, they represent volumes of hydrogen to iron of between 12 and 110. Other investigators have obtained even larger percentages of hydrogen.

Electrolytic iron has a tendency, when deposited on a flat surface, to curve outwards—that is, it becomes concave relative to the anode surface when deposited on the cathode. There are two distinct varieties of electrolytic iron, with varying percentages of hydrogen; the softer kind of iron is silver grey in colour, whilst the other variety is very hard and brittle, breaking as readily as glass, and containing a higher percentage of hydrogen. The hardness varies between these two extremes. A surface can be obtained on the latter of a silvery whiteness, and with a mirror finish without polishing. Either quality can be produced at will by increasing or decreasing the E.M.F. at the terminals of the cell. Iron highly charged with hydrogen is very inert, and not readily attacked by acids. The softer quality is also comparatively inert. Equal surfaces of wrought iron and electrolytic iron were immersed in pure hydrochloric acid, 2°, Twaddell, for 18 hours. The electrolytic iron lost 2·48 per cent. of its weight, and the wrought iron 13·13 per cent. The temperature required for annealing electrolytic iron is slightly in excess of that required for

ordinary rolled sheets. Electrolytic iron, when heated in a closed annealing box, gives off large quantities of hydrogen; and if a pipe is fitted to the annealing box the hydrogen flame can be kept burning during the whole process of annealing, and for a considerable time after the heat has been removed from the annealing box. This phenomenon has been turned to account for removing scale from ordinary rolled sheets by placing some sheets of electrolytic iron in an ordinary annealing box with plates to be scaled. Electrolytic iron gives up considerable quantities of its hydrogen under 100 C. without losing its brittleness, and also when boiled in water or oil.

When iron is deposited under magnetic conditions—that is, if a powerful magnet is placed behind the cathode—lines of magnetic force are obtained similar to those rendered visible with iron filings.

The author summarises the advantages of electrolytic iron as follows: (1) Finished products, such as tubes, sheets and wire, can be produced at less cost than by the processes of smelting, refining and rolling. (2) A product is obtained which does not corrode as readily as steel, at less cost. (3) The process can be worked economically when no coal is available. (4) Iron ore that is useless for ordinary smelting operations can be advantageously utilised by the electrical process. (5) The process is a power process, and utilises but little labour. Small units can be worked economically. (6) The process is more cleanly and healthy than the operations of smelting. (7) Little or no scrap is formed.

In an appendix are given a table showing the theoretical weights, &c., deposited for various current densities, the estimated cost (£105,695) of a plant for producing 5,000 tons per annum, and the cost of operation, which works out at £5. 5s. 3d. per ton, or £3. 15s. 3d. with electrical energy at $\frac{1}{10}$d. per unit, as in Sweden, instead of $\frac{1}{4}$d.

THE PREPAYMENT METER OF MESSRS. FERRANTI, LTD.

To the man who objects to meeting bills quarterly, or indeed, at any time, and prefers to pay for his goods as he has them, the prepayment meter comes as a boon and a blessing. Its only objection is,

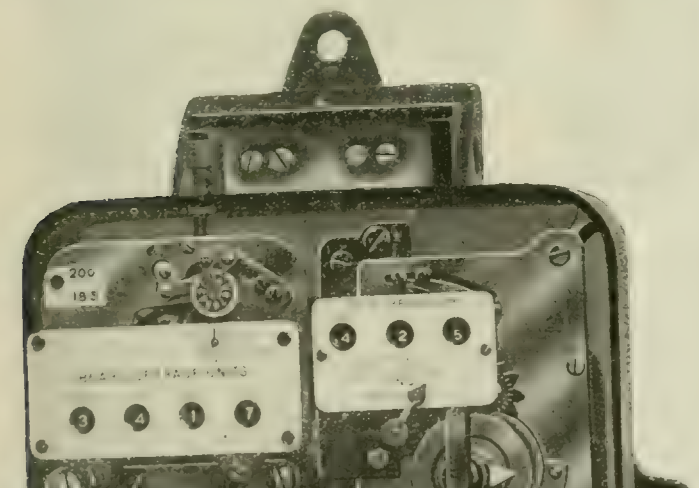


FIG. 1.—FERRANTI CONTINUOUS CURRENT PREPAYMENT METER.

perhaps, the shortage which it makes in the supply of coins, though this is probably often more fancied than real. It, therefore, seems that there should always be a constant demand for this class instrument, especially now such strenuous endeavours are being made to introduce the use of electricity to the small consumer.

Unfortunately, many meters of this type now on the market are rather too delicate for everyday use, with the inevitable consequence that trouble of some sort results. In the case of Messrs. Ferranti's new instrument, however, which is being exhibited by them at the Manchester Exhibition, there is no more, or very little more, liability for it to err than is there in their well-known standard types. In fact, this instrument, which we illustrate in Fig. 1, is nothing more than their well-known standard direct or alternate current meter, as the case may be, fitted with a special prepayment attachment. The circuit connections are the same, as is usually the case, and no extra details are required in this respect.

The special prepayment mechanism to which we refer above is illustrated in Fig. 2. It consists of a coin receiver for penny coins (or shilling coins when required), a total coin register, a coins unused register, a differential gear, a knife switch (the knife of which carries a train of wheels), and the necessary interconnecting wheels. These interconnecting wheels allow of a price per unit, varying from 2d. to 8½d. in ¼d. increments, for penny or for shilling coin meters.

The operation of this mechanism is as follows:—The winged handle in front is brought to the upright position, the coin inserted in the coin chute, the handle may then be turned one complete revolution; in so doing, the switch knife is brought into contact with the two

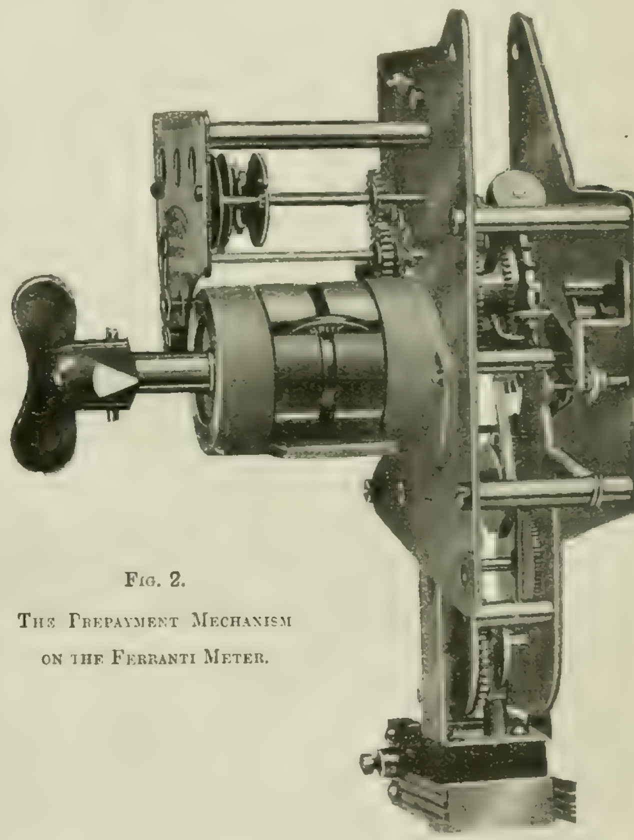


FIG. 2.

THE PREPAYMENT MECHANISM ON THE FERRANTI METER.

blades of the switch, and thereby completes circuit. The coin register is put forward one coin, and the coins unused register is also put forward one coin. Twelve coins unused is the maximum, and the thirteenth coin unused cannot be inserted.

Several advantages are claimed for this arrangement, among them the indubitably important one that the coin cannot be withdrawn. Neither can the meter be operated by a wire or knife blade, and will not work when an improper coin is inserted. The knife switch, mentioned above, is of substantial construction, with a double break and an arcing distance of 1¼ in. It is provided with a quick break action and a special train work reduces the power required for release and therby gives certainty of action. The differential gear is made in such a way as to require no power for the meter. The controlling weight is raised by the motion of the coin handle and is sufficient to release the switch, while the action of the meter allows the weight to descend.

This meter is made for use on voltages up to 250 volts and currents up to 10 amperes. Its weight is 25½ lb., and the coin box is capable of containing 180 penny coins.

We are indebted to Messrs. Ferranti for the loan of the blocks illustrating the article.

MISHAP AT THE CHELSEA GENERATING STATION OF THE "UNDERGROUND."

On Saturday last passengers on the Tube railways, the District Railway and two sections of the London United Tramways were surprised by a total stop in the service. This was initially due, as will be gathered from a perusal of the official account, to a very slfght cause. It, however, necessitated the service being suspended for some hours, though, fortunately, nobody was injured in any way. We are indebted to Mr. J. R. Chapman, chief engineer of the Underground Electric Railways Co. of London for the following details:—

At 2.45 on the afternoon of Saturday, Oct. 3, with five 5,500 turbo-generators in service all carrying approximately full load, one phase was suddenly earthed, bringing into action all the static dischargers and other safety devices in the house, and making it necessary to trip the circuit breakers on the exciters and thus shut down the generators and the 26 sub-stations supplied therefrom.

A review of the whole situation indicates that the initial cause of the trouble was a "short" between the primary and secondary windings of a series transformer in one of the conductors between a generator and its oil switch. These transformers, of which there are, of course, three to each generator, are about 8 in. in diameter and 10 in. long with a ratio of 100 : 1 and a normal load of 300 amperes. Their secondary extends to the control board and actuates ammeters and wattmeters thereon. Each transformer is placed in a brick compartment with one side open so that if a failure occurs there is ample room for the arc to escape. Such transformers are necessarily weak and have failed before in both the generating station and in the substations. They have what might be described as a squirrel cage form of winding, and are accurate within ½ per cent. at all loads. This essential accuracy requires the coils to be very close together, thus increasing the risk of breakdown. The frames of these transformers, and one point in the secondary leading to the control board are earthed. The copper earthing strips in the Chelsea generating station are of very large capacity and, of course, it only took a few seconds to develop sufficient internal pressure in the transformer to cause it to explode. After passing through the transformer the machine cable is carried vertically through porcelain insulators in the concrete floor above and into brick compartments containing the oil switch. In this instance, the force of the explosion drove the arc and flame up through the insulators, thus short-circuiting the cables leading to and from the base of the oil switch. The opening of this switch failed to disconnect the machine cables from the 'bus bars. This 'bus bar is divided into five sections and oil switches of large capacity couple these sections. The surge of current, however, owing to the earthing of one phase, was so great that a number of the static dischargers on the feeder cables were over-taxed and bridged, so that it became necessary to completely shut down in order to clear up the earth connections through the safety devices. The total damage was trifling; even the oil switch above the transformer was ready for service the next morning, and there were enough spare turbo-generators to carry the whole load, and the isolating switch blades were simply opened on the damaged oil switch. It took some little time, however, to clear up the earth connections on the 186 static discharge panels and thus make sure that it was safe to again put 11,000 volts on the 'bus bars. Two similar series transformers failed on feeder cables, and one feeder oil switch, out of 33 that were in service at the time, was slightly damaged.

All substations are supplied through duplicate cables, and, of course, the first supposition was that such a heavy surge might have damaged the cables which were in service, hence all substations were started with the cables which had not been in service at the time of the accident. The rotary converters in nearly all the substations were reversed, hence, generally, the load was taken by the machines which were previously idle, and the polarity of the other machines was thus made normal. A few rotaries flashed over, but that was the extent of the damage in the substations. Of the 357 miles of three phase cable to the substations there was not a single failure.

There were no personal injuries of any kind, either in the generating station or in the substations.

The accident proves that 2½ ft. of free air space and a 6 in. concrete floor are not sufficient between one of these series transformers and the oil switch; hence, this will be increased to 8 ft. Further, that all space between the cable and the inside walls of the insulator should be caulked tight, and with a view to limiting the field of influence. When one of these little transformers fail they will be enclosed in a somewhat larger brick chamber with one side open as at present.

The neutral point of all the generators is earthed through a cast-iron grid resistance of 7 ohms resistance and 2,000 amperes capacity.

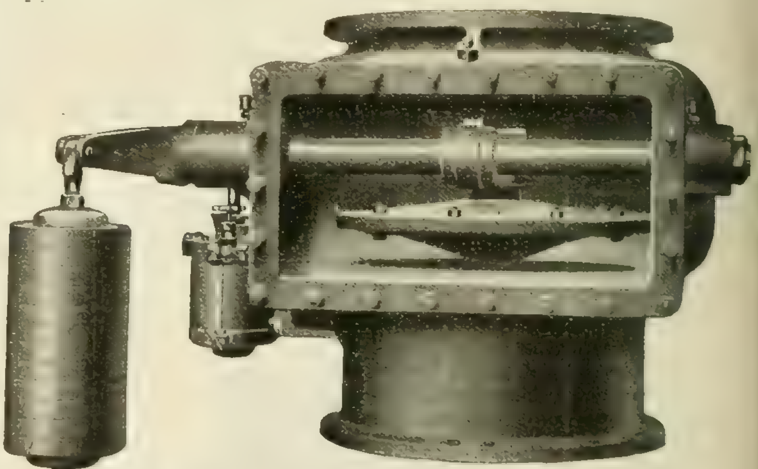
The static discharge panels are each 5 ft. long, have 8 gaps of 0.0047 in. each, and a carbon resistance rod ¾ in. diameter and 33 in. long, its resistance being 375 megohms.

AUTOMATIC EXHAUST RELIEF VALVE.

Messrs. Babcock & Wilcox have prepared for publication some instructive particulars concerning an automatic exhaust relief valve which after full trial is now placed on the market. This valve has been specially designed for work with high-speed engines, steam turbines, &c., and can be relied upon to work effectively, efficiently and noiselessly. Many of the valves have been supplied by the company in connection with the large steam plants they have installed during the last year or two, and are working most satisfactorily. Patterns for various sizes, up to 30 in., are available.

The relief valve, designed as a safety device in automatically relieving pressure in the condenser by bye-passing the exhaust steam to the atmosphere, is held hard down on its seating as long as a vacuum is maintained in the condenser, but any rise of pressure, due to the failure of the air or circulating pumps, lifts the valve and allows the steam to escape freely, thereby preventing the serious damage that might result from the sudden slowing down of an engine due to an accumulation of back pressure. The valve recloses automatically as soon as the condenser has regained its vacuum.

If one condenser is used for several engines, only one automatic relief valve is required; but if each engine has its own independent condensing plant separate valves are needed. It is usually found more convenient to place the valve within reach of the ground, and near the bottom of the uptake pipe to the atmosphere, and in this case the vertical pattern, shown in our illustration, would be used.



View of Vertical Pattern with Cover Removed.

To suit varying piping arrangements, however, it is sometimes convenient to use a valve of either the horizontal, inverted, or angle pattern, and these can, we learn, be supplied to work on the same principle as the vertical type.

The body of the valve is of cast iron fitted with a renewable seating. The valve, also of cast iron, has a white metal seating cast into a dovetailed groove. This arrangement provides an excellent air tight joint, and prevents the valve adhering to its seat. The wear is all taken on the soft metal facing, which can be easily trued up or entirely replaced if necessary. The valve is balanced by an adjustable weight on a lever keyed to a spindle, which is carried in bearings bushed with gunmetal. To prevent hammering, due to intermittent action of the exhaust steam, and to ensure the smooth action of the valve, a small piston, working in a dashpot of oil, is attached to the other end of the counter balance lever. In the valve body an opening is provided large enough to permit the removal of the valve for examination without disturbing any of the connecting pipes. A filling and a drain cock are furnished where a water seal is required, but this is not necessary except under special circumstances. A locking device for holding the valve permanently off its seating when the exhaust steam has to be passed to the atmosphere for lengthened periods is also fitted.

MANCHESTER EXHIBITION RAILWAY ARRANGEMENTS.

We have already given particulars of many of the arrangements (special and ordinary), made by the leading railway companies for enabling visitors to Manchester Exhibition to make the most of their time, while in Cottonopolis. A few further particulars have been forwarded, which we set out below:—

North Eastern Railway.—On the North Eastern line there is a restaurant car service between Newcastle, Darlington, York, Manchester, Normanton and Liverpool, worked alternately by the L. & Y. and N.E. companies. The time table of this service is as follows:—Newcastle

departure 12:30 p.m., reach Darlington 1:20, York 2:35, Manchester arrive (Victoria) 4:20, Liverpool (Exchange) 5:10 p.m.

On the return the train leaves Liverpool (Exchange) 11:10 a.m., Manchester (Victoria) 11:55, and arrives York 1:42, Darlington 2:54, Newcastle 3:48 p.m. The North-Eastern Co. have from Newcastle, Darlington, Harrogate, Hull, and York, provided through carriages with Manchester on some of their trains. These are particularly advantageous to visitors to Manchester whose time in the Midland city is limited. Hull, Newcastle, Darlington and York are all served with through trains to Manchester and Liverpool in this service.

Scottish Service to Manchester.—Parties visiting the Manchester Electrical Exhibition from Scotland will find the service of the Caledonian and London & North-Western companies very convenient. New trains have recently been put on the Scottish-English service—the finest trains in Europe, fitted with all the most modern appliances and requisites for railway travelling. Complete these trains consist of eight vehicles, each 65½ ft. long over the bodies and 69½ ft. over the buffers, giving a total length of 556 ft., exclusive of the engine. The seats of both the first and third class compartments are easy and comfortable, each carriage being fitted with two six-wheeled bogies—12½ ft. wheel base—which are so finely springed that when the train is travelling at full speed the effects of the motion are scarcely perceptible, there being almost a complete absence of vibration, enabling reading and writing without discomfort. Lavatory accommodation for both classes of passengers is excellent, each lavatory being fitted with all the latest conveniences. Special attention has been given to the dining cars, compartments or partition divisions being abandoned, providing more table space and seating accommodation. The lighting arrangements have received particular attention. The new trains are fitted on a most liberal scale with electric light throughout, the light being under the control of the guard. The new system of ventilation in the dining cars also deserves mention, an electrically-driven fan impelling cold air into the compartments in the summer and hot air in the winter by means of ducts, the air being drawn from the outside of the carriage through screens and water. The supply of air can be regulated by the attendants or passengers. The hours of departure of the new trains are :—Aberdeen 10:5 a.m., Dundee (West) 11:35 a.m., Perth 12:15 p.m., Stirling 1:7 p.m., and Glasgow (Central) and Edinburgh (Princes-street) 2 p.m.

LEGAL INTELLIGENCE.

Liability for Tramway Repairs.

At West London Police Court on Monday Mr. Garrett heard a series of summonses taken out by Hammersmith Council against the London United Tramways (Ltd.) for the recovery of penalties in respect of alleged non-compliance with certain statutory obligations in the matter of the maintenance and repair of roads along which the tramway system is operated.

Mr. Bodkin (for the Council) said there were clear statutory obligations imposed on the company in respect of the proper maintenance of their lines, and the local authority had power to enforce those duties, failure to comply with which entailed a penalty of £5 for every day during default.

Mr. L. Macassey (for the defence) objected to evidence being taken, as under sec. 33 of the Tramways Act, 1870, jurisdiction was removed from a Court of Summary Jurisdiction, and he contended that the matter in difference should be settled by a referee appointed by the Board of Trade.

The Magistrate held that he possessed jurisdiction in the matter. He thought the section referred to was intended to deal with a different set of circumstances. He considered, however, that it would be desirable, in a case of such difficulty and importance, that the decision of a higher Court should be obtained, and he adjourned the summonses sine die in order that a case might be taken to the Court above.

MUNICIPAL, FOREIGN & GENERAL NOTES.

APPOINTMENTS VACANT AND FILLED.

The Metropolitan Railway Co. require a traffic manager. Applications to the Secretary, 32, Westbourne-terrace, London, W., by Oct. 17.

Mr. E. E. Benham has resigned his position with the Cleveland & Durham Electric Power (Ltd.) in order to take up an appointment under the Admiralty at Devonport Dockyard.

Mr. W. J. Crawford, B.Sc., of Barrow-in-Furness, has been appointed assistant lecturer and demonstrator in the mechanical engineering department of the Municipal Technical Institute, Belfast.

EDUCATIONAL NOTICES.

Battersea Polytechnic (London, S.W.).—At this polytechnic there are day and evening courses of instruction. The day courses include preparation for the B.Sc. in engineering of the University of London and the polytechnic diploma in (*a*) mechanical, (*b*) electrical and (*c*) civil engineering. The evening classes include preparation for the B.Sc. in engineering, associateship examination of the I.C.E., &c. Prospectus on application to the Secretary.

Armstrong College (Newcastle-on-Tyne).—The session 1908-9 commenced on Sept. 28. There are complete courses of instruction in mechanical, civil, electrical and marine engineering, naval architecture, mining, metallurgy, &c. Particulars from the secretary (Mr. F. H. Pruen).

Barking.—It was reported at the last meeting of the Council that the promoters of the London and District Electricity Supply Bill had accepted the Council's terms for the transfer of the electricity undertaking. The following prices, are to be charged, but there is a proviso for revision by the Board of Trade at the end of five years :—Current for power (maximum), 1·5d. per unit ; traction, 1·25d. ; public lighting, 1·5d. ; private lighting, 3·5d.

The agreement has, therefore, been sealed.

Bermondsey.—The Lighting committee have been authorised to arrange special terms for the supply of electrical energy to a number of large firms, including Messss. Peek, Frean & Co. and Whittard & Co. for power, and to the Star Music Hall for lighting.

Blackburn.—The construction of the tramway extensions authorised by this year's Act, with one exception, is to be proceeded with. The question of making a reduction in the charge for electric current to wiring contractors for exhibiting and displaying electrical apparatus has been referred to Ald. Thompson and Councillor Higham, chairman and vice-chairman of the Tramways committee.

Blackpool.—At the meeting of the Council on Tuesday a suggestion was made that the relaying of a portion of the tramway track, instead of being let out to contract, should be done by direct labour, in order to utilise the unemployed labour in the town.

Mr. Laycock said the relaying of the track gave them an opportunity of providing work for their own unemployed who were competent to do the work. If they employed men in the town they would get the work done better and cheaper. Ald. Grime opposed and said the borough surveyor did not approve of doing the work by direct labour. The committee had expressed a desire that the contractor should employ local labour, and the unemployed would have as good a chance of employment under the contractor as if the Corporation did the work themselves. They never got good value when Corporation departments did such work.

The Tramway committee's proposal that the work should be done by contract was carried.

Bournemouth.—On Tuesday the Council considered the report of the Board of Trade inspector (Major Pringle) on the tramway accident, which occurred on May 1 last.

After considerable discussion it was decided to adopt the Tramway committee's recommendation to appoint Mr. J. B. Hamilton, general manager of Leeds Tramways, to advise as to what alterations (if any) are necessary in the organisation and working of the Bournemouth tramways.

Cardiff.—The city engineer (Mr. Harpur) and the tramways manager (Mr. Arthur Ellis) are preparing a report on the causes of the unsatisfactory state of the tramway track.

In the meantime, Mr. Harpur suggests that a trial be made with "Roadite," a preparation which, he states, is claimed to last as long as macadam and costs only about 2d. per sq. yard. The Tramways committee have agreed to a trial being made with a length of road.

Cheltenham.—The Council has adopted a recommendation of the electricity committee to authorise the borough electrical engineer (Mr. W. J. Bache) to extend mains from time to time where necessary upon obtaining the usual guarantee of 20 per cent. for three years upon the cost of such extensions, provided that no extension be carried out without the previous sanction of the committee if the cost exceeds £50.

Clayton-le-Moors.—The Council will not object to Accrington Corporation applying for a provisional order.

Colne.—The Council have unanimously invited Councillor John Smith, chairman of the Electricity committee, to be Mayor for the ensuing year.

Country House Lighting.—The October calendar issued by Messrs. Mavor & Coulson contains some particulars of the electric lighting arrangements at Kinfauns Castle. Electrical energy is generated by steam power by means of a 32 H.P. horizontal slow speed engine, supplied from a dry back tubular boiler. The plant is erected at the stable premises about a quarter of a mile from the Castle, and includes a storage battery, switchboard, &c. The Castle is wired for about 450 lamps.

Culter (Aberdeen).—The standing joint committee have authorised an expenditure of £112. 10s. for providing lamps and standards for the electric lighting of the village. Electric energy is to be taken from Aberdeen Corporation.

Customs Duties.—It has been decided that cutout resistances for arc lamps (imported separately into New Zealand) are subject (as electric appliances, n.o.e.) to 20 per cent. ad valorem duty if British and 30 per cent. if foreign.

Dudley. On Tuesday the Council decided to abandon the maximum demand system of charging for electric current, and a revised seae of charges for light and power on the flat rate system has been adoplted.

Eastbourne.—At the meeting of the Council on Monday Ald. Duke advocated that a more extended use be made of electricity for street lighting, and the chairman of the Electric Lighting committee (Councillor Simmons) replied that the committee were considering the matter.

Epsom.—The Lighting committee have included £300 in the draft estimates for a new battery. For the June quarter the revenue from private lighting was £677, compared with £534 for the corresponding period of 1907, and from public lighting £527 against £473.

Exhibitions.—The Japanese "Official Gazette" announces that the Tokio International Exhibition will not be held in 1912, as originally announced, but is postponed to 1917.

A report from H.M. Embassy at Berlin explains that the permanent Exhibitions Commission for German Industries, which was founded at the end of 1906, is not a Government Commission, but consists of five delegates from the directorates of each of five large industrial associations. The objects of the Commission are to study the general question of exhibitions, to disseminate information regarding them, and to warn German interests against exhibitions with unreliable credentials. The government departments and all diplomatic and consular missions have been instructed to give the Commission all possible assistance.

Fire.—In the early hours of Saturday morning a fire broke out at the works of Messrs. D. H. Bonnella & Son, electricians and ivory, wood, &c., turners, 43, Kirby-street, London, E.C. The damage was confined to two floors of the large building, and arrangements were made to carry on the works immediately, so that very little delay in the execution of orders has been occasioned.

Fulham (London).—The Electricity committee have decided, for checking the time of employees responsible for lighting and extinguishing public electric lamps, to fix automatic time recorders in some central position from which the men will be required to start and finish their duties. As an experiment an instrument is to be fixed at the Granville sub-station Walham-green, at an estimated cost of £5.

The committee have been conducting experiments with various descriptions of coal for ascertaining the best kind to use with the underfeed stokers, and the contrast has been divided between the firms who quoted for Mapperley, Smitham and Beath peas. The committee have decided to purchase a "Bomb" calorimeter for testing the calorific value of coal at an estimated cost of £35.

Glasgow.—The Tramways committee recommend that a contriburion of £17,500 be made by the department to the common good for the half-year ending Martimas next.

The committee also recommend that further consideration of the question as to the method of operating the brakes on the cars be continued, and that all cars be fitted with additional devices for sanding the rails as proposed by the general manager, Mr. James Dalrymple.

Halifax.—On Wednesday Mr. C. F. Spencer, chairman of the Tramways committee, stated that the approximate cost of settling the claims for compensation in connection with the Pye Nest accident would be about £12,000.

With regard to the Halifax scheme for municipal insurance against third party risks, he said it had been the custom of some corporations to say Halifax had put it forward because they could not get anyone to insure them. He would like to state, therefore, that the committee had secured another option for 12 months from the same company that they dealt with last year. He hoped that before the end of March the scheme would culminate in something concrete.

Heroism of an Electrical Engineer.—At the Whiston-street electricity works of Shoreditch (London) Council on Friday last the parchment certificate of the Royal Humane Society was presented to one of the staff (Mr. A. Lane) for saving the life of a boy. On June 5 last Mr. Lane jumped into the Regent's Canal without waiting to take off his clothes, and rescued Abe Solomon, aged seven years. The men in the station have shown their appreciation of this brave act by framing the certificate. This is not the first rescue made by the Whiston-street staff, as on a previous occasion Mr. J. Kitchen was instrumental in saving the life of a child.

Hornsey.—The Council favour an extension of the tramway service.

There is a steady increase in the number of connections to the electricity supply mains, and from April to August mains were laid in 12 additional roads.

The electrical engineer (Mr. Norman Standand) has been authorised to arrange for the exhibition of posters at a cost not exceeding £25 per annum. A 10 days' show of electrical fittings, &c., is to be held at Muswell Hill.

Inverurie (N.B.)—A correspondent of the "Aberdeen Journal" advocates an electricity supply and electric tramway scheme for this district. It is stated that there is sufficient water power available for the generation of electrical energy.

Islington (London),—At Highgate Hill Infirmary it is proposed to take the current required for the X-ray apparatus from the lighting supply. The Guardians have accepted the offer of the Medical Supply Co. for a switchboard and interrupter at £14. 14s.

Italy.—According to the report of H.M. Consul-General (Major W. P. Chapman) imports to Florence during 1907 (not including goods cleared at the frontier or at Genoa or Leghorn) included dynamos of the value of £7,392 from Germany, £1,344 from the United States, £384 from France and £96 from the United Kingdom.

The Valdarno Mining & Electrical Co., which has a capital of £240,000, and owns lignite mines in the Commune of Cavriglia, have recently equipped an electric power station to generate current (by means of their own fuel) which is to be transmitted at a pressure of 33,000 volts to Florence, Prato, Siena and Arezzo for lighting, &c. The machinery is partly of the Westinghouse make, partly German and partly Italian.

At Portoferraio (Elba) electric power works are being erected to utilise the gas bye-products and the coke furnaces and brick kilns of the Prombino Societa degli Alti Forni and to supply electric energy for the production of calcium carbide. To utilise current generated at the same works an electric tramway is contemplated from Portoferraio to the mining centres of Calamita and Terranova, via Portolongone and Rio Marina.

Leeds.—A site for a new sub-station in East-street has been purchased.

A contract has been entered into with the Middleton Estate & Colliery Co. for 30,000 yards of cable troughing and covers. The construction of the Yeadon and Guiseley tramway is to be proceeded with during the winter as well as the extension from Horseforth to Guiseley.

Leyton.—A sub-committee has been appointed to draw up a further list of roads in which the work of substituting for the gas lamps electric lamps, should be proceeded with during the ensuing half year. Tantalum lamps are to be used for lighting Lea Bridge branch library.

Liverpool.—The final report of the city electrical engineer (Mr. A. Bromley Holmes) on the four steam turbines at Lister Drive station has been issued.

Mr. Holmes concludes his report by stating that the department is now in possession of four sets of plant of identical design each for a normal output of 2,000 kw., and containing the minor improvements in detail which have been made by the contractors (the British Westinghouse Co.) in that type of machine up to the present date. The work of re-construction has been carried out under difficult conditions, without any interruption to the town supply. Under the arrangement made in Sept., 1906, the contractors are, as stated, liable to a specified daily deduction for the period occupied in reconstruction, but taking all the circumstances of the case into consideration, Mr. Holmes is of opinion that such deduction could not fairly be enforced.

London Electric Power Bills.—On Thursday last week a conference took place of representatives of local authorities affected by the London and District Electricity Supply Bill and the London Electric Supply Bill.

Fulham, Finchley, Hornsey, Croydon, St. Pancras, Barnes, Wimbledon, Shoreditch, Camberwell, Islington, Battersea and Bethnal Green Councils were represented.

On the motion of Mr. C. W. Tagg (Camberwell), seconded by Councillor Windus (Camberwell), a resolution was adopted protesting against the principles contained in the London and District Bill, but expressing the opinion that in the event of the measure becoming law the purchase clause should be amended so as to provide that if the undertaking is purchased in 1931 or 1936 the amount paid for goodwill, in addition to the then value of the land, buildings, works, &c., shall not exceed 20 years' compensation, based upon the net annual profits as shown by the accounts of the company during the period of the concession already expired.

Mr. Tagg also moved in regard to the London Electric Supply Companies' Bill that a sterilisation clause, similar to that imposed upon the water companies, be inserted for the protection of London ratepayers (so that no compensation would be paid in respect of capital expenditure incurred under the new powers, together with another condition prohibiting the companies from receiving compensation in respect of severance. This resolution was adopted.

It was further decided to ask the President of the Board of Trade to hear the case for the borough councils being given linking up powers.

Manchester.—On Wednesday the Corporation decided to appoint a special committee to report upon the position of the Mutual Telephone Synd. (Ltd.) and the Corporation, and as to whether any payments should be made by the Corporation to meet the expenditure incurred by the syndicate in their efforts to promote a cheaper and more efficient telephone service for the city.

Oil Eliminators.—The removal of all trace of oil from greasy condensed steam, is a problem of considerable interest to all steam users. The Paterson Engineering Co. state that at the Birmingham Corporation generating station, where all the mechanical oil separators in the

2,000 kw. sets were replaced by a Paterson oil eliminator of 350,000 lb. hourly capacity, results of tests (based on six months' working) have been supplied by the city electrical engineer (Mr. R. A. Chattock). The total cost for chemical reagents was proved to be 0·169d. per 1,000 gallons purified. The temperature of the water leaving the purifier was 4° to 5° higher than when entering, owing to the fact of one or two traps on the steam gauge discharging into the filter tanks. The public analyst's report on the water as discharged by the Paterson purifier stated that it was absolutely free from all trace of oil. The exceptionally low cost for chemical reagent is due to the fact that Paterson oil eliminators are fitted with quartz sand filters for the final purification, so that it is not necessary to form a heavy flocculent precipitate.

Penrith.—A company has been formed, with a capital of £7,000, to take over the Penrith electric lighting orders of 1900 and 1907.

Rotherham.—The Wellgate tramway is to be extended.

Sheffield.—An inquiry was held here on Wednesday into the application of the Corporation for sanction to borrow, among other sums, £11,000 for extensions of the electricity undertaking.

The town clerk (Mr. R. M. PRESCOTT) said that there was a continually increasing demand for electrical energy, particularly for power. On June 2 last the L.G. Board sanctioned a loan of £20,000, and the sum now asked was for further works in connection with the extension of the Neepsend power station.

Mr. A. DAVIDSON (for the local electrical contractors) asked if any portion of the money was to be expended in connection with the Corporation's wiring and fittings department.

The manager (Mr. S. E. FEDDEN) replied in the negative.

The TOWN CLERK said two tenders had been accepted from Mr. Edmund Taylor, one to the amount of £6,268. 4s. 10d. and the other £4,607. In December, 1899, the number of power consumers was six and ordinary consumers 973, compared with 619 and 3,383 respectively on March 20 last. The units sold in December, 1893, totalled 1,329,881, and in March last 8,300,748.

Mr. DAVIDSON, for contractors, suggested that if the Corporation had applied their loans to purposes which were legal instead of applying them to purposes which the traders alleged were illegal, there would have been no necessity for the present application. They had a case pending in which they were opposing the electricity department, who, they contended, were diverting money which they might apply to the purposes for which it had been legally provided.

The INSPECTOR (Mr. H. S. Bidwell): What you object to is the Corporation doing wiring and dealing in fittings?

Mr. DAVIDSON: Yes; selling fittings and doing work which belongs to private traders of the city.

The INSPECTOR said he would keep the statements of Mr. Davidson in mind.

South Africa.—The "British and South African Export Gazette" says it appears inevitable that the dispute at Johannesburg in regard to the rejected gas plant will be fought out in the courts, and the city electrical engineer (Mr. F. C. Stephens) is visiting England in this connection. Contracts for steam plant, &c. (referred to in another column) have been placed.

It is stated that the Swazi Tin Mines (Ltd.) are in the market for electric lighting plant.

Spain.—Mr. Lovelace, British Vice-Consul at Corunna, states that a large electric tip is now at work at the port of Gijon tipping coal and other minerals into hoppers, which in turn shoot them into large buckets, which again are carried on electric trolleys to ships' sides, are picked up by cranes and transporters and thence carried over the ships' hatches.

Stepney (London).—The Finance committee have applied to the L.C.C. for a supplemental loan of £7,000 for Blyth's wharf generating station.

As the new station will not be ready to supply current during the ensuing winter it has been decided to obtain a supply from "a contiguous undertaking" for £100, conditionally, the Council to carry out the work of linking up the mains, and paying a further sum of ¾d. per unit for each unit actually taken. Mains are to be laid in five additional streets.

Stockport.—Sanction has been received to a loan of £10,500 for extensions of the electricity undertaking.

Trackless Tramways.—A syndicate is formulating a scheme of railless electric cars for Falmouth.

On Wednesday Manchester Corporation adopted the report of the Tramways committee recommending that Parliamentary powers be obtained to adopt the trackless trolley system.

Tramway Lease.—Middleton Corporation give notice of intention to lease, for 21 years, to Manchester Corporation tramways from Manchester boundary at Blackley to junction of Manchester New-road and Manchester Old-road, and from a junction with the same tramway at Oldham-road to Middleton boundary. The rent is £9,549. 19s. 10d. per annum from Dec., 1902 to June, 1908, and £1,736. 7s. 3d. per annum after. The lease contains provisions for the electrical equipment of the lines.

Tunstall.—The Public Buildings committee have been requested to consider and report upon the cost of lighting the museum electrically.

Uxbridge.—The Rural Council have given the Uxbridge & District Electric Supply Co. permission to use overhead conductors for the supply of electric current to Wedmore.

Underground Telephone Wires.—At the last meeting of Islington (London) Council it was resolved:—

To petition the President of the L.G. Board and the Postmaster-General on the question of the general state of trade and unemployment and suggesting that it would be a suitable employment of national funds for the Government to immediately take steps to place all telephone wires in London underground.

Walthamstow.—The Council propose to equip show rooms for the display of electric fittings, motors, &c. The hire of arc lamps for outside lighting is also under consideration.

In future Mr. W. H. Taylor will be designated assistant electrical engineer and during the absence of the electrical engineer will have charge of the electricity department.

Wimbledon.—The electricity department has made an agreement with the Foster Arc Lamp & Engineering Co. for a supply of energy to the company's works at 1¼d. per unit, the minimum consumption to be 20,000 units per annum.

Worcester.—It was reported to the Council on Wednesday that a Sheffield firm had purchased for £850 the Powick electric plant.

Smoking Concert.—On 28th ult. a smoking concert was held by the members of the West Ham electricity staff, and among those who contributed to the programme was Mr. A. Hugh Seabrook (the chief engineer) who was encored. During the interval Mr. Seabrook, on behalf of the members of the staff, presented a handsome eight-day marble clock to Mr. F. Farndon, assistant sales manager, as a wedding present. Afterwards prizes were presented to the successful competitors in the sports held at Broxbourne in July.

TRADE NOTES AND NOTICES.

TENDERS INVITED.

Tenders will be received at the office of the *Commonwealth of Australia* representative, 72, Victoria-street, Westminster, London, S.W., until noon, Oct. 19, for supply and delivery at that office of four complete sets of instruments (signalling and protecting), necessary for direct duplex cable working, for the Postmaster-General, Melbourne. Forms of tender, &c., can be obtained at the General Post Offices, Sydney, Melbourne, Adelaide, Perth, and Hobart, and at the Commonwealth office as above. Tenders (on forms supplied) to Capt. Collins, Commonwealth representative, 72, Victoria-street, Westminster, S.W. Further particulars are set out in an advertisement.

Tenders are invited for the supply and erection of installations for wireless telegraphy at *Launceston, Melbourne, King Island* (Bass Straits) and *Flinders Island* (Furneaux Group). Tender forms and specifications may be obtained at the Commonwealth Office, 72, Victoria-street, London, S.W. See also an advertisement.

The Directors of the *Gt. Western Railway Co.* are prepared to receive tenders for the supply of stores, including incandescent electric lamps, electric wires and cables, electric light carbons, telegraph instruments and apparatus, telegraph ironwork and tools, wire, oils, indiarubber goods, ironmongery, steel tools, brasswork, &c., &c. Samples and patterns may be seen at the General Stores, Swindon. Specifications, with forms of tender, may be obtained at the offices of the Stores Superintendent, Swindon, and tenders addressed to the secretary (Mr. G. K. Mills), Paddington Station, London, W., must be in by Oct. 20 for group I., and Nov. 10 for group II.

Leeds Tramways committee invite tenders for the supply of material necessary for constructing the Horseforth-Guiseley tramway, including 1,350 tons rails, three pairs 150 ft rad. cross-over, points and one 1 in 5 8 ft. crossing, 40 tons tie bars, 9,000 tons granite setts, 950 tons cement, 130 street poles and fittings, 70 cast-iron pole bases, 8 miles 0·4 sq. in. paper-insulated lead-covered 600-volt low-tension cable, 12 miles S.W.G. 14 hard-drawn bare telephone wire and 5 miles 4/0 S.W.G. grooved trolley wire. Specifications and forms of tender may be obtained at the Tramways Office, Leeds. Tenders must be received by 10 a.m., Tuesday, Oct. 13.

Salford Electricity committee invite tenders for the supply and delivery of vertical steam feed pumps at the Corporation electricity generating station, Frederick-road, Salford. Specification and form of tender from the borough electrical engineer (Mr. Victor A. H. M'Cowen, M.I.E.E.), to whom tenders are to be sent by noon of Monday, Oct. 12.

London County Council also want tenders by 11 a.m., Oct. 27 for supply of 12 water-tube boilers (each to evaporate 15,000 lb. of water

per hour), mechanical stokers and superheaters, &c. Forms of tender, &c., from the Clerk.

Leeds Tramways committee want tenders by 10 a.m. Oct. 13 for excavating, concreting and paving of about 4 miles of double tramway track. Specifications from the Tramways Office.

Rochdale Guardians want tenders by Oct. 15 for the erection of an overhead bare copper cable at the workhouse. Specifications, &c., from the clerk.

Tenders are wanted for electric (or gas) lighting of Emmanuel Church, *Exeter*. Particulars until Oct. 13, from Mr. J. W. Burt, 3, Comrie-crescent, Queen's-road, Exeter.

Epsom Council want tenders by noon Oct. 14 for supply of 800 tons of coal for the electricity department. Forms of tender from the engineer, Church-street, Epsom.

Tenders are invited by *Melbourne* City Council for the supply of 60 direct current flame arc lamps. Copies of specification, conditions of contract, and forms of tender may be obtained from the agents for the Council (Messrs. McIlwraith, McEacharn & Co., Proprietary, Ltd.), Billiter-square Buildings, London, E.C., to whom tenders by noon of Tuesday, Oct. 20.

Melbourne (City) Council also invite tenders for supply of 770 electricity recording meters and 157 maximum demand indicators. Copies of specification, conditions of contract and forms of tender from the agents for the Council (Messrs. McIlwraith, McEacharn & Co. Proprietary, Ltd.), Billiter-square Buildings, London, E.C., to whom tenders by noon Oct. 13.

Tenders are invited for supply and delivery to the Postmaster-General's Department in *Western Australia* of telegraph and telephone material. Tender forms and specifications may be obtained at the Commonwealth offices, 72, Victoria-street, London, S.W.

The Norwegian State Railways Department, *Christiania*, want tenders by 3 p.m. Oct. 16 for supply of 32,100 kilogs. (70,768 lb.) g.i. wire and 5,500 telegraph insulators. Specifications, &c. (in Norwegian) can be seen at 73, Basinghall-street, Londen, E.C.

The Belgian Telegraph Administration, *Brussels*, want tenders by 11 a.m. Oct. 14 for supply of g.i. wire, copper wire, cables, rods, screws, ironwork, bolts, insulators, &c. Conditions from the Bureau des Adjudications, 15, rue des Augustins, Brusssels.

The Direccion-General de Correos y Telégrafos, *Madrid*, requires tenders by noon Oct. 26 for the working of the telephone system of Jerez de la Frontera, and by noon Oct. 27 for the working of the telephone system of the town of Almeria, both for 15 years. The "Madrid Gazette" for Sept. 26 and 27, containing further information, may be seen at 73, Basinghall-street, London, E.C.

TENDERS RECEIVED AND ACCEPTED.

Woolwich (London) Council has received the following tenders for supply of cable for extensions :—

Western Electric Co. (*accepted*)	£1,450
Johnson & Phillips	1,468
W. T. Glover & Co.	1,471
W. T. Henley's Telegraph Works Co.	1,484
Siemens Bros. & Co.	1,489
Callender's Co.	1,498
British Insulated & Helsby Cables	1,526
St. Helens Cable & Rubber Co.	1,535
Sun Electrical Co.	1,542

The contract is to be completed in six weeks. For 110 yards of three core 0·05 lead sheathed and armoured cable, recently required, the tender of the Western Electric Co. at £22. 3s. 9d. was accepted.

Leyton Council, having considered prices in existing contracts together with amended prices, have extended contracts for supply of following tramway stores, until June 30, 1909 :

General Electric Co., batteries (wet), 1s. 11d. ; electric bells, 4s. 9d., electric bell gongs 1s. 3d., mica (best clear, insulating) 3s. per lb., vulcanite fibre [illegible] in. wide 10d., vulcanite fibre ½in., 10d ; voltalac 9s., linen frame tape, 1 in., 7s. per lb ; linen tape (grey), ¾ in., 9s. ; 7/16 cable, £3. 12s. per 110 yards ; 7/20 cable, £1. 10s. ; 3/22 cable, 15s. 6d. ; electric bell wire, 2s. 3d. *British Westinghouse Co.*, mica cones 12s. 6d. per lb., mica cones 7s. each, controller fingers 8d. each, contact drum rings 1s. 3d., contact arcing tips 4d., power cylinders £6. 10s., handles (main drum) 12s., handles (reverse) 4s. 6d., reverse drums, No. 1, 12s. 9d., motor cutouts, No. 2, 12s., automatic circuit breakers £3. 3s. each, canopy switches £1. 10s., resistance boxes, Nos. 1 and 2, £4 ; resistance boxes, Nos. 3 and 4, £2. 5s., carbon brush holders £2. 2s. each, pinion wheels 8s. 6d., gear wheel £2. 18s. 6d.

Leyton Council have accepted the following tenders for material required for the electrical equipment of the Lea Bridge-road tramway, within the L.C.C. area :—

J. Smith & Co., trolley wire, £88. 4s. 10d. ; J. Spencer (Ltd.), poles, £221. 7s. ; Dick Kerr & Co., bows, &c., £70. 18s. 8d. ; Turner & Manville, insulator bolts, £9. 16s. 8d. ; Brecknell, Munro & Rogers, span brackets, &c., £32. 1s. 6d. ; W. F. Dennis & Co., pin wire, &c., £2. 14s. 6d. ; W. Wood & Co., hangers and ears, £8. 11s.

Dublin Lighting committee have provisionally accepted the tender of Babcock & Wilcox (at £6,423) for boiler plant and accessories, and that of the General Electric Co. for 12 months' supply of electricity meters.

Hull Tramways committee has accepted the tender of Siemens Bros. Dynamo Works for a generating set at £5,926. 10s., that of Amos & Smith for condensing plant at £895 ; and that of Hadfield's Steel Foundry Co., for rails, &c., at £1,213. 6s.

Messrs. James Dunlop & Co. have placed an order with Johnson & Phillips for supply and erection of shaft cables at Boggleshole Colliery.

Leeds Corporation have accepted the tender of T. W. Matthews for supply of 2,200 Osram lamps. 70 magnets for brakes have been ordered from the Electric Machanical Brake & Engineering Co., at £11. 10s. each.

Messrs. Maxwell, Son & Co., of Dundee, have secured the contract for the installation of electric lighting and power plant at the works of the United Mills Equipment Co., Tottenham.

The tender of J. W. Singer & Sons for the supply of electric light fittings, &c., for the extension of Bradford Town Hall at £1,749 is recommended for acceptance.

Lochgelly Iron & Coal Co. have placed an order with Johnson & Phillips for underground switchgear for their Lochgelly pits.

Cleckheaton Council have accepted the tender of W. T. Glover & Co. for 440 yds. of cable at £45. 15s.

Salford Corporation have accepted the tender of the British Insulated & Helsby Cables, for the supply of feeder pillars.

Hornsey Council have accepted the tender of Charrington, Sells, Dale & Co. for supply of Brynteg Welsh coal at £1. 0s. 6d. per ton.

Burnley Guardians have accepted the tender of J. Rawlinson for the supply of electrical stores during the ensuing half-year.

Chester Council have accepted the tender of W. Geipel & Co. for the supply of arc lamp carbons at £112. 5s. 6d.

Rotherham Light & Tramways committee have accepted the tender of Jas. Cooper (at £127) for turbo-generator foundations.

Johannesburg Corporation have placed contracts with Reunert & Lenz for a 1,000 kw. A.E.G.-Belliss steam dynamo, balancer, &c., at £11,174, condensing and exhaust pipes at £2,164, a Babcock boiler, with superheater, flue and mechanical stoker, at £3,515 ; and with Stewarts & Lloyds for pipes and fittings.

Fraser & Chalmers and the A.E.G. Electrical Co. of South Africa have obtained an order for an electric hoist for the New Modderfontein Gold Mining Co.

BUSINESS NOTICES.

Mr. G. Braulik has taken large and commodious additional premises at 8, Lambeth-hill, London, E.C., adjoining his present offices and warehouses.

Karl Oscar Müller & Carl Müller (trading as Charles A. Muller), electrical accessories merchants, 10, Arcade, Westgate, Bradford, have dissolved partnership. Mr. Carl Muller continues.

Sales by Auction.—By order of the liquidator of the Conduit & Insulation Co., Ltd. (in liquidation), Messrs. Fuller, Horsey, Sons & Cassell will sell by auction, in lots, at the Company's works, Riverside-road, Summerstown, London, S.W., on Tuesday, Nov. 3, at 11 a.m., a number of machine tools, electric motors, shafting, belting, &c. ; also the conduit insulation plant and the stock of steel tubes and fittings, cast-iron junction boxes, porcelain fittings and other accessories, general stores, &c. Included in the sale are certain letters patent for the manufacture of conduit insulation and close joint tubes. Further particulars are given in an advertisement. Catalogues from the liquidator (Mr. C. J. March, C.A., Messrs. W. B. Keen & Co.), 23, Queen Victoria-street, E.C.; Messrs. Rehder & Higgs, solicitors, 29, Mincing-lane, E.C.; or of the auctioneers, 11, Billiter-square, E.C.

Messrs. Horne & Co., 8, Delahay-street, Storey's Gate, S.W., will sell by auction at the Royal Arsenal, Woolwich, on 22nd inst., at 11 a.m., some unserviceable and obsolete stores, including quantities of brass, copper, gunmetal, zinc, platinum, aluminium, electric cable and lamps, telegraph instruments, &c. Lots may be viewed at the Royal Arsenal, Woolwich, on the three days preceding and on the morning of sale. Catalogues from the War Office, Whitehall, the Ordnance Office, Tower, and the Ordnance Office, Royal Arsenal, Woolwich. Further particulars are given in an advertisement.

Patent Development.—The proprietor of Patent No. 11,058, 1906, relating to "Improvements in Electric Circuit-breakers," is desirous of negotiating with electrical engineers with the view of granting licences under the Patent. Applications to Messrs. Lloyd Wise & Co., 46, Lincoln's Inn-fields, London, W.C.

Factory Site for Sale.—Messrs. Green & Son, auctioneers, have an extensive site (about 3¾ acres) close to a railway station, and suitable for the erection of engineering works, to be let on building lease. The site is outside the L.C.C. area. Further particulars from Messrs. Green & Son, 72, King-st., Hammersmith, London, W. See an advertisement.

A.M.E. Posters.—In calling attention to Mr. MacBean's instructive series of posters in our last issue we ventured the opinion that there was a slight "flaw in the indictment," inasmuch as one of the men engaged in the apparently unsuccessful effort to start the engine appeared to us to be pulling the wrong way. Mr. MacBean denies the soft impeachment, and writes to us as follows :—

Sir, Will you kindly permit me to correct the impression you have gained from the photograph of my poster (which you are good enough to reproduce in your issue of Oct 2) that the men are opposing each other in their endeavour to turn the gas engine wheel. In the full size picture it is quite evident that they are all trying to move the wheel in one direction ; the fat man in the foreground bringing his weight to bear downwards on the rim whilst the gentleman with the oilcan is lifting upwards on the opposite side. The positions of the other men are quite clear.—Yours truly, L. C. MacBean.

We can only say, with full admiration for Mr. MacBean's good work, that the fellow with the oilcan, if he is pulling the right way, is a malingerer, and it is good for him that the man with the ferocious moustachios can't see him, or his gall would rise, we are sure, at the "inequality of effort."

CATALOGUES, &c.

Conduits.—Simplex Conduits (Ltd.), Garrison-lane, Birmingham, and 113–117, Charing Cross-road, London, W.C., have a further section (T) of their main catalogue ready. This is devoted to conduits and fittings. The reputation of the company in the conduit business is so well and widely known that it is scarcely necessary for them to state that, though material reductions have been made in the price of both conduits and fittings, frequently amounting to 20 per cent. or more, these reductions have not been made at the expense of the quality of manufacture, which still maintains the 11 years' reputation the company have made for themselves as the leading conduit makers in this country. A feature of the new list is the inclusion of prices of galvanised material throughout. The company state :—

The increasing tendency of modern practice towards the use of higher class material in installation work has led us to believe that we are justified in offering galvanised material at but a small percentage increase on the cost of ordinary enamelled. The general arrangement of the new catalogue follows closely on what is now recognised as being the best method of pricing out in clear and concise manner conduits and various fittings. The large number and sizes of accessories makes it difficult to incorporate these in such a manner as to enable the buyer to find exactly what he requires with a minimum of trouble, and to avoid confusion. To further facilitate this, however, a somewhat novel innovation has been made by means of illustrating all sizes of each fitting with a composite half-tone block.

Large extensions are being made both at Garrison-lane works and the various branches of the Company, so that delivery is being facilitated to an even greater extent than has hitherto been the case. Most of the material shown in the catalogue can be obtained from stock at any of the stores at the company's branches, agencies or wholesale suppliers, but such material as is not stocked at these places can be obtained immediately direct from the works.

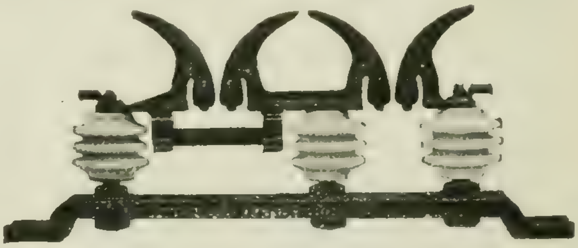
Cluster Fittings.—The grouping of incandescent electric lamps for concentrating the lighting effect, as an economical saving over individual holders distributed over a given area, and as a means of giving a more pleasing effect on account of the artistic possibilities of such grouping, has long been a favourite field for illuminating engineers. The general usage is to provide a central stem for supporting the fixture and enclosing the leading-in wires, and terminating at the point of distribution of light in a body or box ball. From this project nipples or arms to receive the lamp-holders. This device necessitated separate wiring for each holder and soldering the connections. The Benjamin Electric (Ltd.), of 1a, Rosebery-avenue, London, E.C., have brought out a new line of cluster fittings and lighting specialities, the special feature of which is the "wireless" principle which eliminates all separate wiring connections to the lamp-holders.

The Benjamin wireless cluster fitting consists primarily of a body shell with detachable back for supporting cluster to stem or attached direct to surface. Complete lamp holders of a special design are permanently attached to the body shell. These holders are connected internally by connecting conductor rings carrying binding screws for attaching leads from the live circuit, the whole device combining simplicity with utility and efficiency. The type known as "Holophane arcs" consists of cluster body with from three to six holders, supported from the ceiling by either brass stem or chain, and is equipped with holophane prismatic reflectors and shades.

Mr. Chas. F. Trippe, 36, Brooke-street, Holborn, London, E.C., sole agent for the United Kingdom for the Benjamin devices, has fitted up an artistic show room at Brooke-street for displaying a complete line of the various types of cluster fittings installed as in actual use.

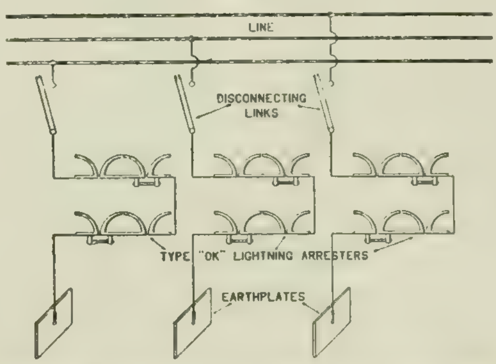
"O. & P." Sliding Board.—The "O. & P." Educational Co., Walthamstow, are issuing particulars and prices of model D of their improved single sliding and folding board, which the company state is useful in reproducing working plans, elevations and sections prepared by the drawing office staff for the guidance of those engaged in the actual production in the factory or works. It is claimed that working drawings may be readily produced in the drawing office in chalk or coloured crayons on the leaves of the board, which are easily detached and placed in position, that the eight surfaces of the board are easily accessible for inspection, and allow of the preservation of the contents as long as required, that the leaves may be moved from one slide to another as required, and any number of additional leaves (inner or outer) may be provided.

Protective Apparatus.—From the General Electric Co. we have received a pamphlet (No. X 1,205), devoted to tension limiters and lightning arresters for direct and alternating currents. The dangers to electrical plant with overhead wire or underground cable trans-



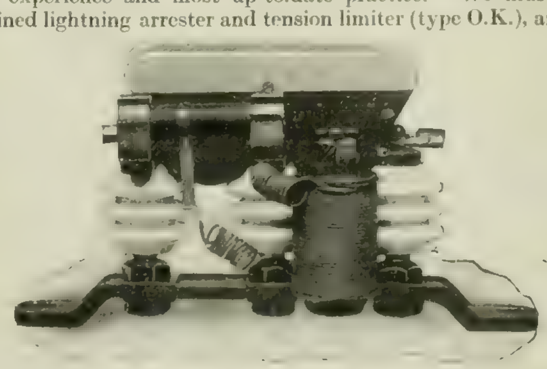
Combined Lightning Arrester and Tension Limiter.

mission, owing to rise of potential, are well known, and it is, therefore, essential that costly electrical machinery should be protected against damage and breakdown from this cause. The company have included in the pamphlet illustrated particulars and prices of a com-



O.K. Arrester on Three-Phase Overhead System.

plete line of protective apparatus, which they claim represents the latest experience and most up-to-date practice. We illustrate a combined lightning arrester and tension limiter (type O.K.), and also



Magnetic Blow-out Apparatus.

the same type of arrester on a 3-phase overhead line of 6,600 volts tension between phases. We also give an illustration of a magnetic blow-out arrester (type O.K.M.) for direct current circuits up to 1,000 volts.

Electric Power Plants.—Electromotors, Ltd., Openshaw, Manchester, are issuing a novelty in the shape of a pictorical index to their catalogues, which consists of a number of folding pages in a neat cover. By means of a tab the whole of the pages are readily exposed to view. Each page is devoted to some special manufacture of the company, reference being given to the section of the catalogue from which further particulars can be readily obtained. The company are specialists in the manufacture and installation of electric power plants in factories and works, and the present pamphlet gives a number of striking illustrations of the various industrial applications of electric power.

Flame Arc Lamps.—The Gilbert Arc Lamp Co., Chingford, Essex, have issued a new price list of flame arc lamps. Three types of the well-known Gilbert flame arc are made, and the list gives representative views, particulars and prices of each of these types, together with instructions as to trimming, &c. The list also gives prices and particulars of carbons, globes, line resistances, choking coils and transformers, together with illustrated particulars and prices of the company's enclosed lamps. Now that the winter lighting season is upon us electrical contractors will require to consult such lists, and copies will be forwarded by the company on request.

Prescot Specialities.—The British Insulated & Helsby Cables have just issued the following leaflets :—P. 59, on aluminium wires, strip and sheet ; P. 60, on transformer fuse boxes (illustrations are given of a standard design for concentric cables, capacity 25 amps, 20,000 volts) ; P. 61, which gives illustrated particulars of terminal boxes for three-core cables ; P. 62, relating to tramway section boxes ; P. 63, giving particulars of Fricker's maximum demand indicators ; and P. 67, on aluminium joints.

BANKRUPTCIES, LIQUIDATIONS, &c.

At Bradford County Court on Wednesday the public examination took place of Wm. T. Garnett, cable manufacturer, &c.

Debtor's gross liabilities were £94,942. 5s. 1d., of which £31,329. 16s. 10d. was expected to rank ; assets (less preferential claims of £257. 2s. 5d.) estimated at £8,129. 5s. 9d. Deficiency £23,200. 11s. 1d. Under the will of his father debtor became entitled to one-half share of the real and personal estate, so that he received about £120,000. While in partnership with his brother as worsted spinners at Barkerend Mills he lost about £40,000. The business was abandoned in 1895, when he was worth about £50,000. He subsequently became interested in other businesses, and in Sept., 1902, he embarked upon the business of a cable and wire manufacturer, but that also did not flourish. The non-success of the latter business was largely due to the fall in the price of copper. In the last 13 months he lost £8,000 in the business, that being caused, in addition to the fall in the price of copper of about 50 per cent., by the stock having been too highly valued previously. He left the stock-taking to his managers, and he was of the opinion that they had worked on too high a rate. From June, 1904, to Feb. 14 last he had a Mr. Stell as partner in the cable-making undertaking, but he introduced no capital, and when the partnership was dissolved received no payment. In May last he had a cheque dishonoured at the bank, but he did not then regard the matter as of serious consequence and did not know that he was insolvent. He knew about the fall in the price of copper, but he had no idea that they had been so heavily hit. He paid the amount of the cheque by depositing some goods. After the cheque had been dishonoured he ordered from Messrs. Frederick Smith & Co. large quantities of goods. Between June 5 and 30 they delivered £400 worth of goods, and on July 2 and 3 another £61 worth.—Examination closed.

Claims against Walter Wardle, electrician, 14, Osborn-road, Levenshulme, are to be sent by Oct. 17 to Mr. J. G. Gibson, Byrom-street, Manchester.

COMPANIES' MEETINGS AND REPORTS.

Willans & Robinson (Ltd.)

The ordinary general meeting was held on Tuesday, under the presidency of Mr. MARK ROBINSON, M.Inst.C.E.

The SECRETARY (Mr. C. S. Essex) having read the notice calling the meeting,

The CHAIRMAN said : I am glad to be able to tell you that the prosperity of the business of Rugby, notwithstanding very adverse conditions of trade, has been well maintained. The profit made for the half-year is almost exactly the same as for the corresponding half of 1907. Nevertheless, the warning given in one of the paragraphs of the directors' report must not be ignored. The times are very difficult and the future is hard to foresee. Demand is small, competition is great and profits are cut to the lowest. Our best customers, the municipalities, are restricting their enterprises, partly, as regards electric lighting, owing to the introduction of the metallic filament lamp, which uses so much less current than the old carbon lamps. Reduced cost to the consumer will doubtless be followed by a great extension of electric lighting, when more plant than ever will be wanted, but for the present there is an undoubted check, which acts unfavourably upon the most important section of our business, the manufacture of steam turbines. Nevertheless, we have a large number of important orders for turbines on hand, while the efforts to extend the scope of our business by cautiously taking up new classes of work are beginning to bear fruit. The Diesel engine work is now considerable enough to be a welcome element in meeting our general charges, and if it cannot be said yet that it does much more than this, the margin between cost and price is increasing, and we are justified in looking forward to a valuable business. Orders for condensing plants (independent of engines or turbines) are also beginning to form an important section of our business —a section entirely created within the last two or three years. There is little in the details of the accounts to note.

Regards our Queen's Ferry establishment, it was decided after careful consideration that the works should not be kept open beyond the present autumn. It is true that the losses shown in recent years are only nominally due to the works being open, for the loss is no more than must be faced whether the works are closed or open. There has been, however, a large sum locked up in working capital which could otherwise have been profitably employed at Rugby. This has convinced us that the time for more drastic measures had come. The works were offered for sale by auction on Sept. 16, when the reserve was not reached. We hope for better things, however, from the negotiations which, as usual in such cases, the auction has brought about.

I am sure some of the shareholders, in view of the difficult times, would have preferred to see a smaller dividend on the ordinary shares, or even none at all. But with new profits, more than sufficient for the purpose, with a fair amount of profit already carried forward, and with expectations no doubt raised by the steady progress of the last half-years, it seemed to us that it was unfair to suddenly cut down the dividend upon which many no doubt had reckoned. I now move the adoption of the report and accounts.

Mr. WRAGG (a shareholder) seconded the motion.

Sir GILBERT A. CLAYTON EAST addressed the meeting at some length, criticising the constitution of the board, certain items in the accounts, and the management and financial position of the company. He concluded by moving, as an amendment, "That no dividend be paid upon the ordinary shares, and that £3,500 be transferred to reserve account, to be invested in securities outside the business."

Mr. ADAMS seconded.

The CHAIRMAN replied to the various points raised by Sir G. Clayton East, and said the solicitor had expressed the opinion that the latter part of the amendment was out of order. The amendment that no dividend be paid was put to the meeting and declared lost. The original motion was then declared carried *nem. con.* The half-year's dividends to June 30 at the rate of 6 per cent. on the preference, and at the rate of 10 per cent. on the ordinary shares, were approved, and a vote of thanks to the chairman and directors terminated the proceedings.

VICTORIA FALLS POWER CO. (LTD.)—The directors' report from the incorporation of the company to Dec. 31 last, states that a profit and loss account has not been included because the year 1907, and also the current year, are, and will be, occupied by the work of construction, during which interest on the preference shares is paid by the British South Africa Co. The surplus of revenue over expenditure (£36,686) is carried forward. The steam-driven electric power plant (of 5,000 H.P.) purchased from the General Electric Power Co. was in full work during the period under review and earned satisfactory profits. The supply of the Witwatersrand market continue to be the first object of the company. It was decided to erect a new 8,000 H.P. station at Brakpan and a second station of 16,000 H.P. capacity at the Simmer Pan, near Germiston. An agreement for an ample supply of water has been obtained on favourable terms and adequate facilities for the delivery of coal by rail. Satisfactory progress has been made in the construction of the new plant. Application is being made to the Transvaal Legislative Council for a private Bill, to enable the company to take advantage of the facilities which acquired under its agreement with the Vereeniging Estates and Messrs. Lewis & Marks, in connection with the erection of a power station at Vereeniging, on the Vaal river. The anticipation that the earnings from the existing station of the General Electric Power Co. would cover the general expenses during the period of construction has been fully realized. These earnings, with those of the Rand Central works, have enabled the company, even during the construction period, to accumulate a substantial fund available for the general purposes of the company.

CITY NOTES.

MEMORANDA (Oct. 8).—Bank rate 2½ per cent. (since May 28, 1908) Price of silver, $23\frac{11}{16}$d. per oz. Consols $84\frac{15}{16}$—$85\frac{1}{16}$ for money and 85¾–85⅞ for account. Consols Pay Day, Nov. 5 ; Stock and Shares Continuation Days, Oct. 13 and 27 ; Ticket Days, Oct. 14 and 28 ; Pay Days, Oct. 15 and 29.

PRICES OF METALS (London). — *Copper*, cash, 59¼ ; three months, 60¼. *Lead*, English, 13⅞–14 ; foreign, 13¼–13⅝. *Spelter*, foreign, 19¾–20¼. *Tin*, English, 133–135 : Fine Foreign cash, 134⅝, three months, 135⅞. *Iron*, Cleveland, cash, and three months, 50/7½.

ANGLO-AMERICAN TELEGRAPH CO. (LTD.)—The directors have resolved, after placing £5,000 to credit of renewal fund, to declare an interim dividend for the quarter ended Sept. 30 of 15s. per cent. on the ordinary stock and £1. 10s. per cent. on the preferred stock (less tax) payable on Nov. 2.

CENTRAL & SOUTH AMERICAN TELEGRAPH CO.—This company has declared a quarterly dividend of 1½ per cent. for the quarter ended Sept. 30 (partly estimated). The surplus was $60,935.

ERNEST SCOTT & MOUNTAIN (LTD.)—The report for the year ended June 30 states that, after deducting all manufacturing and agency charges, the profit is £10,191.

STOCK EXCHANGE NOTICES.—The Stock Exchange committee have granted quotations to a further issue of 1,804 £10 fully paid shares of the *Lanarkshire Tramways Co.*, a further issue of $800,000 $100 7 per cent. cumulative preference stock of the *Mexican Light & Power Co.* (*Ltd.*) and £240,000 £100 first mortgage 6 per cent. 35 year sinking fund gold coupon bonds of the *West Kootenay Power & Light Co.* (*Ltd.*). The committee have been asked to allow £700,000 fully and partly (£50 per cent.) paid 5 per cent. mortgage debenture stock of the *British Aluminium Co.* (*Ltd.*) to be quoted.

SUBMARINE CABLES TRUST.—The coupon due on the 15th inst. will be paid by Messrs. Glyn, Mills & Co., 67, Lombard-street, E.C.

ELECTRIC TRAMWAY AND RAILWAY TRAFFIC RECEIPTS.

Line	Week ended.	Amount.	Inc. or Dec. (a)	Aggregate: No. of weeks.	Aggregate: Amount.	Aggregate: Inc. or Dec. (a)
		£	£		£	£
Aberdeen Corporation	Sept. 30	1,443	+ 32	18	27,557	− 448
Airdrie	,, 25	228	.	38	8,504	+ 24
Anglo-Argentine	,, 30	24,742	+ 7,423	39	791,375	+ 148,607
Ayr Corporation	Oct 3	306	− 16	20	8,178	− 290
Baker St. & Waterloo Ry.	,, 3	3,130	+ 615	14	41,065	+ 9,105
Barnsley	Sept. 25	177	+ 9	38	6,805	+ 384
Barrow	,, 25	272	− 6	38	9,616	− 447
Bath Electric Trams, Ltd.	,, 29	836	− 94	39	29,325	− 2,31[illegible]
Birkenhead Corporation	Oct. 4	1,133	+ 20	1	1,133	+ 20
Birmingham Corporation	,, 3	6,681	+ 380	27	170,336	+ 5,862
Birmingham & Mid.	Sept. 18	837	− 26	37	31,108	+ 762
Blackburn Corporation	...	...	...		...	...
Blackpool Corporation	...	...	...	...	...	...
Blackpool and Fleetwood	Oct 3	797	+ 13	1	797	+ 13
Bolton Corporation	,, 4	2,479	+ 203	27	64,233	+ 1,162
Bombay	Sept. 10	R37,025	+ R4,307	36	R1,278,334	+ R238,262
Bournemouth Corporation.	,, 30	1,752	+ 39	26	47,849	− 2,985
Bradford Corporation	Oct. 3	5,052	+ 268	26	128,877	+ 138
Brighton Corporation	,, 4	1,043	+ 120	26	27,389	+ 465
Bristol Trams & Carriage	,, 2	5,270	+ 33	45	199,450	− 935
Burnley Corporation	,, 3	1,359	− 19	1	1,359	− 19
Burton Corporation	,, 4	292	− 25	27	7,509	− 592
Bury Corporation	,, 4	1,348	+ 237	‡27	32,785	+ 1,874
Calcutta Tramways Co.	,, 3	R52,876	+ R350	14	R666,396	− R3,570
Camborne-Redruth	,, 3	156	+ 28	40	5,122	+ 206
Cardiff Corporation	,, 3	2,210	+ 131	27	60,111	− 224
Cavehill	Sept. 25	78	− 32	38	3,546	+ 155
Central London Railway	Oct. 3	8,331	+ 3,019	14	103,239	+ 35,358
Charing C., Euston & H'stead	,, 3	3,400	+ 760	14	45,740	+ 10,545
Chatham & Dist. Lt. Rys.	,, 1	959	+ 168	39	30,677	+ 1,471
City & South London Rly.	,, 4	2,926	− 80	14	41,596	− 835
City of Birmingham	Sept. 25	2,733	− 225	38	105,769	− 1,094
Colchester Corporation	,, 30	220	− 20	...	...	...
Cork Electric Trams Co.	Oct. 1	450	− 70	39	18,174	− 735
Croydon Corporation	,, 2	1,512	+ 9	27	39,204	− 682
Devonport & Dist. Trams	Sept. 25	461	− 25	38	17,771	− 3
Dover Corporation	...	...	...	...	...	...
Dublin & Lucan Railway	Oct. 2	147	+ 9	13	2,105	− 79
Dublin United	,, 2	5,613	− 1,149	13	77,835	− 23,562
Dudley-Stourbridge	Sept. 25	887	− 76	38	32,291	− 1,622
Dundee Corporation	,, 30	1,237	+ 56	‡20	24,408	+ 1,404
East Ham Council	Oct. 3	961	+ 17	27	23,741	− 1,336
Exeter Corporation	,, 2	360	+ 33	27	8,998	− 190
Falkirk and District	...	...	...	...	...	...
Gateshead & Dist. Trams	Sept. 25	1,078	+ 68	38	38,606	+ 168
Glasgow Corporation	Oct. 3	19,248	− 441	18	309,449	− 5,182
Glossop	Sept. 26	127	− 7	39	5,875	− 322
Gravesend—Northfleet	,, 25	234	− 37	38	8,235	− 1,307
Great Northern & City Rly.	Oct. 3	1,368	− 321	14	18,117	− 4,166
Gt. Northern, Piccadilly, &c	,, 3	5,330	+ 990	14	69,260	+ 14,515
Greenock & Port Glasgow	Sept. 25	505	− 187	38	20,480	− 5,085
Hartlepool Tramways	,, 25	252	− 60	38	9,334	− 1,973
Hastings Elec. Trams Co.	Oct. 1	1,204	− 7	14	19,459	− 1,699
Hong Kong	,, 3	$7,625	− $986	40	$314,937	− $15,377
Huddersfield Corpn.	,, 3	1,703	+ 145	27	44,296	− 107
Hull Corporation	,, 3	2,473	+ 36	27	65,304	+ 313
Ilford District Council	Sept. 26	470	− 8	26	12,009	− 674
Ilkeston District Council	,, 30	151	+ 2	26	3,845	+ 10
Ipswich Corporation	Oct. 3	457	+ 41	27	11,832	− 304
Isle of Thanet Co.	,, 3	626	+ 67	52	31,328	− 578
Jarrow	Sept. 25	109	− 8	38	4,146	− 572
Keighley Corporation	...	...	...	...	...	...
Kidderminster & District	,, 25	105	− 27	38	4,445	− 322
Kilmarnock Corporation	Oct. 3	156	− 10	26	3,174	− 206
Lanarkshire Trams Co.	,, 1	1,420	− 86	39	50,687	+ 3,199
Lancashire United	Sept. 30	1,423	− 17	39	52,810	+ 2,088
Leamington	,, 25	179	+ 2	38	6,599	+ 344
Leeds Corporation	,, 26	6,435	− 426	25	174,535	+ 3,645
Leicester Corporation	Oct. 3	2,305	+ 77	14	31,874	+ 16
Leith Corporation	,, 3	583	+ 25	20	11,287	− 24
Lincoln Corporation	...	...	...	...	...	...
Liverpool Corporation	Sept. 25	10,661	− 759	39	415,835	− 9,308
Liverpool Overhead Rly.	Oct. 4	1,374	− 108	39	20,177	− 2,756
*London County Council	Sept. 26	36,905	+ 3,947	†26	904,023	+ 97,400
London United	Oct. 3	7,572	+ 844	39	268,902	+ 2,718
Lowestoft	,, 3	225	− 2	52	11,033	+ 92
Maidstone Corporation	,, 3	227	...	27	5,562	...
Manchester Corporation	,, 3	16,365	+ 912	27	411,326	+ 9,668
Mersey Railway	,, 3	1,958	− 24	14	25,988	+ 519
Merthyr	Sept. 25	221	− 8	38	8,168	+ 52
Metropolitan Dist. Railway	Oct 3	9,602	+ 1,510	14	125,380	+ 21,661
Metropolitan Elec. Trams	Sept. 25	6,488	+ 1,032	38	220,011	+ 40,521
Middleton	,, 25	330	− 59	38	14,008	+ 213
Nelson Corporation	Oct. 3	140	+ 1	§26	3,828	− 296
Newcastle-on-Tyne Corp.	,, 3	3,959	− 130	27	105,146	− 6,316
Newport (Mon.)	,, 3	703	+ 36	27	18,382	− 1,076
Northampton Corporation	,, 2	484	+ 36	§26	12,856	+ 712
Oldham, Ashton & Hyde	Sept. 25	573	− 81	38	22,851	− 440
Oldham Corporation	Oct. 4	2,083	+ 112	27	55,573	+ 405
Perth (N.B.) Corporation	Sept. 30	165	− 17	20	3,289	− 187
Perth (W.A.) Elec. Trams	Oct. 2	1,312	− 31	40	54,517	− 1,101
Peterborough	Sept. 25	139	− 2	38	4,936	+ 5
Portsmouth Corporation	Oct. 3	2,137	+ 119	27	68,918	− 82
Potteries	Sept. 25	1,782	− 172	38	69,226	− 1,424
Preston Corporation	,, 30	746	− 36	13	10,183	− 498
Rotherham Corporation	Oct. 1	632	+ 10	§26	16,356	+ 52
Rothesay	Sept. 25	174	− 60	38	9,097	− 405
Salford Corporation	Oct. 5	5,122	+ 397	27	128,916	− 97
Sheerness	Sept 23	60	− 6	38	2,240	− 76
Sheffield Corporation	Oct. 4	5,825	+ 104	†28	156,339	− 1,231
Singapore Trams	,, 3	$8,797	− $618	...	...	...
South Metropolitan	Sept. 25	890	− 40	38	31,299	+ 60
South Staffs	,, 25	885	− 47	38	33,760	− 701
Southend Corporation	,, 30	473	+ 22	27	13,728	+ 941
Southport Tramways	,, 25	299	− 52	38	11,190	− 860
Stalybridge, Hyde, &c., Jt. Bd.	Oct. 3	818	+ 21	†27	21,166	− 896
Sunderland Corporation	,, 4	1,345	− 12	27	32,962	− 6,380
Sunderland District	Sept. 30	500	+ 42	48	23,107	+ 1,638
Swansea Trams	,, 25	983	− 36	38	36,342	+ 959
Swindon Corporation	,, 30	145	− 39	...	...	...
Taunton	,, 25	45	− 1	38	1,604	− 96
Tynemouth and District	,, 25	225	− 22	38	9,206	− 767
Tyneside Trams Co.	,, 30	423	− 24	13	5,679	− 653
Wallasey District Council	Oct. 3	962	+ 128	§26	25,150	+ 1,077
Walsall Corpn.	,, 3	565	+ 14	40	21,295	+ 1,135
Weston-super-Mare	Sept. 23	162	− 80	38	6,172	− 288
Wolverhampton Co.	,, 25	446	− 39	38	17,168	− 886
Wolverhampton Corpn.	,, 30	873	− 56	17	11,873	+ 41
*Worcester	,, 25	332	+ 7	38	10,994	− 92
Wrexham	,, 25	128	+ 17	38	3,960	− 17
Yorkshire W.R. Trams	Oct 4	1,340	+ 126	40	49,152	...
Yorkshire Woollen District	Sept. 25	900	+ 7	38	35,169	− 1,052

(a) These comparisons are with the corresponding period last year. § Plus 3 days. Plus 2 days. * Partly electrical. † Minus 3 days ‡ Minus 2 days.

ELECTRICAL COMPANIES' SHARE LIST

Shrs.	Last Dividend	Name.	Price Wed., Oct. 7.	Rate % Yielded. £ s. d.	Dividend Due.	Business Week to Oct. 7. Highest.	Lowest.
		ELECTRICITY SUPPLY.					
10	6 0	Bournemouth & Poole Elec. Sup. Ord.	10 —10½	6 13 6	Mar, Sept,	10,	..
10	4/6	Do. 4½ per Cent. Cum. Pref.	9½—10	4 10 0	Feb, Aug	9½	.
10	6 0	Do. 6 per Cent. Cum. Second Pref.	10⅝—10⅞	5 6 6	Feb, Aug	10½	10⅝
St.	4½	Do. 4½ per Cent. Deb. Stock (red.)	101 —105	4 5 6	Jan, July	..	..
5	2 0	†Bromley (Kent) El. Lt. & Power Shares	4⅜—4⅞	5 12 8	April, Oct	..	..
St.	4½	Do. Do. 1st Debs.	96 —100	4 10 0	May, Nov	..	..
5	4 6	Brompton & Kensington Elec. Sup. Ord.	7 —8	6 5 0	March....	..	..
5	3 6	Do. 7 per Cent. Pref.	7 —8	4 7 6	Mar, Sept	..	..
St.	4%	Central Elec. Sup. Co. 4% Guar. Db. Stock	99 —102	3 18 0	June, Dec	100	..
5	2 6	Charing Cross (W. End & City) El. Sup. Co.	3½—4	6 5 0	Feb, Aug	3¾	..
5	2 3	Do. 4½ per Cent. Pref.	4 —4½	5 0 0	Feb, Aug	.	..
St.	4%	Do. 4 per Cent. Deb. Stock (red.)	98 —99	4 1 0	Jan, July	..	..
5	2 3	Do. City Undertaking 4½% Cm. Pref.	3½—4	5 12 0	Jan, July	..	..
5	2/0	Chelsea Electric Supply Ord.	2¾—3¼	6 18 0	March ..	..	..
St.	4½%	* Do. 4½ per Cent. Deb. Stock (red.)	100 —103	4 7 6	June, Dec	100½	..
10	5 0	City of London Electric Lighting Ord.	9½—10½	5 17 0	Feb, Aug	9⅝	..
10	6/0	Do. 6 per Cent. Cum. Pref.	12 —13	4 12 0	Jan, July		—
St.	5%	Do. 5 per Cent. Deb. Stock (red.)	122 —125	4 0 0	June, Dec	..	..
St.	4½%	Do. 4½ per Cent. 2nd Deb. Stock (red.)	101 —104	4 6 6	Jan, July	..	—
5	2%	County of Durham Elec. P.D. Ord.	2¾—3	8 9 7	April, Oct	..	..
5	5%	Do. 5 per Cent. non Cum. Pref.	3½—4	6 5 0	April, Oct	..	..
10	4.0	County of London Elec. Supply Ord.	7½—8½	6 1 3	Feb, Aug	..	..
10	6 0	Do. 6 per Cent. Cum. Pref.	10⅜—10⅞	5 9 6	Mar, Sept	10⅝	10[illegible]
St.	4½%	Do. 4½% Deb. Stock (red.)	107 —110	4 2 0	Jan, July	..	..
St.	4½%	Do. Second Deb. Stock	99 —102	4 8 0	May, Nov	..	..
5	3/6	†Folkestone Electricity Supply Co. Ord.	4½—5½	5 7 0	April, Oct	..	..
5	2 6	† Do. 5 per Cent. Cum. Pref.	5 —5½	4 11 0	Mar, Sept	—	—
St.	4½%	Do. 4½ 1st Deb. Stock (red)	97 —100	4 10 0	Feb, Aug	..	..
5	4 6	Hove Electric Lighting Ord.	6 —6½	6 11 0	April, Oct	—	..
5	4/0	Kensington & Knightsbridge Ord.	7¾—8¾	5 14 0	Feb, Aug	..	—
5	6%	Do. 6 per Cent. 1st Pref.	6 —6½	4 12 0	Jan, July	..	—
St.	4%	Do. 4 per Cent. Deb. Stock (red.)	94 —97	4 2 6	..	..	..
St.	4%	†Kensingtn. & Kngtbg. Co. & Notting Hill Co. (Joint Station) 4% Deb. Stock (red.)	96 —100	4 0 0	April, Oct	—	..
St.	4½%	Kent Elec. Power Co.	86 —90	5 0 0	Jan, July	..	—
3	1 6	London Electric Supply Ord.	⅞—1⅛	5 8 0	Mar, Sept	..	..
5	3.0	Do. 6 per Cent. Pref.	4⅜—4⅝	6 9 6	Mar, Sept	4[illegible]	..
St.	4%	Do. 4 per Cent. 1st Mort. Deb.	89 —92	4 7 0	Jan, July	90¾	9[illegible]
5	2 6	Metropolitan Electric Sup. Ord.	4¼—4¾	6 16 6	April, Oct	4⅝	—
5	2 3	Do. 4½ per Cent. Cum. Pref.	4½—5	4 10 0	Jan, July	..	..
St.	4½%	Do. 4½ per Cent. Deb. Stock 1st Mort.	105 —109	4 1 6	June, Dec	106½	105½
St.	3½%	Do. 3½ per Cent. Mrt. Deb. Stock (red.)	84 —89	3 19 0	Jan, July	..	..
100	4½%	Midland Elec. Corp. for P.D. 1st Mort. Db.	94 —97	4 12 6	June, Dec	96½	96
10	4%	Newcastle & Dist. Elec. Ltg. Ord.	6¼—6¾	6 3 1	Feb, Aug	—	—
100	4½%	Do. 4½ per Cent. Deb.	94 —96	4 14 9	Jan, July	..	..
5	8%	Newcastle Elec. Supply Ord.	5⅜—5½	7 7 6	Feb, Aug	..	..
5	5%	Do. 5 per Cent. non Cum. Pref.	5⅝—6[illegible]	4 10 10	Feb, Aug	—	..
100	4%	Do. 4 per Cent. Mort. Deb. red. 1907.	95 —97	4 3 4	Jan, July	..	—
1	3%	Northern Counties Elec. Sup.	—	..	Mar, Aug	—	..
100	4½%	Do. 4½ per Cent. Deb.	93 —95	4 15 9	Jan, July	..	..
10	6/0	Notting Hill Electric Ord.	11¾—12¼	5 10 6	March ..	11⅞	11[illegible]
5	2 6	Oxford Electric Ord.	5⅝—6⅛	5 14 0	March ..	..	..
St.	4%	Do. 4 per Cent. Deb. Stock	95 —98	4 2 0	Jan, July	..	..
5	5 0	St. James' & Pall Mall Elec. Ord.	7¼—8¼	6 1 8	Feb, Aug	8	7½
5	3 6	Do. 7 per Cent. Pref.	6½—7½	4 16 6	Feb, Aug	6⅝	—
St.	3½%	Do. 3½ per Cent. Deb. Stock (red.)	86 —90	3 18 0	Jan, July	87	..
5	..	Smithfield Markets Electric Sup. Ord.	¼—¾	..	Feb	..	..
St.	4%	Do. 4 per Cent. Deb. Stock	68 —72	5 11 0	Feb, Aug	..	..
5	4/0	South London Electric Supply Ord.	2¼—2¾	7 5 6	April....	..	..
1	0/6	South Metrop'n Elec. Lt. & Power Ord.	⅝—⅞	4 0 0	..	..	—
1	0 8⅖	Do. 7 per Cent. Cum. Pref.	1[illegible]—1⅛	6 4 0	Feb, Aug	1	1[illegible]
St.	4½%	† Do. 4½ 1st Db. Stk. Red.	98—101	4 9 0	April, Oct	..	—
5	2/6	†Urban Electric Supply Ord.	½—1	—	April, Oct	—	..
5	2/6	† Do. 5 per Cent. Cum. Pref.	1⅝—2⅛	10 12 0	April, Oct	2[illegible]	2
St.	4½%	† Do. 4½ per Cent. 1st Mort. Deb.	80 —83	5 8 3	April, Oct	..	..
5	5/0	Westminster Elec. Sup. Ord.	8 — 9	5 11 0	Mar, Sept	8[illegible]	.
5	2/3	Do. 4½ per Cent. Cum. Pref.	5 —5½	4 2 0	Jan, July	..	—
		ELECTRIC RAILWAYS & TRAMWAYS.					
St.	4%	Baker St. & Waterloo 4% Perp. Db. St.	91 —96	4 3 3	Jan, July	95	94½
1	..	Bath Elec. Trams Pref. Ord.	⅛—⅜	10 13 0	April....	—	—
1	0/6	Do. 5 per Cent. Cum. Pref.	½—¾	6 13 4	Jan, July	..	—
St.	4½%	† Do. 4½ 1st Mort. Deb. Stock (red.)	83 —88	5 2 0	April, Oct	..	..
St.	4½%	B'ham & Midland Trams 4½ 1st Db. Stk.	93 —96	4 13 9	Jan, July	95½	95
10	9%	Bristol Tramways & Carriage Ord.	10½—11	8 3 6	Feb, Aug	..	..
10	4%	Do. Cum. Pref. (fully paid)	8¾—9	4 9 0	..	..	..
St.	4%	Do. 4 per Cent. Debs.	96 —98	4 2 0	Feb, Aug	..	—
10	..	British Electric Traction Ord.	⅞—1⅛	..	June, Dec	..	..
10	8/0	Do. 6 per Cent. Cum. Pref.	3⅞—4⅛	..	Feb, Aug	..	..
St.	5%	† Do. 5 per Cent. Perpetual Debs.	93 —95	5 4 6	April, Oct	94½	93
St.	4½%	Do. 4½ per Cent. 2nd Deb. Stock	76 —78	5 15 0	May, Nov	76½	..
St.	3%	Central London Ordinary Stock	71 —74	4 2 0	Feb, Aug	73½	71
St.	4%	Do. 4 per Cent. Pref. Stock	86 —88	4 11 0	Feb, Aug	..	..
St.	2%	Do. Deferred Stock	51 —54	3 14 0	Feb	52	..
100	4%	Do. 4 per Cent. Debs.	101 —104	3 17 0	Jan, July	102	101
St.	4%	Charing X, Euston & Hmpstd Per. Db. Stk.	85 —87	4 12 0	Jan, July	87	8[illegible]½
5	2/6	City of Birmingham Trams. 5% Cm. Pref.	4¼—4¾	5 5 0	April, Oct	..	..
100	4%	Do. 4 per Cent. 1st Mort. Debs.	98 —102	3 18 6	April, Oct	1[illegible]1	..
St.	1½%	City & South London Rly. Con. Ord.	33½—34½	4 19 6	Feb, Aug	34	..
St.	5%	Do. 5 per Cent. Perp. Pref. (1891)	111 —114	4 7 6	Feb, Aug	..	..
St.	5%	Do. (1896)	109 —112	4 9 3	Feb, Aug	—	..
St.	5%	Do. (1901)	107 —110	4 11 0	Feb, Aug	..	..
St.	5%	Do. (1903)	102 —105	4 15 3	Feb, Aug	..	..
St.	4%	Do. 4 per Cent. Perpetual Debs.	100 —103	3 17 6	May, Nov	102	..
10	6/0	Dublin United Trams. Ord	11½—12½	5 4 0	Feb, Aug	..	..
10	6/0	Do. 6 per Cent. Pref.	12¼—13½	4 10 6	Feb, Aug	..	..
10	..	Gt. Northern & City Rly. Pref. Ord. (4%)	½—1	..	Feb, Aug	..	..
10	0/9	G. Northern, Piccadilly & Brompton Ord.	7¾—8½	—	Feb, Aug	8¼	..
St.	4%	Do. 4 per Cent. Deb. Stock	92 —94	4 5 0	Jan, July	93	92½
5	4/0	Hastings & Dist. Elec. Trams. 6% Cm. Pf.	3 —4	..	Mar, Sept	..	..
St.	4½%	† Do. 4½ Db. St.	90 —94	4 16 9	April, Oct	..	..
10	9%	‡Imperial Tramways Ord.	9½—10½	8 11 8	Mar, Sept	..	..
10	6%	‡Do. 6 per Cent. Pref.	9½—10	6 0 0	Mar, Sept	..	..
St.	4½%	‡Do. 4½ per Cent. Debs.	90 —92	4 18 0	Jan, July	..	..
5	..	I. of Thanet E. T. & Lt. 5 per Cent. Pref.	⅞—1⅜	..	Mar, Sept	..	—
St.	4%	Do. 4 per Cent. Deb. Stock	55 —61	6 11 0	Jan, July	..	—
10	6/0	Lanarkshire Tramways	9⅝—9⅞	6 3 0	Feb, Aug	..	..
St.	5%	Lancs. Utd. Trams 5% Prior Lien Db. St.	92 —94	5 6 6	Jan, July	..	..
10	..	Liverpool Overhead Railway Ord.	1¼—1¾	..	Feb, Aug	..	—
10	5%	Do. 5 per Cent. Pref.	5—5½	9 2 0	Feb, Aug	..	..
St.	4%	Do. 4 per Cent. Deb.	84 —86	4 13 0	Jan, July	..	..
10	5/0	London United Trams. 5% Cum. Pref.	4½—5½	9 2 0	Jan, July	5⅛	..
St.	4%	Do. 4 per Cent. 1st Mort. Deb. Stock	75 —78	5 2 3	Jan, July	..	..
St.	..	Mersey Con. Ord. Stock	1 —3	—	Feb, Aug.	..	—
St.	..	Do. 3 per Cent. Perp. Pref.	3 —6	—	..	..	..
1	..	Metropolitan Elec. Tramways Ord.	⅝—⅞	—	..	..	..
1	..	Do. Def.	[illegible]	..	April.. .	..	..
1	0/6	Do. 5 per Cent. Cum. Pref.	1⅛—1[illegible]	6 3 6	Feb, Aug	[illegible]	..
St.	4½%	Do. 4½ per Cent. Deb. Stock	92 —95	4 14 9	Jan, July	93½	..
St.	½%	Metropolitan Railway Consolidated	39½—40½	1 1 9	Feb, Aug	41⅛	39½
St.	2½%	Do. Surplus Lands Stocks	65 —70	3 18 6	Feb, Aug	69½	67⅞
St.	3½%	Do. 3½ per Cent. Preference	84 —87	4 0 6	Feb, Aug	85½	..
St.	3½%	Do. 3½ per Cent. "A" Preference	76 —78	4 10 0	Feb, Aug	..	..
St.	3½%	Do. 3½ per Cent. Convertible Pref.	75 —78	4 9 9	Feb, Aug	77½	77
St.	3½%	Do. 3½ per Cent. Debenture Stock	91 —93	3 15 3	Jan, July	..	..
St.	3½%	Do. 3½ per Cent. "A" Ditto	88 —91	3 17 0	Jan, July	89½	..

* In calculating the yield allowance has been made for accrued interest but not for redemption.
† Ex Dividend. ‡ The London Stock Exchange Committee have declined to quote these.

ELECTRICAL COMPANIES' SHARE LIST.—*Continued.*

Share.	Last Dividend	Name.	Price Wed., Oct. 7.	Rate % Yielded (£ s. d.)	Dividend Due.	Business Week to Oct. 7. Highest	Lowest
		ELECTRIC RAILWAYS & TRAMWAYS—*Continued.*					
St.	..	Metropolitan District Railway Ord.	13 —14	--	Feb, Aug	15⅞	13½
St.	..	Do. Extension Pref. (5 per Cent.)	24 —29	..	Feb, Aug	27	..
St.	3½%	Do. Assented Ext. Pref. (Int. Guar. by Und. Elec. Rlys. Co. of London, Ltd.)	50 —55	6 7 0	Feb, Aug	..	..
St.	3%	Do. 3 per Cent. Consoltd. Rent-charge	75 —78	3 17 0	Jan, July	76	..
St.	4%	Do. 4 per Cent. Midland Rent-charge	99 —103	3 17 6	Jan, July	102½	100½
St.	[illegible]	Do. Guar. Stock 4 per Cent.	58 —63	3 3 6	Mar, Sept	62	60
St.	6%	Do. 6 per Cent. Perp. Deb. Stock	125 —128	4 13 9	Jan, July	127	125½
St.	4%	Do. 4 per Cent. Ditto	84 —86	4 13 0	Jan, July	83	—
5	..	New Gen. Tract. 6 per Cent. Cum. Pref.	½—¾	--	May	..	—
1	0/9¾	Potteries Electric Traction Ord.	[illegible]	8 0 0	April, Oct	..	—
1	0/6	Do. 5 per Cent. Cum. Pref.	½—¾	6 0 0	Feb, Aug	..	..
St.	4½%	Do. 4½ per Cent. Deb. Stock	92 —95	4 14 9	May, Nov	..	..
1	0 7½	S. Met. Elec. Trams. & Ltg. 6% Cm. Pref.	¾—1	6 0 0	Feb, Aug	..	..
St.	4%	Do. 4 per Cent. Deb. Stock	76 —80	5 0 0	Jan, July	--	..
100	5%	Sunderland Dist. Elec. Trms. 5% 1st Mt. Db.	78 —82	6 2 0	Jan, July	..	..
..	£1/0	Underground Elec. Rys. Co. of London...	43 —47	..	June, Dec	..	..
5	..	Yorkshire (W.R.) Elec. Trams. Ord.	⅞—1⅛	—	March ..	..	..
5	..	Do. 6 per Cent. Cum. Pref.	3 —3½	—	..	..	..
St.	4½	Do. 4½ per Cent. 1st Debs.	84 —87	5 3 0	Jan, July	..	..
		ELECTRIC MANUFACTURING, &c.					
1	..	Aron Electricity Meter Ord.	7/16—11/32	..	..	..	..
1	1 4½	Do. 6% Cum. Pf. (ex on a/c arrears)...	11/16—13/16	7 12 0	April, Oct	..	..
1	1/7½	†Babcock & Wilcox Ord.	3¾—4	5 0 0	April, Oct	3⅞	3 13/16
1	0/7½	† Do. Pref.	1½—1⅝	3 13 9	..	..	..
5	4/0	British Insulated & Helsby Cables Ord.	6¼—6¾	7 8 3	July, Feb	6 5/16	—
5	3/0	Do. 6 per Cent. Pref.	6 —6½	4 12 0	Jan, July	..	..
St.	4½%	Do. 4½ per Cent. 1st Mort. Deb. (red.)	103 —106	4 5 0	Jan, July	..	..
St.	4½%	British Thoms'n-Houst'n 4½% 1st Mt. Db.	91 —96	4 14 0	Mar, Sept	..	..
5	..	British Westinghouse 6 per Cent. Pref...	5/16—9/16	--	Feb, Aug	..	..
St.	4%	Do. 4 per Cent. Mort. Deb. Stock	40 —45	8 17 6	Jan, July	..	..
2	..	Brush Electrical Engineering	½	—	March ..	..	..
2	..	Do. 6 per Cent. Pref. non-Cum.	⅛—⅜	..	Mar, Sept	--	..
St.	4½%	Do. 4½ per Cent. Perp. 1st Deb. Stock	68 —73	6 3 0	Mar, Sept	..	—
St.	4½%	Do. Perpetual 2nd Deb. Stock	50 —54	8 6 6	Jan, July	..	..
5	10 0	Callender's Cable Con. Ord.	9¾—10¾	6 17 6	Jan, July	..	—
5	2/6	Do. 5 per Cent. Cum. Pref.	5¼—5¾	4 7 0	Jan, July	..	..
St.	4½%	Do. 4½ per Cent. 1st Mort Debs. (red.)	107½—109½	4 2 [illegible]	Nov, May	..	..
1	1/0	Castner-Kellner Alkali Co.	1 9/16—1 11/16	8 0 0	May, Nov	1 21/32	1 19/32
St.	4½%	Do. 4½ per Cent. 1st Mort. Deb. (red.).	103 —107	4 4 [illegible]	Feb. Aug	..	..
1	0 9¾	Chadburn's (Ship) Telegraph Ord.	15/16—1 1/16	7 10 6	March ..	..	..
1	0 7½	† Do. 6 per Cent. Cum. Pref.	15/16—1 1/16	5 13 0	April, Oct	..	..
1	0/8¾	Consolidated Electrical Co.	⅜—½	7 0 0	August ...	..	..
1	1/0	Consolidated Signal Co.	1 3/16—1⅜	10 18 0	April, Oct	..	..
1	0 7½	Do. 6 per Cent. Cum. Pref.	29/32—31/32	6 4 0	April, Oct	..	..
3	3/0	*Crompton & Co. (Nos. 1 to 86,000)	1 5/16—1 9/16	9 5 0	Jan, July	..	..
100	5%	Do. 5 per Cent. 1st Mort. Debs. (red.).	98 — 101	4 19 0	Jan, July	100	—
1	0 7½	Davis & Timmins	⅞—1⅛	..	Mar, Sept	..	..
5	2/0	†Dick, Kerr & Co. Ord.	1 1/16—1 5/16	7 12 0	Sept	1 3/16	..
5	0/7½	† Do. 6 per Cent. Cum. Pref.	1 —1¼	4 16 0	Sept ..	..	..
St.	4½%	Do. 4½ per Cent. Deb. Stock	101 —104	4 6 6	Jan, July	..	—
5	2 6	Edison & Swan United ("A" Sh.) (£3 pd.)	½—¾	..	Feb, Aug	11/16	..
5	4/2	Do. (£5 paid)	1½—2½	5 0 0	Feb, Aug	..	—
St	4%	Do. 4 per Cent. Mort. Deb. Stock (rd.)	76 - 79	5 1 6	June, Dec	..	..
St.	5%	† Do. 5 per Cent. 2nd Deb. Stock	84 —87	5 15 6	Mar, Sept	--	..
5	..	Edmundson's Elec. Corp. Ord.	⅛—⅜	..	Jan, July	—	..
5	..	Do. 6 per Cent. Cum. Pref.	½—1	..	May, Nov	..	..
St.	4½%	Do. 4½ per cent. 1st Mort. Deb. (red.)	59 —66	6 16 0	Jan, July	..	..
1	..	Electric Construction Co.	7/16—11/16	..	Jan, July	--	..
1	2/9¾	Do. 7 per Cent. Cum. Pref.	1¼—1¾	8 2 6	July	--	..
St.	4	Do. 4 per Cent. Perp. 1st Mort. Debs.	65 —70	5 14 0	Jan, July	..	..
10	5/0	General Electric (1900) 5% Cum. Pref....	7½—8	6 5 0	June, Dec	..	..
St.	4%	† Do. 4 per Cent. 1st Mort. Debs.	84 —88	4 11 0	Mar, Sept	--	—
5	5/0	Henley's Telegraph Works Ord.	10½—11½	6 11 0	Feb, Aug	..	—
5	2/3	Do. 4½ per Cent. Pref.	5 —5½	4 2 0	Feb, Aug	5 [illegible]	..
St	4½%	Do. 4½ per Cent. 1st Mort. Deb. Stock	107 —109	4 2 6	Mar, Sept	..	..
10	5/0	India Rubber, Gutta Percha, &c., Wrks.	16½—17½	5 14 0	Feb, Aug	..	..
100	4%	Do. 4 per Cent. Debs. (red.)	97 —99	4 1 0	April, Oct	97½	—
1	..	National Elec. Construction Co.	⅛—⅜	..	April	..	..
1	0/9¾	Richardsons, Westgarth & Co., Ltd. Ord.	7/16—9/16	7 2 0	Nov	--	..
1	0/7½	Do. 6 per Cent. Cum. Pref.	¾—⅞	6 17 0	May, Nov	—	..
St	4½%	Do. 4½ per Cent. Perp. Deb. Stock ...	85 —88	5 2 0	Jan, July	..	..
1	..	Simplex Conduits Ord.	1½	--	..	—	—
5	..	Do. 6 per Cent. Cum. Pref.	5¼	—	..	..	—
12	12/0	Telegraph Construction & Maintenance	32 —34	6 5 0	Mar, July	—	..
100	4%	Do. 4 per Cent Deb. Bonds (1909) ...	101 —103	3 17 0	Jan, July	..	..
1	1 0	Vickers, Sons & Maxim, Ltd., Ord.	1¾—1⅞	8 4 0	..	1 [illegible]	1¾
1	0/6	Do. 5 per Cent. non-Cum. Preference	1 — 1⅛	4 9 0	..	1 [illegible]	1 1/16
St.	5%	Do. 5 per Cent. non-Cum. Preferred	101 —104	4 16 0	..	102¾	..
St.	4%	Do. 4 per Cent. 1st Mort. Db. Sk. (red.)	104 —106	3 15 0	June, Dec	104¼	..
100	4½%	Do. 4½ per Cent. 2nd Mort. Deb. (red.)	104 —106	4 5 0	June, Dec	105½	104½
100	15 6	Do. 5 per Cent. 3rd Mort. Debs. Scrip.	104 —106	4 14 0	..	105	104
1	16/0	J. G. White & Co. 6% Cm. Pref.	8½—9½	8 17 9	..	..	..
5	10	Willans & Robinson Ord.	¾—1¼	4 0 0	Apr, Oct	..	..
5	3/0	Do. 6 per Cent. Cum. Pref.	2¾—3¼	9 4 0	Apr, Oct	3	2¾
100	4%	Do. 4 per Cent. 1st Mort. Debs.	72 —76	5 5 6	May, Nov	..	..
		TELEGRAPHS.					
10	..	Amazon Telegraph	2 —3	—	June, Dec	..	—
100	5%	Do. 5 per Cent. Debs. (red.)	90 —93	5 7 6	June, Dec	..	..
St.	16/0	Anglo-American	58 —61	5 16 0	F,My,Ag,N	..	..
St.	30/0	Do. Preferred	103½—104½	5 16 6	F,My,Ag,N	104⅛	103½
St.	1%	Do. Deferred	17 —17½	5 17 0	F,My,Ag,N	17 [illegible]	17⅛
St.	4%	†Commercial Cable 4 per Cent. Deb. Stk.	88 —90	4 9 0	Jn,Ap,Jy,O	90½	88½
10	6 0	Cuba Submarine Ord.	7½—8½	7 0 0	Feb, Aug	--	..
10	10/0	Do. Preference 10 per Cent.	16 —17	5 17 9	Feb, Aug	..	..
5	2/0	†Direct Spanish Ord.	3 —3½	6 4 0	April, Oct	..	..
5	5/0	† Do. 10 per Cent. Cum. Pref.	8 —9	5 11 0	April, Oct	..	..
50	4½%	Do. 4½ per Cent. Deb.	100 —103%	4 7 6	Jan, July	..	..
20	6 0	Direct United States Cable	13½—13¾	6 2 6	Ja,Ap,Jy,O	13⅝	13 [illegible]
10	4½%	Direct West India Cable 4½% Rg. Db. (rd.)	100 —102	4 8 0	June, Dec	..	..
St.	[illegible]	Eastern Ordinary	136 —139	5 0 9	Ja,Ap,Jy,O	138½	136¼
St.	17 6	Do. 3½ per Cent. Pref. Stock	85 —87	4 0 6	Ja,Ap,Jy,O	86½	85⅞
St.	4%	Do. 4 per Cent. Mort. Deb. Stk. (red.)	103 —105	3 16 0	May, Nov	104⅛	10[illegible]
10	2/6	Eastern Extension	12¾—13¼	5 5 6	Ja,Ap,Jy,O	13	12 [illegible]
St.	4%	Do. 4 per Cent. Deb. Stock	101 —103	3 17 9	Feb, Aug	102½	101½
100	4%	Eastern & S. African 4% Mort. Deb. 1909	99½—101½	3 18 6	Feb, Aug	..	..
	4%	Do. 4% Mauritius Sub. Debs. red.	101½—103½	3 16 6	May, Nov	..	..
10	5/0	G. N. of Copenhagen, with Coupon 74	30 —32	6 5 0	Jan, July	..	..
100	4½	Halifax & Bermuda 4½% 1st Mt. Db. (red.)	100 — 102	4 8 0	June, Dec	..	..
[illegible]	[illegible]	Indo-European	[illegible]	5 12 0	May, Nov	..	..
100	$1	Mackay Companies Common	68 —72	5 11 0	Ja,Ap,Jy,O	.	..
100	$1	Do. Preference	68 —72	5 11 0	Ja,Ap,Jy,O	..	..
1		Marconi's Wireless Teleg. Co.	[illegible]	..	April	[illegible]	..
100	4	Pacific & European Tel. 4% Guar. Dbs. (red.)	99 —102	3 18 0	June, Dec	..	—
5	1 3	West Coast of America	1½ —1¾	4 [illegible] 0	May	..	—
100	4%	Do. 4 per Cent. Debs.	99 —102	3 18 0	Jan, July	..	..
1		West India & Panama	[illegible]—2	..	May, Nov	[illegible]	..
10	6 0	Do. 6 per Cent. 1st Pref.	8 —8½	7 1 0	May, Nov	8[illegible]	..
10	[illegible]	Do. 6 per Cent. 2nd Pref.	8¼—9¼	—	May, Nov	..	..
100	5	Do. 5 per Cent. Debs.	101 —103	4 17 0	Jan, July	..	..
10	[illegible]	Western Telegraph	13⅞—14⅛	4 18 6	Mr,Jn,O,D	14	13⅞
St.	4%	Do. 4 per Cent. Deb. Stock (red.)	101½—103½	3 16 6	June, Dec	..	..
..	4%	Western Union Telegh. $1,000 4% Bonds	85 —90	4 9 0	..	..	..

Share.	Last Dividend	Name.	Price Wed., Oct. 7.	Rate % Yielded (£ s. d.)	Dividend Due.	Business Week to Oct. 7. Highest	Lowest
		TELEPHONES.					
100	$8	†Amer. Telephn. & Telegh. Cap. St.	130 —131	5 18 9	..	130¼	130½
..	4%	Do. Coll. Trust $1,000 4 per Cent. Bds	92 —94	4 5 0	Jan, July	95½	..
St.	5%	Anglo-Portug'se Tel. 5% 1st Mt. Db. Stk.	99 —102	4 18 0	Mar, Sept	..	—
5	5 0	Chili Telephone	8 —8½	4 14 0	August ..	..	..
1	0/7½	Monte Video Telephone Ord.	1 —1⅛	6 4 0	Nov	1 1/16	..
1	0/6	Do. 5 per Cent. Pref.	⅞—1	[illegible] 0 0	May, Nov	..	..
St.	6%	National Co. Pref. Stock	109 —111	[illegible] 8 0	Feb, Aug	110	109¾
St.	6%	Do. Def. Stock	118 —120	5 [illegible] 0	Feb, Aug	118⅞	118
10	6/0	Do. 6 per Cent. Cum. 1st Pref.	10½—11½	5 [illegible] 6	Feb, Aug	10⅞	..
10	6/0	Do. 6 per Cent. Cum. 2nd Pref.	10¼—11¼	5 6 6	Feb, Aug	..	..
5	2/6	Do. 5 per Cent. non-Cum. 3rd Pref. ...	5½—6¼	4 7 0	Feb, Aug	6 [illegible]	..
St.	3½%	* Do. Deb. Stock 3½ per Cent. (red.) ...	98½—100½	3 9 6	June, Dec	..	..
St.	4%	Do. 4 per Cent. Deb. Stock (red.)	102 —104	3 17 0	Jan, July	103	102½
1	1/0	Oriental	1¾—1⅞	5 16 3	April, Oct	1 [illegible]	..
1	0 7½	Do. 6 per Cent. Cum. Pref.	1 [illegible]—1 [illegible]	4 11 6	April, Oct	1 [illegible]	..
St.	4%	Do. 4 per Cent. Red. Deb. Stock	89 —92	4 7 0	Jan, July	—	—
St.	4½%	Telephone Co. of Egypt 4½% Db. Stk. (red.)	99 —102	4 12 0	Jan, July	..	..
5	5/0	United River Plate	6¾—7¼	5 10 0	July	7⅛	6 [illegible]
5	2/6	Do. 5 per Cent. Cum. Pref.	5 —5½	4 11 0	June, Dec	5 [illegible]	5 [illegible]
St.	4½%	Do. 4½ Deb. St. Red.	101½—103½	4 4 6	Jan, July	..	..
		FINANCIAL, INVESTMENT, &c.					
5	8/0	Elec. & Gen. Investment 6% Cum. Pref.	3½—4	7 10 0	Jan, July	..	..
10	2 0	†Globe Telegraph & Trust	10[illegible]—11½	5 8 0	Sp Dc Mr Ju	10 [illegible]	10¾
10	3/0	† Do. 6 per Cent. Pref.	13⅝—14⅛	4 5 0	Sp Dc Mr Ju	14	13¾
10	6%	Submarine Cables Trust (Cert.)	130 —133	4 10 3	April, Oct	..	..
		COLONIAL AND FOREIGN ELECTRIC RAILWAYS, TRAMWAYS, &c.					
5	3/0	Anglo-Argentine 6% Cum. 1st Pref.	6¼—6½	4 12 6	April, Oct	6⅜	..
5	5/0	† Do. 10% Non-cum. 2nd Pref.	8⅛—8⅜	5 16 0	Jan, July	8 [illegible]	8 [illegible]
St.	6%	Do. Permanent 6% Deb. Stock	143 —148	4 1 0	June, Dec	..	—
St.	5%	Auckland Elec. Trams. 5% Deb. (red.)...	103 —106	4 14 3	Jan, July	..	..
5	4/0	Brisbane Electric Trams. Invest. Ord....	4 [illegible]—4 [illegible]	4 1 0	May	4 [illegible]	..
5	2/6	Do. 5 per Cent. Cum. Pref.	4 [illegible]—5 [illegible]	4 16 0	May, Nov	5⅛	..
St.	4½%	Do. 4½ per Cent. Db. Prov. Certs.	100 —104	4 6 6	Jan, July	..	..
St.	8%	British Columbia El. Ry. Df. Ord.	136 —140	5 14 0	Mar, Sept	..	..
St.	30 0	Do. Pref. Ord. Stock	117 —121	4 19 0	May, Nov	..	..
St.	5%	Do. 5% Cum. Perp. Pref. Stock	105 —109	4 11 6	Jan, July	..	..
40	4½%	Do. 4½ per Cent. 1st Mort. Debs.	103 —105	4 5 9	April, Oct	..	..
100	4½%	Do. Vancouver Power Debs.	101—104	4 6 6	Jan, July	..	—
St.	4½%	† Do. 4½% Perp. Con. Deb. St.	101 - 105	4 0 6	—	..	..
St.	5%	Buenos Ayres Elec. Trams (1901) Ltd. Deb. St.	97 —102	4 18 6	Ja, Jul ..	..	..
5	..	Buenos Ayres Grand National Ord.	2⅜—2⅞	..	..	2 [illegible]	..
5	2/6	Do. 5 per Cent. Cum. Pref.	4 —4½	5 11 0	Feb, Aug	—	..
100	5½%	Do. 5½ per Cent. Pref. Debs.	100 —105	5 4 6	Jan, July	..	..
100	6%	Do. 6 per Cent. 1st Deb. Bonds.	101 —104	5 15 6	April, Oct	..	..
St.	5%	Buenos Ayres Lacroze Trams 1st Mt. Db.	95½—97½	5 2 6	Mar, Sept	97	9[illegible]
St.	6%	Buenos Ayres Port & City Tram. 1st Mt. Deb. Stock £75 Paid	61 —65	6 12 0	Feb, Aug	..	..
5	2/6	Calcutta Tramways (1 to 137,610)	5¼—5¾	5 4 6	Mar, Sept	5 [illegible]	5 [illegible]
100	2/6	Do. 5 per Cent. Cum. Pref.	4⅞—5¼	4 13 0	Jan, July	..	..
1	4½%	Do. 4½% 1st Deb. Stock (red.)	103 —106	4 5 0	Jan, July	.	..
St.	..	Cape Electric Tram Shares	⅛ - ⅜	..	..	..	—
5	1/3	City of Buenos Ayres Trams Co. (1904) Sh.	5⅜ —5⅞	4 5 3	F,My,A,N	5⅝	5 [illegible]
St.	4%	Do. 4 per Cent. Deb. Stock	99 —103	3 17 [illegible]	June, Dec	..	..
..	5%	Colombo Tr. & Ltg. 5% 1st Mt. Db.	90 —93	5 6 6	May, Nov	..	—
100	5%	Electric Traction Co. of Hong Kong 5 per Cent. 1st Mort. Debs.	85 —90	5 10 0	June, Dec	..	..
1	5%	Havana Elec. Ry. Con. Mt. 5% $1,000 50 year Coup. Bds.	85 —90	5 11 0	Feb, Aug	89	87
1	..	Kalgoorlie Elec. Trams Sh.	[illegible]	..	..	..	..
100	5%	Do. 5 per Cent. "A" Deb. Stock	86 —89	5 12 0	Jan, July	..	—
5	6%	Do. 6 per Cent. "B" Ditto	64 —69	8 14 0	Jan, July	—	..
5	1/0	Lisbon Elec. Trams. Ord.	1 —1¼	4 0 0	July	..	..
100	0/7½	Do. 6 per Cent. Cum. Pref.	1 —1¼	4 16 0	Jan, July	..	..
St.	5%	Do. 5 per Cent. Reg. Mort. Debs	92 —97	5 3 0	Jan, July	..	..
St.	5%	Madras Elec. Trams. 5% Deb. Stk.	93 —96	5 4 0	Jan, July	..	..
..	5%	Manila Elec. Ry. $1,000 Gold Bonds	84 —88	5 14 0	Feb, Aug	.	..
100	4½	Mexico Trams Co. Com. St.	131 —133	3 0 0	..	135	131
500	5%	Do. Gen. Con. 1st Mort. 5% Gold Bds....	92 —93%	5 7 6	..	92⅞	92
St.	4½%	Montreal St. Ry. Sterling 4½ per Cent. Debs. (1922) (Nos. 601 to 2,000)	103 —105	4 5 9	Feb, Aug	..	..
1	1/0	Perth Elec. Trams Ord	⅝—¾	6 13 6	May	..	..
St.	5%	Do. 1st Mt. Db. Stock	101 —104	4 16 0	Jan, July	..	—
5	3/0	Rangoon Elec. Trams & Supply Co. 6% Cum. Pf.	5⅛—5⅝	5 6 6	..	..	—
St.	4½	Do. 4½% 1st Mort. Deb. Stk.	95 —100	4 10 0	..	..	..
..	[illegible]	†Sao Paulo Tramway, Light & Power Co. $100 Stock	151 —155	5 16 0	..	155	152
..	5%	Do. 5 per Cent. 1st Mt. $500 Db.	99 - 100	5 0 0	June, Dec	99½	99[illegible]
100	4½%	Toronto Ry. Co. 1st Mt. 4½% Ster. Bonds	97 —99	5 1 0	Feb, Aug	9[illegible]	9[illegible]
		COLONIAL AND FOREIGN ELECTRICITY SUPPLY &c.					
5	8 0	Adelaide Elec. S'ply Co. 6% Cu. Pr.	5 - 5½	5 9 0	Mar, Sept	..	..
10	6/0	Bombay E. S. & T. 6% Cm. Pf.	9¾—10¼	5 16 3	..	..	..
St.	4½%	Do. 4½ per Cent. Deb. Stk. (red.)	94 —96	4 13 9	Jan, July	94½	94
5	4/9	Calcutta Elec. Supply Ord.	6 —7	5 14 0	April, Oct	6¼	.
100	$1¾	‡Canadian Gen. Elec. Co. Com. St.	102 - 106	6 14 6	..	..	..
100	5%	Castner Electrolytic Alkali Co. (of U.S.A.) 1st Mort. Stl. Debs.	92 97	5 2 6	Jan, July	.	
500	5%	Elect. Development Co. of Ontario	[illegible]	5 15 9	..	[illegible]	[illegible]
5	..	Elec. Ltg. & Trac. Co. of Aust. 6 per Cent. Cum. Pref.	2 —2½	..	Feb, Aug	..	..
St.	5%	Do. 5 per Cent. Deb. Stock	83 —86	5 13 9	Jan, July	..	..
St.	5%	Elec. Supply Co. of Victoria 5 per Cent. 1st Mort. Deb. St.	90 — 93	5 7 6	Jan, July	..	..
St.	6%	Indian Elec. Sup. & Trac. Co. Constn. Deb. St. Rd.	30 — 40	15 0 0	Jan, July	—	..
10s	0/3	Kalgoorlie Elec. Power & Ltg. Ord.	¼—½	..	..	—	.
1	0/7½	Do. 6 per Cent. Cum. Pref.	[illegible]	7 12 0	April, Oct	.	..
St.	5%	Madras E. S. Corp. 5 per Cent. Constn Deb. St.	83 —88	5 13 9	April, Oct	..	..
500	5%	Mexican Elec. Light Co. 5% 1st Mort. Gold Bonds	89—90%	5 11 0	..	90½	89½
St.	$1	Mexican Lt. & Power Co. Com. St.	76 —77	..	..	[illegible]	[illegible]
500	5%	Do. 5% 1st Mort. Gold Bnds.	[illegible]	5 9 6	..	[illegible]	91
100	6/2	Montreal Lt. Ht. & Power Co. Cap. St....	[illegible]	5 13 0	F,My,A,N	[illegible]	[illegible]
1	1/2	River Plate Electricity Co. Ord.	1⅛ 1¼	4 16 0	April ..	1	1⅛
1	1 2½	Do. 6 per Cent. non-Cum. Pref.	[illegible]	5 13 0	May	.	..
St.	6%	Do. 6 per Cent. Deb. Stock	99 —102	4 18 0	Jan, July	[illegible]	..
5	3/0	†Rosario Elec. Co. 6% Pref. (1-20,000)	5 —5½	5 9 0	April, Oct	.	[illegible]
100	$1	Shawinigan Water & Power Co. Cap. St.	79 —81	4 18 9	—	[illegible]	[illegible]
..	5%	Do. 5 per Cent. Bds.	103 - 105½	4 15 6	Jan, July	104	10[illegible]
..	6%	Victoria Falls Power Co. Pref.	[illegible]	—	Jan, July	..	..

* In calculating the yields allowance has been made for accrued interest but *not* for redemption. † Ex dividend. ‡ The London Stock Exchange Committee have declined to quote them.